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WORK NORM ANALYSIS FOR MEDIUM SCALE BUILDING PROJECTS: A CASE STUDY

Master of Business Administration

In

Project Management

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Abstract

It is accepted that construction industry plays a vital role in an economy of a given country. In Sri Lanka, the construction sector was continuously growing at high rate in the pervious years and it has significantly contributed to the Sri Lankan economy. Material and labour components are the main inputs to the construction industry. Planning, controlling, and monitoring of material and labour components are the key factors to successfulness of projects. The standard norms were developed many years ago in order to assist to the above functions. With technology transferring to the industry, work norms for construction industry are to be reviewed; however, it was not touched during the last two decades. In Sri Lankan context, standard work norms are available and it is called as Building Schedule of Rates (BSR). In fact it is very useful in estimating different parameters.

The main objective of this research is to develop the work norms for building construction activities. Further, it investigates the experimental and BSR standard norms on few construction events. This thesis also describes the productivity of the labour, material consumption in construction work. Moreover, daily work completed, material consumption and labour involvements were closely examined in two different sites selected and all the data were recorded on daily basis with respect to the construction events. The experimental data were analyzed by simple statistical techniques and compared with the standard norms available up to date.

The research findings revealed that actual material consumption IS relatively high comparing to the standard BSR values which were previously developed. As per the findings of the research, cement and sand were excessively consumed in all construction events. In this research, daily labour outputs were also examined and it was found that productivity of the labour was higher than the BSR standard values. Furthermore, it is recommended to review the previous standards in order to adapt the current practices.

DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.

U.K.D.L.T. Udawatta

I endorse the declaration by the candidate.

UOM Verified Signature

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List of Abbreviations and Acronyms

BSR	Building Schedule of Rate
DI	Direct Implementation
ICTAD	Institute for Construction Training And Development
SLS	Sri Lanka Standard
SMM	Standard Method of Measurement
UNOPS	United Nations Office for Project Services

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CHAPTER 1

INTRODUCTION

1.1 Background

The Sri Lankan economy recorded a growth of well over 6 percent for the fourth consecutive year for the first time since independence. Hence Sri Lanka has now moved on to a higher growth path of above 6 per cent per annum from the historical average of around 4-5 per cent. The construction industry is one of the main economic sectors in Sri Lanka and its contribution to the GDP is a considerable amount which accounted for a growth of 6.5 in the year 2008 (Central bank annual report, 2008). The construction industry plays a vital role in the economy and in fact it is the backbone of the development process in the economy. It affects human beings directly as well as indirectly. It is so, because the construction sector provides one of our basic needs as shelter and comes up with different infrastructure facilities for a number of secondary needs such as health, education, transportation etc which are essential to human living. In Sri Lanka the construction sector continued to expand at a relatively high rate of 7.8 percent during 2008 in contrast to a 9.0 percent growth in the previous year with a positive contribution from both the government sector and the private sector. (Central Bank Annual Report, 2008). In the last year, construction activities of the government sector were largely concentrated on infrastructure development schemes particularly in road network expansion and harbour development projects. After the war in the northern part of the Sri Lanka, accelerated new development programs are being launched and a rapid construction boom is expected in the construction industry with starting North & East development projects.

The labour force is one of the major judges of macro economic performance in an economy. Labour is always and everywhere the largest factor of production and labour income always contributes to a larger part of the national income. (Ramachandra, 2008, p.54). Construction is a labour intensive industry and considerably a large amount of employment is provided by the construction industry. Increasing of the labour productivity is a major challenge to any industry. However there are several methods available to improve the productivity. Specially in the construction industry, contractors and other external parties such as sub contractors, service providers etc have their own systems to increase the labour productivity towards the motivation, training, teamwork, giving intensive, developing leadership qualities etc. In Sri Lanka, very limited work had been done to study construction productivity in respect of

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labour. (Raftery, 2004) Although a variety of labour force information is usually available from many sources, many are unreliable. Thus calculating of the labour requirement is different construction skills in essential for financing and predicting for the effective construction project planning and executions.

Ganesan (2000) stated that materials account for the large input into construction activities, in the range of 50%-60% of the total cost. In addition a wide variety of materials are used in the construction. Hence material management is another main characteristic to increase the productivity. Proper material planning, scheduling and monitoring are the most essential things at the different stages of procuring, delivering, handling, storing and at the usage. Accurate calculation of the quantities of material is most essential and knowledge of actual material usage is the main factor to determine the precise quantities. Norms of the Building Schedule of Rates (BSR,1988) were taken as the basis for analysis of the material requirements for the work items of the Bill of Quantities. This is justifiable as most contractors use the Building Schedule of Rates (BSR,1988) for estimating and material requisition. However it should be noted that the impact of inaccuracy of the BSR Norms on the calculation has not been taken into consideration. (Rameezdeen and Kulathunga 2004).

UNOPS (United Nations Office for Project Services) is an implementation and project management organization since 2005 in Sri Lanka and more than 400 projects in different scales were delivered during the past five years. ICTAD (Institute for Construction Training and Development) is the organization which controlled and graded the Sri Lankan contractors. Many of the contractors who are registered in the ICTAD in different category were involved in UNOPS bidding process. In the past few years, UNOPS observed that a significant price difference between the lowest and the highest bid value appeared at the bid opening. Some bid values of contractors were more than sixty to eighty percent higher than the engineer's estimate. After a detailed analysis, UNOPS observed that the highest bidder's individual rates were very much higher than the engineer's estimate. Hence it is very difficult to win at the competitive bidding process. The best practice for this type of scenario is that the company's own pricing strategy should be reviewed from time to time considering market trends. However, some contractors are not practicing the above and due to this fact some companies are not getting the competitive bids. To prevent such situations in the construction industry, it is better to review the pricing strategy after analyzing it, through an industry survey.

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It is important to study and analyze the productivity evaluation of the construction labour force and material usage for respective works. Minimization of material wastage and labour idling is one of the aspects of this optimization task. Motivating the work force in general is needed and setting the daily targets to increase the work performance by individuals is also needed for better productivity of an organization. After analyzing the individual work output, this can be used to reward the work. For example, this measure can be used to increase the daily wage for labourers. The estimation of required labour force through a proper analysis is useful and transfer of this knowledge to the on site staff as technical officers, supervisor and even junior engineers would be beneficial. Similarly, to measure the actual material usage for a particular work and to share the knowledge among the organizational management would also be useful.

Construction waste is the waste generated from various activities such as clearing of sites and the building of new structures or infrastructure (Kofoworola and Gheewala, 2008) Calculation of percentage wastage and taking action to minimize it is also beneficial to the organization. In Sri Lanka concrete and mortar showed 21% and 25% of wastage respectively due to the excess use of materials in rectification of inaccuracies (Jayawardana, 1994). The significance of money thrown away as waste was noted by Coomaraswamy (1979). Waste materials in construction to a certain extent are unavoidable. However Jayawardana (1992) noted that the wastage of materials in most of the construction sites in Sri Lanka was beyond the acceptable limit. According to the Rameezdeen (2004) inaccurate quantity calculation was one cause due to material wastage and it was found that inaccurate BSR was used for estimating and requisition.

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1.2 Research Problem

In the Sri Lankan construction industry, Building Schedule of Rates (BSR) is the only available standard document related to the work norms and it is used for planning, estimating and controlling the labour and materials requirement for civil engineering projects. This document was published before the few decades by the building department and last revision was made after work studies on 07.07.1988. Available document was fairly old with technology transferring rate and practicing of outdated guidelines in the civil engineering industry is unethical and need to address by the relevant authorities.

New technology, tools and equipment are being changed day by day and new technology transferring is on a very high rate. In addition new construction methods, product innovations to increase the workability are being introduced to enhance the work performance and productivity. Skilled development and training for the construction work force is another important feature and such programs are being conducted for work forces. In addition human resource development activities are being used to increase the productivity towards the motivation. Hence productivity of the construction work force is relatively high compared to the BSR standard.

Non-availability of the reliable labour and material norms in the construction industry is one of the critical issues especially for contractors, estimators and project managers. This study was based on these problems in the industry and *Work Norms Analysis for Medium Scale Building Projects : A Case Study* which was the research title.

1.3 Research Objectives

Based on the background of this study, the aim of this research study was as work norms analysis for building projects and it was developed as a case study. Moreover, consequent objectives can be given as follows:

- To develop the work norms for building construction sites
- To compare the experimental work norms with BSR standards available
- To analyze of actual material usage for respective activities
- To discuss the causes due to norms differences.

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1.4 Importance/ Benefits of the Study

Planning is the most important task at different phases in any project. At the project execution up to the closing stage different planning techniques and personnel are involved to deliver the project in time, at the estimated cost with desirable quality. This study will help in order to benchmark the planning of labour and material building projects.

Knowledge about the actual material consumption in the construction activities can be considered as is one of the critical things for the construction industry. Further, analysis of labour norms and quantitative values of the manpower requirement is another important feature in this field. This study can be used as a guideline, especially for the construction field staffs and the knowledge can be shared with each other. It will help to monitor the workforce performance, material consumption for respective works, knowledge on wastage, procurement and planning purposes. In addition to these, guideline can be used to motivate the workforce by setting the achievable daily targets.

Building Schedules of Rate (BSR, 1988) is the standard document that was published by the Building Department which is used to identify the composition of the material and labour. However, it is worth nothing that this document has not been updated for the last twenty years. The results and recommendations of this study can be used as guideline for similar purposes. This study can be used to evaluate the overheads and profit margin of the company and maximize the profit in certain activities. As a result, company pricing strategy can be changed with respect to the actual work norms; hence the company can get the competitive advantage at the pricing of the bids when compared to the other bidders.

This is very useful for proper material purchasing, plant operations and equipment planning with actual quantities in construction projects. In addition, this work study will be very useful to the engineers, estimators and project managers for planning, controlling and monitoring of activities.

As an entrepreneur, starting a new business will be exciting and great challenge. In Sri Lanka, there is a new tendency to form new entrepreneurships due to the developing nature in the country. An entrepreneur is a person who has possession of an enterprise, or venture, and assumes significant accountability for the inherent risks and the outcome. An entrepreneur is an independent businessman who efficiently and effectively combines the factors of production or services. If it plans well, the person entering the job market of the future will find the most exciting and rewarding opportunities in entrepreneurship. Establishing of new entrepreneur is one of the solutions to the economic, social and financial problems in Sri Lanka. This is a new initiative and several promotional campaigns are conducted by government bodies to create the new employment opportunities. New entrepreneurs can understand the market trends and reduce the gap on entry barriers to the market. Hence, they can get the competitive advantage at the pricing of the bids compared to the bidders.

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1.5 Research Methodology

In finding the labour and material norms for selected activities such as brick work, plastering, rubble work etc the data was collected from three different ongoing building construction sites. A special template was designed for data collection and data collection was carried out on daily by the site staff. Basic introductory training was conducted for the site staffs and it was covered taking off the quantities, measuring the consumed material & labour quantity and documentation. The following day all the data was entered to the electronic format and

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detailed analysis was carried out by using simple statistical tools. Finally experimental data was compared with the standard BSR norms.

1.6 Limitation of the Research

The research was based on the actual data collected from the selected building sites. Labour and material usages were two main components of the research and individual measurements were taken as data. Labour norms, performance and productivity of the labour force, a particular category in the construction industry were selected and analyzed by taking daily work performance data. Group performance was measured for a given respective activity and it is further analyzed. Material, plant and equipment usage were also measured at the site from the actual data gathered from the construction sites.

- Data collection works were carried out by only UNOPS direct implementation projects due to easy access to any level of staff, controlling and monitoring facility on site.
- Labour involvement can appear in most of the fields such as textile, transport, production, power etc. However, manpower of the building construction sector was taken into consideration for this research.
- There are plenty of activities on construction sites. However, it was basically considered an important civil works due to the time constraint.
- Date collection was limited to the 06 month duration and both project were mobilized since few months. Hence data collection part was concentrated mid to end of the project and finishing activities were focused for the research.
- Specialized work categories such as Aluminum fabrication, water proofing, anti-termite treatment were not considered. Only labour force based activities were considered for this research.
- In this study, less costly and insignificant materials such as nails, screws, admixtures etc. were not included. Note that water also was not considered.
- BSR is the standard document on work norms, and it was used for comparisons.
- Some important activities such as concreting, reinforcement, formwork etc were not evaluated for this research. The main reason was that data collection was limited to a few months and some of the activities were not counted on the research period. Hence, such items were not included in the research.

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1.7 Contents of this Thesis

There are six chapters in this dissertation. The structure of the dissertation is as follows.

Chapter 2 reviews the literature on work norms to get background information on productivity, workforce planning, material management and quantification of the work done, material and labour consumption for the construction industry, wastage of the building construction site.

Chapter 3 explains the methodology used in the research. In this chapter, problem statement for the research, the design of the research, sample design, parameter selection are explained.

Chapter 4 brings the data collection and analysis of this study. In this chapter, preliminary data collection, method used for data collection, data preparation for analysis and material/ labour consumption are explained. In addition the deviation of this study is also clarified

Chapter 5 explains the data interpretation and results in the research. In this chapter, the data interpretation and analysis, comparison of material, labour consumption in this research are explained

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Chapter 6 Finally, conclusions of the study, recommendations and further research areas of the study are presented.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The first chapter shows the general information on research problem, background, objectives, importance of the research and the limitation of the study. However details on the research were further described through the next chapters of the thesis. The construction industry is a critical part of any economy because of both its size and the potential role it can play in the development efforts of the economy. One of the most important economic features is that it creates the facilities that are necessary for the production and distribution of all other goods and services (Ramachandra, 2005). The construction sector encompasses a wide spectrum of activities including building, roads, irrigation, bridges etc. In the developing countries, per capita income is low; the construction sector plays an important role in the development process. The construction industry is one of the main economic sectors in Sri Lanka and the share of it to the GDP was a considerable amount which amounted to 6.5 percent in the year 2008 (Central Bank Report, 2008). The labour force is one of the major judges of macroeconomic performance in an economy. Labour is always the largest factor of the production and this income always contributes a large part of the national income. According to the Central Bank of Sri Lanka, the direct employment by the construction industry numbered around 533,000 and was 7.4 of the total labour force employed in 2008(Central Bank Report, 2008).

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2.2 Productivity of Labour Force

Sri Lanka has a highly skilled labour force, however their availability for the local construction industry is limited due to heightened overseas demand particularly by middle east countries coupled with reluctance of the youth to enter the industry. The remaining element that must come to the point of the work at the right time and in proper sequence is, of course, labour (Warren, 1989). Labour is one of the main elements in construction that significantly influences the cost of the project. Large up front investment is required to begin and execute projects and success or failure rests on the ability to arrange a suitable finance mechanism (Raftery, 2004). Quantity of labour is as important as quality of the end product. The starting point for determining the best manpower levels is usually a careful review of the scope and estimate of the project to determine overall quantities of labour man-hours required by basic activity (Warren, 1989). Labour productivity is the most widely used yardstick of operational efficiency. This does not imply that the labour is the best input element for the productivity measures, however it simply reflects the difficulty or impossibility of obtaining numerical values for the other determinants of productivity (Nimalan, 2004). One common measure of it is average labour productivity which is expressed on a ratio of output per employee. In this study productivity of the labour forces as group performance was also measured and finally productivity of skilled labour per day was calculated.

The relationship between productivity, labour utilization and growth in construction is important. There is a common belief that growth in labour productivity in construction has slowed. It is difficult to achieve mass production due to the one-off nature of the projects and because construction is spread over numerical locations. (Ramachandra, 2008). A similar scenario was observed in this research and it affected some of the activities. However any concern over low productivity should not be confined to labour alone. Furthermore, the construction sector in many developing countries faces the difficult option of expanding output at low labour productivity due to a specific resource (Ganesan, 2000).

In the fields of architecture and civil engineering, construction is a process that consists of the building or assembling of infrastructure. Most of the infrastructure development projects, funded by multilateral development agencies suffer due to delays and low productivity, poor progress, poor quantity outputs, etc, which will retard the economic and social development and present goals to be achieved and expected by the funding agencies. Labour productivity is the most widely used yardstick of operational efficiency.

This does not imply that the labour is the best input element for productivity measurement; however, it simply reflects the difficulty or impossibility of obtaining numerical values for the other determinants of productivity (Rendall and Wolf, cited in Nimalan, 2004, p 23). One of the common measures of it is the average labour productivity, i.e., a ratio of output per employee. The relationship between productivity, labour utilization and growth in the construction industry labour productivity in construction has slowed. Not only is work organized differently, the norms and standards by which it is regulated also differ from one setting to another. In a world where individuals are moving continuously between different work settings, it is natural to compare and contrast different conditions of work and to think of a common set of standards.

Construction is a labour intensive industry which relies heavily on the skills of its labour forces. As the level of construction activity in a country depends on the status of its economy at a given time, it is very difficult for the construction industry to sustain a skilled work force on a long term basis compared to other industries. The skill requirements of the construction labor force change with time due to changes in workload and technology in the industry. (Gunawarana and Jayawardana, 2001). Construction sites are not up to the required standard often resulting in loss of productivity due to accidents, poor health and unsatisfactory welfare aspects (Jayawardana and Sadadcharan, 1996). The root causes of the accidents were found to be the carelessness, ignorance and lack of training, lack of disciplines and poor communication of the people involved. The two main frequent mode of accidents were fall of persons and fall of objects on persons. The majority of the people affected were found to be labourers (Jayawardana and Sadadcharan, 1996).

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2.3 Material Consumption in Construction

Material is the most important component in the construction industry and it accounts for the largest financial input into construction activities, in the range of 50%-60% of the total cost. (Ganwsan, 2000). In addition a wide variety of materials are used in the construction. Quantitative analysis of building material consumption is paramount important for all the parties in the construction field such as clients, designers, contractors and project managers. The main objective of this study is to quantify the material consumption for most commonly used building construction activities. Material reconciliation is a very tedious process and it was limited to the most commonly used materials in the Sri Lankan construction industry (Rameezdeen and Kulathunga, 2004). According to the Rameezdeen study the most commonly used materials in building projects are cement, rubble, steel, timber, aluminum and so on and quantitative values as percentage 10.39, 9.92, 9.54, 5.81 and 3.41 respectively. The methodology described in ICTAD (1998) for computation of input percentages from the Bill of Quantities work items were used in this study. The composition of material for work items is computed based on the norms of the Building Schedule of Rates (1988). This is justifiable as most contractors use the BSR for estimating and material requisition. However it should be noted that the impact of inaccuracy of the BSR norms on the calculation has not been taken into consideration in this study (Rameezeedeen and Kulathunga, 2004)

Cost of waste has a significant impact on the Sri Lankan construction industry. Thus a number of studies have been carried out in this context. According to Jayawardana (1994) concrete and mortar showed 21 and 25 percent of wastage respectively due to the excess use of materials in the rectification of inaccuracies. Even though it has been identified that minimization of waste to a certain extent is unavoidable (Skoyles, 1987). Jayawardana (1994) states that wastage of materials in most construction sites in Sri Lanka is beyond acceptable limits.

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2.4 Building Schedule of Rates (BSR)

Building Schedule of Rates (1988) is the only written standard document that was published by the Building Department. It is used to identify the composition of the material and labour for respective works. The latest revision and necessary adjustments were made by the technical committee appointed by the Ministry of Local Government. The final report was submitted on 07.07.1988 and this document is still being used without any revision. Construction technology, method, tool, equipment etc are being changed day by day. However reliability of these data and applicability of this document is questionable. The building schedule of rates is used by the contractors to price their tenders. Well grown companies may have their own norms derived from past experience. However a guiding document may be very useful to the newcomers, whether they are consultants, contractors or project managers.

This schedule is to be read in conjunction with the standard specification for buildings, the special specification for soil, drainage and water supply except where they are superseded by notes or descriptions in the schedule. During the construction stage, the BSR is useful to calculate material, plant and labour requirement and it is also useful for financial planning, scheduling and monitoring purposes. BSR template is as follows.

Table 2.1: Building Schedule of Rates for Brick Work

Direct Work Items	(1) Labour (days)			(2) Materials						(3) Plant etc.			
	i	ii	iii	i	ii	iii	iv	v	vi	i	ii	iii	iv
	Spc. Sk.	Sk.	Un/Sk.	Brick 1000	Sand M^3	Cement 50 Kg	Wire cut bricks 1000	Acids Ltrs.	Slaked lime 50 Kg			Tools etc.	
Brick work in 1:5 ct. Sand mtr. In foundation. ($3m^3$)		3.2	4.3	1.60	0.75	4.30						3% of (1)	
Ditto - in 1:8 ct. Sand mtr. In foundation. ($3m^3$)		3.20	4.30	1.60	1.15	2.50						3% of (1)	
Ditto - in 1:5 ct. Sand mtr. In 112.5mm thick walls in ground floor. ($10m^2$)		1.60	2.15	0.60	0.30	1.40						3% of (1)	5% of (1)
Ditto - 225 mm thick walls in ground floor. ($10m^2$)		2.40	4.05	1.25	0.60	3.25						3% of (1)	3% of (1)
Ditto - 337.5 mm thick walls in ground floor. ($10m^2$)		3.15	5.90	1.85	0.90	4.85						3% of (1)	2% of (1)
Ditto - in 1:8 ct. Sand mtr. In 225 mm thick walls in ground floor. ($10m^2$)		2.40	3.25	1.25	0.90	1.90						3% of (1)	3% of (1)
Brick work (wire cut) in 1:5 ct. Sand mtr. In 112.5 mm the walls in ground floor ($10m^2$)		1.6	2.15		0.25	1.3	0.6					3% of (1)	5% of (1)
Ditto - 225 mm the walls in ground floor. ($10m^2$)		2.4	4.05		0.55	2.7	1.2					3% of (1)	3% of (1)
Ditto - 337.5 mm the walls in ground floor. ($10m^2$)		4.05	5.9		0.9	4.85	1.8					3% of (1)	2% of (1)

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In above BSR shows that quantitative analysis of labour, material consumption and plant usage for independent construction activity is described in the above table. As example cement, sand and brick are used as row material for construction of 225mm thick brick wall. For this construction activity; material consumption on cement, sand and brick for 10 square meter area are 3.25 of cement bags, 0.60m3 of sand and 125 nos bricks respectively. Labour involvement for 225mm brick work is 2.40 skilled labours and 4.05 unskilled labours. In addition, plant and equipment cost is shown in this table it was calculated as percentage of the labour cost. Similarly some other type of brick work are described in above table and it will be applicable with type of the construction. Basically in this research, these values are reviewed by the recording the actual norms on construction activities in different sites. There are plenty of construction activities available in the construction site, however many of items are present in the BOQ.

2.5 Method of Measurement of Building Works

The Sri Lanka Standard Method of Measurement of Building Works (SLS 573) was first developed on a request made by the National Metric Conservation Authority and was published in 1982 on the recommendations of the Civil Engineering Divisional Committee. Measurement occupied a very important place in the planning and execution of any building work from the time of first estimate to final completion of the project and settlement of payments. This provides guidelines in carrying out this work using only metric units and applies to the preparation of estimates and bill of quantities and to site measurements. In this research, these guidelines were followed mainly for sampling, data collection and analysis

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In Fox, S., Marsh L., and Cockerhanh G. (2002) it is stated that since the early 1960s, the construction industry has been continually criticized for its low productivity and poor quality. Throughout this period, it has been widely recognized that building design has a significant impact on construction performance. As a result, considerable research and industry efforts have been focused on improving information and activities in the building design process. First, design imperatives are defined. Then, an analysis of their determining influence on design information and design activities are provided. Next, it is

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explained how design imperatives, rather than information and activities, constrain productivity and quality by limiting production options. In conclusion, it is argued that design imperatives have a greater influence on productivity and quality than the industry in which design is carried out (Fox, S., Marsh L., and Cockerhanh G, 2002).

2.6 Work Study

Work Study principles and practice were developed from the early 20th century to improve productivity. Method Study and Work Measurement, which are used in examining human work in all its contexts, and which lead to systematic investigation of all the resources and factors affecting the efficiency and economy of the situation being reviewed, in order to effect improvement. The systematic recording and critical examination of the factors and resources involved in existing and proposed ways of doing work, as a means of developing and applying easier and more effective methods and reducing costs. Method Study is that part of Work Study which classifies, selects and defines operations to be studied; records the procedures currently followed; analyzes the method; and develops alternatives from which the optimal is selected, installed and maintained. The application of techniques is designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance. Work Measurement studies the work content of an operation. In order to compare different operations, they are broken into typical tasks and measured in terms of time. Continuous Time Study is more appropriate for operations of a cyclic nature involving a few resources. A construction operation usually consists of several activities. The study measures the total time that has elapsed in a series of activities. Most often, a manual approach allows the stop watch to run continually. Time for each observation is recorded and the incremental times may be computed from the consecutive readings.

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2.7 Wastage on Building Construction Sites

Wastage to a certain extent is inevitable on building sites and this is generally recognized by everybody in the construction industry. However there is considerable evidence to indicate that wastage of materials and labour on our construction sites is beyond acceptable limits (Jayawardana, 1994). Considerable amount of material wastage and idling of human resources on building sites can be eliminated by proper management throughout the project. Any attempt to reduce wastage beyond the reasonable limits will always become uneconomical. However on most of our building sites wastage due to factors such as poor storage, inefficient handling and utilization of construction materials, improper use and lack of maintenance of construction plant, inappropriate construction method, misuse of manpower, poor planning, lack of cost control and poor communication are beyond reasonable limits. Although practitioners do have some idea of these wastage, they are often unaware of the real causes, magnitudes involved and techniques available to reduce them. (Jayawardana, 1992).

Determining the required actual time for construction event is very essential for construction practitioners and it can be used directly for planning and controlling the project. In addition it will help to minimize the construction delays in the project. In modern competitive and complex construction industry, construction delays have a become a major concern to all contracting parties throughout the world. Despite all the planning and negotiations that go into scheduling construction projects, delays are an inevitable part of the process and the key to completing a project successfully is dealing with rather than trying to avoid delays (Jayawardana and Panditha 1999). Construction duration which is generally determined in the preliminary stage of a project is only a part of the life cycle of the project. However this duration is increasingly important I determining the date of commissioning of the project for its intended purpose estimated cost of the project, cash flow requirement and so forth. Delays may drastically affect the above factors and thereby lead to increased project cost and losses to stakeholders in various forms. Various researches were listed various delay factors for construction project and most important causes of delay factors are rainy weather, manpower shortage, material shortage, contractor's cash position and equipment shortage.

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2.8 Summary

The literature review presents previous studies and the relations on research problem and its nature. Hereby major focuses were given for labour productivity, material consumption in construction site, method of measurement of the work and construction waste. Labour productivity was one of the major elements of the research and Sri Lankan labour performances were mainly concentrated under the literature review. Material is most important and largest financial input in the construction industry. As a result material usage and reconciliation on construction industry were reviewed in different studies. In Sri Lanka, BSR was taken as standard for construction industry and it shows material, labour and plant consumption for construction activity. Standard method of measurement was guideline for carrying out the estimation work. Excessive construction waste was one of the major issues in the industry and many researches were carried out to quantify the wastage and develop the mechanism to minimize the wastages in the construction sites. These previous studies were very useful to develop the research background and well supported for detail analysis.

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CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Previous chapter reviewed the background work related to the work norms and productivity in the construction industry. Productivity of labour and material, especially in building construction is taken into consideration in order to review the literature. In addition, it revealed the implications and significance of the topic. This chapter converses the methodological framework supposed to adopt for the development of the study. Moreover, this chapter illustrates the research strategy, research process and limitations which were adopted for this study in detail.

3.2 Problem Statement for the Research

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It is very difficult to predict the human resource performance because it depends on several factors. Especially, the measurement of daily performance of a labour in the construction industry is very difficult task. However, it is very important in all the phases in a given project. Although workforce offers several benefits there is no method to determine the skill level in the construction. Construction is a labour intensive industry that places heavy reliance upon the skills of its workforce. Paucity of skilled workforce results poor quality, high wastage and long term productivity decline in the industry. (Jayawardana and Gunawardana, 1998)

Entry barriers for new entrepreneurs exist in the construction industry due to lack of experience and high competiveness of the field. Most of the new jobs are offered through competitive bids, hence new entrepreneurs are facing to win the bids without own pricing strategy. Most of new bidders rely on BSR work norms until they develop their own pricing formulas. These BSR data was published by the building department and not updated by last twenty years. However, construction techniques, tools and equipment are changed day by day. In fact these standards have been changed slightly and not suitable to use them for developing the rates.

Price difference between the lowest and the highest bid is very high even if it is a competitive bid. Last few years UNOPS has observed that the bid values of some of the bidders were extraordinary high compared to the Engineer's Estimate and the lowest bidder. Meanwhile, it has been observed that such a bidder has not considered reviewing their pricing strategy with the market growth. It was the main disadvantage in the competitive market and mismanaging of the company time, cost and manpower. Hence it is better to review the unsuccessful bidder's pricing strategy in order to survive in the competitive market.

It has been concerned that there are two types of project implementation modalities available to deliver the projects carried out by UNOPS. One is called as "Direct Implementation" which is carried out through in house with a well trained team and using subcontractors in special areas of expertise appointed for particular deliverables of the construction process. Second one is the "direct contract" through a competitive bidding process. In these two scenarios concerned, considerable amount of saving was observed in the process of direct implementation category and finally cumulative figure was approximately 10 - 20% of the total contract sum. After a thorough analysis, basically this money was accumulated on the civil work compared to the Mechanical & Electrical portions.

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In the construction industry, monitoring of the productivity is not accessed though it is important to study the productivity evaluation of the construction industry labour force. There is no standard method to evaluate the construction work force performance and productivity at the site. Material is the major factor in the construction industry and the cost of the materials can exceed half of the project cost. The building materials account for the large input into the building activities and account for 50% to 60% of the total cost. (Gunasan, 2000). Therefore, there is a great necessity to manage the material at the pre and post construction stages. Knowledge about actual material consumption for specific work is more important, hence material wastage can be reduced at different stages of the project. The lack of knowledge of the key personnel such as supervisors, technical officers, store keepers and certain category of engineers at sites about material usage is a major criticism.

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Review the present construction norms is prime requirement in the industry, therefore, it is timely needed to address this research problem.

3.3 Research Design

Here, the research design can be considered as the overall picture of the research which is presented in this section. The design is used to structure the research, to describe how all of the major parts of the research project works together try to address the central research question. This quantitative research was designed as an empirical study rather than a theoretical study. Data collection approaches, research sampling, data collection technique, data analysis techniques and comparison with standard norms were designed as compatible with the particular research. Figure 3.1 shows the important steps to be carried out on the research process.

The research design basically focused on to the research problem. Develop the work norm for building construction was the research objective. In the construction industry, plenty of independent activities are available. With time restriction of the research, few construction activities were focused to carry out the detail analysis. As initial step, some activities on building construction were selected among the various civil engineering field. In building construction industry, different scales of projects are available from multi-storied to single units. Three storied building sites were selected for data collection. Then, a site will be selected in such a way that enough data is available for the study. During data collection period, all the site activities were recorded and raw data was filtered with considering actual records. Complete data sets were taken for final analysis and seven different independent activities were selected considering available data sets. Detail analysis was carried out for selected activities and final comparison with BSR standard and experimental was done for individual activity basis. Final conclusion and recommendation were based on the detail analysis.

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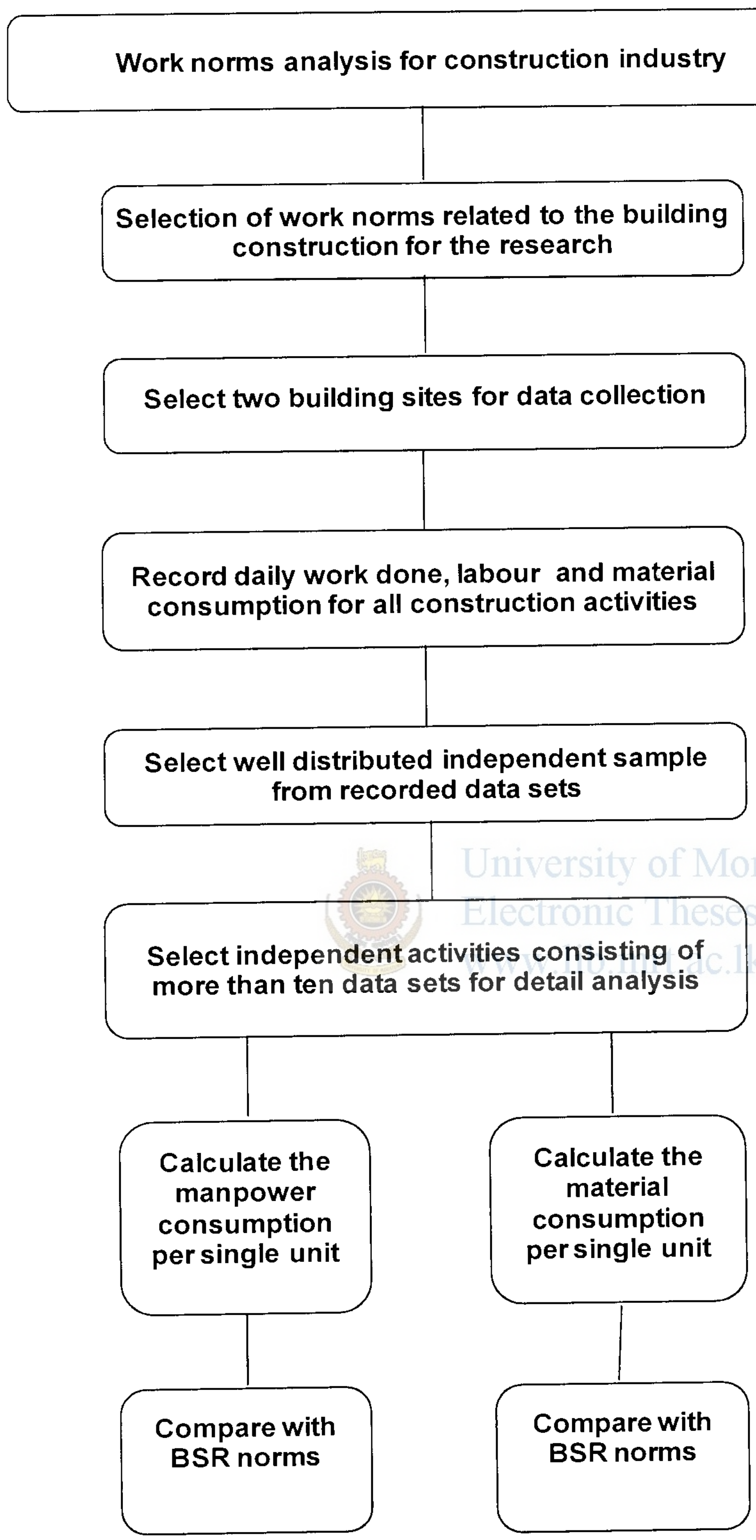

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Figure 3.1 – Flow Diagram on Research Design

Main objective of this research is to develop the work norms for material and labour force in building construction activities. In Figure 3.1, first, we identify the work norm parameters to be analyzed in this study. Basically, research was carried out by using collecting daily records at selected sites. Building construction site was selected in order to collect data according to the availability. Most essential parameters which can be collected from the site were defined at the research design stage. In construction project, there are plenty of activities can be found during the construction phase. For this research, activities related to the civil work were selected and some special work as aluminum work, water proofing, electrical work etc were not selected for the same because these specialized works are usually carried out by using the out-source sub contracts. Basically, works as fabrication will be carried out by the specialist subcontractors at the own premises and fixing & installation works only done at the sites. Hence, it is very difficulty to collect the data with the required standards. Another reason is that civil work is the main body of the construction industry and it covers more than fifty percent of the contract sum and more labours intensive job compared to the other activities.

To fulfill the objectives of the research, defining of the parameters is one of the important tasks. Daily work done on specific task is measured in order to analyze the performance of the workers. Different material and plant quantities used for specific construction activity were measured to analyze the actual norms.

Having prepared a data collection template, a basic introduction work shop was conducted to be trained the supervisors/technical officers and it was covered basically on taking of measurements, grouping the activities, calculating the material quantities, measuring the working hours and entering the data to the template. In addition to the progress recorded on data collection, monitoring part was reviewed at the weekly site meetings. The data collection template was changed several times according to the feed back of the supervisors. Basically it was designed to minimize the writing part and to improve it in a user friendly manner. The data collection part was monitored daily by the site engineer and while the site quantity surveyor calculated the work done and entered into electronic format on the following day. Initially collected data was filtered with respect to the activity basis and entered to the electronic format. After that material usage and labour contribution per unit were calculated. Meanwhile daily work done per skilled labour per day was calculated. In addition to unskilled labour requirement, materials for specific activity were calculated during the time period of a day. For this analysis simple statistical formulas and graphs were used for interpretation. BSR is used to compare the slandered norms with actual norms.

Comparison index can be defined as follows:

$$D = \frac{V_{Actual} - V_{BSR}}{V_{BSR}} \times 100$$

Where, D is the percentage index of a given by a selected activity, V_{Actual} is the actual data measured from respective site and V_{BSR} is the corresponding Building Scheduling of Rate.

3.4 Parameter Selection

In this research, labour and material consumptions were measured in different construction activities. Each construction activity has different parameters with nature of event and such parameters were monitored separately. Table 3.1 given below represents the parameters and relevant variables. Here, item number 1 represents the 225mm thick brick wall in cement and sand 1:5 in super structure in the selected site as an activity. The corresponding materials are cement, sand and bricks whereas it needs skilled and unskilled labor components. Work done of the 225mm thick brickwork is measured as completed work area and unit is square meters. Similarly, item numbers from 2 to 7 bring different activities and their corresponding details. Moreover, the third column shows the unit for each activity.

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Table 3.1: Parameters identified on the research

#	Activity	Unit	Parameters to be measured	
			Material consumption	Labour Consumption
1	225mm thick brick walls in cement and sand1:5 in super structure	m^2	Cement, sand and bricks	Skilled and unskilled labour
2	Internal plaster 12 mm thick in cement, lime and sand 1:1:5 to internal faces of walls and finished smooth with a floating of lime putty.	m^2	Cement, sand and lime	Skilled and unskilled labour
3	External plaster 16mm thick to external faces of walls in cement and sand 1:5 and finished semi rough	m^2	Cement and sand	Skilled and unskilled labour
4	20mm thick cement and sand 1:3 mix rendering on concrete floor, finished smooth with 3mm thick Grey cement putty	m^2	Cement, sand and colour pigment	Skilled and unskilled labour
5	100X12mm skirting in cement and sand 1:3 finished smooth with 3mm thick grey/coloured cement putty	m	Cement, sand and colour pigment	Skilled and unskilled labour
6	Random rubble masonry in cement and sand 1:5 using 150x225mm size broken stone in foundations	m^3	Cement, sand and 6"x9" rubble	Skilled and unskilled labour
7	Smooth plaster 12 mm thick in cement, lime and sand 1:1:5 to sides, sophist of beams, isolated column and finished smooth with a floating of lime putty	m^2	Cement, sand and lime	Skilled and unskilled labour

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In brick work, material and labour consumption for construction of unit area were measured and parameters were defined as cement, sand and bricks for material category. In addition, skilled labour and unskilled labour requirements were measured under labour consumption category. Similarly internal smooth plastering, external semi-rough plastering, floor rendering, floor skirting, random rubble masonry and column/ beam plastering were monitored quantitatively in each site during the research period. In each activity, consumed materials were taken as parameter under the material section and skilled /unskilled labour involvements were selected as parameter under the labour norms analysis.

3.5 Sample Design

Sample design was very important and characteristic of the sample represent the population of the event. The sampling method used to select the organization, activities and set of data was non probability purposive sample. This means that there is no chance to each and every sample for inclusion in population. Purposive means the sample is selected merely for the purpose of the research.

Material consumption and productivity of the labour are vast areas because it extends to various types of labouring activities in the construction and other fields. Hence the construction field has been selected to carry out the research. There has been various construction sites spread all around the country such as irrigation, highway, building, bridge, costal etc. Among the above mention specialized different fields, building construction was selected for the research. Evaluation of labour productivity and actual norms is covered very broad area and considers only the labour involvement of the construction industry.

There are numbers of building projects going on in Sri Lanka. However, as sample of this research, the UNOPS work sites were selected because it is very easy to access, control and monitor the progress of the data collection process. Among the different sites located in different areas, two sites were selected to collect the data and there were the reconstruction of Siddhartha secondary school in Balapitiya, the construction of fisheries harbour at Dodanduwa.

Each officer had to spend around two hours per every day to collect the data and to work out proper documentation. But it is very difficulty to allocate in other organization. Hence mainly UNOPS direct implementation projects were selected for this research. Mainly this data collection part was done by the site supervisors and technical officers directly supervised by the site engineers.

In the building construction work, many of activities can be observed from the foundation to the roof level, however seven construction events were selected finally for the research due to limitation of time.

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3.6 Summary

This chapter brings out how the research design was done owing to the research problem and it further indicates how the parameter selection and sample design was done. Problem statement for the research was described how the research developed through the problems. The research problem was generated from the UNOPS and finally it was developed to find the solutions as case study. Research design can be considered as the overall picture of the research and it was graphically represented in figure 3.1. Parameter selection was another important event of the research. Relevant material and manpower were defined as parameter of the each activity. Finally these parameters were compared with the BSR standard values. In addition, sample was defined representing the population of the event. In this research, two building sites were selected as sample and seven construction activities were chosen for the detail analysis.

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CHAPTER 4

DATA COLLECTION AND ANALYSIS

4.1 Introduction

The previous chapter discussed the research problem, research design selection of parameter and sample design. In this study, data from two construction sites were taken into consideration and sites were mainly the reconstruction of Siddhartha secondary school and Balapitiya, the construction of fisheries harbour in Dodanduwa. All the data were collected on daily basis by the site staffs directly supervised by Engineers and entered in to the electronic format. This process was new a experience for the site staff and some difficulties were faced in identifying the event through collecting and recording the data in each site. A method was introduced to cross check the material labour norms and it helped to collect the unbiased and accurate data set for this research. Simplified template was very useful for the data collection and analysis.

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4.2 Preliminary Data Collection

This research mainly based on quantitative method to gather the data and all the data was measured independently. Data collection process was a very long and difficult task, however it was successfully done in two different sites.

There were two UNOPS DI sites selected for the research. Data collection was carried out by the well trained supervisors and technical officers at each site. Basic training and introductory programs were conducted at the each site. Basically it was covered taking off the work done by measuring daily completed work quantity, direct & indirect labour involvement for respective work and selecting the different activities. In addition to the recording style, the required raw data and the material usage for respective work were explained to the site staff. At the work shop a pre designed template was distributed among the site staffs. At the end of the day daily work done, labour involvement and material usage were measured for respective events.

Data collection period was limited to a six month time period and work norms related to all the construction activities within the period were recorded for the work study. It was found that few data sets were becoming detached from the average due to errors in recording. Hence, incomplete and unrealistic data were eliminated from the data set. In addition, some of labour groups had been involving in several tasks during the day and such a data was not encountered to the data set.

4.2.1 Brick Work

Table 4.1: Material and labour components for brick work

Day	Material			Labour		Work done
	Cement (Bags)	Sand (Sieved) (m^3)	Bricks (nr)	Skilled Labour (Days)	Unskilled Labour (Days)	Qty (m^2)
1	10.0	1.94	2,064	4.00	4.00	17.040
2	17.0	3.41	4,420	5.00	7.25	34.970
3	13.0	2.45	2,494	4.00	3.50	21.610
4	2.5	0.48	750	1.00	1.00	6.500
5	17.0	3.30	4,000	5.63	5.63	31.635
6	4.0	0.78	1,188	2.25	3.38	9.900
7	11.0	2.14	3,430	2.00	7.00	29.300
8	19.0	3.69	4,125	4.22	7.75	38.820
9	13.0	2.45	2,495	4.00	3.50	21.600
10	5.0	0.97	2,500	2.25	4.25	21.250

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In Table 4.1, brick work process data were shown in different sites and ten day data sets were selected among the all of recorded data during the data collection period. On this selection process, data sets such as incomplete, unrealistic and short period time were not taken into the final analysis and minimum one day continuous work duration considered as the least criteria. Usage of cement, sand and bricks were monitored to determine the material consumption. In Table 4.1, 10 cement bags, 1.94m3 sieved sand and 2064 nos of bricks were used during the day 4.0 nos of skilled labours and 4.0 nos of unskilled labours were involved for this event and 17.04 square meters of 225mm brick finished product was completed as daily work done during this day. Similarly end of the each day, material usage, labour involvement and work done were recorded. In the brick work process, final work output was measured in square meters.

4.2.2 External Plastering

Table 4.2: Material and labour components for external plastering

Day	Material		Labour		Work done
	Cement (Bags)	Sand (Sieved) (m^3)	Skilled Labour (Days)	Unskilled Labour (Days)	Qty (m^2)
1	21.0	3.93	9.00	14.63	132.08
2	16.0	4.08	7.87	11.25	108.40
3	6.0	1.11	4.50	6.19	54.37
4	22.0	4.09	7.88	10.13	116.35
5	6.0	1.11	3.00	5.00	32.58
6	7.0	1.30	2.75	4.00	38.23
7	5.0	0.93	5.75	7.00	45.32
8	1.0	0.27	1.00	2.25	7.40
9	3.0	0.85	3.25	2.38	23.19
10	3.0	0.82	3.00	2.00	22.70

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External plastering is the next process which is summarized in Table 4.2. Ten day data set was selected for detail analysis of external plastering. Cement and sand are mostly used as materials for this construction activity, however minor materials such as water was not considered for the research. Only cement and sand were used for external plastering. Commonly, lime is added to increase the workability and smoothness of the surface, however lime was not used in selected sites for external plastering. Similarly manpower consumptions such as skilled and unskilled labours were also calculated on hourly basis, finally it was converted to the daily basis. Total daily output as daily work done was measured during the specified period. Above Table 4.2 show that material, labour consumption and respective daily work done. In first day figures of the table shows that 21 nos of cement bags and 3.93 cubic meters of sand were used for external plastering during this day and 9 nos of skilled labour and 14.63 nos of unskilled labour days were involved. Finally 132.08 square meters of external plastering area was completed by the work group. Similarly table 4.2 shows ten days site data set for norm analysis.

4.2.3 Internal Plastering

Table 4.3: Material and labour components for internal plastering

Day	Material			Labour		Work done
	Cement (Bags)	Sand (Sieved) (m^3)	Lime (Kg)	Skilled Labour (Days)	Unskilled Labour (Days)	Qty (m^2)
1	4.0	0.75	90.00	2.25	3.38	30.33
2	5.0	0.92	90.00	4.22	3.38	42.24
3	7.0	1.30	210.00	5.06	5.06	57.42
4	5.0	0.92	150.00	3.38	4.50	34.75
5	3.0	0.56	100.00	2.00	3.50	21.00
6	7.0	1.30	120.00	3.19	6.38	52.30
7	4.0	0.75	100.00	3.00	5.00	41.00
8	3.5	0.80	60.00	1.00	3.13	36.45
9	3.0	0.68	0.68	3.13	3.25	30.19
10	3.0	0.59	60.00	2.63	3.38	29.58

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Similarly, Table 4.3 shows the summarized labour component for internal plastering. Ten days recorded data sets were used for detail analysis. Basic materials for this activity were cement, sand and lime. Each day material and labour consumption were recorded and in addition, daily completed plastering areas as work outputs were measured separately. As usually work durations were measured hourly basis and finally it was converted to the daily work output. The first data set shows that 2.25 skilled labour days and 3.38 unskilled labour days were consumed to finish 30.33 square meters of internal smooth plastering area. For this quantum of work, 4.0 nos of cement bags, 0.75 m3 sieved sand and 90 kg lime were used as materials. In this observation, material wastage was also encountered to the final figures since used materials were quantified at the beginning of the process. Likewise other sets were too were described in the same manner.

4.2.4 Floor Rendering

Table 4.4: Material and labour components for internal floor rendering

Day	Material			Labour		Work done
	Cement (Bags)	Sand (Sieved) (m^3)	Coloured cemen (Kg)	Skilled Labour (Days)	Unskilled Labour (Days)	Qty (m^2)
1	7.0	0.77	5.00	2.25	3.50	44.40
2	16.0	1.78	18.00	3.38	4.63	51.00
3	14.0	1.56	5.00	3.00	3.38	43.20
4	8.0	1.68	5.00	2.50	2.50	21.60
5	15.0	2.78	10.00	2.50	3.75	50.36
6	2.0	0.36	2.00	1.00	3.00	7.35
7	5.0	0.55	5.00	2.00	2.00	14.77
8	3.8	0.59	1.20	2.25	2.50	15.54
9	4.0	0.24	1.50	2.50	2.50	18.30
10	9.00	0.78	8.00	4.75	4.88	63.03

Next, the floor rendering was taken into analysis. In Table 4.4, summarized data were tabulated. Materials such as cement, sand and coloured cement pigment were used for floor rendering and ten day data were recorded during the research. Meanwhile labour consumption and daily work done for respective days were measured at the end of each day. According to the first data set 7.0 nos of cement bags, 0.77 sieved sand and 5.00 kg colour cement pigments were used to work 44.4 square meter of rendering area during day. For this work, 2.25 days of skilled labour and 3.50 days of unskilled labour were used to complete the said work quantity. It was observed that there was some extra cement powder used to spreading into wet floor before rendering. Such a additional cement quantities also accounted into the final material usage. Similarly Table 4.4 shows the ten day data sets were described the material and labour usage.

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4.2.5 Skirting

Table 4.5: Material and labour components for skirting

Day	Material			Labour		Work done
	Cement (Bags)	Sand (Sieved) (m^3)	Coloured cement (Kg)	Skilled Labour (Days)	Unskilled Labour (Days)	Qty (m^2)
1	1.0	0.120	1.00	1.13	1.13	28.00
2	1.5	0.150	2.00	1.69	1.25	40.00
3	1.0	0.106	1.00	1.13	1.13	26.00
4	1.1	0.130	1.10	1.50	1.25	34.00
5	0.6	0.050	0.60	1.63	1.00	22.49
6	0.30	0.030	0.30	1.00	0.75	16.12
7	0.28	0.030	0.30	1.13	1.00	17.25
8	0.25	0.027	0.25	1.00	0.50	20.70
9	0.23	0.028	0.25	0.88	0.75	20.20
10	0.20	0.021	0.20	0.88	0.63	18.30

In Table 4.5, labour and material component for construction of skirting were tabulated. Construction of 100mm skirting is the part of the floor rendering however work norms on this activity were measured separately. Cement, sand and coloured pigment were used for construction of skirting and work norms related to this activity were measured. In addition daily work done for each day was also measured and Table 4.5 shows the all the recorded that were collected on this research. As per the research data in first row, 01 cement bag, 0.12 cubic meters of sieved sand and 1kg of powder pigment were used to produce 28 meter length of 100mm high skirting. 1.13 skilled and unskilled labour days were consumed for this product. Normal practice, floor rendering and skirting were put up simultaneously, however these sits the process was changed to get the accurate figures. Hence floor rendering and skirting were carried out on two different days.

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4.2.6 Rubble Work

Table 4.6: Material and labour components for rubble work

Day	Material			Labour		Work done
	Cement (Bags)	Sand (Sieved) (m^3)	Rubble (m^3)	Skilled Labour (Days)	Unskilled Labour (Days)	Qty (m^2)
1	5.0	0.96	2.80	2.00	2.50	2.160
2	1.2	0.19	0.90	1.00	1.50	0.640
3	4.5	0.45	2.90	2.00	2.00	2.750
4	8.5	0.62	4.95	3.375	2.00	4.850
5	6.0	1.40	4.30	3.00	3.00	3.280
6	3.0	0.60	2.30	1.75	2.50	1.720
7	1.5	0.29	1.42	1.25	1.13	1.070
8	7.0	2.68	7.08	5.00	3.75	5.390
9	3.5	1.13	2.85	1.63	0.88	2.020
10	5.0	1.01	5.66	4.25	3.00	5.450

Next, the rubble work and its labour component were taken into consideration. Cement, sand and 6"x9" rubble stone are used for construction of less than 450mm width random rubble work and material consumption for this event were measured on this research. Meanwhile labour involvement and their daily output were recorded. The first data set shows that 5 bags of cement, 0.96 cubic meters of sieved sand and 2.80 cubic meters of rubble stones were used to build 2.16 cubic meters of random rubble masonry wall. For this work, 2 no of skilled labour day and 2.5 nos of unskilled labour days were involved. Similarly other day data too sets were recorded for this event. It was very difficult to measure the material quantity especially in this event. Hence special training was conducted to measure the rubble quantity by physical observation and taking off the quantity.

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4.2.7 Column and Beam Plastering

Table 4.7: Material and labour components for column and beam plastering

Day	Material			Labour		Work done
	Cement (Bags)	Sand (Sieved) (m^3)	Lime (Kg)	Skilled Labour (Days)	Unskilled Labour (Days)	Qty (m^2)
1	3.0	0.55	-	2.00	3.00	14.18
2	4.0	0.74	40.00	2.00	3.00	14.18
3	4.0	0.74	30.00	4.00	4.00	19.80
4	4.5	0.82	27.00	2.50	4.00	15.75
5	4.0	0.74	60.00	4.00	4.00	17.24
6	3.0	0.30	-	2.00	2.00	10.49
7	3.0	0.55	-	3.00	2.00	13.60
8	4.0	0.74	-	3.00	3.00	19.85
9	1.0	0.18	-	1.00	0.75	4.40
10	4.00	0.74		2.25	3.00	16.24

In Table 4.7, column and beam plastering were summarized. In this research material consumption and labour involvement for less than 300mm width column & beam plastering were measured, its records were shown in the Table 4.7. The first raw data set shows that 3 bags of cement and 0.55 cubic meters of sieved sand were used to produce 14.18 square meters of the plastering area. 2.0 skilled labour and 3.0 unskilled labour component were consumed for this production. Similarly nine different data sets are shown in the above table.

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4.3 Method Used for Data Collection

Collection of raw date was most important part of the research because the research was based on the experimental data. Hence extra attention was granted at the data collection stage. Data collection part was done by the well trained supervisors and technical officers at each site. At each sites, three well trained staff members were employed for data collection. The data collection process was basically divided into three categories and they were material, labour and work done. Under the material usage, all used materials were physically quantified at the end of the event and finally it was cross checked with the store books. Labour was the second category and it was given an extra attention to quantify the direct and indirect labour involvement respective event. Indirect labour component such as material handling, cleaning etc were also included to the final figure. Skilled and unskilled labour component were measured on hourly basis and it was converted to the daily. It was assumed that normal working day consisting of the eight hour working period. Third one was the work done of the event and it was physically measured as per the guideline described in the standard method of measurements. All the data was entered in to the template by the supervisory staff and hard copies of template have been distributed among the officers and end of the day completed record. Final data sheets were entered into the electronic format and it was used for detail analysis.

4.4 Data Preparation for Analysis

All recorded daily data sheets were checked with basic requirements for the detailed analysis. Incomplete and unrealistic data were removed from the data sample due to arithmetic mistakes. One day working period was considered as the minimum requirement of the raw data set and some of data sheets were removed due to this minimum criterion.

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Table 4.8: Summary on experimental material consumption and BSR norms

#	Activity	Status	Material					
			Cement Bags	Sand m^3	Bricks Nos	Rubble m^3	Lime kg	Coloured Cement kg
1	Brick Work	Actual Norms	0.470	0.091	118	-	-	-
		BSR	0.325	0.060	125	-	-	-
2	External Plastering	Actual Norms	0.148	0.032	-	-	-	-
		BSR	0.086	0.021	-	-	2.150	-
3	Internal Plastering	Actual Norms	0.117	0.023	-	-	2.823	-
		BSR	0.086	0.020	-	-	3.226	-
4	Rendering	Actual Norms	0.268	0.037	-	-	-	0.191
		BSR	0.188	0.024	-	-	-	0.269
5	Skirting	Actual Norms	0.0240	0.0026	-	-	-	0.0255
		BSR	0.0167	0.0014	-	-	-	0.0208
6	Rubble Work	Actual Norms	1.650	0.330	-	1.250	-	-
		BSR	2.560	0.450	-	1.300	-	-
7	Column and Beam Plastering	Actual Norms	0.240	0.042	-	-	1.059	-
		BSR	0.086	0.020	-	-	0.860	-

According to above table seven construction activities which were brick work, external plastering, internal plastering, rendering, skirting, rubble work and column & beam plastering were selected for detailed analysis. This table shows that the main two figures which related to the BSR standard and experimental data were considered for different events. Considering each events, experimental and standard material consumption and detailed analysis were indicated on this table and detail analysis. According to the first row of the Table 4.8 the comparison between BSR and actual work norms on brick work can be found. Actual material norms of the 225mm thick brick work per meter squire area were 0.47 bags of cement, 0.091 cubic meters of sand and 118 nos of standard bricks. However BSR standard norms for 225mm thick brick work were 0.325 of cement bags, 0.60 cubic meters of sand and 125 nos of bricks. Similarly actual and standard work norms were listed for other six construction activities in the above table.

Table 4.9: Summary on experimental labour consumption and BSR norms

#	Activity	Status	Skilled Labour	Unskilled Labour
1	Brick Work	Actual Norms	0.160	0.210
		BSR	0.240	0.410
2	External Plastering	Actual Norms	0.099	0.132
		BSR	0.110	0.130
3	Internal Plastering	Actual Norms	0.088	0.113
		BSR	0.110	0.130
4	Rendering	Actual Norms	0.098	0.136
		BSR	0.130	0.240
5	Skirting	Actual Norms	0.051	0.040
		BSR	0.063	0.052
6	Rubble Work	Actual Norms	0.950	0.970
		BSR	1.060	2.120
7	Column and Beam Plastering	Actual Norms	0.180	0.196
		BSR	0.215	0.215

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Actual and BSR labour norms were described in the Table 4.9 and mainly the labour component was divided into two major components which are skilled and unskilled labours. First data set of the Table 4.9 was described as labour consumption for 225mm brick work to complete one square meter area. As per the research, actual work norms for brick work were recorded as 0.16 skilled labour days and 0.21 unskilled labour days for unit area. Similarly labour norms for other activities were described on Table 4.9.

4.5 Analysis of Material/ Labour Consumption and Deviation

In this research, material and labour consumption and deviation were calculated. Under the material deviation, only cement and sand were considered for evaluation and it was noticed that more materials were consumed in each event compare to the BSR values. Similarly labour consumption and deviation were calculated and it proofed that less labour component was used in each construction activity. As described under research design in section 3, the analysis simple statistical formulas and graphs were used for interpretation. BSR is used to compare the slandered norms with actual norms and comparison index was defined and formula as follows.

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$$D = \frac{V_{Actual} - V_{BSR}}{V_{BSR}} \times 100$$

Where, D is the percentage index of a given by a selected activity, V_{Actual} is the actual data measured from respective site and V_{BSR} is the corresponding Building Scheduling of Rate. As per the comparison index defied above, the percentage deviations of each activity with respect to the different parameters were calculated and details were described.

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4.5.1 Analysis of Cement Consumption and Deviation

Table 4.10: Comparison of Cement Consumption and Deviation

Activity No	Activity	V_{Actual}	V_{BSR}	$A_{ctual} - V_{BSR}$	D
1	Brick Work	0.470	0.325	0.145	44.62
2	External Plastering	0.148	0.086	0.062	72.09
3	Internal plastering	0.117	0.086	0.031	36.05
4	Rendering	0.268	0.188	0.080	42.55
5	Skirting	0.0240	0.0167	0.007	43.71
6	Rubble Work	1.650	2.560	-0.910	-35.55
7	Column and beam plastering	0.240	0.086	0.154	179.07

In Table 4.10 shows the comparison of the actual cement consumption with respect to the BSR norms for all the construction activities. V_{Actual} is the experimental value for cement usage and V_{BSR} is the standard cement consumption for each activity. In addition percentage deviation with BSR value was calculated for each event. According to the first row of the table actual cement consumption to finish the one square meter of 225mm brick wall, 0.47 cement bags were needed and BSR standard value for this event was 0.325 bags and percentage deviation of the activity is 44.62%. Similarly deviations of all the events have been considered for the research as shown in the Table 4.10 as above.

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4.5.2 Analysis of Sand Consumption and Deviation

Table 4.11: Comparison of Sand Consumption and Deviation

Activity No	Activity	V_{Actual}	V_{BSR}	$A_{ctual} - V_{BSR}$	D
1	Brick Work	0.091	0.060	0.031	51.67
2	External Plastering	0.032	0.021	0.011	52.38
3	Internal plastering	0.023	0.020	0.003	15.00
4	Rendering	0.037	0.024	0.013	54.17
5	Skirting	0.0026	0.0014	0.001	85.71
6	Rubble Work	0.330	0.450	-0.120	-26.67
7	Column and beam plastering	0.042	0.020	0.022	110.00

The Table 4.11 shows the sand consumption for selected activities in the research. The first raw describe the actual sand consumption and BSR standard norms for construction of 225mm brick work. In last column shows the percentage deviation on actual value from the standard value. Similarly deviations in different construction activities were taken into the research as shown in above Table 4.11.

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4.5.3 Analysis of Skilled Labour Consumption and Deviation

Table 4.12: Comparison of Skilled Labour Consumption and Deviation

Activity No	Activity	V_{Actual}	V_{BSR}	$A_{ctual} - V_{BSR}$	D
1	Brick Work	0.160	0.240	-0.080	-33.33
2	External Plastering	0.099	0.110	-0.011	-10.00
3	Internal plastering	0.088	0.110	-0.022	-20.00
4	Rendering	0.098	0.130	-0.032	-24.62
5	Skirting	0.051	0.063	-0.012	-19.05
6	Rubble Work	0.950	1.060	-0.110	-10.38
7	Column and beam plastering	0.180	0.215	-0.035	-16.28

The comparison between the actual skilled labour involvement and BSR standard in different construction activities was compared in table 4.12. The first raw was illustrates the actual labour usage for construction of 225mm brick wall and BSR standers. As per experimental data labour usage to finish the square meter of 225mm thick brick work, it takes 0.16 days and BSR standard value was 0.24 days. In addition, the percentage deviation of these two values is 33.33% and negative signs represent the less time taken in actual situation.

4.5.4 Analysis of Skilled Labour Consumption and Deviation

Table 4.13: Comparison of Unskilled Labour Consumption and Deviation

Activity No.	Activity	V_{Actual}	V_{BSR}	$A_{ctual} - V_{BSR}$	D
1	Brick Work	0.210	0.410	-0.200	-48.78
2	External Plastering	0.132	0.130	0.002	1.54
3	Internal plastering	0.113	0.130	-0.017	-13.08
4	Rendering	0.136	0.240	-0.104	-43.33
5	Skirting	0.040	0.052	-0.012	-23.08
6	Rubble Work	0.970	2.120	-1.150	-54.25
7	Column and beam plastering	0.196	0.215	-0.019	-8.84

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In Table 4.13 explained the comparison of unskilled labour consumption of selected construction activities and BSR work norms. In first row of the table shows the actual and BSR unskilled labour values to finish the 225mm thick brick work, these values are 0.21 and 0.41 labour days respectively. Percentage deviation of the unskilled labour component is – 48.78% and negative sign represent, actual unskilled labour involvement and it is less than the estimated value in BSR.

4.6 Problems Encountered

- Induction program was held in each site and more paper work was assigned to the officers. This became an extra duty to the site staff such as supervisors, technical officer, store keeper, quantity survey etc. Some of officers has been spent around two hours time in addition to the duty hours for measuring and recording purposes. Sometimes they were much fed up of overworking as they had to stay after working hours without any intensive.

- In construction sites, several construction activities are continued simultaneously. Some of labours engage in more than one activity specially the unskilled category. In addition new tasks are assigned after finishing some successive work, hence it is vey difficulty to measure the precise time duration for such work done.
- Measuring of work done was difficult task on daily basis. Some of work was difficulty to finish within one day, hence it was measured on average basis.
- Some of materials such as sand, metal, rubble etc were difficulty to measure accurate quantity because stocks were available site and issuing without systematic documentary process. However materials such as cement, steel etc were measured preciously for each activity.
- Tracking system was introduced for material usage with site store and filed. Some days. Some days it was found that small human mistakes were happened and it was rectified with considering total stocks.
- Human errors were found at the measuring, recording, entering and it was cross checked once entered to the electronic format by the site quantity survey and non realistic data sets were rejected while entering the computer.
- Measuring quantitative the daily work performance on work force is very difficult task and it depend on several factors.

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4.7 Summary

This chapter was basically included how the preliminary data collection was done and the methods used for data collection in those selected working sites. Then data collected from major construction activities like brickwork, external & internal plastering, rendering, skirting, rubble work etc were engaged with the BSR standards and presented with deviation. Three main components such as material, labour and work done were recorded in each activity and ten days data sets were collected on respective event. By using simple statistical tools, material and labour requirement were calculated to construct the unit quantity of the work output on each activity. After that cement and sand were selected to calculate the material consumption and their deviation from the standard norms. Similarly skilled and unskilled labour deviations were calculated for selected construction activities. The problems uncounted in this process too were included at a later stage.

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CHAPTER 5

DATA INTERPRETATION AND RESULTS

5.1 Introduction

The former chapter includes data collection methods and collected data from two sites. At the later stage presents an analysis of data together with problems and limitation. The purpose of this research was to review and develop the work norms for construction industry. In doing so, the data from two construction sites were taken into consideration. Namely, reconstruction of Siddhartha secondary school, Balapitiya and construction of fisheries harbour in Dodanaduwa. The most important of the overall statistical analysis carried out in this research could be considered as simple statistical tool. This chapter shows the interpretations of each work norms by experiment and BSR.

5.2 Data Interpretation and Analysis

Analysis of work norms on different construction activities were evaluated on this research and compared with the BSR standard. Work norms were divided into two major categories such as material and labour.

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5.2.1 Interpretation of Brick Work

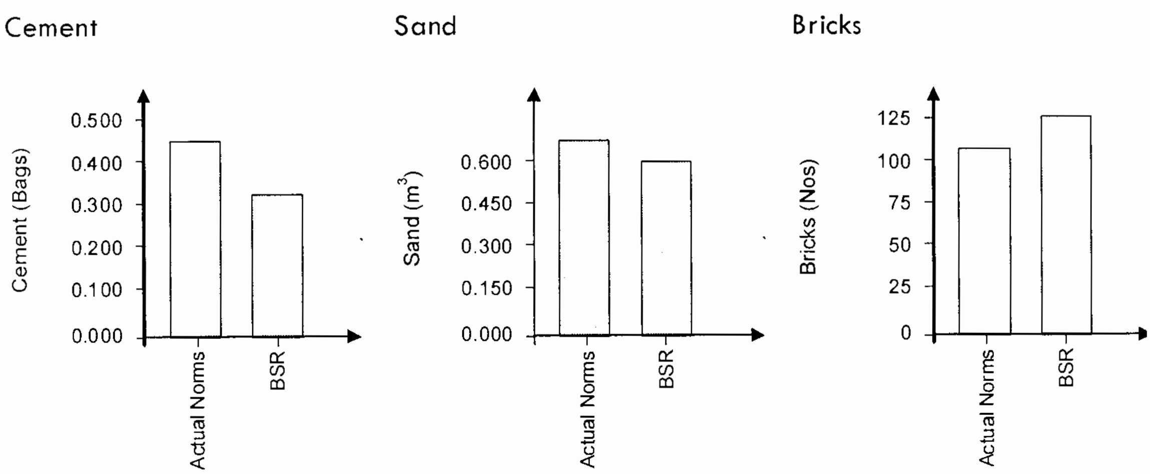

Figure 5.1: Comparison between material consumption on brick work and BSR standard

Figure 5.1 shows the individual material comparison for three items, namely, cement, sand and bricks. This shows the comparison between experimental work norms and building schedule of rates (BSR) standard for brick work. The first graph shows the average cement consumption and it was 0.47 bags for square meter unit area of 225mm brick work whereas in BSR standard norm was 0.325 bags. It indicates that in the normal construction practice more cement was used for brick work. Similarly, more sand was also consumed in this occasion compared to the BSR standard. However, 118 nos. of bricks were used for constructing one square meter unit and it was less than the standard norms in BSR value. This is mainly due to the usage of non-standard bricks which are available in the present market. And also it is due to the malpractices of the masons when they use bricks in constructing the walls and so on. Standard motor thickness and gap between two bricks are defined as 10mm for brick laying. However it was found that specified bed thickness and gap were not considered by the masons. Hence more 1: 5 cement, sand motor mix was consumed compared to the BSR standard.

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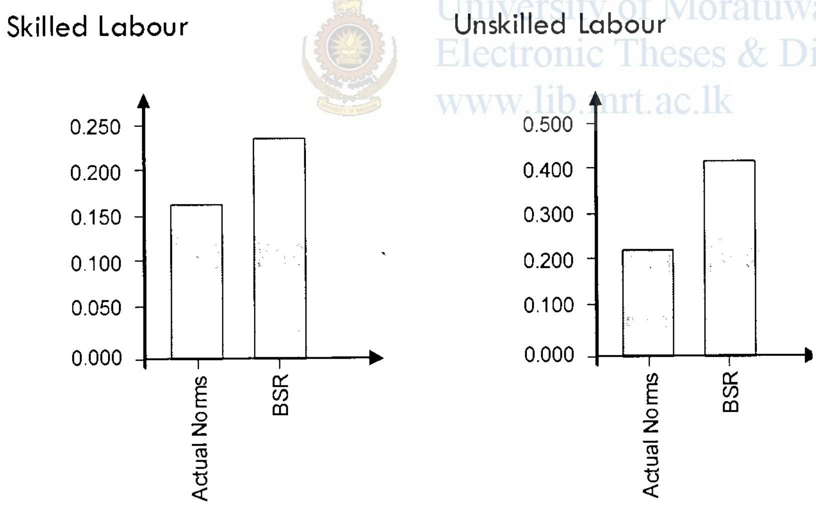

Figure 5.2 Comparison between labour consumption on brick works and BSR Standard

Figure 5.2 shows the daily work output comparison. Here, building schedule of rates (BSR) and manpower consumption for the brick work are compared. Note that the actual average manpower consumption was considerably lower than the standard BSR norms. The first graph shows the average skilled labour consumption and it was 0.160 days for square meter unit area of 225mm brick work whereas in BSR standard norm was 0.240 days. It indicates that normal practice of engaging less labour was used for brick laying activity. Similarly Manpower is the one of the major factors on productivity development in construction industry and different tools, techniques are used to increase the labour productivity. Increasing the productivity through the motivation is one of the main strategies in the field. Motivation represents the forces within a person that affect his direction, intensity and persistence of voluntary behavior. Skills, knowledge, aptitudes and other characteristics of people that lead to superior performance are typically bunched together. Construction tools and techniques were developed rapidly during last few decades. Hence skilled labour performance was relatively very high compared to the BSR.

5.2.2 Interpretation of External Plastering

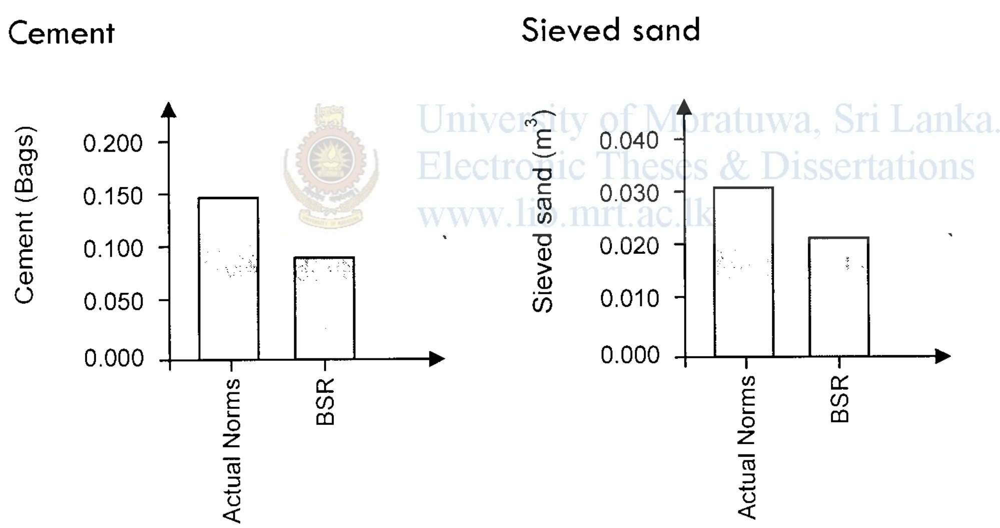

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Figure 5.3 Comparison between material consumption on external plastering works and BSR Standard

Figure 5.3 shows the individual material comparison for two items, namely, cement and sand. This shows the comparison between experimental work norms and building schedule of rates (BSR) standard for external plastering work. The first graph shows the average cement consumption and it was 0.148 bags for square meter unit area of semi rough plastering work whereas in BSR standard norm was 0.086 bags. It indicates that in the normal construction practice more cement was used for plastering work. Similarly, more sand was also consumed in this occasion compared to the BSR standard. 16mm plaster thickness was specified for semi rough wall plastering work in the ICTAD building specification. However it was very difficult to maintain the uniform plaster thickness on especially high rise building because the entire external wall should be on one line to maintain the verticality. Hence automatically plaster thickness may be varied and possible course was increasing the thickness. In addition to this, cement was used as binding agent for especially concrete and wet surfaces. This quantity was not counted in the BSR. These are the main reasons for increasing the sand and cement quantity from the BSR standard.

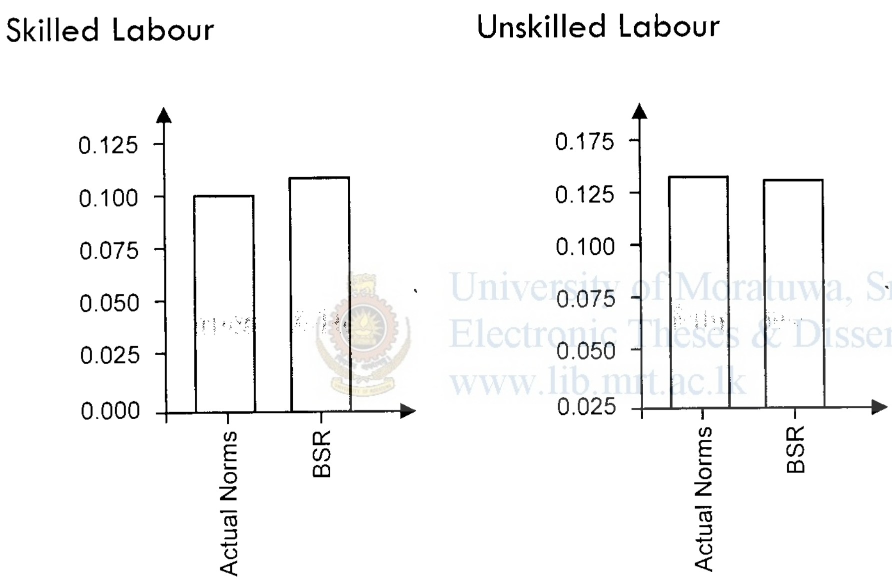

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Figure 5.4 Comparison between labour consumption on external plastering works and BSR Standard

Figure 5.4 shows the daily work output comparison. Here, building schedule of rates (BSR) and manpower consumption for the external plastering works are compared. It is note that the actual average manpower consumption was considerably lower than the standard BSR norms. The first graph shows the average skilled labour consumption and it was 0.099 days for square meter unit area of 16mm thick semi rough plaster work whereas in BSR standard norm was 0.110 days. It indicates that normal practice of engaging less labour was used for brick laying activity. Similarly average unskilled labour consumption was lower than the

BSR standards. Main reason was that group performance was very high in this perojectt.. Increase the productivity through the motivation is one of main strategies in the field. Motivation represents the forces within a person that affect his direction, intensity and persistence of voluntary behavior. Skills, knowledge, aptitudes and other characteristics of people that lead to superior performance are typically bunched together. Hence skilled labour performance was relatively very high compared to the BSR.

5.2.3 Interpretation of Internal Plastering

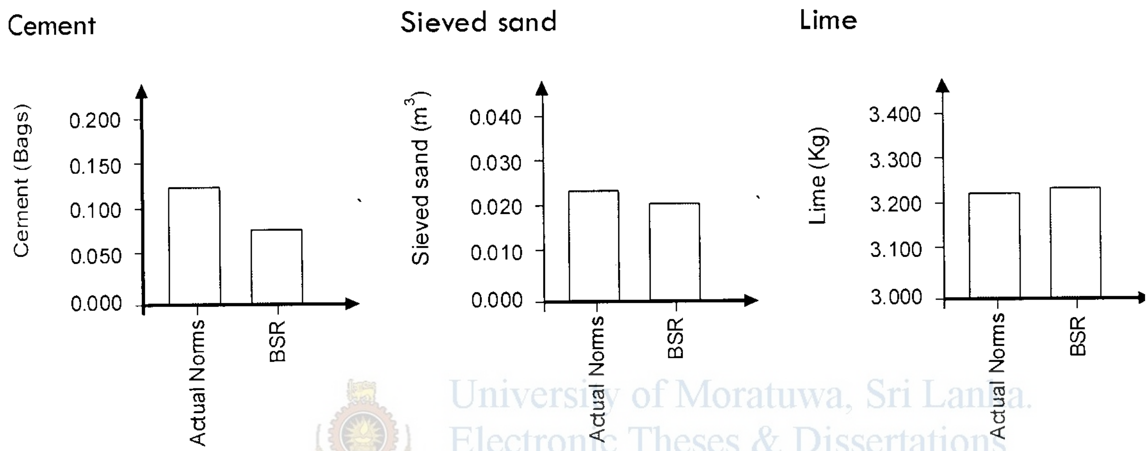

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Figure 5.5: Comparison between material consumption on internal plastering works and BSR standard

Figure 5.5 shows the individual material comparison for construction of internal plastering and the main building materials for plastering work were cement, sand and lime. This shows the comparison between experimental work norms and building schedule of rates (BSR) standard for external plastering work. The first graph shows the average cement consumption and it value was 0.117 bags for square meter unit area of internal smooth plastering work whereas in BSR standard norm was 0.086 bags. It indicates that in the normal construction practice more cement was used for plastering work. Similarly, more sand was also consumed in this occasion compared to the BSR standard. 12mm plaster thickness was specified for smooth wall plastering work in the ICTAD building specification. However it was very difficult to maintain the uniformity of 12mm plaster thickness because all the parallel wall dimension of the selected area should be the same and

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under the correct specification. Hence automatically plaster thickness may be varied and there is a possibility to get increased the thickness. In addition to this, cement was applied in some areas to increase the adhesiveness and workability especially on concrete and wet surfaces. This quantity was not counted in the BSR. These are the main reasons for increasing the sand and cement quantity from the BSR standard.

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Figure 5.6: Comparison between labour consumption on internal plastering works and BSR Standard

Figure 5.6 shows the daily work done output comparison for skilled and unskilled labours. Here, building schedule of rates (BSR) and manpower consumption for the internal plastering works are compared. It is noted that the actual average manpower consumption was considerably lower than the standard BSR norms. The first graph shows the average skilled labour consumption and it was 0.088 days for square meter unit area of 12mm thick smooth plaster work where as in BSR standard norm it was 0.110 days. It indicates that less labour was consumed for brick laying activity while normal operations were carried out. Similarly average unskilled labour consumption was lower than the BSR standards. Main reason was that group performance was very high in this project. Increasing the productivity through the motivation was one of main strategies in the field. Motivation represents the forces within a person that affect his direction, intensity and persistence of voluntary behavior. Skills, knowledge, aptitude and other characteristics of people that lead to superior performance are typically bunched together. Hence skilled labour performance was relatively very high compared to the BSR.

5.2.4 Interpretation of Floor Rendering

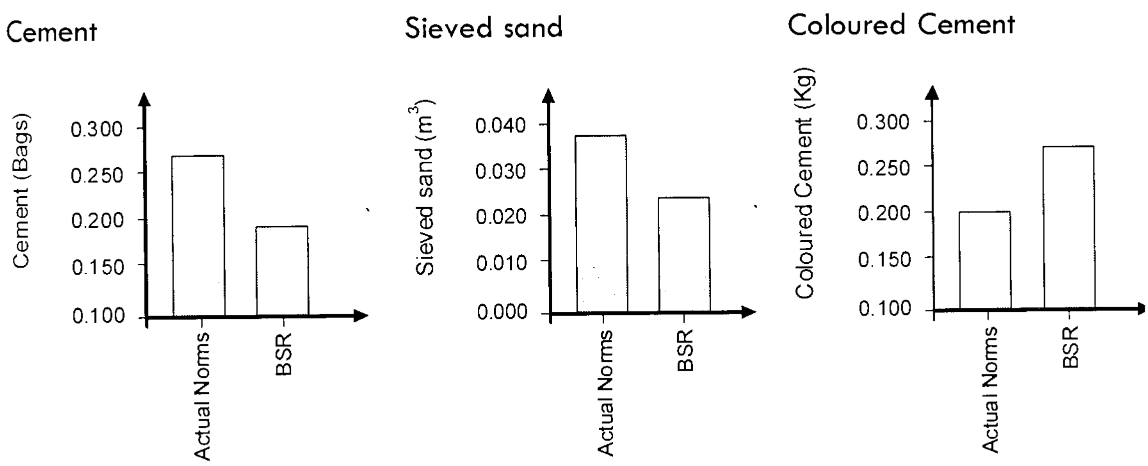

Figure 5.7: Comparison between material consumption on floor rendering work and BSR Standard

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Figure 5.7 shows the individual material comparison for three items such as cement, sand and bricks were considered for a detailed analysis. This shows the comparison between experimental work norms and building schedule of rates (BSR) standard for floor rendering work. The first graph shows the average cement consumption and it was 0.268 bags for square meter unit area of floor rendering where as in BSR standard norm was 0.188 bags. It indicates that in the normal construction practice more cement was used for floor rendering. Cement and sand 1:3 mixer was specified in the building specification, however the practical scenario was totally different from the theoretical base. It was very difficulty to maintain the 20mm thickness layer because layer thickness was much higher due to various reasons. Uneven concrete floor was the main reason for higher consumption of the cement. Usually in construction sites, floor rendering slope was maintained towards the door opening direction, hence the extreme end of the rendering area would be filled with more cement motor. One more reason to consume more cement was malpractice of the construction process. Such as using of cement powder or cement slurry before the spreading of cement sand mixer to increase the bond between dry concrete and new rendering layer. Meanwhile dry cement powder was used to increase the dry state to make easy on finishing surface. Similarly, more sand was also consumed in this occasion compared to the BSR standard. The third graph of the Figure 5.7 shows the average coloured cement consumption and it was 0.191 kg for square meter unit area of floor rendering where as in BSR standard norm was 0.269 kg. It indicates that in the normal construction practice less coloured cement was used for floor rendering.

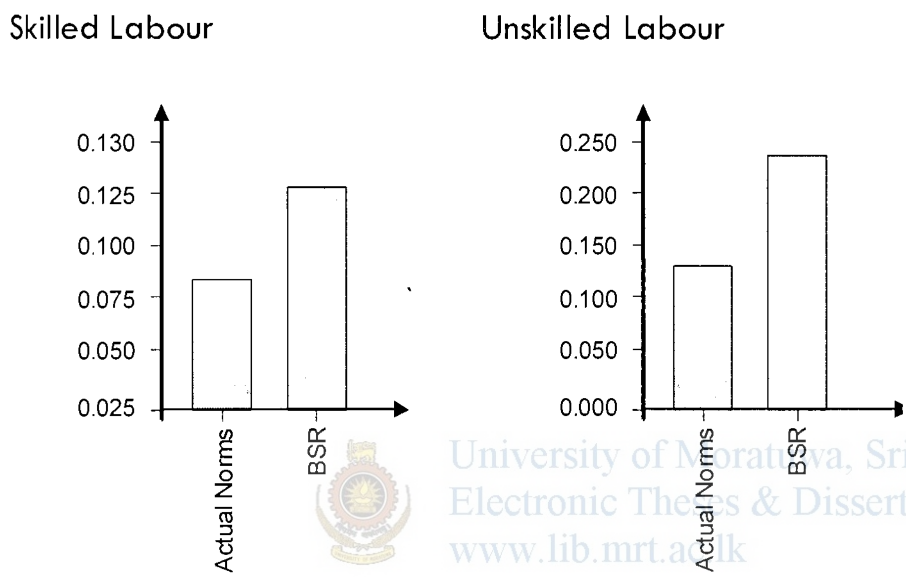

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Figure 5.8: Comparison between labour consumption on floor rendering works and BSR Standard

Next, labour consumption of floor rendering was compared and Figure 5.8 shows the daily work done output comparison for skilled and unskilled labours. Here, building schedule of rates (BSR) and manpower consumption for the floor rendering work was compared. It is noted that the actual average manpower consumption was considerably lower than the standard BSR norms. The first graph shows the average skilled labour consumption and it was 0.098 days for square meter unit area of 20mm thick floor rendering whereas in BSR standard norm it was 0.130 days. It indicates that less labour was consumed for floor rendering activity while normal operations were carried out. Similarly average unskilled labour consumption was lower than the BSR standards. Main reason was that labour outputs were significantly higher than the standard values. Hence skilled labour performance was relatively very high compared to the BSR.

5.2.5 Interpretation of 100mm Skirting

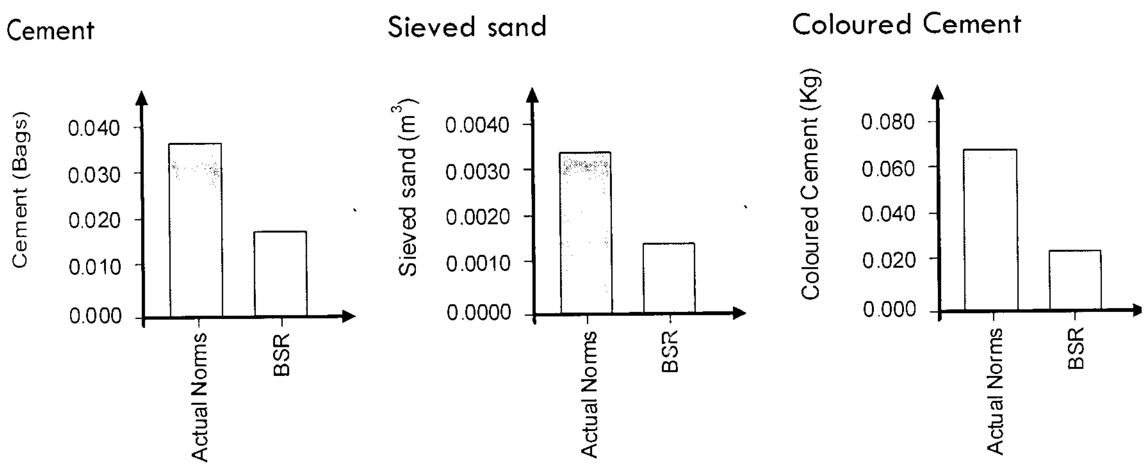

Figure 5.9: Comparison between material consumption on skirting works and BSR Standard

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Next, skirting was taken into interpretation. Figure 5.9 shows the individual material comparison for three items cement, sand and bricks and they were taken in to a detailed analysis. This shows the comparison between experimental work norms and building schedule of rates (BSR) standard for 100mm skirting work. The first graph shows the average cement consumption and it was 0.024 bags for liner meter unit length of skirting where as in BSR standard norm it was 0.0167 bags. It indicates that in the normal construction practice more cement was used for construction of 100mm skirting. Similarly sand and colour cement were consumed more with reference to the BSR standard norms.

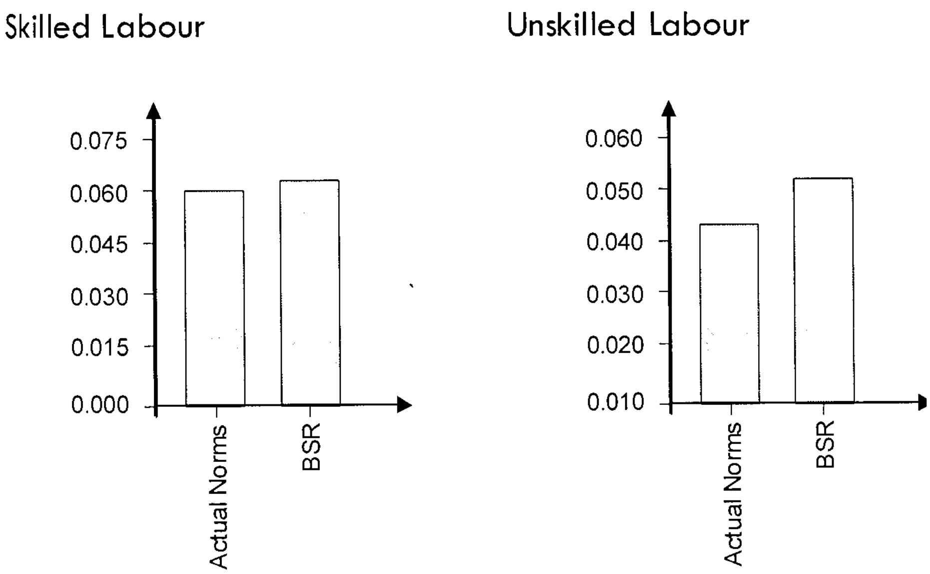

Figure 5.10: Comparison between labour consumption on skirting works and BSR Standard

Similarly, labour consumption of skirting was compared and Figure 5.10 shows the daily work done output comparison for skilled and unskilled labours. Here, building schedule of rates (BSR) and manpower consumption for the floor rendering work was compared. It was noted that the actual average manpower consumption was considerably lower than the standard BSR norms. The first graph shows the average skilled labour consumption and it was 0.051 days for liner meter unit length of 100mm high skirting where as in BSR standard norm was 0.063 days. It indicates that less labour was consumed for construction of 100mm floor skirting while normal operations were carried out. Similarly average unskilled labour consumption was lower than the BSR standards. Main reason was that labour outputs were significantly higher than the standard values. Hence skilled labour performance was relatively very high compared to the BSR.

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5.2.6 Interpretation of Rubble Work

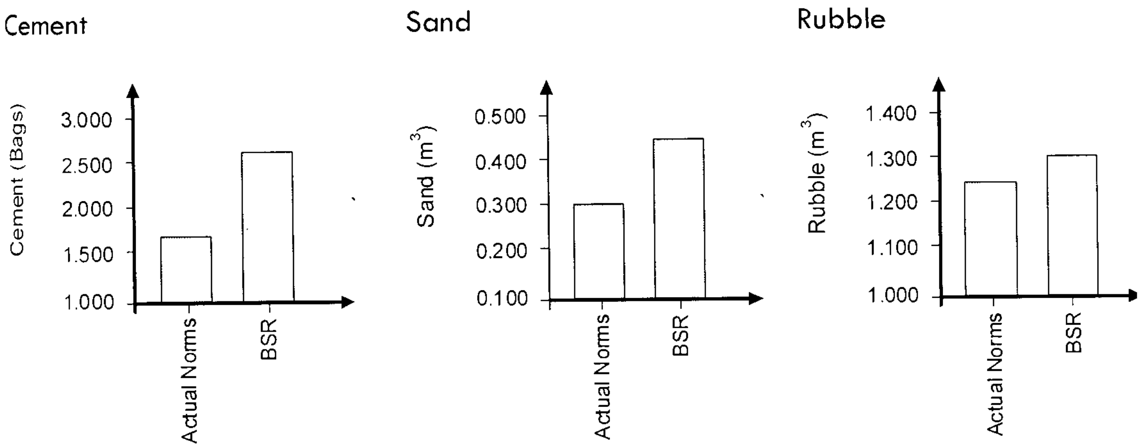

Figure 5.11: Comparison between material consumption on rubble works and BSR Standard

Next activity was the construction of random rubble masonry wall. Figure 5.11 shows the individual material comparison for a random rubble wall and the main building materials for this construction activity were cement, sand and 150x225mm rubble stones. This shows the comparison between experimental work norms and building schedule of rates (BSR) standard for a random rubble masonry work. The first graph shows the average cement consumption and its value was 1.65 bags for cubic meter unit volume of the random rubble masonry wall whereas in BSR standard norm it was 2.56 bags. It indicates that in the normal construction practice less cement was used for rubble work. Similarly, less sand was also consumed in this occasion compared to the BSR standard. Standard size of rubble stone dimension was 150x225mm, however it was noticed that quite larger size of stones were produced at the quarry. Hence higher size of stones was used for the random rubble wall. Due to this reason, less cement and sand were consumed in a random rubble masonry wall. These are the main reasons for increasing the sand and cement quantities from the BSR standard.

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Figure 5.12: Comparison between labour consumption on rubble works and BSR Standard

Similarly, Figure 5.12 shows the daily work done comparison. Here, building schedule of rates (BSR) and manpower consumption for the random rubble works were compared. It was noted that the actual average manpower consumption was considerably lower than the standard BSR norms. The first graph shows the average skilled labour consumption and it was 0.950 days for cubic meter unit volume of random rubble masonry work where as in BSR standard norm was 1.060 days. It indicates that in normal practice less labour was used for rubble work. Similarly Manpower is the one of the major factor on productivity development in construction industry and different tools, techniques are used to increase the labour productivity. Increasing the productivity through the high skill level is one of main factors. Hence skilled labour performance was relatively very high compared to the BSR.

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5.2.7 Interpretation of Column and Beam Plastering Work

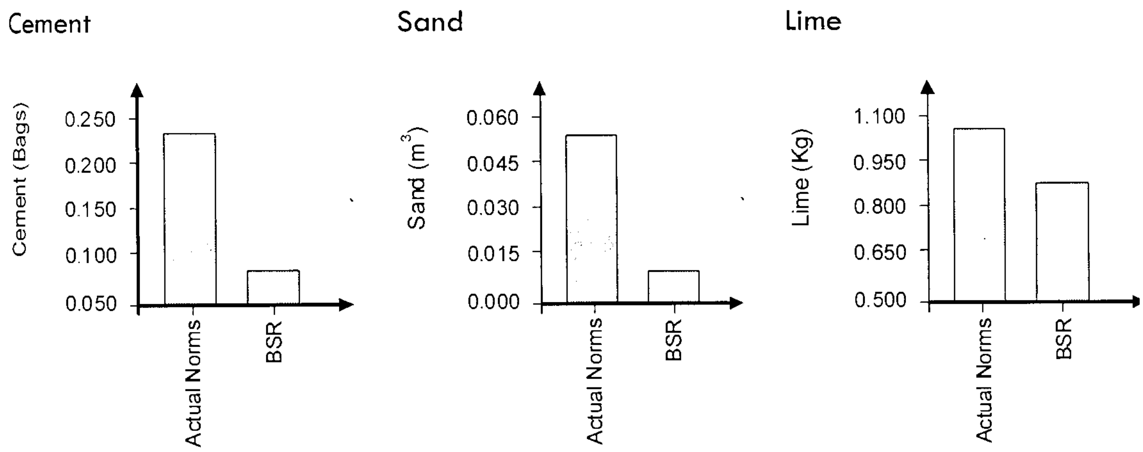

Figure 5.13: Comparison between material consumption on Column and Beam Plastering Work and BSR Standard

In Figure 5.13 shows the individual material comparison for three items, namely, cement, sand and lime. This shows the comparison between experimental work norms and building schedule of rates (BSR) standard for less than 400mm width column and beam plastering. The first graph shows the average cement consumption and it was 0.24 bags for square meter unit area of beam and column plastering where as in BSR standard norm was 0.086 bags. It indicates that in the normal construction practice more cement was used for plastering work. Similarly, more sand and lime were also consumed in this occasion compared to the BSR standard. 12mm plaster thickness was specified for wall plastering work in the ICTAD building specification. However it was very difficult to maintain the uniform plaster thickness because all columns / beams should be on one line to maintain the verticality and same levels. Hence automatically plaster thickness may be varied and there was a possibility to get increased the thickness. In addition to this, cement and lime were used as binding agent for especially concrete and wet surfaces. This quantity was not counted in the BSR. These are the main reasons for increasing the sand and cement quantities from the BSR standard.

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Figure 5.14: Comparison between labour consumption on column and beam plastering work and BSR standard

Figure 5.14 shows the daily work output comparison. Here, building schedule of rates (BSR) and manpower consumption for the brick work are compared. It is noted that the actual average manpower consumption was considerably lower than the standard BSR norms. The first graph shows the average skilled labour consumption and it was 0.180 days for square meter unit area of column & beam plastering work where as in BSR standard norm it was 0.215 days. It indicates that in normal practice less labour was used for this event.

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5.3 Comparison of Material and Labour Consumption

In this research, actual material and labour consumptions for selected construction activities were compared with the BSR standard norms. In addition percentage deviation of the consumption relatively to the BSR value was calculated. Generally it was found that more materials were consumed for construction against the BSR values. Cement and sand were very important construction materials in the construction industry, hence these two material were selected for percentage deviation evaluations. However it was slightly changed in labour component and all the actual values were noted less than the BSR value. Hence these figures were distinguished the efficiency of the present manpower. BSR norms were reviewed more then 20 years back and during the period, technology, tools and skilled level were changed rapidly. Hence performance of the skilled level of the construction works was increased during past few decades.

5.3.1 Comparison of Cement Consumption

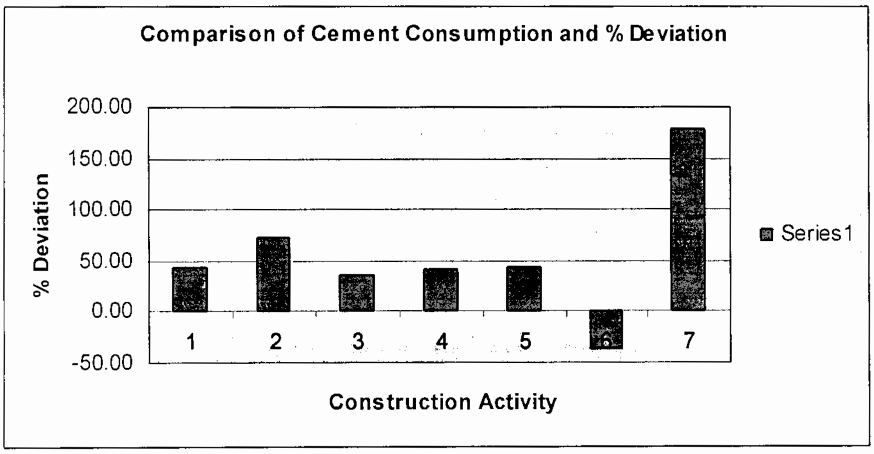

Figure 5.15: Comparison of cement Consumption and % Deviation

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According to Figure 5.15, percentage deviation of the cement consumption was significantly higher than the base value except the activity no 6 represented by the construction of the random rubble masonry wall. Moreover, 150x225mm standard sizes of rubble stones were used for the construction of random rubble masonry wall. However it was noted that material suppliers delivered much higher size of rubble stones compared to the specified sizes. Hence, cement consumption for rubble masonry walls was recorded to be a lesser amount than the standard BSR value. In activity no 7, column and beam plastering was appeared more than 100% of cement consumption deviation in the Figure 5.15. In fact the main reason was that the average plaster thickness was very much higher than the specified 16mm thickness. Most of columns and beams were made out of concrete; hence cement slurry was applied usually by the masons on the concrete surfaces to increase the workability and adhesiveness. These were the main reasons for sending more cement compared to the base value.

5.3.2 Comparison of Sand Consumption

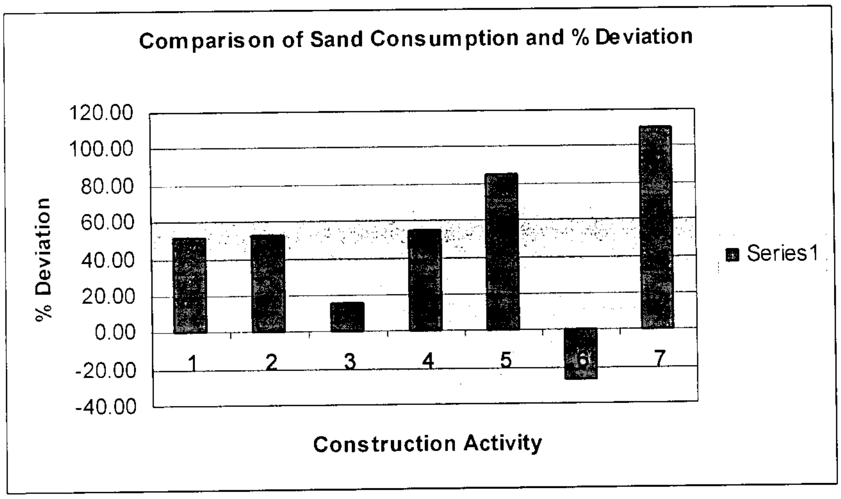

Figure 5.16: Comparison of sand consumption and percentage deviation

According to Figure 5.16, percentage deviation of sand consumption was shown in different construction activities. Most of the construction activities were used extra sand except activity no 6 of random rubble masonry. For this analysis wastage was also included as the specified layer thickness gets violated while construction is carried out with very high speed. As an example, specified layer thickness for brick wall was 10mm, however it was found that no one was maintaining this thickness

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5.3.3 Comparison of Skilled Labour Usage

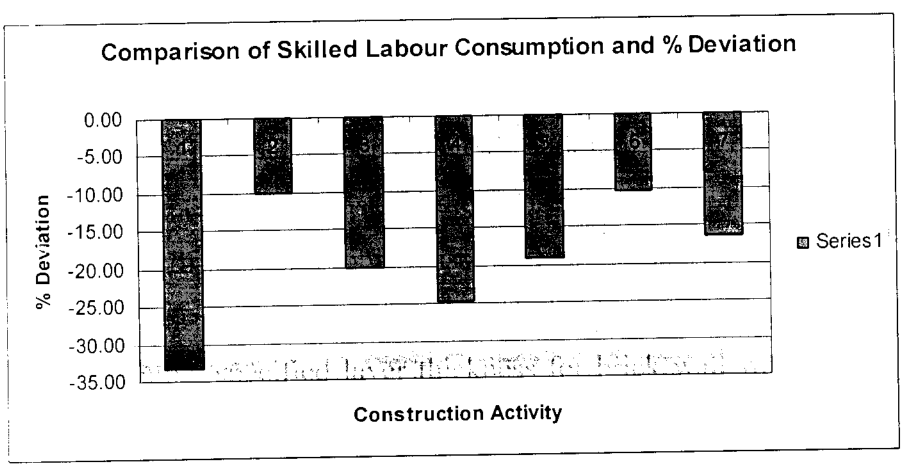

Figure 5.17: Comparison of skilled labour contribution and percentage deviation

CHAPTER 6

CONCLUSIONS

RECOMMENDATIONS & FURTHER STUDY

6.1 Conclusions

The research objective was to develop the work norms for building construction and it was carried out by collecting the actual data from two different sites. At the data collection stage, daily work done, material usage and labour involvement for each activity were recorded. Finally recorded data was filtered with respect to the activities and activity which had more than ten independent data sets were selected for detail analysis. As a result, seven activities were identifies, labour and material consumption were measured for seven construction activities and work norms were compared with the Building Schedule of Rates (BSR) published by ICTAD. In the research process, labour and material consumptions for each construction event were recorded separately. Labour involvement for respective construction event was divided into two categories such as skilled and unskilled labour, all the direct and indirect labour components were encountered for the analysis. Daily performance of the construction labour was evaluated with respect to the standard building norms. In addition, material consumption for seven construction activities were recorded and compared with the standard work norms. The research findings revealed that actual material consumption was much higher than the BSR standard values under the material. Another finding was daily work output was comparatively higher than the BSR norms, it reflects that construction labour performance is in the satisfactory level. Daily performance of the construction labour and material consumption were described in detail under this section. In addition comparison between the research finings and BSR standard also were elaborated under the each category.

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6.1.1 Daily Performance of the Construction Labour

Table 6.1: Summary of average daily work done of the skilled labour

#	Construction Activity	Unit	Daily Work Done	
			Actual Qty	BSR Qty
1	225mm thick brick walls in cement and sand 1:5 in super structure	m^2	7.19	4.21
2	External plaster 16mm thick to external faces of walls in cement and sand 1:5 and finished semi rough	m^2	11.01	9.30
3	Internal plaster 12mm thick in cement, lime and sand to internal faces of walls and finished smooth with a floating of lime putty.	m^2	11.70	9.30
4	18mm thick cement and sand 1:3 mix rendering on concrete floor, finished smooth with coloured cement putty	m^2	12.03	7.44
5	100x12mm skirting in cement and sand 1:3 finished smooth with 3mm thick cloured cement putty.	m	20.44	16.00
6	Random rubble masonry in cement and sand 1:5 using 150x225mm size broken stone in foundations	m^3	1.11	0.94
7	Smooth plaster 12 mm thick in cement, lime and sand 1:1:5 to sides, sophist of beams, isolated column and finished smooth with a floating of lime putty.	m^2	5.77	4.65

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The Table 6.1 describes the summary on research findings and comparisons with BSR relative values. In this research, actual average daily work done per skilled labour was calculated with different working conditions. These figures were shown in the actual quantity column with respect to the construction activities. Owing to the time restriction of the research period, seven activities were selected for final analysis and respective BSR values were shown separately in the table 5.6. Normally BSR is used to develop the construction rates for filling the bill of quantities at the bidding process. At present, construction industry is having a huge market competition and tries to develop its own pricing strategy to become a competitive source in the market. To face this situation, companies should be aware of the actual material and labour consumption, however it is not practicing in the industry level. Moreover, BSR was not revised during past few decades and new comers still use this as a guide to develop the rates. Hence this research is very appropriate to understand the industry behavior. In this research, many of construction activities were represented at the finishing stage of the construction process and today all the stakeholders are more concerned about the final quality of the product. Hence contractors have to spend more time and money to meet the desired quality standards. This was the main reason to use more materials in listed activities in table 6.1.

6.1.2 Material Consumption at Site

Seven construction activities were selected for the research and out comes of the research were described as in the following tables. Experimental material consumption with respect to selected activities were compared with the BSR standards. Generally it was noticed that more materials were consumed in each activity compared to the BSR reference values.

Comparison of Brick Work

Table 6.2 Material consumption for brick work

Status	Type of Material		
	Cement (Bags)	Sand (m^3)	Bricks (Nos)
Experimental Qty	0.470	0.091	118
BSR Qty	0.325	0.060	125

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Table 6.2 shows that material consumption for construction of 225mm thick brick wall square meter area. Experimental material requirement for unit area was much higher than the BSR standards.

Comparison of External Plastering

Table 6.3 Material consumption for external plastering

Status	Type of Material		
	Cement (Bags)	Sand (m^3)	Lime (kg)
Experimental Qty	0.148	0.032	0.0
BSR Qty	0.086	0.021	2.151

Similarly table 6.3 described the material consumption for external plastering work and all the experimental values were higher than the standard values. Hence extra cost for materials was noticed in normal construction practice.

Comparison of Internal Plastering

Table 6.4 Material consumption for internal plastering

Status	Type of Material		
	Cement (Bags)	Sand (m^3)	Lime (kg)
Experimental Qty	0.117	0.023	2.823
BSR Qty	0.086	0.020	3.226

In table 6.4 described comparison between experimental and BSR material usage for external plastering and it was observed that more materials were used for internal plastering.

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Comparison of Floor Rendering

Table 6.5 Material consumption for floor rendering

Status	Type of Material		
	Cement (Bags)	Sand (m^3)	Colour Pigment (kg)
Experimental Qty	0.268	0.037	0.191
BSR Qty	0.188	0.024	0.269

In table 6.4 shows that the experimental material consumption for floor rendering and comparison with BSR values. In this activity also more material consumption were reported with relative to the BSR standard norms.

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Comparison of Skirting

Table 6.6 Material consumption for 100mm high skirting

Status	Type of Material		
	Cement (Bags)	Sand (m^3)	Colour Pigment (kg)
Experimental Qty	0.024	0.003	0.025
BSR Qty	0.017	0.001	0.021

Experimental and BSR values were compared on above table 6.6 and it reflected the more materials were used in real situation.

Comparison of Random Rubble Work

Table 6.7 Material consumption for random rubble work

Status	Type of Material		
	Cement (Bags)	Sand (m^3)	Rubble Stone (m^3)
Experimental Qty	1.650	0.332	1.252
BSR Qty	2.562	0.449	1.300

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Table 6.7 shows that experimental and BSR values for construction of random rubble work and it illustrated less material were consumed for actual situation.

Comparison of Column and Beam Plastering

Table 6.8 Material consumption for column and beam plastering

Status	Type of Material		
	Cement (Bags)	Sand (m^3)	Lime (kg)
Experimental Qty	0.240	0.042	1.059
BSR Qty	0.086	0.009	0.860

In table 6.8 described comparison between experimental and BSR material usage for column and beam plastering and it was observed that more materials were used for less than 400mm width column and beam plastering work in different situation.

6.2 Recommendations and Further Study

This thesis is focused to develop the work norms for medium scale building construction site and research findings were based on the experimental data and some assumption made to generalize the decisions. This research was targeted mainly to find out the daily work done, material consumption for the construction event and labour performance for respective activities. Under the first objective, daily work done was measured for each activity and it was directly proportionate to the labour performance. After detail analysis and comparison with the BSR norms, daily work outputs were satisfactorily good with the technology. Hence it is necessary to maintain the workers daily performance at least same level.

The research findings revealed that more materials were consumed for some activities compare to the standard norms. As a result cost of the event is automatically gone up and this may pave the way to major issue or failure to the project. Hence all the construction organization needs to review their material management process to find the loop holes their system.

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In construction industry, standard norms for labour and material are used for planning and monitoring work and it is very important document in the civil engineering filed. However available document was developed more than twenty years back and reviewing process was also not done during this period. With the technology transfer during last two decades, it was observed that standard norms were slightly different from the actual norms. In this study, basically it was targeted to the review the standard norms with the actual situation. With the time restriction of the research period, data collection and analysis was limited to seven building construction activities, however this process can be applied for all the construction activities after that new work norms can be developed to suit to the present work conditions. This is the prime requirement on construction industry and it is recommended to carry out the further study or separate investigations on that particular sector.

In the industry, standard norms were developed with respect to the field of specialization such as building, road, irrigation etc. This analysis was based only medium scale building project, however it should be covered all the industries in civil engineering filed.

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Activity : Brick Work

APPENDIX - 02

Date	Actual Norms											Norms per Unit						Work quantity per day			
	Material			Labour (Direct Involvement)		Labour (Indirect)		Total Labour		Workdone		Material			Labour			Labour		Quantity per day	Unit
	Descripti	Qty	Unit	Category	hr	Categor	hr	Category	Days			Description	Qty	Unit	Description	Qty (Days)	Hours	Skilled	Unskilled		
3/2/2007	Cement	10.00	bags	Skilled	32	Skilled	0	Skilled	[redacted]	17.04	m2	Cement	0.59	bags	Skilled	0.23	1.88	1.00	1.00	4.26	m^2
	Sand	[redacted]	m^3	Unskilled	24	Unskille	8	Unskilled	4			Sand	0.11	m^3	Unskilled	0.23	1.88				
	Bricks	2064	nr									Bricks	121	nr							
6/2/2007	Cement	17.00	bags	Skilled	40	Skilled	0	Skilled	[redacted]	34.97	m2	Cement	0.49	bags	Skilled	0.14	1.14	1.00	1.45	6.99	m^2
	Sand	[redacted]	m^3	Unskilled	40	Unskille	18	Unskilled	7.25			Sand	0.10	m^3	Unskilled	0.21	1.66				
	Bricks	4420	nr									Bricks	126	nr							
15/2/2007	Cement	13.00	bags	Skilled	32	Skilled	0	Skilled	[redacted]	21.61	m2	Cement	0.60	bags	Skilled	0.19	1.48	1	0.88	5.40	m^2
	Sand	[redacted]	m^3	Unskilled	28	Unskille	0	Unskilled	3.5			Sand	0.11	m^3	Unskilled	0.16	1.30				
	Bricks	2494	nr									Bricks	115	nr							
23/02/2007	Cement	2.50	bags	Skilled	8	Skilled	0	Skilled	[redacted]	6.5	m2	Cement	0.38	bags	Skilled	0.15	1.23	1.00	1.00	6.50	m^2
	Sand	[redacted]	m^3	Unskilled	8	Unskille	0	Unskilled	1			Sand	0.07	m^3	Unskilled	0.15	1.23				
	Bricks	750	nr									Bricks	115	nr							
16/02/2007	Cement	17.00	bags	Skilled	45	Skilled	0	Skilled	[redacted]	31.635	m2	Cement	0.54	bags	Skilled	0.18	1.42	1.00	1.00	5.62	m^2
	Sand	[redacted]	m^3	Unskilled	36	Unskille	9	Unskilled	5.625			Sand	0.10	m^3	Unskilled	0.18	1.42				
	Bricks	4000	nr									Bricks	126	nr							
12/2/2007	Cement	4.00	bags	Skilled	18	Skilled	0	Skilled	[redacted]	9.9	m2	Cement	0.40	bags	Skilled	0.23	1.82	1.00	1.50	4.40	m^2
	Sand	[redacted]	m^3	Unskilled	18	Unskille	9	Unskilled	3.375			Sand	0.08	m^3	Unskilled	0.34	2.73				
	Bricks	1188	nr									Bricks	120	nr							
12/3/2007	Cement	11.00	bags	Skilled	16	Skilled	0	Skilled	[redacted]	29.3	m2	Cement	0.38	bags	Skilled	0.07	0.55	1.00	3.50	14.65	m^2
	Sand	[redacted]	m^3	Unskilled	24	Unskille	32	Unskilled	7.00			Sand	0.07	m^3	Unskilled	0.24	1.91				
	Bricks	3430	nr									Bricks	117	nr							
10/3/2007	Cement	19.00	bags	Skilled	33.75	Skilled	0	Skilled	[redacted]	38.82	m2	Cement	0.49	bags	Skilled	0.11	0.87	1.00	1.84	9.20	m^2
	Sand	[redacted]	m^3	Unskilled	44	Unskille	18	Unskilled	7.75			Sand	0.10	m^3	Unskilled	0.20	1.60				
	Bricks	4125	nr									Bricks	106	nr							
5/2/2007	Cement	13.00	bags	Skilled	32	Skilled	0	Skilled	[redacted]	21.6	m2	Cement	0.60	bags	Skilled	0.19	1.48	1.00	0.88	5.40	m^2
	Sand	[redacted]	m^3	Unskilled	28	Unskille	0	Unskilled	3.50			Sand	0.11	m^3	Unskilled	0.16	1.30				
	Bricks	2495	nr									Bricks	116	nr							
25/02/2007	Cement	5.00	bags	Skilled	18	Skilled	0	Skilled	[redacted]	21.25	m2	Cement	0.24	bags	Skilled	0.11	0.85	1.00	1.89	9.44	m^2
	Sand	[redacted]	m^3	Unskilled	18	Unskille	16	Unskilled	4.25			Sand	0.05	m^3	Unskilled	0.20	1.60				
	Bricks	2500	nr									Bricks	118	nr							
BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR
	Cement	3.25	bags	Skilled	19	Skilled	0	Skilled	2.38	10.00	m2	Cement	0.33	bags	Skilled	0.24	1.90	1	1.71	4.21	m^2
	Sand	0.60	m^3	Unskilled	32.5	Unskille	0	Unskilled	4.06			Sand	0.06	m^3	Unskilled	0.41	3.25				
	Bricks	1250	nr									Bricks	125.00	nr							

Material Usage Per m^2

Material	Unit	Average Work Qty	Standard Norms per m2(BSR)
Cement	Bags	0.470	0.325
Sand	m^3	0.091	0.060
Bricks	Nos	118.12	125.00

Labour Usage Per m^2

Category	Unit	Average Work Qty	Standard Norms Per m2 (BSR)
Skilled Labour	Days	0.16	0.24
UnSkilled Labour	Days	0.21	0.41

Daily Out-Put per Skilled Labour (Per day)

Skill Labour	Actual Work Qty		Standed Work(BSR)	
	Unskill Labour	Work Qty	Unskill Labour	Work Qty
[redacted]				

Activity : External Plastering

APPENDIX - 03

Date	Actual Norms: Material Description	Qty	Unit	Labour (Direct Involvement) Category	hr	Labour (Indirect) Category	hr	Total Labour Category	Days	Workdone Qty	Unit	Norms per Unit (1m²): Material Description	Qty	Unit	Labour Description	Qty (Days)	Hours	Work quantity Per Day: Labour Skilled	Unskilled	Quantity per day	Unit
24/03/2007	Cement	21	bags	Skilled	72	Skilled	0	Skilled	[redacted]	132.082	m²	Cement	0.159	bags	Skilled	0.07	0.55	1	1.63	14.68	m²
[redacted]	Sand (Sieved)	[redacted]	m³	Unskilled	90	Unskilled	27	Unskilled	14.625			Sand (Sieved)	0.030	m³	Unskilled	0.11	0.89				
21/03/2007	Cement	16	bags	Skilled	63	Skilled	0	Skilled	[redacted]	108.4	m²	Cement	0.148	bags	Skilled	0.07	0.58	1	1.43	13.77	m²
[redacted]	Sand (Sieved)	[redacted]	m³	Unskilled	81	Unskilled	9	Unskilled	11.25			Sand (Sieved)	0.038	m³	Unskilled	0.10	0.83				
2/3/2007	Cement	6	bags	Skilled	36	Skilled	0	Skilled	[redacted]	54.37	m²	Cement	0.110	bags	Skilled	0.08	0.66	1	1.38	12.08	m²
[redacted]	Sand (Sieved)	[redacted]	m³	Unskilled	40.5	Unskilled	9	Unskilled	6.19			Sand (Sieved)	0.020	m³	Unskilled	0.11	0.91				
22/03/2007	Cement	22	bags	Skilled	63	Skilled	0	Skilled	[redacted]	116.35	m²	Cement	0.189	bags	Skilled	0.07	0.54	1	1.29	14.77	m²
[redacted]	Sand (Sieved)	[redacted]	m³	Unskilled	63	Unskilled	18	Unskilled	10.13			Sand (Sieved)	0.04	m³	Unskilled	0.09	0.70				
6/3/2007	Cement	6	bags	Skilled	24	Skilled	0	Skilled	[redacted]	32.58	m²	Cement	0.18	bags	Skilled	0.09	0.74	1	1.67	10.86	m²
[redacted]	Sand (Sieved)	[redacted]	m³	Unskilled	32	Unskilled	8	Unskilled	5.00			Sand (Sieved)	0.03	m³	Unskilled	0.15	1.23				
25/02/2007	Cement	7	bags	Skilled	22	Skilled	0	Skilled	[redacted]	38.23	m²	Cement	0.18	bags	Skilled	0.07	0.58	1	1.45	13.90	m²
[redacted]	Sand (Sieved)	[redacted]	m³	Unskilled	24	Unskilled	8	Unskilled	4.00			Sand (Sieved)	0.03	m³	Unskilled	0.10	0.84				
20/07/2007	Cement	5	bags	Skilled	46	Skilled	0	Skilled	[redacted]	45.32	m²	Cement	0.11	bags	Skilled	0.13	1.02	1	1.22	7.88	m²
[redacted]	Sand (Sieved)	[redacted]	m³	Unskilled	48	Unskilled	8	Unskilled	7.00			Sand (Sieved)	0.02	m³	Unskilled	0.15	1.24				
6/11/2008	Cement	1	bags	Skilled	8	Skilled	0	Skilled	[redacted]	7.4	m²	Cement	0.14	bags	Skilled	0.14	1.08	1	2.25	7.40	m²
[redacted]	Sand (Sieved)	[redacted]	m³	Unskilled	10	Unskilled	8	Unskilled	2.25			Sand (Sieved)	0.04	m³	Unskilled	0.30	2.43				
14/06/2009	Cement	3	bags	Skilled	26	Skilled	0	Skilled	[redacted]	23.19	m²	Cement	0.13	bags	Skilled	0.14	1.12	1	0.73	7.14	m²
[redacted]	Sand (Sieved)	[redacted]	m³	Unskilled	19	Unskilled	0	Unskilled	2.38			Sand (Sieved)	0.04	m³	Unskilled	0.10	0.82				
16/06/2009	Cement	3	bags	Skilled	24	Skilled	0	Skilled	[redacted]	22.7	m²	Cement	0.13	bags	Skilled	0.13	1.06	1	0.67	7.57	m²
[redacted]	Sand (Sieved)	[redacted]	m³	Unskilled	16	Unskilled	0	Unskilled	2.00			Sand (Sieved)	0.04	m³	Unskilled	0.09	0.70				
BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR
	Cement	0.8	bags	Skilled	8	Skilled	0	Skilled	1.00	9.3	m²	Cement	0.09	bags	Skilled	0.11	0.86	1	1.25	9.30	m²
	Sand (Sieved)	0.20	m³	Unskilled	10	Unskilled	0	Unskilled	1.25			Sand (Sieved)	0.02	m³	Unskilled	0.134	1.08				
	Lime	20	kg									Lime	2.15	kg							

Material Usage Per m²

Material	Unit	Average Work Qty	Standard Norms per m2(BSR)
Cement	Bags	0.148	0.086
Sand	m³	0.032	0.021
Lime	kg		2.151

Labour Usage Per m²

Category	Unit	Average Work Quantity	Standard Norms Per m2 (BSR)
Skilled Labour	Days	0.099	0.11
UnSkilled Labour	Days	0.132	0.13

Daily Out-Put per Skilled Labour (Per day)

Skill Labour	Actual Work Qty: Unskill Labour	Work Qty	Standed Work(BSR Value): Unskill Labour	Work Qty
[redacted]				

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Date	Actual Norms: Material Description	Qty	Unit	Labour (Direct Involvement) Category	hr	Labour (Indirect) Category	hr	Total Labour Category	Days	Workdone Qty	Unit	Norms per Unit (m²): Material Description	Qty	Unit	Labour Description	Qty (Days)	Hours	Work quantity Per Day: Labour Skilled	Unskilled	Quantity per day	Unit
28/3/2007	Cement	4.00	bags	Skilled	18	Skilled	0	Skilled	[redacted]	30.327	m2	Cem	0.132	bags	Skilled	0.074	0.59	1	1.50	13.5	m²
	Sand (Sie	[redacted]	m³	Unskilled	27	Unskilled	0	Unskilled	3.38			Sand	0.025	m³	Unskilled	0.111	0.89				
[redacted]	Lime	90.00	kg									Lime	2.968	kg							
27/3/2007	Cement	5.00	bags	Skilled	33.75	Skilled	0	Skilled	[redacted]	42.24	m2	Cem	0.118	bags	Skilled	0.100	0.80	1	0.80	10.0	m²
	Sand (Sie	[redacted]	m³	Unskilled	27	Unskilled	0	Unskilled	3.38			Sand	0.022	m³	Unskilled	0.080	0.64				
[redacted]	Lime	90.00	kg									Lime	2.131	kg							
26/3/2007	Cement	7.00	bags	Skilled	40.5	Skilled	0	Skilled	[redacted]	57.42	m2	Cem	0.122	bags	Skilled	0.088	0.71	1	1.00	11.3	m²
	Sand (Sie	[redacted]	m³	Unskilled	40.5	Unskilled	0	Unskilled	5.06			Sand	0.023	m³	Unskilled	0.088	0.71				
[redacted]	Lime	210.00	kg									Lime	3.657	kg							
21/3/2007	Cement	5.00	bags	Skilled	27	Skilled	0	Skilled	[redacted]	34.75	m2	Cem	0.144	bags	Skilled	0.097	0.78	1	1.33	10.3	m²
	Sand (Sie	[redacted]	m³	Unskilled	36	Unskilled	0	Unskilled	4.50			Sand	0.027	m³	Unskilled	0.129	1.04				
[redacted]	Lime	150.00	kg									Lime	4.317	kg							
10/4/2007	Cement	3.00	bags	Skilled	16	Skilled	0	Skilled	[redacted]	21.00	m2	Cem	0.143	bags	Skilled	0.095	0.76	1	1.75	10.5	m²
	Sand (Sie	[redacted]	m³	Unskilled	24	Unskilled	4	Unskilled	3.50			Sand	0.026	m³	Unskilled	0.167	1.33				
[redacted]	Lime	100.00	kg									Lime	4.762	kg							
7/4/2007	Cement	7.00	bags	Skilled	25.5	Skilled	0	Skilled	[redacted]	52.3	m2	Cem	0.134	bags	Skilled	0.061	0.49	1	2.00	16.4	m²
	Sand (Sie	[redacted]	m³	Unskilled	42.5	Unskilled	8.5	Unskilled	6.38			Sand	0.025	m³	Unskilled	0.122	0.98				
[redacted]	Lime	120.00	kg									Lime	2.294	kg							
9/4/2007	Cement	4.00	bags	Skilled	24	Skilled	0	Skilled	[redacted]	41.00	m2	Cem	0.098	bags	Skilled	0.073	0.59	1	1.67	13.7	m²
	Sand (Sie	[redacted]	m³	Unskilled	32	Unskilled	8	Unskilled	5.00			Sand	0.018	m³	Unskilled	0.122	0.98				
[redacted]	Lime	100.00	kg									Lime	2.439	kg							
6/6/2009	Cement	3.50	bags	Skilled	28	Skilled	0	Skilled	[redacted]	38.45	m2	Cem	0.096	bags	Skilled	0.096	0.77	1	0.89	10.4	m²
	Sand (Sie	[redacted]	m³	Unskilled	20	Unskilled	5	Unskilled	3.13			Sand	0.022	m³	Unskilled	0.086	0.69				
[redacted]	Lime	60.00	kg									Lime	1.646	kg							
8/6/2009	Cement	3.00	bags	Skilled	25	Skilled	0	Skilled	[redacted]	30.19	m2	Cem	0.099	bags	Skilled	0.104	0.83	1	1.04	9.7	m²
	Sand (Sie	[redacted]	m³	Unskilled	22	Unskilled	4	Unskilled	3.25			Sand	0.022	m³	Unskilled	0.108	0.86				
[redacted]	Lime	60.00	kg									Lime	1.987	kg							
9/6/2009	Cement	2.50	bags	Skilled	21	Skilled	0	Skilled	[redacted]	29.58	m2	Cem	0.085	bags	Skilled	0.089	0.71	1	1.29	11.3	m²
	Sand (Sie	[redacted]	m³	Unskilled	22	Unskilled	5	Unskilled	3.38			Sand	0.020	m³	Unskilled	0.114	0.91				
[redacted]	Lime	60.00	kg									Lime	2.028	kg							
BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR
	Cement	0.80	bags	Skilled	8	Skilled	0	Skilled	1	9.3	m2	Cem	0.086	bags	Skilled	0.11	0.86	1	1.25	9.3	m²
	Sand (Sie	0.19	m³	Unskilled	10	Unskilled	0	Unskilled	1.25			Sand	0.020	m³	Unskilled	0.13	1.08				
	Lime	30.00	kg									Lime	3.226	kg							

Material Usage Per m²

Material	Unit	Average Work Qty	Standard Norms per m2(BSR)
Cement	Bags	0.117	0.086
Sand	m3	0.023	0.020
Lime	kg	2.823	3.226

Labour Usage Per m²

Category	Unit	Average Work Quantity	Standard Norms Per m2 (BSR)
Skilled Labour	Days	0.088	0.11
UnSkilled Labour	Days	0.113	0.13

Daily Out-Put per Skilled Labour (Per day)

Skill Labour	Actual Work Qty: Unskill Labour	Actual Work Qty: Work Qty	Standed Work(BSR Value): Unskill Labour	Standed Work(BSR Value): Work Qty

	Description	Qty	Unit	Category	hr	Category	hr	Category	Days			Description	Qty	Unit	Description	Qty (Days)	Hours	Skilled	Unskilled	per day	
18/3/2007	Cement	7.00	bags	Skilled	18	Skilled	0	Skilled	[redacted]	44.4	m2	Cement	0.16	bags	Skilled	0.05	0.41	1.00	1.56	19.7	m^2
	Sand (Sieved)	[redacted]	m^3	Unskilled	18	Unskilled	10	Unskilled	3.5			Sand (Sieved)	0.02	m^3	Unskilled	0.08	0.63				
[redacted]	Coloured cement	5.00	kg									Coloured cement	0.11	kg							
30/3/2007	Cement	16.00	bags	Skilled	27	Skilled	0	Skilled	[redacted]	51.00	m2	Cement	0.31	bags	Skilled	0.07	0.53	1.00	1.37	15.1	m^2
	Sand (Sieved)	[redacted]	m^3	Unskilled	27	Unskilled	10	Unskilled	4.63			Sand (Sieved)	0.03	m^3	Unskilled	0.09	0.73				
[redacted]	Coloured cement	18.00	kg									Coloured cement	0.35	kg							
12/3/2007	Cement	14.00	bags	Skilled	24	Skilled	0	Skilled	[redacted]	43.2	m2	Cement	0.32	bags	Skilled	0.07	0.56	1.00	1.13	14.4	m^2
	Sand (Sieved)	[redacted]	m^3	Unskilled	18	Unskilled	9	Unskilled	3.38			Sand (Sieved)	0.04	m^3	Unskilled	0.08	0.63				
[redacted]	Coloured cement	5.00	kg									Coloured cement	0.12	kg							
11/3/2007	Cement	8.00	bags	Skilled	20	Skilled	0	Skilled	[redacted]	21.6	m2	Cement	0.37	bags	Skilled	0.12	0.93	1.00	1.00	8.6	m^2
	Sand (Sieved)	[redacted]	m^3	Unskilled	20	Unskilled	0	Unskilled	2.50			Sand (Sieved)	0.08	m^3	Unskilled	0.12	0.93				
[redacted]	Coloured cement	5.00	kg									Coloured cement	0.23	kg							
6/3/2007	Cement	15.00	bags	Skilled	20	Skilled	0	Skilled	[redacted]	50.36	m2	Cement	0.30	bags	Skilled	0.05	0.40	1.00	1.50	20.1	m^2
	Sand (Sieved)	[redacted]	m^3	Unskilled	20	Unskilled	10	Unskilled	3.75			Sand (Sieved)	0.06	m^3	Unskilled	0.07	0.60				
[redacted]	Coloured cement	10.00	kg									Coloured cement	0.20	kg							
9/3/2007	Cement	2.00	bags	Skilled	8	Skilled	0	Skilled	[redacted]	7.353	m2	Cement	0.27	bags	Skilled	0.14	1.09	1	3.00	7.4	m^2
	Sand (Sieved)	[redacted]	m^3	Unskilled	16	Unskilled	8	Unskilled	3.00			Sand (Sieved)	0.05	m^3	Unskilled	0.41	3.26				
[redacted]	Coloured cement	2.00	kg									Coloured cement	0.27	kg							
8/6/2007	Cement	5.00	bags	Skilled	16	Skilled	0	Skilled	[redacted]	14.765	m2	Cement	0.34	bags	Skilled	0.14	1.08	1	1.00	7.4	m^2
	Sand (Sieved)	[redacted]	m^3	Unskilled	16	Unskilled	0	Unskilled	2.00			Sand (Sieved)	0.04	m^3	Unskilled	0.14	1.08				
[redacted]	Coloured cement	5.00	kg									Coloured cement	0.34	kg							
12/6/2009	Cement	3.75	bags	Skilled	18	Skilled	0	Skilled	[redacted]	15.54	m2	Cement	0.24	bags	Skilled	0.14	1.16	1	1.11	6.9	m^2
	Sand (Sieved)	[redacted]	m^3	Unskilled	16	Unskilled	4	Unskilled	2.50			Sand (Sieved)	0.04	m^3	Unskilled	0.16	1.29				
[redacted]	Coloured cement	1.20	kg									Coloured cement	0.08	kg							
13/6/2009	Cement	4.00	bags	Skilled	20	Skilled	0	Skilled	[redacted]	18.3	m2	Cement	0.22	bags	Skilled	0.14	1.09	1	1.00	7.3	m^2
	Sand (Sieved)	[redacted]	m^3	Unskilled	16	Unskilled	4	Unskilled	2.50			Sand (Sieved)	0.01	m^3	Unskilled	0.14	1.09				
[redacted]	Coloured cement	1.50	kg									Coloured cement	0.08	kg							
24/11/2008	Cement	9.00	bags	Skilled	38	Skilled	0	Skilled	[redacted]	63.03	m2	Cement	0.14	bags	Skilled	0.08	0.60	1	1.03	13.3	m^2
	Sand (Sieved)	[redacted]	m^3	Unskilled	35	Unskilled	4	Unskilled	4.88			Sand (Sieved)	0.01	m^3	Unskilled	0.08	0.62				
[redacted]	Coloured cement	8.00	kg									Coloured cement	0.13	kg							
BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR
	Cement	1.75	bags	Skilled	10	Skilled	0	Skilled	1.25	9.3	m2	Cement	0.19	bags	Skilled	0.13	1.08	1	1.80	7.4	m^2
	Sand (Sieved)	0.23	m^3	Unskilled	16	Unskilled	2	Unskilled	2.25			Sand (Sieved)	0.02	m^3	Unskilled	0.24	1.94				
	Coloured cement	2.50	kg									Coloured cement	0.27	kg							

Material Usage Per m^2

Material	Unit	Average Work Qty	Standard Norms per m2(BSR)
Cement	Bags	0.268	0.188
Sand	m^3	0.037	0.024
loured cem	kg	0.191	0.269

Labour Usage Per m^2

Category	Unit	Average Work Quantity	Standard Norms Per m2 (BSR)
Skilled Labour	Days	0.098	0.13
UnSkilled Labour	Days	0.136	0.24

Daily Out-Put per Skilled Labour (Per day)

Skill Labour	Actual Work Qty		Standed Work(BSR Value)	
	Unskill Labour	Work Qty	Unskill Labour	Work Qty
[redacted]				

Activity : Skirting

APPENDIX - 06

Date	Actual Norms											Norms per Unit						Work quantity per day			
	Material			Labour (Direct Involvement)		Labour (Indirect)		Total Labour		Workdone		Material			Labour			Labour		Quantity per day	Unit
	Description	Qty	unit	Category	hr	Category	hr	Category	Days			Description	Qty	Unit	Descripti	Qty (Days)	Hours	Skilled	Unskilled		
12/3/2007	Cement	1.000		Skilled	9	Skilled	0	Skilled	[redacted]	28.00	m	Cement	0.04	bags	Skilled	0.04	0.32	1.00	1.00	24.89	m
	Sand (Sieved	[redacted]		Unskilled	9	Unskilled	0	Unskilled	1.125			Sand (Sieved)	0.004	m³	Unskilled	0.04	0.32				
[redacted]	Coloured	1.000										Coloured	0.04	kg							
15/3/2007	Cement	1.500	bags	Skilled	13.5	Skilled	0	Skilled	[redacted]	40.00	m	Cement	0.04	bags	Skilled	0.04	0.34	1.00	0.74	23.70	m
	Sand (Sieved	[redacted]	m³	Unskilled	10	Unskilled	0	Unskilled	1.25			Sand (Sieved)	0.004	m³	Unskilled	0.03	0.25				
[redacted]	Coloured	2.000	kg									Coloured cemer	0.05	kg							
16/3/2007	Cement	1.000	bags	Skilled	9	Skilled	0	Skilled	[redacted]	26.00	m	Cement	0.04	bags	Skilled	0.04	0.35	1.00	1.00	23.11	m
	Sand (Sieved	[redacted]	m³	Unskilled	9	Unskilled	0	Unskilled	1.125			Sand (Sieved)	0.004	m³	Unskilled	0.04	0.35				
[redacted]	Coloured cen	1.000	kg									Coloured cemer	0.04	kg							
17/3/2007	Cement	1.100	bags	Skilled	12	Skilled	0	Skilled	[redacted]	34.00	m	Cement	0.03	bags	Skilled	0.04	0.35	1.00	0.83	22.67	m
	Sand (Sieved	[redacted]	m³	Unskilled	10	Unskilled	0	Unskilled	1.25			Sand (Sieved)	0.004	m³	Unskilled	0.04	0.29				
[redacted]	Coloured cen	1.100	kg									Coloured cemer	0.03	kg							
21/11/2008	Cement	0.600	bags	Skilled	13	Skilled	0	Skilled	[redacted]	22.49	m	Cement	0.03	bags	Skilled	0.07	0.58	1.00	0.62	13.84	m
	Sand (Sieved	[redacted]	m³	Unskilled	8	Unskilled	0	Unskilled	1			Sand (Sieved)	0.002	m³	Unskilled	0.04	0.36				
[redacted]	Coloured cen	0.600	kg									Coloured cemer	0.03	kg							
22/11/2008	Cement	0.300	bags	Skilled	8	Skilled	0	Skilled	[redacted]	16.12	m	Cement	0.02	bags	Skilled	0.06	0.50	1.00	0.75	16.12	m
	Sand (Sieved	[redacted]	m³	Unskilled	6	Unskilled	0	Unskilled	0.75			Sand (Sieved)	0.002	m³	Unskilled	0.05	0.37				
[redacted]	Coloured cen	0.300	kg									Coloured cemer	0.02	kg							
23/11/2008	Cement	0.280	bags	Skilled	9	Skilled	0	Skilled	[redacted]	17.25	m	Cement	0.02	bags	Skilled	0.07	0.52	1.00	0.89	15.33	m
	Sand (Sieved	[redacted]	m³	Unskilled	8	Unskilled	0	Unskilled	1			Sand (Sieved)	0.002	m³	Unskilled	0.06	0.46				
[redacted]	Coloured cen	0.300	kg									Coloured cemer	0.02	kg							
12/6/2009	Cement	0.250	bags	Skilled	8	Skilled	0	Skilled	[redacted]	20.70	m	Cement	0.01	bags	Skilled	0.05	0.39	1.00	0.50	20.70	m
	Sand (Sieved	[redacted]	m³	Unskilled	4	Unskilled	0	Unskilled	0.5			Sand (Sieved)	0.001	m³	Unskilled	0.02	0.19				
[redacted]	Coloured cen	0.250	kg									Coloured cemer	0.01	kg							
13/06/2009	Cement	0.230	bags	Skilled	7	Skilled	0	Skilled	[redacted]	20.20	m	Cement	0.01	bags	Skilled	0.04	0.35	1.00	0.86	23.09	m
	Sand (Sieved	[redacted]	m³	Unskilled	6	Unskilled	0	Unskilled	0.75			Sand (Sieved)	0.001	m³	Unskilled	0.04	0.30				
[redacted]	Coloured cen	0.250	kg									Coloured cemer	0.01	kg							
15/06/2009	Cement	0.200	bags	Skilled	7	Skilled	0	Skilled	[redacted]	18.30	m	Cement	0.01	bags	Skilled	0.05	0.38	1.00	0.71	20.91	m
	Sand (Sieved	[redacted]	m³	Unskilled	5	Unskilled	0	Unskilled	0.625			Sand (Sieved)	0.001	m³	Unskilled	0.03	0.27				
[redacted]	Coloured cen	0.200	kg									Coloured cemer	0.01	kg							
BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR
	Cement	0.1	bags	Skilled	3	Skilled	0	Skilled	0.375	6.00	m	Cement	0.02	bags	Skilled	0.06	0.50	1.00	0.83	16.00	m
	Sand (Sieved	0.01	m³	Unskilled	2.5	Unskilled	0	Unskilled	0.3125			Sand (Sieved)	0.001	m³	Unskilled	0.05	0.42				
	Coloured	0.13	kg									Coloured cemer	0.02	kg							

Material Usage Per m

Material	Unit	Average Work Qty	Standard Norms per m(BSR)
Cement	Bags	0.0240	0.0167
Sand	m³	0.0026	0.0014
Coloured	kg	0.0255	0.0208

Labour Usage Per m

Category	Unit	Average Work Quantity	Standard Norms Per m (BSR)
Skilled Labour	Days	0.051	0.063
UnSkilled Labour	Days	0.040	0.052

Daily Out-Put per Skilled Labour (Per day)

Skill Labour	Actual Work Qty		Standed Work(BSR Value)	
	Unskill Labour	Work Qty	Unskill Labour	Work Qty
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Activity : Rubble Work

APPENDIX - 07

Date	Actual Norms											Norms per Unit						Work quantity per day			
	Material			Labour (Direct Involvement)		Labour (Indirect)		Total Labour		Workdone		Material			Labour			Labour		Quantity per day	Unit
	Description	Qty	Unit	Category	hr	Category	hr	Category	Days	Qty	Unit	Description	Qty	Unit	Description	Qty (Days)	Hours	Skilled	Unskilled		
1/3/2007	Cement	5	bags	Skill	16	Skill	0	Skill	[redacted]	2.16	m^3	Cement	2.31	bags	Skill	0.926	7.41	1	1.25	1.08	m^3
	Sand	[redacted]	m^3	Un Skill	20	Un Skill	0	Un Skill	2.5			Sand	0.44	m^3	Un Skill	1.157	9.26				
[redacted]	Rubble	2.8	m^3									Rubble	1.30	m^3							
13/07/2007	Cement	1.2	bags	Skill	8	Skill	0	Skill	[redacted]	0.64	m^3	Cement	1.88	bags	Skill	1.563	12.50	1	1.50	0.64	m^3
	Sand	[redacted]	m^3	Un Skill	8	Un Skill	4	Un Skill	1.5			Sand	0.30	m^3	Un Skill	2.344	18.75				
[redacted]	Rubble	0.9	m^3									Rubble	1.41	m^3							
20/09/2008	Cement	4.5	bags	Skill	16	Skill	0	Skill	[redacted]	2.75	m^3	Cement	1.64	bags	Skill	0.727	5.82	1	1.00	1.38	m^3
	Sand	[redacted]	m^3	Un Skill	16	Un Skill	0	Un Skill	2			Sand	0.16	m^3	Un Skill	0.727	5.82				
[redacted]	Rubble	2.9	m^3									Rubble	1.05	m^3							
4/12/2008	Cement	8.5	bags	Skill	27	Skill	0	Skill	[redacted]	4.85	m^3	Cement	1.75	bags	Skill	0.696	5.57	1	0.59	1.44	m^3
	Sand	[redacted]	m^3	Un Skill	16	Un Skill	0	Un Skill	2			Sand	0.13	m^3	Un Skill	0.412	3.30				
[redacted]	Rubble	4.95	m^3									Rubble	1.02	m^3							
22/09/2008	Cement	6	bags	Skill	24	Skill	0	Skill	[redacted]	3.28	m^3	Cement	1.83	bags	Skill	0.915	7.32	1	1.00	1.09	m^3
	Sand	[redacted]	m^3	Un Skill	16	Un Skill	8	Un Skill	3			Sand	0.43	m^3	Un Skill	0.915	7.32				
[redacted]	Rubble	4.3	m^3									Rubble	1.31	m^3							
1/10/2008	Cement	3	bags	Skill	14	Skill	0	Skill	[redacted]	1.72	m^3	Cement	1.74	bags	Skill	1.017	8.14	1	1.43	0.98	m^3
	Sand	[redacted]	m^3	Un Skill	20	Un Skill	0	Un Skill	2.5			Sand	0.35	m^3	Un Skill	1.453	11.63				
[redacted]	Rubble	2.3	m^3									Rubble	1.34	m^3							
22/05/2009	Cement	1.5	bags	Skill	10	Skill	0	Skill	[redacted]	1.07	m^3	Cement	1.40	bags	Skill	1.168	9.35	1	0.90	0.86	m^3
	Sand	[redacted]	m^3	Un Skill	9	Un Skill	0	Un Skill	1.125			Sand	0.27	m^3	Un Skill	1.051	8.41				
[redacted]	Rubble	1.42	m^3									Rubble	1.33	m^3							
23/05/2009	Cement	7	bags	Skill	40	Skill	0	Skill	[redacted]	5.39	m^3	Cement	1.30	bags	Skill	0.928	7.42	1	0.75	1.08	m^3
	Sand	[redacted]	m^3	Un Skill	30	Un Skill	0	Un Skill	3.75			Sand	0.50	m^3	Un Skill	0.696	5.57				
[redacted]	Rubble	7.075	m^3									Rubble	1.31	m^3							
24/05/2009	Cement	3.5	bags	Skill	13	Skill	0	Skill	[redacted]	2.02	m^3	Cement	1.73	bags	Skill	0.804	6.44	1	0.54	1.24	m^3
	Sand	[redacted]	m^3	Un Skill	7	Un Skill	0	Un Skill	0.875			Sand	0.56	m^3	Un Skill	0.433	3.47				
[redacted]	Rubble	2.85	m^3									Rubble	1.41	m^3							
27/06/2009	Cement	5	bags	Skill	34	Skill	0	Skill	[redacted]	5.45	m^3	Cement	0.92	bags	Skill	0.780	6.24	1	0.71	1.28	m^3
	Sand	[redacted]	m^3	Un Skill	24	Un Skill	0	Un Skill	3			Sand	0.19	m^3	Un Skill	0.550	4.40				
[redacted]	Rubble	5.66	m^3									Rubble	1.04	m^3							
BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR
	Cement	7.25	bags	Skill	24	Skill	0	Skill	3	2.83	m^3	Cement	2.56	bags	Skill	1.060	8.48	1	2.00	0.94	m^3
	Sand	1.27	m^3	Un Skill	48	Un Skill	0	Un Skill	6			Sand	0.45	m^3	Un Skill	2.120	16.96				
	Rubble	3.68	m^3									Rubble	1.30	m^3							
BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR

Material Usage Per m3

Material	Unit	Average Work Qty	Standard Norms per m3(BSR)
Cement	Bags	1.65	2.56
Sand	m^3	0.33	0.45
Rubble	m^3	1.25	1.30

Labour Usage Per m3

Category	Unit	Average Work Quantity	Standard Norms Per m3 (BSR)
Skilled Labour	Days	0.95	1.06
Unskilled Labour	Days	0.97	2.12

Daily Out-Put per Skilled Labour (Per day)

Skill Labour	Actual Work Qty		Standed Work(BSR Value)	
	Unskill	Work Qty	Unskill	Work Qty
[redacted]				

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Activity : Column and Beam Plastering

APPENDIX - 08

Date	Actual Norms: Material Description	Material Qty	Material Unit	Labour (Direct Involvement) Category	hr	Labour (Indirect) Category	hr	Total Labour Category	Days	Workdone Qty	Workdone Unit	Norms per Unit: Material Description	Qty	Unit	Labour Description	Qty (Days)	Hours	Work quantity per day: Labour Skilled	Labour Unskilled	Quantity per day	Unit
15/3/2007	Cement	3.00	bags	Skilled	16	Skilled	0	Skilled	[redacted]	14.178	m^2	Cement	0.21		Skilled	0.14	1.13	1	1.50	7.09	m^2
[redacted]	Sand (Sieve	[redacted]	m^3	Unskilled	24	Unskilled	0	Unskilled	[redacted]			Sand (Sieved	0.04	m^3	Unskilled	0.21	1.69				
28/03/2007	Cement	4.00	bags	Skilled	16	Skilled	0	Skilled	[redacted]	14.177	m^2	Cement	0.28	bags	Skilled	0.14	1.13	1	1.50	7.09	m^2
	Sand (Sieve	[redacted]	m^3	Unskilled	16	Unskilled	8	Unskilled	[redacted]			Sand (Sieved	0.05	m^3	Unskilled	0.21	1.69				
[redacted]	Lime	40.00	kg									Lime	2.82								
6/4/2007	Cement	4.00	bags	Skilled	32	Skilled	0	Skilled	[redacted]	19.8	m^2	Cement	0.20	bags	Skilled	0.20	1.62	1.00	1.00	4.95	m^2
	Sand (Sieve	[redacted]	m^3	Unskilled	24	Unskilled	8	Unskilled	[redacted]			Sand (Sieved	0.04	m^3	Unskilled	0.20	1.62				
[redacted]	Lime	30.00	kg									Lime	1.52	kg							
5/4/2007	Cement	4.50	bags	Skilled	20	Skilled	0	Skilled	[redacted]	15.75	m^2	Cement	0.29	m^2	Skilled	0.16	1.27	1.00	1.60	6.30	m^2
	Sand (Sieve	[redacted]	m^3	Unskilled	24	Unskilled	8	Unskilled	[redacted]			Sand (Sieved	0.05	m^3	Unskilled	0.25	2.03				
[redacted]	Lime	27.00	kg									Lime	1.71	kg							
4/4/2007	Cement	4.00	bags	Skilled	32	Skilled	0	Skilled	[redacted]	17.235	m^2	Cement	0.23	bags	Skilled	0.23	1.86	1.00	1.00	4.31	m^2
	Sand (Sieve	[redacted]	m^3	Unskilled	24	Unskilled	8	Unskilled	[redacted]			Sand (Sieved	0.04	m^3	Unskilled	0.23	1.86				
[redacted]	Lime	60.00	kg									Lime	3.48	kg							
28/2/2007	Cement	3.00	bags	Skilled	16	Skilled	0	Skilled	[redacted]	10.485	m^2	Cement	0.29	bags	Skilled	0.19	1.53	1.00	1.00	5.24	m^2
[redacted]	Sand (Sieve	[redacted]	m^3	Unskilled	16	Unskilled	0	Unskilled	[redacted]			Sand (Sieved	0.03	m^3	Unskilled	0.19	1.53				
7/3/2007	Cement	3.00	bags	Skilled	24	Skilled	0	Skilled	[redacted]	13.6	m^2	Cement	0.22	bags	Skilled	0.22	1.76	1.00	0.67	4.53	m^2
[redacted]	Sand (Sieve	[redacted]	m^3	Unskilled	16	Unskilled	0	Unskilled	[redacted]			Sand (Sieved	0.04	m^3	Unskilled	0.15	1.18				
1/3/2007	Cement	4.00	bags	Skilled	24	Skilled	0	Skilled	[redacted]	19.85	m^2	Cement	0.20	bags	Skilled	0.15	1.21	1.00	1.00	6.62	m^2
[redacted]	Sand (Sieve	[redacted]	m^3	Unskilled	16	Unskilled	8	Unskilled	[redacted]			Sand (Sieved	0.04	m^3	Unskilled	0.15	1.21				
11/6/2007	Cement	1.00	bags	Skilled	8	Skilled	0	Skilled	[redacted]	4.40	m^2	Cement	0.23	bags	Skilled	0.23	1.82	1.00	0.75	4.40	m^2
[redacted]	Sand (Sieve	[redacted]	m^3	Unskilled	6	Unskilled	0	Unskilled	[redacted]			Sand (Sieved	0.04	m^3	Unskilled	0.17	1.36				
28/03/2007	Cement	4.00	bags	Skilled	18	Skilled	0	Skilled	[redacted]	16.24	m^2	Cement	0.25	bags	Skilled	0.14	1.11	1	1.33	7.22	m^2
[redacted]	Sand (Sieve	[redacted]	m^3	Unskilled	16	Unskilled	8	Unskilled	[redacted]			Sand (Sieved	0.05	m^3	Unskilled	0.18	1.48				
BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR	BSR
	Cement	0.80	bags	Skilled	16	Skilled	0	Skilled	2	9.3	m^2	Cement	0.09	bags	Skilled	0.22	1.72	1.00	1.00	4.65	m^2
	Sand (Sieve	0.09	m^3	Unskilled	16	Unskilled	0	Unskilled	2			Sand (Sieved	0.01	m^3	Unskilled	0.22	1.72				
	Lime	8.00	kg									Lime	0.86	Kg							

Material Usage Per m^2

Material	Unit	Average Work Qty	Standard Norms per m2(BSR)
Cement	Bags	0.240	0.086
Sand	m^3	0.042	0.009
Lime	kg	1.059	0.860

Labour Usage Per m^2

Category	Unit	Average Work Quantity	Standard Norms Per m2 (BSR)
Skilled Labour	Days	0.180	0.215
UnSkilled Labour	Days	0.196	0.215

Daily Out-Put per Skilled Labour (Per day)

Skill Labour	Actual Work Qty		Standed Work(BSR Value)	
	Unskill Labour	Work Qty	Unskill Labour	Work Qty
[redacted]				