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Research Article

Utilization of Cranes in Mega Construction Project

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Abstract

Tower crane are commonly constitute of bottleneck production for today's typical building construction project. If we reduce the cycle period of crane cycle we can increase the productivity. This case study deals with the factor affecting the cycle period and how they can be optimize. Two operating mode have been studied. Cab operating mode and remote operating mode and there advantages and disadvantages. This study also identified that it is the balance between fast travel part of the cycle and the professional who are charged with the fast of selection the operation mode (OM). Best suit for the project when both operating systems are optional.

Keywords: *Tower Crane, Crane Operation, Cycle Time, Cab and Remote mode.*

Introduction

[1]In construction of HRB and Big Project we required a huge amount of capital investment and men power although we have the entire thing with us we are unable to complete project on time because there are no. of factor affecting the delay in construction. The main reason behind this might be improper management and illiteracy about the modern equipments. So by using modern equipments we can achieve the targeted goal within time and can optimize the time period required to complete the project based on survey made , it is concluded that 50% of contractor can achieve they target within time with the help of modern equipment. It is also found that few of them have completed the work before time. In which crane is considered to be important part of construction industries they play important role in vertical circulation of material and transportation.

The efficiency of crane depends upon the type of crane used. There are no's of crane with different boom and jib and different working methods. Tower crane is one of the best options to use in India. As environment condition and studied a single zip tower crane is used. As without the help of the staircase we can transport the material. This reduces the frequency of accidents and provides safety to labors.

Necessity to Study the Crane Systems

As the size of boom increases the cyclic period increase and as cycle period increases productivity decreases so to obtain the productivity and to do fast work we required to maintain optimum cyclic period so for that we have to choose a proper crane and boom distance. These are generally two type of operating system cab operating and remote operating system both have different cyclic period.

Selection of Tower Cranes

Each class of cranes possesses certain basic characteristics, which will usually dictate the one most suited to a particular application. Tower cranes must be selected to suit the job. If the crane's basic characteristics do not match the job's requirements, unsafe conditions will be created and accidents are prone to happen.

The type of tower cranes to be used should be considered against the job requirements for a particular application. Points to be considered in making the selection include:

(a) Weights and dimensions of loads.
(b) Heights of lift and distances/areas of movement of loads.
(c) Number and frequency of lifts.
(d) Length of time for which the crane will be required
(e) Workplace conditions, including ground conditions for crane standing, and space available for crane access, erection, operation and dismantling.
(f) Any special operational requirements or limitations imposed including the existence of other cranes in close proximity.

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Types of tower cranes

Static and mobile tower cranes

Static and mobile tower cranes are available in a wide variety of types and configurations according to the particular combination of tower, jib and type of base which they employ.

Tower configurations Tower cranes

Tower configurations Tower cranes are available with either fixed or slewing towers. On the fixed tower type the slewing ring is situated at or near the top of the tower and the jib slews about the vertical axle of the stationary tower. The slewing ring on the slewing tower type is situated at the bottom of the tower and the whole of the tower and jib assembly slew relative to the base of the crane. The towers can be further classified as being mono towers, inner and outer towers and telescopic towers.

a) **Mono Towers -** The jib is carried by a single tower structure, which may be either fixed or slewing. Provision may be made in the design to permit the tower to be extended.

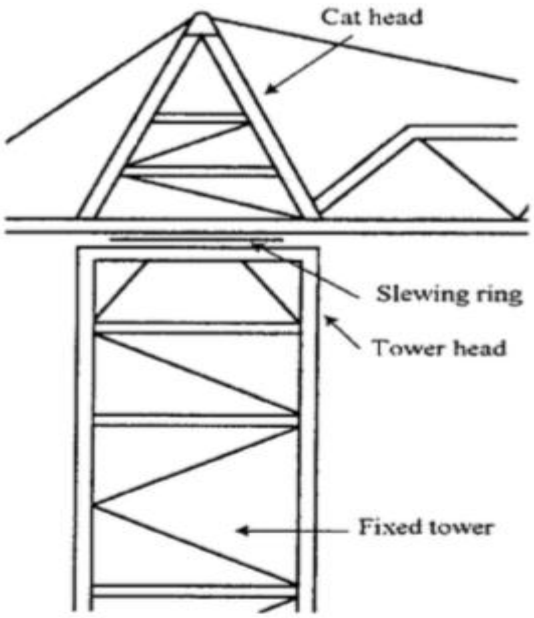

Figure 1 Moon Tower

b) **Inner and Outer Towers -** They are characterized by the jib being carried by a fixed or slewing inner tower which is supported at the top of the fixed outer tower. Provision may be made in the design to permit the outer tower to be extended.

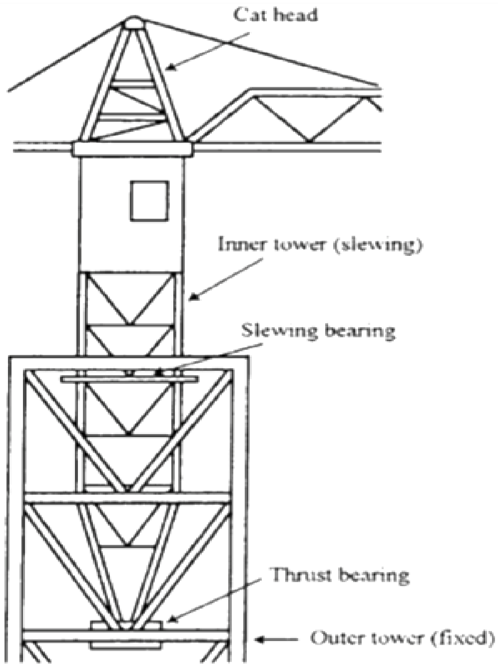

Figure 2 Inner and Outer Tower

Jib configurations Tower cranes

The main types of jib used on tower cranes are horizontal trolley jibs, luffing jibs, fixed-radius jibs, rear-pivoted luffing jibs and articulated jibs.

a) **Horizontal trolley jibs ("a" frame type)**

They are held in a horizontal or slightly raised position by tie bars or ropes connected to an "a" frame on the top of the tower crane. the hook is suspended from a trolley which moves along the jib to alter the hook radius. a suitable allowance needs to be made for defection when calculating the clearance between adjacent cranes.

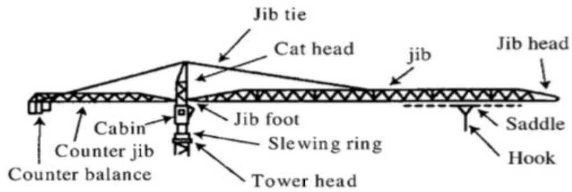

Figure 3 A- frame Jib

b) **Horizontal trolley jibs (flat top type)**

They are connected directly to the tower top and do not require tie bars or ropes connected to an "A" frame. This reduces the overall height of the crane. The hook is suspended from a trolley which moves along the jib to alter the working radius. A suitable allowance needs to be made for defection when calculating the clearance between adjacent cranes.

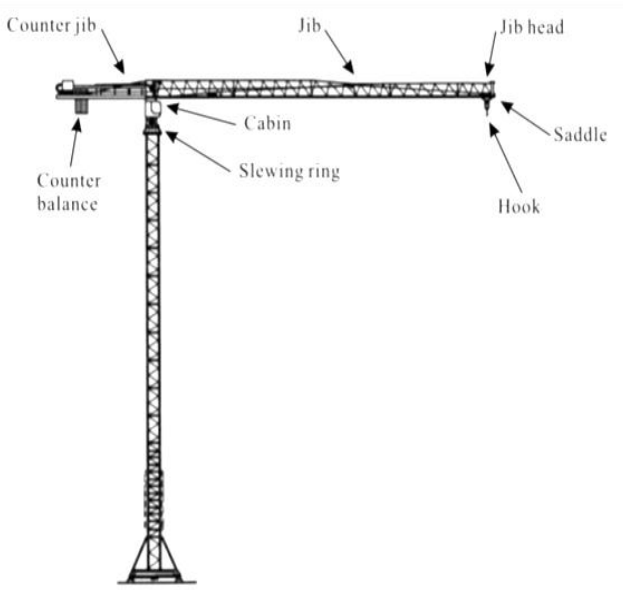

Figure 4 Flat top Jib

Operational characteristics

The operating characteristics of a tower crane are largely determined by its type of mounting, type of tower and type of jib.

- A tower crane with a static base only occupies a limited area but is able to cover, from its fixed position, all points at which loads are to be handled within the maximum slewing radius. They can be set at varying heights up to their maximum free standing height. They can also be extended beyond this limit by tying the crane back to the supporting structure.
- Rail-mounted tower cranes have a larger area of coverage as they can travel along their tracks carrying their rated loads. However, the height requirement should not exceed the free standing height as recommended by the manufacturer. On the other hand, the crane service would be disrupted whenever work must be done on or near the track. The advantage of mobile tower cranes lies in great inward reach without the long jib which would normally be required to reach over the top of the structure.

On-Site Time Study

The current research was based on time studies conducted at the construction site of a large-scale, spread-out project comprising several adjacent low-rise and midrise structures that house educational, training, and residential facilities. The specific structure that served for time measurements and observation was a midrise building (designed to reach 18.4 m when completed) that was serviced by two top-slewing tower cranes, of which one was the test crane for the study. At the time of the study, work was being conducted on the ground floor. Fig. no. 5 shows the layout and elevation of the building and cranes (Crane #1 is the test crane). Five partially-overlapping top-slewing cranes were servicing the entire project at the time of the study, and this number was soon to increase to eight or nine similar cranes. Due to certain restrictions stemming from the location of the site, most of the cranes had to be operated solely from the ground.

Time studies were conducted on five workdays during which the crane was operated from the cab for about half the time and from the ground the other half of the time. Recording was done using the continuous timing method, following the recommendations of and the International Labor Organization

Breakdown of Crane Cycle Time

Crane cycle times are measured by dividing the cycle into segments in different ways that depend on the purpose of the study. For example, were interested in measuring time savings when using a crane-mounted camera as an operator vision aid aimed at reducing dependence on signalpersons. To that end, it was vital to detect the exact time from the onset of landing until the complete halt of the hook and release of the chains/slings. In a much earlier study, divided the cycle time into two two-part phases:

(1) Transferring the hook to the load,
(2) Gripping of the load.
(3) Transferring the load and
(4) Installing the load and releasing the hook that division best served the aim of that study to develop means to shorten the loads' gripping and releasing times

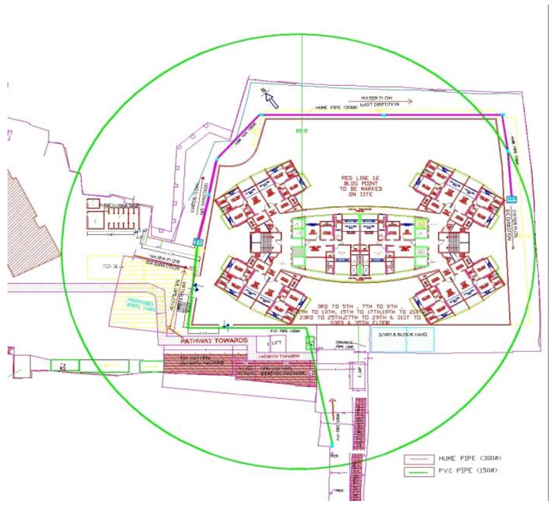

Figure5 Testing building and crane: schematic plan

First observations were discussed when time recordings were well into their second day. A hypothesis was then proposed that there was likely a difference between CO and RO in the operating patterns and speeds, specifically in the hook's fast motion throughout most of the travel path (fast travel) and in its slow motion during the landing process, namely the slowing approach of the hook to the pick-up/drop-off point (fine maneuvering). The breakdown of the half-cycle was, therefore, modified slightly (retaining the division into two segments), and the moment the hook transitions from fast to slow motion was recorded (rather than the moment motion stops). This modification was supported by a practical problem that arose: since the majority of crane work performed during the study consisted of the handling of large wall form panels, it was difficult to determine the exact moment the hook's motion stopped when placing the form panel in its final location; quite often the form had to be lifted slightly after placing and then lowered again in order to correct its placement. While for most practical purposes the latter activity might be considered part of unrigging (and not travel), it appeared to the observant time recorder to be the exact time during which a clear difference existed between CO and RO. Thus, at the onset of the third recording day, the breakdown of each half-cycle time was amended as follows: (1) fast motion time of the hook (lift and fast vertical-horizontal-vertical travel), and (2) slow motion time of the hook (fine maneuvering when approaching the pick-up/drop-off location) and rigging/unrigging time. Consequently, all measurements (i.e., five workdays) were useful for the purpose of overall cycle time comparisons, whereas analyses that required higher resolution and separate investigation by cycle segments (i.e., the amended breakdown), used time measurements made during the last three workdays only.

Table 1 provides the profile of the recordings in terms of time durations and number of half-cycles, with reference to the two rounds of time recordings, Days 1–2 and Days 3–5. Note that in each of the recording rounds separately, both the overall durations and number of half-cycles were too balanced in good approximation between the RO and CO.

Table 1 Profile of Crane Work Cycle Recordings

Operation Mode	Day 1-2 Time (h:min)	No. of half cycles	Days3-5 Time Time (h:min)	No. of half cycles	Total Time Time (h:min)	No. of half cycles
Cab	3.54	56	7.25	100	11.21	156
Remote control	3.27	50	8.24	114	11.51	164
Total	7.22	106	15.41	214	23.1	321

Table 2 Example cycle-time recording sheet

No. (1)	Load (2)	Slewing Angle (°) (3)	Horizontal Distance (M) (4)	Vertical Distance (M) (5) ↑	Vertical Distance (M) (6) ↓	Start Travel (H:M:S) (7)	Start Fine Maneuvering (H:M:S) (8)	End Rigging / Unrigging (H:M:S) (9)	Comments (10)
1	Wall from panel	40	15	6	6	08:20:31	08:21:41	08:24:23	
2	(empty)	30	5	2	2	08:24:24	08:25:25	08:28:28	
3	Wall from panel	30	25	6	6	08:28:29	08:29:52	08:31:45	
4	(empty)	0	30	2	2	08:31:46	08:32:14	08:33:03	
5	Wall from panel	0	2	1	1	08:33:02	08:33:13	08:34:32	(1)
6	(empty)	0	0	0	0	08:34:33	08:34:32	08:38:19	(2)
7	Wall from panel	0	2	1	1	08:38:20	08:38:33	08:39:55	
8	(empty)	80	15	6	6	08:39:56	08:41:17	08:41:43	
9	Steel inserts	180	0	6	6	08:41:44	08:44:15	08:44:33	(3)
10	(empty)	45	20	6	3	08:44:34	08:45:46	08:50:02	
11	Wall from panel	20	35	6	6	08:50:00	08:51:20	09:11:23	(4)
12	(empty)	180	0	3	6	09:11:25	09:13:31	09:14:31	
13	Timber, Plywood	80	0	6	3	09:14:30	09:16:17	09:16:45	
14	(empty)	200	0	6	6	09:16:46	09:17:49	09:20:38	(5)
15	Wall from panel	30	0	6	6	09:20:39	09:22:40	09:24:22	
16	(empty)	60	0	3	3	09:24:21	09:25:20	09:30:09	

1. Mainly for stripping (detecting from cast wall)
2. Mainly turning of form and resisting it against the wall at same location
3. Waiting 50 sec. for signaler
4. 12 m long panel, difficult the maneuvering and placement
5. Longer travel path to by-pass overlapping crane

Parameters of Comparative Time Study

When attempting to compare cycle times of two different OMs, all other parameters potentially affecting cycle durations and productivity should ideally be kept inert throughout the recordings and regardless of the OM (in other words, other parameters may vary, but they must not affect cycle duration and productivity in any way). Since this case study was conducted on a real worksite where, even if some parameters could be controlled, there were always others whose invariability could not be secured,

Certain assurances, empirical or analytical, that any change did not affect the results had to be provided.

The various work conditions and parameters that prevailed during the study also had to be specified in order to characterize the specific case for later examination of the validity of the results obtained here for other cases and under different conditions. This is in line with Price and Harris who drew attention to the inherent difficulty in generalizing productivity rates in construction mainly due to the varied work environments and worker skills.

Table lists the parameters identified and categorized in the current study, according to three states:

(1) Secured already at the research planning stage as invariable.

(2) Monitored during actual time recording to assure they are either constant or exert identical influence regardless of the OM.

(3) Monitored and then analyzed at the completion of the time study for their effect on the results. These parameters characterized the field study as follows:

Crane operators: Two operators were observed, one who was the sole operator on Day 1 and operated the crane only by remote control from the ground, and another who was the sole operator on Days 2–5 and operated the crane alternately from the cab and from the ground. The first operator, a woman, had been operating tower cranes for five years (and had been on the current jobsite one month) and had no other prior construction-related work experience. The second operator, a man, was an "old hand" at crane operation, with 20 years of experience in crane operation (and had been on the current jobsite four months) and earlier experience of five years as a construction laborer. The potential effect of the difference in experience and background, combined with differences in personality and attitude, were considered later in the course of analysis.

Ground Motion of Crane Operator

At some time into the field study, it became obvious that when the crane operators used the remote control from the ground, they were in constant motion; this was in sharp contrast to their stationary position during CO. Such motion may not only affect productivity but also carries with it potential occupational safety and health issues. Thus, it was deemed worth investigating as a unique RO characteristic that provides additional information and adds a quantitative dimension to that provided by the time study. To measure the distance covered by the operator, the record keeper, who stuck close to the respective operators and shadowed their motion in real time, carried an IPhone equipped with an application that records cumulative distance covered.

Analysis Time Study

The results presented in Table 1 provide several insights. First, the overall equivalence of cycle times in CO and RO suggests that the commonly perceived advantage of CO should not be taken for granted. Thus, conditions exist, which are not necessarily rare or unusual, under which the advantages of RO offset those of CO; such were the conditions in the current study. For certain lifts, the advantages of RO may even outweigh those of CO: the results presented in Table show that the advantage of CO stems from fast travel whereas the advantage of RO stems from fine maneuvering (assuming rigging/unrigging is not, in itself, affected by the OM). This indicates that the shorter the travel distance and the more difficult the fine maneuvering, the higher the chances that RO will yield shorter cycle times than CO (e.g., when a crane with a shorter jib satisfies lift requirements or if a load requires more fine maneuvering than usual to position it at the precise location, such as in the case of precast wall elements). And vice versa: lifts with longer travel paths (e.g., between floors or between the floor and the ground in midrise and definitely in high-rise buildings) and uncomplicated fine maneuvering (e.g., buckets of concrete when pouring a floor) will most likely take less time with CO than with RO.

RO also exhibited shorter mean cycle times for all lifts recorded other than those involving wall form panels: if the results in Table 3 indicate an equivalence of cycle times in the two OMs for all lifts and an advantage of 10% to CO for wall formwork, and if wall formwork and all other lifts constituted 55 and 45% of all half-cycles, respectively, then RO had a 12% ($0.1 \times 0.55=0.45$) advantage for all other lifts. It can therefore be concluded that RO may have an advantage on projects with a crane lifting profile that is similar to that of the current study for all lifts other than large wall form panels (e.g., when concrete walls are formed by hand-set systems).

Conclusion

According to study several conclusions can be derived from these analyses: Contrary to the conventional notion that CO of top-slewing cranes is ultimately advantageous over RO of such cranes in terms of work productivity, there prevail certain work conditions under which the two OMs may, overall, yield identical cycle times or even give RO an advantage. Primary such conditions identified in the current study are short hoisting distances, as in the case of low-rise construction and, more specifically, when the pick-up and drop-off locations are on the same floor. The same is true for landing processes that are slowed because of sizable loads, unsupportive landing zones, requirements for precise placement.

- Ultimately, what determines which of the two OMs studied here will generate shorter cycle times, is the balance between the fast-travel part of the cycle and the fine-maneuvering part; the former is first and foremost the result of lift distances whereas the latter is dictated mainly by the type of load lifted. In the current study, productivity associated with the handling of wall form panels, the single element that accounted for most of the crane work observed was 10% higher in CO than in RO, despite short hoisting distances. If those panels, or any other loads, were to be transported between floors or between the ground and a higher floor, the advantage of CO would undoubtedly increase, let alone in high-rise construction.

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