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ESTABLISHING REGRESSION EQUATION BETWEEN VARIOUS HUMAN ACTIVITIES RELATED TO CONCRETING & FINISHING WORK

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ABSTRACT: With the continuous decline in profit margins and increased competition in construction projects, construction contractors are finding ways of eliminating waste and increasing profits. Although numerous approaches have been developed to improve efficiency and effectiveness of construction process, implementing statistical techniques offer the promise to minimize, if not eliminate non value-adding work. The construction industry is one of the largest industries in any economy. It makes a significant contribution to the national economy and provides employment to large number of people. Time and motion study (also referred to as motion and time study, the terms are used interchangeably) is the scientific study of the conservation of human resources in the search for the most efficient method of doing a task. Time and motion study is carried out to asses' human effectiveness by improved planning and sound incentive schemes to its employees. It is employed in the assessment of the human efforts in various aspects to lead systematically to many factors which ultimately affect efficiency and economy of the situation under study in realizing the objectives of bringing about improvements. The purpose of this work is to highlight the benefits of time and motion study employed in construction sector. Time and motion study has been employed to measure the productivity of the operations. It is expected that employing lean concepts to construction will help in increasing productivity and reduce risks. Statistical analysis will help in life cycle of a construction project right from concept to completion and finally in operation and maintenance of the process. In essence, the focus is to apply time and motion study and statistical analysis to various construction processes to the observation data sets generated for various construction processes on site and determines the productivity and establish regression model using statistical analysis.

Keywords: Labour productivity, time motion, work study, regression analysis

I. INTRODUCTION

1.1 General

Labour productivity is an important economic indicator that is closely linked to economic growth, competitiveness, and living standards within an economy. Labour productivity represents the total volume of output (measured in terms of Gross Domestic Product, GDP) produced per unit of labour (measured in terms of the number of employed persons) during a given time reference period. The indicator allows data users to assess GDP-to-labour input levels and growth rates over time, thus providing general information about the efficiency and quality of human capital in the production process for a given economic and social context, including other complementary inputs and innovations used in production Given its usefulness in conveying valuable information on a country's labour market situation, it was one of the indicators used to measure progress towards the achievement of the Millennium Development Goals (MDGs), under Goal 1 (Eradicate poverty and hunger), and it was included as one of the indicators proposed to measure progress towards the achievement of the Sustainable Development Goals (SDG), under Goal 8 (Promote sustained, inclusive and sustainable economic growth, full and productive

employment and decent work for all). Construction performance and productivity improvement are key focus areas in construction industry for any nation. Indian construction industry forms an integral part of economy. Construction constitutes 40% to 50% of India's capital expenditure on projects in various sectors such as highways, roads, railways, energy, airports, irrigation, etc. and is the second largest industry in India after agriculture. It accounts for about 11% of India's GDP. Improving productivity is major concern for any profit oriented organization. In general terms productivity is termed as ratio between input and output. Proper management of available asset can help in improving productivity. Labour is the most important asset to a construction company. In spite of many technological advances, construction continues to be a labour intensive industry. 30% to 50% of total cost of project is spent on labours. Quality of the construction largely depends upon the quality of work done by labour. Labour productivity directly affects construction productivity; it is important to know the factors affecting labour productivity.

1.2 Concepts and definitions:-

Productivity represents the amount of output per unit of input. In ILOSTAT's indicator, output is measured as gross domestic product (GDP) for the aggregate economy expressed at purchasing power parities (PPP) to account for price differences in countries.

The GDP represents the monetary value of all goods and services produced within a country over a specified period of time.

Employment comprises all persons of working age who during a specified brief period, such as one week or one day, were in the following categories: a) paid employment (whether at work or with a job but not at work); or b) self-employment (whether at work or with an enterprise but not at work).

1.3 Method of computation:-

The indicator on labour productivity is calculated as follows:

Labour productivity = GDP at constant prices /Number of employed persons

1.4 Objectives

- To identify problem in the production work process for construction industry
- To improve the work process in terms of production time and to identify the parameters to increase productivity
- To analyze the present method of doing job systematically.
- To measure the work content of a job by measuring the time required to do the job for a worker. To do work sampling for various construction activities.
- To find correlation various human activities related to concreting and establish regression equation between them for concreting as well as finishing work

II. LITERATURE REVIEW

SerdarUlubeyli, AynurKazaz In construction projects, there are three basic planning elements: time, cost, and quality. These concepts are in a close relationship with each other. Labour productivity is also a key concept of construction planning efforts and has a direct interrelationship with the triple constraint mentioned above. Lower labour performance is strongly related to the presence of change of work, disruptions and rework. On average 30% loss of efficiency occurs when changes are done. The most significant types of disruptions are lack of materials and information and having to perform the work out of sequence. These disruptions result in daily loss of efficiency in range of 25% - 50%. (H. Randolf Thomas& Carmen I. Napolitan). Labour productivity is also one of the performance indicators to assess the success of the construction project. Because construction is a labour intensive industry, it can be argued that the work force is the dominant productive resource. Thus construction productivity is

primarily dependent on human effort and performance. Labour productivity is important index because of concentration of labour needed to complete specific work. (Wen yi& Albert P.C.Chan, 2014). Productivity is generally ratio of output to input. In form of equation it can be shown as follows:

Productivity = Output ÷ Input

= Total output ÷ Total work hour.

Abdulaziz M. Jarkas Rebar installation is an integral, labour-intensive trade of this type of construction material. Its walls form major parts of reinforced concrete frames, which are typically associated with a higher unit rate cost compared with other structural elements, especially spread foundations and grade and one-way elevated slabs. Therefore, objective of this research is to investigate the effects and relative influence of the rebar diameter, quantity of reinforcement installed, wall thickness, plan geometry, and wall curvature intensity, on rebar installation labour productivity of walls. To achieve this objective, a sufficiently large volume of installation labour productivity data was collected and analysed using the multiple categorical-regression method. The results obtained show a significant influence of factors investigated on the labour efficiency of the installation operation, which can be used to provide designers feedback on how well their designs consider the requirements of the build ability concept, and the tangible consequences of their decisions on labour productivity. In addition, a set of recommendations

Hyunsoo Kim Adding new labourers during construction is usually considered the easiest option to execute when a schedule delay occurs in a construction project. However, determining the proper number of new labourers to add is quite challenging because newly added labourers' short-term productivity for their first several production cycles could be significantly different from that of existing labourers. While existing studies suggest that newly added labourers' site-learning may cause such a difference, this process has not been considered when forecasting newly added labourers' short-term productivity. In this context, this study presents a method that takes into account site-learning effects and the periodic characteristics of newly added labourers' short-term productivity. The periodic characteristics of productivity are analysed based on a time-series model of existing labourers' productivity. Then, the impact of the site-learning effect on the productivity is considered based on existing learning-effect theory. An illustrative example demonstrates the accuracy and usefulness of the presented method. Its results indicate that the consideration of the site-learning effect prevents the frequent and counterproductive underestimation of the required number of newly added labourers in establishing an accelerated recovery schedule.

III. METHODOLOGY

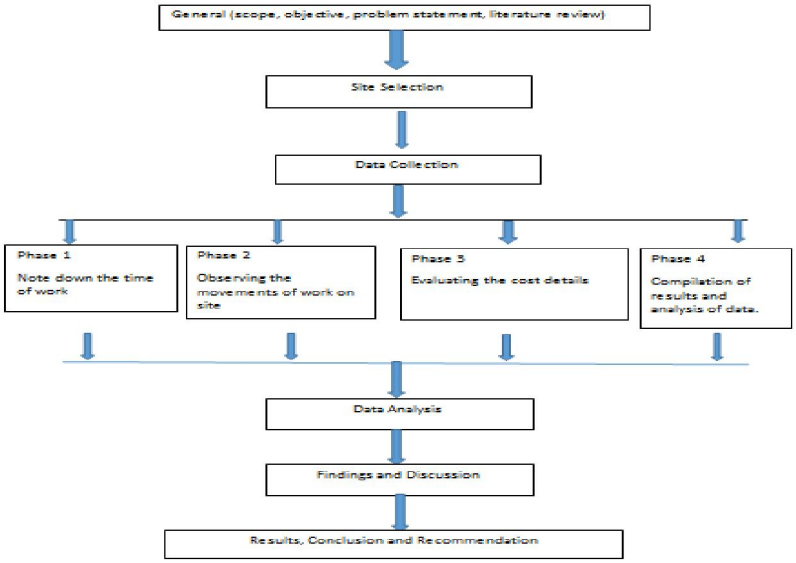


Fig. 1 Methodology

The worker is producing 32 plates per hour. Considering that with the improved methods of work, he will be able to produce 42 plates per hour, then productivity of worker will be improved by 31.25 present. Thus it can be said that more output results into higher productivity or improvement from same amount of resources which means lower money costs and higher net money returns per unit of output. Another productivity concept known as Japanese Holistic View of Productivity explains productivity as a comprehensive holistic phenomenon encompassing all elements required to improve products/ services (output). Productivity in the future must be concern itself with seeking affluence of a kind which will provide people with material wealth as well as spiritual satisfaction. Also the outputs particularly in the form of physical pollution must be controlled in the context of increasing concern of society for clean environment and sustainable development. To improve productivity products must be designed to satisfy customer need with optimum consumption of resources without generation of waste in the manufacturing process.

3.4 Problem Statement

1. What are the different causes of low labour productivity for selected case study?
2. How can the labour productivity be measured and improved for selected case study?

For above objective 5 days observation are recorded from site stargaze, kolte patil,pune.

Site Details

- Name of site : stargaze
- Location of site : BAVDHAN, West Pune zone, Pune, Maharashtra 411021
- A P+14 proposed building of 8 flats and 7 towers is taken for case study location is
- Design Team : JW consultancy
- Owner and Developer :Kolte Patil
- Architect :Manoj Tatuskar and Vikas Acharikar
- Cost of 1 flat: 64.4 Lakhs Onwards
- Cost of project: 52 cr.

IV. RESULT

REGRESSION EQUATION:

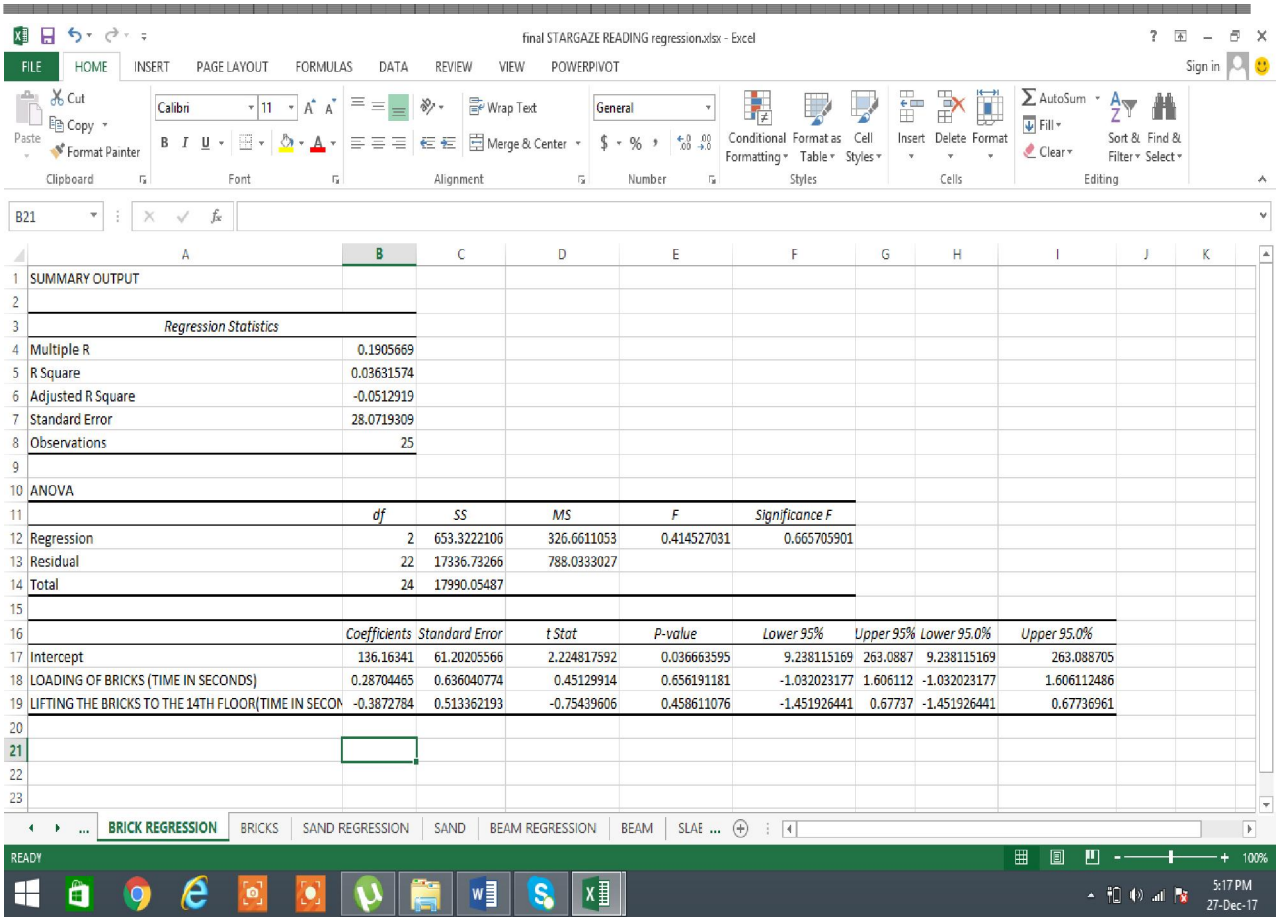
The most common method for fitting a regression line is the method of least-squares. This method calculates the best-fitting line for the observed data by minimizing the sum of the squares of the vertical deviations from each data point to the line (if a point lies on the fitted line exactly, then its vertical deviation is 0). Because the deviations are first squared, then summed, there are no cancellations between positive and negative values.

ESTABLISHING REGRESSION EQUATION USING EXCEL SHEET

MATERIAL HANDLING

BRICKS

SUMMARY OUTPUT


final STARGAZE READING regression.xlsx - Excel

	A	B	C	D	E	F	G	H	I	J	K
1	SUMMARY OUTPUT										
2											
3	*Regression Statistics*										
4	Multiple R	0.1905669									
5	R Square	0.03631574									
6	Adjusted R Square	-0.0512919									
7	Standard Error	28.0719309									
8	Observations	25									
9											
10	ANOVA										
11		*df*	*SS*	*MS*	*F*	*Significance F*					
12	Regression	2	653.3222106	326.6611053	0.414527031	0.665705901					
13	Residual	22	17336.73266	788.0333027							
14	Total	24	17990.05487								
15											
16		*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*		
17	Intercept	136.16341	61.20205566	2.224817592	0.036663595	9.238115169	263.0887	9.238115169	263.088705		
18	LOADING OF BRICKS (TIME IN SECONDS)	0.28704465	0.636040774	0.45129914	0.656191181	-1.032023177	1.606112	-1.032023177	1.606112486		
19	LIFTING THE BRICKS TO THE 14TH FLOOR(TIME IN SECON	-0.3872784	0.513362193	-0.75439606	0.458611076	-1.451926441	0.67737	-1.451926441	0.67736961		
20											
21											
22											
23											

BRICK REGRESSION | BRICKS | SAND REGRESSION | SAND | BEAM REGRESSION | BEAM | SLAE ...

READY

Regression equation is

136.1634101Y= 0.287044655X1 -0.387278415X2

LOADING OF BRICKS (TIME IN SECONDS)	y
LIFTING THE BRICKS TO THE 6TH FLOOR(TIME IN SECONDS)	x1
UNLOADING OF BRICKS	x2

SAND

SUMMARY OUTPUT

From this regression output equation we got is

79.41648383Y= 0.097837532X1+0.494192041X2

X1 is loading of sand

X2 is lifting sand to 6^{th} floor

Y is unloading of sand

PLASTERING

SUMMARY OUTPUT

Regression Statistics

From this regression output equation we got is

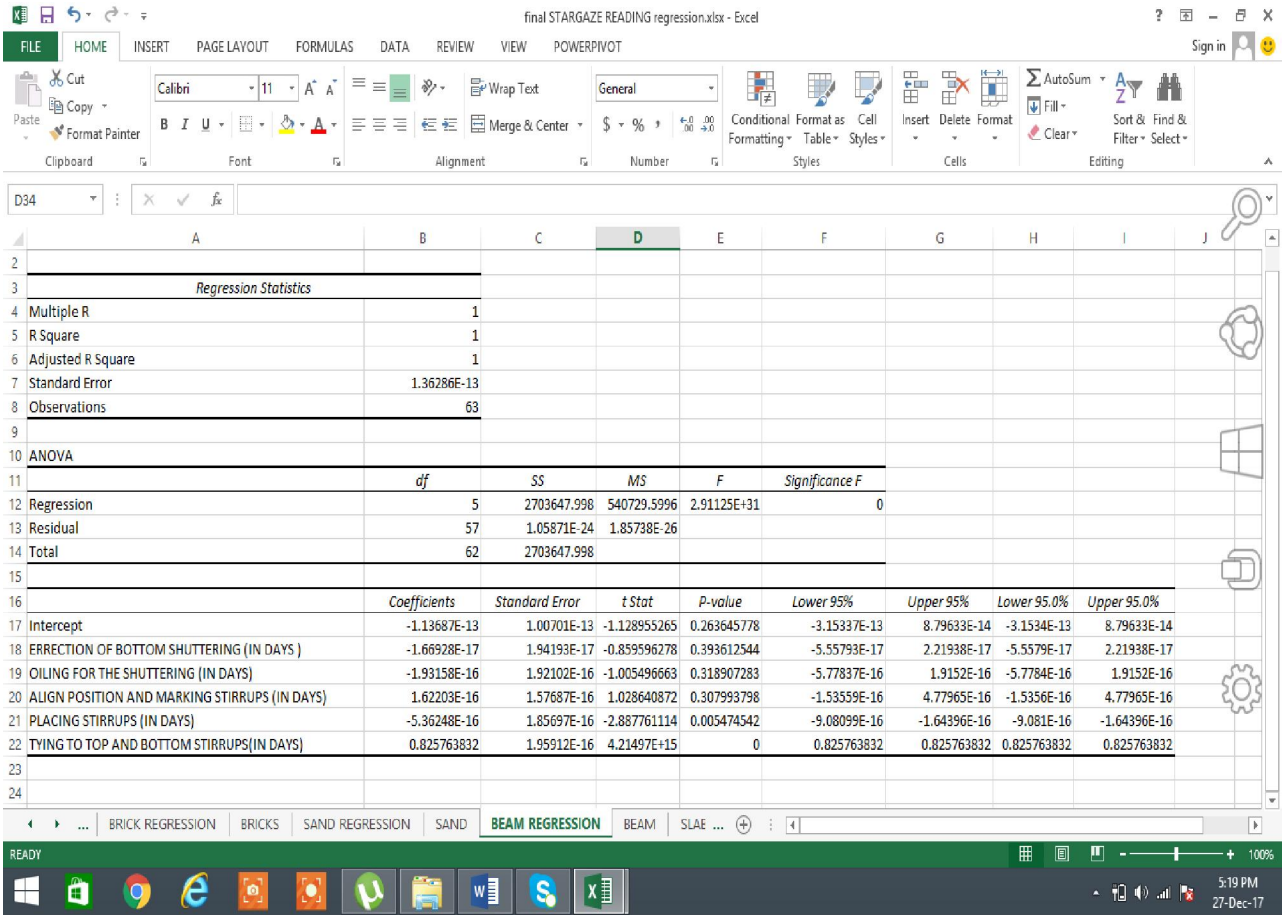
8464.132056y= -4.712442566x1-2.005284286x2+4.090734565x3+0.367543859x4

Where

Intercept	y
SURFACE PREPARATION AND TRANSPORTATION OF MATERIAL(TIME IN SECONDS)	x1
FIXING DOTS AND CHECKS FOR PLUMBS(TIME IN SECONDS)	x2
MIXING OF WATER CEMENT AND SAND (PER BRASS)	x3
APPLYING THE MORTER ON THE WALL(TIME IN SECONDS)	x4

BEAMS

SUMMARY OUTPUT



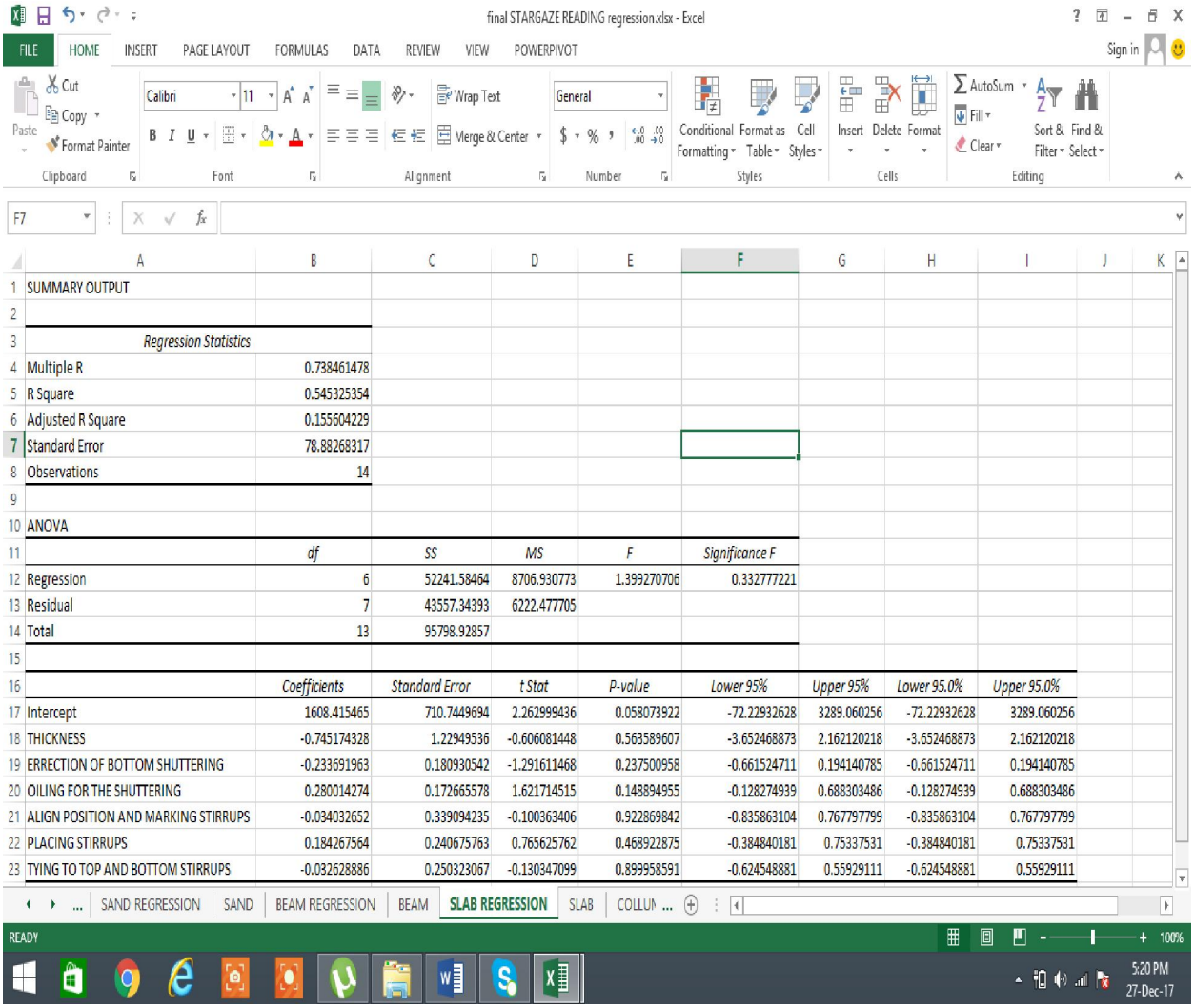
	A	B	C	D	E	F	G	H	I
3	*Regression Statistics*								
4	Multiple R	1							
5	R Square	1							
6	Adjusted R Square	1							
7	Standard Error	1.36286E-13							
8	Observations	63							
10	ANOVA								
11		*df*	*SS*	*MS*	*F*	*Significance F*			
12	Regression	5	2703647.998	540729.5996	2.91125E+31	0			
13	Residual	57	1.05871E-24	1.85738E-26					
14	Total	62	2703647.998						
16		*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
17	Intercept	-1.13687E-13	1.00701E-13	-1.128955265	0.263645778	-3.15337E-13	8.79633E-14	-3.1534E-13	8.79633E-14
18	ERRECTION OF BOTTOM SHUTTERING (IN DAYS)	-1.66928E-17	1.94193E-17	-0.859596278	0.393612544	-5.55793E-17	2.21938E-17	-5.5579E-17	2.21938E-17
19	OILING FOR THE SHUTTERING (IN DAYS)	-1.93158E-16	1.92102E-16	-1.005496663	0.318907283	-5.77837E-16	1.9152E-16	-5.7784E-16	1.9152E-16
20	ALIGN POSITION AND MARKING STIRRUPS (IN DAYS)	1.62203E-16	1.57687E-16	1.028640872	0.307993798	-1.53559E-16	4.77965E-16	-1.5356E-16	4.77965E-16
21	PLACING STIRRUPS (IN DAYS)	-5.36248E-16	1.85697E-16	-2.887761114	0.005474542	-9.08099E-16	-1.64396E-16	-9.081E-16	-1.64396E-16
22	TYING TO TOP AND BOTTOM STIRRUPS(IN DAYS)	0.825763832	1.95912E-16	4.21497E+15	0	0.825763832	0.825763832	0.825763832	0.825763832

-1.13687E-13Y=-1.66928E-17X1-1.93158E-16X2+1.62203E-16X3-5.36248E-16+0.825763832X4

ERRECTION OF BOTTOM SHUTTERING (IN DAYS)	x1
OILING FOR THE SHUTTERING (IN DAYS)	x2
ALIGN POSITION AND MARKING STIRRUPS (IN DAYS)	x3
PLACING STIRRUPS (IN DAYS)	x4
TYING TO TOP AND BOTTOM STIRRUPS(IN DAYS)	x5

SLAB

SUMMARY OUTPUT



	A	B	C	D	E	F	G	H	I
1	SUMMARY OUTPUT								
2									
3	*Regression Statistics*								
4	Multiple R	0.738461478							
5	R Square	0.545325354							
6	Adjusted R Square	0.155604229							
7	Standard Error	78.88268317							
8	Observations	14							
9									
10	ANOVA								
11		*df*	*SS*	*MS*	*F*	*Significance F*			
12	Regression	6	52241.58464	8706.930773	1.399270706	0.332777221			
13	Residual	7	43557.34393	6222.477705					
14	Total	13	95798.92857						
15									
16		*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
17	Intercept	1608.415465	710.7449694	2.262999436	0.058073922	-72.22932628	3289.060256	-72.22932628	3289.060256
18	THICKNESS	-0.745174328	1.22949536	-0.606081448	0.563589607	-3.652468873	2.162120218	-3.652468873	2.162120218
19	ERRECTION OF BOTTOM SHUTTERING	-0.233691963	0.180930542	-1.291611468	0.237500958	-0.661524711	0.194140785	-0.661524711	0.194140785
20	OILING FOR THE SHUTTERING	0.280014274	0.172665578	1.621714515	0.148894955	-0.128274939	0.688303486	-0.128274939	0.688303486
21	ALIGN POSITION AND MARKING STIRRUPS	-0.034032652	0.339094235	-0.100363406	0.922869842	-0.835863104	0.767797799	-0.835863104	0.767797799
22	PLACING STIRRUPS	0.184267564	0.240675763	0.765625762	0.468922875	-0.384840181	0.75337531	-0.384840181	0.75337531
23	TYING TO TOP AND BOTTOM STIRRUPS	-0.032628886	0.250323067	-0.130347099	0.899958591	-0.624548881	0.55929111	-0.624548881	0.55929111

1608.415465Y= -0.745174328X1-0.233691963X2+0.280014274X3-0.034032652X4 +0.184267564X5-0.032628886X6

THICKNESS	x1
ERRECTION OF BOTTOM SHUTTERING	x2
OILING FOR THE SHUTTERING	x3
ALIGN POSITION AND MARKING STIRRUPS	x4
PLACING STIRRUPS	x5
TYING TO TOP AND BOTTOM STIRRUPS	x6

COLUMN

SUMMARY OUTPUT

-45.97487049Y=0.019015496X1+0.108423058X2-0.124318015 X3+0.168687753X4+0.871540465X5 +0.380272209X6

FIXING POSITION	x1
FORMWORK FOR STARTER	x2
STARTERFILLING	x3
COMPLETION REINFORCEMENT	x4
FORMWORK OILING	x5
FORMWORK ERECTION	x6

V. CONCLUSION

1. Expected productivity is 90% but it is observed up to 80% in sampling for 5 days for 170 sampling
2. The delays observed on site are mainly due to change in activity for same labour, some labors observed with insufficient skill for handling the material and shifting the material.
3. From work sampling it can be concluded that for sub activities such as handling material, shifting material machineries with proper operator should be available
4. It is also inferred that if all sub-activities are efficiently performed and the average time requires is reduced to minimum time required around 20% -30 % of time saving can be achieved.
5. Time study applied for rebar placement shows that there was a lot of physical stress and strain for essential contributory work i.e the workers working manually. The stress and strain can be reduced by using machineries for rebar bending and placing
6. Regression equation is established using various mathematical terms such as standard deviation, variance, range , mean , median etc.it gives developer idea for comparison for various labour contractor.

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