

# SELECTION CRITERIA OF EQUIPMENT IN CONSTRUCTION PROJECT

Abdullah Azmi<sup>1</sup>, Dr. Syed Khursheed Ahmad<sup>2</sup>, Mohd Danish<sup>3</sup>

<sup>1</sup>M-tech, student (Construction technology & management), department of civil engineering, Al-Falah University Faridabad Haryana India.

<sup>2</sup>(HOD Civil) Al-Falah University Faridabad Haryana India.

<sup>3</sup> Architect and Urban Planners, Al-Falah University Faridabad Haryana India.

\*\*\*

**Abstract** - Construction projects are highly mechanized now-a-days and becoming more quantity every day. With the growing industrialization of construction projects, the role of onsite equipment and machineries is absolutely necessary in achieving productivity and efficiency. During construction, selection of justified equipment has always been a key factor in the success of any construction work. This decision is typically made by matching equipment in a fleet with tasks. Such matching accounts for equipment productivity, equipment capacity, and cost. Therefore, this paper aims to determine a selection criteria based on the comparison between machine work on site and work by manual. The traditional way to choose equipment was by its performance, in terms of maximum productivity at the lowest cost. A big pressure from Governments and other institutional agencies are forcing the construction industry to further adopt safety and environmental aspects in their normal way of functioning, and so every activity or process that a company carries out has to be rethought in order to achieve this integration of other parameters.

**Key Words:** different types of construction equipment's and manual work...

## 1. INTRODUCTION

### 1.1 General

It is a common fact that we find a wide variety of construction machines on every construction sites, which make the construction jobs easy, safe and quicker. Good project management in construction must vigorously pursue the efficient utilization of labor, material and equipment. The use of new equipment and innovative methods has made possible wholesale changes in construction technologies in recent decades. The selection of the appropriate type and size of construction equipment often affects the required amount of time and effort and thus the jobsite productivity of a project.

These act as a backbone in the case of huge construction projects. Proper use of the appropriate equipment contributes to economy, quality, safety, speed and timely completion of a project. Equipment are use for highway projects, irrigation buildings, power projects etc. Almost 15-

30 of total project cost has been accounted towards equipment and machinery.

It is therefore important for site managers and construction planners to be familiar with the characteristics of the major types of equipment most commonly used in construction.

### 1.2 Objectives

- Factors behind the selection of construction equipment
- State types of construction equipment.
- Explain the use of construction equipment.
- Describe the different types of construction equipment and understand operations of various construction equipment.
- Demonstrate an understanding of construction equipment selection, cycle times, production rates and cost.
- Understand the fundamentals of engineering properties of moving earth, material properties, constructions method focusing on equipment – intensive construction activities.
- Estimate and Perform the analysis needed to determine costs and productions of given construction equipment.
- Enable selection of right equipment for a job with minimum cost.
- Selection of concreting equipment can be complicated and difficult.
- Equipment life and Replacement Alternative

### 1.3 Procedure

The study was designed to apply the most appropriate process to select the equipment for construction which is helpful for control the time and money for the project. At first a literature survey was carried out on pertinent topics based on theses, books in libraries, scientific papers, articles and web sources. This literature survey was carried out on equipment used in construction and their types, and how one equipment used for many works this techniques is used to understand the concepts of project planning and project scheduling, and also to determine the speed in construction which is very important for any construction project

## 1.4 Scope of Study

The study is mainly focus on identification of how to select construction equipment for construction project in Indian construction industry. It will be done by the survey of construction site in whole world in all type of construction and will be great support for planning engineers. The report provides a synthesis of the relevant issues with regards to managing equipment selection for daily use in construction. Representative examples of procedure and practices from different sites are included. Finally recommendations for best practices are suggested.

It will be conducted towards professionals in construction companies.

## 2. FACTORS BEHIND THE SELECTION OF CONSTRUCTION EQUIPMENT:-

There are many types of factors behind the selection of construction equipment, and the types are completely describe below.

**2.1. Economic Consideration.** The economic consideration such as owning costs and operating fuel costs of equipment are most important in selection of equipment. Besides, the resale value, the replacement cost of existing equipment, and the salvage value associated with the equipment are also important.

**2.2. Company – Specific.** The selection of equipment by a company may be governed by its policy on ‘owning’ or ‘renting’. While emphasis on ‘owning’ may result in purchase of equipment keeping in mind, the future requirement of projects, the emphasis on renting may lead to putting too much focus on short term benefits.

**2.3. Site – Specific.** Site condition, both ground conditions as well as climatic conditions may affect the equipment selection decision. For example the soil and profile of a site may dictate whether to go for crawler-mounted equipment. If there is a power line at or in the vicinity of site one may go for a fixed-base kind of equipment rather than a mobile kind of equipment.

**2.4. Equipment – Specific.** Construction equipment come with high price tags. While it may be tempting to go for the equipment with low initial price, it is preferable to optimize for standard equipment. Such equipment are manufactured in large numbers by the manufacturers, and their spare parts are easily available, which would ensure minimum downtime. Besides, they can also fetch good salvage money at the time of their disposal.

**2.5. Client and project – Specific.** The owner/client in a certain project may have certain preferences that are no in line with the construction company’s preferred policies as far

as equipment procurement is concerned. The schedule quality and safety requirements demanded of a particular project may in some cases force the company to yield to the demand of the client.

**2.6. Manufacturer – Specific.** A construction company may prefer to buy equipment from the same manufacturer again and again, and that too from a specific dealer. This may be to bring in uniformity in the equipment fleet possessed by the company or because the company is familiar with the working style of the manufacturer and the dealer.

**2.7. Labor Consideration.** Shortage of manpower in some situations may lead to decision in favor of procuring equipment that is highly automated. Further, the selection of equipment may be governed by the availability or non-availability of trained manpower.

## 3. TYPES OF CONSTRUCTION EQUIPMENTS AND THEIR SELECTION CRITERIA:-

For the selection criteria of construction equipment there are many types of equipment which are completely describe below.

### 3.1. Earthwork Equipment

### 3.2. Concreting Equipment

### 3.3. Hoisting Equipment

#### 3.1.1 Types of Earthwork Equipment

- **Backhoe** – Backhoes are mainly used to clean up construction areas, to dig holes in the ground, to smooth uneven ground, to make trenches, ditches and to help remove deep roots.
- **Front shovel** – Front Shovel are mainly used for excavation purposes above its own track or wheel level. They are suitable for heavy positive cutting in all types of dry soils.
- **Dragline** – they are used for bulk excavation below its track level in loose soils, marshy land and areas containing water.
- **Clamshell** – It consists of a hydraulically controlled bucket suspended from a lifting arm. It is mainly used in pits and trenches.
- **Dozers** – they are used for moving earth up to a distance of about 100m and act as towing tractor and pusher to scraper machines. They can be track-mounted or wheel mounted.
- **Roller Compactor** – Roller Compactor is mainly used for compaction of earth and other materials in large works of highways, canals and airport
- **Scraper** – They are used for site levelling, loading, hauling over distances varying between 150m-900m. they may be towed, two-axle or three-axle type

- **Dumper** – It is used for horizontal transportation of materials on and off sites. Large capacity dumpers are used in mines and quarries.
- **Grader** – It is used for grading and finishing the upper surface of the earthen formations and embankments. They usually operate in the forward direction.

### 3.1.2. Selection Criteria for Earthwork Equipment

- Quantities of material to be moved
- The available time to complete the work the job conditions
- The prevailing soil types, the swell and compaction factors, etc.
- The job conditions include factors such as availability of loading and dumping area, accessibility of site, traffic flows and whether conditions at site.

**In order to plan the number of earthwork equipment needed, the planner first determine the following:-** The suitable class of equipment for earthwork-for example, if the soil to be excavated is loose and marshy, and bulk excavation is involved in the project, one may optimized for a dragline. The appropriate model of equipment based on different characteristics such as payload of bucket and speed required. For example, dragline come in different capacities ranging from 0.30 cum to 3.06 cum; scrapers in capacities ranging from 8 cum to 50 cum and so on. The number of equipment needed for the project to carry out the given quantity. The number of associated equipment required to support the main equipment.

### 3.2.1. Types of Concreting Equipment

- **Concrete batching plant** – They are mainly used for weighing and mixing of concrete constituents. Capacity: - 20cum/hr. – 250cum/hr.
- **Concrete mixer** – They are mainly used for mixing quantities of concrete constituents. Capacity: - 200lt/batch (small mixers) 200-750/batch (large mixers).
- **Concrete transit mixers** – They are mainly used for transporting concrete from batching point capacity: - 3cum-9cum
- **Concrete pump** – They are used for horizontal and vertical transportation of large volumes of concrete in short duration. Capacity: - 30cum/hr. (ordinary construction) 120cum/hr. (specialized construction)

### 3.2.2. Selection Criteria for Concreting Equipment

Selection of concreting equipment can be complicated and difficult. The decision will involve many issues that have to be analyzed. The following factors are net worthy:

- Site characteristics such as boundary conditions, noise limitations and other restrictions.
- Equipment availability-local availability of equipment, whether the contractor owns that equipment

Continuity of operation, Effect of permanent work Weather conditions, Temporary works, Time restrictions, Concrete specifications.

- **Concrete mixing equipment selection will depend on factors such as the-** Maximum and the total output required in a given time frame. The method of transporting the mixed concrete. The requirement of discharge height of the mixer.
- **Concrete-placement equipment selection depends on factors such as the-** Capacity of the vehicle. The output of the vehicle. The site characteristics. The weather conditions. The rental costs, and temporary haul roads.

### 3.3.1 Types of Hoisting Equipment

**3.3.1.1. HOIST** It constitutes a group of equipment which are employed mainly for lifting or lowering of unit load and other. This group of equipment's can be further sub classified into:-

- **Boom Hoist Crane** – Boom hoists are used to lift weights on the hooks that are attached to the special metal ropes designed to bear maximum loads. Boom Hoist is mostly used as industrial machine where it loads the weight on containers.
- **Chain Hoist Crane** – Chain hoists are quite common example of hoist system and it can be seen at most of the construction and industrial purposes. Basically, chain hoist consists of chain rope and pulley that is used to move the load from up to down.
- **Electric Hoist Crane** – electric hoist is modernized form of chain and boom hoist mostly used in the industries for fast working. It is very much popular in material handling industries because it saves labor costs by handling maximum loads at a time with no damage threats.
- **Tractor Hoist Crane** – Tractor hoist consist of a boom that is attached with base of tractor and a hook with rope is installed on this boom that can operated through driver controls.

**3.3.1.2. CRANE** Cranes are considered to be one of the most important equipment used in the construction due to their key role in performing lifting tasks all over the construction site. Plenty of crane models are available in different shapes and sizes though they usually fall into three categories.

- **Derrick Crane** – Derrick Crane is preferable for high-rise and apartment building, it can be used for both long term and short term projects, It is cheaper than mobile and tower crane, It is used when clearance is inadequate for the other units and sufficient space is available for the erection of a tower foundation
- **Mobile Crane** – Mobile Cranes adequate for all types of structures (up to 107m), It is used for short projects duration (less than 4 months). It is not considered to be very safe due to lack of safety devices limited switches to prevent overloading, it can operate in muddy terrain but requires good ground conditions.

**Tower Crane** – Tower Cranes preferable for high rise (over 107m). It is used for longer project duration. It considered to be very safe due to the presence of limit switches. Operate where ground condition poor.

### 3.3.1. Selection Criteria for Cranes

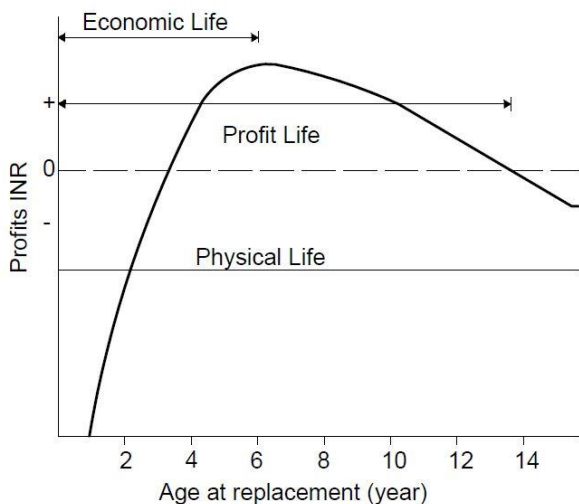
Factors affecting the selection of cranes are-

- **Building Design-** Building Height, Project Duration
- **Capability-** Power Supply, Load Lifting Frequency, Operators Visibility
- **Safety-** Initial planning and Engineering
- **Economy-** Cost of move in, setup, and move out, Cost for rent, Productivity
- **Site Conditions,** Soil stability and ground conditions, Access road requirement and site accessibility, Operating clearance.

### 4. EQUIPMENT LIFE

Construction equipment life can be defined in three ways.

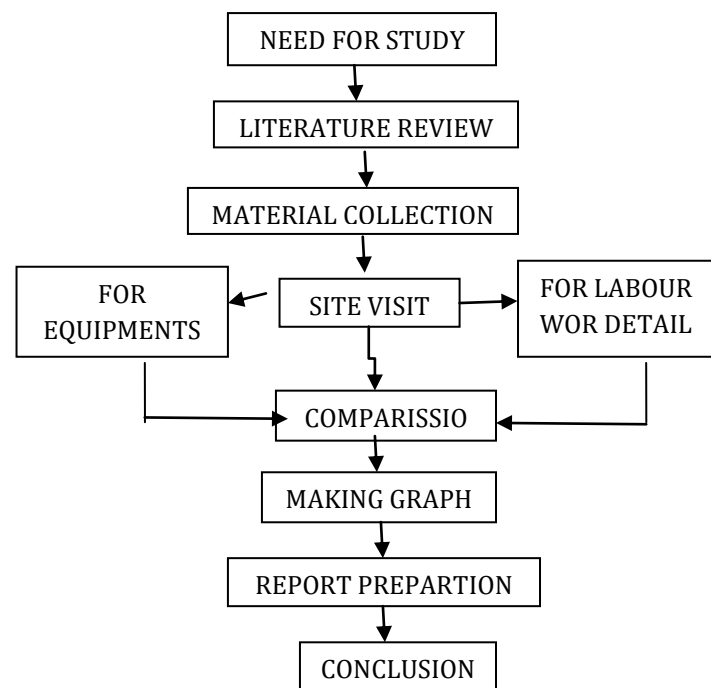
- **Physical Life:** Age at which the machine worn out and can no longer reliably produce.
- **Profit Life:** The profit over which the equipment can earn a profit.
- **Economic Life:** Time period that maximizes the profit over the equipment life



**Chart -1:** Physical life Equipment

The physical life of an asset is not the same as its service life. The service life of an asset is how long it will be useful; its physical life is how long it will be functioning. One factor that affects an asset's service life is that the asset simply wears down over time. Another factor is its inadequacy: If your production needs increase, the equipment you currently own may be inadequate. Lastly, the asset may be obsolete.

### 5. METHODOLOGY



### 6. NEWLY INVENTED AUTOMATIC MACHINES

Today's construction projects are highly mechanized, due to make speed in construction projects there are many types of newly invented equipment are running in the market, so some of them there is three types of newly invented equipment are described below.

#### 6.1. Automatic Stirrup Bender Machine

Recently launched new digital stirrup bender machine, in other words, we can say Automatic stirrup bender machine allows to producing stirrups and cutting to size bar using rebar of up to Ø13mm. It is equipped with wire inlet unit and offers all the advantages of Latest technology and digital servo motors. Its main features are the wide stainless steel front panel and the two servo motors on the driving unit which permit the machine to work at a maximum speed of 150 m/min. it is equipped with a stirrup collecting flap, wire inlet unit, the anti-twist device in the internal straightening unit and sapiens can produce a 200x200 mm stirrups in about two seconds which means, 4,000 stirrups per hour with double wire to the needs.



Fig -1: Automatic Stirrup Bender Machine

### 6.2. Automatic Plastering Wall Machine

Recently launched new machines has been developed to automate the plastering work is very much demand for construction field. It is proposed to automate the plastering work. The completed model was validated by testing the machine using the brick wall and the statistical details of the manual work are also observed at the different conditions.

- This innovative machine is unique and perhaps one kind of automated plastering machinery ideally suitable for the construction/building industry.
- It works with conventional cement mortar which brings it to a smooth, flat finish with variable and adjustable thickness to suit each application.
- It can plaster the wall automatically by moving up and down in vertical direction.
- It has two rails for rising and moving automatically, therefore it can be used for different height and width of the wall.

- It has microcontrollers for controlling the motor to automatic extend of cement flow and to automatic movement of hopper for cement discharge/plastering



Fig -2: Automatic Plastering Wall Machine

### 6.3. Bricklaying Robot

- A robot that can lay bricks six times faster than a builder is set to arrive on building sites in the UK within two years after already starting work in the US.
- The Semi-Automated Mason, nicknamed SAM, can lay 3,000 bricks a day, while a builder's average is 500.
- Experts have spoken out against the robot's arrival and have claimed that the auto-builders could put the jobs of thousands of bricklayers at risk

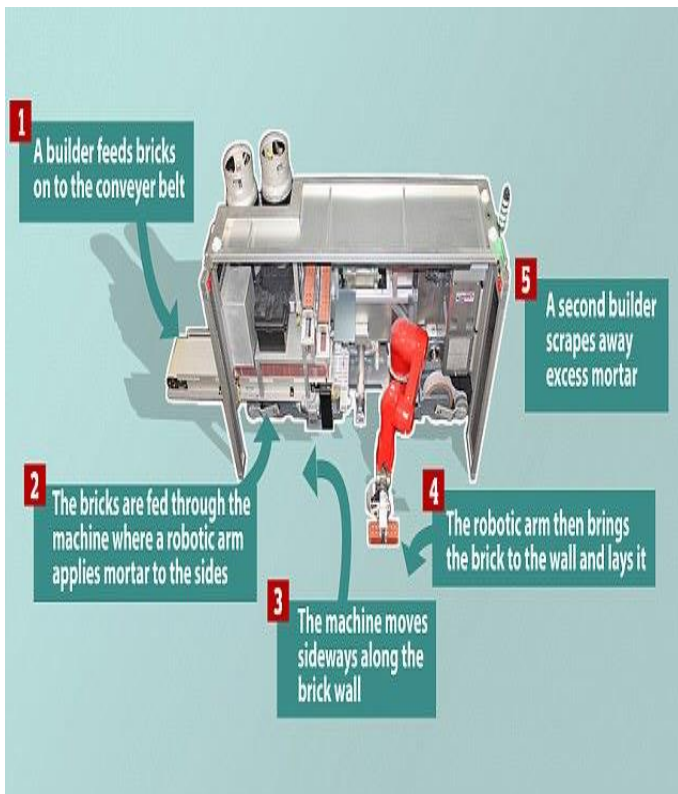


Fig -1: Bricklaying Robot

5. RESULTS

5.1 Comparison between manually and Automatic Stirrup Bender Machine

- If we take machine for 5 years which cost is near about 2Lack.
- So when we calculate on behalf of per day it will 150, including operator’s charge and fuel charge.

Table.no.1

RING MAKING					
Description	Qty	Unit	Rate	Amount	
Detail of steel ring making	32000.0 no's.				
<b>Machine</b>					
1 for five year	1.00	Day	10000.00	10000.00	
			<b>Total</b>	<b>10000.00</b>	
<b>Cost for one ring making Done by machine</b>					<b>0.31.000</b>

Table.no.2

Ring Making					
	Description	Qty	Unit	Rate	Amount
	Detail of steel ring making	250.0 nos			
	<b>Labour</b>				
1	Skilled	1.00	Day	500.00	500.00
				<b>Total</b>	<b>500.00</b>
	<b>Cost for one ring making done manually</b>				<b>2.00</b>

Table.no.3

Description	Manually	By Machine	Result
<b>Amount</b>	Rs.500.00	10000	profit of
<b>Quantity Of Ringc</b>	250.0 nos	32000	Rs.1.69
<b>Duration/ Time</b>	8.00 Hrs	8.00 Hrs	done by
<b>Cost of one no rings</b>	Rs.2.00	Rs.0.31	machine

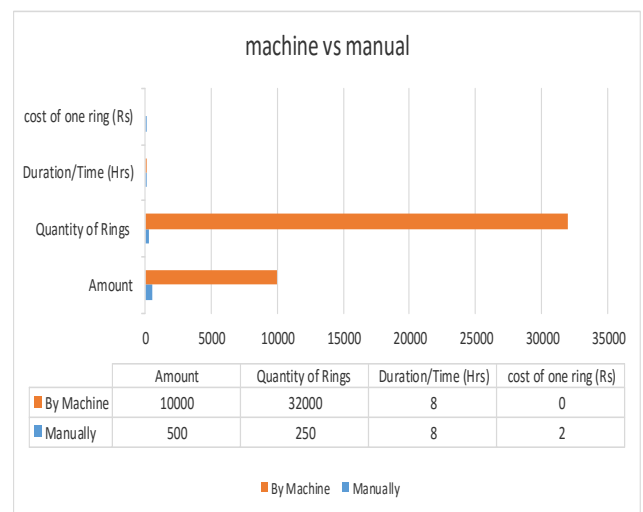


Chart-2 -: Automatic stirrup bender machine

5.2 Comparison between manually and Automatic Plastering Wall Machine

- If we take machine for 5 years which cost is near about 2Lack.
- So when we calculate on behalf of per day it will 150, including operator’s charge and fuel charge.

Table.no.4

PLASTERING					
	Description	Qty	Unit	Rate	Amount
	Detail of cement plaster for 450.0 sqft				
	<b>Machine</b>				
1	for five year	1.00	Day	150.00	150.00
				<b>Total</b>	<b>150.00</b>
	<b>Cost for one sqft plaster done by machine</b>				<b>0.33.000</b>

Table.no.5

PLASTERING					
	Description	Qty	Unit	Rate	Amount
	Detail of cem-ent plaster for 450.0 sqft.				
	<b>Labour</b>				
1	Skilled	1.00	Day	500	500
2	Unskilled	1.00	Day	300	300
				<b>Total</b>	<b>800</b>
	<b>Cost for one sqft plaster done manually</b>				<b>1.78</b>

Work Done

Description	Manually	By Machine	Result
<b>Amount</b>	Rs.800	Rs.150	profit of
<b>Quantity Of Plaster</b>	150Sqft	150Sqft	Rs 1.44
<b>Duration/ Time</b>	8. Hrs	8. Hrs	done by
<b>Cost of one sqft</b>	Rs.1.78	Rs.0.33	machine

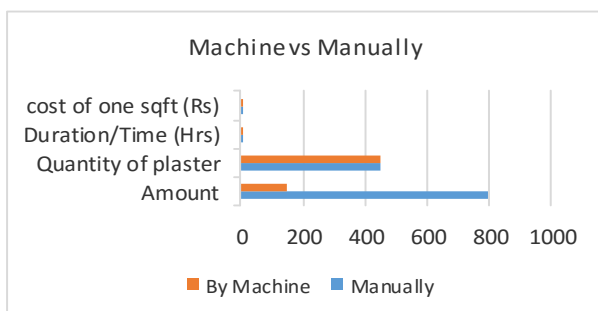


Chart-3 -: Automatic Plastering Wall Machine

5.2 Comparison between manually and Bricklaying robot

- If we take machine on rent for 1 month which cost is near about Rs. 1lack.
- So as per my calculation the per day cost will Rs. 3333

PLASTERING					
	Description	Qty	Unit	Rate	Amount
	Detail of brick work for 3000 brick lay/day				
	<b>Machine</b>				
1	for 1 month rent	1.00	Day	3333.00	3333.00
				<b>Total</b>	<b>3333.00</b>
	<b>Cost for 1 bricklay work done by mmachine</b>				<b>1.10</b>

Table.no.6

Labour					
	Description	Qty	Unit	Rate	Amount
1	Skilled	1.00	Day	500.00	500.00
2	Unskilled	1.00	Day	300.00	300.00
				<b>Total</b>	<b>800.00</b>
	<b>Cost for one bricklay work done manually</b>				<b>1.60</b>
	<b>Work Done</b>				
				Rs.800.00	Rs.3333
	<b>Quantity Of brick work (no's)</b>	<b>500</b>	<b>3000</b>		
	<b>Duration/ Time</b>	<b>8.00 Hrs</b>	<b>8.00 Hrs</b>		
	<b>Cost of one sqft</b>	<b>Rs. 1.60</b>	<b>Rs. 1.10</b>		

Table.no.7

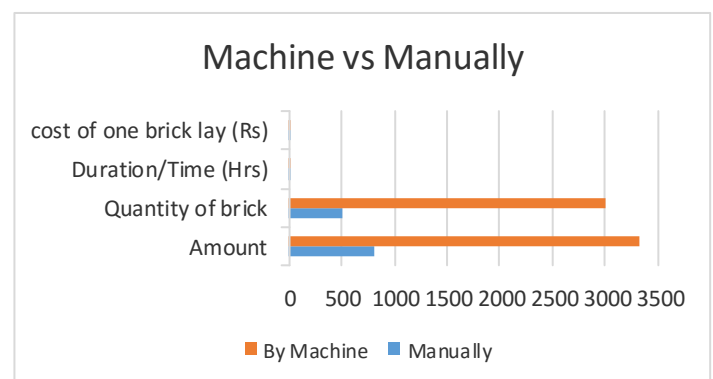


Chart-4 -: Brick Laying Robot

3. CONCLUSIONS

According to my study and research concern to my work has investigated in terms of significant measures for the selection of construction equipment which has its operation, maintenance and affects to accelerate the productivity of required target in wee hours.

Equipment plays an important role in today's infrastructure projects as they are more demanding and magnetizing projects which are needed to be completed in stipulated time with the best quality. Proper selection and planning of equipment are very important for timely completion of projects, within estimated cost as well increasing profit, margin. Selection and planning need to exercise very seriously as it is one of the most remarkable factors that affect the progress of work later reflects on cost reputation, images, and prestige of the firm.

It is therefore important for site managers and construction planners to be familiar with the characteristics of the equipment used in construction.

Finally, we have concluded over it that it has been verified on the basis of above study held at different aspect to minimize the cost time and value of the required work.

It is concluded that the above machine as described for different or specified work is much more important than manual work in such efforts we have experienced that as described that equipment plays a vital role in to put the work on schedule target.

In this way, we can minimize the following on the basis of the above selection of equipment

#### ACKNOWLEDGEMENT

I express my satisfaction on the completion of this Dissertation Project Report submission as a part of the curriculum for the degree of Master of Technology in (Construction Technology and Management). I express my gratitude to my supervisor and guide **Dr. SYED KHURSHEED AHMAD** for his kind guidance during the entire period of completion of Dissertation Phase 2 Project Report. His consistence support and advices has helped me to complete the research project successfully. Also I thank all the members of **DEPARTMENT OF CIVIL ENGINEERING IN AL-FALAH UNIVERSITY** for their kind support. They have always been a source of inspiration to me.

#### REFERENCES

- [1] **D. Aviad Shapira, M.ASCE; and Marat Goldenberg** Associate Professor, Dept. of Civil and Environmental Engineering, Technion-Israel Institute of Technology, Haifa 32000, Israel. Submitted: 11 November 2003
- [2] **Marcelo M. Azambuja; and William J. O'Brien** Assistant Professor, Dept. of Construction, Southern Illinois University Edwardsville
- [3] **David Arditi, Member, ASCE**, Prof., Dept. of Civ. and Arch. Engineering, Illinois Inst. of Technol., Chicago, IL 60616.
- [4] **Serdar Kale and Martino Tangkar** Grad. Student, Dept. of Civ. and Arch. Engineering, Illinois Inst. of Technol., Chicago, IL. Published: 01 December 1997

[5] **R. E. Lile Murphree, Jr., Member, ASCE** Prof., Dept. of Engrg. Mgmt., George Washington Univ., Washington, DC  
**Received:** June 21, 1993 **Published online:** September 01, 1994

[6] **K. William Rasdorf** Professor, Dept. of Civil, Construction, and Environmental Engineering, North Carolina State Univ., Campus Box 7908, Raleigh, NC 27695-7908 **Received:** October 05, 2015 **Accepted:** August 19, 2016 **Published online:** October 28, 2016

#### BIOGRAPHIES



##### **ABDULLAH AZMI**

**M.tech** (Construction Technology & Management )

Department of civil Engineering  
AL-Falah University Faridabad  
Haryana .INDIA