International Journal of Engineering Research and Development
e-ISSN: 2278-067X, **p**-ISSN : 2278-800X, www.ijerd.com
Volume 5, Issue 6 (December 2012), PP. 01-07

Break Even Analysis of a Mobile Crane and Maintenance: a Case Study

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Abstract:- Productivity improvements are always of important aspect of any Industry. As a ressult, introducing the new materials and automated construction processes are always desirable as long as they are less expensive and consistent with desired performance. Mechanical handling and material handling go together as that of hand-in glove in the modern construction of the Dams, Roads, Bridges, Buildings, Over Head Water Tanks, Towers, Residential and Industrial buildings, High-rise buildings having many stories, etc. The manual handling of concrete remains commonplace in the construction of high-rise buildings despite obvious risks to operatives. As such, the construction of a multti-storeyed building is studied. The present paper concentrates on the usage of a Mobile Crane (Hydrau) for loading, mounting, carrying large loads and for work performed in the construction of multi-storeyed buildings. In the paper, the fundamental operations, utilization and maintenance of Mobile crane are analyzed for Break-Even analysis. The time, cost, reputations savings and safety of the manual handling is compared with Mechanical handling and established that the mechanical handling of materials is much better than manual handling in the construction of high-rise buildings.

Key words:- Material handling, Mechanical handling, Mobile crane, Construction, Concrete.

I. INTRODUCTION

Construction is generally hard task and becomes hazardous in the construction of high-rise buildings. The literature states that working days are last due to injuries or illness or fatal deaths. The indirect costs like reduced worker productivity, delays in projects, administrative time, damage to equipment and the facility. In contrast, to most industrial accidents, innocent bystanders may also be injured by construction accidents. Several crane collapses from high rise buildings under construction have resulted in fatalities to passer-byes. Therefore, the Construction Cranes like Mobile Cranes are being used in a long useful working life that far exceeds the common values of their economic life. The manual material handling in the building constructions is very difficult and un-safe. The professional labours and skilled labours more in number is required for manual handling of RCC components in the building construction. It is also a major problem to involve the men for take up the heavy load duties repeatedly. Therefore, the mechanical equipment like Mobile Crane is more useful for lifting, loading, un-loading and carrying of heavy bodies like pre-casted RCC components and steel frames from one place to another. The study consists of the daily out put / usage of the mobile crane for a period of one week, considering regular manual labour charges. The average out-put interms of labour charges is estimated and compared with total expenditure on the vehicle and the Break-even point of Mobile crane is after 4 years from the date of commencement of utility.

II. LITERATURE SURVEY AND OBJECTIVE

Technology Management is a process, which includes planning, directing, control and co-ordination. The implementation of Technological capabilities to shape and accomplish the strategic and operational objectives of the organization [1]. The Mechanical equipment is playing key role for material handling such as Tower Cranes in the construction of high-rise buildings.

The Tower cranes are used for lifting, loading and un-loading of RCC components, in the fixed area height at high-rise buildings construction [2]. The construction of Ground Floor and Stilt Floor is carried out in conventional methods in High-rise buildings [3]. The fundamental motions of a rotary crane are rotation, boom luffing, and load hoisting. Loads are transferred by a combination of these motions. Using a crane, a load can be transferred to any place within a limited area [4], and Break Even Analysis, [5].

The issues of shortening construction time, reducing cost and improving production performance have engaged both practitioners and researchers for a long time. Being one of the greatest technological improvements in construction, pre-fabrication and industrialization have been used successfully in limited

regions such as Finland and Israel as well as in wider regions such as rebuilding of Europe after the destruction of the Second World War [6].

Due to the ennibaliation of valuable components for possible reuse in secondary markets is becoming a popular option. However, recovery processes are characterized by high levels of uncertainty regarding the quality of components returned at their end-of-life [7]. The volume of output at which neither profit nor loss is incurred is called as the Break-Even Point of the particular vehicle. It is also called minimum output to Break even the total cost incurred [8]. Therefore, construction of high-rise building with 14 Floors is taken -up in the present work.

Objective:

The objective of the paper is to find out the utilization of the Mobile Crane (Hydrau) with material handling and utilization charges so as to suggest a suitable Break-Even Analysis on the material handling system.

III. LAY-OUT OF THE SITE

The lay-out of the site under study is shown in Figure – 1. The destinations of each area are shown in Table – 1.

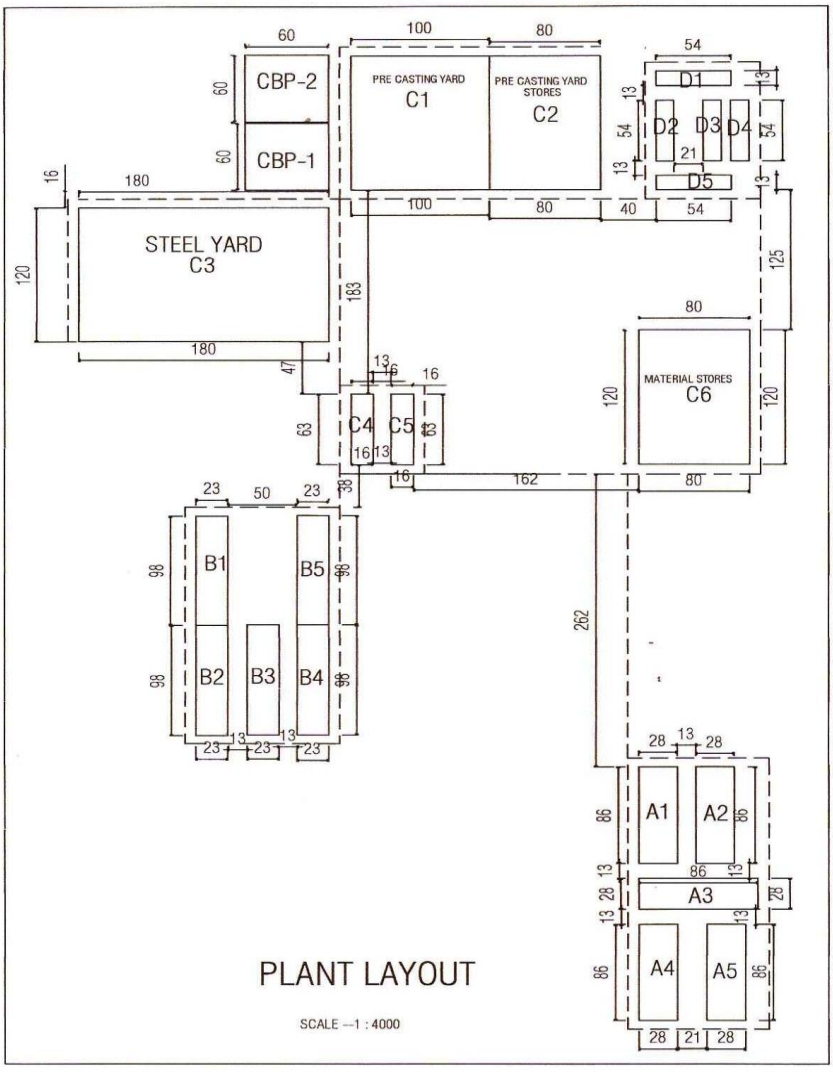


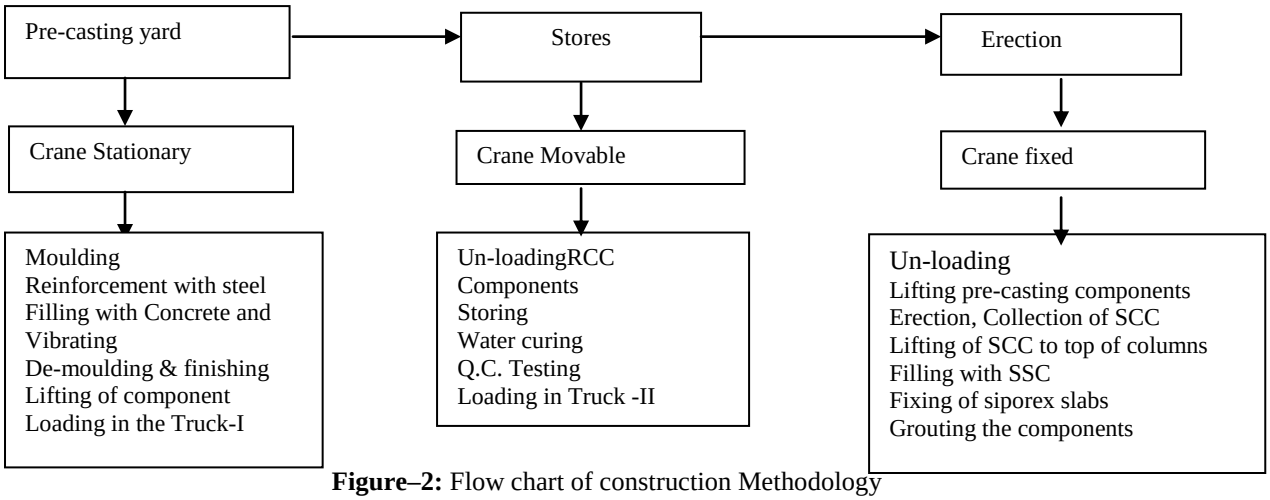
Figure-1: Lay-out of the site

Table – 1. Lay-out and destinations

Location Site Code	Location Name	Area (sqm)	Location site code	Location Name	Area (sqm)
A1	A-type Building(1)	86x28	C1	Pre-casting Yard	100x120
A2	A-type Building(2)	86x28	C2	PCY Stores	80x120
A3	A-type Building(3)	86x28	C3	Steel Yard	180x120
A4	A-type Building(4)	86x28	C4	C-type Building(6)	63x16
A5	A-type Building(5)	86x28	C5	C-type Building(5)	63x16
B1	B-type Building(1)	98x23	C6	Materials stores	120x180
B2	B-type Building(2)	98x23	D1	D-type Building(1)	54x13
B3	B-type Building(3)	98x23	D2	D-type Building(2)	54x13
B4	B-type Building(4)	98x23	D3	D-type Building(3)	54x13
B5	B-type Building(5)	98x23	D4	D -type Building(4)	54x13
			D5	D-type Building(5)	54x13

IV. METHODOLOGY

The Methodology in the construction of the floors is explained in the Flow Chart, Figure – 2, considering different operations. The experiments conducted on Mechanical Handling of materials by the Mobile crane and the destinations at the construction of multi-storeyed building of 17 blocks of each G + 14 floors in an extent of 52.00 Acres are as shown in detail in Table-1.



Figure–2: Flow chart of construction Methodology

Table – 2: Job Description of manual construction and mechanical construction.

Manual Construction			Mechanical Construction					
Sl. No.	**Job Description**	**Trade**	**Sl. No.**	**Job Description**	**Trade**	**Sl. No.**	**Job Description**	**Trade**
1	Bar bending	t_1	1	Bar bending	T_1	11	De-moulding	T_{11}
2	Steel fabrication	t_2	2	Steel fabrication	T_2	12	Storing	T_{12}
3	Centering	t_3	3	Shifting of steel frames	T_3	13	Water Curing	T_{13}
4	Preparation of CC	t_4	4	Preparation of Moulds	T_4	14	Shift of RCC components	T_{14}
5	CC Transportation	t_5	5	Reinforcement	T_5	15	Supply of Siporex Slabs	T_{15}
6	Filling of CC	t_6	6	Preparation of CC	T_6	16	Columns, beams, S. slabs erection	T_{16}

7	CC Compaction	t_7	7	CC Transportation	T_7	17	SCC Preparation	T_{17}
8	Finishing	t_8	8	Concreting	T_8	18	SCC Transport'n	T_{18}
9	Water curing	t_9	9	Compaction	T_9	19	Grout with SCC	T_{19}
10	De-centering	t_{10}	10	Finish of Groves, cores	T_{10}	20	Screed with CC	T_{20}

Mobile Crane:

Mobile Crane used in the handling materials is shown in Figure -3 and the specifications are in the following followed by the handling of RCC Columns s shown in Figure – 4.

Escorts Construction Equipment Limited Model: F 15; Diesel Engine: No: 28 BK 5422.

Cost of the Vehicle : Rs.21.90 Lakhs; Date of Purchase : 21.09.2009

Simple Interest on Capital : Rs.12%; Depreciation time: 15 years.

Figure-3: Conveyance of steel frames RCC columns

Figure-4: Lifting of RCC columns

Output of the Mobile Crane:

The daily ouput of the Mobile Crane (Hydrau) is shown in Table – 3 followed by the daily expenditure on the Mobile Crane in Table -4. The total worth and cumulative output of the Mobile crane for 6 years (Amount in Rs. Lakhs) is shown in Table – 5.

Table-3: Daily output of Mobile Crane on dt: 01-02-2010

Utilisation of the crane : Starting Time - Closing Time = 1662 – 1671 = **9 hrs**

S. No	**Nature of handling**	**Quan - tity**	**Wt. (gs)**	**Transportation**		**Distance travelled**		**Manual requirement**		
				From	**To**	**With load**	**Without load**	**Men**	**Time (Hrs)**	**Labour Charges (Rs)**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	11
1	RCC columns (1.20x0.30x2.535 m)	2	3674	C1	C2	180	-	26	208	3796
2	Return journey	-	-	C2	C1	-	180			
3	RCC columns (1.20x0.30x2.535 m)	2	3674	C1	C2	180	-			
4	Return journey	-	-	C2	C1	-	180			
5	RCC columns (1.20x0.30x2.535 m)	2	3674	C1	C2	180	-			
6	Return journey	-	-	C2	C	-	180			

					1					
7	RCC columns (1.20x0.30x2.535 m)	2	3674	C1	C2	180	-			
8	Return journey	-	-	C2	C3	-	400			
9	Steel Rods shifting	1	1600	C3	A1	1015	-	2	16	292
10	Return journey	-	-	A1	C3	-	1015			
11	Steel Rods shifting	1	2000	C3	C4	290	-	3	24	438
12	Return journey	-	-	C4	C6	-	290			
13	Crane Materials shifting	2	500	C6	A3	503	-	4	32	584
14	Return journey	-	-	A3	C6	-	503			
15	Crane Materials shifting	2	500	C6	A3	503	-			
16	Return journey	-	-	A3	A1	-	41			
17	Concrete Bucket shifting	1	350	A1	A5	217	-	2	16	292
18	Return journey	-	-	A5	C6	-	719			
						3248	**3508**	**37**	**296**	**5402**

Table-4: Daily Expenditure and out put of the Mobile crane from 01-02-2010 to 06-02-2010

S. No.	Date of working	Expenditure		Time taken (Hrs)	Out put (Rs)	Time taken (Hrs)
		Oil Consumption	Labor involved			
1	01.02.2010	450	780	9	5402	296
2	02.02.2010	400	780	8	5110	280
3	03.02.2010	300	780	6	5308	296
4	04.02.2010	450	780	9	4526	248
5	05.02.2010	400	780	8	6570	360
6	06.02.2010	400	780	8	5986	328
Total		**2400**	**4680**	**48**	**32902**	**1808**
Average		**400**	**780**	**8**	**5484**	**301**

Table-5: The total worth and cumulative out put of the Mobile crane for 6 years (Amount in Rs. Lakhs)

Sl. No.	Year	Vehicle Worth	Total Expenditure	Cumulative expenditure	Total worth of vehicle	Total output of vehicle (Avg)	Cumulative Output of vehicle
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	21.9.2009 (Purchase)	21.90	--	--	21.90	--	--
2	1 year	24.53	4.30	--	28.83	12.83	12.83
3	2 years	27.47	4.30	8.61	36.08	12.83	25.66
4	3 years	30.77	4.30	12.92	43.69	12.83	38.49
5	4 years	34.46	4.30	17.22	51.68	12.83	51.32

6	5 years	38.60	4.30	21.53	60.12	12.83	64.15
7	6 years	44.22	4.30	25.83	70.06	12.83	76.98

V. RESULTS AND DISCUSSIONS

The results obtained from the Methodology are discussed in the following. The Mobile Crane (Hydrau) is utilized for handling of different types of materials like, steel rods, steel frames, crane materials, RCC components, etc., between steel yards, pre-casting yard, construction site, and stores as per the requirement. The mobile crane in action is shown in Figures -3 and 4. The daily out-put from the Mobile crane with different types of operations are measured and the results noted down in the Table 2 & 3 for a period of 6 days. The Mechanical handling of materials of the above are also converted into manual handling and noted the same in the Tables -2 & 3. The actual men engaged for Mechanical Handling and maintenance charges of the Mobile crane for the same period are noted down in Table-4.

Labour charges and expenditure on the Mobile Crane are calculated as shown below .

The maximum capacity of a man carrying at single time = 35 Kgs
The maximum working time per day by a man = 8 hrs
The cost of oil consumption for the Mobile crane per hr = Rs.50
The maximum weight of the RCC column per 1.00 Cum = 2400 Kgs
Maintenance charges of the Mobile crane =Rs. 1200 per week (6 days)
Aaverage expenditure on the Mobile crane = Maintenance cost in Rs. + Daily expenditure (Table – 3)
The expenditure . = Rs. 200 + 400 + 780 = Rs. 1380 per day
Annual expenditure on Mobile Crane= Rs. 1380 x 312 days = Rs.430560
The daily output from the Mobile Crane = Rs.5484
The fluctuations in the work out put i.e., 25% = Rs 1371
Therefore, the actual output of the Mobile crane per day = Rs.4113
The annual out put from by the Mobile crane = Rs.4113 x 312 days = Rs.1283256

Worth of the vehicle:

The worth of the crane is calculated using the formulae as follows.

Let, P = Present worth, i = Rate of interest and F = Future worth of P after sometime

At the end of 1 year ; $F1 = P + iP = P(1 + i)$ (1)

At the end of second year; $F2 = P(1 + i) + iP(1 + i) = P(1 + i)^2$ (2)

Similarly, for n years $Fn = P(1 + i)^n$ (3)

Break Even Point:

The total worth and total time taken-up by the Mobile crane as per the Table-4 are compared and found that the Break Even point of the crane is after 4 years as shown in Figurer– 5

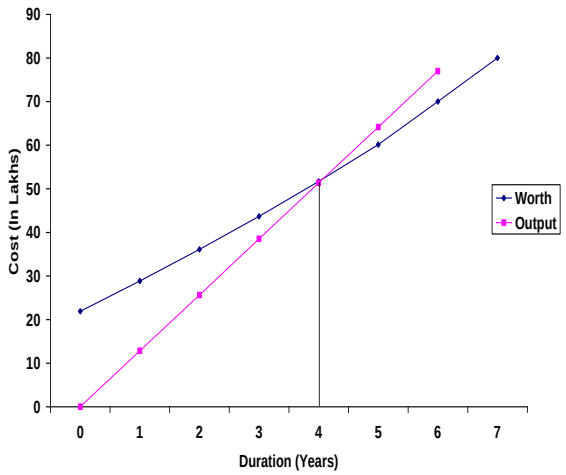


Figure – 5: Break-Even Point of Hydrau

VI. CONCLUSIONS

The Break Even Point of the Mobile crane is shown in Figure-5. It can be see that the Break-Even Point is achieved after 4 years with a worth of Rs.51.32 lakhs. The Mobile crane is used at the construction site for critical handling locations where the Manual handling is not possible and to difficult. The time taken for

Mechanical Handling is 8 hrs per day, where as in manual handling it is 301 hrs for the same output of the work. Therefore, the time saving from the Mechanical handling is 38 times over manual handling. Transportation technique can be applied.

ACKNOWLEDGEMENT

The authors expresses their sense of gratitude for the help and cooperation extended by P. Rajiv Swagruha Corporation Limited, Jawahar Nagar, Hyderabad, India.

REFERENCES

[1]. Shu-hsien Liao Technology management methodologies and applications A Literature review from 1995 to 2003, Technovation, pp: 381-393, .2005.

[2]. Sankariah. M, Rambabu.E and Eswara Reddy.C., Role of Material Handling equipment in construction of High-rise buildings. Proc. of 2nd A.P. Academy of Sciences: S.V. University, Tirupati, India, 2009.

[3]. Sankaraiah.M, Rambabu.E and Reddy.C.E, Mechanical Handling of Materials in the construction of Multi-storeyed buildings – A Case Study; 3rd International Conf. Advances in Mech. Engineering, Surat – India, .Jan 4– 6, 2010.

[4]. Kazuhiko Terashima, Ying Shen and Kenichi YanoModeling an optimal control of a rotary crane using the straight transfer transformations method: Journal of Science Direct: 1179-1192, 2007.

[5]. Sankaraiah.M, Rambabu. E and Eswara Reddy. C., Maintainability and Break Even Analysis of Mobile Crane – A Case Study, Proc. of the National Conference on Recent Advances in Mechanical Engineering, RVR & JC Engineering College, Guntur, India, pp. 227 – 233, July, 7-8, 2011.

[6]. Tam,C.M., Deng.Z .M and Zeng. S.X), Evaluation of construction methods and performance for high rise public housing construction in Hong Kong: Jl. of Building and environment, pp. 983-991, 2002.

[7]. Ajith Kumar Parlikad and Duncan McFarlane**,** Quantifying the impact of AIDC technologies for vehicle component recovery: Journal of Computers and Industrial Engineering, 2010.

[8]. Kumar. B., National Institute of Technology, Jamshedpur, India, Industrial Engineering-Text Book for Engineering Sstudents: Pages 581–583, 1989.