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PLANNING FOR HIGH-RISE BUILDING CONSTRUCTION USING LOCATION BASED REPETITIVE SCHEDULING METHOD (LBRSM)

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ABSTRACT

This paper describes an advanced scheduling methodology that is part of a research program devoted to the topic of Location Based Repetitive Scheduling Method for housing projects in India. Now a day there is a cut throat competition in all fields of Engineering and construction in India. To gain the success in the field of construction in these evolving times, project managers must emphasize efficiency in all aspects of their operations, including resource flow process, mainly the labor crew performance. Most often project manager has to plan location based repetitive projects (LBRP). LBRP are the projects where certain activities are continuously repeating at each locations of the project. Such as commercial housing projects, multistoried sky scrapers, the linear segmented works like roads, long-bridges, airfields, tunnels, pipe network. The LBRP are characterized by the repeating activities, which in most instants arise from the sub division of a generalized activity into specific activities associated with particular locations. For e.g. painting activity for high-rise building may broken into painting for first storey, painting for second storey and so on, where each storey is a significant location of that high-rise building. Activities that repeat from one location to other location creates a very important need for a construction schedule that facilitate the uninterrupted work flow including work crews from one location to next, because it is often this requirement that establishes activity starting times and determines the overall project duration. Hence uninterrupted work flow becomes an extremely important issue for the planning and scheduling of high-rise building, hence high rise building construction planners need to carefully design a process that ensures a continuous and reliable flow of resources through different locations in a project. The conventional Critical Path Method and its resource oriented extension such as time cost trader off, limited resources allocations and resource leveling does not consider the waste time during the transformation of work flow from one location to the other. Location Based Repetitive Scheduling Method (LBRSM) explicitly take care those entire requirements for repetitive nature projects like high rise buildings. The application of such work flow continuity during LBRSM leads to maximizing the use of a learning curve and minimizing idle time of each crew. This paper suggests modified flow-line schedule, here called as 'LBRSM' based on real life case study, which can be implemented at micro-level for high-rise building construction project.

Key-words: Location Based Repetitive Projects, Work Flow, High Rise Building Projects, Location Based Repetitive Scheduling Method (LBRSM).

I. INTRODUCTION

Project plans and schedules are critical to the success of any project. Construction project manager has to plan projects that are characterised by continuous or repeating activities, where the same activities are running at different locations of the project, for example multi storey housing project [7]. The effective advanced scheduling methodology for such project can be achieve by family of repetitive scheduling methods (RSM) such as "Line-of-balance" (LOB), "Linear Schedule Method" (LSM), "Time-location Matrix Model", "Construction Planning Technique", "Time Space Scheduling method" (Harris and Ioannou 1998) [3], "Flow-Line (Mohr 1991) [2], "Location Based Scheduling (LBS) Method"**,** and similar methods. The repetitive scheduling method was first developed in the 1940's as LOB by the Goodyear Company, and then furthered by the U.S. Navy in the 1950's (Arditi & Tokdemir, 2002) [1], but despite its long history it has gained relatively little attention in the construction industry.

The repetitive scheduling methods will in this paper be referred to the comprehensive term of Location Based Repetitive Scheduling Method (LBRSM), firstly described by Kenley (2004) as Location-based Scheduling (LBS) [5]. LBRSM imply a shift in focus, from the discrete activities of the CPM-approach to managing the progress of repetitive activities as performed by crews moving through a building and completing all their work location by location. LBRSM uses the graphical representation technique of a Flow-line chart, which is adapted for planning and management of work-flows that facilitate resources to perform their work without interruptions caused by other resources working with other activities at the same location [8]. Thus, LBRPSM facilitate the establishment of continuous activities and a resource usage with a minimum of waiting time and avoidance of work disturbance.

II. CASE DESCRIPTION

For implementing the 'Location Based Repetitive Scheduling Method (LBRSM) and analyzing the results the commercial housing project 'MEGAPOLIS', at Pune city has been taken as a case study. The data were collected during several visits to the field and site offices form the different persons.

Proposed Residential Development on "Plot No R-1/2, at Rajiv Gandhi Information and Bio technology Park, Phase III, Hinjewadi Industrial Area, Pune, Maharashtra"; MEGAPOLIS is located along the outskirts of Pune, at Rajiv Gandhi Information and Bio-technology Park, Phase III, Hinjewadi. The 150-acre Megapolis site consists of 21-storey premium towers and 14-storey luxurious towers. The alphabets 'A', 'B', 'C' etc are given to these towers to identify them. This integrated township will comprise of about 10000 high end houses. Megapolis has explored various architectural themes offering the residential options ranging from studio to large five bedroom apartments. Megapolis is away from the hustle and bustle of the city, traffic snarls, pollution and offers a salubrious lifestyle that one can deserve. The consultant for the project is RSP, Singapore who are the pioneers in integrated township designs and Belt Collins, Singapore, who are the global leaders in the art of landscaping. This prime project has been introduced by Pegasus Properties Pvt. Ltd. and has taken to execute by Joint Venture of two Leading groups in Pune, 'Kumar Properties' & 'Avinash Bhoslae Group'. Every Building is to be executed with two floors sub structure in conventional works & the rest in 'MIVAN' type of specialized aluminum base material.

III. IMPLEMENTING LBRSM ON MEGAPOLIS

LBRSM Approach

The study is limited for premium towers only. For a building of 21-storeys high, it is consist of 21 typical floors resting on a podium floor. The plan for premium towers looks like typical 'Y-shape' including central core area. As the substructure, podium floor, underground tank work and top dome are of non-repetitive type it is excluded from the study; separate schedule was prepared for this work. The LBRSM approach is applied separately for three different arm of 'Y-shape' and central core area. The schedule is divided for 'MIVAN work', which is a major part of this project and 'RCC work, external rough plastering, internal finishing work'. The 'Logic Diagram' has prepared for one floor considering the sequence and interdependency of each activity. The activity duration has calculated considering the construction methods, practical and location constrains as well as resource constrains and crew optimization. This 'Logic Diagram' will repeat for each floor. The schedule and logic diagram of a single floor for 'MIVAN work' and 'RCC work, external rough plastering, internal finishing work' for 'E' building has sown in Table 1, Table 2, and Figure 1, Figure 2 respectively.

Similarly schedule for internal finishing work and its logic diagram for each arm of 'Y-shape' has prepared. The cycle time for this work comes to fifty three days.

IV. PROPOSED LBRSM FLOWLINE SYSTEM DESIGN

LBRSM follows the 'Flow-line' system of project scheduling which has designed with the basic principle of original time and locations. It is a graphical method in two dimensions where X-axis represents Time, Y-axis represents Locations. Different activities in 'Logic Diagram' which repeats at each location can be shown by flow-lines [4]. The slope of these flow lines represents an output rate of the activities in the 'Logic Diagram' which is calculated by activity duration [6]. Previous research was concentrated for major activities only. Here the modified proposed innovative methodology is adopted at micro level as the different schedules are prepared for different repeating works. The Synchronization and Pacing are carried out when deciding the targeted output rate of each activity to make the schedule more balanced. Synchronization means that planning a similar targeted output rate for all activities. A synchronized schedule can be identified by parallel lines that shows a constant time–space buffer between different tasks and Pacing means that the activities are scheduled to continue from one location to another without interruptions for that the different minor activities and tasks are clubbed tighter which forms an intermediate cycle within a location. The methodology is designed in such a way that the locations, here in this project story of a high-rise tower which are broken down into weekly or daily schedules for various activities considering the minor activities are satisfying the linearity characteristics that is start and end locations having equal output rate of the different activities. Flowline schedules graphically display output rates for each construction activity, and make it extremely easy to track the progress of work at a glance by objective schedule and progress schedule [9]. A typical flowline schedules of tower 'A', 'E', 'F', 'G', 'H' and 'J' for the works 'MIVAN shuttering of RCC Walls and Slab', 'Placing and Fixing Steel of RCC Walls and Slab', 'MIVAN hole packing', and 'Concreting of RCC Walls and Slab' are shown in Figure 3, Figure 4, Figure 5, and 'Figure 6 respectively.

Table 1: Schedule of single floor (one arm of 'Y-shape) for 'MIVAN work'

ACTIVITY	DESCRIPTION	TIME (DAYS)	DEPENDENCY
A	Line out	1	Finish to Start (last activity of previous floor)
B	Reinforcement Binding for Wall	3	A- Finish to Start
C	De-shuttering of MIVAN Panels	3	B - Finish to Start -1d
D	Setting & Fixing of MIVAN Panels	6	C- Finish to Start -1d
E	Conduit Fixing for Electrical Provisions	2	D- Finish to Start
F	Slab & Beams Reinforcement Binding	4	D- Finish to Start-3d
G	Alignment & Checking	3	D- Finish to Start
H	Mortar Packing at bottom of MIVAN panels	1	G- Finish to Start
I	Pouring of Concrete	1	H- Finish to Start
Total Time required for single floor of 'MIVAN work'		16	

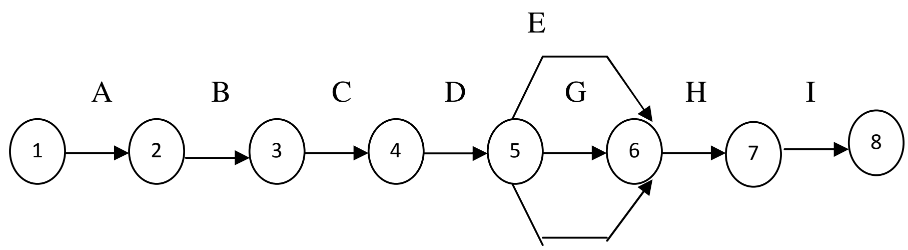

Figure 1: Logic Diagram of single floor (one arm of 'Y-shape) for 'MIVAN work'

Table 2: Schedule of single floor (one arm of 'Y-shape') for 'RCC work'

ACTIVITY	DESCRIPTION	TIME (DAYS)	DEPENDENCY
P	Erection of steel and amenities	3	Finish to Start (last activity of previous floor)
Q	Erection of formwork	3	P- Finish to Start
R	Fixing of steel and amenities	3	Q - Finish to Start
S	casting of slab & shear wall	1	R- Finish to Start
Total Time required for single floor of 'MIVAN work'		10	

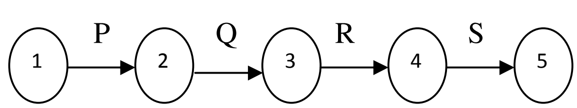

Figure 2: Logic Diagram of single floor (one arm of 'Y-shape)' for 'RCC work'

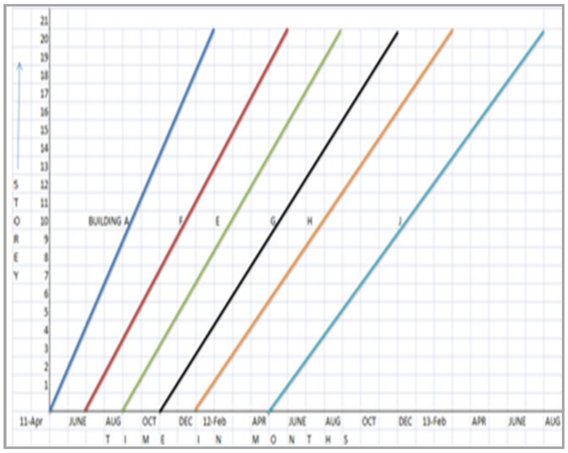

Fig 3 : LBRSM Flow-line schedule for and Fixing Steel of RCC Walls & Slab'

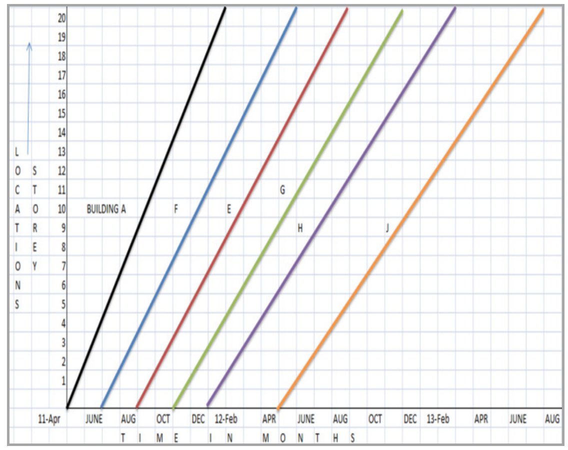

Fig 4 : LBRSM Flow-line schedule for 'Placing 'MIVAN shuttering of RCC Walls & Slab'

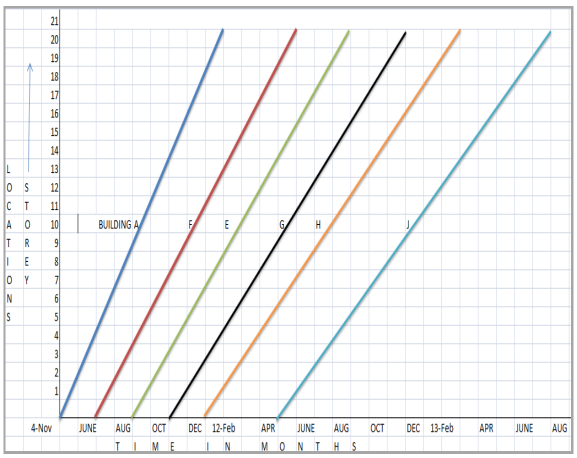

Fig 5: LBRSM Flow-line schedule for 'MIVAN hole packing'

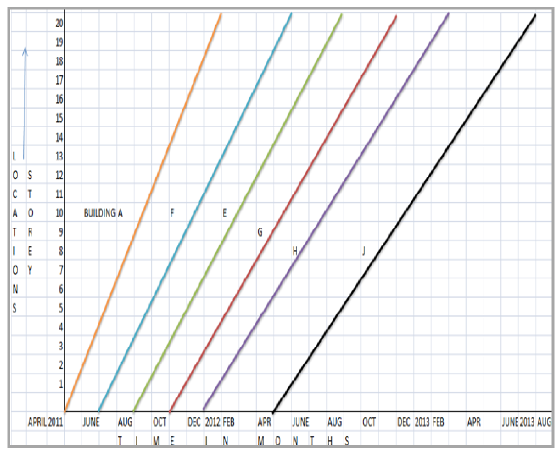

Fig 6: LBRSM Flow-line schedule for 'Concreting of RCC Walls and Slab'

V. CONCLUSION

This paper presented a practical application of an advanced scheduling methodology; here called as 'Location Based Repetitive Scheduling Method (LBRSM), on a high-rise building construction site. This methodology was developed using location based scheduling method applied on repeating projects like high-rise building. LBRSM follows the 'Flow-line' system of project scheduling which has designed with the basic principle of original time and locations [10]. Past researchers had given much attention on major activities only. The LBRSM approach is applied here separately for three different arm of 'Y-shape' and central core area. The schedule is divided for 'MIVAN work', which is a major part of this project and 'RCC work, external rough plastering, minor activities of internal finishing work'. Thus the proposed planning method works at micro-level by taking care of minor activities. The different minor activities and tasks are clubbed tighter which forms an intermediate cycle within a location. The different schedules are prepared for different repeating works. The Synchronization and Pacing are carried out when deciding the targeted output rate of each activity to make the schedule more balanced. The methodology is designed in such a way that the locations, here in this project story of a high-rise tower, which are broken down into weekly or daily schedules for various activities considering the minor activities are satisfying the linearity characteristics that is start and end locations having equal output rate of the different activities. Flowline schedules drawn here graphically display the output rates for each construction activity, and make it extremely easy to track the progress of work at a glance by LBRSM flow-line schedule. The advantage of this approach is that separate LBRSM flow-line schedules can prove a better information and reporting tool for the subcontractors, suppliers and other agencies associated with the high-rise building construction project.

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