# AN INVESTIGATION OF THE RECORDS KEPT BY SUPERVISORS ON CONSTRUCTION SITES

*By*

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My Parents

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*S.O.A. Assadi*

## *Clarification*

Although the masculine is used throughout this thesis, clearly the people operating in the construction industry as contractors, consulting engineers, etc. could certainly be female.

# ABSTRACT

During the execution of a project constructed under the traditional contractual system, separate sets of site records are typically kept by each team of the two main parties on the construction site: the contractor, and the supervisor who looks after the client's interests. While the contractor's prime concern is to construct the project in accordance with the contract documents, one of the site supervisor's main functions is to keep a good record of what actually takes place during the construction process. Identifying the contractor's ability to complete the project on time, confirming that works are carried out correctly, and dealing with contractor's claims, are some instances where site records are likely to be used. It is therefore very important that the record-keeping system adopted by the supervising team provides detailed information in a readily-accessible format to ensure that facts can be established at any time during the construction period, or years later, when disputes may develop.

This research programme studied the nature of existing site records kept by construction supervisors, to identify the types of records kept, the use made of them, and the problems and difficulties encountered in maintaining such records. It concentrated mainly on records of progress of construction works.

The methodology adopted for undertaking this research, apart from reviewing the relevant literature, involved carrying out preliminary studies and conducting a national survey. The preliminary investigation comprised two studies as follows:

- Studying site records kept on a project under construction.
- Studying a set of site records kept on a completed project.

The national survey, using mailed questionnaires, aimed at determining attitudes held and procedures currently adopted in the site record-keeping process in order that the present state of the art might be determined. The data gathered from the survey, in addition to resolving the research aims and objectives, has been used to investigate a number of assertions made regarding particular areas of construction supervisors' site records.

The research findings revealed that the typical set of site records kept by construction supervisors is deficient in a number of respects. Various problems and difficulties relating to the procedures currently adopted by site staff have been identified which will typically affect the quality of these records and hence limit their value. If records are to be more useful, they must be more accessible and this suggests an increasing use of computers. With information held electronically in an organised system, the problems of accessibility should be reduced considerably. In addition to the general conclusions, a number of recommendations to improve site records have been made, including elements of quality procedures for record-keeping, and the potential use of an electronic diary software as a valuable tool for computerising one of the most important sources of site records.

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# Introduction

# *INTRODUCTION*

The construction process comprises three main activities: design, construction, and maintenance. At the design stage, scientific principles, technical information and imagination are used to define a project capable of meeting specified requirements. At the construction stage, efforts are made to execute the works according to what was contractually agreed to achieve the completion of the project. After the project is completed, a remedy for any defects is expected to be carried out during a specified period of time defined usually as the maintenance period.

Three parties are traditionally involved in the construction process. These can be classified as follows :

- The promoter (client): the body for whom the construction is provided, and who may be from the public or private sector and may be an individual or a group.
- The design and technical team (the consulting engineer): the body responsible for providing suitable design schemes to meet the client's requirements and to supervise the construction works.
- The contractor: the body responsible for executing the works according to the client's requirements as detailed in the contract documents.

Once the decision to proceed with a construction project has been made, the client will typically have three principal goals. These are:

- To complete the project within the budget.
- To complete the project on time.
- To ensure completion of the project in conformance with the contract specifications.

For a project to be successful, the construction participants must aim to work toward achieving the client's goals. A number of contractual arrangements are being used to govern the construction process and these range from the traditional approach to alternative systems including, BOOT contracts (build, own, operate, and transfer), and design and build contracts. Under the traditional approach, the general procedure in carrying out construction projects is that the client either appoints the engineer's team from his own organisation, or employs an independent firm of consulting engineers who then conduct the feasibility studies, provide the detailed design, and prepare the contract documents. When it has been decided to proceed with a project, a contractor will be selected after competitive tenders have been invited.

The site supervisor (often known as the resident engineer) represents the engineer's team on the construction site. The prime purpose of the site supervisor is to perform the necessary contract administration functions required to ensure that the client's goals stated previously are fulfilled. In addition to many other duties, he supervises with his site team the contractor's activities to ensure that works are carried out according to the contract documents. Generally, the supervisory staff will consist of: the resident engineer, assistant resident engineer(s), quantity surveyors, inspectors, and technicians. The size of the supervising team should be sufficient to fulfil their functions efficiently. The number of site supervisory staff will obviously vary according to the size and complexity of the project.

One of the main functions of the supervising team on a construction project is to keep a good record of what actually takes place during the construction process. Records are kept on all construction sites in a variety of different ways ranging from written documents to charts and drawings. Under the traditional contractual systems, separate sets of site records are typically kept by the two main parties on the construction site: the contractor, and the supervisor. Site records consist of a range of different types mainly relating to finance, quality, and progress of the construction works. The financial records include all measurements of work quantities as well as agreed rates that allow proper payments to be made to the contractor. The quality related records document the results of tests carried out on the materials used and on the standard of workmanship. Records covering work progress will typically aim to identify the works carried out during the construction phase and include particulars showing what happened, when it happened, and with the use of what resources and with what disruption or delay. These records are maintained throughout the contract period for different purposes, ranging from providing a means of monitoring and controlling the construction process, to performing a fundamental role in resolving construction conflicts and disputes.

An obvious use of site records would be for reference purposes during and after the construction period. There will typically be many occasions where site records would be consulted, for instance, to write a report or reply to a contractor's letter. This would certainly imply the need to have the relevant information readily accessible. Another important use of site records would be for controlling purposes. An example of such a function would be recording the duration of a construction activity; this will help in predicting future progress rates of similar activities. Thus, the overall progress of construction work can be assessed, whether it is on schedule or it needs to be accelerated in order to avoid any potential delays in achieving the targets of the project plans.

The progress of construction works is inevitably affected by changes that occur part-way through the work, which certainly impact on the contractor's payment and may also affect the time in which the work is to be carried out. Disagreements on the actual effects of these changes and other matters will usually result in a claim raised by the contractor in an attempt to obtain adequate compensation. Where the change has caused delay, the contractor may consider that more time should be made available for completion of the work and the overheads for this extended period on site may also be claimed. Assessment of construction claims is also considered to be one of the main roles of the site supervisors, although in some circumstances, specialists may be employed to deal with such matters; these are usually known as claims consultants.

Construction claims are generally considered to be an inevitable feature of major projects that have to be dealt with on the majority of contracts let. In assessing construction claims, the procedure adopted often has two stages. Initially it is essential to check that the basis of the claim is contractually valid and when it is approved, then the details of the claim need to be verified. The information required for the second part of the procedures will typically be in the form of very detailed accounts of work progress, delays, additional resources and materials used: that is, good site records. Undoubtedly, the role of site records in any attempt to justify contract claims of whatever type is paramount. Therefore, in dealing with a construction claim, site records will be searched to determine exactly what took place, and why. Unfortunately, it has been recognised that such searches are difficult, time-consuming and may not produce the required information. Many writers have expressed dissatisfaction with the efficiency of records kept on construction sites, particularly in dealing with construction claims.

The aim of the study presented in this thesis is to investigate the nature of site records kept by construction supervisors. This is to identify what types of records are being kept, the use made of these records, and the problems and difficulties encountered in keeping good site records. It is also hoped to find out how to avoid such difficulties and to maintain such records in a simple, accessible form that will facilitate their use more efficiently. It is then intended to make sensible recommendations that will help to improve these site record-keeping procedures and provide a valuable tool for the various management functions of the construction supervisors.

The study deals mainly with site records kept by the construction supervisors on the traditional type of contracts, but there will still be a need to keep good records, even in other contractual arrangements. The methodology adopted for carrying out this research, in addition to reviewing the literature, included conducting preliminary investigations and undertaking a national survey. As a means of identifying the current practice in keeping site records by construction supervisors, a questionnaire was developed, and a number of site supervisors were surveyed. Considering the relevant experience of claims consultants in dealing with an important aspect of using site records i.e. the assessment of construction claims, it was considered wise to consider their views on the records being kept. Thus, a number of claims consultants were also surveyed. When generating the questions to be included in the questionnaire, it was recognised that it would be necessary to ensure that the most important areas were covered. This was achieved by conducting the two preliminary investigations: studying records kept on a project under construction, and studying a set of records kept on a completed project. Although these were merely two individual examples of construction contracts, they, nonetheless provided an insight into some of the problems of record-keeping on construction sites which experienced engineers have confirmed.

This thesis presents the research work conducted in five chapters. The first chapter covers relevant materials which have been reported in the literature. It begins by providing a general overview of information systems, including qualitative characteristics of information, types and sources of information, and problems encountered with management information systems. Also discussed are some general aspects of the role of information technology and its potential use in the construction industry. The chapter's final part covers the record keeping on construction sites, including the importance of site records, records kept by site supervisors, types and uses of site progress records as well as highlighting problems encountered with site progress records.

The second chapter provides a full account of the preliminary investigations undertaken in the early stages of this research. It describes the two studies involving records kept on a project under construction and records of a completed contract. The two studies are supported with an extensive number of examples in order to provide an insight into the variety and complexity of records kept by construction supervisors. The chapter ends with a summary of the main observations and inferences stemming from the preliminary work.

The third chapter discusses procedures adopted in developing the questionnaire and conducting the national survey. It includes the process of selecting the survey method, defining the subjects to be covered by the questions, pretesting the questionnaire, and selecting the survey sample. It also describes the procedures adopted in preparing and administering the questionnaires, and indicates the rate of responses obtained.

The fourth chapter presents in detail the analysis of the data obtained together with a discussion of the results. It describes the procedures adopted for preparing the research data for the analysis process and the ways in which the results are presented. A summing up of the main points stemming from analysing and discussing the results, is also provided at the end of each main section.

Chapter five details the conclusions drawn and the recommendations made from this research. The first part examines the views raised regarding site record-keeping issues, while specific conclusions drawn from the results of the data analysis and discussion are included in the second part of this chapter. The third part suggests recommendations to improve record-keeping procedures on construction sites. This includes elements of quality procedures for keeping site records and a proposed approach for computerising site diary records. The chapter ends with suggestions for further research.

At the end of the thesis, a number of appendices relating to the different chapters introduced above, are presented together with a list of references used in reporting literature. Finally, a list of the publications resulting from the current research is also presented.

# Chapter 1

## Literature Review

# 1 LITERATURE REVIEW

Having introduced the research presented in this thesis, the related material which has been reported in the literature will now be addressed in this chapter. By reviewing the literature, elements relevant to the research subject can be recognised and then studied. According to Leedy (1989), the literature review can provide the following benefits:

- 'It can reveal similar investigations and it can show how the collateral researchers handled these situations.
- It can suggest a method of dealing with a problematic situation that may also suggest avenues of approach to the solution of similar difficulties that may face the researcher.
- It can reveal other sources of data that the researcher may not have known existed.
- It can introduce the researcher to significant research personalities of whose research efforts and collateral writings he may have had no knowledge.
- It can help the researcher to see his own study in historical and associational perspective and in relation to earlier and more primitive attacks on the same problem.
- It can provide the researcher with new ideas and approaches that may not have occurred to him.
- It can assist the researcher in evaluating his own research efforts by comparing them with related efforts done by others.'

Information systems have been established as an essential prerequisite to the successful attainment of the objectives of any organisation. The construction industry, which involves many organisations with different attitudes and objectives, is characterised by the number of parties involved in a project. As has already been seen, the parties engaged in this endeavour are the client and the members of the designing, supervising, and constructing teams. Construction participants are concerned with executing a project to an acceptable quality, within a specified time period whilst also making a profit. Construction operations involve the creation of individual projects which exhibit a low degree of repetition and usually with a unique set of parties involved in each project. All these parties will typically require information to perform the multitude of tasks associated with the various construction operations from inception to completion. Information, is thus fundamental to the successful execution of a construction project, but there has always been a view that the construction industry faces difficulties when it comes to using, co-ordinating and sharing the information produced by its many participants. This may be for many reasons including the general lack of good quality information. This chapter gives an overview of information systems in general and the role of computer and automatic information identification technologies in providing those systems. The Final part covers record keeping on construction sites, including a review of the problems that inhibit the provision of a good, accurate record of the site work and of how these records sometimes fail to provide the required information.

## 1.1 Systems

Many authors writing on systems theory have described a system as a set of interrelated elements that are connected in some way which makes the thing as a whole interesting. Martin and Powell (1992), have defined a system as follows:

'A system is a collection of entities which are related to each other and to their environment so that they form a whole.'

In a construction-orientated view, Newcombe et al (1990), provided a detailed review of the systems concepts, the systems approach, and the implications of viewing organisations as systems. According to them, the focus of systems theory is upon sub-systems which are interrelated in the pursuit of goals and objectives, and any analysis of a system would be started by defining its primary task. A definition credited to Miller and Rice (1967), the primary task of an organisation is the thing it must do to survive. However, Newcombe et al have identified some important systems concepts including:

- 'Large systems comprise smaller sub-systems which work, preferably independently, towards the larger systems goals or primary task.
- Those sub-systems form a hierarchy of systems, and by studying the inter-relationships of the sub-systems, we can understand the larger system.
- Systems are "open" because they interact with their environment. The environment affects the systems through constraints and imperatives but is not a part of the system because it does not share the goals of the system.
- The system receives inputs from the environment, applies some sort of conversion process and exports outputs to the environment.
- There is a permeable boundary between the system and its environment through which inputs and outputs pass.
- There is feedback when part of the output is fed back to become an input; thus a cycle of events is established which enables the system to monitor its own behaviour.'

According to Ahuja et al (1994), an organisation is a system of personnel procedures and individuals assembled to perform the work and organisation structures are systems for organising human efforts and assigning responsibilities. Newcombe et al (1990) also added that organisations are large systems which contain a hierarchy of sub-systems in the form of functional departments and levels of management which work independently and interdependently towards multiple goals.

Ahuja et al (1994) have defined a construction project system as a system which consists of a number of subsystems that are put in place to facilitate the execution of the job. According to Newcombe et al (1990), the temporary process of the construction projects comprises five interlocking systems as shown in figure 1.1. In a statement credited to Thompson (1967), he indicates that these systems form the environment or context for the construction conversion process and seek to facilitate and protect this 'operating core' from disruptive environmental influences. The five systems, which can be viewed as systems performing input-conversion-output processes, are as follows:

- *Strategic system* which performs the task of deciding and managing the long-term direction of the construction organisation.
- *Organisational system* which seeks to differentiate the work of the construction organisation in a rational way, and to integrate or co-ordinate the activities involved.
- *Social system* which seeks to achieve an output of satisfied, committed and involved personnel through the process of motivation, group formation, leadership and communication.

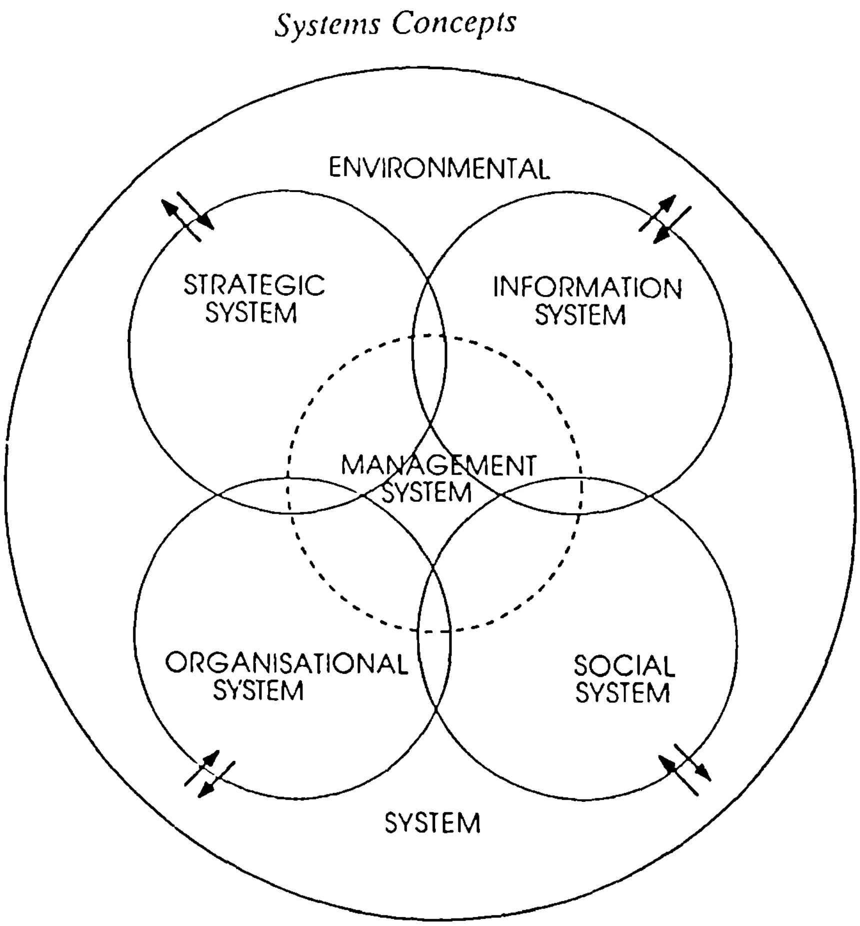



*Figure (1.1): Construction Organisation Systems*

*Source*: Newcombe R., Langford D., and Fellows R., (1990), Construction Technology and Management: Construction Management - Organisation Systems, Mitchell, London, UK.

- *Information system* which provides the lifeblood running through the arteries of the construction organisation. Information is collected, sifted, sorted and disseminated to the other systems in the form of time, cost, quality, resource and statutory data.
- *Management system*, which is shown in figure 1.1 as central to the whole organisational system, occurs at three levels involving strategic, administrative and operational functions. At any level the management role involves making decisions, handling information and interacting with people.

Having described the systems approach, it is, however, recognised that the organisation system that is usually established on a construction site (i.e. the area of concern of the current research), is generally much simpler than a major organisation where more complicated systems are needed to be set up to undertake the required tasks. It is believed that construction site information system that is needed has reasonably defined requirements which must provide information for a number of functions.

## 1.2 Overview of Information Systems

Almost all organisations are founded, developed, and/or improved with the availability of certain types of information. Bocchino (1972) indicates that information moves along channels from point to point through the interrelated network of the operating elements of each organisation. He also adds that such flow includes all data received or produced from the internal and external environment and, in fact, it represents a continuous record of the status of all the appropriate considerations that affect the survival and growth of the organisation. Therefore, a system has to be set up to organise and manage the use of these pieces of information. This view can also be taken of the construction industry and particularly of construction sites where information is required to be used for many different purposes and where it needs to be ready and accessible at any time. This section covers many aspects relating to information systems, including the need for information, qualitative characteristics of information, data processing systems, and problems with management information systems.

### 1.2.1 The need for information

Burch and Grudnitski (1989) have defined information as follows:

> 'Information is data that has been put into a meaningful and useful context and communicated to a recipient who uses it to make decisions. Information involves the communication and reception of intelligence or knowledge. It apprises and notifies, surprises and stimulates, reduces uncertainty, reveals additional alternatives or helps eliminate irrelevant or poor ones, and influences individuals and stimulates them to action.'

Information, thus, forms an essential commodity in carrying out effectively all activities of an organisation. Historically, managers in any organisation have always used information to perform their tasks and duties as decision makers. The art of management is normally seen as making the best decision possible, given the incomplete nature of underlying information. The organisational processing of information goes back many centuries (Burch & Grudnitski, 1989 and Lester, 1992). Management of any business organisation will certainly make its best effort in attempting to ensure that the organisation reaches its goals and objectives. According to Lester (1992) the function of management should be seen as a number of distinct tasks in which it has to make key decisions; these tasks are as follows:

- *Planning*: at this stage the management has to consider the objectives of the organisation and then decide how to achieve them.
- *Organising*: after setting a plan of the organisation's activities, the ways in which the necessary tasks to be undertaken can be organised and then assigned appropriately to departments within the organisation.
- *Directing*: this will involve motivating the workforce, ensuring that the necessary tasks are properly understood and co-ordinating efforts to achieve the planned objectives.
- *Controlling*: the management must monitor the organisation's activities and identify any differences in the objectives as planned and as achieved in order to take, if necessary, any corrective action.

Clearly, all tasks mentioned above need information for their successful performance. Rapid and accurate feedback of relevant information will undoubtedly help the manager in carrying out these functions, particularly the last mentioned management activity, that of controlling. Lester (1992) has also argued that management needs to make sound decisions in order to carry out effectively these functions. He also adds that if it is to be effective, decision-making cannot be carried out in a vacuum; it has to be based upon sound information. This certainly indicates the need to adopt an effective system that provides the necessary information to attain the above requirements.

According to Hicks (1984), information needs are determined by the decisions that must be made, which in turn are determined by organisational objectives. Decision-makers draw extensively on experience and previous judgements when making decisions (Enrico, 1991). Merritt (1994) also stated that success in future operations depends to a large extent on knowledge obtained on previous work. This indicates that management decisions are often made based on information that comes from the past and related to events that will happen in the future. Good managers, it is said, are those who make good decisions. Cooke and Slack (1991) have described a good decision as follows:

> 'A good decision is one where the decision maker fully understands the background, objectives, alternative courses of action, and range of possible consequences of a decision.'

The decision making process is often subdivided into a series of steps. Harrison (1981) envisages this process as consisting of six stages as follows:

- Setting managerial objectives.
- Searching for alternatives.

- Comparing and evaluating alternatives.
- The act of choice.
- Implementing the decision, and,
- Follow-up and control.

He emphasises the need for starting the process of making decisions with setting clear managerial objectives which, by and large, are dependent on the information available. The success of the decision making is highly dependent on the functions that are the components of the process. In the absence of managerial objectives, Harrison stated, there is no basis for a search of alternatives. Without the information obtained through a search, there is no alternative to compare with and, without them, the choice of a particular course of action is unlikely to yield the desired results. An information system which provides the relevant information, is, therefore, crucial for any decision maker searching for improvements in their process of making decisions and implementing the decision taken.

Although the primary purpose of providing information is often seen to be to aid decision making, Lucey (1989) argued that there are other more indirect reasons why information is useful, including:

- *Motivation and learning*: feedback information helps managers to identify how well they are doing and they can learn from the past results;

- *Background enrichment*: information adds to the accumulated knowledge of the recipient, thus expanding and enriching the manager's background.

### 1.2.2 Qualitative characteristics of information

Having seen the important role played by information in any organisation, it is clear that to be valuable to the recipient, this information must be of sufficient quality to make it useful. A number of characteristics that affect the quality of information needed by management have been highlighted by many authors writing on this aspect of management information systems. Amongst these, Martin and Powell (1992) stated that there are several rule-of-thumb criteria which help to create better information, such as:

- *Relevance*: information needs to be relevant to the decision being made. Irrelevant information will distract manager's attention from important issues, waste his valuable time and may induce him to follow an incorrect course of action.
- *Accuracy*: information needs to be accurate enough to serve the manager's purposes. Wrong or misleading information is perhaps as bad as no information at all.
- *Conciseness*: information should represent the minimum necessary to convey what is required for the decision being made. More than what is essential may cause some problems to the manager, such as information overload and increased processing costs.

- *Timeliness*: information must be timely, so that it will not lose its value. If it arrives late, it will clearly be of little use, however accurate and relevant it may have been.
- *Well-presented*: information needs to be well-presented considering its user's requirements. If key information is inaccessible or unclearly indexed, then the decision maker will not have been well served.
- *Completeness*: the decision maker should have all information needed to carry out that task; any missing key pieces of information will affect its value.
- *Up-to-date*: information should be sufficiently up-to-date and reflect the current known facts relating to a decision. Information which is not up-to-date may be considered inaccurate.
- *Cost-effectiveness*: providing the necessary information may incur extra costs to the organisation's budget, but such costs may be justified considering the importance of the decisions being made.

It is believed that producing information which has one or more of these desirable characteristics may well conflict with one of the other characteristics. To obtain information in a very good time may well cost more; to produce a complete set of information may cause some delays and so on. A 'compromise' way which provides as many as possible of the above qualities within a given set of circumstances will often be taken into account when a system is designed to provide the information that is needed (Martin & Powell, 1992).

### 1.2.3 Types and sources of information

The information needed in carrying out an organisation's activities will typically originate from the organisation itself and also from the environment in which it operates. Information is often classified into a number of categorisations including: environmental, competitive, and internal information (Giles and Stanafield,1990).

*Environmental information* generally involves the social, economic, and political aspects of the environment in which the organisation is operating. *Competitive information,* describes the performance, plans, and activities of other competing organisations in the same area of work. The *internal information* covers many aspects relating to the internal affairs of the organisation such as those concerning management of the organisation, the operations involved in the organisation as well as the routine administration of resources and personnel involved in conducting these operations. Information collected here serves managers engaged in the internal regulation and control of the organisation, providing processing support for the day-to-day operations. By and large, according to its use, internal information may also be classified into two main types: information used for planning, and information used for control purposes.

All business organisations, in whatever sphere they operate, will typically generate records that document their daily transactions, and these records will be maintained to fulfil a variety of different needs. Cohen (1984), states that: 'record keeping is not a recent phenomenon of industrialisation but has been a feature of organised societies since such societies have existed. The need to keep records is a basic requirement of any administration that wishes to be efficient ...'. The records that are generally kept in any organisation would typically deal with a variety of topics depending on the nature of the organisation's activities. Scott (1991) has reported a list, not intended to be exhaustive, that defines the different sources of information commonly held within an organisation, as follows:

- Records kept to provide the basis for balance sheets and profit and loss accounts.
- Records kept of individual accounts of debtors and creditors.
- Records kept on the organisation's personnel relating to payments and training developments.
- Records kept of results of any tests on the organisation's products.
- Records kept on quality assurance procedures.

Construction sites, as will be described later, are in some ways not directly comparable with most other types of organisation, but as an active branch of larger organisations (clients/consultants/contractors, etc.), there will certainly be a need to hold similar information Scott (1991). They will, however, also need to maintain other types of records which will be considered in more detail later in this chapter. Because information is a changing commodity and competition is nowadays very tight it is, therefore, crucial for any organisation to keep a wide range of records in such a way that the useful information can be retrieved when needed.

### 1.2.4 Data processing / information systems

Data processing involves the capture, storage, and processing of data to transform it into information useful for management decision-making. During the course of an organisation's working days, many events will usually take place and when the facts relating to such events are recorded, they become data. Data is, therefore, collected facts concerning occurrences or happenings in an organisation, but they are generally not useful for decision making without further processing (Hicks, 1984). Conversely, information, as it has already been described above, is directly useful in making decisions because it is based on processed data. However, the main problem with data that may limit its usefulness, is that it is usually too voluminous and managers would spend a considerable time wading through masses of data in order to identify particular items that are of importance to the decision-making process. To overcome such problems, data processing systems are used to transform data into meaningful information which hopefully possesses the desirable qualities described previously.

As has been seen, information comes from data that has been processed to make it useful in decision-making. According to Hicks (1984), the task of data processing usually comprises four basic components: *input*, *process*, *storage* (sometimes considered as a part of the process component), and *output*. The input stage includes the originating, classifying, and editing of data. At the processing stage, several different operations are performed including sorting, calculating, summarising, and comparing of data collected. The storage step in data processing includes a number of operations such as retrieving, protecting, indexing and updating of the stored data. In the output stage, data which has been processed or retrieved, will be communicated to a data user in many forms such as written reports or diagrams. If computers are used, the latter step may include displaying data on a screen and/or printing reports and documents.

As has been described in section 1.1, a set of interrelated parts that involve the collection, processing of data and producing some form of information for others to use becomes a system and hence an information system. Barton (1985a) defined an information system as an organised way of sending, receiving and recording messages. Lucey (1989) has also viewed information systems as a means of processing data, i.e. the routine facts and figures of the organisation into information which is then used for decision making. Most writers who deal with different management aspects will highlight the importance of information systems, amongst them Martin and Powell (1992), who state the following:

> 'Information systems have become a vital part of all aspects of managerial work and it is hardly possible for the modern manager to do his or her job effectively without a grounding in at least the fundamentals of information systems.'

According to Hicks (1984), much of the information which is initially captured and stored by the data processing system, is used to support management information systems. To contrast the two, he adds, data processing is orientated towards the capture, processing, and storage of data whereas a management information system is orientated towards using that data to produce management information. Although Lucey (1989) has mentioned that there is no universally accepted definition of a management information system and those that exist reflect the emphasis and prejudices of the particular writer, many authors argue that information systems must be clearly differentiated from management information systems. An information system has as objectives the acquisition, processing and dissemination of data, as well as helping in the decision-making function. On the other hand, management information systems are seen as environments of man-machine arrangements and procedures that are directed at increasing the decision maker's ability to deal with planning, operational and control data. In other words, the management information system can be seen as a combination of human and computer-based resources that involves collecting, storing, retrieval, and using of data. The latter description was clearly indicated by Hicks (1984) when he defined the management information system as a formalised computer-based system able to integrate data from various sources to provide the information necessary for management decision making. Regardless of the means by which information is processed and produced, Lucey (1989) has defined a management information system as follows:

> 'It is a system using formalised procedures to provide management at all levels in all functions with appropriate information, based on data from both internal and external sources, to enable them to make timely and effective decisions for planning, directing and controlling the activities for which they are responsible.'

### 1.2.5 Problems with management information systems

According to Place et al (1973), one of the problems of our times is that we have tremendous stockpiles of documents. They also added, 'to have a stockpile of relevant records at hand is like having money in the bank, but it is not any good unless you can take it out when you need it'. Although the amount of information held in any organisation seems generally large, it is quite often found that management complain that the information needed to aid their decision-making is not available. That is to say, not readily available, suggesting that the required data exists, but it is inaccessible and to produce the information needed, would be a time consuming process. Place et al (1973) offered the following suggestion:

> 'To be useful, a stockpile of relevant records must be organised so that any item can be found when it is needed. Therefore, records in big stockpiles, such as we find in business and government today, have to be classified, housed, managed and systematised for quick retrieval and instant use. Unless this is done, the stock-pile is of no value.'

By and large, satisfaction with most management information systems has been doubtful. Such systems have been criticised by a number of writers. Lawler and Rhode (1976) sum this up in the following way:

> 'A large body of research suggests that information and control systems often fail to accomplish their purpose. The systems are often fed invalid data by the members of organisations and they often cause other dysfunctional behaviour.'

Lucey (1989) has also reported a similar inference when he stated the following:

> 'There is abundant evidence from numerous surveys both in the UK and in the USA that existing management information systems, often using advanced computer equipment, have had relatively little success in providing management with the information it needs.'

Scott (1991) indicated that most research into difficulties encountered with information systems considers only those systems set up for assessing an organisation's productivity. Information on the organisations activities, he added, will be held for several purposes other than assessment of productivity, and it is important to understand the variety and complexity of such information. However, the variety in the information types is often justified by the essential uses to which it is put.

According to Barton (1985a), techniques used by organisations for collecting, recording and using data, have often contained many weaknesses, such as:

- *Slowness*: processing of data is slow.
- *Information gaps*: information has been incomplete.
- *Costs*: The expense involved in collecting and processing of information has been considered greater than the improvement in decision-making achieved by obtaining that information.

- *Duplication of information*: the same information has often been collected separately by two or more departments in the same organisation.

According to Lucey (1989), the typical reasons discovered for the general failure of management information systems include the following:

- Lack of management involvement with the design of these systems.
- Narrow and/or inappropriate emphasis of the computer systems.
- Undue concentration on low level data processing applications particularly in the accounting area
- Lack of management knowledge of computers.
- Poor appreciation by information specialists of management's true information requirements and of organisational problems.
- Lack of top management support.

Evaluations of these systems may not be an easy task as management do not always know what information they need and information specialists such as systems analysts and operations researchers, often do not know enough about management in order to produce the necessary relevant information (Lucey, 1989). Evaluations of management information systems, however, can easily be handicapped by inadequate methods of measuring decision-making parameters which are crucial to management effectiveness and business efficiency.

## 1.3 The Role of Information Technology

In recent years, there has been increasing attention given to the need for improved data collection techniques to complement automated, data processing capabilities (Collura et al, 1985). Many experts in information technology have concluded that the greatest technical impact on engineering and construction in the 1990s will come from information automation (Enrico, 1991). This section covers three aspects of information related technologies including the computer, automatic identification and document image processing technologies.

### 1.3.1 Computer technology

It is easy to imagine that the use of computers in business organisations will greatly increase the potential for the storage and processing of management data. The computer should be able to manipulate and provide information for the decision-maker with unprecedented speed and accuracy. According to Bennett (1985), microcomputers can improve managerial productivity by tailoring data more specifically to management's needs and providing information for decision-making more quickly.

Computers have become closely associated with information systems owing to the many functions that can be achieved by implementing a computerised information system. Amongst these, data processing can certainly be carried out much more quickly and at the same time, this data, once collected and processed, can be presented in many different forms. However, as indicated by Barton (1985a), it should be noted that the computer does not guarantee a unified information system. It can only help in the following ways:

- *Rapid data processing*: computers can process data in a few minutes that would otherwise take days. This speed means that information delay is reduced and that management has more information available in time to help with decisions.
- *Accuracy*: given correct information, the computer can do many things with it and unlike manual methods, computers make no mistakes.
- *Avoiding duplication*: a computer's storage devices can act as a common data base for the entire organisation and the computer can be ordered, whenever a user needs the information, to print out or display it on a screen.
- *Forecasting outcomes*: by using simulation techniques, computers can sometimes tell management what the results of a decision will be before it is made.
- *Making decisions for management*: with the use of expert/intelligent systems, management may use the computer to make decisions on routine problems where the procedure for solving the problem follows a series of logical steps.
- *Real-time information systems*: fast information is often needed to make decisions. Where instant information is critical to the decision, a real-time or interactive system is needed.

Cooke and Slack (1984), stated that there are four main benefits from computerised management information systems as follows:

- 'On-line' information giving instant and current information whenever it is needed.
- Availability of 'more' information, due to the high speed of processing data, in a given period of time.
- Timeliness, allowing the decision makers time for better management.
- The computerised system could be programmed to replace low level management decisions.

Computer technology has increasingly improved over the last few years, with more powerful machines becoming ever smaller and cheaper and more sophisticated software now requiring less computer skill. Improvement of the human computer interface is increasingly noticeable, allowing non-computer-literate users access to computing facilities. New generations of computers have been developed that can be operated without the need for a keyboard i.e. pen-based computers and voice actuated computers. All data inputting can be made either using an electronic pen or by speaking and the handwriting or speech will automatically be converted into typescript that can be easily stored, displayed and printed out.

### 1.3.2 Automatic identification technology

Automatic identification techniques are systems designed to identify and recognise automatically an item's or object's identity, location, or status using special machines used for rapid and accurate capture of data. This data can then be used for a variety of purposes. Various techniques of automatic identification systems are in use today including: magnetic strip, voice recognition, and bar codes. Alkaabi (1994) reports an extensive review of the literature on these techniques whilst LA Moreaux (1995) presents a comprehensive source on the bar coding systems. According to Alkaabi (1994), the advantage of automatic identification systems are as follows:

- They provide efficient links between the physical movements of an object and the host computer.
- They provide fast and accurate information.
- They eliminate human errors.
- They enhance profitability by reducing the requirement of skill.
- The techniques are cost effective.
- They allow rapid data entry into a computer.

Based on what has been reported in Alkaabi (1994), a brief description of three different types of automatic identification techniques will now be presented, including their potential uses in the construction industry.

*Magnetic strip* is the name given to a read and write technology in which information is encoded onto a magnetic strip which is attached to a card. This technique consists of a stripe carrying card or ticket and a reader (programmer). The magnetic strip is a thick resin film holding particles of magnetic material. The application of this technique includes: credit, telephone, and cheque cards; access control and time and attendance systems. The potential for use of magnetic strip technology in construction exists for particular areas in head and site offices including access control, time and attendance of site staff.

*Voice recognition* is a technology which allows data to be entered directly into a computer via spoken words or phrases. In this technology, the spoken words, sound and phrases are converted into electrical signals by a microphone. The electrical signals are then encoded into patterns (templates). The features of the patterns are extracted and compared with the vocabulary of word templates previously stored in the computer data base. The vocabulary words used are obtained from the people who are proposing to use the system for collecting data. This technique has been used for inventory control, quality control inspection and goods receiving and shipment. There are still some difficulties with the use of the voice recognition technology but when perfected, it will have the following advantages:

- It improves productivity and efficiency due to freedom of movement.
- It provides simplicity owing to natural use of speech.

- It eliminates paper work.
- It minimises the use of the keyboard for data entry.

Voice recognition has a great potential for the construction industry. This technique could be used for applications such as quality control inspection, material take-off and tool and equipment control. However, vocabulary limitations and the cost associated with the system have meant that the use of this technique is currently limited in the construction industry.

*Bar coding* comprises a combination of dark bars and white spaces for storing information which can be automatically read, decoded and processed. This technique is well established and is more widely used in the industry than any of the other automatic identification techniques It is currently being used in the aerospace and transportation industries, medical field, libraries, retailing, manufacturing and distribution, amongst many other industries. Bar coding technology has proven to be a key in increasing the productivity of labour and in supporting management functions. It has also some inherent advantages in the construction industry over other techniques, for the following reasons:

- The flexibility of reading and printing equipment.
- The ability to withstand the construction environment.
- The capability to read, decode and enter data in one operation.
- The ability to be read from a distance and in any direction.

- The ability to be printed on a variety of substrates.
- The ability to be attached to several types of materials and objects.
- The capability to integrate with other techniques such as electronic data interchange to speed the flow of information.
- The ease of use.
- The relatively low cost of implementation.

Alkaabi (1994) stated that combining the existing systems with automatic identification technologies and in particular bar coding techniques, would produce an effective system and provide major benefits to the construction industry. More details concerning the automatic identification technologies and in particular the bar coding techniques were also reported in: Bell & McGullouch (1988), Rasddoof & Herbert (1990a,b), Stukhart & Cook (1990), Bernold (1990), Blackey (1990), McCullouch & Lueprasert (1994), and Davidson and Skibniewski (1995). These reports concentrated mainly on investigating the possible applications of these techniques in the construction industry. Details of a feasibility study using bar coding systems were also reported in Baldwin et al (1994). The study was undertaken on behalf of a major supplier of pre-stressed structural flooring beams to identify and track the movement of the individual concrete products. It was concluded that the adoption of bar-coding techniques within the company for the identification and tracking of their products was technically, economically and operationally feasible.

### 1.3.3 Document image processing technology

Document image processing is a method of converting paper documents to electronic signals which can be routed, filed, stored, and managed using the powerful computer facilities now available. The most comprehensive information regarding this technology was found in Rottman (1992). According to Rottman (1992), document image processing is a technology, similar to that used for facsimile, which allows system users to convert documents created by others and received as paper into electronic image or signals. Documents are scanned line by line with between 150 and 400 scan lines per vertical inch, and the horizontal scan on each line is also between 150 and 400 scans per horizontal inch. A statement credited by Rottman to Schants (1991) noted that up to 3200 individual bits of information per scan line are created and in an 8 x 10 inch document, up to 12 8 million bits of data are collected. According to what has been reported in Rottman (1992), this technology provides a wide array of benefits to the using organisation. Benefits can be categorised as quantifiable; wherein actual money savings can be assigned, non-quantifiable but clearly advantageous to work processing, and, strategic. Quantifiable benefits include productivity improvements, space savings, and, furniture, hardware and supply savings. Non-quantifiable benefits include records management benefits, non-linear processing (i.e. simultaneous sharing of documents regardless of the user location), management control, improving customer service, and disaster recovery (i.e. easy to back-up). Strategic benefits relate to increasing customer satisfaction, shortening new product lead time, enhancing employee morale, and changing ways of doing business. However, it has also been reported that the document image processing systems are not easy to justify because costs are difficult to determine, and financial benefits are poorly-understood. Nevertheless, Rottman (1992) has identified a number of activities that should be undertaken by an organisation to evaluate the effectiveness of its use of document image processing technology.

## 1.4 Record Keeping on Construction Sites

As has already been noted, a number of different parties are present on a construction project, forming a loosely-based organisation and aiming towards the completion of the project These parties typically interact in many different ways and they would certainly need information to facilitate effective communications. Communications between the project parties, although often delayed, are undoubtedly very important to achieve their goals. According to the Co-ordinated Committee for Project Information, CCPI (1987), there is an increased risk of misunderstanding and oversight owing to the greater number of people involved in both producing and using project information, and hence the quality and co-ordination of the project information has become more important. This section starts by describing the different special characteristics of construction sites, and then briefly describes the construction information system as well as the problems identified with such systems Then the different classifications of construction site records are presented, illustrating the importance of these records. The different types of site records kept by site supervisors are also presented with a brief description of site progress records and their main uses. The section ends by illustrating the problems encountered with site progress records.

### 1.4.1 Construction sites

Construction sites, as has already been noted, are in some respects not comparable with most other types of organisation. Much of the research into management information systems relates to organisations set up, not just to complete a single project, but that are likely to exist on a much longer-term basis. According to Scott (1991) the characteristics that make construction sites differ from other organisations are most likely to fall under the following: the temporary nature of sites, single project basis, and contractual aspects between the main parties represented on the construction sites. Based on the discussion provided by Scott (1991), each point will now be considered in more detail.

- *Temporary nature of sites*: site staff involved in the construction process may well be working together for the first time on that site. Consequently, differences of opinion amongst senior staff may result regarding what needs to be recorded and how. The site team will often include some people who have not worked on a site before i.e. junior members. It is quite possible that the inexperienced staff will not get any guidelines to help them to recognise what records should be kept, although this clearly should not happen. Although such situations would certainly be improved with the use of proper laid-out procedures, the dynamic nature of construction, which needs a quick response to a whole variety of problems, works against such procedures.

- *Single project basis*: keeping records on a single, well-defined construction project should certainly be simpler than recording a number of diverse and separate activities. Considering the nature of projects, which are unlike most process-oriented industries, records of today's activities, if not safely captured, cannot be relied upon to be available in similar vein tomorrow. Thus, continuous and complete records need to be kept in a way that is not so evident for non-project type work. Exactly what should be recorded is also not so clear in some circumstances. As has already been noted, the latter would certainly be overcome by providing proper guidelines and based on experience it should not be such a difficult task to judge what is important to record and what is not. Unfortunately, as has also been noted, that experience will not always be available.

- *Contractual aspects*: the relationship between construction parties will typically be governed by a recognised set of conditions of contract, such as the ICE6 (1991). Many aspects will typically be covered by these conditions, including the different situations in which claiming for additional payment and time can be made. If such a situation is recognised, it is recommended that whenever possible, joint records should be agreed by the two parties on the site. However, such a practice is not always possible and because of that a separate set of site records will be kept by each party. Although most construction claims are normally resolved at the site level, there are occasions where cases are referred to an external body e.g. an arbitrator, and therefore, records kept on construction sites may have to be presented at an arbitration or other external hearing. This requires the supervisor and his team to ensure that their records are acceptable in such surroundings. It is not only those records that a party would like to use that should be kept in good order, for full disclosure may be required.

### 1.4.2 Construction information systems

Any organisation can typically be viewed as a system irrespective of its specific purpose and in various analogies a construction site has been compared to a production system. It is certainly a system where various resources in the form of ideas, designs, labour, materials, and machines etc. interact together to produce a desired objective as an output, usually in the form of a building or other civil engineering structure. Operating on the construction site are various other sub-systems created to aid site management achieve its objectives. Therefore, the site organisation may be treated as a system incorporating a number of sub-systems such as administrative, financial, technological, and information systems. The need for information systems in construction, has been highlighted by many writers such as Sanvido and Paulson (1992) when they state the following:

> 'The design of projects in the 1990s and beyond will produce more complex building systems. This will result in more speciality design and construction contractors, thus increasing the number of organisations represented in a project. The increasing cost of labour, particularly for specialists, will support more prefabrication of components. The faster delivery needs of owners and the increased co-ordination requirements of more specialists will demand better site-level construction information systems. Hence the need is apparent for adding tools to complement the current project control environment in order to provide real-time control and co-ordination of field operations.'

According to Barton (1985b), the general objectives for an information system designed to aid management in the planning and control of construction projects may be stated as follows:

- To provide an organised and efficient means of measuring, collecting, verifying and quantifying data reflecting the progress and status of operations on the project with respect to progress, cost, resources and quality.
- To provide standards against which to measure or compare progress and costs.
- To provide an organised, accurate and efficient means of converting the data from the operation into information.
- To report the correct and necessary information in a form which can best be interpreted by management, and at a level of detail most appropriate for the individual managers or supervisors who will be using it.

- To identify and isolate the most important and critical information for a given situation, and to get it to the correct managers and supervisors, that is those in a position to make best use of it.
- To deliver the information to them in time for consideration and decision making so that, if necessary, corrective action may be taken on those operations that generated the data in the first place.

Going through these objectives, it becomes obvious that the entire control function of site activities and hence success of the project directly bears on the success of its information systems.

### 1.4.3 Problems with construction information systems

O'Brien (1989) reported an extensive and critical review of management information systems in construction. He started with a question as to the extent to which construction practitioners had applied the concepts of management, information and systems to their craft and concluded with the answer - not a lot. In a study made by Guervara and Boyer (1981), four main problems in information flow were recognised relating to 'overload, underload, distortion and gatekeeping'. Based on the results obtained from a questionnaire that was sent out, the highest problem management faced was information overload. Managers often received more information than they could cope with, much of which was unnecessary. Fisher (1991) also indicated that the information flow which occurs in a project is massive. Once such a flow becomes greater than the managers' information processing capacity, it becomes unmanageable and a source of inefficiency. Other design information relating problems were also identified and reported in CCPI (1987). These related to many factors including: missing, late, incorrect, impractical, inappropriate, and insufficient details. Research has also shown duplication and poor information handling within the construction industry. Ndekugri and McCaffer (1988) identified considerable amounts of data duplication within contractors' organisations and they concluded that much construction information is ill-defined and uses informal procedures. Newlove and Carter (1987) have also encountered the same problems within a local authority architectural practice. In addition to the duplication of information flow and storage, haphazard data collection and slow data transmission were also reported in Carter (1976) and Carter et al (1986). Others, such as Bhandari (1978) and Russell & Triassi (1982) have also identified problems of information transmission.

Investigating reports that the majority of medium to large companies within the construction industry make widespread use of computer systems to process purchase ordering, inventory control and production planning, Alkaabi (1994) carried out a study. Based on a number of visits made to different sites, he found that the procedures for processing information on construction sites were predominantly manual and paper-based. Therefore, Alkaabi deduced, information is transcribed at least once before eventually being input into the computer system to close the information loop and this inevitably leads to the following problems:

- Considerable time is involved in the flow and processing of the information.
- Low accuracy, resulting from human error, emphasised by re-keying of the same information.
- Large amounts of paperwork.
- High labour usage associated with manual data entry.
- Slow process of data exchange between parties resulting in delays in the delivery of materials, orders, invoicing, etc.

Although many problems will hopefully be overcome with the rapid growth of organisations adopting computerised systems, it was recognised by many, such as Neale (1983), that care is needed to avoid creation of poor management information systems. In contrast to the amount of work done on the presentation of information, little has been done to establish the information needs of the many contributors to a construction project (Atkin, 1990). 'Construction managers need information of immediate relevance, at a level of detail which is adequate for timely decision-making' (Neale and Barber,1995). The efforts must therefore be concentrated on the identification of the real information needs of project participants to ensure that the required information is available in the most efficient manner and at the right time to whoever needs it.

### 1.4.4 Construction site records

Keeping site records is a daily practice on all building and civil engineering projects and these records are kept for different purposes and maintained throughout the contract period in a variety of different ways, ranging from written documents to charts and drawings. Under the traditional type of contract, which is still in common use throughout the world (Neale, 1995), separate sets of records are typically kept by each of the two main organisations on the site: the contractor, and the supervisor. While the contractor's prime concern would normally be constructing the project works in accordance with contract documents, one of the supervisor's main functions would typically be keeping a good record of what actually takes place during the construction process. All contractors are expected to keep a set of site records for each project and the reasons for maintaining such records may not necessarily be the same for the construction supervisors. Scott (1995) presents a comprehensive list of the different records that are likely to be kept by a typical contractor's organisation at various stages, including marketing and business generation, tendering, and during the construction period. These records, however, are out of the scope of the current research which deals with the records kept by the site supervisors.

As has been noted, different types of site records are normally kept in a wide variety of forms. Twort and Rees (1995) have classified site records into four classes as follows:

- '*Historical*: showing progress of the work, stage by stage, as proposed and as achieved, including all relevant information having a bearing on the subject, such as records of weather, notes of discussions and decisions and other key matters influencing the job.

- *Quantitative and financial*: measuring all that is done together with all relevant particulars, so as to form a basis of fair payment to the contractors and for the furnishing of figures that show the cumulative cost at any time.
- *Qualitative*: being a record of all measurements and observations of the quality and behaviour under test of the component parts of the works, the raw and made-up materials used, and the foundation and other conditions whose characteristics have an influence on the behaviour of the works.
- *As-built records*: being a pictorial record (the record drawings etc.) of all the works as completed, showing the whereabouts and dimensions of all parts as they exist at completion, together with factual descriptions of the origin of equipment and materials incorporated in the works, the proper operation of the works as described in instruction manuals, and the performance of the works under test.'

### 1.4.5 The importance of site records

The importance of keeping site records has been recognised by many writers and researchers, particularly investigators who deal with management problems on construction sites. As has already been noted, construction site records are generally used for different purposes including the following:

- As an aid to construction control by monitoring the physical progress of the project and identifying unsatisfactory progress.
- As an aid to quality assurance, by proving the works are carried out according to the contract specification.
- As an aid to financial control, by monitoring the financial situation of the project.

- As an aid to the design process, by identifying any defects of the project design during construction which can be fed back to the design office to ensure that these problems are avoided in future contracts.
- As an aid to claims preparation, by providing reliable evidence which support the claims.
- As an aid to claims assessment, by supporting the decisions made based on the facts recorded.

Roberts (1980) stated that continuous and complete documentation of the honest facts as they occur is an important function on any construction project. He added that not maintaining proper documentation throughout the duration of a contract is like driving your car down a strange road at one hundred miles per hour, in the dark, with no headlights. According to Watts (1980), the keeping of site records is necessary for two main reasons of equal importance, though opposite in character. Firstly records are kept, rather obviously, for reference purposes during and after the construction period. Secondly, certain forms of record provide a vital and often the only tool in the business of monitoring, controlling and predicting the quality and progress of the works. Fisk (1983) has also emphasised clearly this issue when he said that: 'construction documentation serves several very necessary purposes, not the least of which is its value in claims protection.'

Regarding the importance of keeping site records generally, Wilson (1982) stated:

> 'While no one enjoys record-keeping, and that includes contractors as well as owners and architects/engineers, they are an extremely important part of

construction process. Records need to be kept in order to establish the facts as to what actually happened on the project. When proper records are kept, it is much easier to resolve differences of opinion than when history is left to the 'imagination' of the two disputing parties.'

Jergeas and Hartman (1994) also said:

'Site records may seem to have little future value, but when problems arise over who is responsible for what and how much the associated costs are, they can prove invaluable.'

Similar views were also reported by many others including: Maher (1978), Quinn (1982), Fisk (1983), Clarke (1988), and Seeley (1993). Regarding one particular type of site records i.e. the daily site diary records, almost all writers who dealt with the site record-keeping issue had referred to and highlighted the importance of these records. Amongst them, Clarke (1988) who stated the following:

'The importance of the site diaries cannot be overstated. They provide a complete narrative of the progress of the works and the activities of the resident engineer and his team.'

Trauner (1993) also added:

'One of the most important documents on a construction project is the daily report,... A good daily report notes any significant events, records all equipment on the site, and chronicles the presence of visitors. Anyone who has been involved in a major dispute concerning delays or productivity will recognise the tremendous benefit that records of this type can provide.'

Seeley (1993) stated that the construction industry in the United Kingdom is generally believed to be potentially the most efficient in the world, but it does suffer from the large number of disputes that arise, relating principally to direct loss and expense. Kangari (1995) has also indicated that the construction industry is increasingly burdened with disputes. Today, he added, construction projects are the subject of more disputes than in any other time in history. Seeley (1993), added that it is always a better policy to avoid disputes rather than being involved in their settlement. Regarding the way in which such disputes are usually settled, Kangari (1995) reported the following:

> 'In the majority of construction disputes resolved through arbitration, the evidence presented is primarily document-based. Arbitrators rely on this document-based information to help them reconstruct the circumstances or 'story' under which the dispute occurred. This enables the arbitrator to evaluate the merits of each case presented and to determine which party, if any, deserve an award.'

Abrahamson (1979) clearly emphasised the importance of records in such situations when he wrote, particularly memorably:

> 'A party to a dispute, particularly if there is arbitration, will learn three lessons (often too late): the importance of records, the importance of records and the importance of records.'

Kangari (1995) also added:

> 'Without adequate documentation, a claimant or respondent will have a difficult time proving the standing of his or her case to a panel of arbitrators.'

Keeping good site records is thus clearly identified as one of the most important factors in justifying the rights and benefits to the construction parties, particularly in dealing with construction claims. It has been clearly stated that, for a claim to be successful it must be well prepared, based on the appropriate contract clauses and founded on facts that are clearly recorded, presented and provable (Seeley, 1993). The importance of documenting these facts is clearly highlighted by Jergeas and Hartman (1994) when they indicated that in the absence of written evidence, honest-intention claims have little chance of success as witnesses disappear over time and memories are highly fallible. However, most writers who deal with claims and disputes on construction sites will recognise the difficulty of obtaining good, and accurate records in the form required (Scott, 1991). The latter issue will be dealt with in the final sub-section where a detailed account of these difficulties is given.

As mentioned earlier, one of the main functions of the site supervising team is to maintain good site records because they provide an important aid for the supervisors' assessments and decision-making and may play a fundamental role in resolving any disputes. Emphasising the importance role of the resident engineer's records, Twort and Rees (1995) report the following:

> 'An important part of the resident engineer's work is to keep adequate records. His personal success in the job and the assistance that he can give the engineer depends to a considerable extent upon the efficiency of the record systems that he sets up. These records keep watch over the progress of the work, form the basis for fixing payments to contractors, and testify to the proper execution of the works. They make it possible for designers to be assured that the design assumptions are valid, assist the resolution of new design problems arising during construction, and can throw light on the subsequent performance of the works. Without adequate records, the resident engineer fails in his obligations to the engineer and the employer.'

The importance of such duty in legal matters is also highlighted by Fisk (1992) as follows:

> 'An interesting fact should be recognised by all inspectors. Any project could become involved in litigation, and it could be several years after the incident before testimony of the inspector as a witness is requested. Any record that the inspector makes in writing, which is recorded in a form that will retain its credibility, may be referred to by the inspector while on the witness stand. This is an allowable method of refreshing a witness's memory.'

Failing to fulfil this duty properly may even affect the employment of a member of the supervising team as clearly indicated by Fisk (1992) when he stated:

> 'Any inspector who fails to keep adequate records is not performing a competent job and should be replaced.'

He also adds:

> 'Instead of providing the services to the owner that the latter is paying for, such an inspector is simply adding to the overhead cost of the project, or worse, because the owner is lulled into the feeling that with an inspector on the job, his interests are going to be adequately protected. Had the owner known in time, corrective action could have been taken.'

Clearly, from the above discussion, the maintaining of construction site records is a crucial function as these records play a fundamental role in many management aspects. The subject of the keeping of records should be approached as a positive, immediate means of controlling and monitoring all aspects of construction (Watts, 1980). It is, thus, very important to ensure that sensible efforts are made to establish effective systems that will provide good records so that information needed for planning, control, and decision-making can then be processed and used more efficiently.

### 1.4.6 Records kept by site supervisors

The most comprehensive source of information with regard to the resident engineer's office records was found in Twort and Rees (1995). They described and classified these records as follows:

- Correspondence filing system.
- Confirmation of oral instruction and instructions to contractor.
- Register of drawings.
- Daily and other progress records.
- Quantity records.
- The contractor's interim payment applications.
- Authorisation of dayworks
- Filing system for dayworks sheets.
- Check of materials on site.
- Price increase records.
- Supply contract records.
- Registers of test results.
- Photographs.
- Record drawings.
- Other records.

Clarke (1988) and Seeley (1993) also provided a list of the most common site records kept by the engineer's site staff as follows:

- All correspondence between the resident engineer and the agent, including the engineer's instructions, variation orders and approval forms.
- All correspondence between the engineer for the contract and the resident engineer, the employer and any third parties.
- The minutes or notes of formal meetings.
- Daily, weekly and monthly reports submitted by the engineer's site staff.
- Plant and labour returns, as submitted and corrected where necessary.
- Work records such as dimension books, time sheets and delivery notes.
- Daywork records, as submitted and corrected where necessary.
- Interim statements, as submitted and including any corrections, with copies of all supporting particulars and interim certificates.
- Level and survey books, containing checks on setting out and completed work.
- Progress drawings, charts and revised drawings.
- Site diaries.
- Laboratory reports and other test data.
- Weather records.
- Progress photographs.
- Administrative records, such as leave and sickness returns, and accident reports.

Twort and Rees (1995) also give a description of how the resident engineer's office correspondence filing system can be set up in order to keep all correspondence between him and the client, or the contractor(s), as a part of his records. They give the following list of files that are expected to exist in the resident engineer's office:

- Employer's (client's) file.
- Notes of meetings.
- Contractor's head office.
- Contractor's agent.
- Weekly progress reports.
- Monthly progress reports.
- Planning Authorities.
- Engineer.
- Informal letters to designers.
- Specialist advisers.
- Nominated sub-contractors.
- Supply contractors.
- Miscellaneous suppliers.
- Staffing.
- Miscellaneous (job).
- Miscellaneous (personal).
- Current claim from main contractor.

- Dayworks-current.
- Claims passed.
- Dayworks and extras passed.
- Engineer's certificates and correspondence thereon.
- Variation Orders passed.
- Variation Orders pending or in draft.
- Other contractor's invoices and claims.
- Claims pending for extra charges by main contractor.
- Estimates of future expenditure.
- Petty cash, miscellaneous.

An example of the last six categories of the filing system of a major engineering firm in the U.S. was given by Fisk (1992). In order to give an indication about what types of records are kept in that country, the list is shown in appendix A. The resident engineer and his staff are responsible for providing most of these records.

It is clear from the above lists, that the resident engineer's records are miscellaneous and massive, and they are kept for different purposes and in different formats. Without establishing a practical system of accessing such an amount of site records, it will undoubtedly be very difficult to obtain any useful information efficiently. These records, apart from fulfilling the needs for controlling project costs and forming the basis of fair payment to the contractor, have other important functions, and may be considered under the headings of finance, quality and progress. It is generally believed that problems with financial records are very limited considering the fact that Bills of Quantities, where they are used, are usually completed at regular intervals and thus, there will be a good opportunity to ensure that good records are kept. Additionally, details of the monies paid and amounts of work done would normally be recorded in a number of documents such as interim valuations and certificates. Regarding quality records, it is also believed that any associated problems will be controlled easily and their effects can also be minimised with the increasing number of contractors adopting quality assurance schemes. It is therefore believed that, the main areas of difficulty are likely to exist with progress records and it is recognised that this type of site records often fail to provide the information required in an easily accessible form. That makes many management tasks, particularly supporting and proving claims, all the more difficult. This led the current research to concentrate mainly on the progress type of site records.

### 1.4.7 Types of site progress records

As has been seen, it is extremely important that supervisors and their teams on construction sites keep detailed records in a readily-accessible format so that facts can be established at any time during the construction period, or years later when disputes may develop. Some of the records kept on construction sites may be considered to be essentially held as progress records. These include: site diaries, weekly progress reports, daywork sheets and joint records, photographs, as-built programmes, and minutes of progress meetings. The different types of site progress records will now be considered in more detail as follows:

*Site diaries*

Site diary records are considered to be one of the most important sources of information because they are expected to include an ongoing record of construction made at the time the work takes place. The contents of a site diary may be the only written record that is available on various matters including information on progress of construction works. Personal site diaries are usually maintained by all members of the site staff at every level in the site supervising hierarchy. The format adopted for site diary records is often varied and may include a page-a-day diary, duplicate books or standard report sheets with pre-printed headings. Several topics are expected to be covered by site diaries including:

- Notes on weather.
- Work description.
- Drawings and instructions issued.
- Contractor's queries.
- Discussions and agreements.
- Delays.
- Unforeseen conditions that may lead to claims.
- Accidents.

- Complaints
- Site visitors
- Records of plant, labour, and materials.

*Weekly progress reports*

These reports are produced by the supervisor based on his assessment of construction work progress. The main objective of such reports is usually to provide information to higher levels of management. Site diaries are used to prepare these reports which will identify the work carried out during a specific interval of time and highlight any delay and disruption affecting work progress. A general view on the contractor's performance and any additional instructions or change orders produced, should also be included.

*Daywork sheets and joint records*

These records are usually kept for varied works on a contract. Such records are often more detailed than the records kept for the rest of the contract works as extra payments will be involved and the extent of the payment will be determined by these additional records. Joint records, including dayworks, are those kept by one party and approved by the other. They will usually identify specific plant and labour and the hours for which they worked, together with any additional materials, and also record delays encountered during the construction.

*Photographs*

One picture is worth a thousand words, provided, of course, it is a picture of the area of the site under investigation and taken at the right time. Photographs capture minute details that might otherwise be overlooked in any written attempt to record information. The general work progress is often photographed at regular intervals, with specific shots of events that might be the subject of future claims. Site photographs are instantaneous representations of a continuously changing scene and therefore, provide a wealth of information which may enable a better understanding of the work progress. As intimated, when using photographs to confirm particular details, if the photographs is not taken on the date in question or does not cover the specific area of concern, the investigator will be frustrated.

*As-built programmes*

The planning programme is usually produced by the contractor at the supervisor's request to indicate the various work activities in a project. These programmes also show how long such activities should take to complete and when it is intended that they will be carried out. Such programmes, often in a bar chart format, may be annotated to show when construction activities actually did take place.

*Minutes of progress meetings*

During the construction period, there will usually be a number of progress meetings attended by the client's on-site supervisor, the contractor, and members of head office staff from both organisations. Minutes are prepared at the conclusion of each meeting to represent the agreed statement of the proceedings. These are likely to include discussions on the progress of the works compared to the submitted or revised programme, financial matters including claims assessments, and any outstanding information the contractor may need to complete the works. Progress meetings often take place once a month and will thus contain a general picture of the works' progress at these intervals throughout the contract.

### 1.4.8 Uses of site progress records

Site progress records are kept to fulfil a number of important functions. The main uses may be summarised as follows:

- *Project control*: by regularly comparing the records of actual work progress with the planned progress, as depicted in the contractor's programme, the contractor's ability to complete the project on time can be assessed. Of course, the supervisor has no direct means of acting to rectify any failure and if the rate of progress appears unsatisfactory, the contractor must be informed and exhorted to make greater efforts to meet interim targets and avoid delaying the whole project.

- *Confirmation that construction work has been carried out*: this is particularly important for varied works, where costs are often uncertain and payments due will need to be built up from these records. Where no joint records exist, such records confirm that this varied work has been undertaken and the materials and resources which were used.

- *Dealing with claims*: using site progress records in assessing contractor's claims, and in particular delay claims, is probably one of the most important uses of these records. To determine whether delays occurring during the contract have actually had a knock-on effect on the completion of the project as a whole is invariably a complex matter. Good records of exactly when the various activities took place, when delays had their effect and whether delay in one activity caused subsequent delays in succeeding activities will inevitably aid this difficult process.

Considering the importance of using site progress records in assessing delay claims, as has already been highlighted, this procedure will now be dealt with in more detail to show the importance of the supervisor's function and how good records can assist him in carrying out his duties.

*Assessment of delay claims*

According to Baram (1992), one of the most frequently required procedures in dealing with construction claims is the delay analysis. This, he adds, is usually the most complicated issue in claims presentations as it requires integrating information from many sources and presenting all the surrounding facts in a timely, graphical, simple, yet credible and comprehensible form. Recent research (Scott, 1993) suggests that delay claims will be made on the majority of substantial construction contracts. In contrast to the contractor, whose main concern when he is making a claim is to obtain a solution that is beneficial to his company, the supervisor must aim to make a settlement of the contractor's claim that is just and equitable. Additionally, some Conditions of Contract such as ICE6 (1991) require the engineer to deal with delay claims not just at the end of the contract when the project is complete, but also part-way through the project. Regarding this issue, Haswell and De Silva (1989) state the following:

> 'In civil engineering contracts, claims are invariably submitted by the contractor in the first instance for consideration by the engineer. The engineer has a duty under the contract to resolve disputes and consider claims in an independent and impartial manner without showing bias towards either the employer or the contractor.'

Wilson (1982) also states:

> 'If and when a claim situation develops on your project, every effort should be made to resolve the claim at the project level as quickly as possible. Unlike fine wines, construction claims do not improve with age.'

Describing some aspects relating to the current situations of construction projects, Alkass et al (1991) have reported the following:

> 'In recent years, more and more construction projects have terminated not on site but in the courtroom. Delays are a fact of life, and as a result, analysing construction claims has become an integral part of the project's construction life.'

In assessing construction claims, the procedure adopted often has two stages. Initially it is essential to check that the basis of the claim is contractually valid and when it is approved, then the details of the claim need to be verified. The information required for the second part of the procedures will typically be in the form of very detailed accounts of work progress, delays, additional resources and materials used: that is, good site records.

In general, most methods used for validating delay claims rely upon a basic principle that involves a comparison of the contractor's actual progress with his planned progress to examine the difference between these two to identify the effects of delays. Although it is not intended to deal with such methods, which are out of the research scope, it is felt that it would be useful to recall what is reported by Scott (1991) as a basic technique that should be adopted in any attempt to analyse delay claims (more details were also reported in Scott (1987), Scott (1993), Alkass et al (1991), Kraiem & Diekmann (1987), and Wickwire & Smith (1974)). Scott (1991), however, said that, as each event in the network is achieved on the contract in question, the engineer should:

- Identify all delays and actual activity duration on all paths that lead to that event.

- Attempt to identify not only the duration of delays, but also the party responsible.
- Recognise concurrent delay situations and, taking all the facts into account, reduce these to single delay effects.
- With full knowledge of the relevant facts, assess the time in which the contractor could have achieved this event in the absence of the delays caused by the employer.

Scott (1991) added that this approach, which does not attempt to identify a critical path, will eventually do so when the event being considered is the one that represents completion of the project as a whole. It is also necessary to facilitate determining the effects of each delay upon the progress of the construction works, and, in particular, the project completion date, as an event may delay an activity, but not the overall completion of the project. This, undoubtedly, highlights the need to use the as-built programme records which document the actual progress and delays, not only for what is conceived to be the critical activities, but for all construction activities. The as-built schedule has been described by Baram (1992) amongst many others as one of the first and most important assignments in dealing with claims. It is certainly important for the supervisor, in order to be able to predict the results of delays at any time during the contract period, to adopt a system that is ongoing. The essential information for such a purpose would simply be the actual start and completion dates of each construction activity, as well as its actual progress status during the period between these dates. This method will also allow an accurate record of decisions concerning the liability of such delays, as the facts will be still fresh in the mind if it is done contemporaneously as the project progresses.

### 1.4.9 Problems with site progress records

It is said that inadequate records pave the way to bankruptcy (Place et al,1973). A number of writers, particularly those addressing the problem of dealing with construction claims, express their dissatisfaction with the quality of the progress records kept on construction sites. The preparation of detailed records that properly document the actual progress of the work, as well as problems experienced, can be time-consuming and is rarely as rewarding as designing the project or supervising the construction (Wilson, 1982). Regarding the way to keep such records, Abrahamson (1979) recommends the following:

> 'Obviously there should be concentration on collecting 'real' first-hand evidence while it is fresh, by way of photographs, tests, etc., as the works proceed rather than on argument and confusing and increasingly strident correspondence by which each party concentrates more on trying to build the file than the works.'

He also adds the following suggestion:

> '..... both the contractor and engineer should have an established procedure for record-keeping that will work more or less automatically and painlessly to produce the minimum records necessary.'

A general statement is provided by Jergeas and Hartman (1994) regarding the effects that may result from maintaining poor records:

> 'Our experience in preparing documentation for claims on behalf of contractors has been that contractors generally fail to protect their contractual position. This situation arises from failure to completely understand and actively manage the contract, or failure to keep records.'

It is thus extremely important that the owner and the architect/engineer keep detailed records so that facts can be established years later if disputes develop (Wilson, 1982). Scott (1987) argued that the records kept by the contracting parties will not readily provide the necessary information for the following reasons:

- 'The records kept will be used principally to determine what payment is due to the contractor for contract or varied work and are thus more likely to relate to bill of quantity items than to planning activities (which are typically ill-defined).
- The greatest detail will be available on varied work, where costs are often uncertain and payments due will need to be built up from the records of resources and materials and of the hours for which they are used - contract work will often be less closely documented with the ends of contract activities perhaps only recorded when progress is formally measured.
- The most detailed records are usually kept by the men closest to the work e.g. for the employer, it will be the inspector who watches over a small area of the site whose diary will provide the best records - but the inspector is the man least likely to be aware of the way in which the contractor has sub-divided the project into activities, and therefore his records are unlikely to relate directly to the activities.'

A similar view was also reported by Russel (1993), and in a description by Major and Ranson (1980) of the form in which site records are likely to be available, they report the following:

> 'It is at least unusual for such records (progress records) to be in a form that will enable a detailed analysis of the actual progress of work to be made. Where it is necessary to make such an analysis there are a number of sources that are likely to be available, but invariably a considerable amount of investigation is required in order to establish what actually happened on a project.'

Similar views were also reported in Maher (1978), Quinn (1982), Clarke (1988), and Baram (1992). Although keeping detailed records may be considered to be necessary in some cases (e.g. claims preparation or assessment) unfortunately, in many cases, if not properly kept and indexed, detailed records will confuse and result in complex searches for useful information. The difficulty of obtaining good records in a useful form has been recognised by many writers including Jackson (1986) who stated that:

> 'Data concerning management decisions and their background are collected informally, usually in diaries, and are mainly used for the retrospective reconstruction of controversial events. An obvious use is the formulation or refutation of claims for extra payment. Anyone who has tried to use these data for this purpose will know that they are very variable in quality and therefore unreliable and difficult to abstract and to use.'

Based on a number of visits to a major construction site, Scott (1991) recognised a number of particular areas of difficulty which may be summarised as follows:

- Problems of identifying either or both, the start and/or the end of the construction activities.
- Problems of interference which may occur between the main contractor (including his subcontractors) and other contractors on the same site.
- Problems of accessibility and continuity.
- Problems of classification of records at the time of collection.

Regarding the development of the as-built programme records, some professionals may argue that these records can be compiled retrospectively from schedule updates, site diaries, progress reports and similar documents. It is, however, obvious from the previous comments that this cannot be easily done. Bramble and Callahan (1992) confirm this:

> 'In developing the as-built schedule, one may discover other problems with the available sources of progress information. The writer of the contemporaneous information may have been wrong, may have intentionally misstated the actual job status, or may be reporting the observations of others. The detail of the daily entries may vary, with more detail included early in the job. Later, the pace of the project activities may have overwhelmed the person preparing the progress report. Further, it is often difficult to determine the actual completion dates for certain activities. One may not always assume that an activity is complete merely because there are no more entries in the daily progress reports about the activity.'

Similar view was also reported by the Task Committee on Application of Small Computers in Construction, TCASCC (1985):

> 'Both successful contractors and owners record daily job progress in some type of daily log. Usually one form is used to record each day's progress. At the end of a four-year project, over 1,000 daily reports contain its history. Any contractor or owner who has been through the agony of a construction claim knows how expensive it is to process this daily information, after the fact, and rebuild the job on a daily basis in the hope of proving and collecting its damages.'

Furthermore, in a recent questionnaire-based survey conducted in the U.S., a number of document-related problems which were encountered by arbitrators, were reported in Kangari (1995) as follows:

- Too voluminous, irrelevant, or redundant.
- Not summarised.
- Disorganised / poorly indexed.
- Inferior presentation.

- Inadequate / incomplete.

The need for keeping good quality site records, is clearly obvious from the above discussion. This crucial practice should certainly be carried out continuously throughout the construction period by the main construction parties and particularly by the supervising team as one of the most important roles on construction sites. Fisk (1993) offered the following suggestion:

> 'Not only must we effectively manage the construction phase of a contract, we must become more aware of the need to provide defence against unwarranted claims and to document construction methods and results as a part of an overall quality assurance programme.'

The adoption of quality assurance by some organisations should mean that improvements are made in the area of site record-keeping. The impact of quality assurance on the construction industry will undoubtedly have increased the number of records kept and for those operating quality systems, it is likely to lead to a greater consistency between construction parties in what is recorded and how (Scott 1995). However, although certain procedures may have been tightened up by the advent of quality assurance, a study carried out as a part of this research (reported in Scott & Assadi (1995) and which will be fully described in the next chapter), shows that room still exists for improvement in the keeping of progress records.

### 1.4.10 Record keeping and computers

Computers have become an essential tool in all engineering fields and have been used in civil engineering for many years, being recognised as an important tool for certain applications. In construction, there are many computer applications including planning, cost estimating, bill preparation, cost control, final accounts, and some other administrative uses. The computer's ability to store data and information within its memory and to access and retrieve this information as required, is an obvious advantage and relevant to the area of the research subject. One of the major tasks that the computer can handle more quickly and more accurately is data manipulation and report generation. According to Baram (1992), the rapid advances in computer hardware and software technology over the last decade allow the development of an integrated system of computerised database incorporating all of the available information in a readily retrievable format, which can be used by all involved. A number of attempts at computerising site data collection has been reported in the literature and these will now be described.

Regarding the keeping of site records, a computer program called Record-Keeper has been written by Scott (1991). The program was aimed at keeping records of work progress of each activity on the contractor's programme of construction works. It provides an input facility to describe the project activities and permits the inputted records to be displayed as daily, monthly, or yearly formats. The main advantage of this programme is that it facilitates a better definition of the different possible status of a construction activity. The user can easily use a number of pre-defined codes allowing him to define the real status by allocating each activity the proper code. An example of these codes includes the following:

- X indicates the status of an activity progress as : *working all day.*
- H indicates the status of an activity progress as : *working half day.*
- W indicates the status of an activity progress as : *not working all day owing to weather.*
- R indicates the status of an activity progress as : *not working half day owing to weather.*
- D indicates the status of an activity progress as : *delay effective.*

Scott (1990), reports that the program provides a more flexible and detailed version of record-keeping than the informal colouring by site staff of a contract bar chart as work progresses. Although there is not yet any record available of any site test of this program, Khalifa (1995) has attempted to enhance the input facilities of the old version using the Visualbasic computer programming language to produce a working user-friendly version with a 'windows' style interface. Unfortunately the work is incomplete owing to the failure to link the program produced with the chosen database, so that the program is unable to store records from one session to another.

Another computerised approach for collecting and processing site information was reported in Russell (1993). The proposed approach was based on entering the information from the traditional superintendents' daily site reports into a computerised report format which was standardised around activities, responsibility, and problem-source codes. Problem-source codes were used to indicate the presence of a condition that might point to time, cost, quality, or safety problems. However, after testing the proposed system on two construction projects, it was reported that the use of the system demonstrated the difficulty of accurately determining and recording activity status and problem sources. Russell indicated that the greatest impediment deals with the personnel charged with the task of daily reporting as they vary greatly in their level of education and attitude towards recording daily site information. It was concluded, however, that the success of the approach requires a carefully crafted implementations strategy, including training of site personnel, with occasional reinforcement.

McCullouch and Gunn (1993) reported on a system for collecting data from construction sites using a 286 portable computer machine with a touch screen display. Although the title of the paper indicates that a pen-based computer was used, it was clearly admitted that the machine used did not have hand-written character recognition capability. It was, however, indicated that pen-based computer systems are beneficial when the amount of paperwork time is large. They provide time savings, eliminate the duplication of paper and improve data accuracy. To determine the viability of adopting the proposed system in the construction environment, three applications: time-keeping, a material purchase order, and a daily report sheet were developed using the Easy Touch software. However, the study was conducted on the employee time-keeping application only, while the other two electronic forms were developed with no active fields on the screen. The application could be called up on the screen by touching a named box on the introductory screen which is automatically booted, and appeared when the machine turned on. The data for employee, activity code and cost code could be entered either by selecting from the database or using the keyboard, while the data for working hours were entered through keyboard only. The demonstration of the system to field personnel at two job sites yielded two different reactions: the forman reaction was cautious or lukewarm whereas the general reaction from the superintendents was favourable. It seems, however, that the proposed system is not a system that may easily be used on a construction site, and it requires regular updating and also professional staff to operate the software installed.

## 1.5 Summary

This chapter has generally reviewed the relevant literature on information systems, role of information technology and record-keeping on construction sites. Many aspects relating to the information systems were covered, including the need for information, qualitative characteristics of information, types and sources of information, and problems with management information systems. Three different aspects of information related technologies were also reviewed including the computer, automatic identification and document image processing technologies. The potential use of these technologies in the construction industry, was also highlighted. The final part of this chapter covered a number of issues relating to the record-keeping procedures on construction sites including the importance and types of site records as well as problems encountered with these documents. A number of problems have been reported and these are mainly relating to the inaccessibility of the records maintained and the lack of the required information when it is needed. The next chapter provides a full account of the preliminary investigations undertaken as a part of the methodology adopted to carry out this research. It describes the two studies involving records maintained on a project under construction and records from a completed project.

# Chapter 2

## Preliminary Investigations

# 2 PRELIMINARY INVESTIGATIONS

As mentioned earlier, site records are kept on every building and civil engineering project. However large or small the contract, these records are maintained and will be kept in a variety of different ways, and for many purposes. Two examples of known uses are: to assist control of the construction process and to provide evidence if there is a dispute between the construction parties. To gain a greater understanding of the problems of keeping site records, which it was hoped would help to generate possible hypotheses and views to be tested in the research and thereby lead to sensible and useful questions on the main questionnaire, two studies were carried out. These were: studying site records kept on a project under construction and studying a set of records from a completed project. The two different approaches were adopted for the following reasons:

- The easiest way to inspect a whole set of project records is by studying the records kept on a completed contract, which allows a complete view of the total records and gives an understanding of the quantity of records generated, but the approach has limitations.
- While the construction process is continuing, it is possible to see what is going on and to compare actual progress with what is being recorded, as well as the possibility of recognising the difficulties in keeping such records.

- Also, on a 'live' site, the people keeping the records can be questioned, and their motives understood. This is usually not possible with records from a completed contract.

In this chapter, the two studies will be described and reinforced with an extensive number of examples in order to give an insight into the variety and complexity of the records kept by the supervising party on construction sites. For reasons of confidentiality, the names, locations and dates relating to these samples of site records are omitted. The observations and inferences stemming from these investigations are also presented in this chapter.

### 2.1 The Field Work (Project Under Construction)

It was decided to start with this type of activity as a sensible procedure to gain more practical knowledge about the variety of site records and the systems which are used to keep them. The opportunity to have direct contact with professionals involved in construction supervision and to discuss relevant matters is also an obvious advantage. The objectives were to identify how the resident engineer and his staff keep these records, what formats were being used, and what problems and difficulties they faced in attempting to fulfil such an important duty.

To achieve such objectives, an arrangement was made to have access to a local construction site. The contract was for the construction of a complex retaining wall on particularly difficult ground, and its duration was six months. The retaining wall formed part of an initial infrastructure work and was the first of a number of contracts which when combined would eventually form a new realigned section of a highway. It was not a large scale project, but it was supervised by one of the largest consulting firms in the United Kingdom.

As a starting point, it was necessary to understand all relevant particulars related to the project, in order to follow up its construction process and to predict what the supervising staff would be expected to record. In all, about fifteen visits were made to the construction site in a ten week period for a minimum of five hours per visit. Several points of interest were identified from these site visits which will be described in the next section. The work conducted during this field investigation may be summarised as follows:

- Inspecting the assistant resident engineer's daily site diary (only one diary kept on the site) to identify what daily records were being kept.
- Comparing the contractor's proposed work schedule programme with the works which were progressing on the site and noting how these works were being recorded by the supervising engineer.
- Walking the site and trying to keep progress records related to the contractor's programme.

- Discussing matters related to the records and their keeping system with the resident engineer and his site staff.
- Inspecting the different types of resident engineer's office records and the format adopted for keeping them.
- Keeping a diary of personal activities during the site visits and recording general observations on the adopted record keeping system.

The supervising site staff comprised the resident engineer, assistant resident engineers, and quantity surveyors, and records were kept in files under different titles, including the following:

- Daily site records.
- Minutes of meetings.
- Correspondence with the contractor.
- Site instructions.
- Confirmation of verbal instructions.
- Payments.
- Materials test results and specifications.

The main emphasis of this study was concentrated on the progress records, such as the daily site records and minutes of meetings, which were expected to represent the running records of the construction process. Some examples of these records were inspected and samples of their contents are extracted and presented in the next sub-sections.

For the purpose of describing the study which was conducted, the following sub-divisions have been used:

(2.1.1) A discussion of samples of site records which were maintained in the construction site office;

(2.1.2) A discussion of the observations that stemmed from this study.

### 2.1.1 Samples of site records

#### i) The daily site records

Standard format sheets with pre-printed headings were used by the assistant resident engineer to record daily work on this site. The sheets had two main parts with two headings, which were: work description and resident engineers record. In addition, there were other sub-headings with limited spaces which were prepared to be filled in with the following information:

- Weather, maximum and minimum temperature;
- Schedule of work, i.e. concrete and other works, formwork, and steel fixing;
- Instructions given, no. and description
- Drawings received, no. and source;

- Materials tested, no. and position.

Figure (2.1) shows a blank copy of the standard sheet and samples of the actual records which were kept under the two main headings, were extracted and are listed below:

*Work Description Part*

- Work carried out on site.
- Plant delivered to the site, e.g. large truck delivered to site today to replace the small one.
- Material delivered, e.g. delivering reinforcement to the site.
- Record of a visit to the site.
- Record of problems on the site, e.g. water leak coming up through the road.

*Resident Engineers Record Part*

- Inspection carried out, e.g. inspected surface finish for concrete and informed the contractor that there are a number of cracks on the surface.
- Agreements reached, e.g. agreement given at 2.00pm to the contractor's agent to start casting piles.
- Record of instruction, e.g. instructed the contractor to backfill excavation at 50T test pile with crushed building rubble as no suitable excavated material was available.
- Record of a visit to the site.
- Record of checks carried out, e.g. checking setting out of pin positions for piles.

Job No. Sheet No.

Daily Site Record

Job Title

| Weather | Maximum temperature | Minimum temperature | Date | Signed |
|---|---|---|---|---|
| | | | | |

Work Description

Schedule of work

Concrete and other works

Formwork

Steel fixing

Instructions given

| No. | Description |
|---|---|
| | |

Resident Engineers Record

Drawings received

| No. | Source |
|---|---|
| | |

Materials tested

| No. | Position |
|---|---|
| | |

*Figure 2.1: A Standard Site Diary Sheet*

- Note of plant on site N.B. *such information was maintained in rare cases, and was mentioned only twice in a 9-week period.*
- Record of a query from the contractor, e.g. query from the contractor concerning the extent of the toe of the retaining wall to the north of the test pile area.

**ii) Minutes of meetings**

These are the minutes of meetings held between the supervising staff and the contractor's staff to discuss matters related to the construction of the works. The following are the common subjects with some examples of aspects that were usually reviewed and discussed in such meetings:

- Apologies for absence.
- Previous minutes, e.g. previous minutes of the pre-start meeting were accepted as a true record of the meeting, no amendments required.
- Contractor's programme and progress, e.g., a) the resident engineer confirmed receipt of the contractor's clause(14) programme, b) the resident engineer requested that for future meetings, a report be issued in advance of the meeting, indicating percentages complete for each activity in the programme, the reports to be based upon the Sunday before the meeting.
- Contractor's monthly programme, e.g. the resident engineer requested that a programme be presented at each meeting indicating activities to be carried out for the forthcoming month, the programme to include on and off site activities.

- Outstanding information, e.g. the resident engineer was requested to formalise requirements by the City Engineers Department for inspection of the permanent works.
- Delays/extension of time, e.g. one week extension of time was requested with the submission of the clause(14) programme.
- Subcontractors/suppliers, e.g., a) schedule of subcontractors notified by the contractor, b) the engineer requested samples of materials to be submitted where required.
- Temporary works, e.g. the engineer requested details of temporary works on the site.
- Workmanship, e.g. the engineer confirmed that the workmanship was generally of a satisfactory standard.
- Public utilities, e.g. the contractor advised that there were no problems with other public utilities.
- Valuations e.g. the engineer asked for copies of the daily record sheets and plant/labour returns.
- Safety, e.g. the engineer advised that hard hats should be worn by site personnel at all times.
- Any other business, e.g., a) the client advised that a student from the University of Newcastle (the author) would be visiting the site and he would be accompanied by a member of resident engineer's staff when on site, b) the contractor is reviewing

whether or not any work will be carried out on site during the Easter holiday period.

### iii) Confirmation of oral instruction

This file contained copies of standard forms prepared by the contractor and sent to the resident engineer to confirm any oral (verbal) instructions that were given by the supervising site staff. In addition to the subject of the verbal instruction, information on who had made these instructions and to whom they had been issued, was also included. These forms usually included a request from the contractor to the resident engineer to get his written order to cover the work instructed in addition to a notice of the contractor's intention to submit additional memos that cover financial and delay aspects relating to the instructions. The following are some samples of confirmation of verbal instructions as extracted from that file.

*'We confirm the following verbal instruction as instructed by ............ to ..............:*

- *To remove existing fencing to allow construction of retaining wall no.1 at the following locations .........*
- *To remove extracted material at ch100m left on site by previous contractor - approximate volume 240m$^3$*
- *To incorporate an extension of one week to the construction programme to allow for the Easter holiday break, C114 programme will now be twenty three weeks;*
- *To confirm your requirement by fax of the following items relating to test pile load testing:.....*
- *To break out and remove concrete obstructions between the existing draw pit (south of pumping station) and the new draw pit at approximately drainage 84m.'*

**iv) Site instructions**

This file included a copy of each site instruction issued and a list of all of these instructions (a register of site instructions). A standard form was used for issuing such site instructions. All the site instruction sheets that were kept in this file, were presented in hand-written format. The following are some samples of these instructions.

> *'Under the terms and conditions of contract would you please carry out the following:*
>
> - *Implement traffic management scheme as agreed with the engineer and highway authority. This will include measures at ..... including road signs and road markings as detailed on attached sketch.*
> - *Remove any fencing within your site boundary to facilitate the construction of the works-security of your site will be maintained by use of temporary fencing as allowed for within the contract. Remove from site and dispose of stock piled excavation arisings (by others) from area at approximate chainage 100.*
> - *Carry out road repair to ..... road as discussed with your staff on ....., the repair work to include: i) pumping out surface water ii) remove unsuitable material, iii) place concrete grade 40 reinforced with A252 mesh over all thickness 200mm, iv) apply brush finish to surface. This work is to be carried out for the agreed price of £2490 (excl. VAT) plus £170 (excl. VAT) for provision of traffic lights. The work is to be carried out as soon as possible.'*

**v) Contractor's letters**

All correspondence received from the contractor was kept in this file. A number of subjects were usually covered by this correspondence including the following examples:

- Confirmation of acceptance of the resident engineer's comments.
- Confirmation of site discussion.
- Notification of enclosing of method statement for static pile load testing.
- Notification of results of pile testing.
- Notification of enclosing an updated programme for the resident engineer's approval.
- Notification of progress stages.
- Request for some advice from the resident engineer.

In order to give an idea of how much information is included in such documents that is relevant to the progress of construction works, the following are some samples extracted from this correspondence file.

- *'we are in receipt of your site instruction no. ... dated on... and confirm that we are proceeding in accordance with revised drawings no..., we wish to take this opportunity however, to highlight that the extent of the earth works, insitu concrete and precast concrete works involved with sewer protection to accommodate future piling, requires a re-direction of resources from the retaining wall in order to complete the sewer diversion by ..... As you will appreciate this re-direction of resources is expected to result in delays to the main programme.'*

- *'with regard to letter dated ...... regarding site lighting, we must comment as follows: as you will appreciate our tender was prepared giving due cognisance to the existing site service and as your tender documents did not indicate that the street lighting within our site boundary would be disconnected, we must maintain that this is a variation. We therefore request that you issue an appropriate instruction for the provision of additional temporary site lighting.'*

- *'we hereby give notice in accordance with Cl12(1) of ICE Conditions of Contract that we have encountered a number of artificial obstructions in the area between chainage 120 - 135. This has resulted in the suspension* *of works around this area and the possible requirement to re-design the support work to .... carriage way. We must therefore inform yourselves in accordance with Cl12(2) pursuant to Cl52(4) of our intention to claim for additional payment - we confirm that we are currently investigating alternative measures and will give details and their estimated cost in the near future.'*

### 2.1.2 Observations

A number of observations were made from studying the above samples of site records, and these may be considered as an indication of the likely problems associated with the adopted record keeping system. They are as follows:

- For the daily site records, there were no clear rules or advice as to what should be recorded in the work description part and what in the resident engineers record part.
- As a result of the lack of such guidance, some records that are expected to be kept in the resident engineers record part, were maintained in the work description section (as shown in the example provided in section 2.1.1-i). There were also a number of sheets without any resident engineer records.
- Most of the work descriptions were only made as 'work in progress' or very rarely 'work started on'. It was also very rare to identify records of no work progress and there was no mention of work stopped, or whether work was started on time as programmed, or when works were completed.

- No mention was found about the contractor's programme in the site records diary. Records were kept describing the works carried out on the site without relating or referring to the contractor's programme.
- Although delays were observed on site in some construction activities, no delay records were identified in these daily site records.
- Records of the use of resources (labour & plant) were not properly kept and it was very hard to identify any useful information that would confirm the use of a resource for specific duration, e.g. 2 hours, 6 hours, etc.
- Preparing the daily site record sheets was undertaken at the end of each week for the whole preceding week and relied on daily notes which were written throughout each day. This duplicates the efforts and may end with producing incomplete information owing to the difficulties in remembering all the facts after a period of time, making some facts virtually impossible to recall and document.
- The daily record sheets were maintained in hand-written form and this made some of these records very difficult to understand. Some of these sheets were also written using blue ink pens (or sometimes pencils) ,which made some sheets' photocopies even more difficult to read and understand. If the supervising engineer requests his staff to clarify these unclear sheets, this evidently means more time will be spent needlessly.
- For the other types of site records, e.g. minutes of meetings, correspondence, etc., these documents contain a good deal of information which is important and of value, but it is very inaccessible. If certain information is required for some

purposes, that means a considerable effort must be made for searching for that piece of information, e.g. a whole minute of one meeting may be needed to completely read and searched for a piece of information related to a claim. The lack of some means of cross referencing that allow each record category within these documents to be allocated to a particular construction event, e.g. site instruction, will make them very difficult to access and make their use more difficult.

### 2.2 Study of Records Kept on A Completed Contract

The second preliminary investigation involved the study of records kept on a completed project. The object of this work was to review such a set of records to find out, for instance, what type of records were kept, the format adopted for keeping them, and the use that is made of such records. This was in addition to checking the clarity, continuity, and consistency of these records and also identifying if there are any records which do not fall into the categories already recognised. It was also to gain a good understanding of the problem areas, so that the questions in the questionnaire would be chosen with a good understanding of the likely difficulties.

To achieve this goal, an arrangement was made to have access to a full set of past records archived recently by a firm of consulting engineers on a completed highway contract, which also included a number of concrete bridges. The tender cost was around £15m while the final cost was near to £22m and its duration was 30 months. The supervising team included a resident engineer, assistant resident engineers, senior inspector for road works, senior inspector for bridge works and a number of inspectors. This was in addition to a chief resident engineer who was in charge of a number of resident engineers on the other contracts of the overall scheme.

During the construction period of the project under consideration, Scott (1991) was conducting research dealing with project plans and record-keeping on construction sites and he had visited the site of this highway project during construction. This was understood from discussion with the researcher himself, as well as from the related correspondence found within the set of the project's site records.

For the purpose of describing the work which was done during this study, the following sub-divisions have been used:

(2.2.1) discussing samples of site records kept on the contract under the following headings:

- Site diaries.
- Inspectors daily progress reports.
- Minutes of meetings.
- Weekly programme.
- Monthly measurements.
- Measurement and payment correspondences.

- Monthly as-built programme.
- Claims.

(2.2.2) discussing the observations that stemmed from this study under two headings as follows:

- Problems in keeping site records.
- Miscellaneous observations.

### 2.2.1 Records kept on the contract

The records of the contract were kept in 46 boxes, excluding drawings which were microfilmed and stored in a different place. Each box was 42cm long, 34cm wide, and 26cm deep (figure 2.2). A complete list of the records kept in these boxes is presented in appendix B. Obviously, these measurements and the number of boxes indicate the full extent of these records. If the boxes of this contract's records were to be stacked in the minimum possible space, they would take up a volume of 2 cubic metres but of course they need to take up a greater space to allow easier access to each box. According to a quality system procedure for archives adopted recently by this consulting firm, there is no upper limit for the duration of storage of archive material, and the minimum period of storage for project-related records will be sixteen years from the date of project close-out. Because of this, matters relating to space, accessibility and safety must be highlighted.

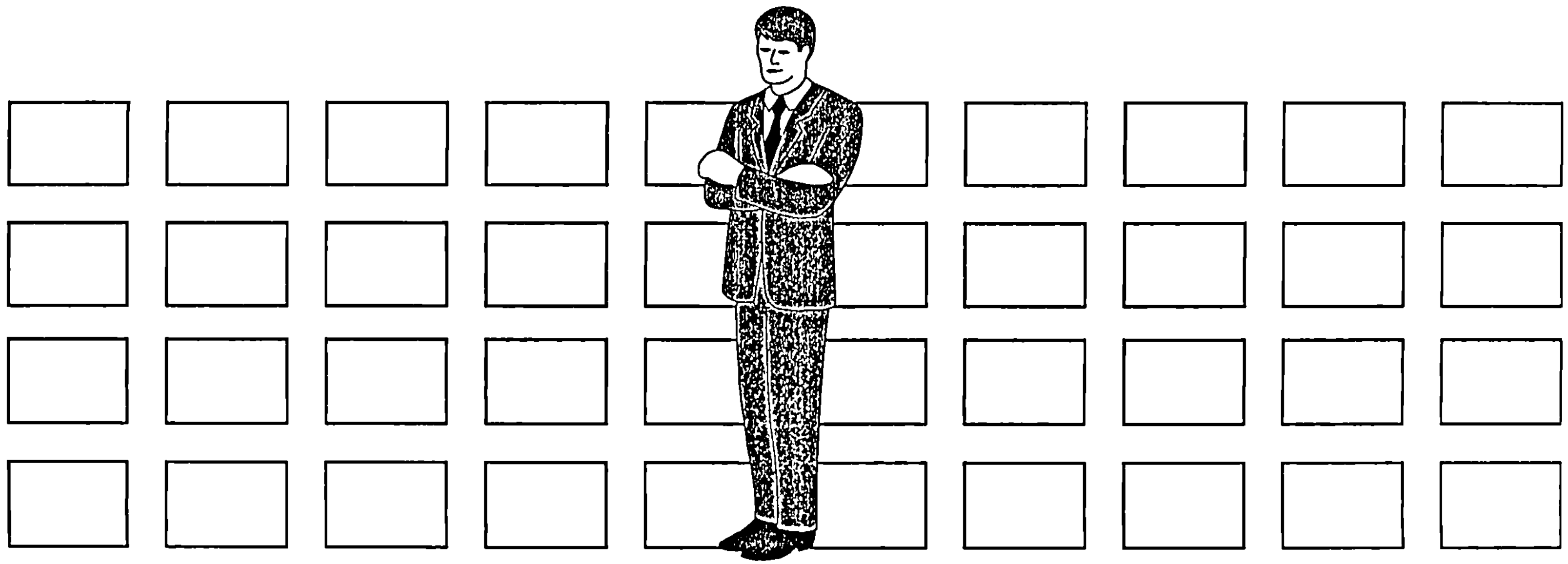


*Figure 2.2: Boxes used to store site records kept on a completed contract*

These boxes were drawn (to scale) to show the extent of the site records kept on a completed contract. The third dimension which is not shown on the figure, is the longest side of the boxes used.

A plan was prepared at the start of this study to ensure that it would be possible to achieve the proposed objectives. Because of the extensive mass of information and the limited time available, it was not possible to study and inspect all of these records. Therefore, a decision was made to extract samples from these records on a random basis for the study purpose. Extra attention was paid to the progress records owing to their importance in many construction management aspects. The following is a description of what was found from the inspection of these records.

**i) Site diaries**

As has been mentioned in the previous chapter, site diaries are expected to represent a running record made at the time construction occurs and their contents may be the only written records that are available on various matters. Therefore, site diary records should be neatly and accurately maintained. Such diaries are usually kept by each engineer and inspector on a construction site. The diaries for the project considered were stored in one box. As a part of this study, samples of records for a period of three months from each of the staff diaries were inspected individually and a summary of their contents is presented below.

### a) The resident engineer

The resident engineer's site diary was a free format diary, providing a blank A4 sheet for each day of the contract, and records were kept on a daily basis. Samples of the diary's contents can be summarised as follows:

- Notes on weather, *N.B. such notes were not kept on every day.*
- Appointments, e.g. meetings.
- Enquiries from the chief resident engineer.
- Personal activities, e.g. office paper work such as letters about claims.
- Complaints from the site staff.
- Time of starting and ending of the resident engineer's working day, e.g. 8.00am to 5.30pm.
- Confirmation of information received or given.
- Visitors, e.g. team of University students visited the site.
- Points to remind himself to do something, e.g. instruct site staff members to do certain works.

***General Comment:***

- There were many white pages, i.e. sheets without records at all, some of them signed with annual leave or sick leave.
- No records of construction work progress were found.
- Most of the daily records consisted of just two or three written lines on a page.

**b) The assistant resident engineer**

This was the site diary kept by the assistant resident engineer for measurement and it was also a free format diary and samples of its contents may be described as follows:

- Checks on the works e.g. checking of exposed excavations.
- Agreements reached with the contractor's agent.
- Enquiries addressed to the resident engineer or to the contractor.
- Appointments and meetings.
- Discussions, e.g. about stating or agreeing a rate for specific works.
- Replies or responses from the resident engineer.
- Personal activities, e.g. spending 75% of today working on claim no.3.
- Unusual occurrences, e.g. electric power cut off till 8.50 am.
- Works to be done, e.g. preparing the next set of variation orders.
- Rate calculations.

*General Comment:*

- Records were not kept on every day, and many pages were maintained with no records at all - almost all pages were empty for more than three months.
- Records were not always clear and understandable.
- Records of unusual information, e.g. word processor arrived today - no mention of for what purpose such information was kept, or what relation it bore to the construction process.

- Records of very personal matters, e.g. he (the assistant resident engineer) stopped smoking again!! *N.B. this was the only information kept on that day sheet.*

**c) The senior inspector for road works**

A free format site diary was used by this senior inspector and records were maintained on a daily basis. Remarks upon records that were kept in this diary are listed as follows:

- Weather notes, e.g. rain, bright & dry, overcast/showers, etc.
- Description of works.
- Records of no working hours, e.g. no work between 11am to 1pm with no mention of any reasons.
- Records of traffic management.
- Personal activities and appointments.

***General Comment:***

- Records were very hard to understand owing to difficulties in reading them, see figure (2.3).
- There were a number of pages maintained without any records and sometimes signed with holiday.

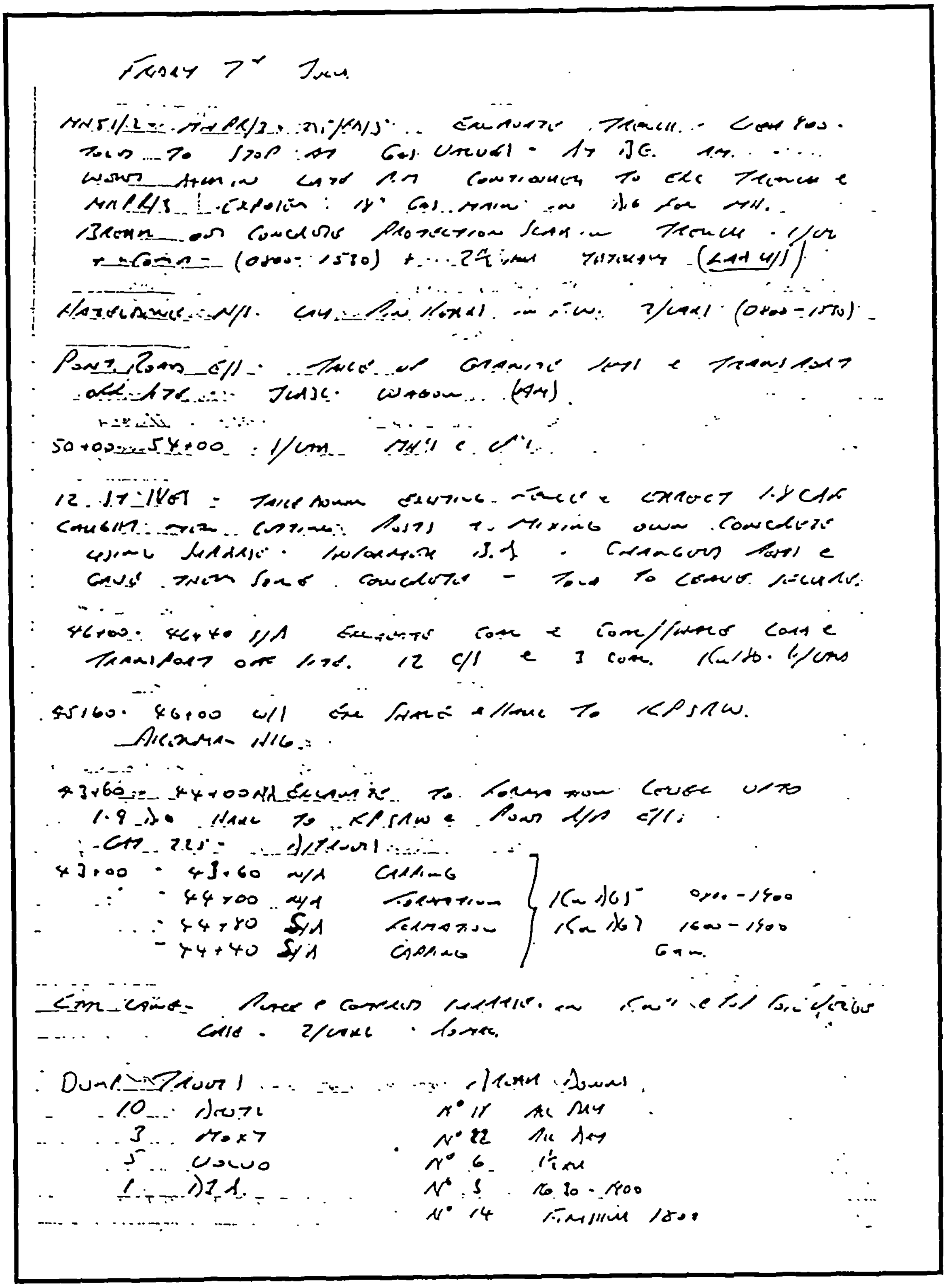


Figure 2.3: A Copy of site diary page kept by senior inspector for road works

### d) The senior inspector for bridge works

The bridge works senior inspector's diary was also a free format diary and records were also kept on a daily basis. It was noted that the records of this site diary were kept in a better organised manner compared with other staff diaries, and because of that it was decided to look at this inspector's diary for a whole one year period. The points that are made from studying this diary's contents are as follows:

- The senior inspector used two main headings on each page of his diary, i.e. work carried out and remarks or comments.
- Records of no work, e.g. no work on some bridges.
- Weather notes for each day, e.g. fine, showers.
- Records of daily working hours, e.g. 8.00-17.30.
- Visitors.
- Records of labour force records were kept in most cases against each activity;
- Times of meetings.
- Advice given to the contractor's agent, e.g. site engineer advised to remove concrete core.
- Accidents.
- Commencing and completing of concreting.
- Enquiries to the contractor's agent, e.g. pointing out problems to the contractor's site engineer, and whether any action had been taken on previously reported problems.

- Notes about the labour force, e.g. there was a mass exodus of the contractor's men at 15.30 leaving only the site engineer, the section engineer, and the general foreman to carry on cleaning out the formwork.
- Notes about security, e.g. insufficient safeguards used;
- Tests, e.g. slump tests or cube samples taken.
- Records of a technical point of view given to the contractor's staff;
- Records of defects in carrying out the works e.g. the concreting was carried out without official approval being given.
- Records of absence of inspectors.
- Records of disruption caused to work due to lack of equipment, e.g. joiners were unable to gain access to stores for their tools because the man responsible for keys was absent and no spare keys available.
- Records of rejected works, e.g. work rejected because it did not conform to specification and contractor site engineer advised accordingly.
- Delay records, e.g. serious delays were encountered to the erection of the remaining 5 beams at bridge no.1. The crane arrived but was unable to commence the erection due to a shortage of ballast and spreader plates. The erectors waited until 19.30 hours but the material had not been delivered by this time. They left the site. The material arrived on site at 20.30 hours.
- Records of weather effects, e.g. i- works delayed by weather conditions, for example, entire deck covered in snow. ii- works not affected by rain although some of the work force declined to work during the daily period.

- Records of discussion with the assistant resident engineer.
- Records of theft e.g. the entire quantity of the tools box has been stolen.
- Recording of difference in opinions between the senior inspector and any other site staff, e.g. "with regard to the void formers, I have insisted that they should be positioned without any damage. The assistant resident engineer is prepared to accept some damage to the void formers. I contend that when the void formers were delivered to site they were in mint condition. Any damage to them has been caused by the contractor's failure to protect them and consequently they should be rejected. I have issued a directive to the contractor's site engineer asking him to replace them."
- Record of a decision made to remedy an error, e.g., it has been decided that the bars which were incorrectly bent for the cantilevers at bridge no.2 will have to be replaced.
- Record of material delivered to the site.
- Record of additional materials used due to contractors faults, e.g. additional concrete used at bridge no.3 and this is purely the contractors responsibility;
- Record of works finished, e.g. bridge no.2 opened to traffic.

*General Comments:*

- The records of this site diary were maintained with clear handwriting.

- The records which were kept in this inspector's site diary, were good compared with other staff diaries i.e. detailed information was kept including some delay records, but there were some difficulties.
- Most of the detailed information was mixed and maintained without clear categorisations e.g. different types of information were kept under one section only i.e. the remark or comment section, and as result of that, these records are not accessible due to the wide variety of such information.
- From the handwriting, it was clear that some pages of the diary had been filled in by somebody other than the senior inspector without any indication of who had kept these records.

**ii) Inspectors daily progress reports**

Records of works carried out were maintained by the inspectors on a standard format report on a daily basis. There were two standard sheets, one prepared for road works, and another one for keeping records of structural works. In addition to a description of works carried out, information about plant & labour force and materials were required to be supplied in these reports. Each report was designed to keep progress records under several headings as shown below:

**a) the daily road works progress reports**

- Inspector's name
- Day / date

- Road section details
- Contractor's hours
- Fill section
- Details of works
- Chainage: from and to
- Plant: type, hours worked, hours standing, and hours breakdown
- Labour
- Materials: type and quantity
- Subcontractors
- Remarks
- Weather
- Site conditions
- Instruction given
- Signature of resident engineer and contractor's site engineer

**b) the daily bridge works progress report**

- Day / date
- Inspector's name
- Contractors hours
- Structure no.
- Section
- Details of work

- Plant: type, hours worked, hours standing, hours breakdown
- Labour
- Materials: type and quantity
- Subcontractors
- Remarks
- Weather
- Instruction given
- Signature of resident engineer and contractor's site engineer

*General comments:*

The following observations were made from inspecting both inspectors' daily progress reports:

- Filling in of the forms was not always undertaken properly, i.e. some information which was required to be maintained in these forms, did not appear e.g. no information was available on the materials used.
- Some records were kept in a disorganised manner, i.e. it was very hard sometimes to judge to which records kept in one column, information of other columns belonged (see page 3, appendix D).
- The handwriting of some records kept in these sheets was not clear or legible.
- The approval required by the resident engineer and the contractor's site engineer was not evident on the sheets, i.e. no resident or site engineer's signatures were evident.

### iii) Minutes of meetings

Minutes of meetings are expected to represent records of discussions between the contractor's site staff and the resident engineer's staff about subjects related to the construction process. This is in addition to records of any agreement reached between the two parties on matters related to work progress as planned and as achieved. In the set of records kept on the project under study, there were two types of meetings records i.e. minutes of meetings held between the chief resident engineer and his staff and minutes of progress meetings held between the two parties on the construction site.

#### a) meetings with the chief resident engineer

The chief resident engineer was responsible for supervising the whole highway project scheme which was composed of four contracts, each supervised by a resident engineer. The set of contract records studied and presented in this chapter, is related to one of these four contracts. His meetings with the resident engineers were usually conducted on a monthly basis to discuss matters related to the construction works and to improve internal communications. Such meetings were expected to offer an opportunity to the supervising team to exchange experiences and relevant information about the construction process. It was also an opportunity for the chief resident engineer to advise his team on the suitable procedures that would help in conducting their duties. The example presented in section 2.2.2.2-(iii) provides a clear instance of such functions. Minutes were produced at the end of each meeting to record the discussions and decisions. A sample of the contents of one of these meetings can be summarised as follows:

- Reports on the staff's activities and staff-related business e.g. staff movements to other contracts or new members joining the staff.
- Notes on site safety, e.g. no matters were raised under this item except damage to an electricity cable which occurred on .... (at ....).
- Reports on contract no.1, e.g. progress on outstanding and remedial works is as reported. The bridge works have slowed down during the past week or so and concern has been expressed to the contractor about lack of progress on fencing. The long period of dry weather is preventing landscaping works being advanced.
- Report on contract no.1A, e.g. claims for excessive water and boulders encountered during the thrust boring operation are being processed.
- Report on contract no.2, e.g., (1) progress on the deck cantilevers is variable according to the competence of the construction teams. A further week has been lost on the NE deck. (2) Instructions need to be issued for the heights to which the bridge deck safety fence post plinths have to be cast. Predictions as to the final deck levels cannot be made with 100% accuracy. (3) A revised programme has been requested as the finishing operations are being carried out in a different sequence than shown on the current programme and other operations are slipping.

- Reports on contract no.3, e.g. the sources of supply of pre-coated chippings for wearing courses on the various contracts were discussed and it was concluded that no great changes of surface colour would occur.
- Materials e.g. discussions referred to the difficulties faced at the laboratory by the volume of tests required; up to 300 samples per week were generated by the works whereas only 6 tests per day could be completed. The importance of the nuclear density meter testing was emphasised.
- Site visits.
- Date of next meetings.

**b) monthly progress meetings and reports**

Progress meetings were held between the supervising engineer's staff and the contractor's agent (project manager and/or site engineer) on a monthly basis. The results of the discussions and agreements made usually appeared in the minutes of the meetings which were usually approved or refuted afterwards by the people who had attended the meetings. The common subjects that were usually discussed in such meetings in addition to the apologies for absence, were presented in an agenda as follows:

- Minutes of previous meeting, e.g. to state that it is accepted as a true record or if there are any reservations.

- Matters arising - any matters arising from the previous meeting and which would be dealt with in the relevant section of the agenda, e.g. to discuss the contractors remedial proposals for certain works.
- Works programme, e.g. to discuss works to be carried out this month, to identify any defects, to discuss traffic management proposals, or to discuss differing views on the clause 14 programme.
- Progress report e.g. to describe the state of the works: whether activities have commenced, are on programme, delayed, or completed;
- Finance, e.g. confirmation of receiving an interim certificate no. ... and a payment of £... was recommended by the resident engineer to the engineer for approval.
- Claims, e.g. stating the results of claim's assessments, stating whether the payment is being authorised or not, or to discuss methods of payment.
- Outstanding information e.g. to clarify the location of the different types of safety barrier posts required, the engineer asked if it was feasible to complete the verges in advance of the fence work so that tests could be carried out. The contractor's agent agreed that it was.
- Third party claims: to discuss claims submitted by the public to recover damages caused by the construction process, e.g. damage to paint work from dust emission.
- Materials - to discuss test results e.g. the surfacing on ... road has been rejected on surface texture. The resident engineer commented that results had confirmed the

suspicion that the chipper was too light and perversely another area had suffered plucking because the rate of chipping was too heavy.

- Workmanship e.g. the resident engineer has rejected some of the bearing mortar plinths on bridge no... because of cracking due to lack of curing, which is in contradiction of both the specification and the manufacture's recommendations.
- Any other business e.g. the contractor being requested to deal with the complaints from the city council environmental health department about the noise from wagons parked and maintained on ... road and about dust from landscaping adjacent to ... park.
- Date and place of the next meeting.

**iv) Weekly programmes**

These were sheets submitted by the contractor to the resident engineer in a bar chart format. Each sheet was designed to show two weeks duration of construction works and submitted either to clarify how works were going to be carried out, or to get approval from the resident engineer for a proposed future work schedule. No records were found of whether the resident engineer commented on these programme sheets and whether he agreed or disagreed with the contractor's short term work programme.

### v) Monthly measurement of progress

These were two sets of sheets maintained by the supervising staff on a monthly basis, one for road works and another one for structural works. A list of activities was prepared for each type of works to record the percentage completion against each of them based on monetary values. Each sheet was related to one interim valuation. It is believed that such records would form the basis of the payment certificates.

### vi) Measurement and payment correspondence

These were copies of correspondence between the resident engineer and the project manager, who represents the contractor's interest (the contractor's agent), and related to the agreement or disagreement about measurement, rates, and payment methods. The following are some examples extracted from this correspondence:

**a) from the project manager to the resident engineer**

- *... further to your site instruction no..., we enclose details of revised rate for seeking for your agreement;*
- *... due to your late varying requirements in this area, we will submit records of the above work for your verification and require payment in accordance with clause 52 of the condition of contract. Please issue the necessary variation order;*
- *... we will therefore keep contemporary records of all additional works in this area and will seek reimbursement through the contract;*

- *... disagree with resident engineer's statement that bill rates reasonably describe the operation, we consider that bill rates do not cover the following conditions: difficult plant access, and restricted working of plant due to the proximity of existing fencing;*

- *... we herewith apply for a certificate of completion of the works, as of ..., pursuant to clause 48(1) of the condition of contract. We hereby undertake to finish any outstanding work during the period of maintenance.*

**b) from the resident engineer to the contractor's agent**

- *... I would point out that the delays to this work are mainly due to your method of working and lack of resources. I will not accept any additional costs connected with surfacing due to your late completion of this work;*

- *... with reference to site instruction no...., there will be no extra payment to the bill of quantities rate for this work because it is only an increase in quantity of the proposed works, not an isolated one-off section;*

- *... I refer to your letter of ..., and can not agree that a 3 hours delay was incurred because additional plant had to be brought on the site;*

- *... I accept the rate of £... for the additional item "obtain bulk samples from boreholes".*

**vii) Monthly as-built programmes**

These were bar chart format sheets which were to be filled in for each month. To show the works which were carried out during a one month period, the records were to be kept against each construction activity listed on the sheet. In the project under consideration, only structures' as-built records were kept on these bar chart sheets against construction works that were carried out. Figure (2.4) shows an example of the sheets. It seems that the records were not properly kept and only to show the

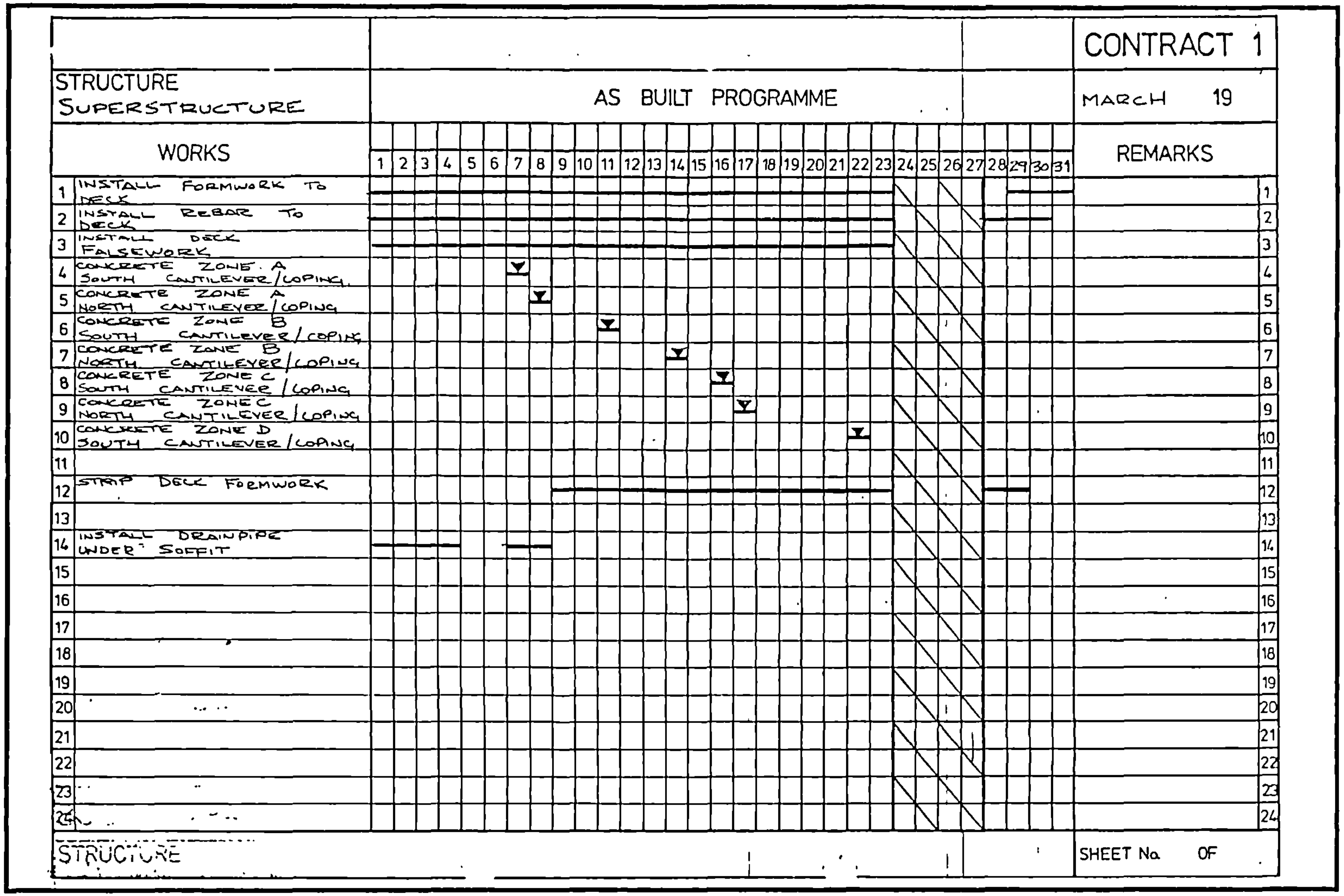



*Figure 2.4: A copy of monthly as-built programme*

duration that an activity took rather than recording the actual daily progress status of that activity. As shown in the example, the records indicate that works on the first three activities were continuing for the whole 3 weeks. It is, for instance, unusual that works would be conducted on Sundays and it is also unlikely that bad weather, particularly in March, would not disrupt such construction works. Additionally, as these sheets were only prepared on a monthly basis, it means that they were prepared based on information already maintained in other site documents such as site diaries; that is they were not a contemporary record of events.

**viii) Joint records for varied works**

It is good practice to keep joint records for varied works, to help avoid unnecessary conflicts and resolve any related claims. However, in the set of records of the project under consideration, such arrangements were not observed. A letter containing matters related to this issue, was sent as a response to a letter from the contractor, but it appears that no procedures to ensure that records were jointly agreed were implemented. The contents of these two letters are given below.

**a) from the contractor's agent to the resident engineer**

> *'We refer to the various correspondence, instruction and variation orders issued to date relating to altered, amended and additional works to earthworks and structures and comment as follows:*
> *As a consequence of the above, we have incurred and continue to incur considerable delay and disruptive effects upon the programme and progress of our structures operations. The effects of these delays and disruptions are as*

*follows: 1) disruptions to works on particular structure operations and subsequent "knock-on" effects to other structures. 2) the necessary re-allocation and re-programming of operations on structures necessitated by delays and disruptions. 3) retention of resources on delayed structures for longer periods than anticipated, resulting in uneconomic and inefficient usage of resources. 4) retention of supervisory staff and ancillary resources for extended periods.*
*We confirm that we will require to be reimbursed for all additional costs incurred as a result of the above and will maintain such contemporary records as we believe necessary to substantiate our contentions on such matters.'*

**b) the reply letter from the resident engineer to the contractor's agent**

*'I acknowledge receipt of your letter dated ....(the above letter) and note the contents. Your work will be valued in accordance with the contract, which evaluation will take account of all the relevant factors. I agree that keeping of joint records of varied work is in all of our interests to assist in the speedy resolution of disputed items. However if you require that your daily records are signed by my staff then please ensure: a) you inform me in writing that you intend to keep records, b) the records are handed over the following day for signature.'*

**ix) Claims**

Records kept under this title were either correspondence between the parties on the construction site, or claims submitted by the contractor for the engineer's approval. Each submitted claim was usually supported by relevant documents, and the following parts were included in one claim folder found in the set of records inspected:

- Contract particulars: including general information, e.g. client, engineer, contractor, conditions of contract, specification, method of measurement, tender sum, and time for completion.
- Description of contract works: e.g. location and brief description of works.

- Statement of claim: brief description of situation of construction process and reasons raised for submitting the claim as well as referring to all correspondence with the engineer related to the subject of the claim.
- Detailed particulars: tender information that was related to the claim, e.g., (1) to argue why such matters subjected to claim were not covered in the tender, (2) actual events, to describe what happened, (3) to show the effect of the unexpected occurrence to validate the claim.
- Evaluation of costs: to show the costs incurred due to the occurrence of the matters subject to the claim, i.e. details of evaluation including hiring costs of plant, labour, access road material, and sundry charges.
- Instructions: a list and copies of all site instructions that related to the claim.
- Correspondence, copies of all correspondence with the resident engineer which related to the claim.
- Programmes: this consisted of copies of work programmes which were submitted during the construction period that preceded the claim - such records were submitted in a bar chart programme format, and also included records of resources used on the construction activities involved in the claim.
- Delay references: referring to the delays related to the submitted claim, including a brief abstract of these delays, e.g. suspension of works awaiting engineers instruction for the stabilisation of ground conditions.

Correspondence files kept on claims contained copies of letters sent backwards and forwards between the two site parties including claim notifications, delays, resident engineer's instruction and confirmations, and requests to submit details to substantiate, for instance, costs claimed. In addition to that type of correspondence, letters sent by the engineer to the client concerning the progress of the construction works and matters relevant to the contractor's claims were also included in such files. Examples of such correspondence were extracted from these files as follows:

**a) the contractor's agent sent the resident engineer the following letter:**

*'... during the execution of our works, we have encountered adverse physical conditions which could not reasonably have been foreseen by an experienced contractor on the basis of the tender. Conditions encountered below ground level are in the form of a layer of unsuitable material approximately 1.5m thick at ground level. We anticipate that these physical conditions will cause additional cost and delay to the contract and therefore give notice pursuant to clause 12(1) of the condition of the contract. Trial holes excavated in accordance with your instructions on ... have confirmed the presence of material which is unsuitable and unstable in this area. We would point out that there is no unsuitable material shown above or below earth works outline on earthworks drawings or schedules for this area, with a minimal volume of 100m3 of unsuitable billed for this structure,... The conditions now being encountered require us to take special temporary works measures in order to progress the works. We are currently producing what we consider to be the most economic scheme in order to mitigate delay and additional cost to the contract and will submit this for your approval as soon as possible. We confirm that we will require to be reimbursed all additional costs incurred in the above and request your issue of a variation order to cover this work.'*

**b) the resident engineer's response to the above contractor's letter:**

*'... I do not consider your claim to be acceptable because it takes no account of the soil investigation data. An experienced contractor would have consulted this before planning the method of bridge excavation and tendered accordingly. The physical ground conditions are conditions which could have*

*been reasonably foreseen from soil investigation data supplied as part of the contract documents. ..., please, supply your detailed proposals for excavating the foundations as a matter of urgency.'*

**c) a letter sent by the engineer to the client regarding the contractor's claims:**

*'As the contract is nearing substantial completion, we have carried out an assessment of the contractor's entitlement to an extension of time, in accordance with clause 44 of the condition of contract. As you are aware, additional and varied works have been instructed and a summary of the major items which have affected overall progress is given below:*

- *change landscaping requirements - 4 weeks delay*
- *varied works - 2 weeks delay*
- *unsuitable material and public utility delays - 3 weeks delay*
- *additional works to .... - 1 week delay*
- *.... pavement construction - 3 weeks delay*

*Many of these variations have been concurrent or non-critical and we assess the overall prolongation of the works to be five weeks. To this period, one week should be added to take account of the works being extended further into the winter period and a two week allowance should be made for Christmas holidays. The overall prolongation to which the contractor is considered to be entitled is therefore eight weeks. As the programme completion date is ... , i.e. some five months earlier than the contract completion date, it is not necessary for an extension of time to be granted. we propose however to certify payment of the additional site overheads and head office costs incurred by the contractor for the eight week period of delay which we estimate will amount to approximately £... . The contractor considers our assessment of eight weeks insufficient and seeks much higher costs. This assessment of delays and cost will need to be reviewed following completion of the works and we will keep you informed of any changes which may occur. We will be pleased to provide any further information you may require.'*

### 2.2.2 Observations and problems in the record-keeping system

The following points stem from studying this contract's set of records and are listed under two headings as follows:

(2.2.2.1) problems observed in keeping site records, and;

(2.2.2.2) miscellaneous observations.

### 2.2.2.1 Problems observed in keeping site records

#### i) the problem of illegibility

All personal records, which represent a considerable proportion of the site records, are hand written records with a variable degree of legibility. On this contract, some of these records were not clear and some were completely unreadable. It was sometimes very difficult even to identify the subject matter of the maintained records. Some standard forms were also not properly filled in and much required information was missed and incomplete, even though the forms were prepared in an attempt to simplify the procedures of record keeping. Samples of such illegible records are presented in appendix C. The issue raised here is that while efforts were made and time was spent to keep records on the site, some records were produced of such poor quality that they cannot be used for any purpose. This simply means effort and time were wasted which could have been used in conducting other useful tasks. Illegible records will undoubtedly affect the accessibility of such records which may include important or essential information. Whether there is a need to keep and store such records for a long time after the completion of the project (as required by this consultant firm's quality system for archives, i.e. minimum of 16 years after the project is completed) is also another matter of concern which needs to be dealt with, particularly when the available storage space becomes very limited. Some professionals may argue that these records should be kept, even if they were illegible, in case of arbitration; they could always be recognised by the person who had maintained them to refresh his memory in a dispute. Of course, in 16 years, the same people may not always be available.

**ii) lack of continuity**

One of the problems which the daily site records suffered from was discontinuity. The most common reasons for this were the absence of the site staff due to sickness or holidays. Annual leave taking is approximately 30 days per year for each site staff member. This means for such a project of 2.5 years duration, at least 60 days would be spent on holidays by most of the supervising staff, individually, excluding any sickness or other absences. Although management may suggest alternative persons to substitute for the absentees, such a remedy was not observed within the samples of site diaries inspected, i.e. many pages of the diaries were left with no records kept. Such breaking up of records clearly influences their continuity. As stated previously, some daily records are illegible, and continuity of site records is also affected by the illegibility problem. The discontinuity in, for instance, one week's records would typically result if records kept on one or more days during that week, could not be read or understood. Records that nobody can read or understand, are almost the same as no records at all. In order to check the continuity of the maintained records on the contract under consideration, samples of personal site diaries were inspected for a random period of three months. In these site diaries, a considerable number of pages were left blank without any records. Such a problem, may reflect the deficiency of the procedures adopted for record-keeping. Records of construction process on any particular day, are expected to be available in such documents, but, with blank diaries, it is not possible to obtain the required information. Such difficulties will typically limit the uses of these records and undermine the reasons for keeping them.

**iii) lack of consistency**

Another problem observed within the personal site records, which also reflects one of the defects of the adopted record-keeping system, is that these records contained inconsistencies. For the same construction activity, some records were found inconsistent with other information kept by different personnel, e.g. for x type of work activity, one record stated that 4 labourers worked to construct the work, while in another record kept by a different person on the same aspect of the work, only 2 labourers were used. In this investigation, a trial was carried out to check the consistency of the maintained records by comparing the records kept by the senior inspector with another inspector's records; both were responsible for inspecting the same type of work. An example extracted from the records kept by the inspectors for bridge works to show this comparison is shown below. The senior inspector's records were kept in a free format site diary while the records kept by the inspector were maintained in prepared sheets described as progress reports. Both the inspector and the senior inspector were describing works that were carried out on the same day as shown in Tables 2.1 & 2.2. As shown in this example, differences in some records clearly exist (e.g. records of labour forces used as kept by the two persons for these bridges on the same working day). Copies of these records as maintained on the site, are presented in Appendix D. Keeping records in such a manner i.e. two records of the same part of the site that contradict each other, will, undoubtedly affect the credibility of the records. Although keeping records on the same activities by different people will provide an opportunity to avoid the discontinuity of these records, this can sometimes create problems. When two records confirm differing activities / resources / times, which one can be considered as the factually accurate information?

**Table 2.1: The senior inspector's diary records** (Monday 26th of September 199.)

| |
|---|
| *Bridge (A)*<br>1. Installing formwork to N/E N/Abutment<br>(3 Scaffolders)<br>2. Rubbing up parapet edge S/W wing wall<br>(1 Finisher)<br>3. Cleaning tendon box out anchorages<br>4. Drilling holes for anchor bolts |
| *Bridge (B)*<br>1. Erecting scaffold N/Face N/Abutment<br>(3 Scaffolders) |
| *Bridge (C)*<br>1. Drilling anchor holes for void formers<br>(2 Joiners)<br>2. Sanding down joints in deck soffit<br>(1 Joiner)<br>3. Loading rebar to deck NGK<br>(4 S/Fixer) |

**Table 2.2: The inspector's daily bridgeworks progress report** (Monday 26/9/199.)

| |
|---|
| *Bridge (A)*<br>1. Strip formwork from N.E wing wall cantilever<br>(4 Joiners)<br>2. Fabricating S.W parapet formwork (wing wall)<br>(1 Operator, 3 Labs.)<br>3. Rub up & care finish S.W wing wall parapet<br>(1 Ganger.)<br>4. Scabble const for N.E wing wall parapet<br>(3 Labs) |
| *Bridge (B)*<br>1. No progress general tidying up of site |
| *Bridge (C)*<br>1. Deck soffit remedial work<br>(5 Joiners)<br>2. Steel fixing progressing<br>(5 Fixers)<br>3. Wing wall formwork progressing<br>(1 Operator, 1 Lab.) |

**iv) the large amount of correspondence**

The huge amount of correspondence between the resident engineer and the contractor's agent is obviously noteworthy. As mentioned earlier, these documents contain a good deal of information which is important and of value, but accessing this information will not be an easy task. The lack of an effective system for managing such a large amount of correspondence, makes such valuable information inaccessible, i.e. obtaining useful information from these documents, will be a time-consuming process. If an effective system was established, for instance, using a coding system to allocate this correspondence to each construction event such as site instructions, variation orders, claims etc., it is believed that the accessibility would be improved and the searching process would undoubtedly be simplified. Unfortunately, such systematic arrangements were not observed within the set of records inspected. A policy which seems to be adopted deliberately by a number of contractors is pumping the resident engineer with a stream of letters on an almost daily basis for the whole period of the contract. This policy will undoubtedly result in keeping the resident engineer busy with paper work during the official working daily hours because the contractor knows that the supervising engineer has to respond to these letters. This means the resident engineer will be kept from fulfilling other duties such as monitoring the construction works and maintaining adequate records. Such circumstances may provide an excuse as to why the resident engineer's site diaries were lacking in progress records.

**v) the problem of accessibility**

The maintained site records were, in most cases, difficult to access for various reasons, and if certain information was required for any purpose, it meant a considerable effort to find it. Several trials were carried out to identify what was going on during different periods of one week of construction works from the records that were kept in a number of site diaries, but it was not easy to gain useful information that would help to develop a complete picture of what had happened on individual construction site activities. It was also not easy to link some information that was maintained on one particular day to records kept on other days during the week under consideration for a number of reasons. These included difficulties in understanding some of these records and was sometimes due to the discontinuity of the information. The accessibility of site records is affected by a number of factors, including: their legibility, lack of well-defined categorisation, large amount of correspondence, and lack of effective record-keeping systems. This is in addition to the fact that some records did not provide actual information and simply redirected the search, for example, in some diaries the entry under a particular part of the works would be 'same as yesterday'!.

**vi) the storage space problem**

As mentioned earlier, the quality procedure for archiving which was adopted by the consulting firm, stated that project-related records should be stored for at least 16 years. The contract records studied related to only one of the four contracts that were established for the overall highway scheme. Some of the other contracts' records were kept in a number of boxes of the same size that were used to store the records of the contract under consideration and larger boxes were also used. About 145 boxes of records (minimum size of 42*34*26cm), excluding drawings, were used to store the records of these four contracts which, as mentioned above, formed only one complete project. Of course, many other sets of records would be kept by this consulting firm on other different projects, which would typically need to occupy additional space for a long period of time. This means a considerable storage area is needed to store this large volume of records for many years and accessibility to these boxes should also be provided to allow the records to be utilised. This is usually a problem as the available space is often limited. In addition, procedures to keep these records safe from fire etc., should always be carefully established to protect such valuable information. There is no doubt that all of these factors will incur additional costs.

#### 2.2.2.2 Miscellaneous observations

**i) The duties of the supervising engineers**

As an indication of the importance of defining the duties of the supervising engineer, a letter was sent by the chief resident engineer to the resident engineers to clarify such duties which were agreed with the client. The letter was sent 18 months after the project commencement date. The resident engineers were, of course, mostly senior engineers and should have had good experience of conducting such jobs but, for one reason or another these duties were stated again to them. This may indicate that, such duties are still not well carried out and there is a need to specify and clarify the functions of the supervising staff. Keeping site records was clearly stated as one of these duties. The chief resident engineer's letter stated that a meeting took place recently with the client at which supervising procedures were discussed and the duties of the supervising staff were briefly confirmed as follows:

- *To be thoroughly conversant with the relevant drawings, specifications and any agreed method statement.*
- *To see that the work is properly supervised at all times and carried out fully in accordance with the above documents.*
- *To notify the contractor's person in charge if any deviation is observed, and to confirm this by a hand-written note from a site duplicate book unless it is immediately rectified.*
- *To notify the consulting engineer responsible for the work as soon as practical.*
- *To keep adequate records.*

A move towards decreasing the number of supervising staff members on construction sites, which was mentioned by one of the consulting firm's staff, for the purpose of controlling expenditure, may affect the supervisor's ability to perform such duties, particularly the record keeping function. This undoubtedly highlights the importance of adopting an effective record-keeping system to maintain adequate site records whatever the size of site staff.

**ii) The need to maintain as-built records**

As one of his duties, the chief resident engineer was responsible for advising the supervising engineers on how they should conduct their job properly, and as stated earlier, one of their important duties would always be keeping adequate records. To fulfil such function, an inter office memorandum was sent by the chief resident engineer to the resident engineers to prompt them to maintain as-built records. This memorandum was sent six months after the project commencement date, and in fact it reflects the importance of keeping site records and the need to improve such records to be available for optimum utilisation. The following records the contents of that memorandum:

> *'Construction Records - At the risk of preaching to the converted, I would like to stress the benefits which are obtained from the preparation of an as-built programme showing activities worked each day as the job proceeds. The activities should include those on the Clause 14 programme plus any major variations. Such programmes can assist greatly in the assessment of extension of time and disruption claims by collating information that would otherwise have to be found by ploughing through inspector's and engineers' reports. Please arrange for them to be produced on your contract if you have not already done so.'*

The provision of such an as-built record, pulling together other records in an orderly manner certainly seems to be a step forward. However, the decision to compile such a record almost certainly stemmed from Scott's involvement (Scott 1991) with this contract as mentioned earlier in section (2.2).

**iii) The need to improve site progress reports**

In one of the chief resident engineer's meetings at the beginning of the project, the chief resident engineer stated the outline of the progress reports which he expected to be produced for and discussed in such meetings as follows:

> *'... I would like to use the experience to improve further meetings. One area where improvement is possible is in the standardisation of the format of the resident engineer's reports, and to this end I have set out below the required layout in more detail than in my previous memo. on the subject dated on (six weeks before):*
>
> - *Progress report: A brief description of progress since the last meeting, including in particular details of problems which have arisen.*

- *Progress summary: A list of progress on the main current activities on the programme showing items ahead as +ve, items late as -ve, and change since last month in brackets e.g.:*
- *Fencing & site clearance -2 weeks (0)*
- *Geotechnical work +1 week (+1)*
- *Resident engineer's forecast: This is the resident engineer's current forecast of when certain critical or significant events will occur. The particular events are to be agreed with me, but will include contract completion, dates for providing access to others, plus a number of clearly identifiable events at roughly three months intervals to act as 'milestones'. The forecast should be in chart form.*
- *Information required: A list of any information required from the contractor, the client, the consultant head office, ...etc.*
- *Complaints: a summary of complaints received during the month.'*

14 months after that, the chief resident engineer sent a letter to a resident engineer in which he expressed his concern about the detailed records being produced which were obviously taking considerable time and effort to prepare. Rather than simply providing the essential information required these records were clearly very detailed, so much so that they were confusing. Unnecessary details may complicate and restrict searches for a certain piece of information that is required for specific purposes and such unwanted details make the task of accessing these records more difficult. These arguments highlighted the need for an effective record-keeping system to ensure that efforts and time are not wasted and to produce useful reports. The contents of that letter are as follows:

*'... your progress reports are superbly detailed, but I fear are taking a disproportionate effort to produce. Please therefore make future reports consist only of:*

- *a brief description of progress, mentioning only major activities or problem areas, e.g. where delays are occurring;*
- *your best forecast of when key events will happen;*
- *a list of outstanding design information;*
- *a list of outstanding material approvals;*

- *a summary of complaints received.*

*I feel that actual progress is covered well enough by the contract progress meeting minutes and I wish to avoid undue duplication of effort. Your whole report should normally be no more than 2 sides of A4.'*

**iv) The need to improve claims assessment procedures**

The engineer usually assesses contractor's claims by comparing the contractor's version of events with his own records. A number of these claims might be dropped sooner if the engineer was able to support his assessment with good, consistent and clear records. An example of a number of letters written with regard to a delay claim was extracted from the set of records kept on the highway project as an attempt to substantiate this view. The contractor's agent gave notice of his intention to submit a delay claim by a letter as follows:

*'.... we refer to our director's letter of ... regarding our practice of recording any delay to works on a weekly basis. Please find enclosed a copy of appendices no... regarding delays which have occurred up to and including week ending.... Since the enclosed details could form the basis of a claim for extension under the provision of the clause 44 of the condition of contract, and where appropriate for price adjustment. We would ask for your confirmation that facts as presented are a true record.'*

The engineer's response to this notification was presented in a number of letters sent back simultaneously to the contractor. Each letter related to each delay and the following are a few examples:

- *'... with reference to your delay notification no.1, my records indicate that on the date for which the delay is claimed, work on the fixings had not commenced. Accordingly I am unable to accept that the claimed delay actually occurred.'*

- *'... your notification no.2 refers to a delay of a half week due to the excavation of unsuitable material at the bridge site as claimed in delay notification no.... Please refer to my letter dated ... regarding notification no... the delay for which was refuted. I am therefore, unable to accept that consequential delays resulted from this excavation work.'*

- *'... In connection with your delay notification no.3, I wish to refer you to my letter dated ... The finish to the supplied bolts was not to specification and no costs or delays resulting from their rejection will be accepted under the contract.'*

- *'... with ref. to your delay notification no.4, I agree that a delay of one week occurred during the construction of that side road roundabout due to late notification of the site clearance requirements for existing street furniture.'*

- *'... with reference to your delay notification no.5, I acknowledge that additional work has been involved in the construction of the footbridge ramp-end detail. As this work has been carried out intermittently over a long period of time it is difficult to assess whether delays to other operations have occurred. So far as I am aware however no works which are critical to the overall completion of the contract have been affected.'*

- *'... your delay notifications refer to additional work involved in the cleaning off and partial replacement of capping layer contaminated as a result of it being used as a haul road. As stated in previous correspondence no delays or additional costs arising from this operation can be accepted by the client.'*

The contractor's agent, thereafter, was not convinced with the engineer's replies and sent him back the following letter:

> *'... we write to record that we do not intend to perpetuate correspondence on your replies to our delay notifications. Any further amplification or explanation of the delays claimed will be handled within the delay and disruption claim.'*

This is a simple example of what usually occurs between the supervising engineer and the contractor's agent on a construction claim. A large amount of backwards and forwards correspondence will typically result from an assessment of a contractor's claims. The last letter shown above gives a general impression that the contractor's agent was not prepared to comply with the assessment of the supervising engineer. Contractors are usually not easily satisfied with the engineer's decision and this may make the assessment procedure more complicated. This reflects the importance of adopting sensible procedures for claims assessments with the assistance of good record-keeping systems and hence adequate site records that help in settling construction conflicts.

**v) The use of computers**

The ability of computers to store, retrieve, and process large amounts of data is well advanced nowadays, but it appears that the use of such facilities on construction sites for this purpose is very limited. In this study of site records kept recently on one civil engineering project, the use of computers was not observed for any thing other than word processing. The question raised here is, what are the reasons for that shortage of computer use by the parties on construction sites? Both parties are collecting and dealing with large amounts of data, which it can easily be argued readily lends itself to computerisation. The era of computers that can recognise handwriting and human speech has begun and the construction industry should benefit from such advanced technology.

## 2.3 The Main Observations

It is recognised that the two studies carried out were simply samples of construction contracts and that any inference drawn from this work would need to be tested much more widely before being accepted as generally true. Nevertheless, this work has provided an insight into some problems of records kept on construction sites and the main observations stemming from the two preliminary studies, are listed below.

### 2.3.1 The field work

- It may be useful to provide clearer guidance to advise the supervising staff on what records it is important to keep and to document, as well as on the best format to be adopted for maintaining such records.
- The progress records kept by the supervising staff may need to be closely related to the contractor's programme, i.e. keeping records at the level of each construction activity to improve their accessibility.
- Delays at the construction activity level and their effects on the subsequent activities during the construction process, may need to be recorded in more detail.
- The level of resources and their use at each construction activity level as well as their movements from one activity to another may require more careful monitoring and recording to provide assistance in dealing with contractor's claims.
- It could be helpful to write site records more clearly, to avoid illegibility problems.

- Preparing site diaries at the end of each working day may be necessary to avoid difficulties in remembering all the facts after a period of time.

### 2.3.2 Studying of records on a completed contract

- The number of the records kept on construction sites seems to be rather large and many problems such as lack of accessibility will typically result due to this huge volume of information.
- Some site records seem to suffer from a lack of consistency, continuity, and legibility.
- Site records and their keeping system could be improved to avoid such problems and difficulties.
- It might therefore be desirable perhaps to utilise computer facilities to provide assistance in keeping and accessing site records, avoiding many other problems such as illegibility, and to minimise space required to store such valuable information over a long period.

## 2.4 Summary

This chapter has described the preliminary investigations undertaken. It comprised a detailed account of the two studies and provided an extensive number of examples of site records as well as highlighted a number of problems and difficulties experienced during the preliminary work. This work revealed a number of issues which is believed worth studying and provided a considerable assistance in understanding some of the problems of record keeping on construction sites. A number of problems with site records were identified including records being difficult to access, records being illegible, lacking continuity and consistency, and records failing to provide a useful as-built picture of what actually happened. The next chapter provides a full account of the procedures adopted in developing the research questionnaire and conducting the national survey.

# Chapter 3

## Development of the Questionnaire and Conducting the Survey

# 3 DEVELOPMENT OF THE QUESTIONNAIRE AND CONDUCTING THE SURVEY

Any research primarily depends on an essential ingredient; the data. In many engineering fields, the necessary data is obtained from carrying out laboratory work which usually lends itself to easy manipulation and mathematical analysis. This was not the case with the research area under investigation. The data derived for this research was not found to be available from other sources, and therefore, collection of primary data was inevitable. This chapter presents a general description of the survey method adopted for this research, and the main stages implemented in developing the research questionnaire. The final part describes the process of administrating and conducting the national survey as well as giving details of the rate of response obtained.

## 3.1 Selection of the Survey Method

According to Rea and Parker (1992), the three main techniques used for primary data collection are: (a) survey research, (b) direct measurement, and (c) observation. They add that secondary research is a fourth means of data collection which consists of compiling and analysing data that have already been collected, and also confirm that:

> 'There is no better method of research than the sample survey process for determining, with a known level of accuracy, information about large populations.'

According to Smith (1991), survey methods have become the most used methods throughout the social sciences and he gives the following reasons in support of these methods:

- The survey method is a good technique for the exploration of individuals' attitudes, values, beliefs and motives. It also allows retrieval of information about individuals' past histories.
- Data collection is efficient as it can be structured in order to obtain specific information from a wide population.
- The data is standardised in that respondents are assumed to react to the same stimuli.
- As a form of data collection in social research, survey methods are comparatively cheap, simple and easy to administer.
- It is possible to analyse data through a variety of standard statistical procedures.

While admitting of numerous methods of data collection, Oppenheim (1992) identifies two main approaches. These are: (a) interviews conducted on the basis of a structured questionnaire, and (b) questionnaires distributed by mail. Similarly Baker (1994), states that there are two primary modes of carrying out a survey: using questionnaires or giving interviews. He adds:

> 'Both methods are based on a set of questions. In the questionnaire, these questions are written down and the respondent reads them and gives written answers. In an interview, the interviewer asks the questions as they are written in an interview schedule and then records the respondent's answers either by writing them down or recording them electronically.'

As has been widely reported in the literature, both methods have advantages and disadvantages, which can be summarised as follows:

*Interviews*

- The researcher has the opportunity to personally evaluate each respondent (advantage).
- Ambiguity in question or response may be clarified by the interviewer immediately (advantage).
- Bias: leading questions may unintentionally be asked during the interview and the interviewer can easily give an impression of his/her views by a change in tone of voice or other subtle means (disadvantage).

*Mailed questionnaires*

- This method is cheaper than other methods of survey research (advantage).
- A widely spread sample is possible allowing a greater coverage to be achieved (advantage).
- It avoids the problems associated with the use of interviews, such as interviewer bias (advantage).
- Mailed questionnaires are suitable with questions demanding a considered rather than an immediate answer, particularly if the answer requires consultation of documents (advantage).
- It is more convenient for the respondent in that he can complete the questionnaire in his own time (advantage).
- The questions need to be relatively simple (disadvantage).

- The method suffers from poor response rates and may also be affected by response bias (disadvantage).

Thus, considering these characteristics and recognising the greater coverage that is possible with the mailed questionnaire and the fact that questions to be asked are relatively straightforward, it was considered that the most appropriate method for collecting this research data was likely to be through the use of mailed questionnaires. Adams and Schvaneveldt (1991) described such instruments as follows:

> 'A questionnaire is a data-gathering device that elicits from a respondent the answer or reactions to printed (pre-arranged) questions presented in a specific order.'

As has already been noted, the main concern with the mailed questionnaire method is normally with obtaining a reasonable rate of response. According to Nachmias and Nachmias (1976), the typical response rate for a mailed questionnaire is between 20% and 40%, whereas Weisberg et al (1996) indicated that these rates tend to be between 10% and 50%. Weisberg et al also reported that, 'mail questionnaire return rates have never been high, but they have been further threatened by the frustration that many people have with fund-raising attempts masquerading as surveys'. Nevertheless, many techniques aiming to improve the response rates were recommended in the literature such as using stamped self-addressed envelopes and conducting a follow-up process.

Scott (1991) indicates that the method of investigation using questionnaires falls short of traditional scientific procedures (i.e. manipulations and mathematical analysis of numerical data). But he adds that this must not be seen as an excuse for poor work and it is essential that the method is adopted with as much scientific rigour as possible. This, he suggests, is likely to manifest itself in a number of ways, including:

- 'Ensuring that the most pertinent questions are included in the questionnaire and that, where possible, the method of analysis has been defined before data collection begins;
- Good design of the questionnaire, in terms of the ordering of the questions and method of questioning;
- Careful wording of questions to ensure, as far as possible, that no ambiguity occurs;
- Accurate recording and orderly classification of responses;
- Logical analysis of results.'

To comply with the first point, the reasons for gathering the data, together with the uses to which the data will be put, must be clearly understood. The way in which site records are maintained, checked and subsequently used has received little coverage in the literature, although a number of writers have expressed their concerns on the efficiency of these records. Additionally, the results of the preliminary investigations described in the previous chapter, revealed a number of problems and difficulties with site records. Here, then, is an important reason for collecting data in this area: to add to our knowledge of factors influencing one of the important site procedures and to recommend good practice, where it can be identified, to improve these procedures. What is recorded in the literature is the recognition of the importance of site records and the need for maintaining good site records particularly for the process of claims preparation or assessment. It is believed that the source of aggravation and frustration stemming from inadequate records may be relieved to some extent by proper keeping of site records, from which the wish to recommend sensible procedures stems. These then constitute the principal reasons for collecting data. It is anticipated that the questionnaire will provide:

- Data required for resolving the research objectives and hypothesis;
- An opportunity to obtain an adequate sample of data to enable generalisation of the research findings to be made;
- An opportunity to obtain an adequate knowledge to enable sensible recommendations for improving the procedures of site record-keeping to be made.

The research investigates the records kept by construction supervisors, and therefore they are the main target of the survey. In addition to interrogating site supervisors, a decision was made to elicit the views of the people involved in using some of these site records i.e. claims consultants. Claims consultants consult such documents when they are involved in dealing with construction claims. The nature of the questions to be addressed to the site supervisors differed slightly from those to be addressed to claims consultants and therefore, two questionnaires were designed for use in this survey. A full account of the questionnaires' development and the way in which the survey was conducted are given in the remaining parts of this chapter.

## 3.2 Defining the Question Areas

Rea and Parker (1992) pointed out that: 'prior to the development of a survey instrument (questionnaire), it is necessary to gather information about the subject matter under investigation from interested parties and key individuals'. This was, indeed, the main objective of conducting the preliminary investigations described earlier in chapter two. The hope was that this would provide the understanding necessary to define this important area: to gain a greater understanding of the problems of keeping site records which would help to generate the research hypothesis and thereby lead to sensible and useful questions to be considered in the questionnaire. Such approaches have been recommended by writers such as Douglas (1985) who dealt with the business of collecting data by surveys. Douglas was interested in collecting information about the sex-lives of his interviewees, and recommended a process that he called 'immersion' for identifying the important aspects of an area of research. This was exactly what was done during the preliminary investigations, studying site records kept on a project under construction and also a full set of site records of a completed contract. Douglas sees this as a means of approaching the truth by 'de-focusing' - not thinking about the bigger meanings of things until we have experienced them directly. He also suggests that you should '.. keep going with your explorations until you stop hitting "pay-dirt" - that is, new truths about the phenomenon you are studying'. Having finally made the decision that no more 'pay-dirt' was likely to be revealed, the process of writing the questionnaire began. As previously stated, the questionnaire aimed at providing the necessary data to resolve the research objectives and this could not be achieved unless the questions generated were arranged and presented in a sensible order to help elicit useful responses. From the literature review and preliminary investigations, a number of interesting questions were raised and these were analysed and eventually recognised to be of three different types. There was a hypothesis, a number of views to be tested and also areas in which useful information could be gathered. These will be considered in turn.

**i) The research hypothesis**

The research aims and objectives may also be viewed through logical constructs, termed hypotheses. An 'hypothesis is a logical supposition, a reasonable guess, an educated conjecture which may give directions to thinking with respect to the problem and thus aid in solving it' (Leedy, 1989). Leedy also noted that hypotheses are necessary because: (a) the researcher needs to have some points around which the research may be orientated in terms of searching for relevant data, and (b) they allow us to comprehend the research project and the motives of the researcher.

The term 'hypothesis' bewilders many people unless they understand that it has two entirely different meanings in the literature (Leedy, 1989, and Adams & Schvaneveldt, 1991). The first meaning is limited to a statistically-orientated hypothesis. When one comes across the phrase 'test of hypothesis', this refers to a statistical hypothesis, commonly known as the null hypothesis. According to Leedy (1989):

> 'The null hypothesis postulates that there is no statistically significant relationship between the variables. If a relationship does occur and the

> magnitude of the relationship is such as to exceed the possibility of its having been caused by random error or pure chance, then we conclude that some intervening variable(s), aside from the factor fortuitousness of nature, is energising the data and, in consequence, we reject the null hypothesis.'

He adds:

> 'It is this comparison of observed data with the expected results of normative values that we call testing the hypotheses, or perhaps more accurately, testing the null hypothesis.'

The second meaning restricts the word hypothesis to a research-objective-orientated hypothesis. Adams and Schvaneveldt (1991) point out that:

> 'The second style is frequently referred to as a directional hypothesis. In the second meaning, a hypothesis exists because the research problem or the sub-objectives issuing from it arouse a curiosity in the researcher's mind which, in turn, results in the position of a tentative guess relative to the resolution of the problematic situation.'

Leedy (1989) also asserted that the purpose of a research-objective-orientated hypothesis is a very practical one. It provides a tentative objective, an operational bull's eye, a logical construct which helps the researcher look for the data. Based on the conclusions to which the data force the person, the researcher must either confirm or deny the hypothesis as posited (Leedy, 1989). 'This style is commonly used when previous research has demonstrated the possibility of a directional relationship between two or more variables' Adams and Schvaneveldt (1991).

It was recognised that the hypothesis to be considered was of this second type, because what has been reported in the literature and what has been gained from the preliminary investigations, have demonstrated the possibility of a relationship between the stated variables. The hypothesis developed was as follows:

- A reason why records kept by supervisors on construction sites do not provide all the information needed in the most efficient manner is because the site supervisors do not have a good understanding of all possible uses that will be made of those records.

**ii) Views to be tested**

The views, generated from the literature search and the preliminary work, were as follows:

- Although records kept on construction sites are often extensive, the current approach to keeping such records fails to provide all the information that is needed.

- Although there are still some constraints impeding the computerising of site records, the use of computers on construction sites is one way in which improvements in the record-keeping procedures can be made. Some of these constraints can be overcome.

- Site supervisors' quality systems, where they have one, will not contain procedures covering the keeping of site progress records. Such procedures can be developed and would be accepted and followed by site staff.

- With the current record-keeping approach, the site supervisors will not be able to assess construction claims, in particular delay claims, with a reasonable precision or certainty. Improvement is possible.

### iii) Information gathering

The following items were identified as information gathering questions to be addressed in the questionnaire. Some of these points are not applicable to the claims consultants and thus were not included in their questionnaire. The identified items are classified into six main areas as follows:

***General***

- Affiliation/experience of the survey participants: questions including the main areas of experience, number of years involved in supervision of construction and size of contracts being supervised by those participating in the survey.
- Policies adopted by the companies with regard to record-keeping procedures.

***Site records - general***

- Confirming the complete set of records kept on construction sites.
- Identifying how record-keeping procedures on construction sites could be simplified / improved.
- Extent of current use of computers on construction sites.
- Identifying problems in record-keeping, the extent of such problems and the ways in which site records fail.

- Identifying the percentage of time given to the daily record-keeping process.

*Progress records*

- Identifying whether contemporaneous 'as-built' records are kept on construction sites, that define when each construction activity on the contractor's project plan was actually carried out.
- Identifying whether records of the times at which links between subsequent activities in the construction network occur are kept.
- Identifying the methods used for keeping site records. Categories for personal records: types of records kept by resident engineer, assistant resident engineer and inspectors/clerks of works.
- Identifying the most useful personal records kept on construction sites: the engineering staff's or the clerks of works' records.
- Identifying whether quality systems exist in this area. How often does the site supervisor check his staff's records? Does he attempt to help his staff understand the unusual occurrences that might lead to a dispute and that will need good records kept about their developments?

*Records of delays and resources*

- Identifying when an event should be recorded as a delay event, and how delay records are kept and what is recorded as well as how effective these records are.
- Identifying how information on the use of resources is recorded, and whether resources are recorded on a daily basis against specific activities on the contractor programme.

- Identifying what records should be kept to deal with claims, and how efficient these records are as well as how decisions on claims are documented.
- Identifying whether site supervisors, with the records they keep, are easily able to determine the contractor's rights to an extension of time.

*Uses of site records*

- Identifying which of the recognised uses of contract records are seen to be the most important. What other uses are made of them? What searches of site records are made?
- Identifying which type of records will be most useful for a search that involves assessment of progress (e.g. claims for extension of time).

*Miscellaneous*

- Identifying whether site supervisors are proactive. Do they look for claims situations to become aware of them before the contractor gives notice of a claim?
- Identifying whether there is any opportunity to relate records maintained in the standard forms to the contractor's programme of work activities.
- Identifying whether there is any opportunity to relate payments of the contractor to the site progress records.

### 3.3 Developing the Questionnaire

Having identified the aims of the survey questions, the next stage involved writing up the questions. Rea and Parker (1992) pointed out that: 'the development of the survey instrument or questionnaire is a crucial component of the survey research process'. According to Baker (1994), in a written questionnaire, the words that make up the questions are the basis for the study and hence careful attention must be paid to develop unambiguous, clear, and simple questions which serve the purpose of the research study. Thus, a set of rules that were credited by Baker (1994) to de Vous (1986), were identified to be followed in writing these study questions. These are:

- Are the words that make up this question, and the meaning of the question, simple and clear?
- Could the question have an alternative meaning to some respondents?
- Word questions in such a way that respondents are not likely to give false information to make themselves look more socially desirable or prestigious.
- Avoid negative questions.
- Avoid double-barrelled questions.
- Check for bias in your question!
- Should the question be posed directly or indirectly?

Having taken these rules into consideration when words of the proposed questions were identified, the next step was defining the types of question format to fulfil the aims stated earlier, i.e. open-ended or close-ended forms of questions. An open-ended question format allows respondents to supply answers in an unstructured manner whereas a closed-ended question format restricts them to respond within a range of pre-arranged response categories. According to Adams and Schvaneveldt (1991), the advantage of open-ended questions is that the respondent is given an opportunity to openly express what he or she believes, feels, or recommends. In contrast, closed-ended questions may force the respondent to choose from a number of response categories, none of which may really apply to their situation or frame of reference, which may lead to distortion of validity and an overuse of the response "don't know". In Adams and Schvaneveldt (1991), Bailey (1978) is quoted as suggesting that some respondents may have a difficult time writing an answer that reflects their feelings even if they are motivated and willing to participate, and hence the need for closed-ended question. Adams and Schvaneveldt (1991) offered the following suggestion:

> 'It should be clear that each question format has distinct advantages and disadvantages. For exploratory work or research in which feelings, attitudes, or type of behaviour are not known or well understood, the open-ended questions would be better than the closed type. On the other hand, in terms of return rate, time, expense, objectivity, ease of scoring and analysis, the closed-ended type (fixed-alternative) question is much superior.'

The topics covered by the questionnaire included measuring of attitudes held towards the site record-keeping process, and identifying what kind of records were kept and the ways in which these records were maintained. At the same time, it was hoped to achieve a good response rate and to have responses that would allow simple and effective analysis methods. Therefore, it was felt that using the two types of question formats where appropriate would be beneficial to this study in getting most of the advantages and reducing the effects of the disadvantages of both approaches.

At the first attempt, over one hundred questions were generated. After reviewing these questions in great depth, it was decided to reconsider them and consider how they helped to answer question areas described earlier. This resulted in a shorter questionnaire which it was hoped would give a better response rate.

The next stage in developing the questionnaire was organising and ordering these identified questions in a sensible manner which defined the structure of the questionnaire. The aim was to simplify the answering procedures and thereafter the analysis process when the final stage of gathering the research data came to end. Many writers suggest sensible procedures that aim to ensure that questionnaires are structured in a useful manner. Amongst them, Weisberg et al (1996), who advise to 'organise the questions so that they flow smoothly, so that early questions are not threatening, and so that early questions do not direct later answers'. Having taken such advice into consideration, the questionnaire was structured and presented in eight sections as follows:

- Section (A): covers questions regarding respondents' background.
- Section (B): covers questions regarding companies policies.
- Section (C): covers questions concerning site records in general.
- Section (D): covers questions concerning general progress records and site diary records.
- Section (E): covers questions relating to delay records.
- Section (F): covers questions relating to records of resources.
- Section (G): covers questions relating to the general use and searches of site records.

- Section (H): covers questions regarding miscellaneous issues relating to site record-keeping.

After three reviews of the draft questionnaire, a decision was made to pilot the questionnaires before developing the final versions.

### 3.4 Pretesting the Questionnaire

> 'Questionnaire construction is really an art, much of which is learned through practice. In fact, it is so difficult that researchers rarely use a questionnaire in a survey without first pretesting it'.
>
> Weisberg et al (1996)

Although a good deal of time and effort was put into preparing the initial draft of the questionnaires, it was realised that they may not be as obvious in their intent as might be hoped. Therefore, it was thought wise to carry out an initial pilot study to assess understanding of the questions posed and to obtain further information for improving the questionnaires. A sample of professionals with relevant experience of the research area was approached for the pilot survey. The pilot team included senior resident engineers, resident engineers, and claims consultants, and they were initially contacted either in person or over the telephone when the purpose of the study was made known to them. They were asked to attempt to complete the draft questionnaire and to indicate any areas of difficulty. After completion of the pilot questionnaires, the comments were reviewed and as a result of this initial study, a number of revisions were made involving deleting, adding or rewriting questions. Copies of the original questions used in the pilot study which were subsequently amended, are presented in Appendix E.

After making these amendments, the final draft was further reviewed by the author and discussed in depth with the supervisor. These reviews led to the final versions of the questionnaires shown in Appendix F. The resulting questionnaires were considered to be rather long, but in spite of this, it was felt that no more of the questions could be deleted. The next stage was to select the survey sample and carry out the main survey with the revised questionnaires.

### 3.5 Selecting the Survey Sample

The questionnaire survey is aimed at studying the records kept by site supervisors and this category of the construction industry participants would normally be employed by civil engineering consultants' firms. It was decided to select organisations from the NCE consultant's file (1994), which includes details of 205 firms with over 15 civil and structural staff operating in the UK. The details provided include information on the type of work they do, where they work, staff numbers, turnover and status as partnership or limited company. Details of contact addresses, however, were available for only 138 consulting engineering practices.

Regarding claims consultants, there was no obvious source of information that could help to identify the organisations which provide this service. A first contact was made with the Institution of Civil Engineers (ICE); unfortunately they did not have this information. However, acting on the advice of the ICE, it was decided to contact the Royal Institution of Chartered Surveyors (RICS). Finally, a very long list of individuals (just over 500 addresses) registered as individuals who may be able to provide such services, was obtained from the RICS information centre.

From the experience in carrying out the pilot study, it seemed that a reasonable response could be expected. It was thus decided to dispatch 150 questionnaires to the consulting firms included in the NCE consultant's file. Of these questionnaires, two copies were sent to two different regional offices of the larger companies (i.e. about 15 firms which employed more than 500 civil and structural staff and with a turnover of more than £50m). It was also decided that 50 questionnaires should be sent to the claims consultants who were selected randomly from the list provided by the RICS (i.e. about 10%). Of course, for reasons of confidentiality, the names of the organisations and individuals contributing to the study cannot be disclosed.

### 3.6 Conducting the Main Survey

A considerable effort was made to produce the questionnaires in the most efficient professional manner. According to Adams and Schvaneveldt (1991), the questionnaire should be attractive in appearance, easy to read, and clear to follow. Baker (1994) also pointed out that:

> 'The appearance of a questionnaire will have an effect on the respondent. A potential respondent will react to a questionnaire initially in terms of its overall appearance. Crowded questionnaires, which look wordy and squeezed together, generally draw fewer responses than a slightly longer questionnaire which appears more spacious.'

Each of the 200 questionnaires was prepared in booklet form and introduced by highlighting the importance of the respondent's contribution to the study as well as assuring him that all responses would be treated confidentially. Each questionnaire was sent, together with a letter directed to the consulting company office, explaining the purposes of the study and requesting the company to nominate one of its staff with the relevant experience of site supervision to participate in the survey. A stamped self-addressed envelope was also enclosed with each questionnaire to encourage quick responses. Claims consultants' questionnaires were sent directly to each individual address along with a letter as well as a stamped self-addressed envelope for return of the completed questionnaires. Although the initial rate of response was encouraging, a follow-up was made to non-respondent companies and individuals after eight weeks.

By the end of the 15th week after the original mailing, a total of 119 (about 60%) questionnaires were returned - 99 site supervisors and 20 claims consultants. Of these, only 73 (i.e. 66% & 40% of the supervisors' and claims consultants' questionnaires respectively) were useable. Sixty five were from site supervisors and eight from claims consultants. The remaining were returned along with either letters, memos, or comments on the original letter explaining reasons for not contributing to the survey. Among the reasons given were:

- Adopting a policy of returning such forms uncompleted.
- Regretting not to participate due to the pressure of work.
- Do not have resident engineers at the present time.
- Do not have sufficient construction supervision work in hand.

However, although 40 percent of the organisations and individuals approached did not respond at all even after the follow up process, the overall response rate was seen as quite reasonable considering the nature of the matters being studied. It may also safely be said that the overall response rate is quite acceptable given the widely reported low response rates of studies using mailshot questionnaires and the lukewarm response to questionnaire surveys in construction generally.

### 3.7 Summary

After reviewing the relevant material reported in the literature and describing the preliminary studies carried out to investigate samples of site records from two contracts, this chapter has described the procedures adopted in developing the instrument used for collecting the research data as well as carrying out the national survey. It included the process of selecting the survey method, defining the question areas, pilot study, and preparing the final version of the questionnaire. The main stages implemented in administering and conducting the national survey, and the rate of responses obtained were also covered in this chapter. The next chapter deals with the analysis and discussion of the collected research data. It describes the procedures adopted for preparing the data for the analysis process and the ways in which the results are presented.

# Chapter 4

## Analysis and Discussion of Results

# 4 ANALYSIS AND DISCUSSION OF RESULTS

The questionnaire design and approach to administrating and conducting the national survey, together with rates of response have all been described in the previous chapter. This chapter presents in detail the results of the data analysis together with a discussion of the results. The data available for analysis comprised two parts: the completed questionnaires from the 65 site supervisors and those from the 8 claims consultants. The method of analysis adopted involved three principal stages, as follows:

i) Firstly, the data was manipulated by producing a word processor file for each question in the site supervisors questionnaire and recording responses of each supervisor beneath the relevant question in turn. The respondents were given a code number classification according to their experience, to ensure that all questions belonging to any one experience category could be grouped together. This was done to facilitate easy and useful comparison between respondents' views. The same process was also repeated for responses from the claims consultants.

ii) A second file was created for each question, with a list of summary points obtained from the responses presented in the first stage, identifying where possible the most widely held viewpoint. Each identified point was annotated by the code number of each respondent making that point to allow reference to its source and to identify how many respondents stated that point. Views were considered to be commonly shared when mentioned by at least two respondents.

iii) From the data produced in the second stage it was possible to analyse each question in turn under the headings specified in the questionnaire. A summary of inferences, which stemmed from the analysis and discussion of the results obtained is also presented at the end of each section.

It should be noted that questions $Q_A$ to $Q_H$ are contained in the site supervisors questionnaire whereas questions $Q_I$ to $Q_O$ refer to those in the claims consultants questionnaire. Where a question was asked of both site supervisors and claims consultants, the responses of the supervisors are given first, followed by those of the claims consultants.

It was recognised that the number of the claims consultants who participated in the survey was smaller than the sample of site supervisors and therefore, it was decided to carry out statistical tests where differences of the views exist, to investigate how significant these differences were. When two or more samples are obtained from different populations, non-parametric tests such as Mann-Whitney tests are used as an inferential statistical method (Miller et al, 1990). The Mann-Whitney tests were carried out for this research using the Minitab statistical computer programme. These were conducted to test the hypothesis that states that differences exist in the views of the two groups against the null hypothesis which indicates that there are no differences in these two groups' views. The result of each test conducted is reported with the relevant question and these results will be used in testing the research hypothesis stated previously in chapter three. Assessment of the research hypothesis and views is presented in the next chapter. The full computer output of the Mann-Whitney tests is presented in Appendix G.

The data obtained from the research survey is thus analysed and discussed under the following headings:

- Participants in the survey
- Policies adopted by the companies
- Site records - general
- Site progress records
- Records of delays
- Records of resources
- Use of site records
- Miscellaneous

## 4.1 Survey Participants

In this section, the aim was to identify information regarding affiliation and experience of the individuals who participated in the survey.

### 4.1.1 Site supervisors

The questions presented under this sub-section relate to the main areas of experience, number of years in supervising construction and typical size of contracts that site supervisors were involved in.

***Current position ($Q_{A1}$)***

Question $Q_{A1}$ aimed to identify the respondents names (which shall remain confidential) and the current position they hold. More than three-quarters of respondents, who were involved in the supervision of construction, hold an engineering position (e.g. resident engineer) and of the remainder, various posts such as project manager, director, associate and site quantity surveyor were indicated.

***Breadth of experience ($Q_{A2}$)***

$Q_{A2}$ asked respondents to indicate the main areas in which they have experience of construction by ticking the appropriate response from the list provided. Figure 4.1 shows that the five most common areas are highways, building construction, drainage and sewerage, foundation and piling, and bridges. It could certainly be considered an advantage that most respondents had experienced different areas of building and civil engineering construction projects where different types of site records are being kept.

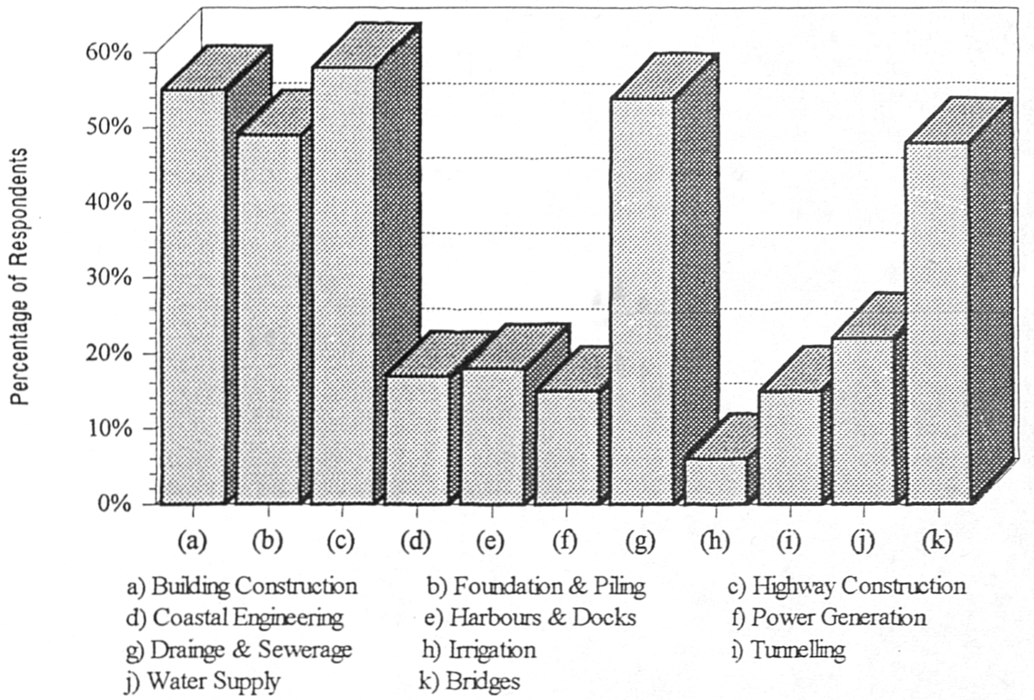
Respondents were also asked to identify any other areas of experience and as such railways and airport engineering were indicated.

*Number of years of experience in construction supervision ($Q_{A3}$)*

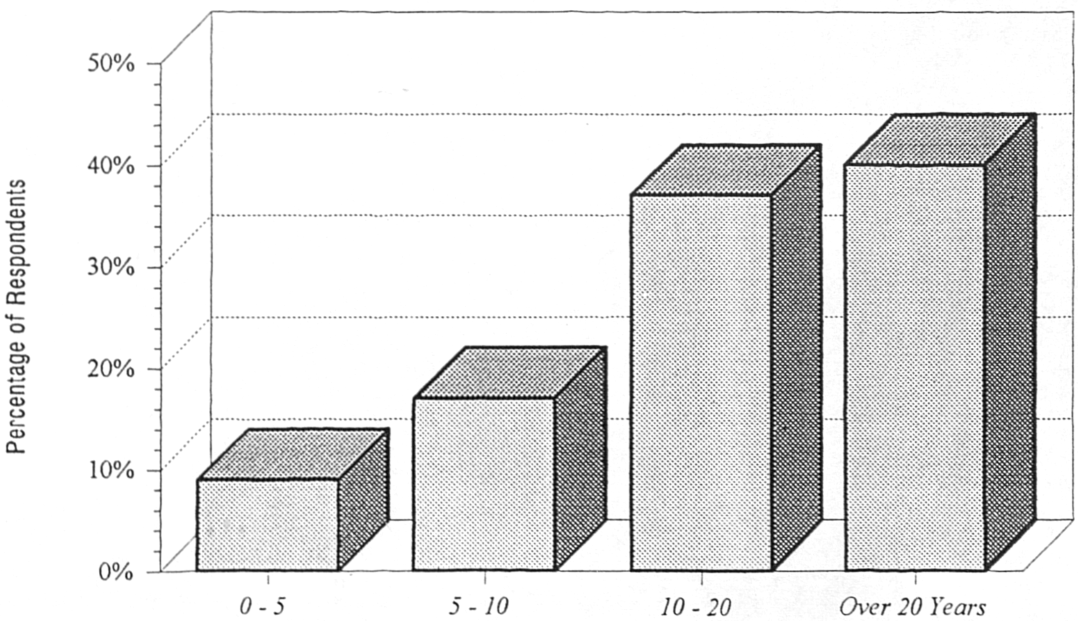
This question aimed to determine the respondent's years of experience of supervising construction projects. The results are shown in figure 4.2 and it can be seen that more than two-thirds of respondents have spent at least 10 years (52 percent of them more than 20 years) in the supervision of construction. This indicates that the majority of the people contributing to this survey are experienced supervisors which adds credence to the results.

*Size of projects supervised by participants ($Q_{A4}$)*

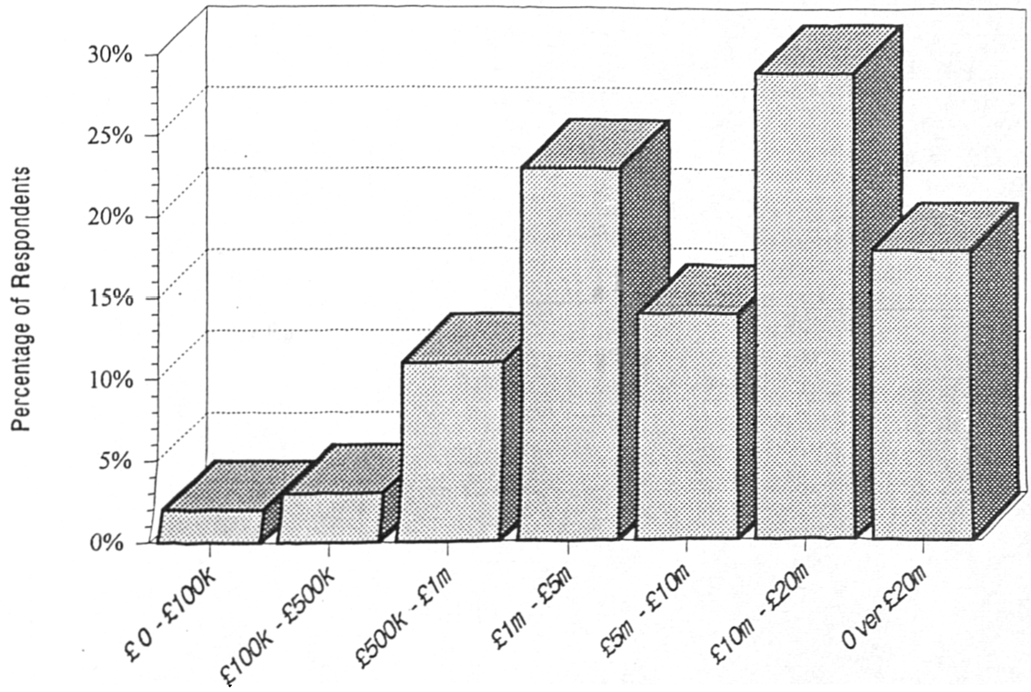
The magnitude of projects that supervisors have worked on is considered to have an impact on their experience, hence, question $Q_{A4}$ was aimed at identifying what value of contracts respondents had mostly been involved in over the past 10 years. The results are shown in figure 4.3, which indicates that about two-thirds of respondents were mostly involved in projects with costs of at least £5m. Almost half of the supervisors who had more than 10 years experience, were involved in projects with costs of more than £10m (as shown in figure 4.4). This indicates that a considerable number of the respondents were involved in large projects where more formalised approaches for keeping site records are most likely to be established. This adds value to the study as it shows that many of the



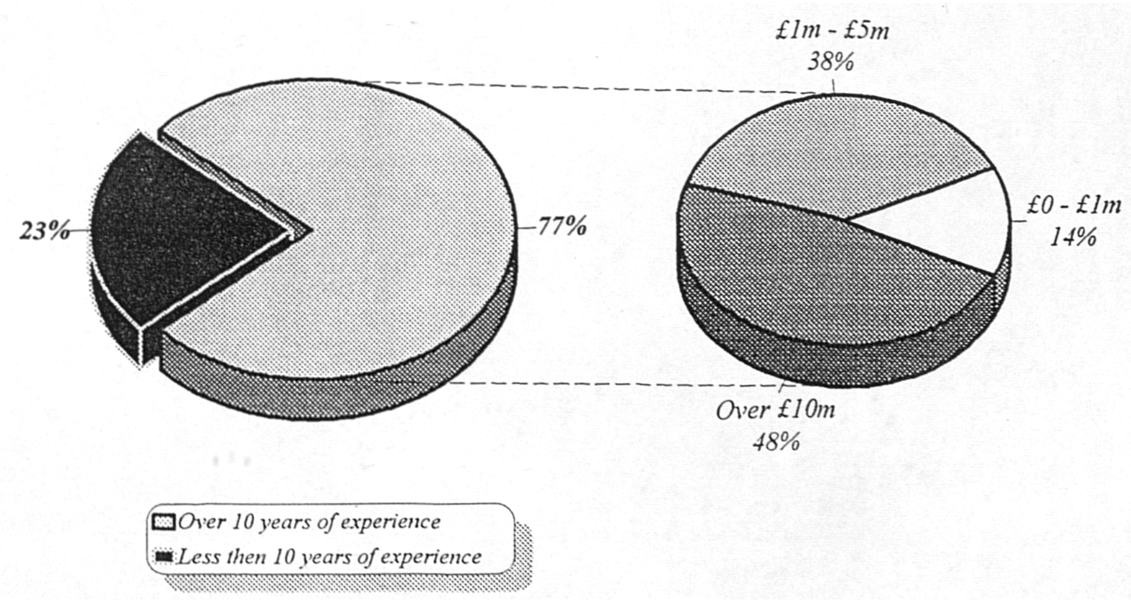

***Figure(4.1): Breadth of Experience***




***Figure(4.2): Experience of Construction Supervision***




***Figure(4.3): Size of Contracts Supervised***




***Figure(4.4): Sizes of Contracts Supervised by Experienced Supervisors***

people who participated possess several years of experience of supervision of medium to large projects.

### 4.1.2 Claims consultants

This sub-section covers questions aimed at identifying the number of years of experience that the surveyed claims consultants had in dealing with claims, the values of typical claims they dealt with and the percentage of their involvement with construction parties with respect to the assessment of claims.

*Access to the records kept on construction sites ($Q_{12}$)*

Claims consultants were asked question $Q_{12}$ to determine how often they had acted for contractors, promoters or others, when involved in investigating claims. This was intended to indicate how much opportunity they had to access site records belonging to the two parties, contractor or supervisor, on the site. Analysis of responses to this question (figure 4.5) revealed clearly that the surveyed claims consultants had acted almost exclusively for promoters and hence had largely accessed site supervisors' records when dealing with claims. This means that the views of both supervisors and claims consultants on records will relate to the records kept by the supervisors.

*Number of years of experience in dealing with claims ($Q_{13}$)*

$Q_{13}$ was aimed at eliciting how many years those participating in the survey had in claims consulting. The analysis results (figure 4.6) showed two-thirds of them (6/8) had at least 5 years experience, with one-third having more than 20 years.

*Values of claims being investigated ($Q_{14}$)*

This question aimed to establish the values of claims that the surveyed claims consultants had been involved with during the past 10 years. Analysis of the responses (figure 4.7) indicated that claims values being investigated by most of the consultants (5/8) were in the range of £0 to £100k.

### 4.1.3 Summing up

The following two points can be made from analysing the responses to the questions relating to the survey participants:

i) The survey sample included a considerable number of site supervisors who had spent many years (more than 10 years) in supervising the construction of different types and sizes of building and civil engineering projects.

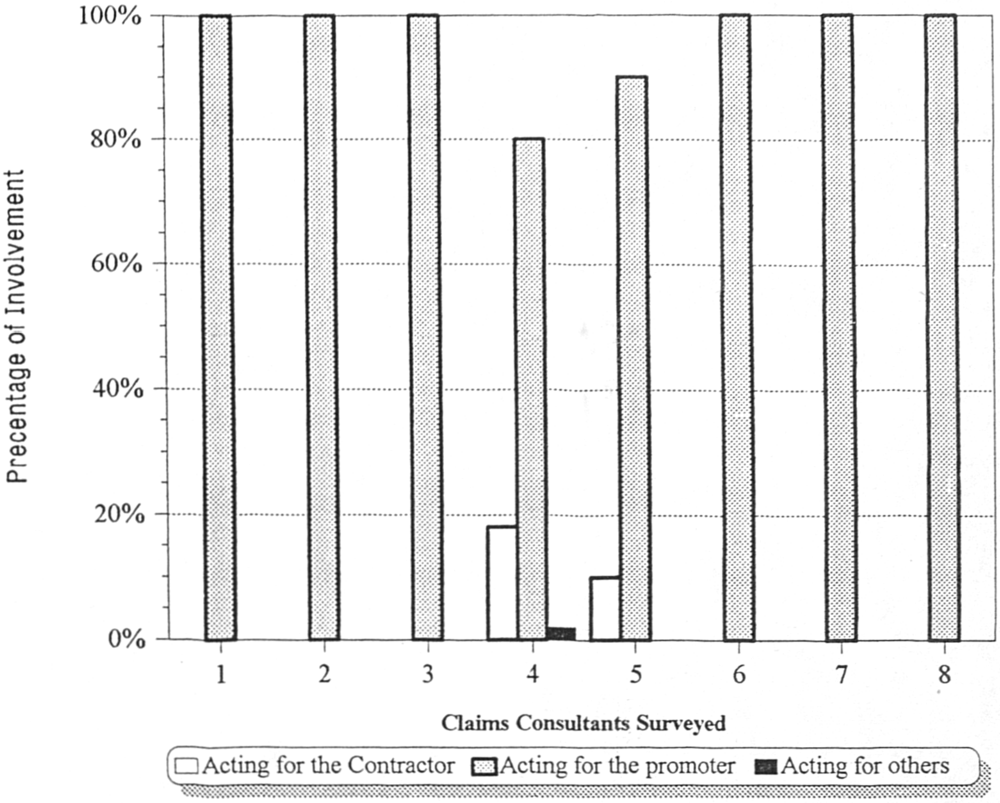



*Figure (4.5): Type of Client of Claims Consultants Surveyed*

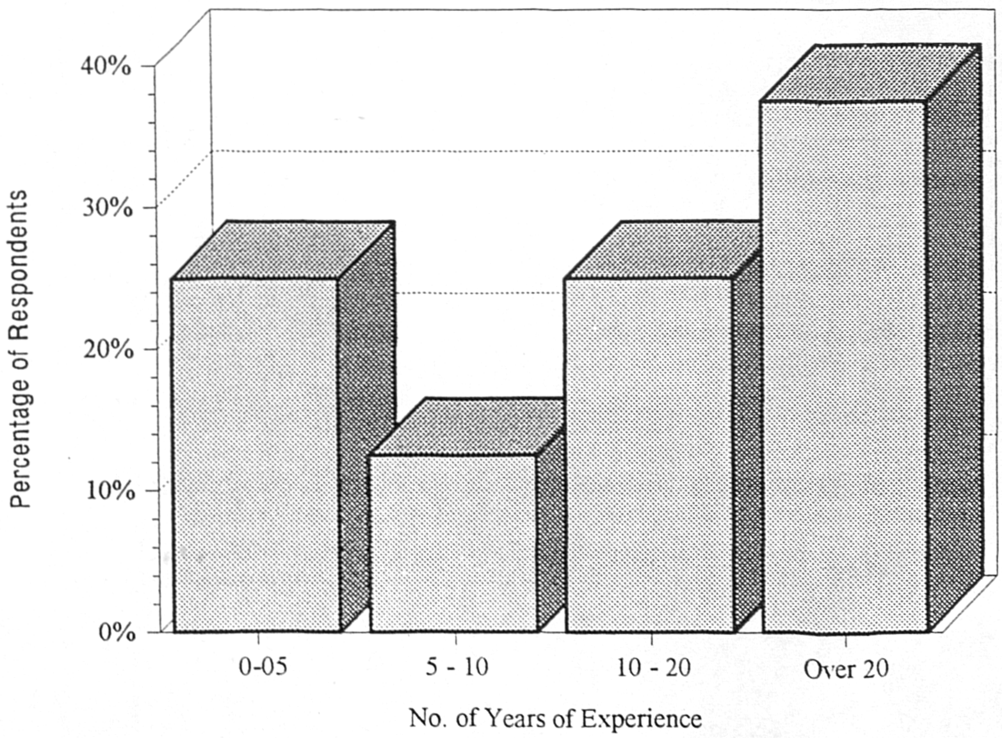



*Figure (4.6): Years of Experience in Dealing with Claims*

ii) Almost all claims consultants who contributed to the survey had acted for promoters, i.e. when dealing with claims the majority of records they had access to were kept by site supervisors.

## 4.2 Company Policies

This section was aimed at identifying the policies implemented by the companies of the surveyed participants, regarding the adoption of quality schemes for record keeping procedures on construction sites. These questions were not addressed to the claims consultants.

***Organisations' quality management schemes ($Q_{B1}$)***

This question was intended to determine whether the respondent's organisation operated a quality management scheme registered in accordance with BS5750. 78 percent of the respondents replied that their organisation did operate such procedures, although some (10 percent) indicated that they were only operated in the design office and not yet on site. With regard to record-keeping, BS5750 requires the organisation to establish and maintain documented procedures for identification, collection, indexing, access, filing, storage, maintenance and disposition of *quality records*, i.e. records confirming the quality of work done. It is clearly possible that such procedures may not be applied to the other records kept on construction sites. However the analysis of the responses to this question show that there are still some organisations (22 percent), who do not even operate a quality management scheme registered in accordance with BS5750.

*Quality procedures ($Q_{B2}$)*

$Q_{B2}$ asked respondents whether their organisation operated a documented quality procedure for monitoring the supervising engineer's work in the following areas:

a) issuing of variation orders;

b) maintaining site records;

c) assessment of claims.

Responses showed that for points (a) & (b), the majority, 72% and 62% respectively, did have such procedures. The responses were equally split on point (c), 49 percent admitted to having a procedure for the assessment of claims and the same percentage indicated that they had no such procedure.

*Guidelines for record-keeping ($Q_{B3}$)*

To obtain more information about record-keeping policies, this question asked whether any guidelines were provided for advising site supervisory staff on what records should be kept in the following areas:

a) Financial b) Quality c) Progress d) As-built

The analysis of responses to this question (figure 4.8) shows that the majority of the respondents' organisations do provide such guidelines in these areas. About 20 percent of the organisations, however, do not provide any such guidelines and presumably rely on the good sense and experience of their staff.

*Claims consultant services ($Q_{B4}$)*

Respondents were asked how often the services of claims consultants were used to deal with claims arising from the contracts they supervise by choosing between; often, seldom and never. Results of the analysis of these responses (figure 4.9) revealed that the vast majority of such claims are dealt with in-house by the organisations' own staff.

### 4.2.1 Summing up

The following points stemmed from analysis of responses to the questions relating to the policies implemented by companies regarding their site record-keeping procedures:

i) The majority of the surveyed site supervisors organisations operate quality schemes registered in accordance with BS5750.

ii) Most of the supervisors organisations also operate quality procedures for monitoring site supervisors' work in issuing variation orders and keeping site records. Procedures

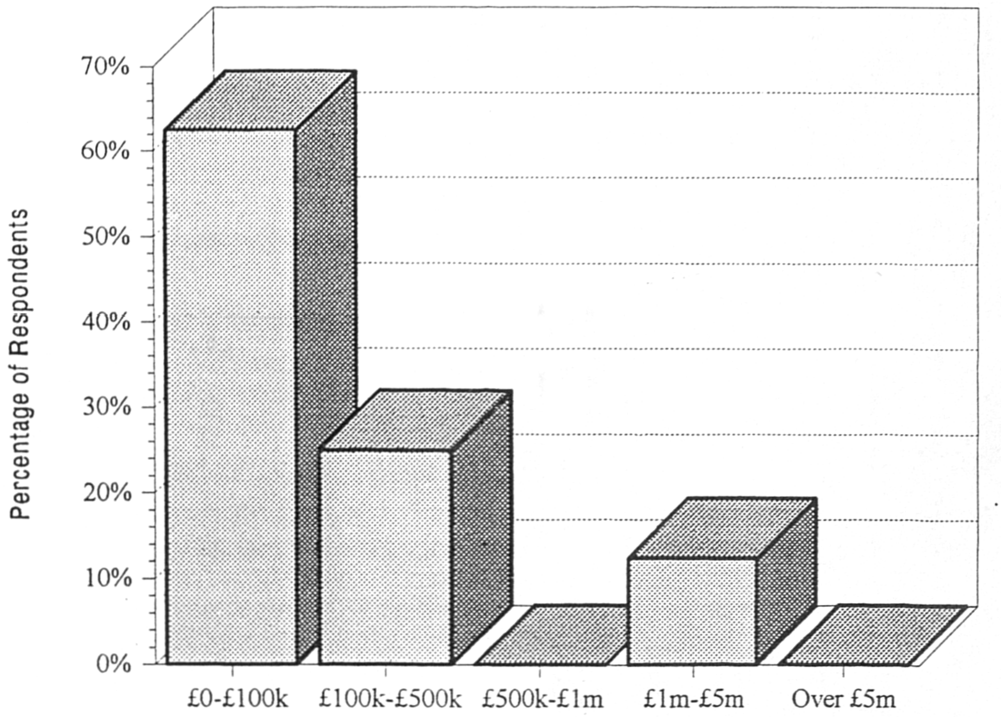



***Figure (4.7): Value of Claims Being Dealt With***

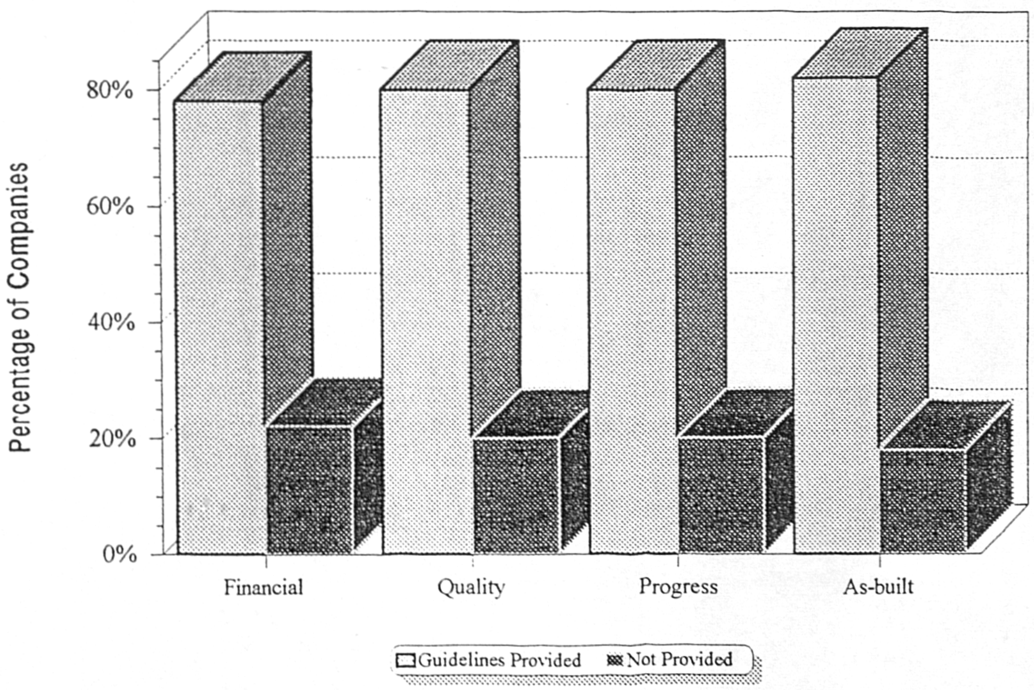



***Figure (4.8): Guidelines for Keeping Site Records***

regarding the assessment of claims were indicated as being implemented by half of the respondents' organisations.

iii) Guidelines for advising the supervising staff on what site records to keep were provided by the majority of the organisations.

iv) The vast majority of construction claims originating from contracts supervised by the surveyed participants are dealt with by their organisations' own staff.

## 4.3 Site Records - General

Questions presented here relate to the participant's views of the current procedures for keeping site records generally and how these records could be improved as well as trying to confirm the totality of the records being kept. An attempt was also made to identify the current amount of computer usage on construction sites.

*Views on current procedures for record keeping ($Q_{C1}$,$Q_{J1}$)*

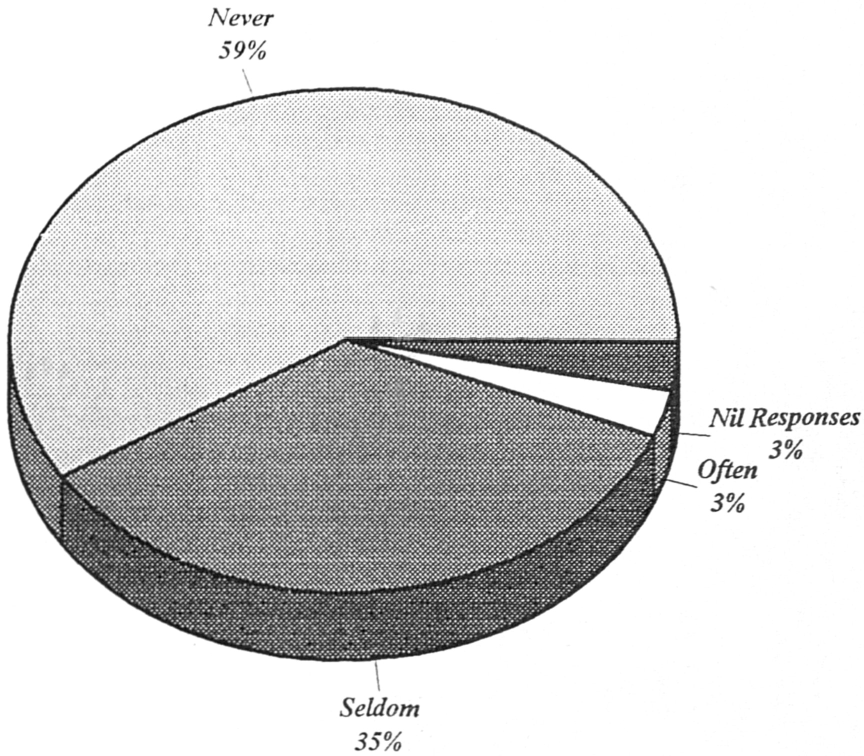
Question $Q_{C1}$ attempted to identify the site supervisors' level of satisfaction with current record-keeping systems on construction sites. The respondents were asked whether the current approach to keeping construction site records was: suitable & adequate or inadequate & in need of improvement. 60 percent of respondents viewed the present system as suitable and adequate, 14 percent (who had selected 'suitable and adequate' but who made additional comments) were satisfied with the current approach but considered it could be improved indicating a conditional satisfaction, while the remaining 25 percent considered the current approach to keeping site records inadequate and in need of improvement. Of the 14 percent who considered that improvements could be made, they said that procedures were only suitable when carried out properly. This suggests that they have difficulty getting staff to follow the procedures laid down.

When claims consultants were asked the same question ($Q_{J1}$), the majority (5/8) considered records generally inadequate, and in need of improvement.

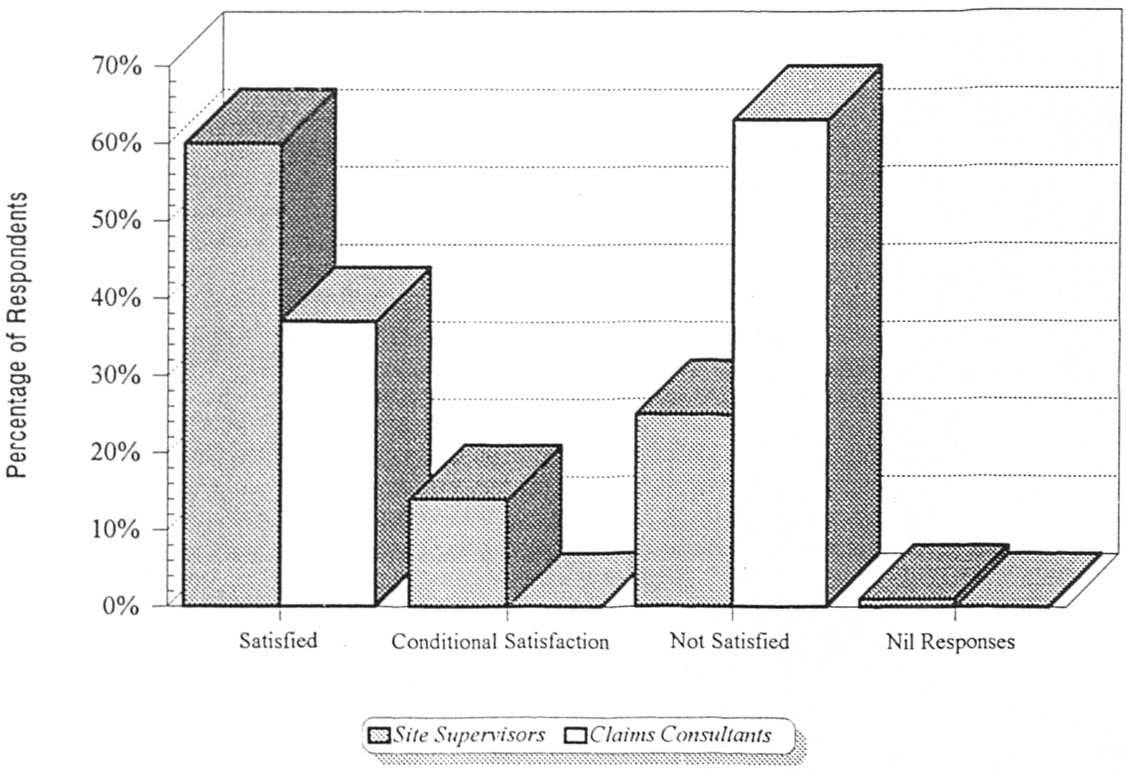
The results, presented in figure 4.10, clearly show that the majority of site supervisors are satisfied with record-keeping procedures currently adopted on construction sites, whereas the majority of claims consultants are not. A Mann-Whitney test was conducted and the test was significant at 0.0368. By Comparing this result with the level of significance set for the Mann-Whitney test used in this study ($\alpha$=0.05), the null hypothesis that assumes no differences exist between the measures of central tendency for the two groups is rejected.

*Awareness of the problems involved in keeping site records ($Q_{C2}$, $Q_{J2}$)*

The object of this question was to identify any specific problems involved in keeping good site records. 60 percent admitted to being aware of some problems in maintaining good




***Figure(4.9): Use of Claims Consultants' Services***




***Figure(4.10): Views on Current Procedures for Record-Keeping***

site records, whereas almost one-third indicated that they had no problems. 9 percent of respondents failed to answer this question (figure 4.11).

The respondents who admitted to having problems gave a variety of reasons for this. These can be classified under two main headings; problems related to the adopted procedures, and those related to the site staff and they have been summarised below.

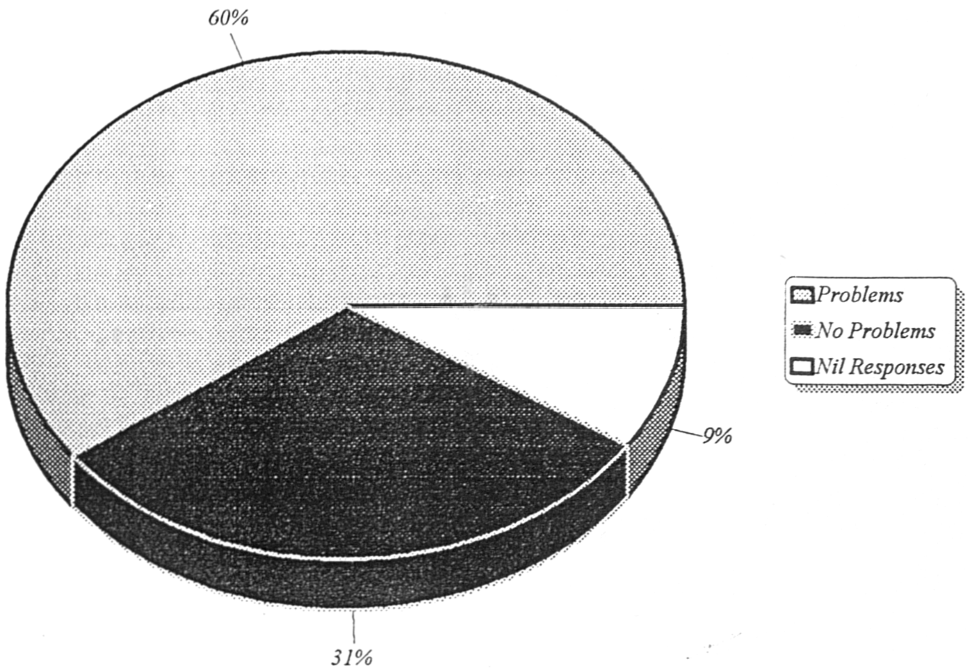
i) Problems with the site procedures

- Lack of an organised and formalised approach. (Organised approach).
- Lack of clear rules and guidelines as to what records should be kept and how they should be adopted within the system (Rules).
- Difficulties in ensuring the consistency of reporting by the various responsible individuals (Consistency).
- Lack of arrangements for the agreement of records with the contractor (Agreement).

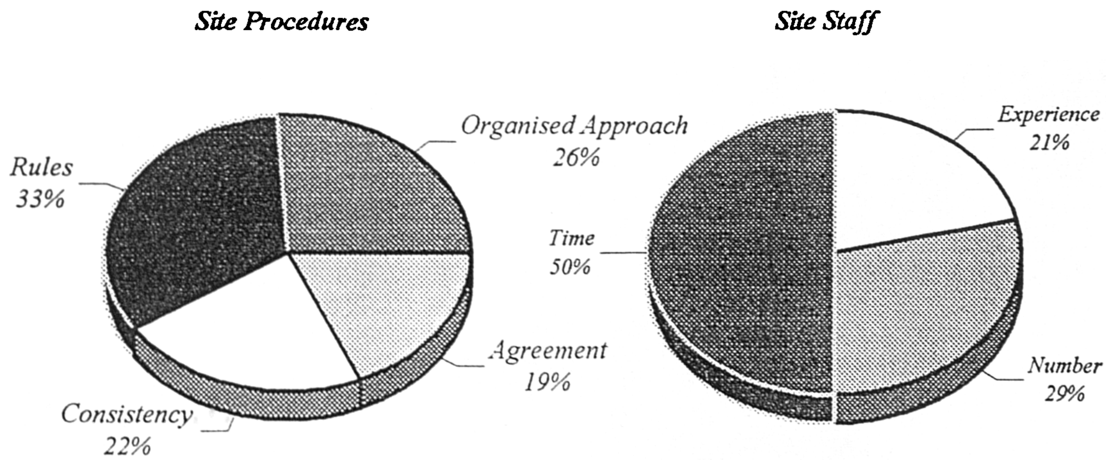
ii) Problems with the site staff

- Lack of time available to site staff for the record keeping process (Time).
- Insufficient number of site staff (Number).
- Variable experience of site staff (Experience).

The extent to which these views were held by this section of the respondents is indicated in figure 4.12.




**Figure(4.11): Awareness of Problems in Keeping Site Records**




**Figure(4.12): Problems with Site Procedures and Staff**

Other points were raised by some respondents with regard to the problems of maintaining good site records but were not commonly shared. These included lack of motivation and commitment of site staff.

As shown above, some respondents complained of a lack of time and this is perhaps a reflection of the low status given to record keeping. Measurement of quantities for the purpose of paying the contractor would not normally be considered as a time-consuming process, because it must be done no matter what the conditions. When time is short, those activities that can be delayed or done less thoroughly will be. Record keeping may come into this category.

The comment about inadequate numbers of site staff could suggest that the consultants' firms are decreasing the number of site staff in order to win a tender (cost savings). Concerns were also raised by some respondents about the experience of site staff. Sites have always been used as training grounds where junior staff gain good experience, however their performance is unlikely to be as good as the performance of experienced people. The experienced staff should also know better how to maintain good records in less time. It is also believed that a relationship may exist between the number of site staff and the time available for record-keeping. With an adequate number of staff, the effort will be shared and hence the time required from each will be reduced. These points are undoubtedly helpful in highlighting some of the difficulties in developing good procedures.

The same question was addressed to the claims consultants ($Q_{J2}$). About two-thirds (5/8) cited problems in keeping good site records, some of which confirmed the supervisors' views. Problems not raised by the supervisors included a lack of timely recording of events, a lack of recording delay effects and a bias on the part of engineers, who defend their design at all costs.

***Views on the improvement of site records ($Q_{C3}$, $Q_{J3}$)***

This question was put to determine what site supervisors thought could be done to improve the quality of site records. 75 percent of the respondents (25 percent failed to respond) made suggestions which, as with the previous question, could be categorised as relating to the system adopted or to the site staff employed. They were as follows:

i) Suggestions relating to the record keeping system as follows:

- Adopt better methods of record keeping (Method) by:
    - using standard forms (Standard Forms);
    - computerising the record-keeping process (Computerisation);
    - keeping more detailed records (Detailed Records);
    - keeping joint records with contractors (Joint Records).
- Provide clear rules and guidelines to ensure better site records (Rules).
- Make regular inspections to check the quality of site records (Checks).

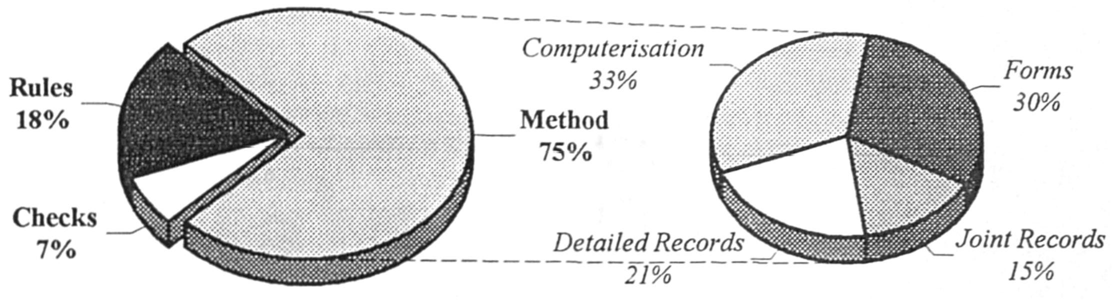
Figure 4.13 shows the extent to which these views were held by this section of the respondents.

ii) Suggestions relating to the site staff are shown in figure 4.14 and were as follows:

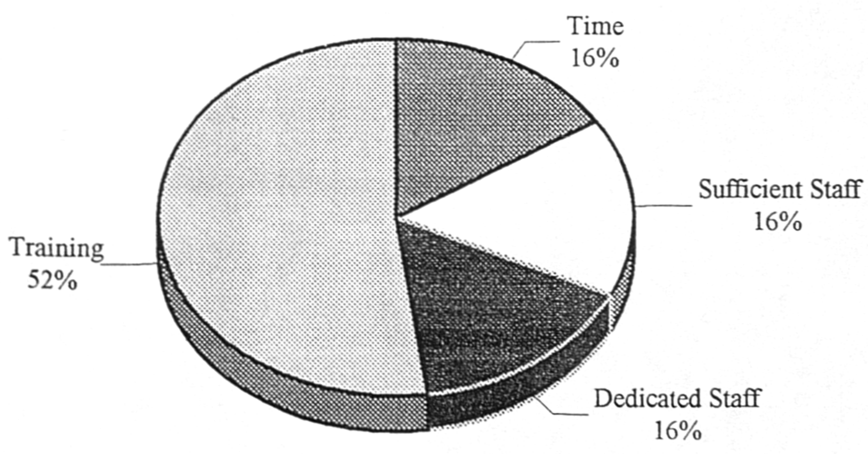
- Train and educate site staff in the record-keeping process (Training).
- Employ a dedicated staff member for record keeping (Dedicated staff).
- Employ a sufficient number of site staff (Sufficient staff).
- Provide more time for the record-keeping process (Time).

It can be clearly seen from the above that the majority of supervisors see the need for improving record keeping methods on construction sites. This may indicate that they are, in reality, not satisfied with the current methods and certainly such views contradict the responses to $Q_{C1}$ as reported earlier. With regard to the issue of checking the quality of site records, it seems generally that this is not seen as an important area for improvement. This may be because checks are already being carried out or because the respondents are not aware of the importance of such checks. They may even be concerned that these checking processes will cause personnel problems, particularly with those staff members who are not doing their jobs properly.

From the above suggestions relating to staff, it is clear that training and educating is seen by the majority of respondents as one of the best ways to make improvements. However, as has already been noted, the overall suggestions provided by respondents support the




***Figure(4.13): Views on Improvements of Site Records (System)***




***Figure(4.14): Views on Improvements of Site Records (Site Staff)***

argument that site records are in need of improvement and this puts in doubt previous results from $Q_{C1}$ where the majority of site supervisors described the current procedures adopted for record-keeping as suitable and adequate.

Similar attitudes to those of site supervisors were also shown by the majority of claims consultants (5/8) in their responses to $Q_{J3}$. They particularly emphasised the need to make more use of standard forms.

***The variety of records kept on construction sites ($Q_{C4}$, $Q_{J4}$)***

Rather than ask the supervisors to list the records they usually kept, question $Q_{C4}$ identified those records that would be expected to be kept and asked respondents to indicate if they were indeed kept. They were also asked to add any other records they keep that were not included in the list provided. The majority of respondents ticked all the listed types of records and other types were also added (40 percent of the respondents did not add any other types). Some of the types of records added can be considered additional to the recognised ones, however, others fall into certain categories already identified in the list provided in the question. Table 4.1 shows the record types which were seen by the respondents as additional to those in the list. The most common type of record added was safety/accident records, but several other categories of records were clearly identified. These included separate records on complaints, visitors, method statements, etc. Only 3 respondents indicated that they kept as-built records. The use of video recording as a

Table (4.1): Other types of records kept on construction sites

| Type of Site Records | Percentage of Respondents |
|---|---|
| Contractual claims | 6 |
| Confirmation of verbal instruction | 5 |
| Third party claims | 9 |
| Completion certificate | 5 |
| Drawing register | 6 |
| Sub-contractor file | 5 |
| Safety / accident records | 22 |
| Material records | 14 |
| Service / utilities records | 5 |
| As-constructed/as-built progress chart | 5 |
| Concrete pour records | 6 |
| Complaints file | 3 |
| Measurement records | 9 |
| Visitors book | 5 |
| Method Statement | 3 |
| Earthwork / piling records | 5 |
| Video records | 3 |
| Site photographs | 3 |

method of recording activities on construction sites was also mentioned, but only by two respondents.

The above analysis of responses to this question shows the extensive variety of records kept by supervisors on construction sites. In addition to those mentioned in Table 4.1, the following types of site records (as listed in the question) were confirmed by the vast majority of site supervisors:

- Site instructions.
- Variation orders.
- Correspondence.
- Minutes of meetings.
- Progress reports.
- Plant & labour returns.
- Interim valuations.
- Daywork records.
- Revised drawings.
- Weather records.
- Site diaries.
- Progress photographs.
- Updated planning charts.
- Field and level books.
- Laboratory reports and test data.

The claims consultants were asked in question $Q_{J4}$ to identify the type of records, from the same list used in $Q_{C4}$, that are usually needed in dealing with a claim. All but 4 of these were confirmed by the majority of the respondents (5/8) as being required. This clearly indicates that many types of records are needed to deal with claims. Those excluded were as follows:

- Interim valuations.
- Daywork records.

- Field and level books.
- Laboratory reports and tests data.

***Site records that are worth keeping but not generally maintained ($Q_{C5}$& $Q_{C6}$, $Q_{J5}$& $Q_{J6}$)***

Questions $Q_{C5}$ and $Q_{C6}$ asked whether site supervisors could identify any other types of record that would be worth keeping but that are not generally maintained and of course the reason(s) why keeping such records would be beneficial. 69 percent of respondents stated that they did not think that there were any records worth keeping apart from those records normally kept, while 28 percent did suggest different types of records and gave their reasons (3 percent failed to respond). However, some of these suggested types such as records of safety measures and inspections, had already been indicated by some other respondents in replying to the final part of $Q_{C4}$. Some of the records pinpointed were detailed progress reports and delay records and related factual information on resources used. These types of record were seen by those who suggested them as worth keeping because they are useful in dealing with contractors' claims and in particular claims for extension of time. Such records were also seen as being useful for monitoring construction performance and allowing better future planning. Other suggested records included records of contractors' 'faux pas', although it was admitted that these are not always evident because contractors redirect resources to overcome self-inflicted problems. Records of traffic management were also highlighted because they are useful in preparing reports on accidents and in dealing with third party claims after an accident.

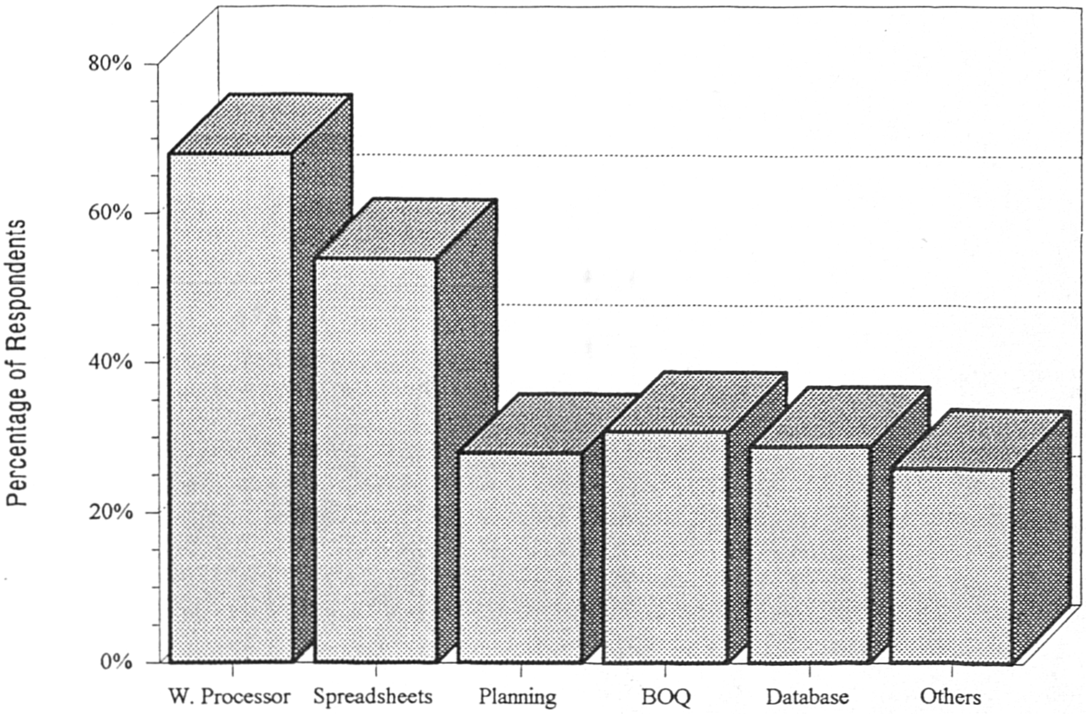
The same questions ($Q_{J5}$ & $Q_{J6}$) were also addressed to the claims consultants to identify any other records they might consider worth keeping. Again, almost two-thirds (5/8) indicated that they did not consider any other records should be kept. Those respondents who did indicate other records be kept, suggested records related to standing time of resources and the use of additional plant for the purpose of assessing claims. Actual production output records achieved prior to and after the issue of variation orders were also suggested to be worth keeping to assist in the evaluation of disruption events.

*The extent of computer usage on construction sites ($Q_{C7}$& $Q_{C8}$, $Q_{J7}$)*

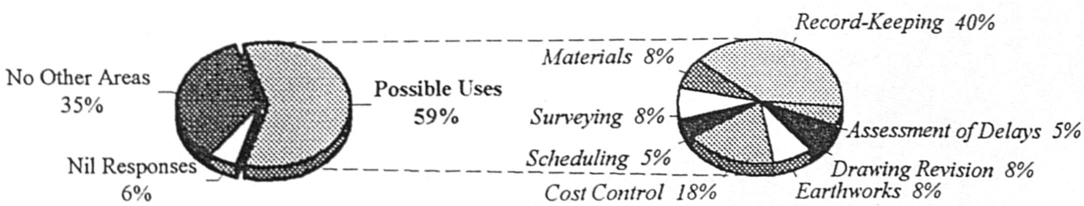
The first question in this sub-section ($Q_{C7}$) was aimed at determining the extent of computer use on construction sites, in part to determine whether site environments have become computer-friendly. This was done by asking whether particular types of software were used (word processor, spreadsheets, planning, Bills of Quantity BOQ, database and others) and what they were used for. Whether site staff would be ready to accept and use computers for activities such as record-keeping might also be indirectly gauged from the extent of current use. Analysing the answers to this question revealed that some construction sites are still computer-free. 22 percent of respondents, 79 percent of whom had spent more than 10 years in supervising construction, gave no evidence of having any type of software in use on their sites. Only 9 percent of respondents indicated a use of all the software listed in the question.

With regard to the use of software, figure 4.15 shows that 68 percent of the respondents confirmed the use of word processors on sites for correspondence, minutes of meetings and reports. The use of spreadsheet on sites was confirmed by 54 percent of respondents, mainly for preparing financial reports. Planning software was only used on 28 percent of construction sites for monitoring work programmes and assessing work progress, and 31 percent of sites used BOQ computer software for preparing interim valuations, measurements and final accounts. The use of database software was reported by 29 percent, mainly for storing laboratory results and preparing test reports. Only 26 percent of respondents identified other software in use on sites. The main other software reported was design & drawing packages for adjustment of design, and surveying packages for earth works measurements and setting out calculations.

When respondents were asked in question $Q_{C8}$ whether they considered the use of computers as being valuable in any other areas of site work, 59 percent did recognise other potential uses. Keeping site records was the most commonly quoted area by those who admitted the possibility of other uses for computers on site as shown in figure 4.16. However, most proposed areas of computer use had already been stated by some respondents in replying to the final part of the question $Q_{C7}$ 'define other software used'. These included cost monitoring and control, drawing revision, surveying, planning and scheduling of work programmes and calculation of earthwork quantities.




*Figure(4.15): Use of Computers on Construction Sites*




*Figure(4.16): Views on Other Areas of Computer Use*

When the claims consultants were asked ($Q_{J7}$), if there were any ways in which they could foresee particular value in the use of computers on construction sites to deal with claims, 50 percent of them admitted the possibility of using computers on site to help in dealing with claims.

From the above analysis, it can be concluded that computers are being used to a limited extent by the supervising team on construction sites, although future benefits of using such technology in new areas were appreciated by a reasonable percentage of respondents. Record-keeping was the area recognised by most as having potential for future computer applications.

### 4.3.1 Summing up

The following points stemmed from analysing and discussing the results obtained relating to general site records:

i) Although the majority of site supervisors viewed the current approach to keeping site records as suitable and adequate, the existence of a number of problems that prevent the keeping of good site records was also confirmed.

ii) Additionally, a considerable majority of site supervisors made suggestions to improve site records which can be considered as an indication of a lack satisfaction of the records being kept.

iii) The problems recognised mainly fall into two categories, as follows:

- Problems related to procedures, such as the lack of an effective, organised approach for record-keeping.
- Problems related to site staff concerning the time available and the number and experience of site staff.

iv) Site records can be improved by adopting better methods and procedures for keeping them as well as establishing effective training programmes for site staff, which concentrate on the importance of site records and the best ways of keeping them.

v) The extent to which records are kept on construction sites varies, but the range of these records emphasises the importance of adopting effective procedures for keeping them. Only by having good systems is it possible to ensure that the records serve the purposes for which they are maintained and provide the necessary information in good time and in an appropriate way.

vi) Although the advantages of using computers were properly appreciated, the areas in which computers are used on construction sites are limited. There are still a number of computer-free sites. The most widely recognised future use of computers in such an environment was for record-keeping purposes.

### 4.4 Site Progress Records

This section, which comprises two sub-sections, covers questions related to the general progress records and the records kept by site personnel. The general progress records sub-section included recording when exactly construction activities took place, identifying links (in time) between subsequent activities and producing reports on the progress of construction works. The questions asked in this sub-section relate to progress records kept by the site organisation as distinct from personal site diary records. The site personnel records sub-section comprised questions aimed at identifying the nature of site diary records, the format adopted to keep these records, the value of using standard forms and problems with site diary records. Additional information was sought on how these site documents can be improved by identifying views on general practice and the use of computers as well as the possibility of covering such practice by quality procedures.

#### 4.4.1 General progress records

***Recording when construction works exactly took place ($Q_{D1}$ & $Q_{D2}$ and $Q_{K1}$, $Q_{K2}$ & $Q_{K3}$)***

Respondents were asked if they kept a record of progress showing, for each of the activities on the contractor's programme, on exactly which days construction work took place. 65 percent of respondents indicated that they did keep such a record. The remaining 35 percent admitted that they did not record this type of information for various reasons, including the fact that some contractors' work programmes are insufficiently detailed to allow this. Some respondents also stated that this type of record is not normally kept as a specific undertaking. Some also considered such practice impractical and time-consuming, particularly where similar information can be obtained from other sources such as site diaries.

Although a serious attempt had been made to ensure that the wording of the question was unambiguous, some respondents still stated that they do keep such a record and yet their comments quite clearly showed that they do not. 'Maintaining records on key and/or critical activities' and 'information on construction events within the text of a site diary' or 'in an inspector's report', are examples of such respondents' comments. These are not the answers that it was hoped the question would elicit. It seems also from some of these comments that many of them are not aware of the difficulty of preparing such a record retrospectively (i.e. from site diaries). Of the majority of respondents who said 'yes', they do keep this type of record, the comments of 43 percent of them strongly suggested that they do not. Considering this result, only 37 percent of the respondents can be assumed to maintain such records. It is also worthy of note that 45 percent of the respondents who stated that they kept such records did not comment on their answers which also casts some doubt on the figure of 37 percent. This leads to a general conclusion that the majority of respondents (at least 63 percent and possibly more) do not keep records of progress that show against each of the work activities on the contractor's programme, exactly when work took place.

When claims consultant were asked in $Q_{K3}$ whether such records are usually kept by the supervising engineers' staff, almost two-thirds of them (5/8) indicated that this type of record is not kept on construction sites. No comments were provided by the remaining respondents which could assist in understanding their confirmation of the existence of these records.

In $Q_{D2}$, site supervisors were asked whether they considered that keeping a record showing on exactly which days construction activities took place would be useful. 75 percent of respondents believed that keeping such records is beneficial. In comparing the results obtained from $Q_{D1}$ and $Q_{D2}$, it is believed that at most 37 percent kept these records and yet three-quarters indicated that it would be worth keeping such a record as an index to other records and as an as-built record of progress. This is strong support for the view that such records should indeed be kept.

This type of record is seen by some respondents as essential information for assessing contractors' claims, although some also commented that maintaining these records is not an easy task. The difficulty of keeping hand written records owing to time constraints, the need for dedicated members of staff with planning responsibilities, and the difficulties due to the frequent changes of construction programmes, are some examples. The comments give an indication of a general lack of understanding as to what type of information is really needed to be maintained, which is simply to record exactly when and what is occurring in a particular construction activity.

The vast majority of claims consultant (7/8), in their responses to questions $Q_{K1}$ and $Q_{K2}$, strongly supported the keeping of such records to identify on exactly which days each activity on a contractor's work programme took place.

***Identifying links between construction activities ($Q_{D3}$& $Q_{D4}$, $Q_{K4}$& $Q_{K5}$)***

These questions were aimed at determining whether site supervisors identify links between subsequent construction activities which define the actual point in time during the completion of one activity, when a subsequent dependent activity(s) can commence. Such information is most important in building up a record of 'as-constructed' (as-built) programmes. The aim of preparing an 'as-built' programme is not only to identify when an activity took place, but also to allow an understanding of when subsequent activity(s) can commence. If, for instance, one construction activity is not quite completed, but at that time does not prevent the contractor from starting the next job (i.e. he could start that task but he does not), then effectively this is the contractor's responsibility for not doing so. It is certainly important that the supervisor's report records such facts. This is one of the reasons why supervisors should identify these links and record when they occur. Unless such a practice is continuously carried out, a full 'as-built' network cannot be built up as construction work progresses.

Figure 4.17 shows that only 38 percent of the respondents stated that they always identify such links, and out of this 38 percent, 52 percent either did not comment or commented in such a way that it threw doubt on whether the 'always' answer was correctly chosen. An example of these comments is that 'the contractor programme is kept up to date and commented upon at each submission'. It should also be borne in mind that identifying such links does not necessarily mean that a record has been kept of when they occurred. The results thus suggest that the majority of respondents (at least 62 percent and possibly more) do not keep a complete 'as-built' record of events.

By studying some respondents' comments on the answer to this question in detail, one gains an impression of a lack of understanding of what should be done with, and what should be obtained from, the record keeping process. 'Links would be identified where there is value in so doing', 'checks are made on logic links between activities', 'how critical path and float for non-critical activities are indicated by the programme', and 'contractor programme is kept up to date', are some examples of the comments made.

It seems also from some comments that the discussion is often associated with the links as shown on the idealised plan and not those that governed actual construction. Examples of these comments are: 'many programmes are not in network format' and 'contractors rarely carry out their operations in such a clear-cut fashion as their programme would indicate'.

Some comments also suggested that this practice should only be done in retrospect. Some respondents indicated also that such links should only be paid attention to when there is a claim. Another respondent stated that 'identifying such links serves no particular purpose for the engineer unless a claim is being investigated!' There is no doubt that the best time to identify these links and record their occurrence is when they actually happen and not at a later time. It is often not clear that there will be a claim at any point and therefore all possible links must be identified and recorded. This should be done continuously to ensure that site records contain all necessary information and will be ready at any time to serve the purpose for which they are kept.

Although 63 percent of site supervisors admitted that they always or often identify such links between subsequent activities, 75 percent of claims consultant ($Q_{K5}$) indicated clearly that such records are not usually kept by the site supervising staff.

In question $Q_{D4}$, the respondents were asked if they see any value in keeping a record of these links as they occur and almost 85 percent agreed that there is value in keeping this type of record. By comparing these results with the responses to the previous question (i.e. only about one-third of the respondents always identify links), this appears to be yet another area where practice fails to be guided by belief. It also throws into question the result from $Q_{C1}$ where the majority of site supervisors were satisfied with the record-keeping procedures currently in use and yet, here again, the majority saw value in what is done by a minority of them.

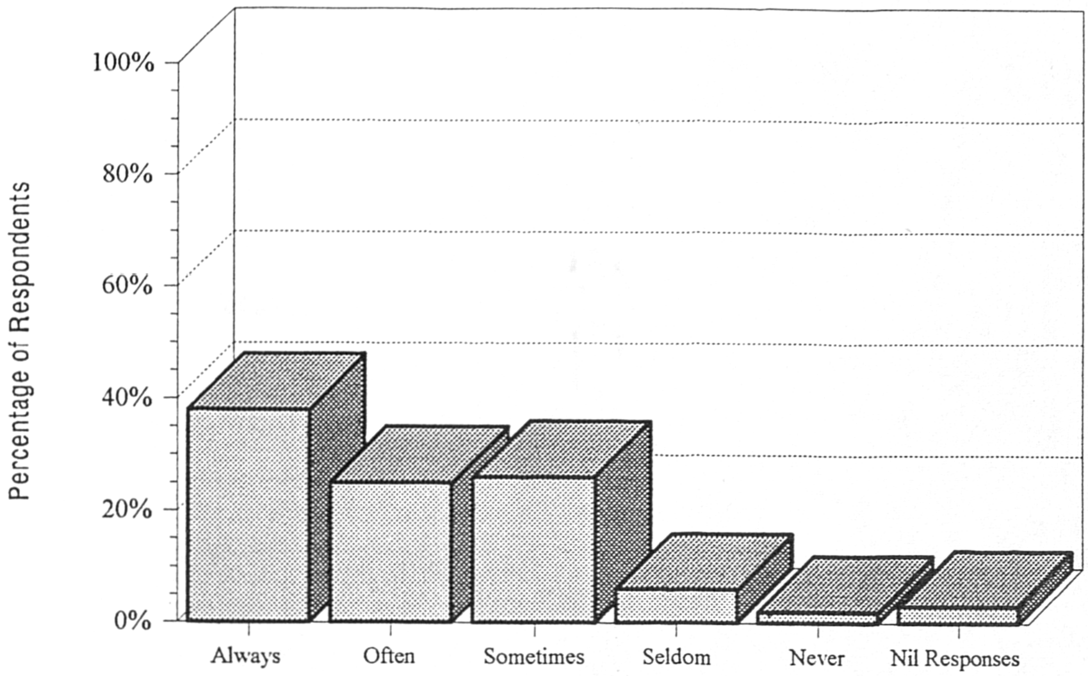
All claims consultants admitted in their responses to $Q_{K4}$ that it would be useful to identify such links to allow a recognition of the actual point in time during the completion of an activity at which a subsequent activity can commence.

There is no doubt that 'as-built' records containing identifying links between construction activities play a vital role in project control. This type of record helps in monitoring the progress of construction works and assessing contractors' claims. In the event of a delay occurring, such records may indicate the source of that delay and its consequences as well as identifying problem areas where actions can be taken in good time to overcome such conflicts.

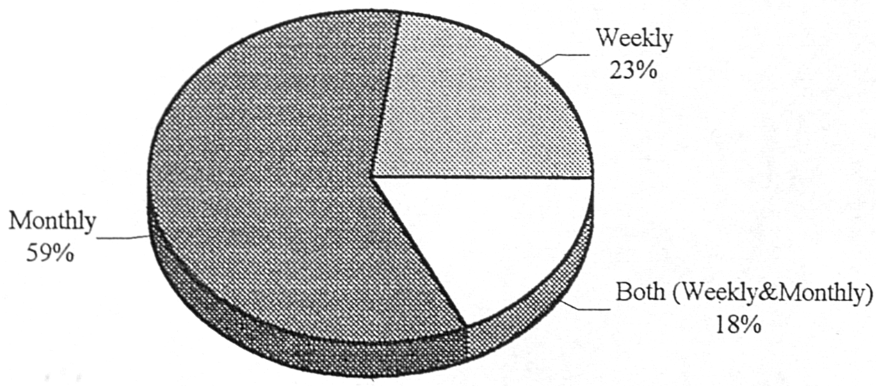
*Assessment of and producing reports on progress of works ($Q_{D5}$)*

At the end of this sub-section, a question which was not addressed to claims consultants was asked to identify how often site supervisors assess and produce a report on the progress of construction works. 59 percent of respondents, figure 4.18, do this only on a monthly basis with 23 percent producing a weekly report and 18 percent producing both weekly and monthly reports.

The fact that so many only produce a report once a month may be an indication of the difficulty of preparing such reports in short periods of time (i.e. on a weekly basis). This task may not be an easy one for various reasons, including the difficulty in obtaining




***Figure(4.17): Identifying Links Between Construction Activities***




***Figure(4.18): Preparing Progress Reports***

records from individual site staff in good time that will facilitate preparing such progress reports on a weekly basis. Additionally, it has been seen that certain types of records that help in assessing work progress are not always available.

### 4.4.2 Personal site diary records

*The most useful site diary records ($Q_{D6}$, $Q_{K6}$)*

This question was aimed at confirming who keeps better site records, the engineering staff or the clerks of works. It was intended that the results of the question would, in part, assist and direct the people who are going to use such records on the best source, at least as a starting point, for searching for useful information. It would, of course, also be useful to know as much as possible about the quality and content of existing records when considering any new proposals for the organisation of site records.

It is generally believed that clerks of works' (i.e. inspectors') records are more detailed than those of the engineering staff and hence it could be argued that they are more useful. Responses to this question, shown in figure 4.19, do not reveal strong support for such an argument. 25 percent of respondents stated that engineers' diary records are most useful whereas 35 percent admitted that the clerks of works' diaries records are the best. 40 percent of respondents either had no views or were unwilling to state which record was most useful. It should, of course, be remembered that it was the site supervisors (i.e. engineers) who were answering this question.

From the comments, most emphasised that the diary records of the two site staff categories are both important. About 23 percent of respondents considered that clerks of works' diary records represent a detailed record of daily activities and some respondents commented that engineers' diaries are more likely to record unusual events and highlight problems.

When the same question was addressed to claims consultants ($Q_{K6}$), although one-quarter failed to distinguish between the two site diaries, the vast majority (5/6) of those who expressed a view, indicated that clerk of works site diary records are more useful than those of engineering staff.

***Nature of Site Diary Records ($Q_{D7}$)***

The aim of this question (not addressed to the claims consultants) was to identify the nature of the site diary records kept by the main members of the site supervising team: resident engineers, assistant resident engineers, and clerks of works, i.e. the typical records kept by each. A number of areas were identified by the respondents for each category of site staff, and most of them were common for all, but with varied degrees of emphasis.

However, some areas were said to be recorded in resident engineers' diaries only and some were said to be recorded in clerks of works diaries only, as shown in Table 4.2.

The analysis of the total responses to this question is shown in figure 4.20. It is clear from this data, for example, that anybody searching for details of actual resources employed is likely to gain most from the records kept by the clerks of works.

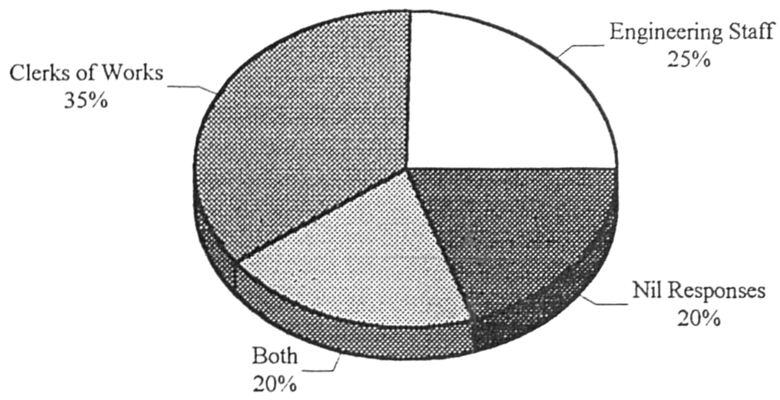
From the above points, which were highlighted by the respondents to this question, a general statement that would help to define the nature of each site staff category diary records can be concluded as follows:

- Resident engineers site diary records

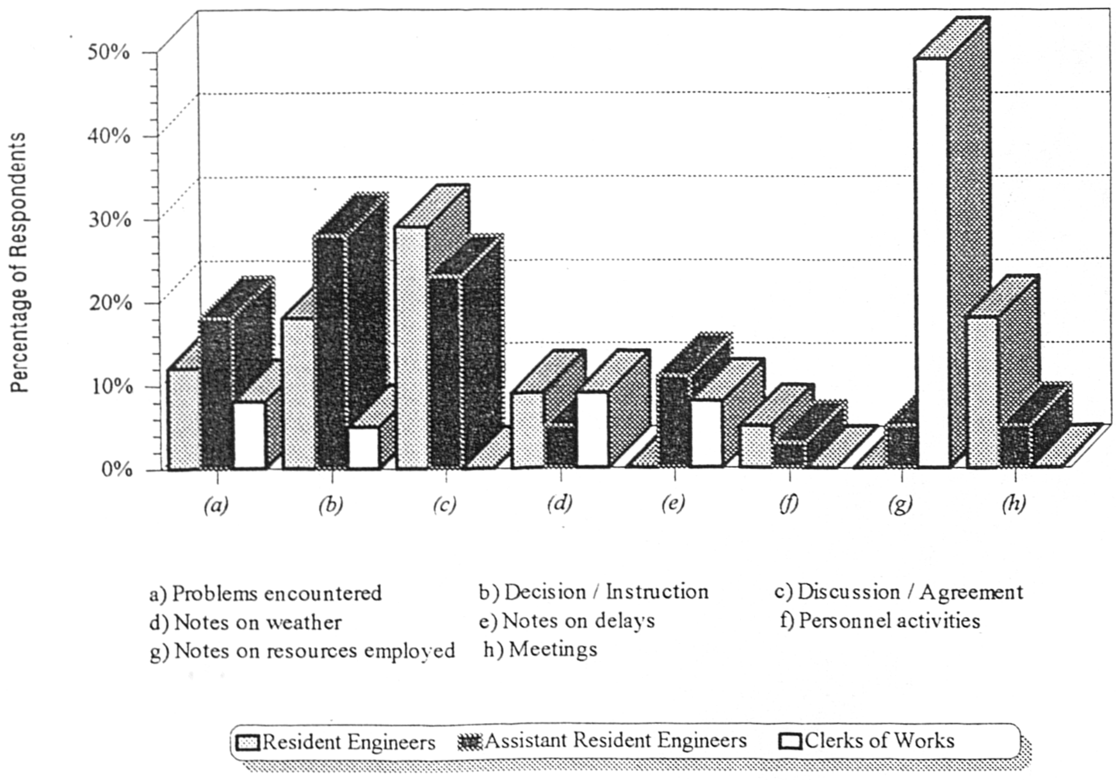
  *General record of major events and items related to administrating the supervision of construction works including conversations, observations, discussions, agreements, decisions, and overview of overall work progress.*

- Assistant resident engineers site diary records

  *General record of events with more emphasis on site matters, particularly problems encountered and their influences, instructions issued, and changes or amendments made to construction works.*




***Figure(4.19): Best Site Diary Records***




***Figure(4.20): Common Types of Contents of Site Diary Records***

Table (4.2): Areas of records specified only for each site staff diary

| Site Staff Category | Areas of Records |
|---|---|
| Resident Engineers | • General overview of work progress.<br>• Discussion and agreements.<br>• Telephone conversation.<br>• Observations.<br>• Contractual issues.<br>• Summary of daily events.<br>• General information. |
| Assistant Resident Engineers | • Records of work progress.<br>• Discussion and contact with contractor's staff. |
| Clerks of Works | • Detailed records of activities actually taken place.<br>• Detailed records of resources used.<br>• Materials.<br>• Quality of works.<br>• Site conditions. |

- Clerks of works site diary records

  *Factual detailed record of site activities related to the progress of construction works including resources used, material and quality of work produced as well as workmanship.*

***Site diary records and the contractor's programme ($Q_{D8}$, $Q_{K7}$)***

It was the site supervisors' views on the value of relating site diary records of progress to the activities on the contractor's programme that were being investigated in question $Q_{D8}$. 71 percent of respondents felt that there was value in keeping diary records relating to the contractor's programme while 17 percent stated that they saw no value in doing so. The other 12 percent expressed various views on this issue such as the value of relating diary records to the work programme activities is dependent on circumstances; whenever it is necessary it can automatically happen, but need not be done as a matter of course. More than one-third of the respondents who felt that keeping diary records in such a way was beneficial, stated that such records would help in monitoring work progress and would be very useful in the event of claims. As claims situations are not always obvious, this emphasises the need for a daily relating of these site records to the contractor's programme activities.

Although it was not asked whether site staff are used to this practice, the results show that more than two-thirds of respondents support such an approach. One respondent said that a site diary is pointless without relating its records to the work programme, while another stated clearly that such a practice is rare. The standard site diary sheets sent in response to $Q_{H8}$ and discussed much later in this chapter, show no evidence of a place to record the contractor's planned activities, as defined on his programme.

Some respondents' comments gave a general impression that site staff do not relate their diary progress records to the contractor's programme, possibly owing to the concern expressed by some of them that contractors' programmes are continuously changing. It seems again that some of these supervisors have a basic lack of understanding of the difference between the as-built record of what took place and the up-dated project plans. The project plan, even though the schedule time may be wrong, is still a systematic method of breaking down the job. Giving that this breakdown is used for planning the time, then that is believed to be the most important classification system that can be used to record what is happening and when. Despite the fact that it is not known when this activity should have taken place, because an up-dated version of the plan is not yet available and the initial schedule plan is no longer valid, it is still valuable to record when that activity did take place. If the project plan is also used for control purposes, as indicated in previous research (Scott,1991), then perhaps they discount the plan because it fails to help them to control the job. If site personnel have discounted the plan because it is not often up-dated and is therefore not useful for control purposes, they may have overlooked its use for claims assessment. The importance of knowing at any time when items of work occurred by making them identifiable from site records cannot be over-stressed.

In their responses to question $Q_{K7}$, all claims consultants supported the idea of relating site diary records of progress to the activities on the contractor's programme.

*Types of site diary formats ($Q_{D9}$)*

This question (not addressed to the claims consultants) was meant to identify the format adopted to keep individual site diary records by the various categories of supervising staff. The results, reproduced in figure 4.21, clearly show that the majority of engineering staff used bound page-a-day diaries for keeping their site records, while standard record sheets were the most popular format used by the clerks of works. Other formats were also identified by a few respondents such as duplicate books and pocket site notebooks, and some respondents admitted that more than one type of format was used by some site staff, mainly the clerks of works. That is, they might fill in a standard record sheet and a loose leaf diary. This would increase the effort made by those staff and undoubtedly more time would be used, perhaps needlessly. It is doubtful, even with extra effort, whether some staff would ever relate their records to the contractor's programme activities (as discussed in the previous question) as clerks of works are not usually familiar with project plans (Scott, 1987 and Russel, 1993). Also, the number of copies of the project plan is usually limited and they are normally kept in the main site office. It is therefore less likely that the clerks of works will have an opportunity to examine them.

### *Views on the use of standard record sheets ($Q_{D10}$, $Q_{K8}$)*

$Q_{D10}$ attempted to obtain respondents' views on the use of standard record sheets with pre-printed headings. 60 percent (figure 4.22) supported the use of such forms; some describing them as a very important method of ensuring that essential information is maintained and also that using them may result in more precise records being kept in an accessible way, enabling quick retrieval of information. Some respondents viewed such forms as a useful way of enforcing standardisation to ensure that important topics are covered and that later analysis of thousands of sheets is facilitated. However, about 14 percent of respondents indicated opposite views, describing these standard sheets as too restricted and inflexible and leading to only answering the question/section identified on the standard sheet rather than recording actual events. This can lead to misreporting, since if an item does not fit into one of the standard form's headings, it may not be recorded at all. Some respondents indicated that a space need to be provided for additional comments/remarks, and this may help to overcome the latter problem. Having too many headings on a form may discourage people from filling in their diary which would tend to defeat the purpose. On the other hand, open format diaries can facilitate mental down-loading and allow the reporter to express himself freely without obligation to answer specific questions, although adopting such a format may result in difficulties in retrieving and accessing information maintained in this way. Spaces provided for comments/remarks within the standard sheets should not be treated as if they were open format diaries and a substitute for the main sections of the standard sheets.

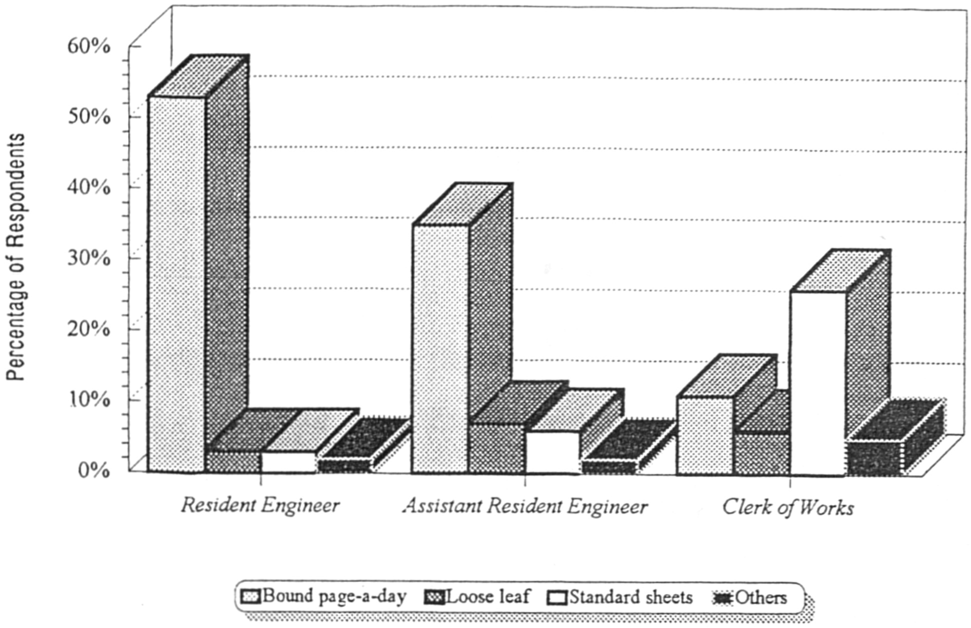
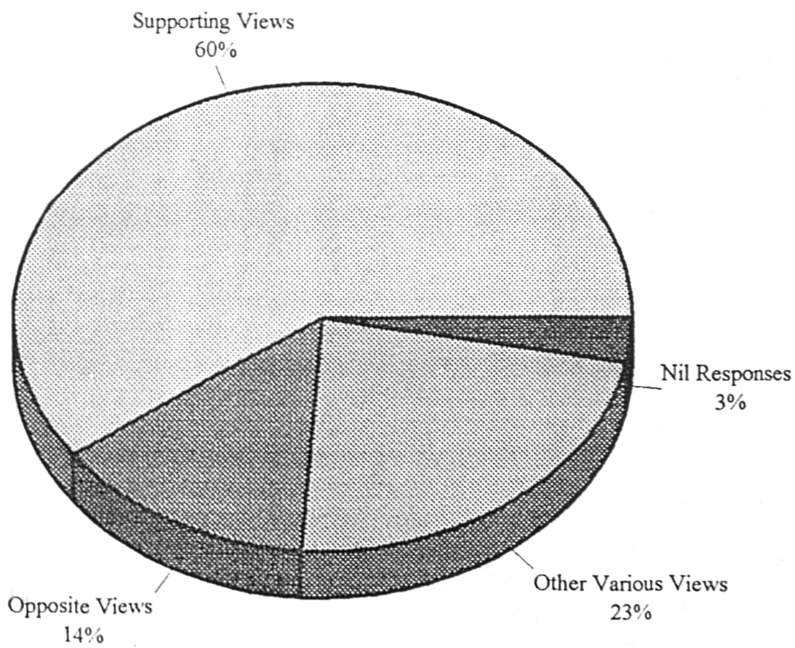



***Figure (4.21): Types of Site Diary Format***




***Figure(4.22): Views on the Use of Standard Record Sheets***

Some respondents (23 percent) expressed a variety views on the use of such standard forms. Some indicated that these sheets can be of limited use unless tailored to a specific type of construction activity, such as concrete pours, piling, etc. Some also indicated that certain headings are not used and others do not have enough space for a particular subject.

It is believed that computers can provide considerable assistance in such situations. In addition to improving accessibility, and providing more space, another advantage of computerising site diaries in a standard form would be that the computer would effectively insist that all questions be answered, before that data file could be closed. This would ensure the keeping of all required information and the provision of enough space for all records deemed necessary.

A considerable majority of the claims consultants (7/8) in their responses to $Q_{K8}$, generally viewed the use of such standard record sheets as beneficial. Some respondents indicated that these forms would be useful in introducing standard procedures and that using them would aid the speedy completion of the required information and hence encourage their completion. Some also pointed out that this method of keeping site diary records needs adapting to suit a particular contract.

Despite some of the comments made, it seems that using standard forms should simplify the task of obtaining the necessary records and if properly filled in, they should become more consistent. The use of computers would overcome the problem of not having enough space for certain items, and the data in electronic format would be much easier to search.

### *Recommended pre-printed headings of standard forms ($Q_{D11}$, $Q_{K9}$)*

This question was addressed to the supervisors to identify what pre-printed headings they would recommend for use on standard record sheets. These reports are usually designed with the aim of obtaining all basic information needed, therefore, it is essential to ensure that all the required information is covered by the specified headings. A number of headings were suggested by the respondents as clearly shown in figure 4.23, where the most commonly shared view on the type of headings was 'plant', and the least common opinion was 'delay'. It is probably thought that delay events are not generally indicated to be recorded in a separate section as they do not occur very often, and the spaces on the forms, if allocated, would only be used occasionally. As stated in the previous question, if such standard sheets were computerised, then space need not be considered an issue.

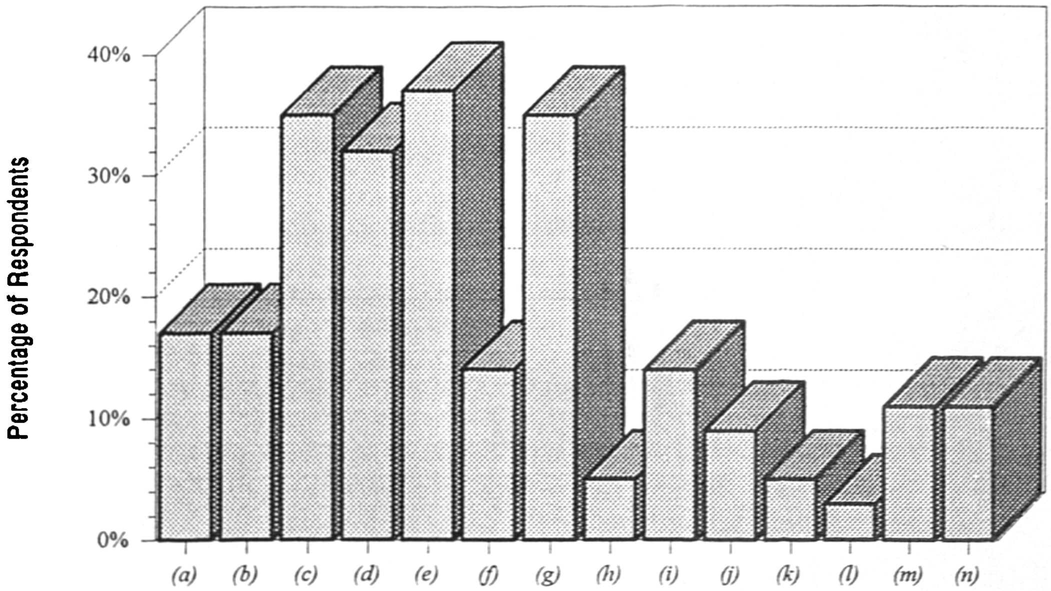
Although 'activity' was clearly suggested by many respondents as one of the headings that should be pre-printed on these forms, there was no indication (except by one respondent) of relating these activities to an activity reference number/code on the contractor's programme. Additionally, other headings were also suggested but only by very few respondents (i.e. some suggested only by one respondent) such as movement of plant and section of work complete.

The headings suggested by the claims consultants in $Q_{K9}$ included the following: activity, location, resources, and hours. Also suggested were sections for date, weather, site instructions, variation orders, contractor and job number.

It is clearly obvious that the types of heading that need to be included in these standard forms are varied, which is to be expected as contracts vary in size and type of works. This emphasises the need for flexible types of standard forms that consider the nature of different projects and cope with any required changes. This would obviously be possible to achieve by the use of computers, where any type of headings and spaces can be changed to suit each project's requirements.

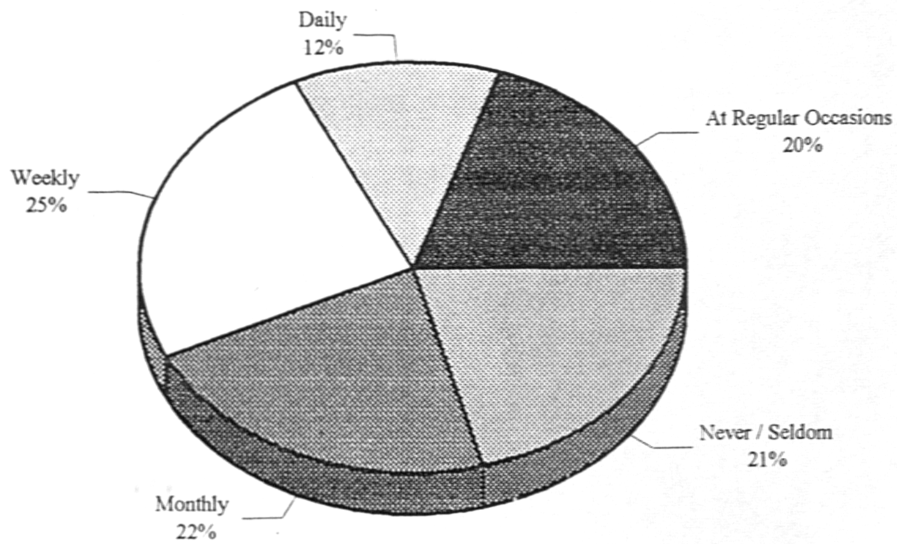
*Checks on site diaries ($Q_{D12}$)*

This question (not addressed to claims consultants) was put to determine how often site supervisors check their staff's diary records. Checking site diaries, when properly done, can help to avoid many problems as well as providing an opportunity to direct and advise site staff, in particular junior members, on suitable ways of keeping records. Corrective action can also be taken in good time to overcome any problems resulting from missing records. Analysis of the responses to this question, shown in figure 4.24, reveals that the majority of respondents (79 percent) check their site staff diary records on daily, weekly, monthly or at regular occasions. In one of the associated comments, some concern was




a) Date / Week no. b) Location c) Activity d) Labour e) Plant f) Hours
g) Weather h) Instruction i) Material /Test j) Visitors k) Programme l) Delays
m) Comments / Remarks n) Variations

***Figure(4.23): Recommended Pre-printed Headings on Standard Forms***




***Figure(4.24): Checks on Site Diary Records***

expressed that such checks may show a lack of trust, and although understandable, such an attitude is surely not supportable. However, if record-keeping procedures were computerised with each individual inputting his site diary records into a central storage medium, the supervisor could then inspect and check staff diaries without obvious signs of so doing. Additionally, if each member of the site staff had the opportunity to access such central computer storage (main network), then the supervisor would have the opportunity to communicate with his staff without, for instance, asking them to attend meetings (via e.g. the electronic mail).

***Problems with site diary records ($Q_{D13}$, $Q_{K10}$)***

During the preliminary investigations, described earlier in chapter two, a number of problems and difficulties with site diary records were identified concerning their accessibility, legibility, continuity and consistency. Question $Q_{D13}$ attempted to determine whether site supervisors have experienced such problems and also the severity of the problems. The analysis of the responses to this question is presented under two headings: the problem of acknowledgement, and the problem of severity.

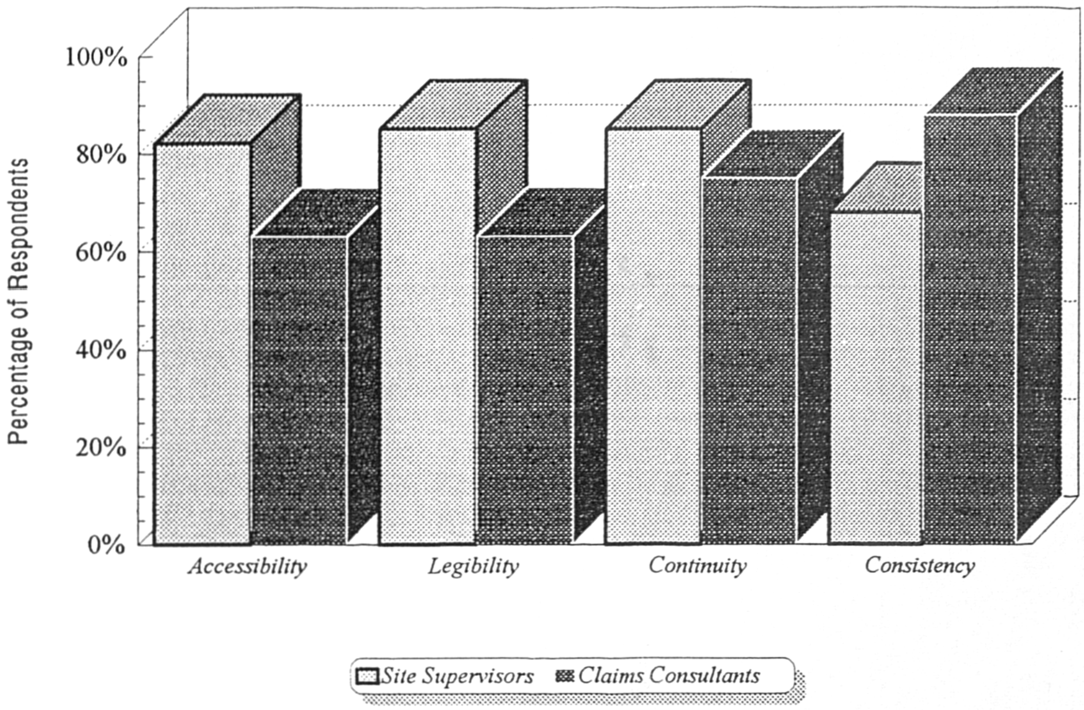
i) <u>Acknowledgement of problems</u>

Analysis of the first part of the question, shown in figure 4.25, reveals that almost 85 percent of respondents experienced problems related to the legibility and continuity of site diary records, while 78 percent and 68 percent of them admitted the existence of problems related to record accessibility and consistency, respectively. The results indicate that a great majority of site supervisors had suffered from such problems and difficulties.

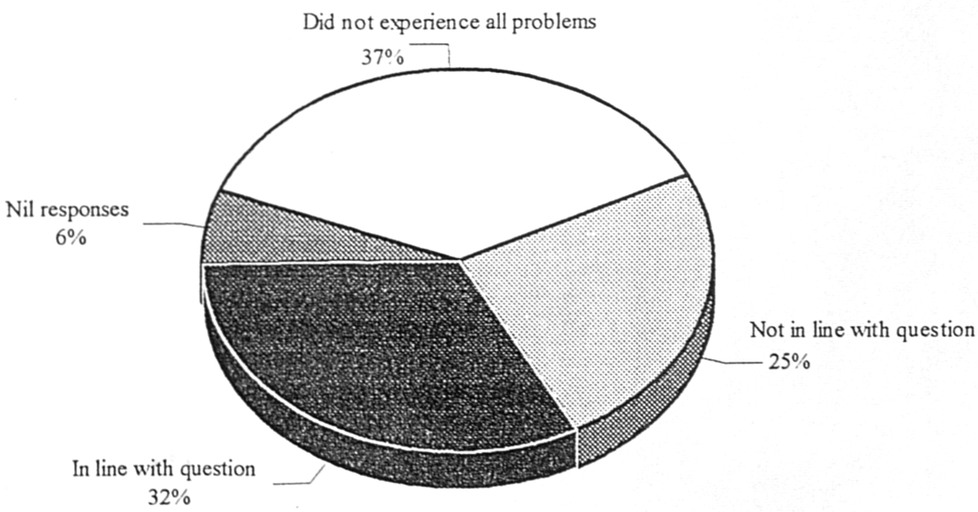
Most claims consultants also confirmed (as shown in figure 4.25), in their response to $Q_{K10}$, the existence of these problems. The most common type of problem experienced by claims consultants involved consistency.

ii) Problems of severity

With regard to severity, respondents were asked to rank the four problem types recognised from 1 (most severe) to 4 (least severe). Although serious attempts were made to make the question as clear as possible, a considerable percentage of respondents (almost 65 percent) failed to respond as required to this part of the question. This may either have been because they did not understand the question, they did not feel that they could rank them in order or because they had not experienced all of these problems. So, when the replies to the question were carefully inspected, it was noted that respondents had answered in three different ways (as shown in figure 4.26). Some responded in-line with the question (i.e. problem severity ranked 1 to 4), but others did not use all the ranking figures (for example `1,4,4,3') and some only gave a ranking to 3 or less of the problems. The question requested the relative ranking of the severity of problems and so the responses of those who had not experienced all these difficulties were not included in the analysis of this part of the question as they were not compatible with the other data. It was therefore decided to analyse the data in two ways: applying the weighting process for




***Figure(4.25): Confirmation of Problems with Site Diary Records***




***Figure(4.26): Nature of Data: the problem of severity***

all data in accordance with the question (group I), and applying the procedure of summing of the ranking figures for data not in-line with the question (group II). Analysis procedures are described in detail under two sub-headings as follows: analysis of group I data and analysis of group II data.

Similarly, responses of the majority of the claims consultants ($Q_{K10}$) were found not to be in-line with the question and therefore, the analysis was conducted as for the supervisors' group II data.

a) Analysis of group I data

Table 4.3 contains results obtained from those who responded in accordance with the question (21 respondents), together with analysis of the figures. A weighting was applied to these choices, with the ranking '1' attracting a weighting of 4, '2' attracting a weighting of 3, '3' and '4' a weighting of 2 and 1 respectively. The weighted values of the choices made are also shown in the table. To provide an indication of majority views, two other figures have been calculated. These were a datum, and a figure that aims to show more clearly the range of severity of the problems. The datum represents the least possible weight which assumes that all respondents (21) would rank one of these problems as the least severe '4' which attracts a weighting of 1. Thus, by subtracting this datum (21*1=21) from the weighted scores, and dividing the result by the total new weighted scores (126) (i.e. the sum of weighted scores less datum), then the results will indicate respondents' concern about the severity ranges of these problems. The result of the analysis, shown in

Table (4.3): Severity of Problems with Site Diary Records

| | Difficulties | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Accessibility | | | | Legibility | | | | Continuity | | | | Consistency | | | |
| | Severity Ranking | | | | Severity Ranking | | | | Severity Ranking | | | | Severity Ranking | | | |
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| No. of Choices | 4 | 7 | 3 | 7 | 3 | 7 | 5 | 6 | 10 | 3 | 5 | 3 | 4 | 4 | 8 | 5 |
| Weighted | 16 | 21 | 6 | 7 | 12 | 21 | 10 | 6 | 40 | 9 | 10 | 3 | 16 | 12 | 16 | 5 |
| Weighted Scores (A) | 50 | | | | 49 | | | | 62 | | | | 49 | | | |
| No. of Responses (B) | 21 | | | | 21 | | | | 21 | | | | 21 | | | |
| Datum (C)=(A)-(B) | 29 | | | | 28 | | | | 41 | | | | 28 | | | |
| Total New Weighted Scores (D) | (29) + (28) + (41) + (28) = (126) | | | | | | | | | | | | | | | |
| Percentage (C)/(D) | 23 | | | | 22 | | | | 33 | | | | 22 | | | |

figure 4.27, reveals that the problems related to accessibility, legibility and consistency are almost all of equal severity with respondents showing most concern about the continuity of site records.

b) Analysis of group II data

The above weighting process cannot be used in a situation where respondents have not properly ranked the severity of the recognised problems, and therefore, in this case, it would be appropriate to sum the ranking points against each problem (the respondents were asked to rank 1 as the most severe and 4 as the least severe). The ranking figures were converted (1 to 4, 2 to 3, ..etc.) to facilitate a useful comparison with the results obtained from the analysis of group I data, as shown in Table 4.4. The higher figures will indicate the most severe and the lowest the least severe . The result, as shown in figure 4.27, reveals that the recognised problems with site diary records are almost of equal severity and those related to the continuity of site diary records are the most severe. These are in-line with the results obtained from analysis of group I responses.

Analysis of the claims consultants responses was carried out in a similar manner. The ranking figures were also converted and summed as shown in Table 4.5 where the higher sum indicates the most severe and the lower sum indicates the least severe. The results shown in the table indicate that the most severe problems, according to claims consultants, are accessibility related problems. This result might be expected as claims consultants are

Table (4.4) Analysis of data of severity of problems with site diary records - Site Supervisors, (group ii).

| | Difficulties | | | |
|---|---|---|---|---|
| | (i) | (ii) | (iii) | (iv) |
| Sum of the converted ranking figures (A) | 38 | 36 | 43 | 37 |
| Total (B) | (38)+(36)+(43)+(37)=(154) | | | |
| Percentage (A)/(B) | 25 | 23 | 28 | 24 |
| (i)=Accessibility, (ii)=Legibility, (iii)=Continuity, (iv)=Consistency | | | | |

Table (4.5) Data analysis of severity of problems with site diary records (Claims Consultants).

| | Difficulties | | | |
|---|---|---|---|---|
| | (i) | (ii) | (iii) | (iv) |
| Sum of the converted ranking figures (A) | 19 | 11 | 11 | 14 |
| Total (B) | (19)+(11)+(11)+(14)=(55) | | | |
| Percentage (A)/(B) | 35 | 20 | 20 | 25 |
| (i)=Accessibility, (ii)=Legibility, (iii)=Continuity, (iv)=Consistency | | | | |

generally more concerned with amount of time that is going to be spent on their work i.e. when investigating a claim, inaccessible records will take more of their time to unravel.

In the comments associated with this question, site diaries were highlighted by some respondent as the most vital records kept on any site. It is clear from the analysis of responses to the $Q_{D13}$ and $Q_{K10}$, however, that there are a number of common problems with site diary records which affect their quality and these problems are in general of an equal degree of severity. This undoubtedly affects the purpose of keeping such vital records and would typically affect the supervisors ability to function effectively. No single problem has been identified as especially severe, therefore an overall effort must be made to overcome all such difficulties.

*Other problems with site diary records ($Q_{D14}$, $Q_{K11}$)*

$Q_{D14}$ aimed to establish whether site supervisors had experienced any similar kinds of difficulties in addition to those listed in $Q_{D13}$. Almost 59 percent of respondents indicated that they had not experienced any other kinds of problem; 32 percent (of whom 81 percent have more than 10 years in supervising construction) admitted having had some problems, while 9 percent failed to respond to this question. From the comments provided by the 32 percent, a number of additional problem areas were described. These related to the experience of site personnel, lack of detail in records and various other points which add to the understanding of the problem of accessibility of site diary records already identified and explained in chapter two. Points relating to the problem of accessibility, that may be considered as extra definition, can be summarised as follows:

- Disappearance of site diaries (i.e. due to staff movements).
- Inaccurate, incomplete, or misleading site diary entries.
- Varying ways of referencing the same work activities.
- The volume of diaries generated.

The lack of experience of some site staff is also identified as further difficulty in obtaining good site diary records. Difficulties in this area included the following:

- Site staff being unaware of the importance of keeping accurate records.
- Lack of adequate information/reports owing to inexperienced reporters.
- Lack of records owing to problems not being identified until too late.

As stated above, lack of detail (brevity of information) is also another problem that was highlighted by some respondents. Although detailed records may generate an enormous volume of data and can create problems when accessing information, insufficient records can mean that necessary information cannot be obtained because it was simply not recorded. If an effective system to cope with a large amount of records can be found, then having too many records will not be a problem, because when information is required, it will be found with much less difficulty.

When the same question ($Q_{K11}$) was addressed to the claims consultants, most (5/8) indicated that they had not experienced any other similar kinds of difficulty. Some, however, highlighted the problem of lack of detail in site diary records.

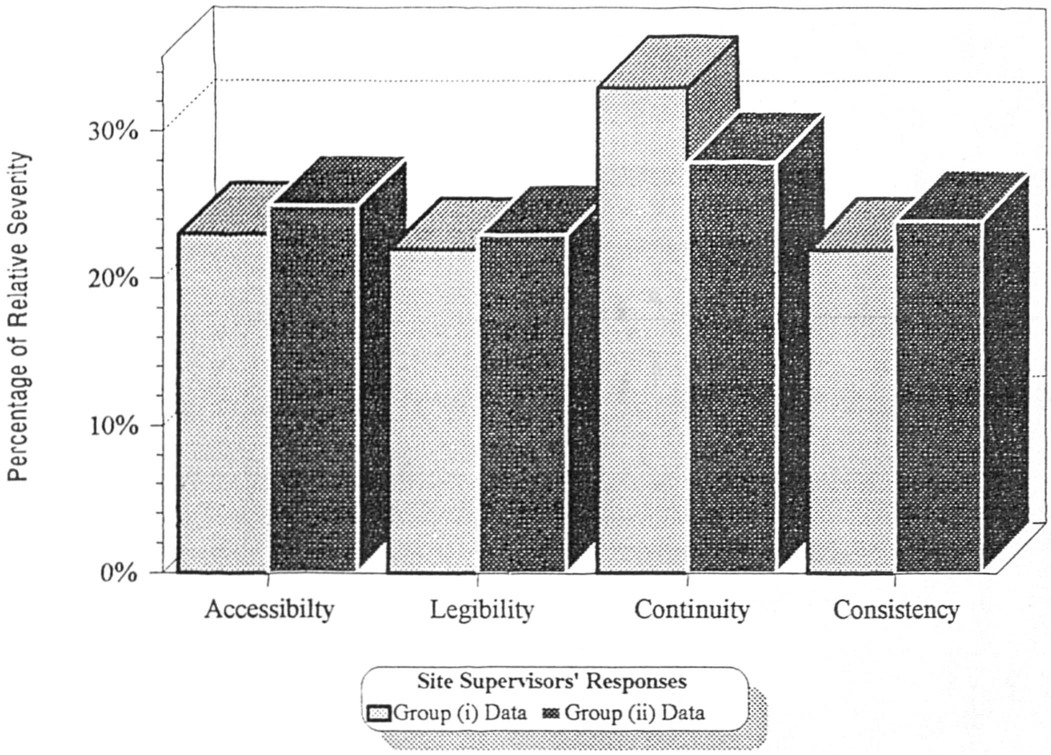
*Computerising site diary records ($Q_{D15}$)*

This question (not addressed to the claims consultants) was put to establish whether respondents could imagine their staff keeping site diary records on a computer. Almost two-thirds of respondents stated that they could foresee such an eventuality, and as these are the people who know most about this process, this obviously supports the proposition. The remaining respondents denied the possibility of such computerisation, setting out various drawbacks in their comments to the question. Some argued that certain categories of site staff categories (e.g. clerks of works / inspectors) may not be able to cope with such arrangements since some of them are not computer literate and lack keyboard skills. Some respondents also stated that the computerising process could be time-consuming owing to the need to travel to the computer area and also imagined a limited number of terminals resulting in diarists waiting in a queue. Some indicated that handwriting may be quicker, while others stated that most computers are not suited to site use.

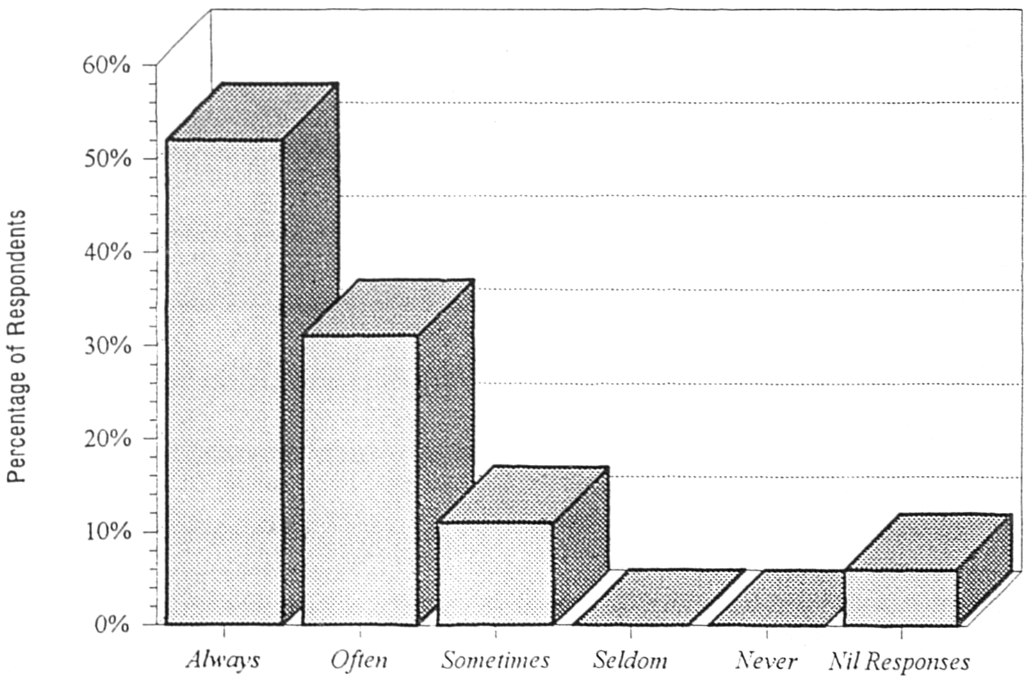
It is believed that by implementing good training programmes, and utilising the latest computer technology it would be possible to overcome most of these drawbacks. As has already been noted in chapter one, more sophisticated hardware and software packages are now available which require less computer skills. Even the concern raised by some respondents, regarding the legal status of computer records as such records can be falsified or changed, can be overcome by limiting the access to these records. If a system could be derived whereby records were sent to a central computerised store and having been received there, could not be updated but read only, this would be a positive step. It would also help to confirm that the maintained records were contemporaneous. In addition to the great advantage of using computers, a further benefit of having a central store of all staff records would emerge. The site supervisor, by sensible checks on a daily basis, could ensure that his site staff were making efforts to keep good records, and where necessary, take action to amend bad practice in good time.

*Advice on keeping site records ($Q_{D16}$)*

$Q_{D16}$ was addressed to site supervisors only, to determine whether they assist their site staff in understanding unusual occurrences on site that might lead to disputes, and that will need good records kept about their development. The responses showed that the great majority of respondents (94 percent) carried out such practice, at least sometimes, as shown in figure 4.28. This was seen by some respondents as a routine duty of the resident engineer and one that should be emphasised by site quality plans to ensure the maintenance of good records. Some stated these issues are communicated to site staff via regular meetings, briefing them from the outset about potential disputes and training them to identify such occurrences as well as encouraging them to keep appropriate records. This




***Figure(4.27): Severity of Problems with Site Diary Records***




*Figure(4.28): Advice on Keeping Site Records* was also seen by some as a vital part of staff training during the construction stages - in particular for junior and less experienced staff. Half of the respondents admitted that they always helped their site staff to understand unusual occurrences on which good records needed to be kept, and that would certainly seem to be a sensible attitude.

*Quality procedures for keeping site diary records ($Q_{D17}$)*

Site supervisors were asked in question $Q_{D17}$ (the claims consultants not included) to state whether they have quality procedures that cover the keeping of site diary records. 51 percent answered 'yes' and 49 percent answered 'no'. Almost two-thirds of the respondents did not comment on their answers, which would have provided a clearer understanding of their choices. By studying the comments that were made, it was clear that at least 27 percent of respondents who indicated that they have implemented such quality procedures, did not in actual fact do so. Guidance notes issued at the commencement of each contract and standard headings on daily record sheets are some examples of the comments made, but they can hardly be said to be proper quality procedures. From this result, only 37 percent of the respondents can be considered to have such procedures, although there is some doubt even about these, as the great majority of respondents did not comment on their 'yes' answers. Therefore, it can be concluded that the majority of respondents (at least 63 percent and possibly more) do not have quality procedures covering the keeping of site diary records.

*Views on quality procedures for site diary records ($Q_{D18}$)*

$Q_{D18}$ (not addressed to the claims consultants) was meant to determine site supervisors' views on the possibility of developing quality procedures for keeping site diary records. The question was structured to allow the respondent to express a view irrespective of whether he had such procedures. Respondents were asked to tick boxes (agree/disagree/don't know) that most closely represented their views on the following statements:

a) *There are no procedures that could ever usefully cover the record-keeping process.*

b) *Such procedures are necessary for the keeping and managing of site records.*

c) *Such procedures would be helpful but would be difficult to identify.*

d) *Even if sensible procedures were identified, they would not be accepted and followed by the site staff.*

Figure 4.29 shows the data obtained from the responses to this question. Analysis of the views on statement (a) shows that the great majority of respondents (85 percent) disagreed with the statement and that could be considered as an affirmation of the fact that such quality procedures can be developed. Two-thirds of the respondents felt that such procedures are necessary for keeping and managing site records (statement b) although there were a number of dissenting views to this statement. The majority of the respondents (71 percent) who disagreed with the second statement admitted in their responses to the previous question that they did not have such procedures. Respondents' views on the third statement (c), were fairly evenly split, with 49 percent stating that identifying such procedures would not be a difficult task whereas 43 percent would find these procedures difficult to identify. A considerable majority of respondents (78 percent) disagreed with the fourth statement (d) suggesting that providing sensible procedures were established, they believe they could get their site staff to adopt them.

Based on the responses to this question, it seems that a great majority of site supervisors agree that quality procedures for the record-keeping process can be developed, that such procedures are necessary for keeping site records, and that their site staff would accept and follow such procedures. Considering these results and the fact that most respondents do not have such quality procedures (as indicated by the results of $Q_{D17}$), this can be considered as supporting the need for developing sensible procedures covering the record-keeping process.

***Factors affecting the setting up of quality procedures ($Q_{D19}$)***

This question, which was not addressed to claims consultants, aimed to identify factors that might affect the setting up of quality procedures for keeping site diary records. Although 18 percent of the respondents failed to respond, one-third had expressed their concern about the nature of such procedures and the need for any approach to be flexible mainly because of the varying nature of job type / complexity / size.

Some respondents (31 percent) indicated that they have problems with site staff that would affect the setting up of these record-keeping quality procedures. Lack of commitment, varying experience of individuals, and lack of time available to follow these procedures due to workload pressure, were the main points raised by these respondents.

Some respondents (18 percent) considered that an important factor would be effect of company polices with regard to this issue and identified the low status given by some companies to this process. 'This is not seen as a high priority by such firms, particularly those concerned with design', is an example of these responses. Also identified is that, there is a lack of the necessary motivation for site staff to become involved in such processes.

It is, however, believed that the flexibility of any approach and hence its adoption would be affected by any attempt at standardising systems for projects that vary in nature and size. It is, therefore, an important task to ensure that such procedures are sufficiently flexible and ensure that they are suited to those keeping the records, to minimise the effects of these problems.

***Time devoted to keeping site diary records ($Q_{D20}$)***

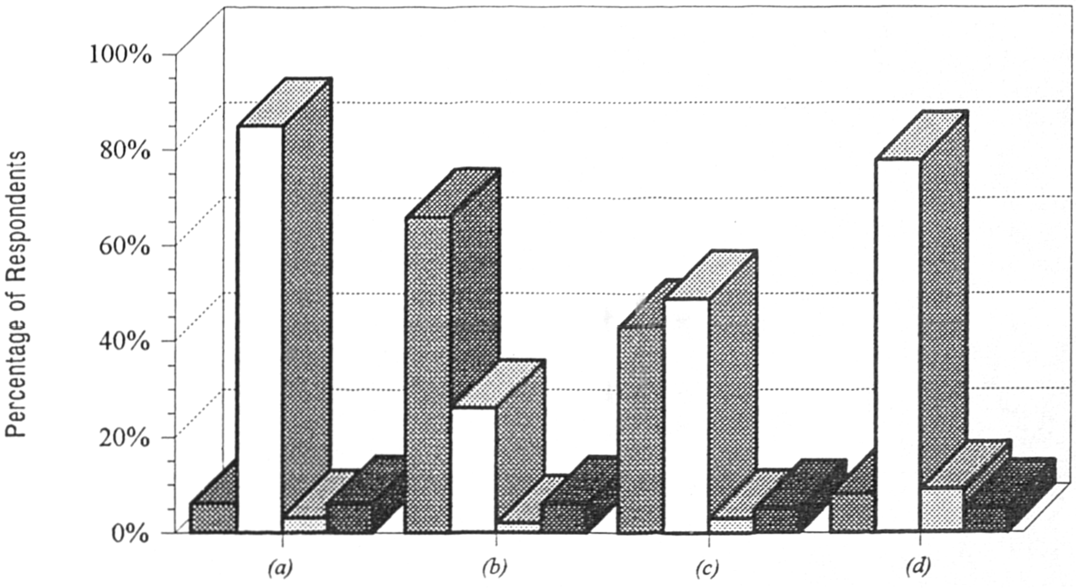
This question, not addressed to the claims consultants, was aimed at determining the average number of hours per week spent by each supervising staff member in keeping site diary records. Responses varied, ranging from 1 to 30 hours each 50-hour working week. The results are shown in the bar chart contained in figure 4.30. Almost three-quarters (74 percent) of respondents' answers to this question ranged from 1 to 5 hours per week and the calculated overall average was found to be 5 hours per week (which roughly means 1 hour per day) spent by each supervising staff member in keeping his site diary records.

### 4.4.3 Summing up

The following points stemmed from analysing and discussing the responses to the questions related to the general progress records and individual site diary records:

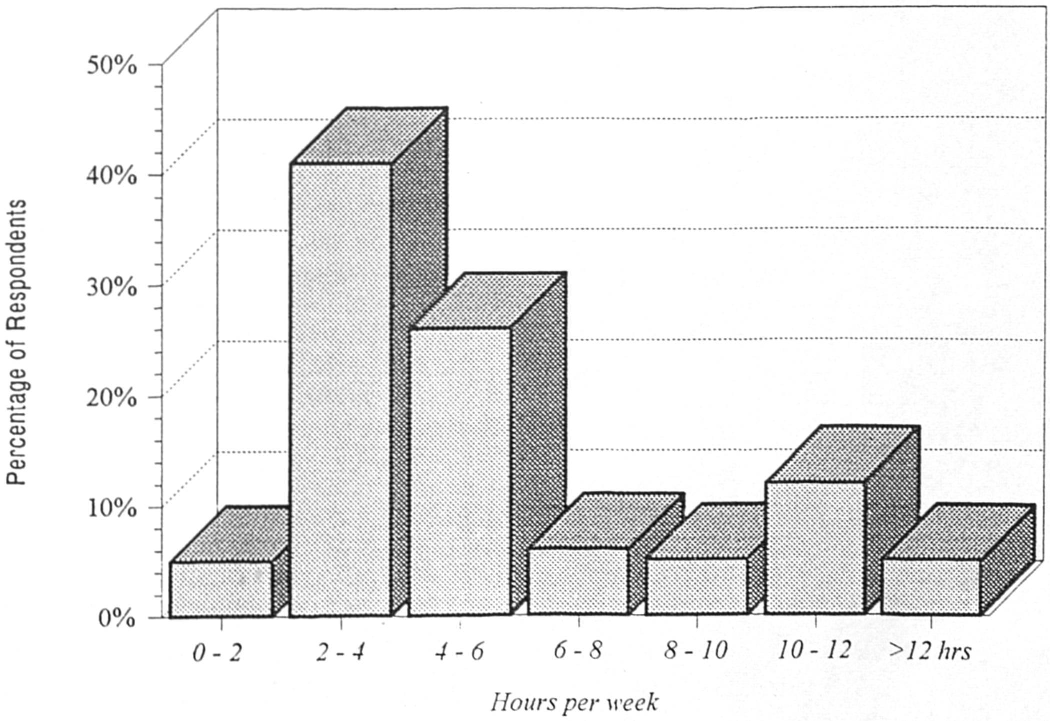
i) Although the benefits of keeping records of progress which show exactly on which day each activity on the contractor's programme took place were appreciated, it was clear that many respondents did not keep such a record.

ii) The advantages of identifying links between subsequent activities in the contractor's plans representing the actual point in time during the completion of one activity that a subsequent activity(s) could commence were also recognised. However, only a minority of the respondents confirmed that they always kept such a record, indicating that many site records will lack complete 'as-built' networks.




*See page 4-68 for statments (a), (b), etc.*

***Figure(4.29): Views on Quality Procedures for Keeping Site Diary Records***




***Figure(4.30): Average Time Spent for Keeping Site Diary Records***

iii) In both (i) and (ii) above, there was a general recognition of the value of keeping these records, but the majority of the respondents did not actually operate in this way.

iv) The majority of the reports on the progress of construction works were only prepared once a month.

v) Although no clear indication was given as to whose site diary records (engineering staff or clerk of works) are found most useful, some differences in the nature of these diary records were recognised. The contents of the engineering staff's site diaries were defined as records of progress in general, as well as discussion and agreements, while for detailed records of work taking place, including detailed resources employed, these were most likely to be found in clerks of works' site diaries.

vi) The importance of relating site diary records to activities on the contractor's programme of construction works was generally accepted by the respondents even though it is doubtful whether such information is actually being kept.

vii) Bound page-a-day diaries (with blank pages) are still the most common type used by the engineering staff for keeping site records, whereas standard record sheets (i.e. forms with pre-printed headings) are used most frequently by clerks of works.

viii) The use of standard forms was regarded by many respondents as a useful way of ensuring that the essential information is kept in an organised format. The most commonly proposed pre-printed headings on these sheets were descriptions of work activities, labour & plant, weather conditions, location, and week number.

ix) Checks on staff site diary records were generally carried out but at varying intervals (e.g. weekly, monthly, etc.).

x) Problems with site diary records were confirmed. These problems related to accessibility, legibility, continuity and consistency. Although continuity was seen as the most serious, the other three were viewed as being of almost equal severity. Other similar types of difficulties with site diary records were identified relating to accessibility, lack of experience of site staff, and lack of detail in the records.

xi) The majority of respondents could foresee site diary records being kept on computer by their staff in the future. Some difficulties were anticipated, but it seems that these may be overcome with the availability of current or near-future technology and the adoption of training programmes.

xii) That site staff should be advised to look out for unusual occurrences to enable efficient records to be kept about the development of such events, was agreed, although, only half of the supervisors admitted that they always carried out such practice.

xiii) The possibility of developing quality procedures for record-keeping purposes was generally acknowledged, although it was clear that the majority of respondents did not have such procedures. The importance of these procedures was also recognised although, some concern was expressed regarding the difficulty of their development. It was generally indicated that if sensible procedures were developed, then site staff could be made to accept and follow them in keeping their site records.

xiv) Various factors were highlighted to be taken into consideration when establishing new quality procedures covering the record-keeping process. The most important of these was the flexibility of any proposed approach which should take into account job type, complexity and size to ensure their suitability for the different categories of those keeping site records. This particularly useful for those with time constraints, as the average time spent by each site staff member for keeping site records was indicated as being at least one hour per day.

### 4.5 Records of Delays

Questions presented under this section relate to the nature of delays, attitudes affecting the keeping of delay records, and the way in which delay and disruption records are kept, in addition to identifying what is being recorded when a delay event has become evident.

*Views on the nature of a delay ($Q_{E1}$, $Q_{L1}$)*

$Q_{E1}$ was aimed at identifying site supervisors' understanding of the nature of delays and when an event should be recorded as a delay event. Respondents were asked to tick boxes (agree/disagree/don't know) that most closely represented their views on the following three statements:

a) *A delay should be recorded whenever the contractor fails to complete an activity within his planned duration.*

b) *A delay should be recorded whenever an incident occurs that allows the contractor to claim for a possible extension of time.*

c) *A delay should be recorded whenever work stops, provided the stop is not programmed.*

Analysis of the responses to this question (figure 4.31a) showed that in general most of the respondents agreed that all three statements illustrate a situation in which a delay can be said to have occurred, and should be recorded as a delay event. It was the second statement that was thought to be the one the respondents would most readily accept and, in fact, this was the most widely accepted of all three statements. However, as has already been said, the other two statements were also generally well accepted. It had perhaps been expected that delays might have been seen as always caused by the employer or by acts of God, but the response to the first statement suggests that delays which are the responsibility of the contractor are also well recognised.

$Q_{L1}$ was identical to $Q_{E1}$ and was addressed to the claims consultants. The results are shown in figure 4.31b and confirm the claims consultants' strong acceptance of all the above statements describing the occurrence of delays.

***Views on attitudes affecting the keeping of delay records ($Q_{E2}$)***

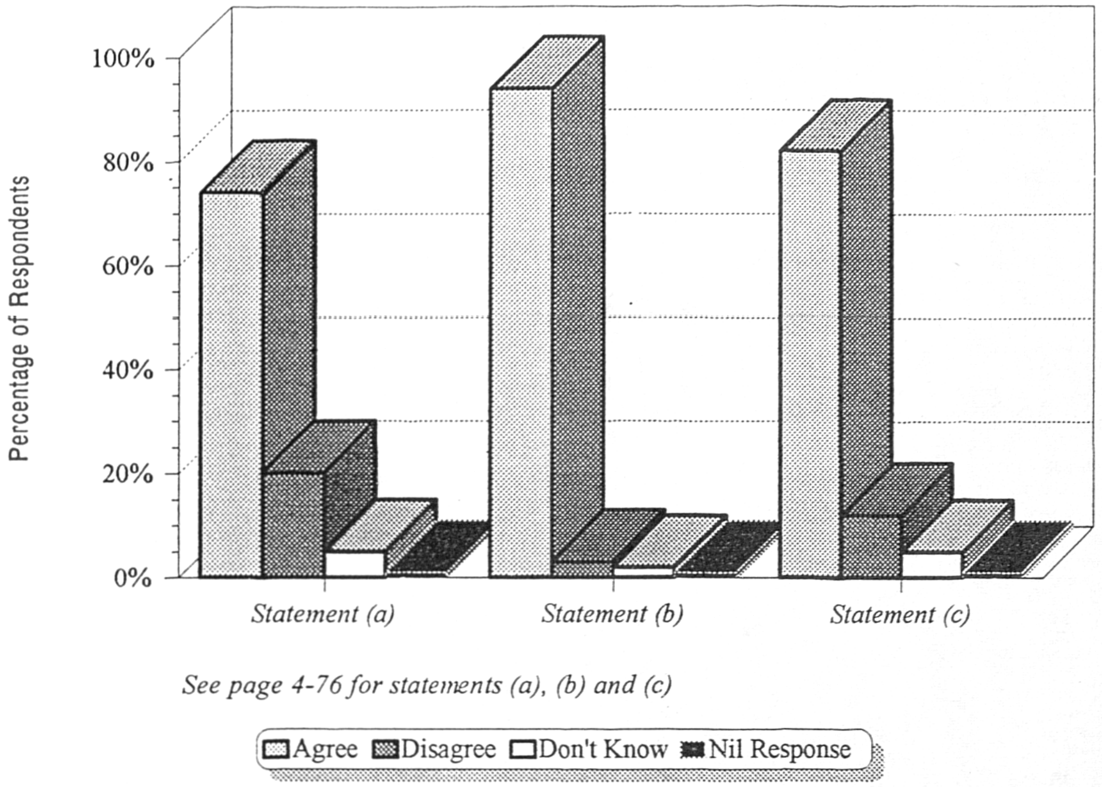
To obtain site supervisors' views on the general attitude of site staff concerning the recording of delays on contracts, respondents were asked to indicate whether they agreed or disagreed with the following statements (don't know was also an option):

a) *It is the contractor's job to identify delays - when he notifies us of a delay, we will then keep records.*

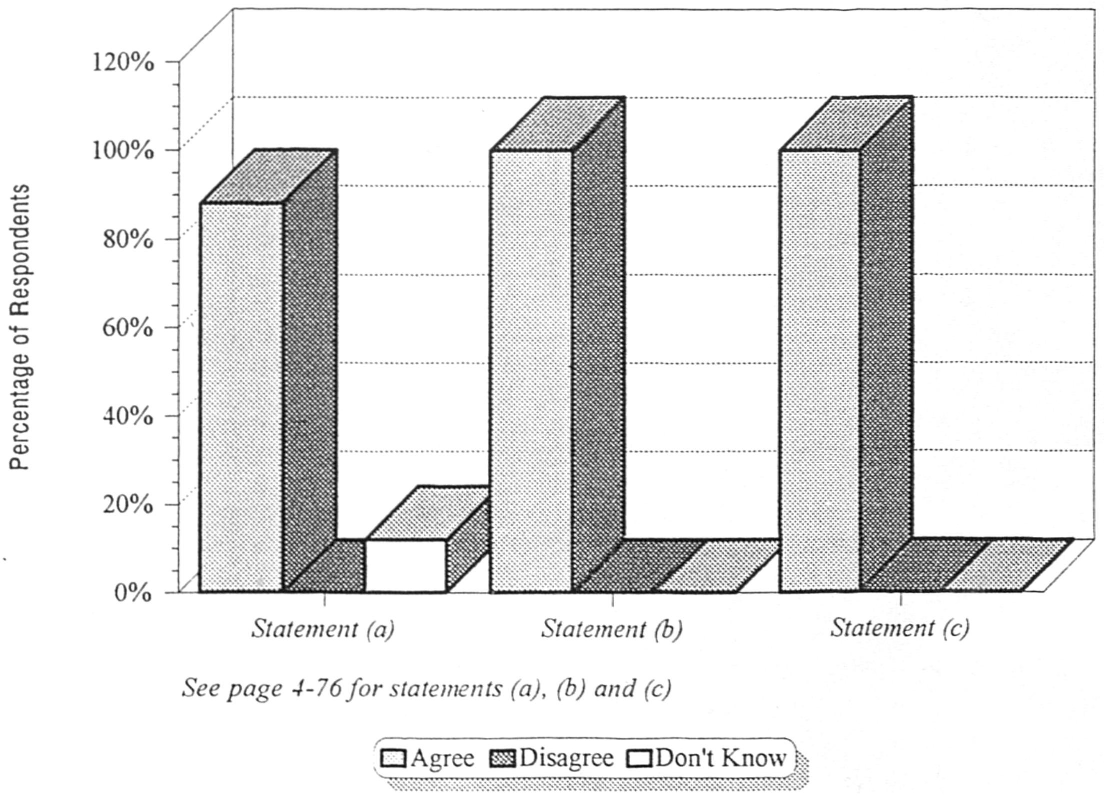
b) *Site staff must constantly be looking for potential sources of delays to the contract.*

c) *When a delay becomes evident, site staff are expected to record its existence.*

Analysing the responses, figure 4.32 shows that the majority of respondents disagreed with the first statement, although a small percentage of them (16 percent) did accept it. Statements (b) and (c) were agreed by almost all respondents who clearly felt that vigilance was necessary in this area and that delays when evident must be recorded. Although 52 percent of the respondents did not comment on their answers to this question, the remaining indicated varied views (not widely shared), some of them were significant and were important enough to be addressed. In these comments, some respondents identified a need to keep site records continuously and not rely on the




***Figure(4.31a): Views on Nature of Delays - Site Supervisors***




***Figure(4.31b): Views on Nature of Delays - Claims Consultants***

contractor's notifications of delays, while others highlighted that delay records need to be agreed with the contractor.

Some respondents indicated that contractors would be selective in notifying delays and would only record delays that suit their companies, not usually identifying delays of their own making. This would indicate that one cannot rely on the contractor to notify the engineer of a delay. Hence site staff should be constantly identifying potential delays, to highlight problems as they occur, locate the cause and if possible their affects on construction activities. In some comments, there was an indication of a general lack of understanding of the way in which a delay can affect other activities. This view was shown by statements that non-critical delays were not recorded, which meant that a delay would not be recorded if it did not occur to an activity on the initial critical path. This may indicate that they were not aware of the fact that critical paths may change and if a delay occurred to a non-critical activity, that would typically have a knock-on-effect which could change the critical path.

From other comments, it would seem that the definition of a delay to some of the respondents may be tied up with the possibility of an extension of time resulting from it. Other respondents expressed the opinion that all delays should be recorded and that costs arising from delays may not be fully appreciated at the actual time of the delay. Thus all delays need to be adequately recorded as they may have a bearing on a subsequent claim.

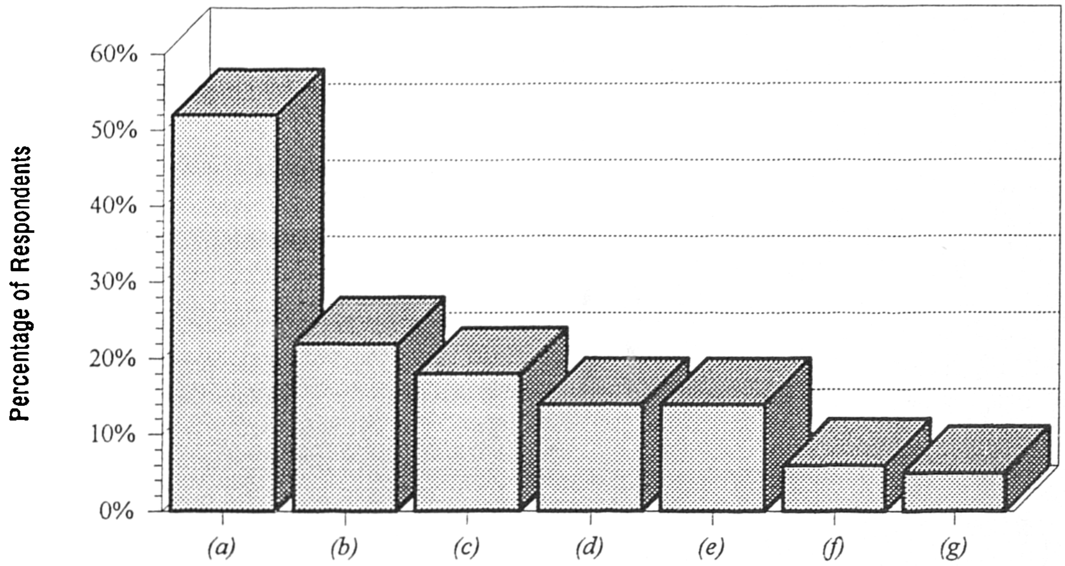
*Level of satisfaction with delay records ($Q_{E3}$, $Q_{L2}$)*

$Q_{E3}$ was asked to determine the site supervisors' levels of satisfaction with the way in which delay records are kept on their sites. Given the option of choosing between: very satisfied, quite satisfied and not satisfied, the majority view of supervisors, as shown in figure 4.33, was that they were quite satisfied (83 percent) with only 12 percent very satisfied and 5 percent not satisfied. Replying to a similar question ($Q_{L2}$) the majority of claims consultants (5/8) also indicated that the records were quite satisfactory, although a much larger percentage felt that the records were not satisfactory (figure 4.33). These results certainly suggest that there is room for improvement.

A Mann-Whitney test was also conducted for this question's data and it was significant at 0.0069. This indicates that the null hypothesis that assumes no differences exist between the measures of central tendency for the two groups' views is not true.

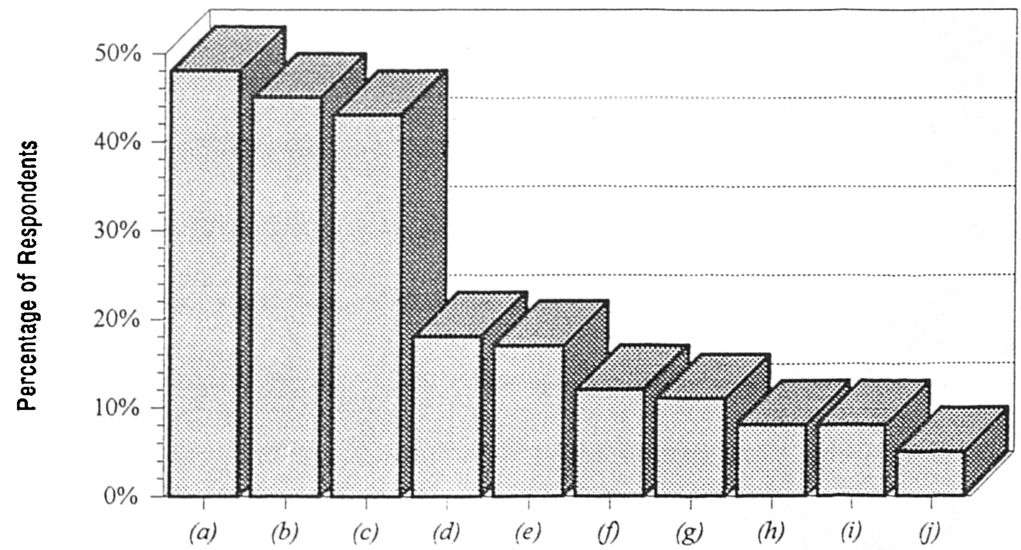
*Methods of keeping delay records ($Q_{E4}$, $Q_{L2}$)*

In this question, site supervisors were asked how delays and their effects were recorded. As expected, in the normal course of events, incidents affecting the rate of progress will typically be recorded in site diaries. The analysis of responses to this question, figure 4.34, revealed that site diaries are the most popular place for keeping delay records as indicated clearly by a significant number of respondents (53 percent). Other sources mentioned




a) Site Diaries  b) Correspondence  c) Weekly/Monthly Reports  d) Minutes of Progress Meetings
e) Programmes  f) Agreed Records with Contractor  g) Special Reports

*Figure(4.34): Methods of Keeping Delay Records*




a) Duration  b) Cause of Delay  c) Resources Involved  d) Activity Involved
e) Time & Dates  f) Effects on Other Activities  g) Location  h) Material
i) Decisions Undertaken  j) Relevant Records

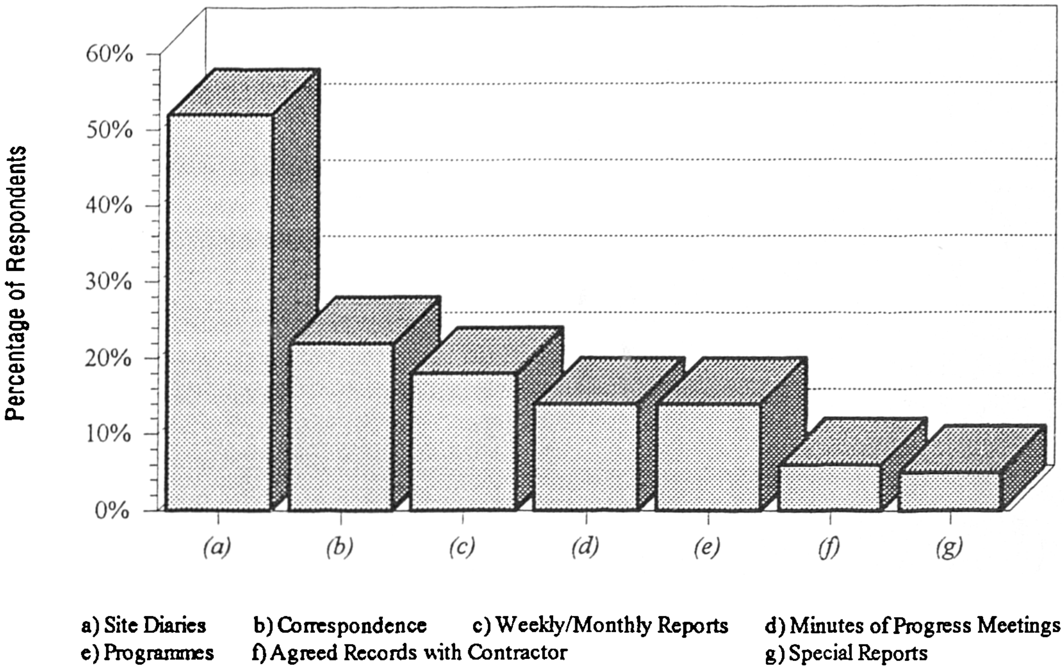
*Figure (4.35): Contents of Delay Records* were correspondence, special delay reports, progress reports and minutes of meetings, although the contents of such documents were usually said to be based on information extracted from site diaries. Some respondents (18 percent) indicated keeping delay records on as-built / as-constructed programmes or by updating programmes of work.

When claims consultants were asked how they thought delays and their effects should be recorded, in $Q_{L3}$, responses were varied. Some respondents indicated that delays should be recorded using standard forms, while others emphasised the need for immediate writing of all factual information on circumstances causing delays and their effects on other activities.

The responses to this question indicated that delays are recorded in a number of ways, though site diaries are the most common format. This again highlights the importance of these diaries and emphasises the need for improving them, because a number of problems with the records kept in these documents have already been confirmed.

***Contents of delay records($Q_{E5}$, $Q_{L4}$)***

$Q_{E5}$ was asked to identify what is actually recorded when a delay becomes evident and a number of varied items were listed by the respondents in their answers to this question. Figure 4.35 shows these items with the different levels of response emphasised by the respondents (i.e. a representation of how many times each item was mentioned by the




*Figure(4.34): Methods of Keeping Delay Records*

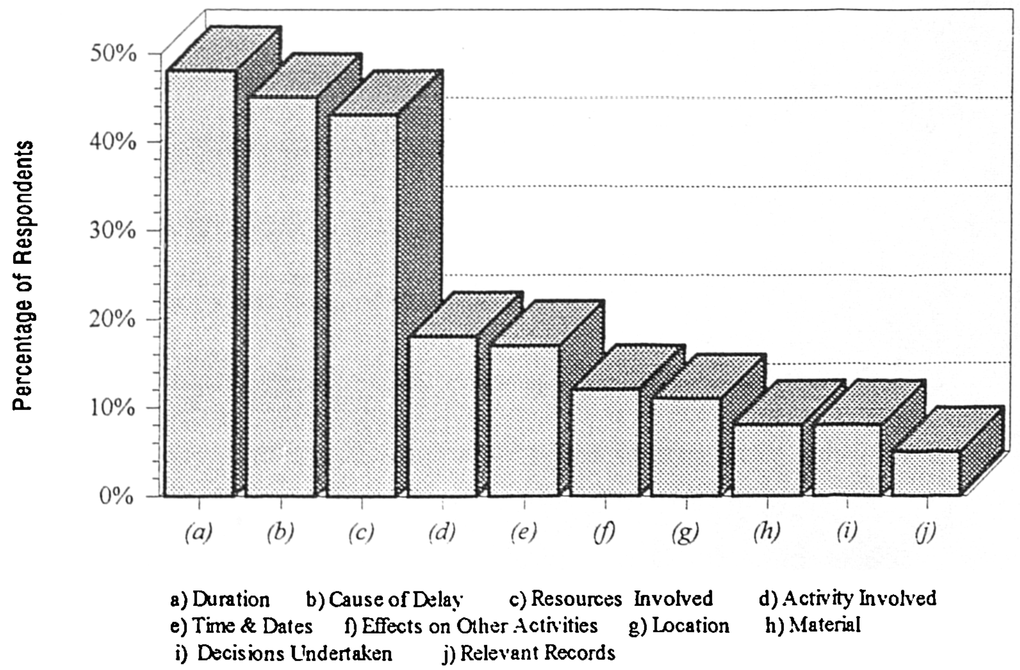



*Figure (4.35): Contents of Delay Records* respondents). The most commonly identified items were delay duration, cause of delays and resources involved. Although this is very important information, other items such as time/dates, location, activity involved, and delay effects were not given a great deal of attention, as indicated by the results. No clear evidence of concern about the effects of a delay on subsequent activity(s) was identified and this may be considered as an indication of the lack of good records in such an important area.

Most claims consultants in their responses to $Q_{L4}$ about what should be recorded, identified some items on delays such as reasons, duration, and resources employed. Some respondents also highlighted the need for recording the effects of such delays.

*Efficiency of delay records ($Q_{E6}$, $Q_{L5}$)*

This question attempted to establish whether site supervisors are able, from their site records, to pinpoint exactly when each of the delays on the contract occurred. The analysis, shown in figure 4.36, indicated that the majority of respondents felt that they were often able to identify exactly when each delay occurred, but only 18 percent said that they were always able to do so from the records they kept. This is rather surprising as it could be argued that records of delays are some of the most important records kept. Without knowing when such important events occurred, it would clearly be very difficult to construct an as-built record of events. This supports the previous inference stemming from the responses to $Q_{D1}$ & $Q_{D3}$ that an as-built programme is not usually compiled by most site supervisors.

When claims consultants were asked in $Q_{L5}$, whether they were able from the supervising staff's records, to pinpoint the exact occurrence of each delay on contracts, the majority indicated that they are only sometimes able to obtain such information from these records. Figure 4.36 contains a comparison of the views of site supervisors and claims consultants and clearly indicates a less impressive picture even than the one painted by the site supervisors.

When a Mann-Whitney test was conducted, it was found that the test was significant at 0.0000. This certainly indicates a strong rejection of the null hypothesis that no differences exist between the views of the two groups.

***Recording of disruption ($Q_{E7}$, $Q_{L6}$)***

This question was aimed at determining how site supervisors record the effect of disruptions, which do not stop work but reduce efficiency. While 12 percent indicated that they record the cause of the disruption and related facts, 11 percent stated clearly that they do not, and another 11 percent stated that it is the contractor's responsibility to do so. Some respondents (28 percent) admitted that recording the disruption and its effects is a very difficult task. Others (22 percent) indicated that it would be possible to identify disruption events by comparing the work progress on an activity against the rate of progress on similar work for the same contract (i.e. comparing with non disrupted progress). Regarding the way disruption records are kept, 22 percent of respondents stated that they would note the effects of disruption within the daily site diary while 14 percent would note the level of resourcing. However, there were no suggestion made (except by one respondent) to treat the disruption as a delay event nor to be equated to a full delay (e.g. 8 days at 75 percent rate of productivity equal to 6 days at 100 percent rate of productivity plus 2 days' delay).

$Q_{L6}$ was also addressed to claims consultants to identify how the effects of disruption should be recorded, but half of them did not provide any significant answer. The others suggested to record the cause and duration of disruption and the resources employed.

Responses to this question tend to indicate the complexity of the issue of disruption. No common approach for keeping disruption records was identified, confirming the difficulty of keeping such records of disruption and its effects on the work progress.

### 4.5.1 Summing up

The following points stemmed from analysing and discussing the responses to the question related to the records of delays.

i) There was general agreement that the following statements define a delay event to be recorded:

- If an incident occurs that allows the contractor to claim for a possible extension of time.
- If construction work stops, provided the stop is not programmed.
- If the contractor fails to complete an activity within the specified time.

ii) Site supervisory staff are required to be constantly looking for potential sources of delays which they are expected to record as soon as they become evident (not waiting for notifications from the contractor).

iii) Information on delays and their developments are documented in different ways, including progress reports, minutes of meetings and correspondence, but the most common way for maintaining delay records is through site diaries.

iv) The cause and duration of delays and the resources involved are the most common types of information kept on delays. Few respondents stated that they actually recorded the effects of delays on other activities.

v) It seems that the delay records kept are inefficient, as the percentage of site supervisors who were always able from their records to pinpoint when exactly each delay event occurred, did not exceed one-fifth. This is also confirmed by the fact that the vast majority of site supervisors were not very satisfied with the way in which delay records were kept.

vi) There is room for improvement in recording delays as current methods do not fully fulfil their purpose.

vii) The difficulty in identifying and recording disruption events which do not stop work but affect productivity, was confirmed. No common method was identified for keeping records on the effects of disruption.

## 4.6 Records of Resources

This section covers questions that were aimed to identify: methods of keeping records of resources; what information is kept on contractor's resources; if these records are related to the construction programme of works; whether information is kept on plant movements.

***Methods used for keeping records of resources ($Q_{F1}$,$Q_{M1}$)***

$Q_{F1}$ was aimed at identifying the way in which records of resources are kept for the main contract works (excluding variations). From the list provided with the question, respondents were asked to indicate the statement that most closely represented how they keep such records. The statements were as follows:

a) *There is no need to keep such records, the contractor's records will provide the information that is needed.*

b) *Detailed records of resources, including both labour and plant are kept on daily basis.*

c) *Detailed records of resources, including both labour and plant are kept on weekly basis.*

d) *A full list of the major items of plant being used on the contract is kept on a daily basis.*

e) *A full list of the major items of plant being used on the contract is kept on a weekly basis.*

Although only one statement was intended to be identified by each respondent, some ticked more than one statement. For such responses it was decided to consider only one of the statements indicated, i.e. the statement that was most comprehensive and embodied the other selected statement, for example, if the respondent selected (b) and (d), statement (b) was the one considered. If respondents ticked any other statement along with statement (a), then that was considered an invalid response and omitted from the analysis as such statements contradict each other. When the responses were analysed, figure 4.37, the majority of respondents (almost two-thirds) identified statement (b) as the one that

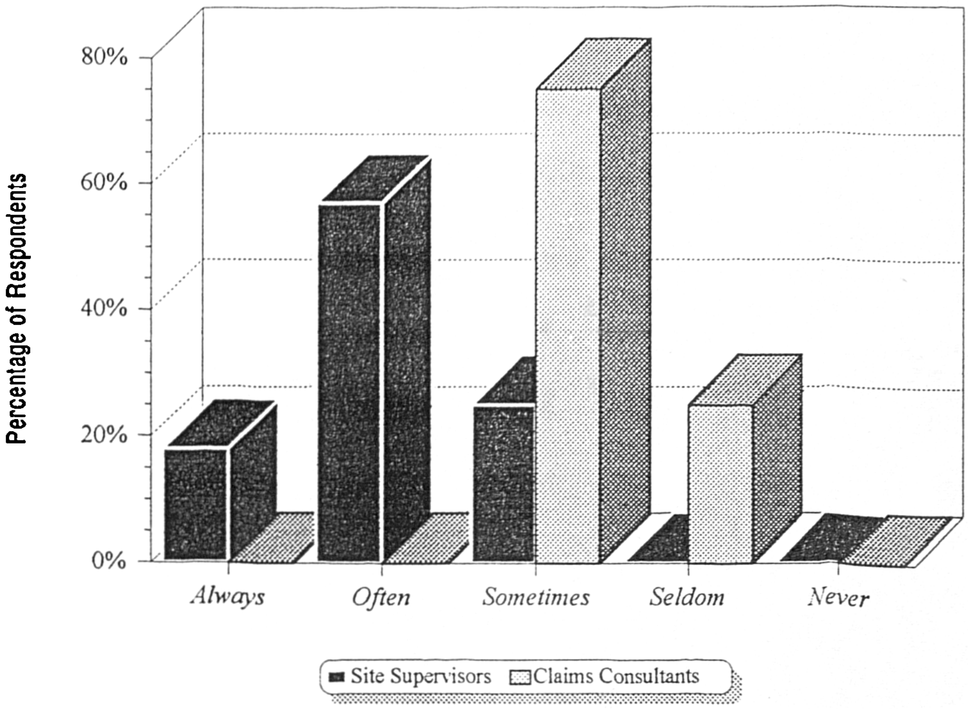
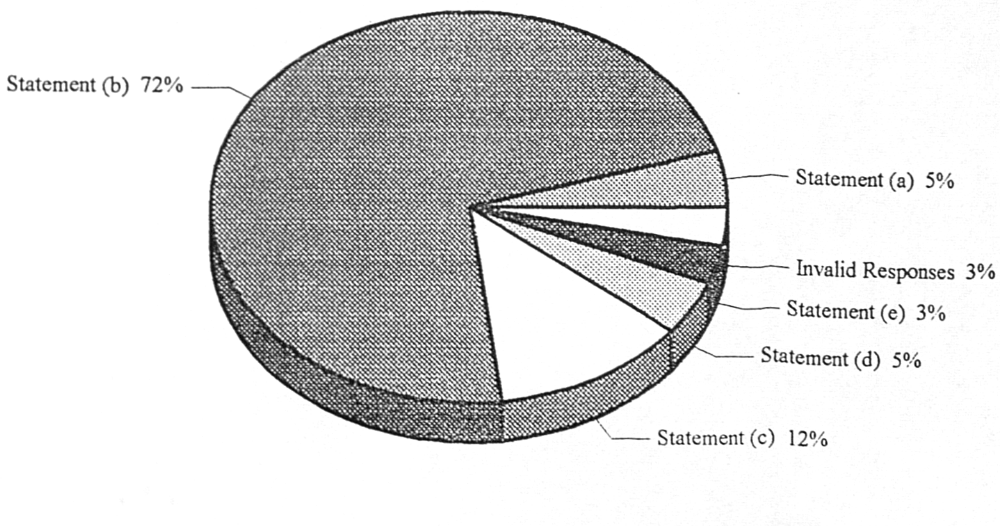



Figure (4.36): Efficiency of Delay Records




*See page 4-89 for statements (a), (b), etc.*

*Site Supervisors' Responses*

Figure(4.37): Methods of Keeping Record of Resources represented the way in which they keep records of resources and confirmed that full daily records of resources are being kept.

When claims consultants were asked in $Q_{M1}$ to indicate which of the provided statements (a to e) most closely represented the way in which they consider that records of resources should be kept by supervising staff, the vast majority (7/8) identified statement (b). This view is in line with the way in which the majority of site supervisors say that they actually keep these records.

*Information on contractor's resources ($Q_{F2}$, $Q_{M2}$)*

Respondents were asked whether they ask the contractor to specify the level of resources that he intends to use when he submits his construction programme ($Q_{F2}$). 68 percent of respondents indicated that they did ask for such information, though about one-third of them commented that it is often poorly and vaguely responded to by the contractors. 28 percent of respondents stated that they did not ask for this information at the submission of the work programme (4 percent did not give a clear answer i.e. yes or no). Although 37 percent of the respondents did not comment and some indicated that this information can be difficult to obtain as contractors are often reluctant to oblige, there were respondents who were concerned that providing for such information is not a contractual obligation and it should be rectified in the contract requirements. However, ICE6 (1991) Condition of Contract does allow the engineer to require 'further information' in Clause 14(2)(c) as follows:

> 'The Engineer shall within 21 days after receipt of the Contractor's programme request the Contractor to supply further information to clarify or substantiate the programme or to satisfy the Engineer as to its reasonableness having regard to the Contractor's obligations under the Contract.'

It is clear that the supervisor under a variety of Conditions of Contracts has considerable power to ask for such information to be submitted with the programme, even though the Conditions of Contract may not insist that this be done. The supervisor is supposed to assess the construction programme and he is not in a position to indicate that the programme is a reasonable one without knowledge of the resources available. It is only with an understanding of the level of resourcing that the engineer can judge whether it is possible to do the amount of work in the planned time. Such information, when available, will help the supervisor to identify the contractor's ability to carry out the job and hence identify situations where inadequate resources are proposed, which may delay the work. The supervisor will certainly wish to bring these areas to the attention of the contractor and to express his misgivings. The relatively high figure of 28 percent of respondents who do not request information on resources suggests that these people are not very programme-orientated.

Claims consultants were asked in $Q_{M2}$ whether they think it would be worth asking the contractor to specify the level of resources intended to be used. The vast majority (7/8), supported this approach, which was compatible with the responses of the majority of site supervisors.

### *Relating records of resources to the work programme ($Q_{F3}$,$Q_{M3}$)*

Site supervisors were asked whether they saw any value in relating records of resources to the work activities on the contractor's programme. A considerable majority of respondents (86 percent) stated that they did see value in doing so. Some respondents indicated that such information would be essential for assessment of contractor's claims and evaluating disruptive affects. Some also saw it as useful in determining the cause and effect of delays, i.e. should a delay occur in an activity, one reason for that delay could be due to lack of sufficient resources being used for constructing that activity. Such records would help to clarify the source of such problems. One respondent stated that actual resources can be used to pinpoint difficulties or indeed inefficiency where no difficulties are identified.

Relating such records to the programme was also seen as useful by other respondents for control purposes, since it is the supervisor's duty to try to ensure that the contractor completes the works on time. When he believes that is not going to happen, he must prompt the contractor to do his best to complete the job on time, and may recommend that more resources are made available.

Two-thirds of claims consultants ($Q_{M3}$) were also supportive of this view and agreed that there was value in keeping resource records in such a way.

The result of the analysis of responses to this question clearly shows positive support for a record-keeping system that relates records of resources to work activities on contractor's construction programmes.

*Movement of plant on and off site ($Q_{F4}$& $Q_{F5}$, $Q_{M4}$& $Q_{M5}$)*

Respondents were asked whether they could identify the movement of major items of plant on and off the project site directly from specific records or indirectly from other records, e.g. site diaries. All respondents indicated that they could identify this from the records kept on the site. 57 percent of respondents stated that they could identify the movement of major items of plant directly from their records, while 38 percent stated that such information can be identified from other records. 5 percent of respondents invalidated their responses as they ticked both choices. Of the 57 percent who stated they kept separate records, 68 percent did not comment on their answers, whereas two-thirds of respondents who did comment indicated that such information would be extracted from site diaries and this is, of course, not a valid answer, i.e. not a separate record. Considering this, only 45 percent of the respondents can be assumed to have separate records of plant movement on and off sites. Some respondents indicated that they would obtain such information from the contractor's labour and plant returns.

All claims consultants specified in their responses to $Q_{M4}$ that records of the movement of major items of plant on and off the site would be worth keeping.

Site supervisors were then asked in $Q_{F5}$ to say whether they see value in having such information as the movement of major items of plant on and off the project site. Almost all respondents agreed that obtaining such information is valuable from many aspects. 56 percent of respondents clearly stated that such records would be essential when investigating a contractor's justification of claims concerning delay or disruption.

The results show that although virtually all respondents appear to consider this information valuable, only about half of them make a special effort to keep specific records.

Almost one-third of respondents stressed that this information would prove useful in assessing the overall progress of construction works and the performance of the contractor. An indication of the completion of a significant section of work can be obtained by establishing whether sufficient resources were available on site and when major plant was moved off site. Some respondents also mentioned that recording this information would help in managing costs and forming the basis of a valuation.

No comments were made regarding the vesting of plant (clients under most conditions of contracts have the rights to seize contractor's plant on site if the contractor defaults on the contract to cover any losses incurred). Identifying the type of plant available on site at any particular time is extremely important for this purpose.

All claims consultants agreed in their response to $Q_{M5}$ with the value of having such information, mainly for claims evaluation, and the mitigation of delays.

*Movement of plant between construction activities ($Q_{F6}$& $Q_{F7}$, $Q_{M6}$& $Q_{M7}$)*

$Q_{F6}$ was aimed at determining whether site supervisors could identify the movement of major items of plant between construction activities directly from special records or indirectly from other records such as site diaries. 86 percent of respondents answered in the affirmative while 14 percent admitted that such records are not kept for reasons such as shortage of site staff and time. Of the 86 percent, 40 percent stated that they could obtain such information directly from separate records, yet comments of almost one-third (69 percent did not comment) suggested that these are not special records but, for example, the clerk of works diary. Considering this, separate records on the movement of plant between construction activities were not kept by at least 58 percent of respondents. Although most respondents stated that they could obtain this valuable information, it seems that they are more concerned about identifying information on the movement of plant on and off the project site as appears in the results for $Q_{F4}$, where all of them had admitted keeping such records.

Substantial completion of an activity might be indicated by the movement of a major piece of plant to another activity, and it is, therefore clear that information on the movement of major plant between construction activities could be used as evidence in identifying 'soft links' between activities. This might help prove the effects of a delay.

Claims consultants were also asked in $Q_{M6}$ whether they thought it would be worth recording the movement of major items of plant between construction activities, and all of them agreed that this would be worth doing, indicating support for such an approach.

$Q_{F7}$ was put to site supervisors, to find out what value they would see in having information on the movements of major items of plant between construction activities. Almost half (45 percent) stated that such information would be very useful in the assessment and evaluation of construction claims, while one-quarter indicated that it would be useful in monitoring overall progress and assessing the contractor's performance. Some respondents also stated that maintaining such information would help in managing costs.

It is worthy of note that some responses indicate a lack of awareness of the potential of developing an as-built network when they pointed out that having such information would be of limited value. None of the responses to this question, however, clearly refer to a link between maintaining such information and developing an as-built network programme.

This helps to confirm the results obtained from the analysis of the responses to $Q_{D3}$, which was specifically related to links between activities.

*Time spent on individual activities by specific items of plant ($Q_{F8}$& $Q_{F9}$, $Q_{M8}$& $Q_{M9}$)*

This question was asked to find out whether site supervisors record the time that major items of plant spend on each individual activity. 52 percent of the respondents indicated that they kept this type of information while 45 percent stated they did not (3 percent failed to respond). Although 54 percent did not comment on their answers, almost half of the respondents who did comment, indicated it would be possible to identify such information from the site diary records. Some also indicated that this type of information was kept only in general terms such as morning, afternoon or only on a daily basis.

When claims consultants were asked in $Q_{M8}$, whether they thought it would be worth recording the time spent on individual activities, they all agreed that this would be beneficial.

When the site supervisors were asked in $Q_{F9}$ what value they could see in having such information, 43 percent of the respondents (20 percent failed to respond) stated that keeping such records would be useful in the investigation and evaluation of claims. Some respondents (17 percent) indicated that having this type of information could prove helpful in assessing the progress of construction works, identifying delay and disruption and comparing actual outputs with the planned programme to predict completion dates for individual activities. 11 percent also mentioned that such information could be useful in checking variation orders and dayworks and 12 percent considered that there was value in maintaining such records for valuation and cost checking, as well as for post-contract analysis and further planning. There were also unclear responses provided by some respondents (12 percent) such as 'having such information has limited value' or 'just a completeness of records'. The analysis, however, shows that most site supervisors (68 percent) agreed it would be useful to have this information and yet such records were kept by less than half of them as indicated by the previous question's results ($Q_{F8}$).

Most claims consultants (6/8) agreed in their responses to $Q_{M9}$ that having such information would help in assessing work progress by identifying the efficiency of using such items of plant and would outline important areas e.g. delays.

### 4.6.1 Summing up

The following points stemmed from the analysis and discussion of the responses to questions relating to the records of resources.

i) The most common method of keeping records of resources was by recording both labour and plant on a daily basis.

ii) Asking the contractor to specify the level of resources he intends to use when he submits his construction programme was confirmed as being carried out by most site supervisors, although it was indicated that contractors often do not respond.

iii) The value of relating records of resources to the contractor's programme activities was widely confirmed, particularly in the case of investigating delay claims.

iv) The value of keeping records of movement of plant on and off site and the movement between construction activities was strongly confirmed, particularly in the assessment of claims, although keeping them as a special undertaking was not widely confirmed.

v) Keeping records of the exact time that plant spent on individual construction activities was only undertaken by about half of the respondents, although keeping such information was seen as useful, particularly in the investigation and valuation of claims.

### 4.7 Use of Site Records

This section, which comprises two sub-sections, covers questions related to the general use of site records and the searches conducted of these records. In the first sub-section, the questions were aimed at identifying: the relative importance of a set of defined uses of site records, other uses they were put to, records used in dealing with extension of time claims, and views on the usefulness of the records kept. This sub-section also attempted to identify which records are used for preparing progress reports. The second sub-section comprises questions which were aimed at identifying how often site records are searched and how difficult this is. Also included are questions which aimed at identifying the most useful type of site documents for assessing work progress, the frequency of different recognised types of searches of site progress records, and other searches made of these records.

### 4.7.1 General

*Relative Importance of the uses of site records ($Q_{G1}$)*

$Q_{G1}$ (not addressed to the claims consultants) sought to obtain supervisors' views on which of several recognised uses of site records they considered to be the most important. This information should be useful in deciding what minimum records should be kept to service these particular demands. Respondents were asked to rank in order of importance, six common uses provided with the question (1= most important through to 6= least important). The list of uses was as follows:

a) *Providing information on the contractor's ability to complete the project on time.*
b) *Assisting in the financial control of the project and forming the basis of fair payment to the contractor.*
c) *Providing feedback to the designers of defects in the design/documents, to ensure that these are not repeated in the subsequent contracts.*

d) *Confirming that the works are carried out according to the contract specification.*

e) *Identifying the need for additional information from the engineer and ensuring it is produced in time.*

f) *Assisting in dealing with contractor's claims.*

When the responses to the question were examined, it was noted that respondents answered in two ways: in-line with the question (i.e. uses ranked relatively 1 to 6) and others that were not in-line with the question (i.e. not all of the ranking figures were used, e.g. 1,4,6,4,6,1). Considering the fact that the great majority of responses were in-line with the question (89 percent) and also the fact that almost half of the invalid answers were merely comments stating that all uses were equally important, it was decided that these invalid answers, which did not comply with the question's requirements, would not be included in the analysis. Therefore the analysis of responses shown in Table 4.6 contains only data obtained from those responses that were in-line with the question (58 respondents). A weighting was then applied to the respondents' choices, with the ranking '1' attracting a weighting of 6, `2' attracting a weighting of 5, etc. The weighted values of the choices made are also shown in the table. To obtain some indication of majority views, two other figures have been calculated. These were a datum and a figure that aims to show more clearly the real perceived importance of these recognised uses. The datum represents the least possible score that can be obtained by any of the uses, which assumes that all the respondents (58) would rank it as the least important, and it would attract a weighting of 1. By subtracting this datum (58*1=58) from the weighted scores and

Table(4. 6)i: Data analysis to identify the important uses of site records.

| | **Uses of Site Records** | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Use (a) | | | | | | Use (b) | | | | | | Use (c) | | | | | |
| | Ranking of Importance | | | | | | Ranking of Importance | | | | | | Ranking of Importance | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
| No. of Choices | 9 | 13 | 8 | 11 | 12 | 5 | 10 | 10 | 21 | 10 | 5 | 2 | 1 | 2 | 1 | 7 | 11 | 36 |
| Weighted | 54 | 65 | 32 | 33 | 24 | 5 | 60 | 50 | 84 | 30 | 10 | 2 | 6 | 10 | 4 | 21 | 22 | 36 |
| Weighted Scores (A) | 213 | | | | | | 236 | | | | | | 99 | | | | | |
| No. of Responses (B) | 58 | | | | | | 58 | | | | | | 58 | | | | | |
| Datum (C)=(A)-(B) | 155 | | | | | | 178 | | | | | | 41 | | | | | |
| Total New Weighted Scores (D) | $(155)_a + (178)_b + (41)_c + (192)_d + (97)_e + (206)_f = (869)$ *These figures related to all uses (a to f) presented in both tables (4.6)i & ii* | | | | | | | | | | | | | | | | | |
| Percentage (C)/(D) | 18 | | | | | | 20 | | | | | | 5 | | | | | |

Table(4.6)ii: Data analysis to identify the important uses of site records.

| | Uses of Site Records | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Use (d) | | | | | | Use (e) | | | | | | Use (f) | | | | | |
| | Ranking of Importance | | | | | | Ranking of Importance | | | | | | Ranking of Importance | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
| No. of Choices | 17 | 13 | 9 | 12 | 4 | 3 | 0 | 8 | 8 | 15 | 19 | 8 | 22 | 13 | 11 | 2 | 7 | 3 |
| Weighted | 102 | 65 | 36 | 36 | 8 | 3 | 0 | 40 | 24 | 45 | 38 | 8 | 132 | 65 | 44 | 6 | 14 | 3 |
| Weighted Scores (A) | 250 | | | | | | 155 | | | | | | 264 | | | | | |
| No. of Responses (B) | 58 | | | | | | 58 | | | | | | 58 | | | | | |
| Datum (C)=(A)-(B) | 192 | | | | | | 97 | | | | | | 206 | | | | | |
| Total New Weighted Scores (D) | $(155)_a + (178)_b + (41)_c + (192)_d + (97)_e + (206)_f = (869)$ *These figures related to all uses (a to f) presented in both tables (4.6)i & ii* | | | | | | | | | | | | | | | | | |
| Percentage (C)/(D) | 22 | | | | | | 11 | | | | | | 24 | | | | | |

dividing the result by the total new weighted scores (869) i.e. the sum of weighted scores less datum, the figures produced will show the real perceived importance of these results.

The results of the analysis are shown in figure 4.38 and reveal that dealing with claims is identified as the most important use, although it is only marginally higher than the uses described in points (d),(b), and (a) concerning checking quality, controlling costs, and monitoring performance respectively. These were identified as being of almost equal importance, while the use concerning the feedback process (c) is seen as the least important of all. This could be seen as evidence of a weak link between the site supervision team and the design office, as the information obtained from constructing a job is arguably the best information one can have to assess the job design. However, the information obtained only proves that this use is seen as of lesser importance than others, not that such a use is not important.

The major uses identified by site supervisors indicate the need to keep specific kinds of records to suit several purposes. Progress records facilitate a fundamental role of almost all these uses by defining what, where, when, and how works are being carried out. This type of information is needed for assessing the contractor's performance, paying him for the work done, and defining the work being done to facilitate the confirmation that the contract specification is being enforced. Identifying the use of site records in dealing with contractor's claims as the most important use of site records, emphasises the particular need to keep such type of records (i.e. progress records) to serve this vital purpose. These points highlight the importance of an effective record-keeping system.

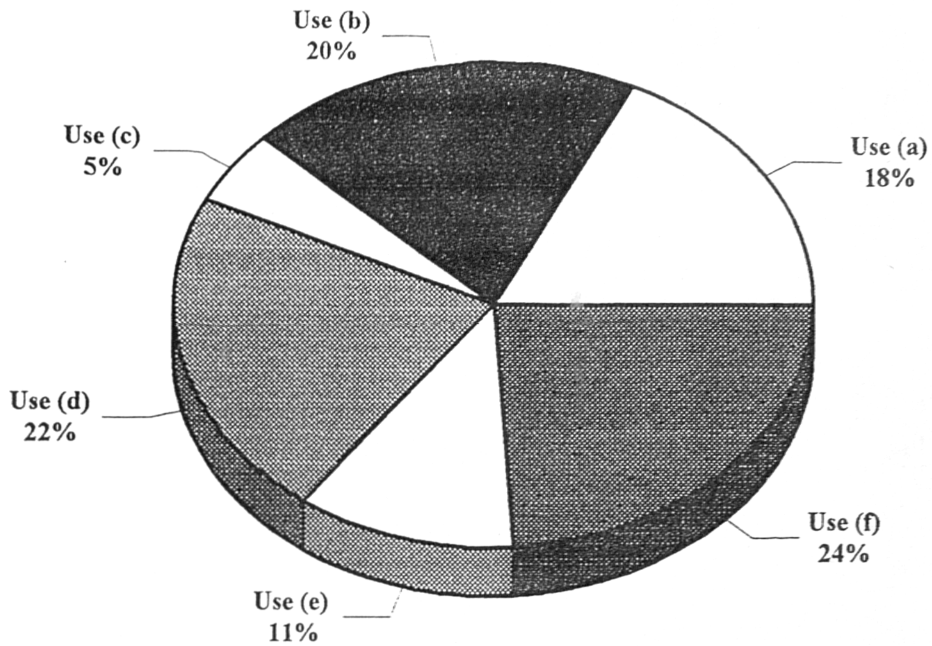
*Other uses made of site records ($Q_{G2}$)*

$Q_{G2}$ (not addressed to the claims consultants) asked respondents to indicate what other uses they make of site records. Almost 45 percent of them did not mention any other uses (of whom 12 percent admitted clearly that no other significant uses than those listed in $Q_{G1}$ were made). The remaining 55 percent of respondents did suggest other uses of site records additional to the uses already recognised and these can be summarised as follows:

- Preparation of maintenance manuals and as-built drawings.
- Providing progress position statements and reports.
- Investigating defects in construction works.
- Dealing with third party claims.

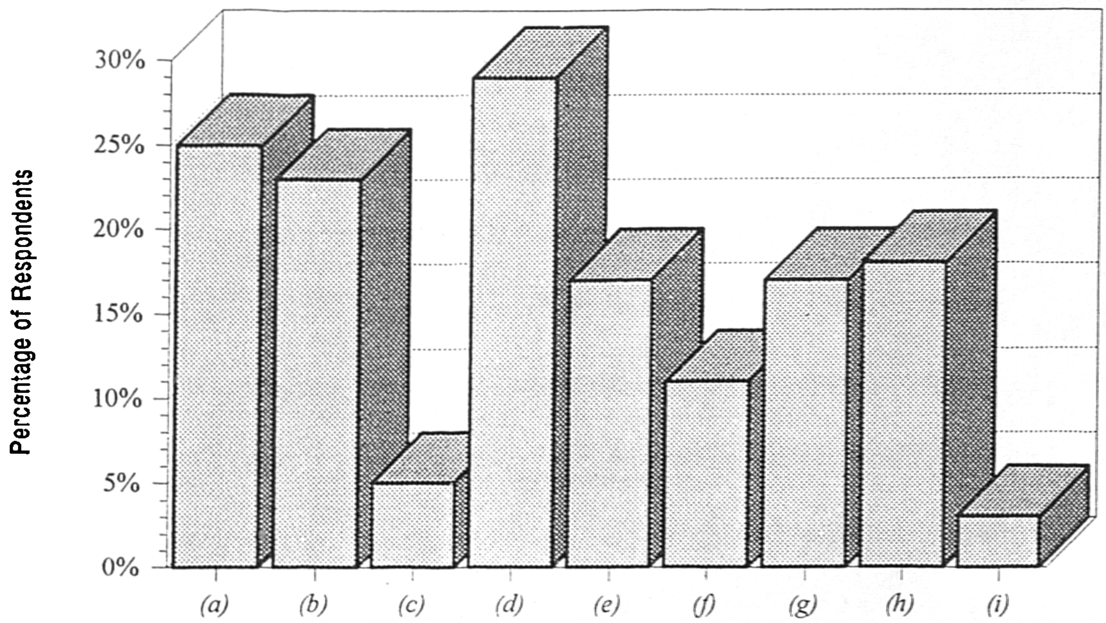
***Records needed for assessing contractor's claims for an extension of time ($Q_{G3}$, $Q_{N1}$)***

In order to identify the types of site records that are used specifically for assessing contractor's claims for an extension of time, $Q_{G3}$ asked the respondents to specify what these records were. Although the question attempted to identify specific record types, some respondents (about one-quarter) responded in very general terms, with comments such as: site diaries or all records that are relevant and available. Figure 4.39 shows the




See pages 4-101 & 4-102 for Uses (a), (b), etc.

***Figure(4.38): Important Uses of Site Records***




a) Delay records b) Programme c) Meetings Notes d) Records of Resources e) As-built Charts f) Correspondence g) Weather Records h) Variations Instructions i) Photographs

***Figure(4.39): Records Used for Assessing Claims for Extension of Time***

different types of site records identified by most of the remaining respondents as specifically needed to help in assessing contractors' claims. The importance of each identified type of site records for this particular purpose was indicated by the number of times it was mentioned. The analysis of responses revealed that records of resources, delays, work programmes, variation details and as-built charts are the main areas of concern in conducting this an important task..

Most claims consultants (7/8) indicated in their responses to $Q_{N1}$, that the records needed to help assess contractor's claims are as follows: variation orders and site instructions, weather, resources used, and planned and actual outputs.

*Views on the usefulness of the records kept ($Q_{G4}$,$Q_{N2}$)*

This question was asked to identify whether site supervisors are easily able to assess the contractor's rights to an extension of time from the records they keep. Respondents were asked to choose their answers from the following options: always, often, sometimes, seldom, and never. Only 22 percent of respondents indicated that they were always easily able to determine such rights, while 49 percent reported that they were often able to. The percentage who admitted only sometimes being able to easily identify them, was just over 29 percent. Almost all respondents who stated that they can always assess these rights from their records, did not comment on their answers. When these respondents' answers were compared with their responses to $Q_{E6}$, it was found that almost 60 percent of them were not always able to pinpoint exactly from their records when each of the delays on the contract was effective and this clearly casts some doubt on their responses to this particular question. These figures reveal that the vast majority of site supervisors are not always easily able to determine contractors' rights to an extension of project time and that may indicate the inability of their record-keeping systems and hence the site records kept to cope with such requirements.

When claims consultant were asked in $Q_{N2}$ whether they were easily able to validate the contractor's rights in such situations, with the records kept by the supervising staff, the vast majority (7/8) indicated only sometimes. Figure 4.40 shows a comparison between the answers of site supervisors and claims consultants with regard to this issue from which the resulting majority view of site supervisors tends to be that they are often able to determine the rights to an extension of time, whereas the majority view of the claims consultants clearly shows that they are only sometimes able to do so.

A Mann-Whitney test was significant at 0.0027 and the null hypothesis that assumes no differences exist between the two groups' views was rejected.

*Records used for preparing progress reports ($Q_{G5}$)*

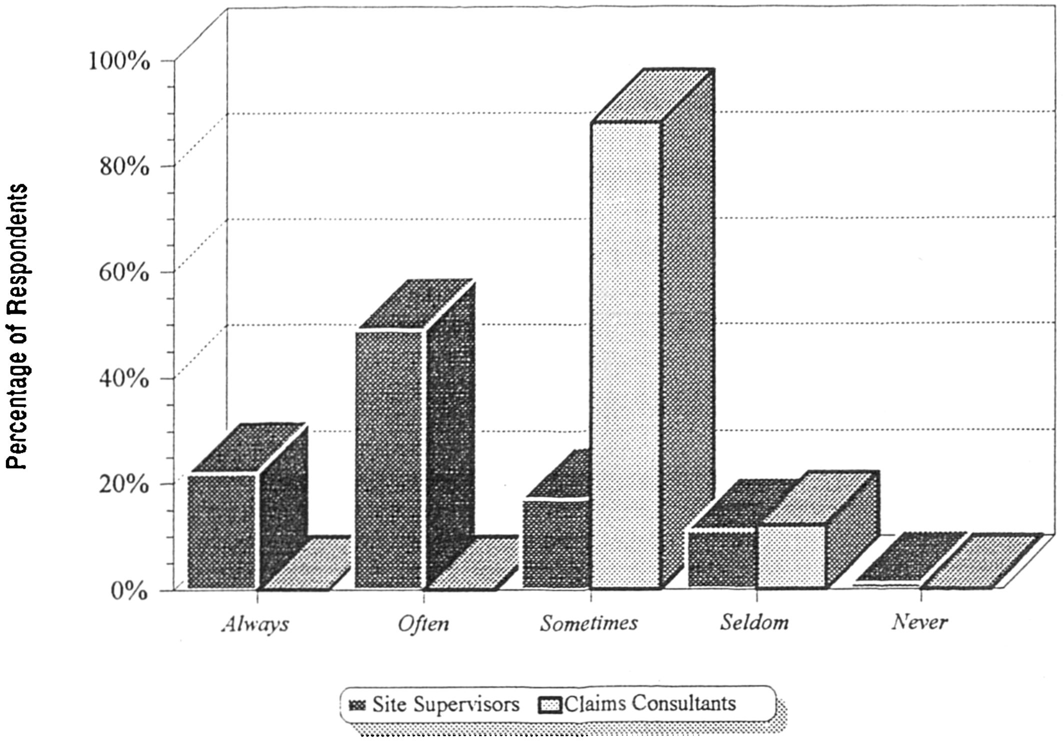
Site supervisors were asked in this question, which was not addressed to claims consultants, to state the most important source of information they use to produce progress reports. Identifying such sources should help to direct searching for the best site documents to provide the most useful information on progress of the construction works, and for this reason, the question was included. In addition to site diaries, a number of other types of document, as shown in figure 4.41, were also cited by some respondents as a source of information that would be used for preparing such reports. By far the most important source identified for this information was the site diaries, and as can be seen in the figure, the next most important source, site inspections, only gained about a quarter of the 'votes' cast for site diaries. There are of course a number of problems already identified with the records kept in site diaries, and these may clearly have an impact on the quality of the progress reports which rely on diaries as a main source of information.

### 4.7.2 Searches of records

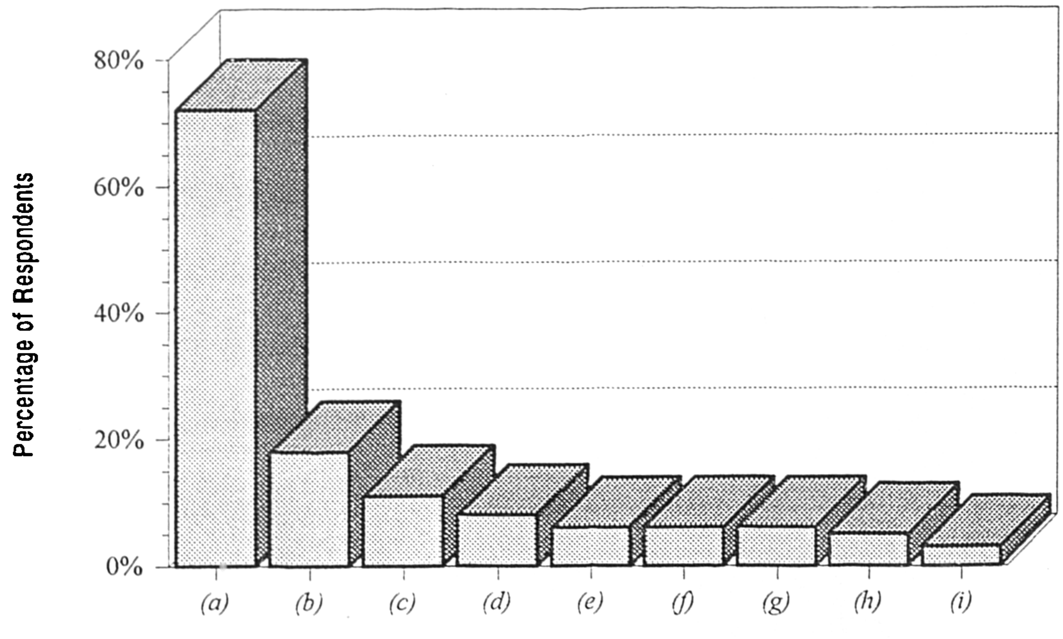
*Searches of site records ($Q_{G6}$, $Q_{N3}$)*

Site supervisors were asked in $Q_{G6}$ to express their views on the searching process conducted within the three main categories of site records: quality, progress, and finance records. They were specifically asked to indicate the following:

a) The frequency with which they conduct searches of the various different types of record (by ranking 1 to 3, where 1 is most frequent and 3 is least frequent);
b) The difficulty they have in searching the particular types of record (by ranking 1 to 3 where 1 is most difficult and 3 is least difficult).




***Figure(4.40): Efficiency of Site Records in Assessment of Delay Claims***




a) Site Diaries b) Site Inspection c) Work Programme d) As-built Programme
e) Measurements of Progress f) Measurements for Payments g) Inspector's / Engineer's Reports
h) Site Meetings i) Contractor's Progress Reports

***Figure(4.41): Records Used for Preparing Progress Reports***

Identifying the type of searches of records that are made is clearly an important issue in setting up any site record keeping system. Given that certain searches are difficult to conduct and other searches may seldom be carried out, the records can then be set up in such a way as to facilitate the types of search most frequently implemented. This information will indicate what records site supervisors are most concerned with and which types are considered less important. The analysis of responses to this question will be presented under two headings: search frequency, and search difficulty.

i) Search frequency

Careful inspection of the data revealed that some respondents' data was not complete i.e. the respondent had not answered in accordance with the question's requirements (e.g. types of records were not properly ranked), but 77 percent of the respondents made their responses as requested in the question. It was therefore, decided to analyse the data in two ways: applying a weighting process for data that was in-line with the question (group A), and summing up the ranking points for the remaining set of data (group B). As the data obtained from the claims consultants in their responses to $Q_{N3}$ (a parallel question to $Q_{G6}$) was found not to be in-line with the question requirements, it was decided to treat it in a similar way to the supervisors' group B data. Table 4.7 contains the results obtained from those supervisors belonging to group A (50 respondents) with some analysis of the figures. A weighting was applied to these choices, with the ranking '1' attracting a weighting of 3, '2' and '3' attracting a weighting of 2 and 1 respectively. The weighted values of the choices are also shown in the table. Two other figures have also been calculated in order to obtain an indication of the majority views. These were a datum and a figure that aims to show more clearly the frequency of searches conducted. The datum represents the least possible weight that a choice can attract and assumes that all respondents (50) would rank this choice 3rd which would attract a weighting of 1. Thus by subtracting this datum, (50*1=50) from the weighted scores, and dividing the result by the total new scores (150), the results produced indicate the respondents' views on the frequency with which these records are searched. The results of the above analysis, as shown in figure 4.42, reveal that searches of site progress records are the most frequent, but also that these searches are conducted three times more often than searches of quality records and almost twice as often as searches of finance records.

The analysis of the group B data obtained from site supervisors' responses (about one-third of them were nil or partially ranked responses which were excluded) was carried out by summing up the ranking points. These ranking figures were firstly converted (1 to 3 and 3 to 1) to facilitate a useful comparison with the results obtained from the analysis of group A data. The converted figures were then summed up as shown in Table 4.8, where the higher percentage indicates most frequent and the lower least frequent searches. The figures shown in the table, as reproduced in figure 4.42, indicate some compatibility with the results from group A in that searches of quality records were indicated by both data groups as the least frequently conducted searches.

Analysis of the data obtained from the claims consultants' responses to this part of $Q_{N3}$ (as shown in Table 4.9, and reproduced in figure 4.42) gives some confirmation to the majority of site supervisors' views in that searches of site progress records are the most frequent.

ii) Search difficulty

The respondents also responded to this part of the question in two different ways as with the question's first part. The analysis was therefore also conducted in a similar way to the analysis of the first part: applying a weighting process (Table 4.10) for the data that was in-line with the question (group C; 66 percent of the respondents), and the procedures of summing up the converted ranking points, (Table 4.11), for the other set of data (group D; 34 percent). The claims consultants' data was also found to be not in line with the question requirements, and therefore it was treated in a similar way to the group D site supervisors' data (as shown in Table 4.12).

The results of the analyses of the two data groups of this part of the question (figure 4.43) show very little variation indicating that searches of the different types of site records are equally difficult.

***Searches for assessment of work progress ($Q_{G7}$, $Q_{N4}$)***

Question $Q_{G7}$ was asked to identify the type of site records that would typically be most useful for a search that involves assessment of progress (e.g. claims for delay and

Table (4.7): Analysis of data (Supervisors-group a) of search frequency of site records

| | Type of Site Records | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quality records | | | Progress records | | | Finance records | | |
| | Ranking of Search Frequency | | | Ranking of Search Frequency | | | Ranking of Search Frequency | | |
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| No. of Choices | 8 | 10 | 32 | 32 | 16 | 2 | 10 | 24 | 16 |
| Weighted | 24 | 20 | 32 | 96 | 32 | 2 | 30 | 48 | 16 |
| Weighted Scores (A) | 76 | | | 130 | | | 94 | | |
| No. of Responses (B) | 50 | | | 50 | | | 50 | | |
| Datum (C)=(A)-(B) | 26 | | | 80 | | | 44 | | |
| Total New Weighted Scores (D) | (26) + (80) + (44) = (150) | | | | | | | | |
| Percentage (C)/(D) | 17 | | | 53 | | | 29 | | |

Table (4.8): Data analysis of search frequency of site records-Supervisors(group b)

| | Type of Site Records | | |
|---|---|---|---|
| | Quality | Progress | Finance |
| Sum of the converted ranking figures (A) | 17 | 21 | 21 |
| Total (B) | (17)+(21)+(21)=(59) | | |
| Percentage (A)/(B) | 28.8 | 35.6 | 35.6 |

Table (4.9): Data analysis of search frequency of site records - Claims Consultants

| | Type of Site Records | | |
|---|---|---|---|
| | Quality | Progress | Finance |
| Sum of the converted ranking figures (A) | 9 | 20 | 18 |
| Total (B) | (9)+(20)+(18)=(47) | | |
| Percentage (A)/(B) | 19 | 43 | 38 |

Table(4.10): Analysis of data (Supervisors-group c) of search difficulty of site records

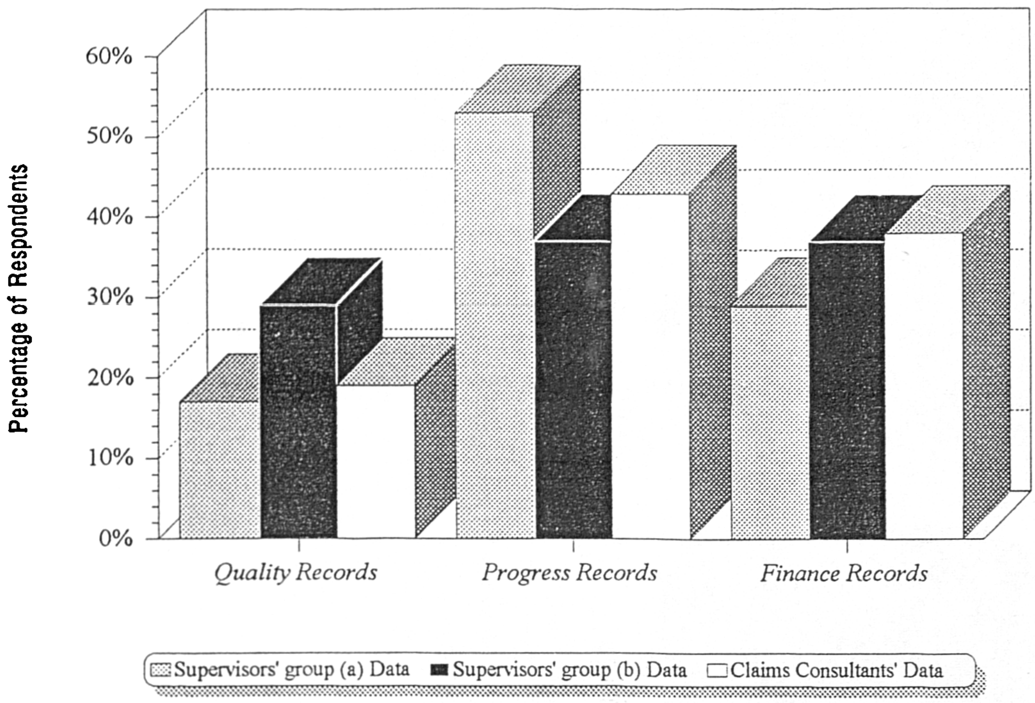
| | Type of Site Records | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quality records | | | Progress records | | | Finance records | | |
| | Ranking of Search Difficulty | | | Ranking of Search Difficulty | | | Ranking of Search Difficulty | | |
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| No. of Choices | 13 | 14 | 16 | 17 | 12 | 14 | 13 | 17 | 13 |
| Weighted | 39 | 28 | 16 | 51 | 24 | 14 | 39 | 34 | 13 |
| Weighted Scores (A) | 83 | | | 89 | | | 86 | | |
| No. of Responses (B) | 43 | | | 43 | | | 43 | | |
| Datum (C)=(A)-(B) | 40 | | | 46 | | | 43 | | |
| Total New Weighted Scores (D) | (40) + (46) + (43) = (129) | | | | | | | | |
| Percentage (C)/(D) | 31 | | | 36 | | | 33 | | |

Table (4.11) Data analysis of search difficulty of site records-Supervisors(group d)

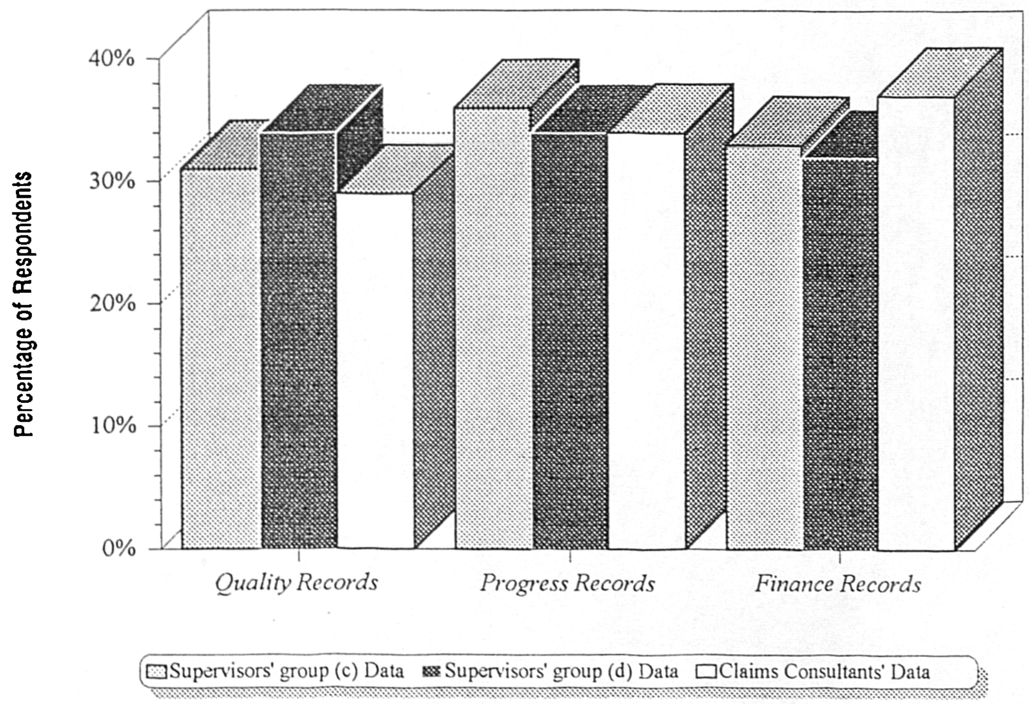
| | Type of Site Records | | |
|---|---|---|---|
| | Quality | Progress | Finance |
| Sum of the converted ranking figures (A) | 25 | 25 | 24 |
| Total (B) | (25)+(25)+(24)=(74) | | |
| Percentage (A)/(B) | 34 | 34 | 32 |

Table (4.12) Data analysis of search difficulty of site records - Claims Consultants

| | Type of Site Records | | |
|---|---|---|---|
| | Quality | Progress | Finance |
| Sum of the converted ranking figures (A) | 10 | 12 | 13 |
| Total (B) | (10)+(12)+(13)=(35) | | |
| Percentage (A)/(B) | 29 | 34 | 37 |




***Figure(4.42): Search Frequency of Site Records***




***Figure(4.43): Search Difficulty of Site Records***

extension of time). Respondents were asked to rank (i.e. 1 to 5, where 1 is most useful and 5 is least useful) the following type of site records:

a) *Engineer's diary.*

b) *Clerk of work's diary.*

c) *Progress photographs.*

d) *Minutes of progress meetings.*

e) *Progress reports.*

Identifying such information should facilitate the easy assessment of work progress by directing the people who conduct these searches to the best source of information. When the provided data was examined, some responses were found to be invalid and not in line with the requirements of the question, but the majority of the respondents (85 percent) were able to respond in-line with the question. Half of the improper responses were either nil responses or partially ranked, leaving the remaining improper responses to nearly 8 percent of the total respondents and thus it was decided not to include them in the analysis. The analysis was carried out in a similar way to that of $Q_{G6}$, by applying the weighting process. The full analysis is shown in Table 4.13, and the percentages deduced indicate the usefulness of these record types in assessing work progress.

The results of the analysis of site supervisors data (as shown in figure 4.44) indicate that the most useful type of record to be searched for assessment of progress of construction works is the site diary. The results also confirm that the engineer's diary and clerk of

Table (4.13): The most useful site records for assessment of progress - Site Supervisors' Responses

| | Type of Site Records | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Engineer's Diary | | | | | Clerk of Works' Diary | | | | | Progress Photographs | | | | | Minutes of Meetings | | | | | Progress Reports | | | | |
| | Ranking of Usefulness | | | | | Ranking of Usefulness | | | | | Ranking of Usefulness | | | | | Ranking of Usefulness | | | | | Ranking of Usefulness | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 3 | 4 |
| A | 16 | 16 | 7 | 10 | 6 | 22 | 11 | 5 | 9 | 8 | 0 | 6 | 9 | 15 | 25 | 2 | 15 | 14 | 13 | 11 | 15 | 7 | 20 | 8 | 5 |
| B | 80 | 64 | 21 | 20 | 6 | 110 | 44 | 15 | 18 | 8 | 0 | 24 | 27 | 30 | 25 | 10 | 60 | 42 | 26 | 11 | 75 | 28 | 60 | 16 | 5 |
| C | 191 | | | | | 195 | | | | | 106 | | | | | 149 | | | | | 184 | | | | |
| D | 55 | | | | | 55 | | | | | 55 | | | | | 55 | | | | | 55 | | | | |
| E | 136 | | | | | 140 | | | | | 51 | | | | | 94 | | | | | 129 | | | | |
| F | (136) + (140) + (51) + (94) + (129) = (550) | | | | | | | | | | | | | | | | | | | | | | | | |
| G | 25 | | | | | 25 | | | | | 9 | | | | | 17 | | | | | 23 | | | | |

A=No. of choices, B=Weighted, C=Weighted score, D=No. of responses, E=Datum=(C)-(D), F=Total new weighted scores, G=Percentage of usefulness=(E/F) work's diary are of almost equal importance; this is in-line with results obtained for question $Q_{D6}$. Progress reports were also seen as very important with regard to this matter though, as shown by the results for question $Q_{G5}$, these documents depend mainly on site diaries.

As the majority of claims consultants responded in-line with the requirements of $Q_{N4}$, the analysis (as shown in Table 4.14), was conducted in a similar way to the data obtained from the supervisors' responses. The results (as shown in figure 4.44) indicate that claims consultants identified clerks of works diaries as the most useful source of information and indicate that progress photographs are not so important. Claims consultants also found engineers' diaries less important than clerks of works' diaries and this confirms their responses to $Q_{K6}$.

Identifying such documents (i.e. site diaries) as the most useful source of information to help in the assessment of progress, highlights the need to improve the documents to facilitate easier and more effective searches.

*Searches of site progress records ($Q_{G8}$, $Q_{N5}$)*

$Q_{G8}$ aimed at identifying the frequency with which different types of searches of site progress records were made. Respondents were provided with seven types of searches and asked to indicate the frequency with which each was carried out, by selecting 1 for

Table (4.14): The most useful site records for assessment of progress - Claims Consultants' Responses

| | Type of Site Records | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Engineer's Diary | | | | | Clerk of Works' Diary | | | | | Progress Photographs | | | | | Minutes of Meetings | | | | | Progress Reports | | | | |
| | Ranking of Usefulness | | | | | Ranking of Usefulness | | | | | Ranking of Usefulness | | | | | Ranking of Usefulness | | | | | Ranking of Usefulness | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 3 | 4 |
| A | 1 | 1 | 0 | 2 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 1 | 1 | 1 | 2 | 0 | 1 | 2 | 2 | 0 | 0 |
| B | 5 | 4 | 0 | 4 | 1 | 10 | 4 | 6 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 5 | 4 | 3 | 4 | 0 | 5 | 8 | 6 | 0 | 0 |
| C | 14 | | | | | 20 | | | | | 6 | | | | | 16 | | | | | 19 | | | | |
| D | 5 | | | | | 5 | | | | | 5 | | | | | 5 | | | | | 5 | | | | |
| E | 9 | | | | | 15 | | | | | 1 | | | | | 11 | | | | | 14 | | | | |
| F | (9) + (15) + (1) + (11) + (14) = (50) | | | | | | | | | | | | | | | | | | | | | | | | |
| G | 18 | | | | | 31 | | | | | 2 | | | | | 22 | | | | | 28 | | | | |

A=No. of choices, B=Weighted, C=Weighted score, D=No. of responses, E=Datum=(C)-(D), F=Total new weighted scores, G=Percentage of usefulness(E/F) very frequent, 2 as fairly frequent, and 3 for seldom or never done. The types were as follows:

a) *To find out when a particular event took place.*

b) *To find out what happened on a particular day.*

c) *To find out what happened during a particular period.*

d) *To find out when a delay was effective.*

e) *To identify the level of resources used on a particular construction activity.*

f) *To refer to a decision agreed with another party on specific problems.*

g) *To refer to any instructions given on particular construction activities.*

The question was set up in this way because it was recognised that ranking 7 items in order would not be an easy task. Each type of search was typically a search that might be expected to be conducted on progress records and it was considered easier for a respondent to assess how frequently he carried out such a search rather than ranking how frequently all of these searches would occur. It was also felt that this way of addressing the question would be accepted by respondents and would allow them to make useful responses. This is reflected by the fact that all responses (100 percent) were in line with the question requirements.

The analysis was carried out by applying a weighting process for each single type of search in view of the way in which the question was addressed. The weighting was applied to respondents' choices, with the ranking '1' attracting a weighting of 3, and '2','3' attracting a weighting of 2 and 1 respectively. The weighted scores were then divided by the number of respondents (65) to obtain an average relative weighting choice for each single type of search, i.e. the higher average score the more frequent, and the lower the less frequent. The full analysis is shown in Table 4.15.

The results of the above analysis (as shown in figure 4.45) reveal that all these recognised searches need to be considered, but that search type (a) seems to be conducted very frequently, and none of the other types of search were identified as seldom/never done.

The claims consultants' responses to question $Q_{N5}$ were also analysed (as shown in Table 4.16), and the results are also shown in figure 4.45 and confirm the site supervisors' views.

*Other searches of progress records ($Q_{G9}$, $Q_{N6}$)*

$Q_{G9}$ was addressed to the respondents to identify any other searches of progress records that they carry out; 69 percent of the respondents gave no response to this question. Other types of search were mentioned by a minority of respondents, and these have been added to the searches already recognised, to obtain a fairly comprehensive list. In Table 4.17, search types (h) to (k) were identified from the responses to this question and have been added to the list provided with $Q_{G8}$.

Table (4.15): Frequency of Searches of Progress Records (Site Supervisors)

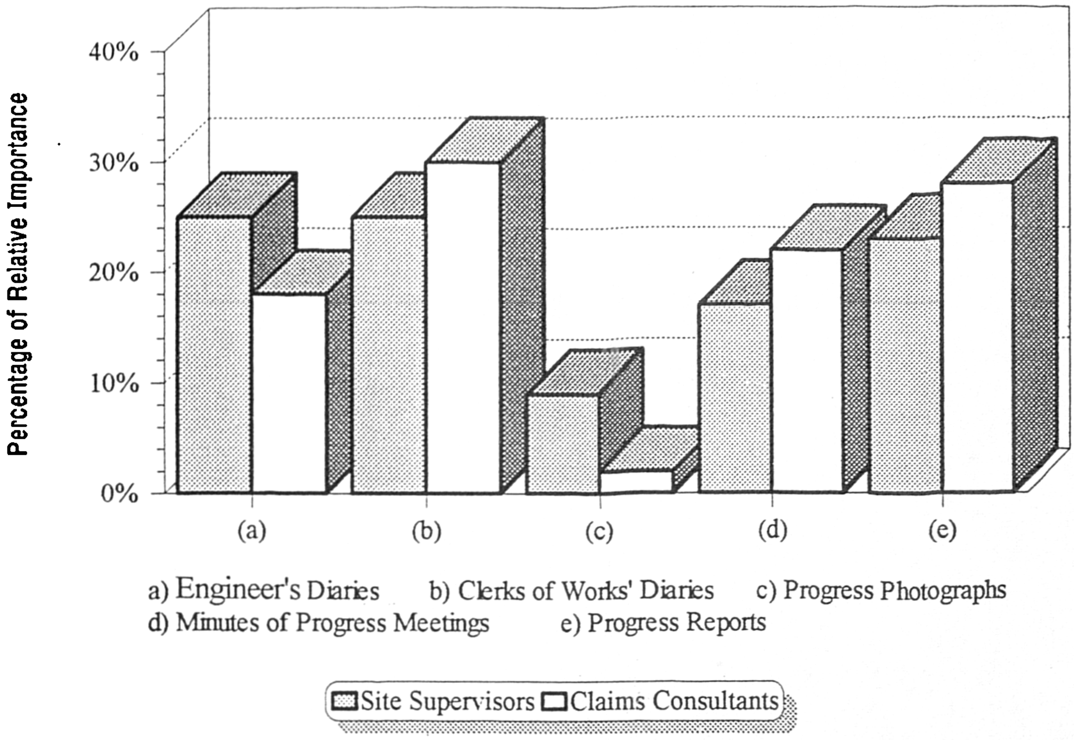
| | Type of Searches of Progress Records | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Type (a) | | | Type (b) | | | Type (c) | | | Type (d) | | | Type (e) | | | Type (f) | | | Type (g) | | |
| | Search Frequency | | | Search Frequency | | | Search Frequency | | | Search Frequency | | | Search Frequency | | | Search Frequency | | | Search Frequency | | |
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| A | 50 | 14 | 1 | 21 | 30 | 14 | 22 | 33 | 10 | 28 | 31 | 6 | 16 | 36 | 13 | 19 | 25 | 21 | 27 | 26 | 12 |
| B | 150 | 28 | 1 | 63 | 60 | 14 | 66 | 66 | 10 | 84 | 62 | 6 | 48 | 72 | 13 | 57 | 50 | 21 | 81 | 52 | 12 |
| C | 179 | | | 137 | | | 142 | | | 152 | | | 133 | | | 128 | | | 145 | | |
| D | 65 | | | 65 | | | 65 | | | 65 | | | 65 | | | 65 | | | 65 | | |
| E | 2.75 | | | 2.11 | | | 2.18 | | | 2.34 | | | 2.05 | | | 1.97 | | | 2.23 | | |

A=No. of choices, B=Weighted, C=Weighted score, D=No. of responses, and
E=Average weighted scores of frequencies of searches of progress records (C/D)

Table (4.16): Frequency of Searches of Progress Records (Claims Consultants)

| | Type of Searches of Progress Records | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Type (a) | | | Type (b) | | | Type (c) | | | Type (d) | | | Type (e) | | | Type (f) | | | Type (g) | | |
| | Search Frequency | | | Search Frequency | | | Search Frequency | | | Search Frequency | | | Search Frequency | | | Search Frequency | | | Search Frequency | | |
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| A | 8 | 0 | 0 | 4 | 3 | 1 | 3 | 4 | 1 | 5 | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 3 |
| B | 24 | 0 | 0 | 12 | 6 | 1 | 9 | 8 | 1 | 15 | 2 | 2 | 9 | 6 | 2 | 6 | 6 | 3 | 9 | 4 | 3 |
| C | 24 | | | 19 | | | 18 | | | 19 | | | 17 | | | 15 | | | 17 | | |
| D | 8 | | | 8 | | | 8 | | | 8 | | | 8 | | | 8 | | | 8 | | |
| E | 3 | | | 2.38 | | | 2.25 | | | 2.38 | | | 2.13 | | | 1.88 | | | 2.13 | | |

A=No. of choices, B=Weighted, C=Weighted score, D=No. of responses, and
E=Average weighted scores of frequencies of searches of progress records (C/D)




***Figure(4.44): Useful Records for Assessement of Work Progress***

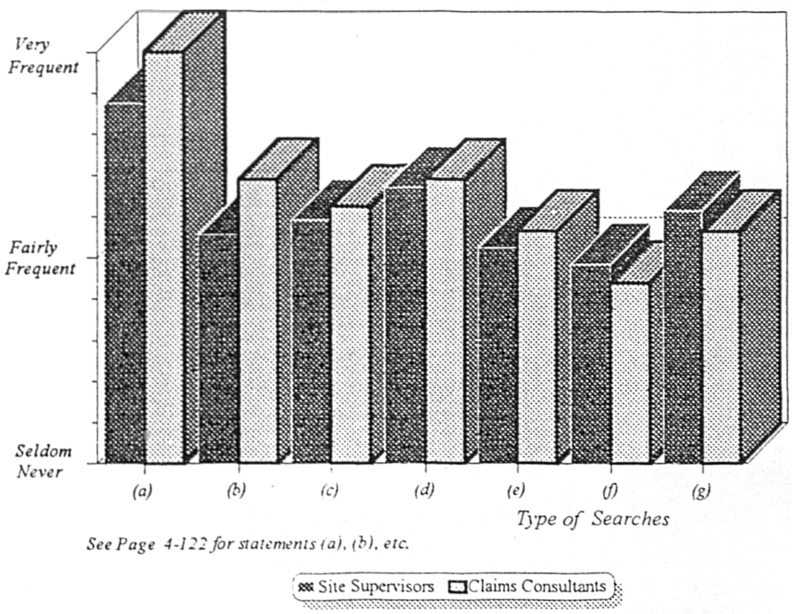



***Figure (4.45): Frequency of Searches of Progress Records***

Table (4.17) A comprehensive set of searches of progress records

| | Type of Search of Progress Records |
|---|---|
| a | To find out when a particular event took place. |
| b | To find out what happened on a particular day. |
| c | To find out what happened during a particular period. |
| d | To find out when a delay was effective. |
| e | To identify the level of resources used on a particular construction activity. |
| f | To refer to a decision agreed with another party on specific problems. |
| g | To refer to any instruction given on particular construction activities. |
| h | To find out information about material quality. |
| i | To find out information about resource movements. |
| j | To find out information about weather conditions |
| k | To find out information about problems that arose and actions taken to resolve them. |

In their responses to $Q_{N6}$, claims consultants were not able to add any other types of progress record searches.

### 4.7.3 Summing up

The following points stemmed from the analysis and discussion of the responses to questions relating to the use of site records.

i) A wide range of uses of site records was confirmed and their most important use was identified as assisting in dealing with contractors' claims. The next three uses identified as being important were concerned with checking quality, controlling costs and monitoring contractor performance.

ii) Records of resources, delays, work programmes, variations and as-built records are the most commonly indicated types of information necessary for assessing contractor's claims.

iii) The possibility of always being able easily to determine the contractor's rights to an extension of time from the records kept was not widely confirmed.

iv) Site diaries were identified as the most useful document for a search involving assessment of work progress, although problems with these records had already been expressed.

v) Progress records were confirmed as the most frequently searched type of site record, but quality and finance records were confirmed to be as difficult to search as the progress records.

vi) A wide range of types of search of progress records was confirmed as being conducted at least fairly frequently, whereas searches for finding out when a particular event took place were conducted very frequently.

## 4.8 Miscellaneous

This final section covers various subjects related generally to the record keeping process. Questions addressed include: the duties of site supervising staff, anticipation of claims situation, documentation of decisions on claims, and relating contract payments to the progress records. Other questions were also addressed to identify the respondents' interest in the study.

***Duties of site supervising staff ($Q_{H1}$)***

From a list of recognised duties of site supervising staff, the respondents were asked in $Q_{H1}$ (not addressed to claims consultants) to indicate relative importance by ranking 1 as most important, 6 as least important. The duties were as follows:

a) *Inspection of construction work and enforcement of contract specification.*

b) *Resolution of construction problems.*

c) *Payment of the contractor.*

d) *Resolution of contractor's claims.*

e) *Maintenance of good site records.*

f) *Other duties.*

This question was mainly concerned with identifying what importance respondents gave to the keeping of site records, compared with other common duties. This approach was adopted rather than asking them to rank a long list of recognised duties, which would obviously be difficult to do. This is the reason behind the structure adopted for the question, i.e. listing and asking for ranking of the most common duties and giving the opportunity to rank others (f). The responses were made in two ways: in accordance with and not in accordance with the question requirements, although the majority (82 percent) gave appropriate responses. Two-thirds of invalid responses were either nil or partially ranked as they expressed difficulty in ranking these duties. Since the invalid data obtained was in the minority, it was decided to carry out the analysis using only the appropriate data. The analysis was conducted in a similar way to that for $Q_{G1}$, i.e. applying a weighting process to obtain the ranges of the importance of these duties as seen by the respondents. Table 4.18 shows the full analysis where weighting was applied to the choices made by respondents ranging from the ranking '1' attracting a weighting of 6 to ranking '6' attracting a weighting of 1. The datum was then subtracted from the weighted scores and the output divided by the total new weighted scores (797) to obtain the percentage indicating the importance ranges of the specified duties.

The results of the analysis, as shown in figure 4.46, reveal that the most important duties of the supervising staff are contained within the list (a to e). The supervisors, quite reasonably, see their most important functions as ensuring that work is carried out acceptably and dealing with particular construction problems. These two tasks require a knowledge of what is to be constructed but are unlikely to demand any accessing of existing site records, although they will often generate such records. The function in the list which does require substantial use of records, resolution of contractor's claims, is not seen as very important, although the maintenance of good records is seen as important. If the most important tasks the supervisors must undertake involve little or no use of site records, perhaps their concern about the quality of those records will be affected by this.

Table (4.18)i: Data analysis to identify the important duties of site supervising staff.

| | Duties of Site Supervising Staff | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Duty (a) | | | | | | Duty (b) | | | | | | Duty (c) | | | | | |
| | Ranking of Importance | | | | | | Ranking of Importance | | | | | | Ranking of Importance | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
| No. of Choices | 41 | 8 | 4 | 0 | 0 | 0 | 8 | 30 | 12 | 2 | 1 | 0 | 0 | 1 | 11 | 18 | 18 | 5 |
| Weighted | 246 | 40 | 16 | 0 | 0 | 0 | 48 | 150 | 48 | 6 | 2 | 0 | 0 | 5 | 44 | 54 | 36 | 5 |
| Weighted Scores (A) | 302 | | | | | | 254 | | | | | | 144 | | | | | |
| No. of Responses (B) | 53 | | | | | | 53 | | | | | | 53 | | | | | |
| Datum (C)=(A)-(B) | 249 | | | | | | 201 | | | | | | 91 | | | | | |
| Total New Weighted Scores (D) | $(249)_a + (201)_b + (91)_c + (75)_d + (157)_e + (24)_f = (797)$<br>*These figures related to all duties (a to f) presented in both tables (4.18)i & ii* | | | | | | | | | | | | | | | | | |
| Percentage (C)/(D) | 31 | | | | | | 25 | | | | | | 12 | | | | | |

Table (4.18)ii: Data analysis to identify the important duties of site supervising staff.

| | Duties of Site Supervising Staff | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Duty (d) | | | | | | Duty (e) | | | | | | Other Duties (f) | | | | | |
| | Ranking of Importance | | | | | | Ranking of Importance | | | | | | Ranking of Importance | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
| No. of Choices | 1 | 0 | 3 | 16 | 29 | 4 | 3 | 12 | 22 | 12 | 4 | 0 | 1 | 2 | 0 | 5 | 1 | 44 |
| Weighted | 6 | 0 | 12 | 48 | 58 | 4 | 18 | 60 | 88 | 36 | 8 | 0 | 6 | 10 | 0 | 15 | 2 | 44 |
| Weighted Scores (A) | 128 | | | | | | 210 | | | | | | 77 | | | | | |
| No. of Responses (B) | 53 | | | | | | 53 | | | | | | 53 | | | | | |
| Datum (C)=(A)-(B) | 75 | | | | | | 157 | | | | | | 24 | | | | | |
| Total New Weighted Scores (D) | $(249)_a + (201)_b + (91)_c + (75)_d + (157)_e + (24)_f = (797)$<br>*These figures related to all duties (a to f) presented in both tables (4.18)i & ii* | | | | | | | | | | | | | | | | | |
| Percentage (C)/(D) | 9 | | | | | | 20 | | | | | | 3 | | | | | |

*Other duties for site supervising staff ($Q_{H2}$)*

This question was intended to allow respondents to state other duties that are expected to be carried out by site supervising staff (claims consultants were not included). It was hoped that this would also provide an opportunity to identify any duty related to or dependent on the record-keeping function. Some of the duties indicated were already covered by the recognised duties stated in question $Q_{H1}$ (i.e. checking of the setting out and issuing of site instructions/variation orders). The other duties identified included:

- Liaison with clients.
- Liaison with third parties.
- Monitoring of contract progress.
- Inspection of site safety.
- Feedback of information to design office.
- Anticipation of problems.

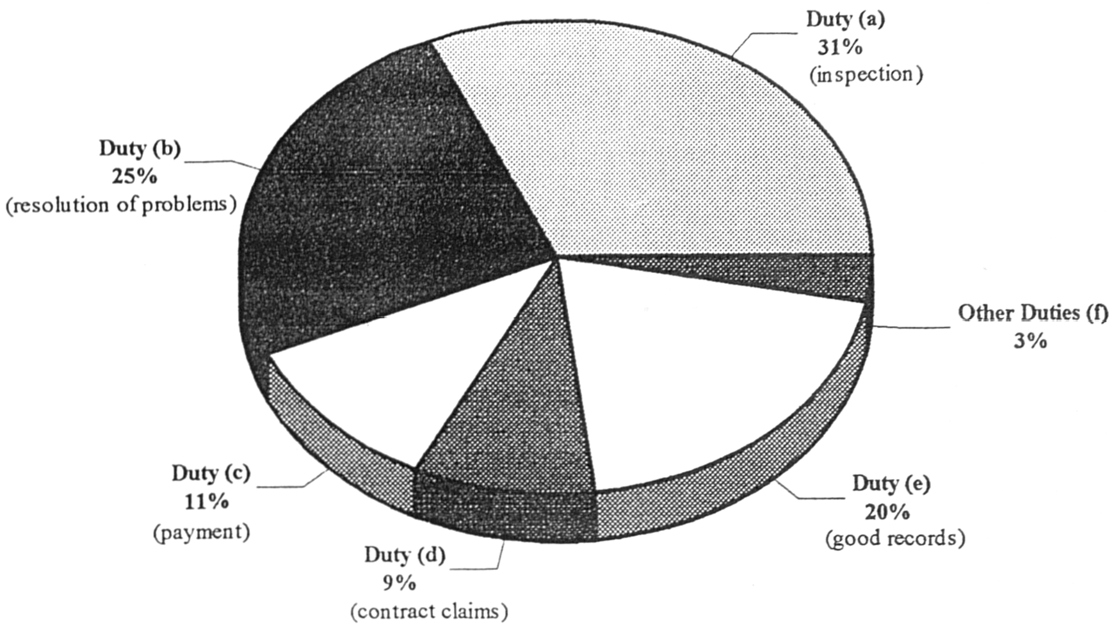
Clearly most of the above mentioned duties are record-oriented and further records either result from such duties or are needed to allow the work to be carried out, affirming the value of the record-keeping function.

*Supervision without keeping site records ($Q_{H3}$)*

Site supervisors were asked in $Q_{H3}$ (not addressed to claims consultants) if they could imagine supervising constructing works without maintaining records. The question aimed at eliciting their views on conducting such an important function on construction sites. The vast majority of respondents (89 percent) stated clearly that they could not imagine undertaking supervision duties without records being kept. Even respondents who admitted the possibility of supervising construction without keeping records, qualified their response with comments such as, 'it is possible but only on contracts where no claims would be allowed.' Of course, site records, are used for many purposes other than for the important area of claims assessment, as indicated clearly by the results of $Q_{G1}$ & $Q_{G2}$. One respondent commented that site records must be kept if for no other reason than to demonstrate that the works had been adequately supervised. Others commented that whatever the type and size of contract there will always be a need to know what the contractor did, when and how he did it. The responses to this question may give an impression that most site supervisors recognise the essential need for keeping site records.

*Anticipation of claims situations on sites ($Q_{H4}$)*

$Q_{H4}$, not addressed to claims consultants, asked whether site supervisors attempted to anticipate claims situations on site in order to become aware of them as soon as possible. The result of analysing the responses to this question, figure 4.47, revealed that only half




*See page 4-130 for duties (a), (b), etc.*

***Figure(4.46): Important Duties of Site Supervising Staff***

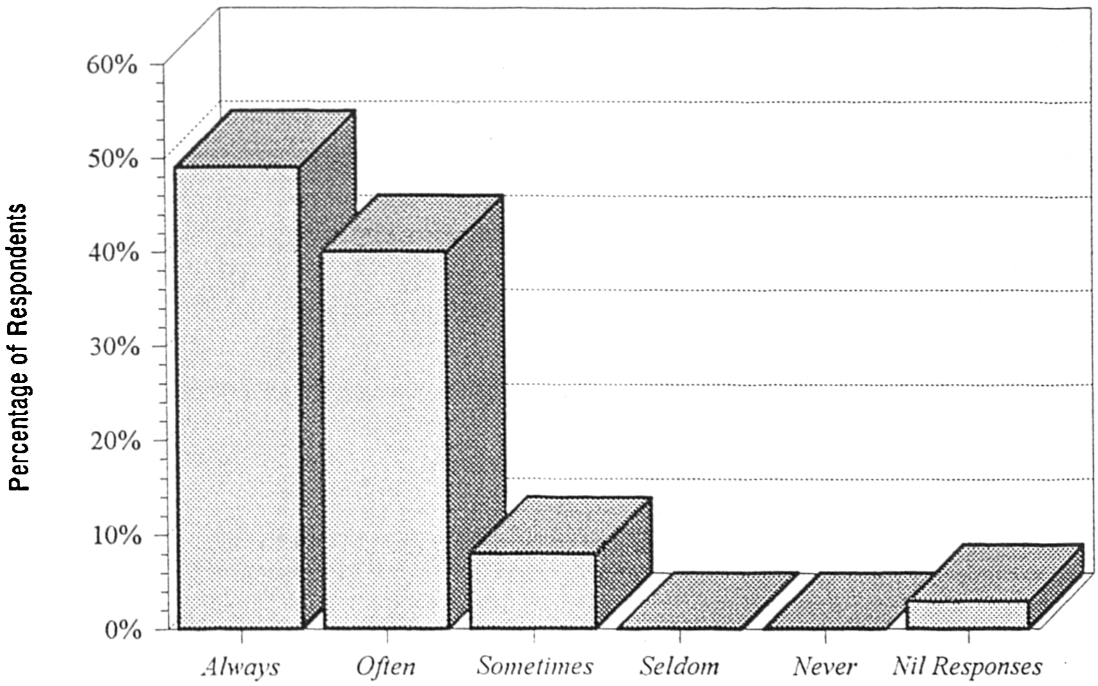



***Figure (4.47): Anticipation of Claims Situations on Sites***

of the sample indicated that they always attempt to anticipate claims situations. Some respondents admitted difficulty in anticipating such situations, and highlighted the importance of experience; others described this as an essential skill for an engineer and his site staff. It may be argued that some of the problems of dealing with claims may be reduced if efficient site records are maintained as soon as the problem is identified and the respondents' general wish to anticipate claims situations would suggest that they concur with this view.

***Documentation of decisions on claims ($Q_{H5}$)***

Contractors usually submit claims containing a number of documents justifying the claim and the engineer is obliged to make an assessment to establish its validity and then decide how much time the contractor is going to be granted or how much he is going to be paid. When a decision is made on the claim, the contractor is informed, but how are these decisions made, and on what basis? A part of the procedure might be expected to involve a written report laying out the basis for the decision and to see whether this is actually done, respondents were asked in $Q_{H5}$ (not addressed to claims consultants) to say how decisions on contractor's claims are documented.

28 percent of the respondents indicated that they keep such information in separate reports while 55 percent admitted that their responses to such claims were sent in the form of a

letter to the contractor, and 14 percent stated that these types of records were maintained within the minutes of meetings.

The information contained in a letter to the contractor or reported in a meeting will probably be not much more than notification of the decision, with little or no attempt to justify. If this so, there may be no formal document that lays out *how* the decision on the claim was actually made and therefore no formal means of reassessing the claim or of using the details for training purposes. Clear documenting of such procedures would help in any training programmes for inexperienced staff by educating them as to how these procedures are conducted, what type of records should be consulted, how effective the records were, and how a final decision was made.

*Payment tied to progress records ($Q_{H6}$)*

Respondents were asked in $Q_{H6}$ (not addressed to claims consultants), whether they could imagine a contract where payment of a contractor was tied directly to progress records i.e. the percentage of completion of an activity for which the payment will be made, is assessed from the progress records. 58 percent admitted the possibility of doing so whereas 40 percent doubted such a possibility. Some stated that they had already worked on such a basis, others indicated that this happens on certain types of contracts such as design and build contracts and fixed price contracts. This, of course, will increase the importance of site progress records and emphasises the need to keep more useful site records.

*The best set of site records ($Q_{O1}$)*

As claims consultants generally have a good opportunity to inspect site records when claims are dealt with, they were asked in $Q_{O1}$ (not addressed to site supervisors), to indicate, based on their experience, which set of site records were the best: the contractor's records or the supervising engineers' records. One-third invalidated their answers to the question and two-thirds of the remaining respondents indicated that supervisor's staff records are better. However, this is not considered to be a very significant result for, as was indicated in $Q_{I2}$, the majority of the claims consultants surveyed worked almost exclusively for clients, where their main access would be to the supervisor's site records.

*Respondents' interests in this study ($Q_{H7}$, $Q_{O2}$)*

To identify how interested site supervisors were in this study, which deals with one of their admitted most important functions, $Q_{H7}$ asked whether they wished to receive a copy of the results. The vast majority (94 percent) indicated their wish to obtain a copy of the results indicating the value they accord to the study. More importantly, it reflects their concern about the issue of record-keeping on construction sites. The same views were also expressed by the vast majority of claims consultants (7/8) when asked this question in $Q_{O2}$.

*Copies of standard forms for record keeping ($Q_{H8}$)*

Respondents were asked in $Q_{H8}$ (not addressed to claims consultants) to send a copy of any standard record sheets they used for keeping site records, and more than one-third of the sample responded and sent a number of their forms ranging from one to as many as 10 forms from each. Some respondents stated that company policies prevented sending such forms. The main reason for asking for these, was to study the standard daily record sheets, often used in place of site diaries. In total, 15 standard daily record sheets were identified and carefully examined. In addition to the typical information contained in almost all forms such as contract no., day/date, week no., temperature/weather, name and section, the following headings were printed on most of these forms:

- Time / hours.
- Locations.
- Work description.
- Plant.
- Labour.
- Time lost.
- Comments/remarks.
- Visitors.

There was no evidence on any of these sheets of an attempt to relate work on the site directly to activities on the contractor's programme which seems to confirm the view stemming from the analysis of responses to $Q_{D7}$, and $Q_{D8}$ which indicated that site diary records are not generally related to the contractor's work programme. This may also affect the quality of progress reports produced as responses to $Q_{G5}$ revealed that the most important source of information used to prepare such reports is site diaries. The lack of such references may also have its impact on the efficiency of the claims assessment procedures particularly when these documents (site diaries and progress reports) are identified in $Q_{G7}$ as the most useful records for searches involving assessment of work progress.

***Further comments ($Q_{H9}$, $Q_{O3}$)***

At the end of the questionnaires, an opportunity was provided for respondents to express any additional opinions. While no significant comments were made by claims consultants in their responses to $Q_{O3}$, a number of points were made by some of the site supervisors responding to $Q_{H9}$ and were, in most cases views supporting the research. 'Sound useful research', one respondent stated, adding that, 'it is certainly an area that requires review and discussion.' Another indicated that he would be very interested to see the results of this work as it identifies the failings in the normal site records. These are just some examples of their supporting comments, although others expressed their concern about the length of the questionnaire, and some also criticised the questionnaire for not taking account of the various forms of contract. Although the study concentrated on the traditional type of contract, some of the issues raised in the questionnaire are also valid for other forms. One respondent commented in this regard stating that he suspects many clients will pursue a hybrid scheme as the concern with design and build contracts is that they lack engineering management and quality control. Another stated that he does not believe that the client gets the best project when adequate supervision is not undertaken. Other supportive opinions were also expressed by some respondents. One stated that because the number of site staff available will inevitably be less than desirable, record-keeping needs to be both accurate and limited to the minimum necessary for the proper administration of the contract. Minimising site records is an issue discussed by some writers such as Abrahamson (1979) who advises to keep the minimum needed records, but of course to do that one needs to understand the purposes for keeping records before it can be decided what the limits are. Another respondent commented that the most important item on sites is the record-keeping. This, he adds, should be carried out at all times to record any significant event on site, as on a busy site it is very easy to forget an important conversation or completion of an inspection which may be involved in a claim.

### 4.8.1 Summing up

The following points stemmed from the analysis and discussion of the miscellaneous questions.

i) The most important duties of site supervising staff were identified. Duties that generate site records were seen as relatively more important than those which depend on these records. Maintaining good site records was identified as one of the important duties of the supervising team on construction sites.

ii) Anticipation of a claims situation on construction sites was generally admitted and the role of experience in identifying such circumstances was highlighted. On the other hand, clear documentation of decisions made on claims was not clearly evident.

iii) An attempt to relate the information maintained within the daily standard sheets to the contractor's programme activities was not evident, which may confirm that these records are not generally related to the work programme activities, although it was clearly admitted that there is a value in doing so.

iv) A number of supportive views were expressed by many respondents indicating their feelings about the importance of the study as well as their concern about site record-keeping procedures.

### 4.9 Summary

After describing the procedures of developing the questionnaire and approach adopted to administrating and conducting the national survey as well as indicating the rates of response, this chapter has presented in detail the analysis and discussion of the collected data. The procedures adopted for analysing the data and presenting the results have been described and a summing up of the main findings has also been provided at the end of each main section of this chapter. The next chapter examines the assertions being raised regarding site supervisors records which were described in chapter three and presents the conclusions drawn and the recommendations made to improve the record keeping procedures on construction sites.

# Chapter 5

# Conclusions and Recommendations

# 5 CONCLUSIONS and RECOMMENDATIONS

The previous chapter provided a detailed analysis and discussion of the research data for each question in turn, within a number of sections. This chapter uses that data to present the general conclusions by considering the principal views and hypothesis set out initially and testing these against the survey results. Also included are the specific conclusions which arose from the analysis and discussion of the results. In the final part of this chapter, a number of recommendations and suggestions for further research have been made. The principal aim of the work carried out for this thesis has always been twofold. Initially, the wish was to identify current practice and common attitudes in the area of record-keeping on construction sites and this has been dealt with in chapter four and is continued in the first part of this chapter. The intention, however, was always to use this information to make recommendations that will hopefully promote good practice in the future and this will be addressed in the latter half of this chapter.

## 5.1 Conclusions

### 5.1.1 General conclusions

The main conclusions of the research work will now be considered by attempting to answer the questions originally stated in chapter three (i.e. the views to be tested and the hypothesis). The main aim of the research hypothesis was to provide assistance in developing sensible and useful questions in order to obtain data relevant to the study. It must, however, be stated that the data gathering process was also geared towards identifying current record-keeping procedures, not only the limited focus of the questions and hypothesis or the research objectives. Hence, the data is wider in its scope and comprehensiveness than the hypothesis and objectives set out previously. Therefore, it is within the wider context of the data that evidence will be drawn to support or refute the hypothesis and views. It must be emphasised once again that the research hypothesis is objective-orientated and not statistically-orientated. Evaluation of the research hypothesis and the views to be tested will therefore be based upon balanced and honest conclusions drawn from analysis and discussion of the research results. Each view will now be considered in turn starting with the first, which was:

> *'Although records kept on construction sites are often extensive, the current approach to keeping such records fails to provide all the information that is needed.'*

As has been seen, records maintained on construction sites may generally be classified into three main categories: financial, quality, and progress records. These records are kept in a range of different forms for a variety of reasons. It has been recognised that site records, apart from fulfilling the needs for controlling project costs and forming the basis of fair payment to the contractor, have other important functions. Of these, as well as confirming that the works are carried out according to the contract specification and monitoring work progress and contractor performance, the records kept will be the main source of information from which claims for additional payment and/or time will be assessed by construction supervisors. It can generally be argued that financial records are not a major problem considering the fact that Bills of Quantities on the traditional type of contracts are usually completed at regular intervals and thus ensure that good records are kept. Additionally, monies paid and the amount of work done and paid for would normally be recorded in a number of documents such as interim valuations and payment slips. Concerning quality records, it might also be safe to say that this type of record is now probably improved with many contractors using quality assurance schemes. This is also supported by the results of this study, indicating that the majority of the site supervisors' organisations are registered in accordance with BS5750 ($Q_{B1}$). It is believed that. the main areas of difficulties are more likely to exist with records of site work progress and the recognition of resources applied to work, especially varied work; this led the study to concentrate mainly on this type of site record. In the absence of good progress records, the supervisor will be hindered in performing a number of essential functions. The most important of these are:

- Assessment of claims (especially claims for delay).
- Assessment of variation orders.
- Prediction of likely completion date.

The problem of resolving contractors' delay claims is particularly difficult and most Conditions of Contracts require supervisors to deal with such claims, not just at the end of the contract when the project is complete, but also part-way through the project. Most methods used for validating delay claims rely generally upon a basic principle that involves a comparison of the contractor's actual progress with his planned progress to examine the difference between them and to identify the effects of delays. The effects of each delay upon the progress of the construction works and in particular, the project completion date need to be determined, since an event may delay an activity but not the overall completion of the actual project. This undoubtedly emphasises the need to keep certain types of site record in a particular way in order to ensure easy attainment of the above requirements. It is believed that the most effective way to achieve such aims is by constructing an 'as-built' record of actual progress and delays, not only for what are conceived to be critical activities, but for all construction activities. It is also believed that developing such as-built records would not be a difficult task if a record of progress was kept showing, against each of the activities on the contractor's programme, exactly on which days work took place and defining the actual progress status of each construction activity. Identifying links between subsequent construction activities (which is defined as the actual point in time during the completion of one activity, when a subsequent dependent activity/activities can commence) is also very important in building up a complete record of as-built programmes. This will help to indicate, in the event of a delay occurring, the source of that delay and its consequences.

A number of questions that relate to the first view have been extracted and are shown in outline in Table 5.1. It must be stressed that it was not intended to identify all the ways in which the total records kept failed, but simply to point out a number of particular areas of failure. The survey shows that dealing with construction claims is one of the most important uses made of site records and regardless of the methodology adopted for assessing construction claims, one essential type of information that is most likely to be needed, particularly in assessing delay claims, is the 'as-built' programme. As can be seen from the questions presented in the Table, the majority of site supervisors do not keep this type of information, i.e. when specific activities on the contractor's programme took place, nor details of the links in time between successive activities. The importance of such information in dealing with construction claims is clearly admitted by the wide majority of site supervisors and claims consultants. This indicates that at least one of the most important uses of site records is not well provided for. Additionally, the general failure of records to be legible, continuous and consistent on some days means that they will fail not only to help in assessing construction claims but in many other areas also. In the light of the above arguments, it appears that the research findings provide strong evidence to support the first view.

Table 5.1: View one related questions and responses.
(*S-S* = Site Supervisors, *C-C* = Claims Consultants, Majority = 60%-85% of respondents, Vast Majority = >85%)

| Q No. (S-S's Question-naire) | Brief Description of Question's Content | Brief Description of Views Received |
|---|---|---|
| C2 | Identifying any specific problems in keeping good site records | The majority of s-s and c-c admitted to some problems. Problems identified related to site procedures and site staff. |
| C4 | Confirming the totality of site records kept. | A variety of records were confirmed as being kept, as indicated by the majority of s-s. Keeping of as-built programmes as one of the other types of records kept on sites was indicated by only 5% of s-s. |
| C5&6 | Identifying any other records that are not generally kept. | The majority of s-s and c-c could not think of any other records worth keeping that are not generally kept. |
| D1 | Identifying whether records of exactly which days work took place are kept against the activities on the contractor's programme. | The results revealed that the majority of s-s do not keep this type of records, and the lack of such records was also confirmed by the majority of c-c. |
| D2 | Viewing the usefulness of keeping site records in such a way ($Q_{D1}$) | The majority of s-s saw value in keeping such records and the same view was also confirmed by the vast majority of c-c. |
| D3 | Identifying whether links in time between subsequent activities are identified. | Only 38% of s-s indicated that they always did identify such links, this indicates that the majority of s-s do not keep complete 'as-built' programmes. The majority of c-c also said that such records did not exist. |
| D4 | Viewing the usefulness of identifying such links. | The vast majority of s-s saw value in keeping such records and all c-c indicated the same view. |
| D7 | Nature of site diary records. | Site diary records, as indicated by the majority of s-s, describe the most important particulars of construction work progress. |
| D13 | Identifying whether the recognised problems with site diary records were experienced, and the severity of these problems. | The majority of s-s and c-c had experienced problems relating to the accessibility, consistency, legibility and continuity of site diary records. All these problems were viewed as of almost equal severity, although s-s expressed more concern about continuity and c-c were more concerned about accessibility problems. |
| D14 | Identifying any other similar difficulties to those already recognised. | The majority of s-s and c-c indicated that they had not experienced any other similar difficulties. The remaining indicated some other problems relating to the accessibility, lack of detail in records and lack of experience of site staff. |
| G5 | Identifying the most important source of information used to produce progress reports. | The most important source identified by the majority of s-s was site diaries. |

The second view was as follows:

> *"Although there are still some constraints impeding the computerising of site records, the use of computers on construction sites is one way in which improvements in the record-keeping procedures can be made. Some of these constraints can be overcome."*

Table 5.2 shows in outline a number of questions which have been extracted that are relevant to this view. Considering their importance, the discussion will again concentrate on progress records as they form the major source of information and the area where most searches of records are conducted. From the survey results, it is clear that computers are not widely used on construction sites and no indication was given of using such technology for the purpose of keeping site diary records, although the record keeping area was the most widely foreseen potential use of computers on construction sites. The results showed that the record keeping function is an important part of the site supervising team's job and site diary records are the most important record of work progress from which other sources generally stem. It was also found that site progress records are searched fairly frequently but, as shown in the first view, the existence of problems that make these documents inaccessible was confirmed. These points emphasise the need to improve these records to facilitate their more efficient use and an obvious way of improvement would be by using computers, although some misgivings were expressed by some respondents.

Table 5.2: View two related questions and responses.
(S-S = Site Supervisors, C-C = Claims Consultants, Majority = 60%-85% of respondents, Vast Majority = >85% )

| Q No. (S-S's Question-naire) | Brief Description of Question's Content | Brief Description of Views Received |
|---|---|---|
| C7&8 | Identifying current computer usage. | The areas in which computers are used on construction sites are limited. No indication was given of using computers for the purpose of keeping site records other than storing laboratory test results, correspondence, and minutes of meetings. The most widely recognised future use of computers was for record-keeping purposes. |
| D10 & D11 | Viewing the use of standard record sheets and what pre-printed headings would be recommended. | The majority of s-s supported the use of such forms, the same view was also indicated by the vast majority of c-c. The number and types of headings that are needed to be included on these forms varied and this emphasises the need for a flexible type of standard form. |
| D12 | Identifying how often staff's site diary records were checked. | The majority of s-s did check their site staff diaries daily, weekly, monthly, or at regular occasions. |
| D13 | Identifying whether the recognised problems with site diary records were experienced, and the severity of these problems. | The majority of s-s and c-c had experienced problems relating to the accessibility, consistency, legibility and continuity of site diary records. All these problems were viewed as of almost equal severity, although s-s expressed more concern about continuity and c-c were more concerned about accessibility problems. |
| D15 | Identifying whether site staff would keep their site diary records on a computer. | The majority of s-s indicated that they could foresee such an eventuality. However, some misgivings were also highlighted such as problems with using keyboards, accessing to computers and time available. |
| G5 | Identifying the most important source of information used to produce progress reports. | The most important source identified by the majority of s-s was site diaries. |
| G7 | Identifying the most useful site records for a search involving assessment of progress of construction works. | The most useful type of site records to be searched for such an assessment as indicated by the majority of both s-s and c-c, is the site diary. |
| G8&9 | Identifying the frequency of recognised searches of progress records. | A wide range of searches of progress records was confirmed as being conducted at least fairly frequently. |
| H1 | Identifying the most important duty of site supervising staff. | Duties that generate site records were seen as more relatively important than those which depend on these records. Maintaining good site records was one of the most important duties identified. |

It is believed that by implementing good training programmes and using the latest computer technology, it would be possible to overcome most of the drawbacks highlighted. As has already been noted in chapter one, computer technology has rapidly improved over the last few years, with more powerful machines becoming ever smaller and cheaper. More sophisticated hardware and software are now available requiring less computer skill. Improvement of the human-computer interface is increasingly noticeable, allowing non-computer-literate users access to computing facilities. Nowadays there are computers that can be operated with a stylus, without the need for a keyboard (i.e. pen-based computers). This would undoubtedly help to overcome the problem raised by some respondents that some site staff categories will not use computers because they cannot use a keyboard effectively. Additionally, as data input to such computers will be by electronic pen writing directly on the screen, it is believed that it would also be faster than inputting data using a keyboard. Furthermore, the compact size and the reasonable costs of some computers will allow many site staff to have separate units to ensure the contemporaneous keeping of site records. The reduction in computer sizes also permits them to be easily fitted into a person's pocket so they can be kept safe even in rough situations such as construction sites.

As will also be seen in the second part of this chapter, computerising site diary records will provide considerable assistance in avoiding the many problems identified with these documents. Problems of accessibility, continuity, consistency and legibility of records can certainly be overcome by utilising the computer's powerful facilities. More details of the professed advantages of computerising site records will be addressed later in the recommendations. The above arguments provide evidence to support the second view.

The third view was as follows:

> *"Site supervisors' quality systems, where they have one, will not contain procedures covering the keeping of site progress records. Such procedures can be developed and would be accepted and followed by site staff."*

The questions relating to this view were extracted and are shown in outline in Table 5.3. As can be seen from question $Q_{B1}$, the majority of the consulting organisations have quality systems and it might then reasonably be expected that they all have quality procedures for all normal areas of work both in design offices and on construction sites. This is further supported by responses to question $Q_{B2}$ where site supervisors say that their organisations do have procedures for monitoring their work in a number of areas including keeping site records. However, when respondents were asked a very specific question ($Q_{D17}$) regarding quality procedures for keeping site diary records, the majority indicated that such procedures do not exist.

Although there was no evidence of quality procedures specifically written to govern the way in which site progress records are kept, there is an indication of concern in this area,

Table 5.3: View three related questions and responses.
(*S-S* = Site Supervisors, *C-C* = Claims Consultants, Majority = 60%-85% of respondents, Vast Majority = >85%)

| Q No. (S-S's Questionnaire) | Brief Description of Question's Content | Brief Description of Views Received |
|---|---|---|
| B1 | Identifying whether organisations operated a quality scheme registered according to BS 5750. | The majority of organisation did operate such procedures |
| B2 | Do you have quality documented procedures for monitoring the supervisors site work. | The majority of s-s admitted that such procedures existed in the areas of issuing variation orders, and maintaining site records. For assessment of claims, existence of such procedures were confirmed only by half of s-s. |
| B3 | Do you have guidelines to advise the supervising staff on what site records should be kept. | The majority of organisations did provide such guidelines. |
| D10 & D11 | Viewing the use of standard record sheets and what pre-printed headings would be recommended. | The majority of s-s supported the use of such forms, the same view was also indicated by the vast majority of c-c. The number and types of headings that are needed to be included on these forms varied and this emphasises the need for a flexible type of standard form. |
| D12 | Identifying how often staff's site diary records were checked. | The majority of s-s did check their site staff diaries daily, weekly, monthly, or at regular occasions. |
| D16 | Helping site staff to understand unusual occurrences on site. | The majority of s-s indicated that they carried out such practice, at least sometimes. |
| D17 | Identifying whether quality procedures for keeping site diary records existed. | The results revealed that the majority of s-s do not have quality procedures covering the keeping of site diary records. |
| D18 | Viewing the quality procedures for keeping site diary records. | The majority of s-s indicated that such procedures can be developed and they also felt that such procedures are necessary for keeping and managing site records. About half of them stated that identifying such procedures would not be a difficult task and a statement that indicated that site staff would not accept and follow such procedures, was disagreed with by the majority of them. |
| D19 | Factors affecting the setting up of quality procedures for keeping site diary records. | The majority views indicated that any approach needed to be flexible to consider nature of job/complexity/size. Other factors related to site staff, such as experience and time, and the status given by companies to this process. |
| H4 | Anticipating claims situations on site. | Only half of s-s indicated that they always attempt to anticipate claims situations. |
| H8 | Copies of standard forms used for keeping the daily site dairy records. | No evidence of a place to record the contractor's planning activities was found in the standard forms sent. |

as many elements of such procedures do exist. Providing guidelines on what site records should be kept and conducting regular checks on the site staff's diaries are examples of such concern.

Regarding the possibility of developing such procedures, the majority of site supervisors admitted that quality procedures are necessary for keeping and managing site records and if they were sensibly identified, site staff would accept and follow them. The results also show that the vast majority of respondents denied the statement that '*there are no procedures that could ever usefully cover the record-keeping process*'. This undoubtedly indicates that such procedures can be developed although some factors were also highlighted that should be considered when setting up any quality procedures for the keeping of site diary records. Thus, it appears that the research results provide evidence in support of the third view.

The fourth view was as follows:

> *"With the current record-keeping approach, the site supervisors will not be able to assess construction claims, in particular delay claims, with a reasonable precision or certainty. Improvement is possible."*

Table 5.4 shows in outline the related questions that have been extracted and as can be seen, question $Q_{G4}$ is probably the most relevant one that directly addresses this issue.

Table 5.4 : View four related questions and responses.
( *S-S* = Site Supervisors, *C-C* = Claims Consultants, Majority = 60%-85% of respondents, Vast Majority = >85% )

| Q No. (S-S's Question-naire) | Brief Description of Question's Content | Brief Description of Views Received |
|---|---|---|
| C4 | Confirming the totality of site records kept. | A variety of records were confirmed as being kept, as indicated by the majority of s-s. Keeping of as-built records as one of the other types of records kept on sites was indicated by only 5% of s-s. |
| D1 | Identifying whether records of exactly which days work took place, are kept against the activities on the contractor's programme. | The results revealed that the majority of s-s do not keep such type of records, and this was also confirmed by the majority of c-c. |
| D3 | Identifying whether links in time between subsequent activities are identified. | Only 38% of s-s indicated that they always did identify such links; this indicates that the majority of s-s do not keep complete 'as-built' programmes. The majority of c-c also said that such records did not exist. |
| D13 | Identifying whether the recognised problems with site diary records were experienced, and the severity of these problems. | The majority of s-s and c-c had experienced problems related to the accessibility, consistency, legibility and continuity of site diary records. All these problems were viewed as of almost equal severity although s-s expressed more concern about continuity and c-c were more concerned about accessibility problems. |
| E1 | Identifying when delays should be recorded. | The majority of s-s agreed with the following statements defining a delay event as: if an incident occur that allows the contractor to claim for a possible extension of time, if the construction work stops, provided the stop is not programmed, and if the contractor fail to complete an activity within the specified time. |
| E2 | Identifying the way in which site staff record delays on contracts. | The majority of s-s disagreed with the statement indicates that identifying delays is the contractors' job. The majority of them also agreed that site staff are required to be constantly looking for potential sources of delays which they are expected to be recorded as soon as they become evident. |
| E3 | Determining the level of satisfaction with delay records. | The majority of s-s viewed delay records as quite satisfactory and so did the majority of c-c, although a larger percentage of c-c felt that such records were not satisfactory. |
| E4 | Identifying how delay and their effects were recorded. | Information on delays is documented in different ways, such as progress reports, and minutes of meetings, but the most common way for maintaining such information is through site diaries. |
| E5 | Identifying what is recorded when delay becomes evident. | The commonly identified items as indicated by s-s were delay duration, cause of delays and resources involved. No clear evidence of concern about the effects of delays on subsequent activities was identified. Similar items of information were also identified by the c-c. |

| Q No. (S-S's Question-naire) | Brief Description of Question's Content | Brief Description of Views Received |
|---|---|---|
| E6 | Testing the efficiency of the records kept on delays. | The majority of s-s felt that they were *often* able to identify exactly when each delay occurred (only 18% were always able to do so). The majority of c-c indicated that they were only *sometimes* able to obtain such information from site records. |
| E7 | Identifying how disruption and its effects were recorded. | No common approach was identified for recording disruption and its effects. |
| F1 | Identifying the way in which records of resources were kept. | The majority of s-s indicated that detailed records of resources are kept on a daily basis; the vast majority of c-c supported this approach. |
| F2 | Identifying whether contractors were asked to specify the level of resources they intended to use. | The majority of s-s indicated that they did ask the contractor to provide such information when he submits his programme although contractors often do not respond. The vast majority of c-c supported this approach. |
| F3 | Relating records of resources to the activities on the contractor's programme of works. | The vast majority of s-s stated that they see value in doing so, and this was also supported by the majority of c-c. |
| F4&5 | Identifying movements of major items of plant on & off site. | All s-s admitted that they can identify such movements from their records but half of them had made a special effort to keep specific records on such movements. All s-s and c-c see value in having such information. |
| F6&7 | Identifying movements of items of plant between construction activities. | The vast majority of s-s indicated that they can identify such movements from their records, although specific records of such movements were not compiled by the majority of them. The majority of s-s and c-c see value in having such information. |
| F8&9 | Recording time that major items of plant spent on each construction activity. | Half of the s-s indicated that they do record such information. The majority of s-s and c-c see value in having such information. |
| G1 | Of the recognised uses made of site records, identifying the most important uses. | Assisting in dealing with contractor's claims, checking quality, controlling costs and monitoring contractor performance are the most important uses made of site records. |
| G4 | Testing the efficiency of the records kept in determining the contractor's rights to an extension of time. | Only 22% of s-s indicated that they were *always* easily able to assess such rights. This reveals that the vast majority of s-s were not *always* easily able to determine contractor's rights for such extension of time. The vast majority of c-c were only sometimes able to do so. |
| H5 | Documenting decision on contractor's claims. | No clear responses were given on how these decisions were documented. Half of s-s indicated that such decisions were kept in a letter format and only about one-third of s-s indicated that they keep such information in separate reports. |

Site supervisors were asked (given five choices to select i.e. always, often, sometimes, seldom, and never), whether they were easily able to determine from their records the contractor's rights to an extension of time. Only about one-quarter of them stated that they were *always* able to do so. This percentage may even be questioned considering their responses to question $Q_{E6}$ where the majority stated that they were not *always* able to pinpoint exactly from their records, when each of the delays on the contract was effective. Based on these figures, it can reasonably be argued that the majority of site supervisors are not *always* easily able to determine contractors' rights to an extension of project time. Other information was also collected in the survey which is relevant to this view and as has been argued in the first view, the 'as-built' programmes are needed in dealing with construction claims whatever the methodology adopted for assessing these claims. It becomes clear that the majority of site supervisors do not specifically build up such 'as-built' programmes i.e. they do not keep records in-line with the contractor's programme activities on a daily basis and they do not identify links in time between subsequent activities. The importance of such information was highly appreciated by the vast majority of site supervisors and claims consultants, particularly in dealing with delay claims. Clearly as part of the 'as-built' programmes, delays would have to be recorded and it is clear from responses to a number of questions that such important events (i.e. delays) are not always easily recoverable from records kept on construction sites. Also, the movement of resources (i.e. major items of plant) between construction activities that may well help to define links between these activities, is not generally well recorded.

It is believed that improving this area would be possible by keeping better site records. Table 5.5 shows a number of ideas, contributed by the respondents, that would improve the record keeping in this area. These were also highly appreciated by the majority of respondents as valuable information needed in dealing with construction claims. Considering the above points, it can then be argued that the research data provides evidence in support of the fourth view.

The research hypothesis was as follows:

> *"A reason why records kept by supervisors on construction sites do not provide all the information needed in the most efficient manner is because the site supervisors do not have a good understanding of all possible uses that will be made of those records."*

It has already been argued that the records kept on construction sites do not provide all the information needed in a convenient form. The question being asked now is what is the reason for this failure? The hypothesis clearly suggests that one reason is that site supervisors do not have a good understanding of all uses that will be made of site records. In attempting to provide support for this hypothesis, the views of the people who hopefully have a good understanding of how to deal with one particular aspect of record use, which is assessment of construction claims (the area identified as one of the most important uses of site records), will be compared with those of site supervisors.

Table 5.5: Elements of Improvement of Site Records for Assessment of Construction Claims

| | Suggested Elements of Improvement |
|---|---|
| • | Keeping a complete set of as-built programmes |
| • | Keeping good records of delay events particularly if:<br>» an incident occurred which may allow the contractor to claim for a possible extension of time;<br>» the construction works stopped, providing the stop was not programmed;<br>» the contractor failed to complete an activity within the specified time. |
| • | Identifying the level of resources that are intended to be used by the contractor when he submits his programme of construction works. |
| • | Relating records of resources to the work activities on the construction programme. |
| • | Keeping records of movements of major items of plant on & off construction sites. |
| • | Keeping records of movements of major items of plant between construction activities. |
| • | Recording time that major items of plant spent on each construction activity. |
| • | Adopting good documentation of the decisions made on contractors claims. |

The relevant questions are extracted and shown in outline in Table 5.6, together with the statistical results of the Mann-Whitney tests. All of these questions involved judgements being made on: the adequacy of the records in general, records of delay and the ease with which the records could be used to determine the contractor's rights to an extension of time. In each question, respondents were given the opportunity to select from a range of responses, e.g. very satisfied, quite satisfied, not satisfied. By taking each question in turn and comparing the results given by supervisors with those given by claims consultants using a Mann-Whitney test, it was possible to show how likely it was that the views of these two groups were significantly different. In all four cases, the claims consultants were less impressed with the quality and usefulness of these records and when the alpha level ($\alpha$) i.e. the level of significance, is set at 0.05, a normal level for this kind of work, it can be said with reasonable confidence that there was a significant difference between these views in all cases. Indeed, the fact that this result is true in four separate and relevant questions reinforces this confidence. The claims consultants, with a greater understanding of the type of records needed to deal with claims, were thus significantly less impressed with the records typically used for this work. This difference in view suggests that if the site supervisors were more aware of the problems of using records to resolve claims, they would be less satisfied with the records they keep and might then make efforts to improve them. In the light of the above arguments and the relevant views being tested, it can be argued that the survey data provides evidence in support of the research hypothesis.

Table 5.6: The research hypothesis related questions and responses.
( *S-S* = Site Supervisors, *C-C* = Claims Consultants, Majority = 60%-85% of respondents, Vast Majority = >85%)

| Q No. (S-S's Questionnaire) | Brief Description of Question's Content | Brief Description of Views Received |
|---|---|---|
| C1 | Viewing the suitability of the current approach to keeping construction site records | The majority of s-s were satisfied with the current approach whereas the majority of c-c were not. Mann-Whitney test was signficant at 0.0368 |
| E3 | Determining the level of satisfaction with delay records. | The majority of s-s viewed delay records as quite satisfactory and so did the majority of c-c, although a larger percentage of c-c felt that such records were not satisfactory. Mann-Whitney test was signficant at 0.0069 |
| E6 | Testing the efficiency of the records kept on delays. | The majority of s-s felt that they were *often* able to identify exactly when each delay occurred (only 18% were *always* able to do so). The majority of c-c indicated that they were only *sometimes* able to obtain such information from site records. Mann-Whitney test was signficant at 0.0000 |
| G4 | Testing the efficiency of the records kept in determining the contractor's rights to an extension of time. | Only 22% of s-s indicated that they were *always* easily able to assess such rights. This reveals that the vast majority of s-s were not *always* easily able to determine contractor's right for such extension of time. The vast majority of c-c were only *sometimes* able to do so. Mann-Whitney test was signficant at 0.0027 |

### 5.1.2 Specific Conclusions

In this section, the main findings, summarised at the end of each section of chapter four, will now be brought together succinctly. They are as follows:

- The extent to which records are kept on construction sites varies, but the quantity of these records can be considerable.

- The existence of a number of problems that generally impede the keeping of good site records was confirmed. These mainly fall into two categories as follows: problems related to procedures such as the lack of an effective, organised approach for record-keeping, and those related to site staff regarding time constraints and the number and experience of site staff. It was, however, admitted that site records can be improved by adopting better methods and procedures as well as establishing effective training programmes.

- Although the advantages of using computers were generally appreciated, the areas in which computers are used on construction sites are limited. The most widely recognised future use of computers was for record-keeping purposes, particularly site diary records.

- The value of keeping records of progress which show exactly on which day each activity on the contractor's programme took place, was clearly admitted. The advantages of identifying links between subsequent activities in the contractor's plans representing the actual point in time during the completion of one activity that a subsequent activity can be commenced, were also highly appreciated. Although there was a general recognition of the value of keeping these records in a particular way, operating in this way was not so evident.

- A bound page-a-day diary (with blank pages) is still the most common type of site diary used by the engineering staff for keeping site records, whereas standard record sheets (forms with pre-printed headings) are used most frequently by the site clerks of works. The contents of engineering staff's site diaries were defined as a general record of work progress as well as records of discussion and agreements. Detailed records of work taking place, including resources employed, were most likely to be found in the site clerks of works' diaries.

- The value of relating site diary records to activities on the contractor's programme was generally confirmed, and the use of standard forms was regarded as a useful way to ensure maintaining essential information. The most commonly proposed pre-printed headings on these forms were: description of work activities, labour & plant, weather conditions, location, and week number.

- The existence of a number of problems with site diary records were confirmed. These include problems relating to the accessibility, legibility, continuity, and consistency of the records maintained.

- The importance and possibility of developing quality procedures for record-keeping purposes were generally acknowledged, although some concern was expressed regarding the difficulty of their development. A number of factors were indicated to be considered when establishing such quality procedures. The most important was the flexibility of any proposed approach which should take into account job type, complexity, and size.

- It was confirmed that an event should be recorded as a delay event if: (a) an incident occurs that allows the contractor to claim for a possible extension of time, (b) construction work stops, provided the stop is not programmed, (c) the contractor fails to complete an activity within the specified time. The cause and duration of delays and resources involved are the most common types of information kept on delay events. The difficulty in identifying and recording disruption events which do not stop construction works but affect productivity was also indicated.

- The daily recording of labour and plant was confirmed as the most common method adopted for keeping records of resources. It was also indicated that contractors were asked to specify the level of resources they intend to employ when submitting construction programmes.

- The value of relating records of resources to the contractor's programme activities, and the value in keeping records of: (a) movement of major items of plant on & off site and between construction activities, (b) the exact time that plant was used on individual construction activities, were highly appreciated.

- The most important use of site records was identified as assisting in dealing with contractor claims. The other important uses were concerned with checking quality, controlling costs, and monitoring contractor performance.

- Although it was confirmed that all types of site records are difficult to search, progress records were identified as the most frequently searched type. A wide range of searches of progress records was indicated as being frequently conducted, the most frequent search being to find out when a particular event took place.

- Site diaries, the most important source of site records, were identified as: (a) the most common way for maintaining information on delays and their developments, (b) the most useful document for a search involving assessment of work progress, and (c) the most important source used to produce progress reports.

- The site supervising duties that generate site records were identified as more important than those which rely on these records. Maintaining good site records was identified as one of the most important duties, indicating a positive attitude towards the record-keeping issue.

- Supportive attitudes of the supervisors were clearly indicated on many occasions such as: (a) they support many suggestions that were made to improve site record-keeping e.g. relating records to programme activities, computerising site records, etc., (b) performing checks on staff site diary records though at varying intervals, (c) they agreed that site staff should be advised to look out for unusual occurrences to enable efficient records to be kept about the development of such events, (d) admitting that site staff are required to be constantly looking for potential sources of delays which they are expected to record as soon as they become evident, (e) admitting that they anticipate claims situations on construction sites in order to become aware of them as soon as possible, and, (f) showing an interest in the study, when they expressed their wish to obtain a copy of the results indicating the value they accord to the study. Undoubtedly all these points show a concern in this area and are encouraging signs that the recommendations made will hopefully be acted upon by the concerned parties.

## 5.2 Recommendations

In this section, a number of recommendations are presented which are aimed at improving site record-keeping procedures. These are: elements of a quality procedure for record-keeping, use of document image processing, use of bar-coding technology, and the use of computers for the purpose of keeping site diary records on construction sites.

### 5.2.1 Elements to be included in a quality procedure for progress records

Here, a number of points are suggested to be considered in any attempt to develop a quality procedure for keeping progress records on construction sites. It is, however, recognised that using computers will be of considerable assistance in most of these areas. The recommended elements are as follows:

- Careful identification of specific record-keeping responsibilities (i.e. who keeps records of what!). This is to define the specific types of records that each of the various levels of record-keeping staff in the organisation should keep.

- Adopting a system for changing responsibilities as necessary when people are absent. For example, when one of the record-keeping staff is absent, there needs to be a procedure for identifying another member of staff to keep the records which would otherwise not be kept. If these records are to be kept in the diary of the substitute record-keeper, there should be a note in the diary of the absentee record-keeper to redirect any search to the relevant document.

- For all site diaries it is necessary to identify the geographical area and responsibility covered by each. It is also important to ensure that site diaries are treated as the property of the project/company, retained with the other project records, and never allowed to leave the site.

- Adopting a system to conduct regular audits of site diaries to check quality and consistency, and to communicate and advise site staff, in good time, of important issues that need to be recorded.

- Use of planning activity codes as standard, whenever possible, for keeping progress records in site diaries, progress reports, site instructions, minutes of meetings, etc. It will also be of value to adopt a system that defines the different possible status of an activity's progress (e.g. postponed, started, stopped, completed, etc.), and ensures that all staff use it as a standard when reporting on construction progress.

- A system to ensure that an 'as-built' daily record of exactly when the activities on the contractor's programme took place and the periods of influence of delays are maintained. It is also important to ensure that 'real' links between activities are recorded to identify exactly the time when subsequent dependent activities were able to begin. This may best be achieved by recording at the end of an activity, what subsequent activities could then begin.

- A system to organise site progress photographs. For example, relating each photograph to the correspondent construction activity and ensuring that a note of any photograph taken is clearly made in the site diary.

- A system to ensure that site staff keep records of all incidents that might affect the construction process which may not be solely limited to what the main contractor and his sub-contractor(s) are doing, e.g. recording of independent contractors' activities on the site.

- Ensuring that effective training programmes are established and specific tuition is given to site staff, particularly young, inexperienced people to help them understand the importance of the records, how their records may be used and to recognise the events that must be recorded.

- Ensuring that sensible efforts are made regarding the computerising of site records to as great an extent as possible, considering the available facilities.

- It is also recommended that when anybody during the construction phase makes use of the records and finds them wanting in any respect, that information should be made available to the person in charge and it might well be fed back to improve future quality procedures.

- Agreeing joint records with the contractor, whenever possible.

The subsequent recommendations which will be presented in the following sections would, of course, also affect the quality procedures set for the record-keeping process. If the recommended technologies are used, then the quality procedures would be related to those methods of record keeping.

### 5.2.2 Use of document image processing

One important recommendation which will, no doubt, eventually be implemented, is the use of electronic mail by construction participants. The exchange of information will undoubtedly be simplified by adopting such technology. This will certainly help because all documents received in this way will be held electronically with the option to carry out computer searches. However, until the process of sending and receiving correspondence, reports, minutes of meetings, interim valuations, etc. by electronic mail becomes the norm, it is recommended that document image processing technology might be used to convert current hard copy documents into electronic documents. By scanning such documents into a computer database, they will hopefully be more accessible and searching for information maintained within these documents will be more efficient. Each document (e.g. correspondence), could be allocated a code to make it uniquely identifiable, thus simplifying the storing, sorting and searching procedures. Furthermore, it might also be useful to consider sending documents originally prepared using computer to the parties concerned in both formats, a computerised copy and the hard copy. All these steps are recommended in order to pave the way to the full computerisation of site records.

### 5.2.3 Use of bar-coding technology

Considering the importance of identifying the movements of major items of plant on and off site and between construction activities, bar-coding technology is recommended to be used for this purpose. Use of this technology would also facilitate recording the time spent by each major item of plant on each construction activity. These items of plant could be directly identified as unique because each single item could have attached to it a specific bar-code label (a metal label should be used for reasons of durability). The movements of plant items could then be identified from records by scanning these individual pieces of plant using a portable scanner (i.e. a bar-coding reader). To be more effective, a list of activities on the contractor's programme with a unique code being allocated to each one could also be prepared and then used along with the process of tracking and identification of plant movements by recording each item of plant against each activity at intervals through the day. Many other codes could also be added, allowing more precise recording of information; these might include on site, off site, idle, etc. This would ensure that records of resources used were related to the contractor's programme activities.

### 5.2.4 Use of computers for site diaries

In addition to describing the potential use of electronic diary software, this section presents the professed advantages of computerising site records, with perhaps the most important advantage being to improve accessibility. If records are held on magnetic medium and sensibly coded, powerful searching facilities will allow retrieval of any information with much less effort and in much less time than that taken by ordinary manual procedures. In addition, accessibility will certainly be improved by avoiding illegibility problems as already highlighted. Other advantages can also be identified concerning the issues of continuity and consistency.

Not all of the supervisor's site staff will be experienced professionals and it is recognised that regular checking of the site diaries of staff will allow problems to be identified early, as well as providing an opportunity to direct and advise site staff, in particular junior members, on suitable ways of keeping good records. Such checks, it is argued, may show a lack of trust, but if the record-keeping procedures were computerised, with each individual inputting his site diary records into a central storage medium on a daily basis, the supervisor could then inspect and check staff diaries without obvious signs of so doing. If such checks were conducted sensibly on a regular basis, this could ensure that the staff adopted good practice and, where necessary, action could be taken in good time to amend bad practice. Additionally, with this overview of the total records kept by all supervisory staff, any lack of consistency could immediately be found and measures taken to confirm what actually happened.

As stated in chapter four, lack of detail (brevity of information) is a problem that was highlighted by some supervisors. Although detailed records may generate an enormous volume of data and can create problems when accessing information, insufficient records can mean that necessary information cannot be obtained because it was simply not recorded. Computerised systems can cope with large amounts of records, and having too many records would not pose a problem, because when information is required, it will be found with much less difficulty.

When using standard forms to record information, problems can occur because the standard headings on the company's sheets may not properly suit every contract. There can also be difficulties because the amount of space provided under each heading will be fixed. Both of these problems can be easily overcome with the use of computers, where headings can be fixed to suit the requirements of the specific contract and the space used for a record can be readily varied. In addition to improving accessibility, and providing more space, another advantage of computerising site diaries in a standard form would be that the computer could be made to effectively insist that all questions be answered, before that data file could be closed. This would ensure that the record-keeper had been forced to address all the possible areas in which records may need to be kept.

Regarding the concern raised by some supervisors about the legal status of computer records, the technology can again assist by limiting access to these records (e.g. some users would only be provided with read only access). If a system could be derived whereby records were sent to a central computerised store and having been received there, could not be updated but read only, this would be a positive step and would also help to confirm that the maintained records were contemporaneous.

In the light of the above arguments, it is clear that record-keeping procedures would benefit considerably from the computerisation process and keeping site records in such a way would be very useful to the site supervising team. As has already been identified, site diary records are the backbone of the records kept on construction sites and the major source of information to generate more general records of work progress.

Computerising this essential type of site records, is considered to be a vital step towards the computerisation of all site records.

#### 5.2.4.1 Electronic diaries

An example of a computerised diary currently exists in the software market and is called *Lotus Organiser*, which was developed by the Lotus Corporation (1996). This software provides more sophisticated facilities than a paper-based organiser and is intended to be used as a personal time manager. It works as a computerised diary as well as providing many other functions such as notepad, planner and managing names and addresses. Additionally, the organiser also provides some other useful functions that use the computer's powerful facilities, such as searching for specific information and cross-referencing or linking information maintained within the context of the organiser. Although not intended to be used as a site diary, this software, even as it stands, could be used on sites and would bring benefits, as will be shown in the next sections.

#### 5.2.4.2 Keeping an electronic site diary

In this section, the intention is merely to give a brief description of how the different parts of the *Lotus Organiser* can be used for keeping site diary records. Instead of using the ordinary diary or standard form, the staff member would simply enter the daily information in the appropriately defined sections of the organiser appearing on the computer's screen. Of course, a copy of the daily records could be printed out when required.

*Diary section*

The diary can be used to schedule activities on a daily basis and for specific events to record exactly when they occurred. The diary format can be displayed in a number of ways, e.g., day per page, week per page, etc., and the start and end time of the work day can be set to the nearest hour, e.g., 8am to 6pm. The time slots between records on any day can also be controlled and may vary between 5 minutes and 60 minutes. Thus for work progressing all day, this would probably be recorded against a time of (say) 8.00am, whereas for work that only started in the afternoon, this would be recorded as starting at (say) 2.00pm. The times at which specific instructions were given could also be recorded as shown in the example (figure 5.1). It is clear that the searching process would be simplified if the activities recorded in the electronic diary were kept with specific codes and for this purpose, the activities in the contractor's plan would normally be the basis for categorisation. Again a coding system is used in the example.

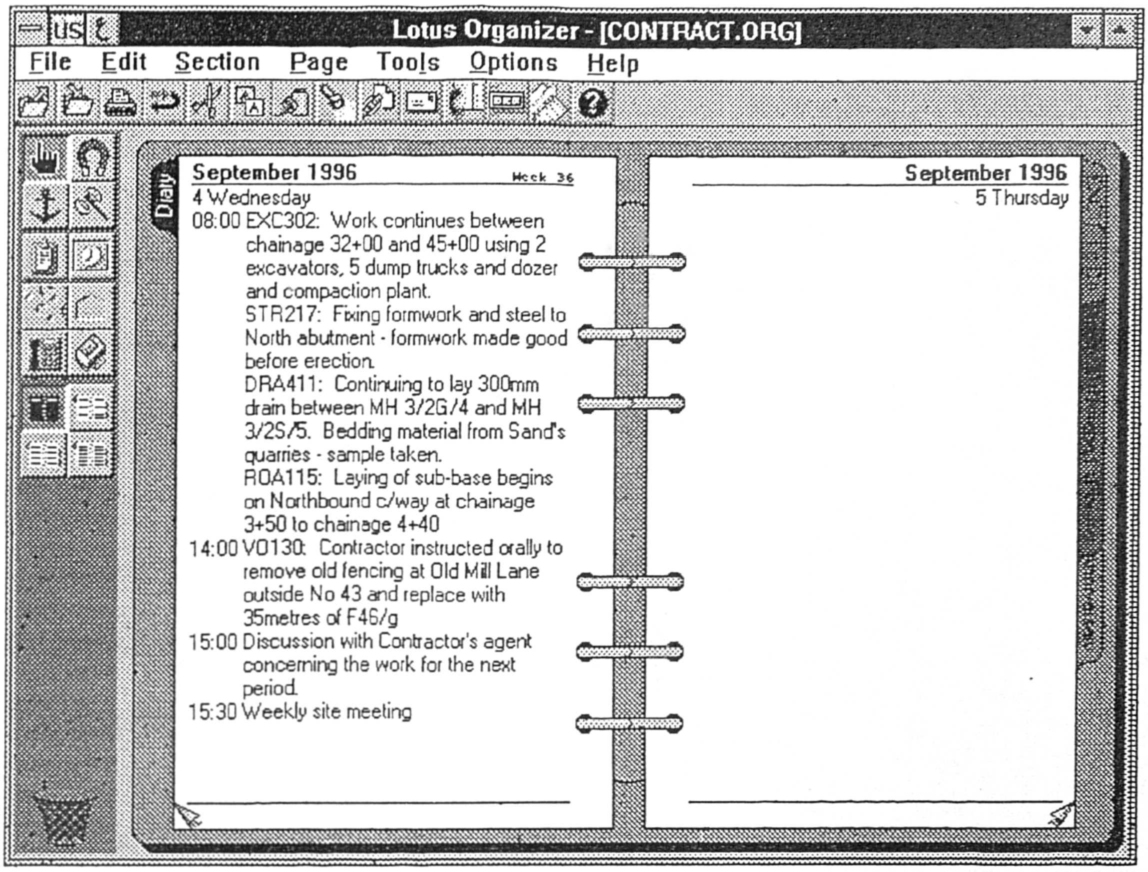



*Figure 5.1: Lotus Organiser Diary Page*

*Notepad section*

The notepad section of the organiser (figure 5.2), can be used to keep notes or memos, which on a normal non-computerised organiser would be written on paper. In the computer version, the diarist can type as much text as he would like and can scroll up and down the text if it is longer than one page. The contents of the notepad can easily be arranged into a number of chapters, which for a site diary might include: list of activities, site instructions, delays, problems encountered, information requested, etc., and would appear in a table of contents at the first page of the notepad. This would facilitate easier access in a very systematic manner to the information maintained and would also allow easy addition of information related to each chapter. By relating each of the activities/ delays/ site instructions, etc., to a code number, the diary pages can simply report work progressing on an activity by referencing its code, which could be looked up in the notepad section for further details. The information maintained within the diary can also be linked to any notepad page and this would permit an instantaneous look-up in the notepad for specific information about a code reported in the diary.

*Planner section*

The planner is a computerised chart which looks like a wall chart where events, tasks, or milestones can be marked with coloured blocks or strips. It helps in scheduling and preparing

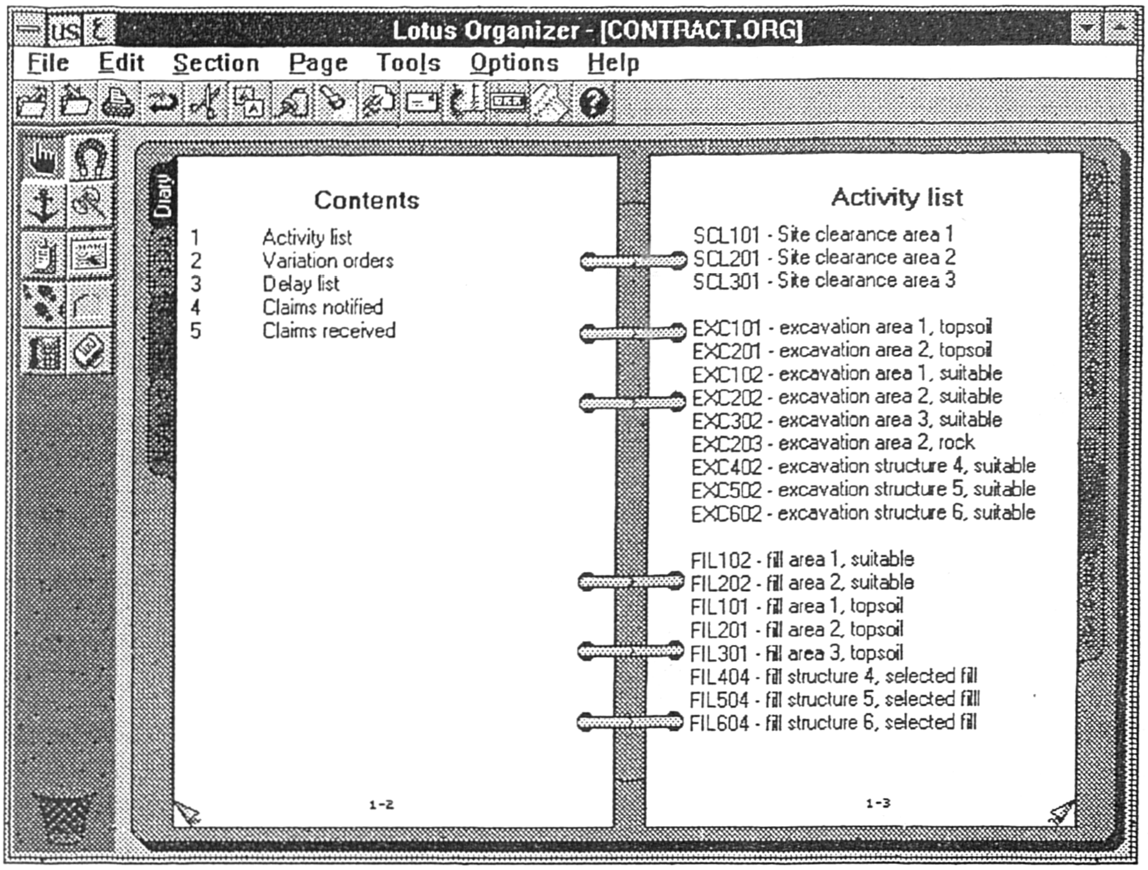
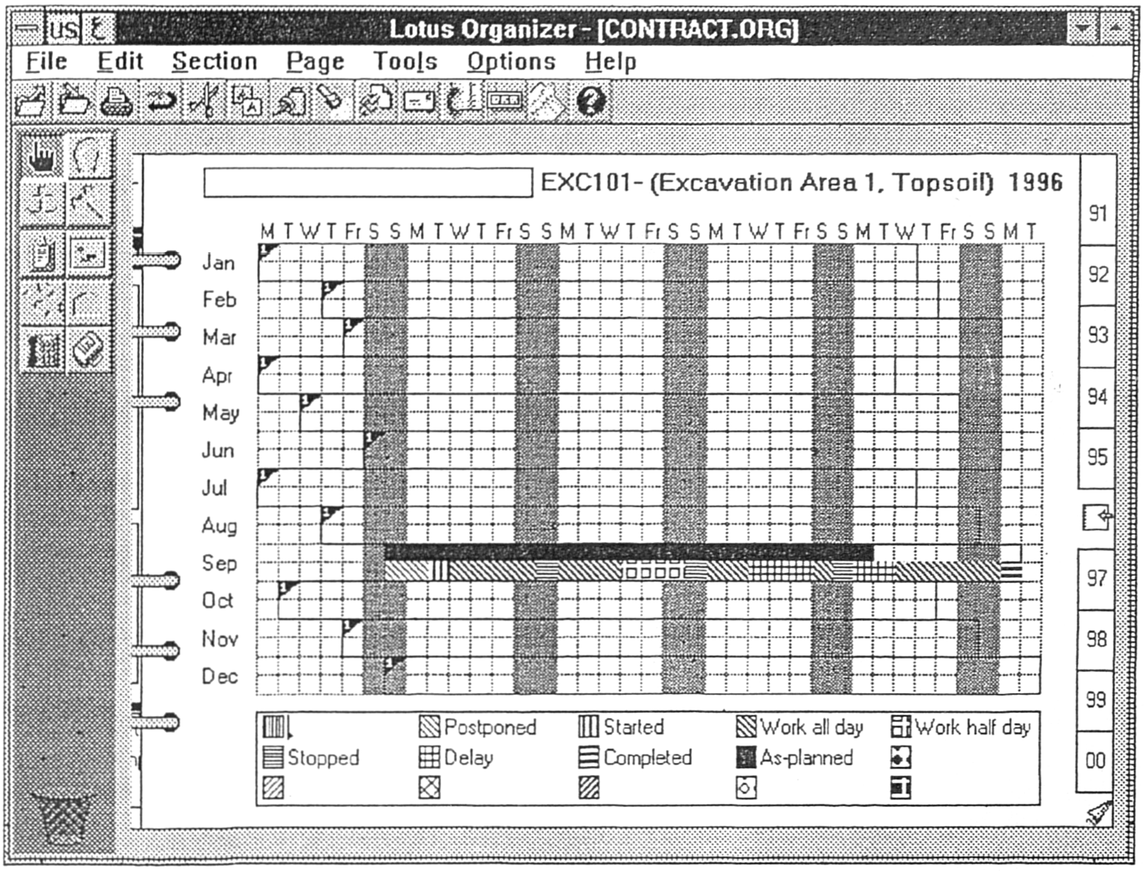



*Figure 5.2: Lotus Organiser Notepad Section*

for important events that need to be considered in planning the current year or years ahead. Planned events can also be shown in the diary section to trace upcoming commitments in the context of the diary. The planner provides a number of coloured keys (or patterns on a monochrome system) that can be placed on the chart to mark activities that span at least an entire morning or afternoon. With the planner, events that continue for one or more days can easily be entered. One can also enter events that happen only in the morning by marking off the AM block in the top half of the day's block, or events that happen only in the afternoon by marking off the PM block in the bottom half. The key descriptions which define clearly any group of events, can be customised to suit specific needs.

This section of the *lotus organiser* can also be used by the site diarists, as shown in figure 5.3, to keep daily information that defines the progress status of construction activities. As the planner section can easily be customised and renamed, each construction activity can be allocated a separate planner file. The key list can then be customised to indicate the different expected progress status of an activity. An example of the possible descriptions of an activity progress status includes: duration-as-planned, postponed, started, working all day, working half day, stopped, delay, completed and so on. At the commencement of the activity concerned, the AM blocks can be assigned with the key defined as 'duration-as-planned'; this will show the planned duration of that activity which can be done at once for the whole planned duration. Every day, each construction activity can be assigned with the appropriate progress status from the key list provided. This method will allow plotting the actual progress




A Planner chart showing an activity progress as planned and as achieved

*Figure 5.3 : Lotus Organiser Planner Section*

of work activities as achieved against the planned progress with an exact definition of the daily progress status. Clearly, the example given in figure 5.3, is rather a difficult activity, but it is shown to illustrate the use of the various codes of progress status suggested.

#### 5.2.4.3 Effect on site procedures

It is believed that for an automated system to be successfully implemented, it should not differ too much from the ordinary procedures currently in use. This would cause the least resistance for acceptance within an environment that can easily resist change. It is also very important that whatever automation method is implemented it must not require any additional effort and time than is currently required on the part of the user. A possible system would involve each member of site staff responsible for keeping records being provided with one of the personal digital assistants (PDA) such as Newton MessagePad 120, figure 5.4, (Branscombe, 1995). PDAs are essentially hand-held computers designed to be portable and some of them have full word processing and spreadsheet capabilities (Austin, 1995), but their most important function is their ability to recognise the diarist's handwriting. Some PDAs are very reliable and can easily fit into the diarist's pocket so they can be kept safely even in a rough situation such as a construction site. Each day, the member of the site staff concerned would keep his records as normal using an electronic pen to write directly on the PDA screen. The individual responsible would clearly need to have a good understanding of the construction programme and the way in

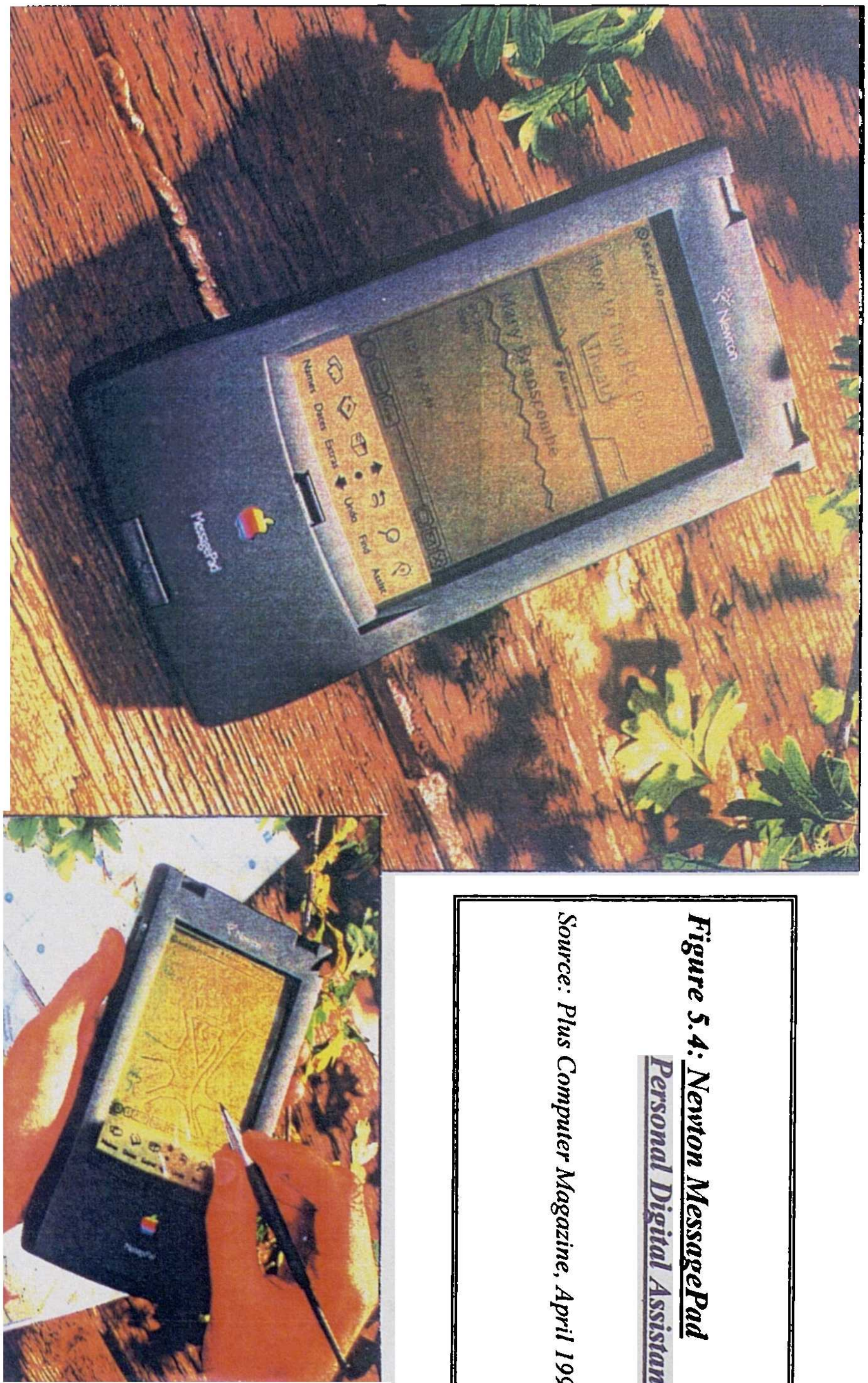


**Figure 5.4: Newton MessagePad Personal Digital Assistant**

*Source: Plus Computer Magazine, April 1995* which the work had been broken down in that programme to enable him to assign his records with appropriate codes which, as stated earlier, will much improve the accessibility of these records. At the end of each working day, the diarist would then download his daily records into the lotus organiser installed on the main computer kept in the site office. This would provide the main site supervisor with the opportunity to inspect and use his staff records in a computerised format and facilitate preparation of any subsequent reports efficiently.

#### 5.2.4.4 Benefits of computerising site diary records

The main advantages of keeping site diary records in an electronic format are as follows:

- *Searching of records*: this would probably be the most important benefit for the site supervisor from the computerising of site records. The computer's powerful ability to recognise codes (words, numbers, etc.) and match them with similar ones is extremely beneficial. The *lotus organiser's* searching facility allows the supervisor to search for codes/words within all its sections and then easily to turn to all the places where relevant information has been found. Additionally, it is possible to enter into any specific period by pointing directly to the exact date on the calendar and then inspect each section of the organiser. These are the main kinds of searches that supervisors reported they would normally carry out and it is clear that such procedures would be accomplished much faster when the information resides in a computer's memory.

- ***Linking of information***: the organiser's ability to cross-reference or link pieces of information is also very helpful and it can be used by the supervisor to visualise a network of associated material kept within the organiser's context. For any event recorded in the diary, the supervisor can easily link it to all records related to that event kept, for example, in the notepad, such as associated instructions, delays, etc. This can also be seen as a significant step in improving accessibility to the site diary records. In this way, the supervisor will thus have a good opportunity to gain a complete picture of what happened on the construction site by understanding all the particulars maintained in the site diaries.

## 5.3 Recommendations for further studies

A number of points are recommended to be considered for future research work. These are as follows:

- Computerising site diary records may be seen as the first step towards the computerisation of all site records, for by having site diary records in a computer format, other documents such as progress reports could then be easily prepared. It is recognised that the available version of the *lotus organiser* is meant for much more general purposes than to record construction site activities. Although, using the organiser would still bring benefits even in its current form, it is realised that if a special version of the electronic diary could be designed for the construction industry that considered the particular nature of site work, this would bring even more benefits. It would also apply to contractors who undoubtedly need effective record-keeping that would, in addition to many other functions, allow them a better chance of proving their rights to contractual claims. Potential improvements include:

a) Facilitating form design within the electronic diaries to allow users to design their own forms which conform with their company's standards and policies.
b) Enabling the display of more than one activity progress chart in the planner section of the electronic diary to provide efficient comparison for control purposes.
c) Facilitating an automatic display in the planner section, of the activity daily progress status as recorded in the diary section.

The possibility of integrating the electronic diary with document image processing technology to facilitate scanning site progress photographs into the site diary context to allow documenting work progress more precisely, should also be investigated.

Practical testing on construction sites before introducing the new version of the software to the industry would be recommended.

- It is recognised that studies conducted in the area of adopting bar-coding technology in the construction industry are mainly aimed at the contractors' business affairs, for areas such as materials management. There is however, opportunity for their use by supervisors, and a study is recommended of the potential uses of this technology for the benefits of the site supervising team in areas such as document control and construction control. These uses should be validated by conducting feasibility studies and carrying out practical testing on construction sites. It would also be worthwhile to study the possibility of integrating the personal digital assistant computers with the bar-coding techniques in order to produce an integrated system that facilitates the keeping of daily records with the use of both technologies, i.e., writing directly on the screen and reading the bar codes.

## 5.4 Summary

After presenting the detailed analysis of the obtained data and discussing the survey results, this chapter has given the general conclusions by testing the research principal views and hypothesis set out initially against the survey results. The obtained results provided evidence in support of the different assertions being investigated regarding particular areas of construction supervisors' site records. The chapter has also presented succinctly the main findings of this research and suggested a number of recommendations to improve the site record-keeping procedures. These included elements of quality procedures for keeping site records and a proposed approach for computerising site diary records. The chapter ended with making suggestions for further research.

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# Appendices

Appendix (A): *Records kept by an engineering organisation*

Appendix (B): *Site document archive index*

Appendix (C): *Samples of site diary records*

Appendix (D): *Sample of inconsistent site records*

Appendix (E): *Questions of the pilot study*

Appendix (F): *The research questionnaires*

Appendix (G): *Results of Mann-Whitney statistical tests*

# Appendix A

## Records Kept by An Engineering Organisation

This appendix presents an example of the last six categories of the filing system of a major engineering firm in the United States of America as given by Fisk (1992).

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**8.0 BID PHASE ACTIVITIES**

8.1 Advertisement for Bids
8.2 Bidder List (Documents Issued)
8.3 Bid Opening Reports
8.4 Summary and Evaluation of Bids
8.5 Pre-award Submittals

**9.0 PRE-CONSTRUCTION PHASE**

9.1 Inspection and Testing Manual
9.2 R/W, Easement. and Permit Documents
9.3 Pre-construction Conference
9.4 Contractor Submittals
- 9.4.1 Bonds and Insurance
- 9.4.2 Bids Breakdown(Schedule of Values)
- 9.4.3 Preliminary Schedule(CPM, etc.)

9.5 Notices to Contractor
- 9.5.1 Award
- 9.5.2 Proceed

**10.0 CONSTRUCTION PHASE**

10.1 Inspection Records and Reports
- 10.1.1 Daily Construction Reports
- 10.1.2 Field Diaries
- 10.1.3 Certificates and Delivery Tickets
- 10.1.4 Nonconformance Reports
- 10.1.5 Batch Plant Records
- 10.1.6 Special Inspection Reports

10.2 Quality/Materials Testing
- 10.2.1 Pipe
- 10.2.2 Concrete
- 10.2.3 Soils
- 10.2.4 Asphalt Products

10.14.1 Surveys
10.14.2 Testing Laboratories
10.14.3 Special Inspections
10.14.4 Consultants

**11.0 PROJECT CLOSE-OUT**

11.1 Operational Testing and Evaluation
11.2 Punch Lists
11.3 Final Submittals from Contractor
  11.3.1 Record Drawings
  11.3.2 Keying Schedule
  11.3.3 Spare Parts
  11.3.4 Tools
11.4 Notice of Completion
11.5 Final Progress Payment
11.6 Release of Retainage and Withholding

**12.0 O&M AND PROJECT STARTUP**

12.1 Correspondence with Contractors and Manufacturers
12.2 Training
  12.2.1 Manufacturer's Training
  12.2.2 Training Manual Draft
  12.2.3 Operator Certification Material
  12.2.4 Audiovisual Aids and Materials
12.3 O&M Manual
  12.3.1 Draft O&M Manual
  12.3.2 Review Comments from Client, EPA, etc.
  12.3.3 Staff Review/Technical Manual Summaries
  12.3.4 Graphic Materials; Photos
12.4 Startup
  12.4.1 Equip Inspection/Review Report
  12.4.2 Troubleshooting/Process Problems
  12.4.3 Scheduling(Plan of Operation)
  12.4.4 Startup Meeting Summary
  12.4.5 Equipment Warranties/Plant Acceptance

**13.0 PROJECT FOLLOW-UP**

13.1 Site Visit Notes and Memos
13.2 Photos
13.3 Final Project Accounting

# Appendix B

## *Site Documents Archive Index*

This appendix presents a list of the boxes containing site records kept on the completed contract. The list excludes project drawings which were microfilmed and kept in a different place - (chapter two). For reasons of confidentiality, names, locations and dates are omitted.

### *Site Box 1*

Correspondence Files

| File no. | Contents | Case | Wallet |
|---|---|---|---|
| c1/1/01 | Administration General | 1 | 1/1 |
| c1/7/01 | Traffic Signs | 1 | 1/2 |
| c1/7/03 | Soil Investigation | 1 | 1/3 |
| c1/8/01 | Materials General | 1 | 1/4 |
| c1/8/02 | Fencing/Hedges | 1 | 1/5 |
| c1/8/03 | Drainage | 1 | 1/6 |
| c1/8/04 | Earthworks and Geotechnics | 2 | 2/1,2,3 |
| c1/8/05 | Sub-base and Road-base | 3 | 3/1 |
| c1/8/06 | Surfacing | 3 | 3/2 |
| c1/8/07 | Kerbs/Footways/Paved Areas | 3 | 3/3 |
| c1/8/08 | Signs/Road Markings/Lighting | 3 | 3/4 |

## *Site Box 2*

Correspondence Files

| File no. | Contents | Case | Wallet |
|---|---|---|---|
| c1/8/10 | Formwork/Falsework | 1 | 1/1,2 |
| c1/8/11 | Reinforcement | 1 | 1/3 |
| c1/8/12 | Concrete (for 10 months) | 2 | 2/1,2,3,4 |
| c1/8/12 | Concrete (for another 8) | 3 | 3/1,2,3 |

## *Site Box 3*

Correspondence Files

| File no. | Contents | Case | Wallet |
|---|---|---|---|
| c1/8/13 | Precast Units and Beams | 1 | 1/1 |
| c1/8/14 | Structural Steelwork | 1 | 1/2,3 |
| c1/8/15 | Waterproofing | 1 | 1/4 |
| c1/8/16 | Bearings (for 23 months) | 2 | 2/1,2,2,3 |
| c1/8/17 | Parapets | 3 | 3/1 |
| c1/8/18 | Post Tensioning of Structures | 3 | 3/2 |
| c1/8/19 | Setting Out Approval Requests | 3 | 3/3 |
| c1/8/20 | Anti Graffiti Paint | 3 | 3/4 |
| c1/8/21 | Remedial Works | 3 | 3/5 |
| c1/8/22 | Cover Meter Surveys-General | 3 | 3/6 |
| c1/9/13 | Road Design - General | 4 | 4/1 |
| c1/10/01 | Bridge Design - General | 4 | 4/2 |
| c1/10/01 | Bridge Design - General | 4 | 4/3 |

## *Site Box 4*

Correspondence File

| File no. | Contents | Case | Wallet |
|---|---|---|---|
| c1/10/02 | B38 ..... Lane Overbridge | 1 | 1/1,2 |
| c1/10/03 | B39 ..... Road South Overbridge | 1,2 | 1/3,2/1 |
| c1/10/03A | B39 .... Rd South Overbridge Rem. | 2 | 2/2,3 |
| c1/10/04 | B40 ..... Road North Overbridge | 3 | 3/1 |
| c1/10/05 | B41 ..... ....... Avenue Footbridge | 3 | 3/2 |
| c1/10/06 | B42 ........ Footbridge | 3 | 3/3 |
| c1/10/06A | B42 ..... Footbridge Beam Replace. | 3 | 3/4 |

## *Site Box 5*

Correspondence File

| File no. | Contents | Case | Wallet |
|---|---|---|---|
| c1/10/07 | B43 ...... Railway Underbridge | 1 | 1/1 |
| c1/10/08 | B44 .... .... Footbridge | 1 | 1/2 |
| c1/10/09 | B45 .... ... S. Overbridge | 1 | 1/3 |
| c1/10/10 | B46 ... .... N. Overbridge | 1 | 1/4,5 |
| c1/10/11 | B47 ....... Culvert | 2 | 2/1 |
| c1/10/12 | B48 .... Lane Overbridge | 2 | 2/2,3 |
| c1/10/13 | B48A Culvert at CH .... | 2 | 2/4 |
| c1/10/14 | B49 N. ..... South Overbridge | 3 | 3/1 |
| c1/10/15 | B50 N. ..... North Overbridge | 3 | 3/2 |
| c1/10/16 | B51 ....... Park Culvert | 3 | 3/3 |
| c1/10/17 | Sign Gantries | 3 | 3/4 |
| c1/10/18 | Principal Inspection Reports | 3 | 3/5 |
| c1/10/19 | Silane Treatment to Structures | 3 | 3/6 |

## *Site Box 6*

Correspondence Files

| File no. | Contents | Case | Wallet |
|---|---|---|---|
| cl/14/01 | Lighting | 1 | 1/1 |
| cl/15/01 | Gas Board | 1 | 1/2 |
| cl/16/01 | Electricity Board | 1 | 1/3 |
| cl/18/01 | National Coal Board | 1 | 1/4 |
| cl/19/01 | .... Water Authority | 1 | 1/5 |
| cl/19/03 | ..... Water Company | 1 | 1/6 |
| cl/19/02 | .... Water Authority- Water Supply | 1 | 2/1 |
| cl/20/001 | Public Complaints | 2 | 2/2,3 |
| cl/22/01 | River & Drainage Boards | 2 | 2/4 |
| cl/23/01 | British Telecom | 2 | 2/5 |
| cl/23/02 | Cable Vision | 2 | 2/6 |
| cl/24/01 | .... City Council | 3 | 3/1 |
| cl/26/01 | Road Traffic Act 1984 | 3 | 3/2 |
| cl/27/001 | Land - General | 3 | 3/3 |
| cl/27/002 | Accommodation Works - Fence | 3 | 3/5 |
| cl/27/104 | Accommodation Works - East .... .... | 3 | 3/6 |

## *Site Box 7*

Correspondence Files

| File no. | Contents | Case | Wallet |
|---|---|---|---|
| cl/27/104 | Accom. Works- Schedule & Plans | 1 | 1/1 |
| cl/27/114 | Accom. Works- ..... ..... Cottages | 1 | 1/2 |
| cl/27/115 | Accom. Works- ...... ..... Hotel | 1 | 1/3 |
| cl/27/116 | Accom. Works- S & N .... Ltd. | 1 | 1/4 |
| cl/27/117 | Accom. Works- .... Restaurants Ltd. | 1 | 1/5 |
| cl/30/01 | Landscaping - General | 1 | 1/6 |
| cl/34/01 | Contract preparation and letting | 2 | 2/1 |
| cl/34/02 | Issue of Drawings- post tender | 2 | 2/2 |
| cl/35/01 | Site staff | 2 | 2/3 |
| cl/35/01A | Health and Safety | 2 | 2/4 |
| cl/35/02A | R.E's Vehicles | 3 | 3/1 |

| | | | |
|---|---|---|---|
| c1/35/02B | R.E.'s Offices | 3 | 3/2 |
| c1/35/02C | R.E.'s Equipment | 3 | 3/3 |
| c1/35/02D | R.E.'s Radio Communication | 3 | 3/4 |
| c1/35/02E | Stationery | 3 | 3/5 |
| c1/36/01 | Programme of Works | 3 | 3/6 |

## *Site Box 8*

Correspondence Files

| File no. | Contents | Case | Wallet |
|---|---|---|---|
| c1/36/01A | Earthworks Programme | 1 | 1/1 |
| c1/36/03/01 | C.R.E's Meetings | 1 | 1/2,3 |
| c1/36/02 | Weekly Programme | 1 | 1/4 |
| c1/36/02 | Weekly Programme | 2 | 2/1,2,3 |
| c1/36/03A | Progress Meetings and Reports | 3 | 3/1,2,3,4 |

## *Site Box 9*

Correspondence Files

| File no. | Contents | Case | Wallet |
|---|---|---|---|
| c1/36/03B | Meetings | 1 | 1/1,2 |
| c1/36/03C | Photographs | 1 | 1/3 |
| c1/36/04 | Plant and Labour Returns | 1 | 1/4 |
| c1/36/04 | Plant and Labour returns | 2 | 2/1,2,3 |
| c1/36/05 | Weather records | 2 | 2/4,5 |
| c1/36/06 | Site Visits | 3 | 3/1 |
| c1/36/07 | Police Consultations | 3 | 3/2 |
| c1/36/08 | Publicity | 3 | 3/3 |
| c1/36/09 | Temporary Traffic Diversions | 3 | 3/4,5,6 |

## *Site Box 10*

Correspondence Files

| File no. | Contents | Case | Wallet |
|---|---|---|---|
| c1/36/10 | Site Instructions- general | 1 | 1/1 |
| c1/36/11 | Site Instructions- site clearance | 1 | 1/2 |
| c1/36/12 | Site Instructions- Hedges & Fencing | 1 | 1/3 |
| c1/36/12A | Site Instruction- ........ & .... Close | 1 | 1/4 |
| c1/36/13 | Site Instructions- Drainage | 1 | 1/5,6 |
| c1/36/14 | Site Instructions- Earthworks | 2 | 2/1,2,3 |
| c1/36/15 | Site Instructions-Roadworks | 3 | 3/1 |
| c1/36/16 | Site Instructions-Sub-base/Road-base | 3 | 3/2 |
| c1/36/17 | Site Instructions- surfacing | 3 | 3/3 |
| c1/36/19 | S. Instructions-Kerbs/Footways/.. | 3 | 3/4 |
| c1/36/20 | S. Instructions-Traffic Rd-markings | 3 | 3/5 |

## *Site Box 11*

Correspondence Files

| File no. | Contents | Case | Wallet |
|---|---|---|---|
| c1/36/20A | ..... & ..... Lighting | 1 | 1/1 |
| c1/36/21 | Site Instructions-Bridges | 1 | 1/2 |
| c1/36/22 | Site Instructions-Accom. Works | 1 | 1/3 |
| c1/36/23 | Automatic Traffic Counters | 1 | 1/4 |
| c1/37/01 | Geotechnical Instruments | 1 | 1/5 |
| c1/37/02 | Measurement + Payments | 1,2 | 1/6,2/1 |
| c1/38/01A | Variation Orders | 2 | 2/2 |
| c1/38/01B | Dayworks | 2 | 2/3 |
| c1/39/01/01 | Adverse physical conditions-... | 3 | 3/1 |
| c1/39/01 | Contractor's Claims - General | 3 | 3/2,3,4 |
| c1/40/01 | Work by Local Authority | 4 | 4/1 |
| c1/41/01 | Site + Lab. Testing | 4 | 4/2,3,4 |

## *Site Box 12*

Correspondence Files

| File no. | Contents | Case | Wallet |
|---|---|---|---|
| c1/41/03 | Aggregate Reports | 1 | 1/1 |
| c1/41/04 | Soil Reports | 1 | 1/2 |
| c1/41/05 | Grout reports | 1 | 1/3 |
| c1/41/06 | Soil Samples | 1 | 1/4 |
| c1/41/07 | Materials Approval | 1 | 1/5 |
| c1/42/01 | Remedial Works/Maintenance Period | 2 | 2/1 |
| c1/42/02 | Outstanding and remedial works | 2 | 2/2 |
| c1/42/03 | Road pavement Tolerance Checks | 2 | 2/3 |
| c1/42/04 | General remedial works | 2 | 2/4 |
| c1/44/01 | Third party claims | 3 | 3/1,2,3,4 |

## *Site Box 13*

Staff Diaries

| Year | Name | Duty |
|---|---|---|
| ........ | ............................ | Resident Engineer |
| ........ | ............................ | Senior Inspector (Roads) |
| ........ | ............................ | A R E Measurement |
| ........ | ............................ | Resident Engineer |
| ........ | ............................ | Senior Inspector (Roads) |
| ........ | ............................ | Senior Inspector (Bridge) |
| ........ | ............................ | A R E Measurement |
| ........ | ............................ | |
| ........ | ............................ | Resident Engineer |
| ........ | ............................ | A R E Measurement |
| ........ | ............................ | Senior Inspector (Roads) |
| ........ | ............................ | Senior Inspector (Bridge) |
| ........ | ............................ | Resident Engineer |
| ........ | ............................ | A R E Measurement |
| ........ | ............................ | Senior Inspector (Roads) |

## *Site Box 14*

Daily Progress Reports

| Contents | Case | Wallet |
|---|---|---|
| Roadworks Daily Records (from ... to ...) | 1 | 1/1,2,3,4,5,6 |
| Roadworks Daily Records (from ... to ...) | 2 | 2/1,2,3,4,5 |
| Roadworks Daily Records (from ... to ...) | 3 | 3/1,2,3,4,5 |
| Roadworks Daily Records (from ... to ...) | 4 | 4/1,2 |

## *Site Box 15*

Daily Progress Reports

| Contents | Case | Wallet |
|---|---|---|
| Structures Daily Records (from ... to ...) | 1 | 1/1,2,3,4,5 |
| Structures Daily Records (from ... to ...) | 2 | 2/1,2,3,4,5 |
| Structures Daily Records (from ... to ...) | 3 | 3/1,2 |

## *Site Box 16*

Material Test Reports - Approvals

| Contents | Case | Wallet |
|---|---|---|
| Site Laboratory Books | 1 | |
| Site Weather Reports | 2 | 2/1 |
| Sub-Formation Test Results | 2 | 2/2 |
| Moisture Test results | 2 | 2/3,4,5,6,7,8 |
| Capping Layer Test Results | 3 | 3/1,2,3,4,5 |

## *Site Box 17*

### Material Test Reports - Approvals

| Contents | Case | Wallet |
|---|---|---|
| Lean Mix Test Results | 1 | 1/1,2,3,4 |
| Pipe Bedding Test Results | 2 | 2/1,2,3 |
| Granular Fill to Structures Test Results | 2 | 2/4,5 |
| Filter Media test Results | 2 | 2/6 |
| Lean Mix Design Trials | 2 | 2/7,8 |
| Type 1 sub Base Test Results | 3 | 3/1,2,3,4 |
| Type 3 Sub Base Test Results | 3 | 3/5 |
| Trial Cube Test Results | 3 | 3/6 |
| Grout Test Results | 3 | 3/7 |
| Lean Mix Placement Records ..... to ..... | 4 | 4/1,2,3 |

## *Site Box 18*

### Material Testing - Approval

| Contents | Case | Wallet |
|---|---|---|
| Lean Mix Cube Locations .... to .... | 1 | 1/1,2,3 |
| Lean Mix Cube Test Results | 2 | 2/1,2,3,4,5 |
| Concrete Pour Records ..... to ..... | 3 | 3/1,2,3,4 |
| Concrete Pour Records ..... to ..... | 4 | 4/1,2,3,4 |

## *Site Box 19*

### Material Testing - Approval

| Contents | Case | Wallet |
|---|---|---|
| Concrete Pour Locations ..... to ..... | 1 | 1/1,2,3,4 |
| Concrete Cube Test Results - Bridges | 2 | 2/1,2,3,4,5,6 |

| | | |
|---|---|---|
| Concrete Cube Test Results - Bridges | 3 | 3/1,2,3,4,5,6 |
| Concrete Cube Test Results Misc. | 4 | 4/1,2 |
| Concrete Aggregate Test Results | 4 | 4/3,4 |

## *Site Box 20*

Material Testing - Approval

| Contents | Case | Wallet |
|---|---|---|
| Concrete Cube Test Results Misc. | 1 | 1/1,2 |
| Concrete Cube Test Results General Concrete Products | 1 | 1/3 |
| Concrete Cube results Summary | 1 | 1/4 |
| Bituminous Material Records | 2 | 2/1,2,3 |
| Bituminous Material Deliveries | 2 | 2/4,5 |
| Bituminous Material Test Results | 3 | 3/1,2,3,4,5 |

## *Site Box 21*

Material Testing - Approval

| Contents | Case | Wallet |
|---|---|---|
| Nuclear Density Test Results | 1 | 1/1,2 |
| Insitu Dry Density Test Results | 1 | 1/3,4,5 |
| Dry Density Test Results | 2 | 2/1,2,3,4,5 |
| Sand Aggregates | 3 | 3/1 |
| Pavement Tolerance Areas Surveys | 3 | 3/2 |
| Rolling Straight Edge Test Results | 3 | 3/3,4 |
| Surface Texture Measurement | | 3 3/5 |
| Pavement Construction Schedule | 3 | 3/6 |
| Dip Sheets (Capping Layer) | 4 | 4/1 |
| Dip Sheets (Lean Mix) | 4 | 4/2,3 |

## *Site Box 22*

### Material Testing - Approval

| Contents | Case | Wallet |
|---|---|---|
| Pavement Dip Sheets (Sub-Base) | 1 | 1/1,2 |
| Pavement Dip Sheets (Road-base) | 1 | 1/3 |
| Pavement Dip Sheets (Basecourse) | 1 | 1/4 |
| Pavement Dip Sheets (Wearing Course) | 1 | 1/5 |
| Materials Approvals | 1 | 1/6 |
| Cleaning & Testing of Gullies | 2 | 2/1 |
| Cleaning & Testing of Drains | 2 | 2/2 |
| Cleaning & Testing of Manholes & Catchpits | 2 | 2/3 |
| Covermeter Surveys | 2 | 2/4,5 |
| Soil Test Reports | 2 | 2/6 |
| Field Books | 3 | |

## *Site Box 23*

| Contents | Case |
|---|---|
| Level Books | 1 |
| Level Books | 2 |
| Level Books | 3 |

## *Site Box 24*

| Contents | Case | Wallet |
|---|---|---|
| Clause 14 Programmes | 1 | 1/1 |
| Borehole Plans | 1 | 1/2 |
| Daily Drilling Logs ..... to ..... | 1 | 1/3,4,5 |

| | | |
|---|---|---|
| Daily Drilling Logs ..... to ..... | 2 | 2/1,2,3,4,5 |
| Grouting Records | 3 | 3/1,2,3 |
| Additional Grouting ..... Road | 3 | 3/4 |
| Grouting Materials | 3 | 3/5,6 |
| Stressing Records - Bridges | 4 | 4/1,2,3,4 |

## *Site Box 25*

| Contents | Case | Wallet |
|---|---|---|
| Staff Working Papers | 1 | |
| Staff Working Papers | 2 | |
| Staff Working Papers | 3 | |

## *Site Box 26*

| Contents | Case | Wallet |
|---|---|---|
| Interim Valuation No. 1,2,3,4,5 | 1 | 1/1,2,3,4,5 |
| Interim Valuation No. 6,7,8 | 2 | 2/1,2,3,4,5,6 |
| Interim Valuation No. 9,10 | 3 | 3/1,2,3,4 |

## *Site Box 27*

| Contents | Case | Wallet |
|---|---|---|
| Interim Valuation No. 11 | 1 | 1/1,2 |
| Interim Valuation No. 12 | 1 | 1/3,4 |
| Interim Valuation No. 13 | 2 | 2/1,2 |

| | | |
|---|---|---|
| Interim Valuation No. 14 | 2 | 2/3,4 |
| Interim Valuation No. 15 | 3 | 3/1,2 |
| Interim Valuation No. 16 | 3 | 3/3,4 |
| Interim Valuation No. 17 | 3 | 3/5,6 |

## *Site Box 28*

| Contents | Case | Wallet |
|---|---|---|
| Interim Valuation No. 18 | 1 | 1/1,2 |
| Interim Valuation No. 19 | 1 | 1/3,4 |
| Interim Valuation No. 20 | 2 | 2/1,2 |
| Interim Valuation No. 21 | 2 | 2/3,4 |
| Interim Valuation No. 22 | 3 | 3/1,2 |
| Interim Valuation No. 23 | 3 | 3/3,4 |
| Interim Valuation No. 24 | 3 | 3/5,6 |

## *Site Box 29*

| Contents | Case | Wallet |
|---|---|---|
| Interim Valuation No. 25 | 1 | 1/1,2 |
| Interim Valuation No. 26 | 1 | 1/3,4 |
| Interim Valuation No. 27 | 2 | 2/1,2 |
| Interim Valuation No. 28 | 2 | 2/3,4 |
| Interim Valuation No. 29 | 3 | 3/1,2 |
| Interim Valuation No. 30 | 3 | 3/3,4 |

## *Site Box 30*

| Contents | Case | Wallet |
|---|---|---|
| Interim Valuation No. 31 | 1 | 1/1,2 |
| Interim Valuation No. 32,33,34 | 1 | 1/3,4,5 |
| Interim Valuation No. 35,36,37 | 2 | 2/1,2,3 |
| Interim Valuation No. 38,39,40 | 2 | 2/4,5,6 |
| Interim Valuation No. 41,42 | 3 | 3/1,2 |
| Interim Valuation No. 43,44 | 3 | 3/3,4 |
| Interim Valuation No. 45,46 | 3 | 3/5,6 |

## *Site Box 31*

| Contents | Case | Wallet |
|---|---|---|
| Site Instructions (Costs) | 1 | 1/1,2,3,4 |
| Site Instructions (Costs) | 2 | 2/1,2,3,4 |
| Bridgework Site Instructions (costs) | 3 | 3/1,2,3 |

## *Site Box 32*

| Contents | Case | Wallet |
|---|---|---|
| Variations Orders 1 to 271 | 1 | 1/1,2,3,4,5,6 |
| Dayworks 1 to 334 | 2 | 2/1,2,3,4,5,6 |
| Confirmation of Field Instructions | 3 | 3/1 |
| V.O. & Daywork Correspondence | 3 | 3/2 |
| Dayworks Reconciliation | 3 | 3/3 |

## Site Box 33

| Contents | Case | Wallet |
|---|---|---|
| V.O. Daily Records ..... to ..... | 1 | 1/1,2,3,4 |
| V.O. Daily Records ..... to ..... | 2 | 2/1,2,3,4 |
| V.O. Daily Records Misc. | 2 | 2/5 |
| Delivery Tickets | 3 | 3/1,2 |
| General Take Off Files | 3 | 3/3 |
| Quantities for Tender | 4 | 4/1,2,3 |

## Site Box 34

| Contents | Case | Wallet |
|---|---|---|
| Preliminaries | 1 | 1/1,2,3,4 |
| Site Clearance and Fencing | 2 | 2/1 |
| Earthworks | 2 | 2/2,3,4 |
| Earthworks (Record Sheets) | 3 | 3/1,2 |
| Earthworks | 3 | 3/3,4,5 |

## Site Box 35

Final Measure

| Contents | Case | Wallet |
|---|---|---|
| Topsoil and Seeding Measure | 1 | 1/1 |
| Earthwork Adjustments | 1 | 1/2,3,4 |
| Drilling and Grouting | 2 | 2/1,2,3 |
| Coal | 2 | 2/4 |
| Drainage | 3 | 3/1,2 |
| Capping Layer | 3 | 3/3,4 |
| Sub-Base | 4 | 4/1,2 |
| Flexible Surfacing | 4 | 4/3,4 |

## *Site Box 36*

Final Measure

| Contents | Case | Wallet |
|---|---|---|
| Lighting | 1 | 1/1 |
| Road Markings | 1 | 1/2 |
| Traffic Signs | 1 | 1/3 |
| Accommodation Works | 1 | 1/4,5 |
| Earthworks | 2 | 2/1 |
| Lighting | 2 | 2/2,3,4 |
| Acceleration Account | 3 | 3/1,2,3,4 |
| Rate Agreements | 4 | 4/1,2,3 |

## *Site Box 37*

Final Measure

| Contents | Case | Wallet |
|---|---|---|
| Rate Calculations | 1 | 1/1,2,3,4,5 |
| ..... Lane Overbridge | 2 | 2/1 |
| ..... Road South Overbridge | 2 | 2/2 |
| ..... Road North Overbridge | 2 | 2/3 |
| ..... Avenue Footbridge | 2 | 2/4 |
| ..... Footbridge | 2 | 2/5 |
| ..... Park Footbridge | 2 | 2/6 |
| ..... Park South Overbridge | 2 | 2/7 |
| ..... Park North Overbridge | 2 | 2/8 |
| ..... Culvert | 3 | 3/1 |
| ..... Lane Overbridge | 3 | 3/2 |
| Culvert at CH. ..... | 3 | 3/3 |
| North ..... South Overbridge | 3 | 3/4 |
| North ..... North Overbridge | 3 | 3/5 |
| ..... Park Culvert Extension | 3 | 3/6 |
| Sign Gantries | 3 | 3/7 |
| Site Clearance | 3 | 3/8 |
| Hedges | 3 | 3/9 |
| Fencing | 3 | 3/10 |

## *Site Box 38*

Final Measure

| Contents | Case | Wallet |
|---|---|---|
| Main Carriageway Drainage | 1 | 1/1 |
| Side Road Drainage | 1 | 1/2 |
| Sub-base and Road base (Interchange) | 1 | 1/3 |
| Flexible Surfacing (Interchanges) | 1 | 1/4 |
| Kerbs and Footways (Interchanges) | 1 | 1/5 |
| Sub-base and Road base (side Roads) | 1 | 1/6 |
| Flexible Surfacing (Side Roads) | 1 | 1/7 |
| Kerbs and Footways (Side Roads) | 1 | 1/8 |
| Sub-base and Road base (Main Carriage) | 2 | 2/1 |
| Flexible Surfacing (Main Carriage) | 2 | 2/2 |
| Kerbs and Footways(Main Carriage) | 2 | 2/3 |
| Traffic Signs | 2 | 2/4 |
| Road Markings | 2 | 2/5 |
| Lighting and Cabling | 2 | 2/6 |
| Statutory Bodies | 2 | 2/7 |
| Dimension Sheets | 2 | 2/8 |
| Accommodation Works | 3 | 3/1 |
| Final Account | 3 | 3/2,3 |

## *Site Box 39*

| Contents | Case | Wallet |
|---|---|---|
| Contractor's Claims General | 1 | 1/1 |
| Claim 1 | 1 | 1/2 |
| Claim 2 | 1 | 1/3 |
| Claim 3 | 1 | 1/4 |
| Claims 4,5,6,7 and 8 | 1 | 1/5 |
| Contractor's Claims Correspondence | 2 | 2/1,2,3,4 |
| Delay Assessments | 2 | 2/5 |
| Claims Submissions and Correspondence | 3 | 3/1,2,3,4,5,6 |

## Site Box 40

| Contents | Case | Wallet |
|---|---|---|
| Evaluation Details | 1 | 1/1,2,3,4 |
| Site Instruction Register | 2 | 2/1 |
| Variation Order Register | 2 | 2/2 |
| Drawing Register | 2 | 2/3 |
| Reinforcement Schedule Register | 2 | 2/4 |
| Daywork Register | 2 | 2/5 |
| Monthly Measurement Progress | 2 | 2/6 |
| Financial Review Notification | 2 | 2/7 |
| Site Office Stationery | 2 | 2/8,9 |
| Monthly As Built Programmes | 3 | 3/1,2,3 |
| Lean Mix Correspondence | 4 | 4/1,2,3,4 |

## Site Box 41

| Contents | Case | Wallet |
|---|---|---|
| Plant and Labour Returns ...... to ..... | 1 | 1/1,2,3,4,5 |
| Setting Out Calculations - ..... Park | 2 | 2/1 |
| Setting Out Calculations - Main Line | 2 | 2/2 |
| Setting Out Calculations - ..... Road | 2 | 2/3 |
| Setting Out Calculations - North B.... | 2 | 2/4 |
| Setting Out Calculations - North G.... | 2 | 2/5 |
| Vertical Alignments | 3 | 3/1,2,3,4,5 |

## Site Box 42

| Contents | Case | Wallet |
|---|---|---|
| Road Re-design | 1,2 | |
| Noise Insulation | 3 | 3/1,2 |
| ..... Railway Bridge | 3 | 3/3 |

## *Site Box 43*

| Contents | Case | Wallet |
| --- | --- | --- |
| PHOTOGRAPHS | | |

## *Site Box 44*

| Contents | Case | Wallet |
| --- | --- | --- |
| PHOTOGRAPHS | | |

## *Site Box 45*

| Contents | Case | Wallet |
| --- | --- | --- |
| Contractors Claims | | |

## *Site Box 46*

| Contents | Case | Wallet |
| --- | --- | --- |
| Contract Document Volumes | | |
| . ...... - Note Books | | |
| Incoming Mail Book | | |
| Outgoing Mail Book | | |

# Appendix C

## Samples of Site Diary Records

This appendix presents three samples of site diary records extracted from three different site diaries (5 days each) kept on a completed contract - chapter two.

**19** **July**

0800 - 1830
Bright Day.

**Monday** **3**
184–181 Week 27
Holiday (Canada)
● New Moon

North Trl. · N.W. Slip · Verify Fill · Liem 900 · D/T · Gang · [illegible] 90. – D/T Dozing [illegible] on w/c changed 3 times – Also [illegible] [illegible] hard & tight [illegible] out [illegible] · Told B.A – A.A/G.A. also informed [illegible] Tilcon [illegible] [illegible] [illegible]

Abies · · [illegible] & Repair 9" [illegible] – [illegible] [illegible] [illegible] –

Bruston [illegible] – Need Street Lighting – [illegible] [illegible]

4/1 T.A. · 2/[illegible] [illegible] (0800-1400)

CH 85+22 CH 75+60 S/B Tilcon [illegible] [illegible] 1230 T.

Bruston Land MH [illegible]/2 – MH B4/5 150/A/8 – [illegible] [illegible] [illegible] – [illegible]

4/1 T.P · 2/[illegible] [illegible]

CH 85+22 CH 75+60 S/A S/L Tilcon [illegible] [illegible] 1230 T.

KP.SRW · Landscape Area · D6 [illegible] out material – [illegible] from stockpile in area & compact.

KPSW Slip – Starting to trim [illegible] ready for [illegible] & [illegible] – No [illegible] [illegible] to work too. – Told B.A. would not agree to this since all the work being done is wrong & will all have to be done again when [illegible] [illegible] · [illegible]
Liem 900 · 1/[illegible] (0800-1000) + (1700-1900)

K.S.P NW Slip. 9+35 - 5+72
CH 86+74 CH 86+39 N/A
CH 87+04 CH 86+94 S/A F/C
Cemmix. 338 cu M

[illegible] Construction Cemmix CH 87+04 CH 86+94 S/A F/C
[illegible] H3 · – Liem 900 ·

F S S | M T W T F S S | M T W T F S S | M T W T F S S | M T W T F S S | M T
5 6 | 7 8 9 10 11 12 13 | 14 15 16 17 18 19 20 | 21 22 23 24 25 26 27 | 28 29 30 31

Monday July 3rd

55+10 - 55+60 N/S Spread Sub Base & Trim
56+60 - 58+00 N/A Spread Cobble & Trim
Grader : Kom D65 + 727 - Cam - Cat

54+00 - 60+00 C/R Turn all M.V. Coils to Sit Across
in C/R - Cat 900.

CP52/1 - MH51/2 225/1015 Cut Trench Kom 210 - Hand Exc.
Under 6 Wide North Ditch -
CP54/2 - CP53/2 - CP52/5 - Cat Pipes - Cat 900 - 2/Labr
CP52/4 - CP52/5 225/1915 Break Out Lower Ackerman 113 (1300 - )
S/A Down.

CH - - CH Excavate Shale Ctrl Canal & Haul to
T.P. - Stockpile Part. S/A C/L - K.P. S/A C/L.
Ackerman H16 (0800 - 1900)

CH 46+00 CH 46+40 S/A Excavate to Ctrl Coal.
Kom 110 - Cat Volvo

44+00 - 45+00 C/L Trim Batter Kom D63 (0930 - 1900)

43+40 - 44+30 S/A Place Compact Fill Unsuitable C/L Coal
Removal. Kom D63 + 727 (0800 - 0930) - Cat 211 (0800 - 0930)

43+00 43+20 S/C Excavate to Formation Level, Haul
Mat. to Stockpile Part. S/A C/L.
Cat 225 - 7/Volvo - 2/Mory (0930 - 1900)
Kom D65 ( - 1900) Cam

Ctrl Canal N.E. Cat Fin Kom 2/Cat.

Ctrl Canal N.E. Culvert 110 Pipe with Diversion
Existing Drain - Temp Line.

Break Down
6 1630 - 1900
4 All Day
22 1000 - 1900
1 1000 - 1900
7 Tire
14 Kom

# July

**Tuesday** **4**
185–180 Week 27
Independence Day (USA)

0800 – 1930
BRIGHT DAY.

AG125 SOUTH T.C. – NEED ON SITE TO GET CABLE THROUGH 9" DUCT: GOT LARRY TO [illegible] [illegible]. COULD NOT GET ROD THROUGH DUCT WENT ALL DAY.
1 1/LAB + COMP 1000 [illegible] BREAK OUT CONCRETE BACKFILL TO [illegible] DUCT – GAV [illegible] – WORKED MOST OF DAY EXCAVATING CONCRETE THEN TRIED ROD THROUGH DUCT FROM E/1 WHICH [illegible] TO GET THROUGH GET CABLE + DRAW CORD THROUGH.

BRUNTON LNK. NEEDS [illegible] LIGHTING – LAY CABLE BACKFILL – 4/[illegible] (0800–1600)

BRUNTON LNK. CONCRETE GULLEY – 1/LAB + [illegible] DAY.

NORTH T.C. [illegible] FILL – LOAD + TRANSPORT SOIL FROM STOCKPILE D50. LIEB 900. D/T. – 1/GR. [illegible] (0800–1900)

BRUNTON LANE MH 3C/2 – MH 3C/5 [illegible] LAY [illegible] [illegible]

U/S T.P – 2/DYE [illegible] (0800–1900)

75+95 – 75+80 S/A F/L [illegible] [illegible] L/B
81+50 – 83+40 S/A [illegible] [illegible] R/B
85+20 – 76+83 S/B F/L [illegible] B/C

80+00 – 70+00 BRICKWORK + FRAMES TO [illegible] 7/LAB + DUMPER

KPSRW – LANDSCAPE AREA. ROCK FILL – D6 (NO ROLLER).

KPSW SUB – TRIM [illegible] AFTER CUTTING TO TO LEVEL – WORKED TO WRONG LEVEL AT FIRST ATTEMPT AT 400 FOR SOIL AREA. SHOULD HAVE BEEN 1.4 T [illegible] 0.4. HAVE NOT STARTED ON TREATMENT [illegible] IN [illegible] AT [illegible] LIEB 900 – 1/LAB. 0800 – 1900
MORRIS 2[illegible]

| July | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M | T | W | T | F | S | S | M | T | W | T | F | S | S | M | T | W | T | F | S | S | M | T | W | T | F | S | S | M | T | W | T | F | S | S |
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |

Tuesday 4th July.

55+10 - 58+50 - N/A Second [illegible] & Tom.
Grader - Cat - Can (0700 - 1900) (Com 162 (0800 - )
Tractor + 727.

CP 56/5 - CP 52/1 225/[illegible] Break out rock 3+60 - 4+20
Aickerman HS. (0700 - 1900)
CP 53/2 - CP 52/5 225/[illegible] Cat [illegible]
CP 54/1 - MH 54/2 225/[illegible] " "
HP Cat 900 - Jake - 2/Cat (0700 - 1900)

Hazardous Container N/1 - Fork Container HP Cat 900 - 1/Cat (1330 - 1600)
(1700 - 1900) Does not look at [illegible] [illegible] Container
[illegible] 6 [illegible] [illegible] [illegible]. ?

K.P. New [illegible] at 5166 ch 66? [illegible]. 333 mm
74+66 - 74+13 N/A

CH 46+20 CH 46+00
Exposé Coal Com 110 - 2/Volvo - 1/Cat (0700 - 1900)

[illegible] - [illegible] [illegible] to K/S/W -
[illegible] [illegible] [illegible] [illegible] N/A [illegible].

CH 45+20 CH 45+80 S/M [illegible] [illegible] [illegible] [illegible]
[illegible] [illegible] [illegible] [illegible] - Com 161 ( - 1900) 727.

43+00 - 45+00 D/I [illegible] [illegible] Case 850 (0700 - 1900)

43+00 - 43+20 [illegible] to formation level Cat 225 D/T.
43+00 - 43+40 S/B Trim formation Com 165. ( - 1900)
( Pond. N/A [illegible] [illegible] )

[illegible] W.E - [illegible] [illegible] [illegible] [illegible]
All [illegible] out. - [illegible] [illegible] [illegible] [illegible] of K.W.
2/Cat (0700 - 1230)

[illegible] AD/KP to [illegible] [illegible] at 2 [illegible].

K.P. - Metro [illegible] 1.8 [illegible] [illegible] [illegible] on [illegible].

( Breakdowns - No 4 (0700 - ) No 22 (0700 - ) [illegible] (0700 -
No 5 (0700 - ) [illegible] [illegible] on [illegible]
[illegible]

19 **July**

0800 – 1930
BRIGHT & DRY.

**Wednesday**
186–179 Week 27
**5**

95+00 – 97+00 N.W. S/B [illegible] [illegible] [illegible]
[illegible] 900 – [illegible] [illegible] (0800–1900) D/T. (0800–1400 + 1630 – )

97+00 – 92+00 BRICKWORK & FRAMES TO MH'S & CB' 3/[illegible] [illegible]

BRUNTON R/A & N.W. S/B – GULLIES. CONCRETE [illegible] COVERS. [illegible] [illegible]

BRUNTON INT. – NESB STREET LIGHTING – CABLE. 3/MEN.

BRUNTON S.B S/B – BRUNTON LANE R/A SURFACE [illegible]. [illegible] [illegible] (0800–1630.

75+81 – 75+03 S/B F/L – [illegible] [illegible] [illegible].
85+20 – 75+68 S/B S/L – " " " BASE COURSE
76+84 – 75+07 S/B F/L – " " BASE COURSE

4/1 T.P. – 2/DRIVER [illegible] (0800 – 1900)

CH 74+13 CH 73+37 N/B & S/B [illegible] 333 [illegible]

K.P. [illegible] [illegible] [illegible] – [illegible] (0800 – 1800)

CH CH S.W S/B – [illegible] [illegible] TO M/L
[illegible] 900 – (0800 – ) VOLVO (0800 – ) [illegible]
TRAINING [illegible] TO [illegible] TAKING OFF TOP OF [illegible] [illegible]
NOT [illegible] ON [illegible] STABILIZATION AT YET. WORKING ON
K.P. [illegible] [illegible] (1100–1500) – [illegible] [illegible] (1600–1900)

C.P. 54/5 – CH 52/1 [illegible] [illegible] [illegible] ON [illegible] [illegible] H? 0800–1030
[illegible] TO [illegible] & [illegible] ONTO [illegible] (1030 – )

54+00 – 50+00 – MH'S & CB'S – 2/MEN – [illegible] 900.

54+00 – 51+40 S/B CLEAN OFF [illegible] – [illegible] [illegible] [illegible]
[illegible] 65+72 (0800 – 1800) – [illegible] [illegible] (1300 – 1800)
[illegible] 900 – D/T. (0800 – 1100) [illegible] [illegible] [illegible] [illegible] OFF
[illegible] ON SUNDAY.

| August | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M | T | W | T | F | S | S | M | T | W | T | F | S | S | M | T | W | T | F | S | S | M | T | W | T | F | S | S | M | T | W | T | F | S | S | M | T |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | | | | | |

Wednesday 5th July

43+00 - 43+80 U/A Stream Capping } (CM263-727 (0700-18
43+40 - 44+00 U/A Trim Formation } Gran
43+60 - 44+20 U/A Exc to Formation Level. CAT 615. D/T.
Waiting on most of day for D/Truck slow op.

44+00 - 45+00 U/A Trim Batter CAT 550 (0700-1800)

46+00 - 46+20 U/A Excavate to crusher core, load & haul/lay off site Nch. - KM 170. D/T. Waggons U/L (0700-1800)

46+00 Excavate spoil & haul to [illegible] & [illegible] Akerman H16. D/Truck

Dump D/T. 6 (0700- ) 22 (0700- ) 16 (0700- )
8 (0700- ) 18 (1230- )
No 18 D/T. Turned over on Metro on North lane moving south at 1230.

Etal Land N.E. [illegible] waiting on [illegible] most of day waiting for materials [illegible]
N.W. [illegible]

Etal Cove Diversion - Drain up Pond [illegible] Akerman H3 (1330- Akerman H16 (1300-1800)

55+10 - 58+50 U/A Trim [illegible] (Drain) Grader Cat [illegible] (0700-1

# July

**Thursday** 87-178 Week 27 PAYE week 14

**6** 0800 - 1900
Bright Day

CH 95+00 - CH 99+60 N.W. Slip - Top Batter Fill - Trim Verges.
CH ... - CH ... NW Slip Top Soil Batter & Verges.
Lift 900 - (0800-1900) - 1/Cat & Bomag.
N/T ( - ) N/T ( ) Cat 950 (1600-1800)
Load Top Soil from Brunton Int. S/H. Lift 900. ( -1900)

Brunton N.W. Slip & S/A - Gullies cast & set frames - Gan/UA

95+00 - Brickwork & frames to MH & CP 9/... & Sumps

Brunton Int. - Need Street Lighting - Cable & Connection of L.C. - 1/Man.

CH CH S/S S/L Tarcon Cam Road Base.
CH 65+90 CH 78+07 S/A S/L Tarcon Cam Haddon - Too Harsh Channel Stripping having to hand chip affecting surface texture (Low)

S/L Trk - 2 ... (0700-1900)

Kilbow Landslide Area - Completion soil for landslide at 1000m ... landslide area ... (0800-1900)

54+00 - 54+80 S/A & Slip
47+40 - 49+40 S/A
55+10 - 58+50 N/A
Port. S & Slip (0+60 - 00+00 + 4+30 - 9+40)

Mark & Crush Surface Coats
2/Wilow - Tractor Tanker - Roller.

54+00 - 57+40 S/A & Slip - Stacking Landslide ... (0800-1100)
59+80 - 54+00 S/A & Slip Grader ... Cat. Bomag(s)

| July | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M | T | W | T | F | S | S | M | T | W | T | F | S | S | M | T | W | T | F | S | S | M | T | W | T | F | S | S | M | T | W | T | F | S | S | M | |
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | |

THURSDAY 6th JULY.

52+00 - 51+60 E/I - MOUNT T.A.C. SHAPING MAKE UP MOUNT SNAKE UP BATTER. (CAT D6) (1000 - 1200)

54+00 - 50+00 - M/H'S & C/I - 7/LANE - (0800 - 1730)

MH 51/2 - MH 52/3 - 52/54/1 EXC. TRENCH CAT 900 - 11/CM EXCAVATOR (PLANT KING & SCHICOM SLAB)
C/I 53/2 - C/I 52/5 - C/I 52/1 - LAY & HAUNCH & BACKFILL THRU - 7/LANE - CAT 900.

ETAL LANE - N.W. LAY ARMCO TO TIE IN MAIN MAN-HOLE DRAINAGE IN LINE NW & NE - CASE - 7/LANE ASSIST. - (REALIGNED 2ND KERB ON NARIUS AVENUE).

45+40 - 46+00 W/I EXCAVATE MAKE & HAUL TO K/I/AW CANNISTER ALSO - PLANT KING. ACKERMAN H16 D/TRUCK

46+00 - 46+40 EXCAVATE TO EXPOSE COAL - HAUL OFF MAT. TO POINT N/A E/I STOCKPILE - (CAT 140 - 1/CM VOLVO'S) - (0100 - 1900)

43+00 - 45+100 E/I TRIM BATTER CAT 950 (0100 - 1500)

43+00 - 43+60 N/A EXCAVATE TO FORMATION LEVEL CAT 225 - D/TRUCK HAUL TO K/I/AW. - NAKAMURA 5[illegible]
44+00 - 44+40 S/A TRIM FORMATION } (CAT D6) ( - 1900)
43+00 - 43+40 N/A TRIM FORMATION }
43+00 - 44+00 S/A SPREAD [illegible] (CAT D6) (0800 - 1900) GRAVEL.

BROKEN DOWN
No 22 [illegible]
No 18 - [illegible]
7 [illegible]

47+00 - N/I SPRAY WEEDKILLER ON BATTER 2/m (1600 - 1700)

19 July

0800 · 1900 — Friday 7

OVERCAST . DRY . — 188–177 Week 27

Brunton N.W. Slip · Top Soil Village & Pattern - Case 900 · Crosscut / Gan · Loading Topsoil from R/A S/I - Case 900 - D17 (0800 - 1400) - D17 (1630 - 1800)

Brunton R/A & N.W. Slip - Gullies · - Gan/CAA.

95+00 · 90+00 · Brickwork Chambers to MH's & G' 2/Gan · Simon

Brunton Int. - Neer Street Lighting - Lay Cable & Connect u.c. - 3/Men.

75+67 - 75+08 S/A S/L Tucon Lain S/C + Carry 83+46 - 81+5
82+90 · 79+25 N/A S/L Tucon Lain Drainc.
(Tarmac Supplier)

78+70 · 77+50 N/A S/L Tack GP to Wain and S/C Bowls w/c · Haven in Position Set (2 Men · Tarmac col.)

4/1 T.P · 2/Ryedox.

80+00 - S/A Cut out for Gullies in Kacuta 2/Carrolan.

K.P. Bridge S/I Arcadia - Carry/1 · 11/A (0800 - 1830) Jackson

K.P. S.R.W. · Stockpile Tarmac in Landscape Area. - D6 (0800 - 1900)

54+00 - 51+80 S/A Trim Surface · Grader · Gan - Can
49+60 · 50+10 S/A Trim Capping

Port North Bridge Level out Capping around Bridge Area Ready for Laying of Tarmac Base for Surfacing
16 D6 (0800 - 1530)

August
M T W T F S S | M T W T F S S | M T W T F S S | M T W T F S S | M T W T F S S | M T
1 2 3 4 5 6 | 7 8 9 10 11 12 13 | 14 15 16 17 18 19 20 | 21 22 23 24 25 26 27 | 28 29 30 31

FRIDAY 7th JULY

MH51/12 - MH AR/13 - MH/AR/15 .. EXCAVATE TRENCH - CAN POSITION TO STOP AT GAS VALVE - AT 3C. AM. WENT AGAIN LATE PM CONTINUED TO EXC TRENCH & MAR/13 EXPOSED 18" GAS MAIN IN H6 FOR MH. BROKEN OUT CONCRETE PROTECTION SLAB IN TRENCH - 1/CM + 1 COMP - (0800 - 1530) + 2 GANG TRAFFIC (LAB W/1)

HAZELDENE: N/1. LAY PAV HOARD IN [illegible] 2/LABS (0800 - 1530)

PONT ROAD C/1: TAKE UP GRANITE SETS & TRANSPORT OFF SITE JCB WAGON (AM).

50+00 - 54+00 : 1/CM MH 1 & C/1

12 - 17 NOV : TAKE DOWN EXISTING FENCE & ERECT 1.4 CHAIN LINK CAUGHT [illegible] CUTTING POSTS + MIXING OWN CONCRETE USING [illegible] · INFORMED J.A · CHANGED POSTS & GIVE THEM SOME CONCRETE - TOLD TO LEAVE [illegible]

46+00 - 46+40 N/A EXCAVATE CORE & CORE/[illegible] CORE & TRANSPORT OFF SITE. 12 C/1 & 1 COMP. [illegible] 6/LABS

45+60 - 46+00 W/1 [illegible] & HAUL TO KPSRW. [illegible] H16

43+60 - 44+00 N/A EXCAVATE TO FORM NEW LEVEL UPTO 1.9 [illegible] HAUL TO KPSRW & [illegible] N/A C/1; CM 225 - DITCHING

43+00 - 43+60 N/A CAPPING
- 44+00 N/A FORMATION
- 44+80 S/A FORMATION
- 44+40 S/A CAPPING

} KEN 1G1 0800 - 1900 / KEN 1G7 1600 - 1900 / G [illegible]

CM CARR - PLACE & COMPACT [illegible] IN [illegible] CABLE - 2/LABS · [illegible]

DUMP TRUCKS ... [illegible] DOWN

| | | | |
|---|---|---|---|
| 10 | DROTT | N° 11 | AC AM |
| 3 | MOXY | N° 12 | AC AM |
| 5 | VOLVO | N° 6 | [illegible] |
| 1 | D.T.A. | N° 5 | 1630 - 1800 |
| | | N° 14 | FINISHED 1800 |

AUGUST 199

6. Monday ○ Bank & public holiday, R of Ireland Bank holiday, Scotland
Week 32 · 218-147

a.m. Fine p.m. Overcast, some rain

Colin Scott informed me that Pitchmastic are returning to site today and HAT will recommence works on the 13/8/9

Micky Butcher pointed out that the radius on the kerbs at north end of Dutton-Forshaw reinstatement area cannot be 7.5m though he has ordered the kerbs and they are already on site. I agreed this was the case and requested that he checks to see whether 7.5m can be accommodated on site.

Micky Butcher queried the angle of the drain run from manhole 4/1 to the headwall and it was confirmed as 32°.

Colin Scott informed me that he intends laying men off this evening as lack of information with respect to works beneath the Viaduct prevents the contractor from ensuring continuity of the works. He is going to write stating that Bill Rates will no longer apply if the men have to be laid off and work is carried out at a later date. I inform him that info on the Creamery area ~~is~~ is with Wayne (WR @ CRE's meeting) and should be available later on today.

Geoff Skelton informed me that he will be ordering bricks to the dwarf walls to Dutton-Forshaw matching as closely as possible with the existing. I showed him a list of outstanding work (not exhaustive) which indicates that the men do not need laying off. G.S. queried the PA1 paving at Marshall Branson's as they appeared to be unaware that it is required. I showed him the drawings and later confirmed that it is required.

Informed WR of Colin Scott's intention to lay men off and he took up the matter.

Informed Micky Butcher that profile and drain levels on run MH4/1 to headwall are OK (setting out checked by Steve Donnelly).

Confirmed with G. Skelton that sawcuts are to be made to both the north and south of the footpath at Dutton-Forshaw to provide a clean line for the new slab to butt up to.

| August | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri |
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199 AUGUST

Tuesday
Week 32 · 219-146
7

am Fine. p.m. Overcast, clearing later

Pitchmastic arrived on site @ 6.30pm last night and Colin Scott permitted them to commence works on the upstand only as Butler's not represented. Pitchmastic are carrying out (night-time working) to avoid the blistering that occurred on the west deck. Joe Copeland left site @ 9.00pm and is to do night shifts, 6.30pm onwards until Pitchmastic have completed the works.
Primer had been applied to the central reserve upstand and plinths for Pier 13 down to the approximate position of the effluent plant.

Connecting drains from Junction Pier to catchpits 3/1 and 3/2 made (160 mm OD uPVC pipes).

Installation of drain run MH4/1 to headwall continuing.

Sub-base behind kerbs at Pier 12 being laid.

Reinstatement works to Dutton-Forshaw continuing.

G. Skelton / M Butcher informed of these by IGWS/KD

- kerbs to west of paved area to run northward in a straight line & connect into kerbs @ Pier 9
- Use a 7.5m radius kerb to replace the broken kerb at the temporary fence line north of Dutton Forshaw
- connect the kerbs @ Pier 9 with the 7.5m radius kerb to complete kerb lines @ Dutton Forshaw
- M Butcher given sketch of the above by K Durkin.

Benching to manholes being carried out.

September | Sat Sun | Mon Tue Wed Thu Fri Sat Sun | Mon Tue Wed Thu Fri Sat Sun | Mon Tue Wed Thu Fri Sat Sun | Mon Tue Wed Thu Fri Sat Sun
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AUGUST 199

8 Wednesday
Week 32 · 220-145 am fine pm cloudy + dull

Fitchmastic had problems with waterproofing last night – Joe Rowlands's note attached & Spraying unit broke down; Colin Scott informed me that Fitchmastic arranging for repairs and works would be continuing tonight. Informed Joe of this when he telephoned.

Bob Russet brought to my attention some staining that had occurred to the surfacing on the fast lane of the west deck. ENR did not think it was diesel or oil. It was noticed that Fitzgerald Addison (Safety barrier sub-contractor) had parked a car on the fast lane + also a generator. Later on in the day it appeared that the affected areas had been covered in sand. Fitchmastic (Tony [illegible]) confirmed that they had not been on the west deck.

Drain run MH2/1 to MH3/2 has been laid 125mm too high and it transpired that the drain layers had followed the wrong travellers. Levels south of MH2/1 and north of MH3/2 are O.K. The result is the invert on the manhole rings have been set 125mm too high and as such brickwork cannot be laid for the covers to sit on. WK concerned that the covers may move as insufficient sub-base will surround them and hard spots will be created in the access road.

Colin Scott informed me that the kerb layers at Sutton Coldfield had been prevented from completing the foundations due to lack of information. I stated that Mr Butcher had been informed of our intentions in due time and that the reason for non-completion had been due to insufficiency of [illegible]. We agreed to meet Friday morning 10/8/9[illegible] to discuss works under the Viaduct.

Obtained 3no. 3.0m tapes from B. Skelton.

Rang Martin Lacey of Sandbergs to give advance warning that UAT I are due back on site on 13th Aug. 199 . He is to arrange with Tom [illegible] to have someone available next week.

| August | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri |
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199 AUGUST

Thursday 9
Week 32 · 221-144

am Overcast; clearing mid-morning
pm Rain early afternoon, clearing later then becoming overcast.

Reinstatement works continuing at Dutton-Forshaw - installation of sub-base.

Drain exiting from east stem pier 1 - concrete cut back to allow for installation of bend and fall to manhole MH1/1. Cutting back OK though precast concrete ring forming the manhole destroyed in process.

Works on drain run MH4/1 to headwall continuing.

Armstrong-Addison brought safety barrier posts, to protect vehicles parked on slow + fast lanes of west deck together with a compressor.

G. Skelton confirmed that sand had been put down to stained areas on the fast lane of the west deck though he still does not consider it to be diesel.

He proposed surrounding the manhole covers + frames + biscuits in concrete for manholes MH2/1 to MH3/2 to overcome the problem of the biscuits which had been set 125mm too high. The concrete would finish flush with the finished road levels.

Refurbacting unable to fix machine yesterday and hence worked until midnight only last night.

3.00pm Mtg with Titcon re: surface texture depth results on fast lane of west deck - see Meetings book.

M. Butcher proposed connecting the drain exiting from pier 1 with manhole MH1/1 using a flexi-pipe. Agreed that the proposal could be tried out provided a decent bend could be formed and the risk of movement was minimised.

Asked M. Butcher how ENL proposed to construct the headwall.

Noted ENL carrying out survey of spalled kerbs on west deck.

| September | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun |
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AUGUST 199

10 Friday
Week 32 · 222-143

am fine, some cloud pm. as am.

9.00am Mtg. with Colin Scott re: works beneath Viaduct
ENL office: - see meeting file

Colin Scott informed me that Tilcon considered that a tack coat his regd. to the concrete in the verges prior to the base course & wearing course being installed. WR/DAH considered that this may be the case.

Pitchmastic have commenced laying of membrane last night - some rain damage but not serious.

Confirmed with M. Butcher that the cover level of manhole MH 3/1 should be dropped to 7.75 (trief kerb and road levels on dwg. 311A do not tie in should be 300mm difference not 200mm as shown).

August 1 2 3 4 5 5 | 6 7 8 9 10 11 12 | 13 14 15 16 17 18 19 | 20 21 22 23 24 25 26 | 27 28 29 30 31

MARCH 199

**5** Monday
Week 10 · 64-301

WEATHER – cloudy and dull with gale force winds for most of day. No work on the Viaduct superstructure after 10-00 hrs, some men carried on with ground works but majority left site at 13-00 hrs.

HIGHLAND CONSTRUCTION – loaded materials onto vehicles and awaiting lift from EN to place mats on deck. Erected some posts but when lift never materialised due to wind removed posts and returned materials to security store. Noted today that with work done over weekend Highland are rapidly approaching a point where they will overtake EN's work on the remedials to the edge beam which in some cases involves breaking out poor concrete around post anchorages.

SPAN 7-8 – continue with the erection of formwork to the central reservation cantilever coping and safety barrier plinths on the west deck. EN have still to do something with a section of bar, approx 1·5m long at Pier 7 where cover is reduced. Agreed to allow cover go down to a minimum of 35mm in this area. This takes into account the high grade of concrete in the deck. EN's bar are still below this value. Awaiting action that Colin Scott is still going through this usual action with WR trying to say it will be OK. – discussed with WR and he agrees action as necessary.

PIER 2 – continue to set up formwork to the west deck parapet cantilever and edge beam.

SPAN 1-2 – continue with the erection of the east deck parapet cantilever and edge beam – Joe Gysland has spoken to EN about joints + [illegible] tile to during through this but can get no sense from anyone.

SOUTH ABUTMENT – breaking out uncompacted concrete to the east wing wall parapet edge beam adjacent to the expansion joint.

PG TRIAL PANEL – fixing reinforcement to the second attempt at the trial panel.

2 joiners working in shop making up shutters for the central reservation coping and individual safety barrier plinths.

Spoke to Graham Northrop about travelling shutter to parapet cantilever and edge beam at east deck, span 1-2. He agrees that timber 'nipping' will be needed at joints and agreed that if flush plugs are good for through bolt tie holes then these would be fully mortared.

Trying to sort out connection detail between post base and lower mesh support rail – details received from Alan Wanless at Wolverton but I do not think it will work either. Contacted Eric Tyler at Barco and size of extruded U section given.

Spoke to Joe Gysland and Bob Binge about the importance of making sure cover surveys are up to date. Noted we are only in span 7-8 with the work on west deck parapet edge beam and cantilever as parapet erection is nearing this position.

Paul Ellis informs me that EN are trying to arrange a road closure at Strawbridge Road to erect parapet cantilever on Tuesday night / Wednesday morning – very short notice. Bob Major phoned later to say that he had spoken to EN and told them that this was at too short notice and agreed with EN that a closure on 9/3/9 was OK. Phoned Bob Major later in day to remind him that traffic regulation order did not cover Friday – he was not in but left message. He phoned back later to say that because of this 9/3/9 was no good. He would inform EN in morning.

| March | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat |
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199 MARCH

Tuesday
Week 10 · 65-300 6

WEATHER – dull, cloudy and cold but remained dry with some bright periods – strong gusty to gale force winds.

HIGHLAND CONSTRUCTION – Following the cancellation by SMBC of Friday morning's road closure at Strawbridge Road EH have decided to send Highland Construction off site. Not a great deal achieved today only general tidy up and left site mid-afternoon. 35No. posts complete with rails and mesh to top two panels erected.
PIER ⑥ – SOUTH – continue with remedial works to the parapet cantilever edge beam – "bagging up" minor defects plus breaking out defective concrete at parapet post locations.
SPAN ⑦-⑧ – Erecting formwork to the central reservation cantilever coping on the west deck.
PIER ⑦ – Cutting off the long return ends to the transverse deck reinforcement which "bobs" up into the central reservation cantilever coping. Bars are 20mm – 30mm too long and protruding into top cover. No problem was identified at the time of pouring the deck slab.
SPAN ③-④ – Continue with the erection of formwork to the east deck central reservation cantilever coping.
PIER ② – Erecting formwork to the west deck parapet edge beam and cantilever.
SPAN ①-② – Completed formwork to the east deck parapet cantilever and edge beam – our checks revealed that shutter was 20mm east of true position at north end (mark supplied by EH engineers for Jamie was 20mm out of position). Shutter moved to correct line, completed minor reinforcement snagging, cleaned out and concrete poured. Started pour at 13-30 hrs, completed 16-30 hrs with only 1No. supply truck on turn around basis.
Started to remove wedges and packs from the Pier ① bearings.
SOUTH ABUTMENT – Continue to break back poor concrete to east wing wall parapet edge beam at north end. Removed falsework and formwork from the west wing wall parapet edge beam soffit.

Erected access scaffold to facilitate formwork erection on the second P6 trial panel.

Joiners making up extra central reservation cantilever coping shutters and safety barrier plinth shutters in the shop.

Spoke to Paul Ellis about formwork to end beam and abutment ballast wall under the expansion joint. He is proposing to use a block of polystyrene. Told him I would consider this but pointed out that expansion of bridge deck will crush polystyrene and could reduce cover to reinforcement in wet concrete.

John Scott in his usual stupid manner is still arguing about bars with lack of cover at central reservation cantilever coping Pier ⑦ west – told that 55mm was the absolute minimum and remedial work required.

John Scott informs us that Highland Construction are to leave site and return when east deck edge beam cast – thus erection over Strawbridge Road can be done with 1No. closure for both decks.

Sorted out revised detail for PE/113 parapet bottom rail to parapet post fixing.

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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MARCH 199

7 Wednesday
Week 10 · 66-299

Weather – dull and cloudy but very mild. Strong westerly wind.

Arrived at 06-30hrs to carry out a check on the 3rd MEBT datum marks installed on 28/2/9

HIGHLAND CONSTRUCTION – Completed erection of parapet up to Pier (8), erected another 9No posts + rails [illegible] two mesh panels. Left site mid-afternoon for another contract. 104No posts + rails + [illegible] two mesh panels erected in total. Of all the posts erected 138No of the bolts to the front two positions on the base are too short (66%) – engagement of thread into anchorage less than 30mm. Highland have a [illegible] stopped fixing the angle bracket to the base on [illegible] No posts.

SPAN (9)-(10) – Continue with remedial work on the west deck parapet edge beam.

SPAN (8)-(9) – Erecting formwork to the individual safety barrier plinths to the east deck central reservation.

SPAN (7)-(8) – Completed magging, cleaned out and concrete poured to the central reservation cantilever coping. Started pour at 9-30 – completed at 10-30 hrs. Area where cover to the links is less than minimum requirement left uncast.

PIER (7) – Preparing formwork for the central reservation cantilever coping and making adjustment to links which have been bent too wide prior to full shutter erection.

SPAN (4)-(5) – Erecting formwork to the east deck central reservation cantilever coping.

SPAN (3)-(4) – Cleaning away grout leakage etc from edge of top flange of girders at joint with parapet cantilever soffit using chipping hammer grinder (A).

PIER (2) – Completed the formwork and reinforcement, cleaned out and ready to concrete early afternoon the parapet cantilever and edge beam but pour postponed until tomorrow as no concrete available.

SPAN (1)-(2) – Erecting shutters to the east deck parapet cantilever and edge beam.

PIER (1) – Removing wedges and temporary packs from beneath the bearings to girders.

SOUTH ABUTMENT – Continue to break out the poor quality concrete to the east wing wall parapet edge beam.

2 Joiners erecting formwork to the PC [illegible].

Note: – watch preparation of CS to girder (H) in span (8)-(9).

Immediately upon request Bramfield Construction tidied up land beneath viaduct where they may had caused disturbance using JCB.

Survey of MEBT marks: confirmed that original marks OK. Carried out bearing survey again and this confirmed that bearings out in some cases by over 50mm – considering calculate to see if this is acceptable.

March | Thu Fri Sat Sun 1 2 3 4 | Mon Tue Wed Thu Fri Sat Sun 5 6 7 8 9 10 11 | Mon Tue Wed Thu Fri Sat Sun 12 13 14 15 16 17 18 | Mon Tue Wed Thu Fri Sat Sun 19 20 21 22 23 24 25 | Mon Tue Wed Thu Fri Sat 26 27 28 29 30 31

199 MARCH

Thursday
Week 10 · 67-298 **8**

Weather – dull and cloudy but remained dry. Very mild with strong winds by late afternoon.
Span ⑧-⑨ – Formwork completed and concrete to 12No. type A, individual safety barrier plinths to the east deck central reservation poured.
Span ⑦-⑧ – Removed formwork to the west deck central reservation cantilever coping and safety barrier plinths. Spoke to Joe Wayland and asked him to make sure that CWL cover these spans etc during periods when stripped.
Span ④-⑤ – Continue with formwork to the central reservation cantilever coping on the east deck – G had positioned support timbers in such a position to prevent us to check levels to top (CWL had done this prior to timbers being installed but never informed us) After pressure they agreed to change support arrangement to give access. At 17-10 hrs CWL requesting checks on this section to start at 8-00 hrs in morning – told it was too late as Kieran Durkin had gone home. If they wanted such service they should have requested this earlier giving us time to arrange.
Span ②-③ – Cleaning grout runs etc from joint between girder Ⓐ top flange and parapet cantilever soffit using a chipping hammer.
Pier ② – Concrete to the west deck parapet cantilever and edge beam cast. Started pour at 8-30 hrs and completed at 10-30 hrs. Once again a 50 min delay between 1st load completion and 2nd load going into the shutter.
Span ①-② – Removed formwork from east deck parapet cantilever and edge beam and move travelling shutter into span ②-③. A very poor plan alignment has been achieved on the edge beam due to the shutter having taken up the curvature of the west deck during casting of this edge. Spoke to Paul Ellis / Geoff Skelton and they will attempt to straighten out using jacks to rods on the next pour – no mention of remedials in this section. As usual Paul Ellis making stupid comments on blaming the moving of the north end of the shutter onto correct alignment as the reason for this.

Delights – water jet preparation of CJ to girder Ⓗ span ⑩-⑪.

Cleaning up site and deck in vicinity of the South Abutment.

Spoke to Hazel CCO – she had gentleman at CCO complaining about damage to cars in Dalton-Le-Dale from water jet preparation of CJ's to girder Ⓗ – told her to send him to CWL in first instance.

PG Test Panel – altered length of reinforcement as incorrect and erected steel shutter to front panel. Pointed out a number of defects / points on shutter but once again it seems that CWL are uninterested in doing a good job.

Reconsidering CWL calculations for Mean Effective Bridge Temperature (MEBT) – seem OK but incorrect bridge length used to calculate movements. Spoke to Dick du Burgh and he was to change and if new values calculated and a revised graph drawn.

Steve Howard BR on site – delayed the start of the lockout for PG construction until 19/5/9

Spoke to BACO about use of tie on parapet mesh – Alan Shields says not now required only on end panels.

Spoke to Barnfield Construction about drain under access road – require details in next 2 weeks – started to prepare information.

April | Sun 1 | Mon 2 Tue 3 Wed 4 Thu 5 Fri 6 Sat 7 Sun 8 | Mon 9 Tue 10 Wed 11 Thu 12 Fri 13 Sat 14 Sun 15 | Mon 16 Tue 17 Wed 18 Thu 19 Fri 20 Sat 21 Sun 22 | Mon 23 Tue 24 Wed 25 Thu 26 Fri 27 Sat 28 Sun 29 | Mon 30

MARCH 19

9 Friday
Week 10 · 68-297

Weather - dull, cold and very windy - occasional bright periods with showers of rain [illegible].

Spans ⑧-⑱ - Waiting on completion of finishing works on the parapet cantilever edge beam then [illegible] for [illegible] surfacing. According to EHL request for inspection this work was completed yesterday.
Span ⑤-⑧ - removing formwork from the individual safety barrier plinths to the east deck [illegible] concrete placed yesterday.
Span ⑥-⑦ - Erecting formwork to the west deck central reservation cantilever coping and safety barrier plinths.
Span ④-⑤ - Completed formwork to the east deck central reservation cantilever coping, moved on to repair cover requirement (links too high in places) and cleaned out ready to concrete. OK to order concrete for 13.30hrs but could not supply so pour cancelled.
Span ③-④ - Steelfixers have made a start fixing reinforcement to the west deck PG parapet at Pier ④.
Span ②-③ - Erecting formwork to the east deck parapet cantilever and edge beam.
Spans ①-④ - Remedial works to the west deck outer parapet cantilever and edge beam [illegible] progress.
Pier ① - Removing steel wedges and shims from underside of bearings.

PG Trial Panel - concrete to 1st section of the second attempt at this trial panel poured today.

Neolith - Preparing CJ's by water jet to girder ⑭ spans ⑭-⑮ and individual [illegible] plinths to central reservation spans ⑪-⑫ east deck.

Considering shrinkage effects on the deck as this will make situation with the bearings at Pier even worse.

Joe Spalford on ½ day holiday pm so spent most of afternoon on site.

Asked Joe Spalford to make sure that cover surveys are kept up to date and that as many as possible are carried out. He was to investigate position w.r.t. this over weekend.

March | Thu Fri Sat Sun 1 2 3 4 | Mon Tue Wed Thu Fri Sat Sun 5 6 7 8 9 10 11 | Mon Tue Wed Thu Fri Sat Sun 12 13 14 15 16 17 18 | Mon Tue Wed Thu Fri Sat Sun 19 20 21 22 23 24 25 | Mon Tue Wed Thu Fri Sat 26 27 28 29 30 31

# <u>Appendix D</u>

## Sample of Inconsistent Site Records

This appendix presents a sample of inconsistent site diary records extracted from the site records kept on a completed contract - chapter two.

WEATHER. A.M. FINE.
OVERCAST. WINDY.

## SEPTEMBER 19

WEATHER. P.M. FINE.

**26** Monday
Week 39 · 270-96

08 00 -
WORK CARRIED OUT

BRIDGE. 38
·1 BOLTING UP BRIDGE STRUCTURE. (2 ERECTORS R.S.H.)
·2. INSTALLING DECK TIMBERS TO N/W PARAPET. (2 JOINERS.)
COMPOUND.
·1 INSPECTING TRANSITION DUCT FORMWORK.*
·2 CONCRETING TRANSITION DUCT. (1 GANGER 2. CONCRETORS 1 JCB
PONTELAND INTERCHANGE BRIDGE. 39
·1. PAINT PRIME COAT TO INSITE OF S/W WING WALL (2 LABOURERS)
·2 BACKFILL TO U/S OF BRIDGE DECK. 2. HANOMAG 1DG + T72. 2 LABOURERS
·3. DRESSING CONCRETE N/E WING WALL. (1 FINISHER)

BRIDGE. 41
·1. STRIPPING KICKER FORMWORK PIER G. (2 JOINERS)
·2. POSITIONING BASE REINFORCEMENT N/E. ABUTMENT. (2. JOINERS)
·3 FIXING KICKER N/E ABUTMENT. (2 JOINERS 1 LABOURER)
·4 ERECTING SCAFFOLD. ·5. RUBBING UP CONCRETE.
BRUNTON BRIDGE $\boxed{50}$.
·1. DRILLING ANCHOR HOLES FOR VOID FORMERS (2 JOINERS.
·2 SANDING DOWN JOINTS IN DECK SOFFIT. (1 JOINER) ·3 LOADING REBAR TO DECK NGK. (4.5/FIXERS)

BRIDGE $\boxed{49}$.
·1. ERECTING SCAFFOLD N/FACE N/ABUTMENT. (3. SCAFFOLDERS)

BRIDGE $\boxed{46}$
·1 INSTALLING FORMWORK TO N/E WING WALL PARAPET (3 JOINERS)
·2. RUBBING UP PARAPET EDGE S/W WING WALL. (1 FINISHER)
·3 CLEANING TENDON BOX OUT ANCHORAGES,
·4 DRILLING HOLES FOR ANCHOR BOLTS.

(

COMMENCED CONCRETING 11.45
COMPLETED CONCRETING 14.20.
ACTUAL & THEORETICAL VOLUME 5M³
MIX 50/10 METHOD OF DELIVERY TO FORM. JCB
VIBRATOR POKER BROKEN DOWN W.E.F. 13.00
ONE HANOMAG DOZER FINISHED AT 1500 THE OTHER AT 1730
THE DG WORKED THROUGH TO 19 00
THE ARE BRIDGES DECIDED THAT 25 M/M COVER WOULD BE
SUFFICIENT FOR THE TRANSITION DUCT IN VIEW OF THE SMALLER
AGGREGATE BEING USED. 10 M/M

September | Thu Fri Sat Sun 1 2 3 4 | Mon Tue Wed Thu Fri Sat Sun 5 6 7 8 9 10 11 | Mon Tue Wed Thu Fri Sat Sun 12 13 14 15 16 17 18 | Mon Tue Wed Thu Fri Sat Sun 19 20 21 22 23 24 25 | Mon Tue Wed Thu Fri 26 27 28 29 30

# Daily Bridgeworks Progress Report

Name: ... ......................

Day/Date ..Mon 26th Sept..................

Contractors Hours: ..0800 - 1730.........

| Struct. No. | Section / VO | Details of Work | Plant: Type | Plant: Hours Worked | Plant: Hours Standing | Plant: Hours B.down | Labour | Materials: Type | Materials: Quantity | Sub Contractor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 846 | | Strip formwork from N.E. wingwall cantilever<br>fabrication of N.W. parrapet formwork (wingwall)<br>Rub up & cone finish S.W. wingwall parrapet.<br>Scabble const jt for N.E wingwall parrapet. | NK250 E Comp + tools | | | | 4 joiners<br>1 operator<br>3 labs<br>1 gagr.<br>3 labs. | | | | |
| 849 | | No Progress General tydeing up of site. | | | | | | | | | |
| 850 | | Deck soffit & remedial work.<br>Steel fixing progressing<br>Wingwall formwork progressing | 605 Comp | | | | 5 joiners<br>5 fixers<br>1 operator<br>1 lab. | | | | |

General Remarks:- Discussions Shields/Rowe/Waggitt re condition of formwork. B50 soffit, doubt surrounding the formwork now constructed will fail to give the finish req'd in the spec.

Weather ..Fair..........

Instructions given: Compromise solution given in that the formwork will be approved in sections. I am concerned that the clients

Seen by: RE
SE

# Appendix E

## Questions of the pilot study

This Appendix presents the original questions which were included in the pilot study and changed thereafter in the final versions of the questionnaires. Also presented are the new questions that were added to the questionnaires as a result of the pilot study. It should be noted that the final versions' questions $Q_A$ to $Q_H$ are contained in the site supervisors questionnaire whereas $Q_I$ to $Q_O$ refer to those in the claims consultants.

Q1 *(changed to $Q_{A1}$ and $Q_{I1}$)*

Name: ..................................
Position: ..............................

Q2 *(changed to $Q_{A4}$ )*

Over the last ten years, what is the size of a typical contract that you have been involved in:

☐£ 0 - 100k ☐ £ 100k - 500k ☐ £ 500K - 1m ☐ £ 1m - 5m
☐£ 5m - 10m ☐£ 10m - 20m ☐ Over £ 20m

Q3 *(a new question added and became $Q_{B1}$)*

Does your organisation operate a quality management scheme registered in accordance with BS5750? ☐ Yes ☐ No

Q4 *(a new question added and became $Q_{B4}$)*

Does your organisation use the services of a claims consultant to deal with claims arising from the contracts that you supervise?

☐Often ☐ Seldom ☐Never

Q5 *(changed to $Q_{D16}$)*

Do you attempt to help your staff understand the unusual occurrences on site that might lead to a dispute, and that will need good records kept about their development?

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Q6 *(changed to $Q_{D18}$)*

Whether you have such procedures or not, please tick the box below which most closely represents your view:

☐ There are no procedures that could ever usefully cover the record-keeping process.

☐ Such procedures are necessary for the keeping and managing of site records.

☐ Such procedures would be helpful but would be difficult to identify.

☐ Even if sensible procedures were identified, they would not be accepted and followed by the site staff.

Q7 *(changed to $Q_{E1}$ and $Q_{L1}$)*

Please indicate which of the statements below most closely represents your view:

☐ A delay should be recorded whenever the contractor fails to complete an activity within his planned duration.

☐ A delay should be recorded whenever an incident occurs that allows the contractor to claim for a possible extension of time.

☐ A delay should be recorded whenever work stops.

Q8 *(changed to $Q_{E2}$)*

Please identify the view that most closely resembles your attitude to the way in which your site staff record delays on contracts:

☐ It is the contractor's job to identify delays - when he notifies us of a delay, we will then keep records.

☐ Site staff must be constantly looking for potential sources of delays to the contract.

☐ When a delay becomes evident, site staff are expected to record its existence.

Comment:..........................................................................................................
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Q9 *(changed to $Q_{E6}$ and $Q_{L5}$)*

From your records, are you able to pinpoint exactly when each of the delays on the contract was effective?

☐ Yes ☐ Sometimes ☐ No

Q10 *(changed to $Q_{F4}$)*

Can you identify the movement of major items of plant on and off the project site?

☐ Yes ☐ No

Q11 *(changed to $Q_{F6}$)*

Can you identify the movements of major items of plant between construction activities?

☐ Yes ☐ No

Q12 *(changed to $Q_{F8}$ )*

Do you record the actual uses of each major item of plant spend on individual activities?

☐ Yes ☐No

Q13 *(changed to $Q_{H1}$)*

Of the following recognised duties of the site supervising staff, which are seen to be the most important? Please, rank the duties in order of importance. (1= most important, 6= least important)

- ☐ Inspection of construction work and enforcement of contract specifications.
- ☐ Prompt resolution of construction problems.
- ☐ Prompt payment of the contractor.
- ☐ Prompt resolution of contractor's claims.
- ☐ Maintenance of good site records.
- ☐ Other duties. (please, specify)

Q14 *(a new question added and became $Q_{H2}$)*

What are other duties that are expected to be carried out by the site supervising staff?

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Q15 *(changed to $Q_{H4}$)*

Do you look for claims situations on the site, in order to become aware of them before the contractor gives notice of a claim?

☐ Yes ☐ No

Comment:.............................................................................................................................
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# Appendix (F)

## The Research Questionnaires

This appendix presents a copy of the following questionnires:

*(1)* *Site Supervisors Questionnaire, and;*

*(2)* *Claims Consultants Questionnaire*

UNIVERSITY OF
NEWCASTLE UPON TYNE

Department of Civil Engineering

Cassie Building
The University
Newcastle upon Tyne NE1 7RU
United Kingdom

Head of Department
M B Pescod OBE

Dear Sirs,

*RESEARCH PROJECT INTO RECORD-KEEPING ON CONSTRUCTION SITES*

I am conducting research in the field of Construction Management under the supervision of Dr. S. Scott in the Civil Engineering Department of the University of Newcastle upon Tyne. The aim of the research is to study the nature of construction site records kept by the supervising engineer, to identify what types of records are kept, the formats adopted for keeping them and the use that is made of these records. In addition, I wish to identify any problems and difficulties that may exist in keeping such records, to find out how to avoid such difficulties, and how to keep these site records in a simple, accessible form. The intention, therefore, is to carry out a survey on this issue using a questionnaire.

**My purpose in writing to you is, thus, to enlist your help in this matter, by nominating one of your resident engineers to complete the enclosed questionnaire and return it using the enclosed self-addressed envelope.**

It is hoped that the research will eventually lead to material which may be published, but no mention will be made of the particular organisations involved and all information received will be treated in the strictest confidence.

I would be most grateful if you could assist me in this study and will be happy to answer any queries you may have.

Thank you very much for your anticipated co-operation

Yours faithfully

Mr. S. O. A. Assadi
Researcher,
Civil Engineering Department

Telephone · 091 222 6000
Fax · 091 261 1182
Telex · 53654 (UNINEW G)

UNIVERSITY OF
NEWCASTLE UPON TYNE

CIVIL ENGINEERING DEPARTMENT
UNIVERSITY OF NEWCASTLE-UPON-TYNE

# A QUESTIONNAIRE TO INVESTIGATE THE NATURE OF THE SUPERVISING ENGINEERS' SITE RECORDS

UNIVERSITY OF
NEWCASTLE UPON TYNE

Department of Civil Engineering
Cassie Building
The University
Newcastle upon Tyne NE1 7RU
United Kingdom
Head of Department
M B Pescod OBE

CIVIL ENGINEERING DEPARTMENT
UNIVERSITY OF NEWCASTLE UPON TYNE

# A QUESTIONNAIRE TO INVESTIGATE THE NATURE OF THE SUPERVISING ENGINEER'S SITE RECORDS

*Dear Respondent;*

*We need your help. The information you provide is an essential part of this investigation which hopefully will result in useful recommendations that will help to improve site procedures.*

*The aim of this investigation is to determine attitudes held and procedures currently adopted in the record-keeping process on construction sites in order that the present state of the art may be determined. By studying the current approach to keeping site records by supervising engineers and identifying any specific problem areas, it is hoped to be able to offer helpful guidelines which will define good practice in keeping and managing good site records.*

*Please, take the time to complete the enclosed questionnaire and also try to comment whenever you have a view. There are no correct or incorrect responses, only your much-needed opinions. This form contains an identification number that will be used for follow-up purposes only. All responses will be treated confidentially and will in no way be traceable to individual respondents once the survey process has been concluded. Please, send your completed questionnaire using the enclosed stamped addressed envelope as soon as possible.*

*Thank you very much for your assistance. We care what you think.*

*Yours sincerely*

*Mr. S.O.A. Assadi*

Questionnaire No. {      }

Telephone · 091 222 6000
Fax · 091 261 1182
Telex · 53654 (UNINEW G)

## *Section* (A): PERSONAL DETAILS

$Q_{A1}$ Name: .....................................
Current position: ......................

$Q_{A2}$ Please indicate the main areas in which you have experience of supervision of construction:

| | | |
|---|---|---|
| ☐ Building construction | ☐ Foundation & Piling | ☐ Highway Construction |
| ☐ Coastal Engineering | ☐ Harbours & Docks | ☐ Power Generation |
| ☐ Drainage & Sewerage | ☐ Irrigation | ☐ Tunnelling |
| ☐ Water Supply | ☐ Bridges | ☐ Other (please specify): |
| ☐ ..................... | ☐ ........................ | ☐ ...................... |

$Q_{A3}$ How many years of experience do you have in supervision of construction ?

☐ 0 - 5 ☐ 5 - 10 ☐ 10 - 20 ☐ Over 20

$Q_{A4}$ Over the last 10 years, what is the size of contract that you have *mostly* been involved in:

| | | | |
|---|---|---|---|
| ☐ £ 0 - 100k | ☐ £ 100k - 500k | ☐ £ 500K - 1m | ☐ £ 1m - 5m |
| ☐ £ 5m - 10m | ☐ £ 10m - 20m | ☐ Over £ 20m | |

## *Section* (B): COMPANY POLICY

$Q_{B1}$ Does your organisation operate a quality management scheme registered in accordance with BS5750? ☐ Yes ☐ No

$Q_{B2}$ Does your organisation operate quality documented procedures for monitoring the supervising engineer's work in:

| | Yes | No |
|---|---|---|
| The issuing of variation orders | ☐ | ☐ |
| Keeping site records | ☐ | ☐ |
| Assessment of claims | ☐ | ☐ |

$Q_{B3}$ Does your organisation provide any guidelines to advise the supervising staff on what site records should be kept in the following areas:

| | Yes | No |
|---|---|---|
| Financial | ☐ | ☐ |
| Quality | ☐ | ☐ |
| Progress | ☐ | ☐ |
| As-built | ☐ | ☐ |

$Q_{B4}$ Does your organisation use the services of a claims consultant to deal with claims arising from the contracts that you supervise?

☐ Often ☐ Seldom ☐ Never

*Section* **(C): <u>SITE RECORDS - GENERAL</u>**

$Q_{C1}$ Do you think that the current approach to keeping construction site records is :

- ☐ Suitable and adequate
- ☐ Inadequate and in need of improvement

$Q_{C2}$ Are you aware of any specific problems in keeping good site records? ☐ Yes ☐ No
If yes, what are these problems?

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$Q_{C3}$ How do you think that site records can be improved?

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$Q_{C4}$ The list below sets out those site records that are traditionally believed to be kept by supervising engineers. Please tick the records that are usually kept on your sites and indicate any other records that you keep.

| | | |
|---|---|---|
| ☐ Site instructions | ☐ Variation orders | ☐ Correspondence |
| ☐ Minutes of meetings | ☐ Progress reports | ☐ Plant & labour returns |
| ☐ Interim valuations | ☐ Daywork records | ☐ Revised drawings |
| ☐ Weather records | ☐ Site diaries | ☐ Progress photographs |
| ☐ Updated planning charts (bar charts) | | ☐ Field and level books |
| ☐ Laboratory reports and test data | | ☐ Others, please specify: |
| ☐ ...................... | ☐ ..................... | ☐ ...................... |
| ☐ ...................... | ☐ ..................... | ☐ ...................... |

$Q_{C5}$ Are there any records that you think are worth keeping that are not generally maintained?
☐ Yes ☐ No {If No, go to $Q_{C7}$}
If yes, what are they?

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........................................................................................................................................

$Q_{C6}$ Why should such records be kept?

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........................................................................................................................................
........................................................................................................................................

$Q_{C7}$ Please identify any software that you normally use on your ***construction sites*** by ticking the boxes below and stating the specific use(s):

| (✓) | *Software Type* | *Used for:* |
|---|---|---|
| | Word processor | |
| | Spreadsheets | |
| | Planning | |
| | BOQ | |
| | Databases | |
| | Other(please specify): ........................... | |
| | ........................... | |

$Q_{C8}$ Are there any other areas of site work in which you can foresee particular value in the use of computers? ☐ Yes ☐ No
Comment:......................................................................................................................................
.....................................................................................................................................................
.....................................................................................................................................................

*Section* **(D):** **SITE RECORDS - PROGRESS**

*i.* ***General Progress Records***

$Q_{D1}$ Do you keep a record of progress which shows against ***each*** of the activities on the contractor's programme, on exactly which days work took place? ☐ Yes ☐ No
Comment:......................................................................................................................................
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$Q_{D2}$ Do you think it would be worth keeping such a record as an index to other records and as an 'as-built' record of progress? ☐ Yes ☐ No
Comment:......................................................................................................................................
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$Q_{D3}$ Do you identify links between subsequent activities in the contractor's plan, i.e., the actual point in time during the completion of one activity, that a subsequent dependent activity(s) was able to start?

☐ Always ☐ Often ☐ Sometimes ☐ Seldom ☐ Never

Comment:............................ ......................................................................................

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$Q_{D4}$ Do you see any value in keeping such records?

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$Q_{D5}$ How often do you assess and produce a report on the progress of the construction works?

☐ Weekly ☐ Monthly

*ii. Personal Site Diary Records*

$Q_{D6}$ Whose site diary records are most useful?

☐ Engineering staff's ☐ Clerks of works'

Comment:..............................................................................................................

.......................................................................................................................

$Q_{D7}$ In one sentence, please identify the nature of the site diary records kept by the following supervising staff:

| |
|---|
| Resident engineer<br>.......................................................................................................................<br>....................................................................................................................... |
| Assistant resident engineer<br>.......................................................................................................................<br>....................................................................................................................... |
| Clerk of works<br>.......................................................................................................................<br>....................................................................................................................... |

$Q_{D8}$ Do you see any value in relating site diary records of progress to the activities on the contractor's programme?.

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$Q_{D9}$ What is the format adopted to keep individual site diary records by the following categories of supervising staff? Please, ring the appropriate answers.

| | | | | |
|---|---|---|---|---|
| Resident Engineer | B | L | S | O |
| Assistant Resident Engineer | B | L | S | O |
| Clerk of Works | B | L | S | O |

Where:

B = Bound page a day diary - blank pages.
L = Loose leaf diary - blank pages.
S = Standard record sheets - pages with pre-printed headings.
O = Other (Please identify): ............................
............................

$Q_{D10}$ What is your view of the use of standard record sheets with pre-printed headings?
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$Q_{D11}$ What pre-printed headings would you recommend should be used on standard record sheets?
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$Q_{D12}$ How often do you check your staff's site diary records?
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$Q_{D13}$ It has been recognised that there are a number of problems with site diary records that affect their quality. These problems relate to the following:

i) *Accessibility:* it can be a time-consuming process to obtain useful information from these records.

ii) *Legibility:* some records are very difficult to read.

iii) *Continuity:* records are sometimes missing, and the information required is not then available.

iv) *Consistency:* two records of the same activity may contradict each other.

Please identify, by ticking a box, whether you have experienced these difficulties and also indicate which you consider the most severe by ranking the difficulties 1 to 4 (1= most severe, 4= least severe).

| Problem Type | I have experienced this problem (✓) | Rank severity (1,2,3, or 4) |
|---|---|---|
| Accessibility | | |
| Legibility | | |
| Continuity | | |
| Consistency | | |

Comment:.......................................................................................................................
.......................................................................................................................
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$Q_{D14}$ Have you experienced any other similar kinds of difficulty? ☐ Yes ☐ No
Comment:.......................................................................................................................
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$Q_{D15}$ Can you imagine your staff keeping their site diary records on a computer?
☐ Yes ☐ No
Comment:.......................................................................................................................
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$Q_{D16}$ Do you attempt to help your staff understand the unusual occurrences on site that might lead to a dispute, and that will need good records kept about their development?

□ Always □ Often □ Sometimes □ Seldom □ Never

Comment: ........................................................................................................................
..........................................................................................................................................
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$Q_{D17}$ Do you have quality procedures covering the keeping of site diary records?

□ Yes □ No

Comment:.........................................................................................................................
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$Q_{D18}$ Whether you have such procedures or not, please tick the boxes below that most closely represent your views of the following statements:

| *Statement* | *Agree* (✓) | *Disagree* (✓) | *Don't Know* (✓) |
|---|---|---|---|
| There are no procedures that could ever usefully cover the record-keeping process. | | | |
| Such procedures are necessary for the keeping and managing of site records. | | | |
| Such procedures would be helpful but would be difficult to identify. | | | |
| Even if sensible procedures were identified, they would not be accepted and followed by the site staff. | | | |

$Q_{D19}$ What are the factors that might affect the setting up of quality procedures for keeping site diary records?

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$Q_{D20}$ How many hours are spent per week by each supervising staff member for keeping site diary records? (on average)

| |
|---|
| _______ Hours |

*Section* (E): **Records of Delay**

$Q_{E1}$ Please tick the boxes below that most closely represent your views of the following statements:

| *Statement* | *Agree* (✓) | *Disagree* (✓) | *Don't know* (✓) |
|---|---|---|---|
| A delay should be recorded whenever the contractor fails to complete an activity within his planned duration. | | | |
| A delay should be recorded whenever an incident occurs that allows the contractor to claim for a possible extension of time. | | | |
| A delay should be recorded whenever work stops, provided the stop is not programmed. | | | |

$Q_{E2}$ Please tick the boxes below that most closely represent your views on the way in which your site staff record delays on contracts:

| *Statement* | *Agree* (✓) | *Disagree* (✓) | *Don't know* (✓) |
|---|---|---|---|
| It is the contractor's job to identify delays - when he notifies us of a delay, we will then keep records. | | | |
| Site staff must be constantly looking for potential sources of delays to the contract. | | | |
| When a delay becomes evident, site staff are expected to record its existence. | | | |

Comment:..........................................................................................................................
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$Q_{E3}$ Are you satisfied with the way in which delay records are kept on your sites?

☐ Very satisfied ☐ Quite satisfied ☐ Not satisfied

$Q_{E4}$ How are delays and their effects recorded?

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$Q_{E5}$ What is recorded?

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$Q_{E6}$ From your records, are you able to pinpoint exactly when each of the delays on the contract was effective?

☐ Always ☐ Often ☐ Sometimes ☐ Seldom ☐ Never

$Q_{E7}$ How do you record the effects of disruption, which do not stop work but reduce its efficiency?

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## *Section* (F): <u>Records of Resources</u>

$Q_{F1}$ For the main contract work (excluding variations), please indicate the statement that most closely represents the way in which you keep records of resources:

☐ There is no need to keep such records, the contractor's records will provide the information that is needed.

☐ Detailed records of resources, including both labour and plant are kept on a daily basis.

☐ Detailed records of resources, including both labour and plant are kept on a weekly basis.

☐ A full list of the major items of plant being used on the contract is kept on a daily basis.

☐ A full list of the major items of plant being used on the contract is kept on a weekly basis.

$Q_{F2}$ Do you ask the contractor to specify the level of resources that he intends to use when he submits his programme? ☐ Yes ☐ No

Comment:...............................................................................................................................
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$Q_{F3}$ Do you see any value in relating *records of resources* to the work activities on the contractor's programme?

☐ Yes ☐ No

Comment:.......................................................................................................................
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$Q_{F4}$ Can you identify the movement of major items of plant on and off the project site?

☐ Yes, directly ☐ Yes, indirectly from other records ☐ No

Comment:.......................................................................................................................
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$Q_{F5}$ What value would you see in having such information?
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$Q_{F6}$ Can you identify the movements of major items of plant between construction activities?

☐ Yes, directly ☐ Yes, indirectly from other records ☐ No

Comment:.......................................................................................................................
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$Q_{F7}$ What value would you see in having such information?
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$Q_{F8}$ Do you record the time that major items of plant spend on each individual activity?

☐ Yes ☐ No

Comment:.......................................................................................................................
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$Q_{F9}$ What value would you see in having such information?
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*Section* (G): <u>USE OF SITE RECORDS</u>

i. *General*

$Q_{G1}$ Of the following recognised uses of site records, which do you consider to be the most important? Please, rank these six uses in order of importance.(1= most important, 6= least important)

☐ Providing information on the contractor's ability to complete the project on time.

☐ Assisting in the financial control of the project and forming the basis of fair payment to the contractor.

☐ Providing feedback to the designers of defects in the design/documents, to ensure that these are not repeated in subsequent contracts.

☐ Confirming that the works are carried out according to the contract specification.

☐ Identifying the need for additional information from the Engineer and ensuring it is produced in time.

☐ Assisting in dealing with contractor's claims.

$Q_{G2}$ What other uses do you make of site records?

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$Q_{G3}$ What records are needed to help assess a contractor's claim for an extension of time?

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$Q_{G4}$ With the records that you keep, are you easily able to determine the contractor's rights to an extension of time?

☐ Always ☐ Often ☐ Sometimes ☐ Seldom ☐ Never

Comment:...........................................................................................................................
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$Q_{G5}$ What is the most important source of information that you use to produce progress reports?

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### *ii. Searches of Records*

$Q_{G6}$ Please indicate in the table below:

i) The frequency with which you conduct searches of these different types of record. (rank 1 to 3, 1= most frequent, 3= least frequent)

ii) The difficulty you have in searching the particular types of record. ( rank 1 to 3, 1= most difficult, 3= least difficult)

| *Type of Records* | *i)Search Frequency (1, 2, or 3)* | *ii)Search Difficulty (1, 2, or 3)* |
|---|---|---|
| Quality Records | | |
| Progress Records | | |
| Finance Records | | |

$Q_{G7}$ For a search that involves assessment of progress (e.g. claims for delay and extension of time), which records will typically be most useful? ( rank 1 to 5, 1= most useful, 5= least useful)

| | |
|---|---|
| | Engineer's diary |
| | Clerk of work's diary |
| | Progress photographs |
| | Minutes of progress meetings |
| | Progress reports |

$Q_{G8}$ When searching progress records, please indicate the frequency with which the following types of searches would be carried out by ringing the appropriate box. (1= very frequent; 2= fairly frequent; 3= seldom/never)

| | | | |
|---|---|---|---|
| To find out when a particular event took place. | 1 | 2 | 3 |
| To find out what happened on a particular day. | 1 | 2 | 3 |
| To find out what happened during a particular period. | 1 | 2 | 3 |
| To find out when a delay was effective. | 1 | 2 | 3 |
| To identify the level of resources used on a particular construction activity. | 1 | 2 | 3 |
| To refer to a decision agreed with another party on specific problems. | 1 | 2 | 3 |
| To refer to any instructions given on particular construction activities. | 1 | 2 | 3 |

$Q_{G9}$ What other searches of progress records do you carry out?

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*Section* (H): **MISCELLANEOUS**

$Q_{H1}$ Of the following recognised duties of the site supervising staff, which are seen to be the most important? Please, rank the duties in order of importance. (1= most important, 6= least important)

☐ Inspection of construction work and enforcement of contract specifications.

☐ Resolution of construction problems.

☐ Payment of the contractor.

☐ Resolution of contractor's claims.

Maintenance of good site records.

Other duties. (see $Q_{H2}$)

$Q_{H2}$ What are other duties that are expected to be carried out by the site supervising staff?

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$Q_{H3}$ Can you imagine a supervision of construction works with out keeping site records?

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$Q_{H4}$ Do you attempt to anticipate claims situations on the site, in order to become aware of them as soon as possible?

☐ Always ☐ Often ☐ Sometimes ☐ Seldom ☐ Never

Comment:.........................................................................................................................
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$Q_{H5}$ How are decisions on contractor's claims documented?

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$Q_{H6}$ Can you imagine a contract where payment of the contractor is tied directly to the progress records?

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$Q_{H7}$ Do you want to receive a copy of the results of this study? ☐ Yes ☐ No

$Q_{H8}$ Would you please, send us a copy of any standard record sheets you use for keeping site records?

$Q_{H9}$ Would you like to add any further comments:

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*We are very grateful indeed for your help. Please return the completed questionnaire in the stamped addressed envelope provided to:*

Mr. S. O. A. Assadi
Civil Engineering Dept.
Drummond Building
University of Newcastle
Newcastle-upon-Tyne
NE1 7RU

UNIVERSITY OF
NEWCASTLE

**Department of Civil Engineering**
Cassie Building
University of Newcastle
Newcastle upon Tyne NE1 7RU
United Kingdom

Head of Department
Professor M B Pescod OBE

Dear Sir,

*RESEARCH PROJECT INTO RECORD-KEEPING ON CONSTRUCTION SITES*

I am conducting research in the field of Construction Management under the supervision of Dr. S. Scott in the Civil Engineering Department of the University of Newcastle upon Tyne. The aim of the research is to study the nature of construction site records kept by the supervising engineer, to identify what types of records are kept, the formats adopted for keeping them and the use that is made of these records. In addition, I wish to identify any problems and difficulties that may exist in keeping such records, to find out how to avoid such difficulties, and how to keep these site records in a simple, accessible form. The intention, therefore, is to carry out a survey on these issues using a questionnaire.

**My purpose in writing to you is, thus, to enlist your help in this matter. One of the hypotheses to be tested in the research is that supervising engineers may not have a particularly good understanding of the way in which their records will be used to assess claims from the contractor. As a claims consultant, who has had to make use of supervising engineer's site records for this specific purpose, I believe that you may have a better understanding of exactly how those records should be kept. It is for this reason that I am asking you to complete the enclosed questionnaire and return it using the enclosed stamped self-addressed envelope.**

It is hoped that the research will eventually lead to material which may be published, but no mention will be made of the particular organisations involved and all information received will be treated in the strictest confidence.

I would be most grateful if you could assist me in this study and will be happy to answer any queries you may have.

Thank you very much for your anticipated co-operation

Yours faithfully

Mr. S. O. A. Assadi
Researcher, Civil Engineering Department

Telephone · 091 222 6000
Fax · 091 222 6502
Telex · 53654 (UNINEW G)

UNIVERSITY OF
NEWCASTLE

CIVIL ENGINEERING DEPARTMENT
UNIVERSITY OF NEWCASTLE-UPON-TYNE

# THE CLAIMS CONSULTANT'S VIEW OF SUPERVISING ENGINEERS' SITE RECORDS

UNIVERSITY OF
NEWCASTLE UPON TYNE

Department of Civil Engineering
Cassie Building
The University
Newcastle upon Tyne NE1 7RU
United Kingdom

Head of Department
M B Pescod OBE

CIVIL ENGINEERING DEPARTMENT
UNIVERSITY OF NEWCASTLE UPON TYNE

# THE CLAIMS CONSULTANT'S VIEW OF SUPERVISING ENGINEERS' SITE RECORDS

*Dear Respondent,*

*We need your help. The information you provide is an essential part of this investigation which hopefully will result in useful recommendations that will help to improve site procedures.*

*Please, take the time to complete the enclosed questionnaire and also try to comment whenever you have a view. There are no correct or incorrect responses, only your much-needed opinions. This form contains an identification number that will be used for follow-up purposes only. All responses will be treated confidentially and will in no way be traceable to individual respondents once the survey process has been concluded. Please, send your completed questionnaire using the enclosed stamped addressed envelope as soon as possible.*

*Thank you very much for your assistance. We care what you think.*

*Yours sincerely*

*Mr. S.O.A. Assadi*

Questionnaire No. { }

Telephone · 091 222 6000
Fax · 091 261 1182
Telex · 53654 (UNINEW G)

*Section* **(I):** **PERSONAL DETAILS**

$Q_{I1}$ Name: ..........................

Current position: .............

$Q_{I2}$ Of the claims that you have been asked to investigate, please state how often your involvement has been:

_% Acting for the Contractor (with access to contractor's records)

_% Acting for the Promoter (with access to supervising engineer's records)

_% Other (please specify):...................
...................

100%

$Q_{I3}$ How many years of experience do you have in claims consulting?

- ☐ 0 - 5
- ☐ 5 - 10
- ☐ 10 - 20
- ☐ Over 20

$Q_{I4}$ Over the last 10 years, what is the value of a typical claim that you have dealt with?

- ☐ £ 0 - 100K
- ☐ £ 100K - 500K
- ☐ £ 500K - 1m
- ☐ £ 1m - 5m
- ☐ Over £ 5m

***PLEASE NOTE THAT IT IS THE SITE RECORDS KEPT BY THE SUPERVISING ENGINEER THAT ARE BEING CONSIDERED IN THIS STUDY***

*Section* **(J):** **<u>SITE RECORDS - GENERAL</u>**

$Q_{J1}$ Do you think that the current approach to keeping construction site records is:

□ Suitable and adequate
□ Inadequate and in need of improvement

$Q_{J2}$ Are you aware of any specific problems in keeping good site records? □ Yes □ No
If yes, what are these problems?

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$Q_{J3}$ How do you think that site records can be improved?

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$Q_{J4}$ The list below sets out those site records that are traditionally believed to be kept by supervising engineers. Please tick the records that are usually needed in dealing with a claim .

| | | |
|---|---|---|
| □ Site instructions | □ Variation orders | □ Correspondence |
| □ Minutes of meetings | □ Progress reports | □ Plant & labour returns |
| □ Interim valuations | □ Daywork records | □ Revised drawings |
| □ Weather records | □ Site diaries | □ Progress photographs |
| □ Updated planning charts (bar charts) | | □ Field and level books |
| □ Laboratory reports and test data | | □ Others, please specify: |
| □ ..................... | □ ..................... | □ ..................... |
| □ ..................... | □ ..................... | □ ..................... |

$Q_{J5}$ Are there any records that you think are worth keeping that are not generally maintained?
□ Yes □ No {If No, go to $Q_{J7}$}
If yes, what are they?

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$Q_{J6}$ Why should such records be kept?

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$Q_{J7}$ Are there any ways in which you can foresee particular value in the use of computers on construction sites to deal with claims ? □ Yes □ No
Comment:..................................................................................................................................
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*Section* **(K):** <u>**SITE RECORDS - PROGRESS**</u>

## i. *General Progress Records*

$Q_{K1}$ Do you see any value in keeping a record of progress which shows against ***each*** of the activities on the contractor's programme, on exactly which days work took place?

☐ Yes ☐ No

Comment:...........................................................................................................

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$Q_{K2}$ Do you think it would be worth keeping such a record as an index to other records and as an 'as-built' record of progress? ☐ Yes ☐ No

Comment:...........................................................................................................

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$Q_{K3}$ Are such records usually kept by the supervising engineer's staff? ☐ Yes ☐ No

Comment:...........................................................................................................

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$Q_{K4}$ Do you think it would be useful to attempt to identify links between subsequent activities in the construction network, i.e., the actual point in time during the completion of one activity, that a subsequent dependent activity(s) was able to start?

☐ Yes ☐ No

Comment:...........................................................................................................

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$Q_{K5}$ Are such records usually kept by the supervising engineer's staff? ☐ Yes ☐ No

Comment:...........................................................................................................

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## ii. *Personal Site Diary Records*

$Q_{K6}$ Whose site diary records do you find are most useful?

☐ Engineering staff's ☐ Clerks of works'

Comment:...........................................................................................................

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$Q_{K7}$ Do you see any value in relating site diary records of progress to the activities on the contractor's programme?.

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$Q_{K8}$ What is your view of the use of standard record sheets with pre-printed headings?

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$Q_{K9}$ What pre-printed headings would you recommend should be used on standard record sheets?

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$Q_{K10}$ It has been recognised that there are a number of problems with site diary records that affect their quality. These problems relate to the following:

i) *__Accessibility:__* it can be a time-consuming process to obtain useful information from these records.

ii) *__Legibility:__* some records are very difficult to read.

iii) *__Continuity:__* records are sometimes missing, and the information required is not then available.

iv) *__Consistency:__* two records of the same activity may contradict each other.

Please identify, by ticking a box, whether you have experienced these difficulties and also indicate which you consider the most severe by ranking the difficulties 1 to 4 (1= most severe, 4= least severe).

| Problem Type | I have experienced this problem (✓) | Rank severity (1,2,3, or 4) |
|---|---|---|
| Accessibility | | |
| Legibility | | |
| Continuity | | |
| Consistency | | |

Comment:.......................................................................................................................

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$Q_{K10}$ Have you experienced any other similar kinds of difficulty?

☐ Yes ☐ No

Comment:....................................................................................................................

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## *Section* (L): Records of Delay

$Q_{L1}$ Please tick the boxes below that most closely represent your views of the following statements:

| *Statement* | *Agree* (✓) | *Disagree* (✓) | *Don't know* (✓) |
|---|---|---|---|
| A delay should be recorded whenever the contractor fails to complete an activity within his planned duration. | | | |
| A delay should be recorded whenever an incident occurs that allows the contractor to claim for a possible extension of time. | | | |
| A delay should be recorded whenever work stops, provided the stop is not programmed. | | | |

$Q_{L2}$ Do you consider that the way in which delay records are kept by the supervising engineers on construction sites is:

☐ Very satisfactory
☐ Quite satisfactory
☐ Not satisfactory

$Q_{L3}$ How should delays and their effects be recorded?

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$Q_{L4}$ What should be recorded?

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$Q_{L5}$ From the records kept by supervising engineers on sites, are you able to pinpoint exactly when each of the delays on the contract was effective?

☐ Always ☐ Often ☐ Sometimes ☐ Seldom ☐ Never

$Q_{L6}$ How do you think that the effects of disruption, which do not stop work but reduce its efficiency, should be recorded?

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## *Section* (M): Records of Resources

$Q_{M1}$ For the main contract work (excluding variations), please indicate the statement that most closely represents the way in which you consider that records of resources should be kept by the supervising engineer:

☐ There is no need to keep such records, the contractor's records will provide the information that is needed.

☐ Detailed records of resources, including both labour and plant should be kept on a daily basis.

☐ Detailed records of resources, including both labour and plant should be kept on a weekly basis.

☐ A full list of the major items of plant being used on the contract should be kept on a daily basis.

☐ A full list of the major items of plant being used on the contract should be kept on a weekly basis.

$Q_{M2}$ Do you think it would be worth asking the contractor to specify the level of resources that he intends to use when he submits his programme?

☐ Yes ☐ No

Comment:..............................................................................................................

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$Q_{M3}$ Do you see any value in relating *records of resources* to the work activities on the contractor's programme?

☐ Yes ☐ No

Comment:..............................................................................................................

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$Q_{M4}$ Do you think it would be worth recording the movement of major items of plant on and off the project site?

☐ Yes ☐ No

Comment:.......................................................................................................................
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$Q_{M5}$ What value would you see in having such information?

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$Q_{M6}$ Do you think it would be worth recording the movements of major items of plant between construction activities?

☐ Yes ☐ No

Comment:.......................................................................................................................
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$Q_{M7}$ What value would you see in having such information?

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$Q_{M8}$ Do you think it would be worth recording the time that major items of plant spend on each individual activity?

☐ Yes ☐ No

Comment:.......................................................................................................................
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$Q_{M9}$ What value would you see in having such information?

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## *Section* (N): USE OF SITE RECORDS

### *i. General*

$Q_{N1}$ What records are needed to help assess a contractor's claim for an extension of time?

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$Q_{N2}$ With the records that are kept by the supervising staff, are you easily able to determine the contractor's rights to an extension of time?

☐ Always ☐ Often ☐ Sometimes ☐ Seldom ☐ Never

Comment:..........................................................................................................................

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## *ii. Searches of Records*

$Q_{N3}$ Please indicate in the table below:

i) The frequency with which you conduct searches of these different types of record. (rank 1 to 3, 1= most frequent, 3= least frequent)

ii) The difficulty you have in searching the particular types of record. (rank 1 to 3, 1= most difficult, 3= least difficult).

| *Type of Records* | *i)Search Frequency (1, 2, or 3)* | *ii)Search Difficulty (1, 2, or 3)* |
|---|---|---|
| Quality Records | | |
| Progress Records | | |
| Finance Records | | |

$Q_{N4}$ For a search that involves assessment of progress (e.g. claims for delay and extension of time), which records will typically be most useful? ( rank 1 to 5, 1= most useful, 5= least useful)

| | |
|---|---|
| | Engineer's diary |
| | Clerk of work's diary |
| | Progress photographs |
| | Minutes of progress meetings |
| | Progress reports |

$Q_{N5}$ When searching progress records, please indicate the frequency with which the following types of searches would be carried out by ringing the appropriate box.

(1= very frequent; 2= fairly frequent; 3= seldom/never)

| | | | |
|---|---|---|---|
| To find out when a particular event took place | 1 | 2 | 3 |
| To find out what happened on a particular day | 1 | 2 | 3 |
| To find out what happened during a particular period | 1 | 2 | 3 |
| To find out when a delay was effective | 1 | 2 | 3 |
| To identify the level of resources used on a particular construction activity | 1 | 2 | 3 |
| To refer to a decision agreed with another party on specific problems | 1 | 2 | 3 |
| To refer to any instructions given on particular construction activities | 1 | 2 | 3 |

$Q_{N6}$ What other searches of progress records do you carry out?

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## *Section* (O): MISCELLANEOUS

$Q_{O1}$ Based on your experience, which set of records is the best?

☐ The contractor's staff's records
☐ The supervising engineer's staff's records

$Q_{O2}$ Do you want to receive a copy of the results of this study ? ☐ Yes ☐ No

$Q_{O3}$ Would you like to add any further comments:

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*We are very grateful indeed for your help. Please return the completed questionnaire in the stamped addressed envelope provided to:*

Mr. S. O. A. Assadi,
Civil Engineering Dept.
Drummond Building
University of Newcastle
Newcastle upon Tyne, NE1 7RU

# Appendix G

## *Results of Mann-Whitney Statistical Tests*

This appendix presents the results of the Mann-Whitney tests carried out using the Minitab statistical computer program - chapter four.

- *Questions ($Q_{C1}$ and $Q_{J1}$)*

Do you think that the current approach to keeping construction site records is:

**a)** Suitable and adequate.
**b)** Inadequate and in need of improvement.

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Choice **(a)** ranked 2 and **(b)** ranked 1, C1=Site supervisors' data , C2=Claims consultants' data

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Worksheet size: 74499 cells

MTB > Print C1 C2.

MTB > Info.

Information on the Worksheet

| Column | Name | Count |
|---|---|---|
| C1 | | 65 |
| C2 | | 8 |

MTB >

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| Row | C1 | C2 |
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| 1 | 2 | 2 |
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| 62 | 1 |
| 63 | 1 |
| 64 | 1 |
| 65 | 1 |

MTB > Mann-Whitney 95.0 C1 C2;
SUBC> Alternative 0.

**Mann-Whitney Confidence Interval and Test**

C1 N = 65 Median = 2.0000
C2 N = 8 Median = 1.0000
Point estimate for ETA1-ETA2 is 0.0000
95.1 Percent C.I. for ETA1-ETA2 is (0.0002,0.9998)
W = 2499.5
Test of ETA1 = ETA2 vs. ETA1 ~= ETA2 is significant at 0.0969
The test is significant at **0.0368** (adjusted for ties)

- ***Questions ($Q_{E3}$ and $Q_{L2}$)***

Are you satisfied with the way in which delay records are kept?

**(a)** Very satisfied
**(b)** Quite satisfied
**(c)** Not satisfied

---

Choice **(a)** ranked 3, **(b)** 2 and **(c)** 1, C1=Site supervisors' data , C2=Claims consultants' data

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Worksheet size: 100000 cells

MTB > Info.

Information on the Worksheet

| Column | Name | Count |
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| C1 | | 65 |
| C2 | | 8 |

MTB > Print C1 C2.

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| 61 | 2 |
| 62 | 2 |
| 63 | 1 |
| 64 | 1 |
| 65 | 1 |

MTB > Mann-Whitney 95.0 C1 C2;
SUBC> Alternative 0.

**Mann-Whitney Confidence Interval and Test**

C1 N = 65 Median = 2.0000
C2 N = 8 Median = 2.0000
Point estimate for ETA1-ETA2 is 0.0000
95.1 Percent C.I. for ETA1-ETA2 is (0.0001,0.9999)

W = 2510.5
Test of ETA1 = ETA2 vs. ETA1 ~= ETA2 is significant at 0.0637
The test is significant at **0.0069** (adjusted for ties)

MTB>

- ***Questions ($Q_{E6}$ and $Q_{L5}$)***

From your records, are you able to pinpoint exactly when each of the delays on the contract was effective?

**(a)** Always **(b)** Often **(c)** Sometimes **(d)** Seldom **(e)** Never

---

Choice **(a)** ranked 5, **(b)** 4, **(c)** 3, **(d)** 2 and **(e)** 1, C1=Site supervisors' data, C2=Claims consultants' data

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MTB > Print C1 C2.

Data Display

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MTB > Info.

Information on the Worksheet

| Column | Name | Count |
|---|---|---|
| C1 | | 65 |
| C2 | | 8 |

MTB > Mann-Whitney 95.0 C1 C2;
SUBC> Alternative 0.

**Mann-Whitney Confidence Interval and Test**

C1 N = 65 Median = 4.0000
C2 N = 8 Median = 3.0000
Point estimate for ETA1-ETA2 is 1.0000
95.1 Percent C.I. for ETA1-ETA2 is (1.0002,1.9999)
W = 2617.0
Test of ETA1 = ETA2 vs. ETA1 ~= ETA2 is significant at 0.0002
The test is significant at **0.0000** (adjusted for ties)

- ***Questions ($Q_{G4}$ and $Q_{N2}$)***

With the records that you keep, are you easily able to determine the contractor's rights to an extension of time?

**(a)** Always **(b)** Often **(c)** Sometimes **(d)** Seldom **(e)** Never

---

Choice **(a)** ranked 5, **(b)** 4, **(c)** 3, **(d)** 2 and **(e)** 1, C1=Site supervisors' data, C2=Claims consultants' data

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MTB > Print C1 C2.

Data Display

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| 65 | 1 |

MTB > Info.

Information on the Worksheet

| Column | Name | Count |
|---|---|---|
| C1 | | 65 |
| C2 | | 8 |

MTB > Mann-Whitney 95.0 C1 C2;
SUBC> Alternative 0.

**Mann-Whitney Confidence Interval and Test**

C1 N = 65 Median = 4.0000
C2 N = 8 Median = 3.0000
Point estimate for ETA1-ETA2 is 1.0000
95.1 Percent C.I. for ETA1-ETA2 is (0.9999,1.0001)
W = 2566.0
Test of ETA1 = ETA2 vs. ETA1 ~= ETA2 is significant at 0.0046
The test is significant at **0.0027** (adjusted for ties)

MTB >

# *LIST OF PUBLICATIONS*

Resulting from the work carried out as a part of this thesis, the following papers have already been published:

- Scott S. and Assadi S.O.A., ***The Quality of Site Records***, First International Conference on Construction Project Management, Singapore, January 1995, pp 437-443.

- Assadi S.O.A. and Scott S., ***Computerising Construction Site Records***, International Conference on Developments in Building Technology, Slovakia, September 1996, pp 1-10.

- Assadi S.O.A. and Scott S., ***Improving Claims Assessment Procedures by Keeping Better Site Records***, 2nd International Conference on Construction Management - The Origin, Incidence and Resolution of Construction Conflict, United Kingdom, September 1996.