

TIME OPTIMIZATION OF PRECAST PLANNING USING BIM SOFTWARE

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Abstract - Time is the essence of any project. Adoption of precast construction is the key to meet the timeline for any fast track construction projects whereas planning is a vital part for the successful completion of precast projects. Being precast, advance planning is necessary. Conventional method is the most common practice for the planning of any precast projects whereas BIM software is not yet well-practiced. Hence, software Tekla (a BIM software) has been adopted for the planning of a precast construction project of a G+3 structure. Precast planning involves precast element layout, casting yard, moulds, production, stacking, transportation, erection, and finishing of precast elements. This paper emphasizes the application of BIM software for time optimization of the planning of precast elements, since it benefits precast construction planning especially in production planning, saves time in the planning process, prevents human errors, automation of production and tracking of projects. The model provides a platform where the information is stored and it can be utilized in various phases during the precast construction process, directly by using functionalities in Tekla structures, or by linking the building information to other software solutions. Even though the software has more advantages over the conventional method, still the awareness of technology needs more encouragement to meet the global benchmark.

Key Words: Precast Planning, Tekla, Organizer, Palletizer, Crane Checks, Task Manager.

1. INTRODUCTION

Precast construction is one of the most promising solutions to the fast-growing infrastructure in any country. Precast construction has more advantages over cast-in-place construction including better quality production, speedy construction, less wastage, less manpower requirement, safe construction site, etc. In precast construction, structural components are standardized based on structural and production requirements, produced in plants / yards at a location nearer to the construction site, cured, transported to the site and erected. Planning is the crucial stage for successful completion of any precast construction. Effective, detailed and advance planning is necessary for any precast construction project

Building Information Modelling benefits the user by providing a platform which enables to create and manage all aspects of a building with the help of numerous virtual models. With BIM, buildings can be created virtually before they are constructed at the site and have many features

including model-based cost estimation, better builds, better collaboration, and communication, etc.

1.1 Project Brief

A sample live project, Construction of additional buildings for boys and girls hostels has been considered. It consists of 1+3 precast buildings of G+3 storey each.

No. of Buildings	: 4 no.s
Total Built up Area	: 4414.64 sqm per hostel
Plan Size	: 69.79 m x 16.94 m
Height	: + 17.3 m above GL
No. of Storeys	: 4
Type of construction	: Precast

2. METHODOLOGY

The challenge is to adopt a BIM software solution which enables the planning of precast project in an effective manner. Hence in this paper, Tekla structures has been analyzed for precast planning and the time optimization in precast planning using software is studied. All the activities in a precast construction project, i.e. from quantity estimation to project monitoring and tracking, can be done using this BIM software. It helps to collaborate on site activities with the schedule to track the project as well as to compensate for the delays.

2.1 Precast Elements Layout

Precast element layout is the basic input for any precast construction planning. Typical floor layout and the details of total precast elements for the project are listed below.

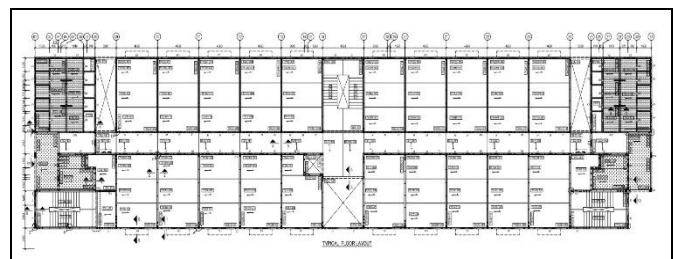


Fig -1: Typical Floor Plan

Table -1: Details of precast elements

Element	Total element per hostel	Total elements need to be produced
Wall	538	2152
Beam	96	384
Column	47	188
Slab	392	1568
Stairs	24	96
POD	8	32
Total	1105	4420

Table -2: Quantity estimate

Elements	Total no. of elements (no.s)	Volume of concrete (cu. m)	Weight (ton)
Wall	538	1028.74	2571.78
Beam	96	57.1	142.74
Column	47	15.96	39.91
Slab	392	345.9	864.79
Stairs	24	51.56	128.91
Pod	8	18.55	46.36
Total	1105	1517.81	3794.49

2.2 Modelling using BIM

The structural drawing can be imported to software, using Reference model, from which the structure can be developed. Reference model can be of various file formats including IFC, DWG, XML, DXF, SKP, PDF, etc. From the model, quantity estimation, pallet arrangements, lifting hooks, cranes, stacking, scheduling and tracking has been done using various tools namely organizer, palletizer, lifting anchors, crane checker, stacker and task manager respectively. The model developed is shown below.

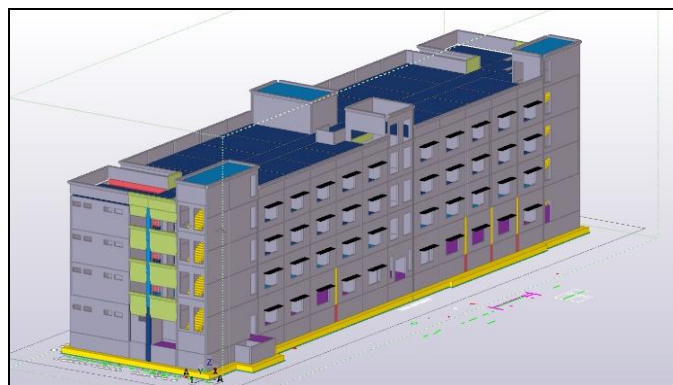


Fig -2: 3D View of model

2.3 Quantity Estimation

Model based quantity estimate can be obtained from software using organizer or reports. Organizer can be used for managing all model information, for queries regarding object properties and for object classification. Reports of various aspects can be created using predefined or user defined templates.

Software provides individual element estimate and it can be sorted to get the required quantities. Summary of estimate obtained from table are given below.

Time optimization for quantity estimation using software is approximately 85%.

2.4 Palletizer

Factory based production has all standard moulds and only approximately 30% non-standard moulds need to be produced for any project specification. Palletizer tool is used for planning the optimal pallet layout for precast elements. Once the elements are imported to palletizer, it allocates elements on the production pallets based on geometry, visualizes them and defines the casting sequence. Limit values and occupancy ratio (for optimizing) will be automatically calculated and notified. Manual placing, low spacing and UDA spacing are various options available. Even though options for providing spacing between moulds for activities like shuttering and de shuttering is not available, it will provide approximate arrangement of moulds and it can be exported to pdf. Time optimization is around 60% - 70%.

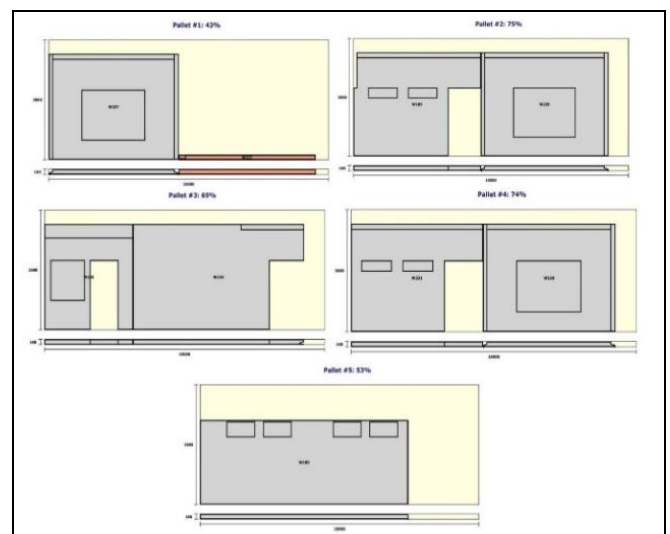


Fig -4: Pallet arrangement for typical walls

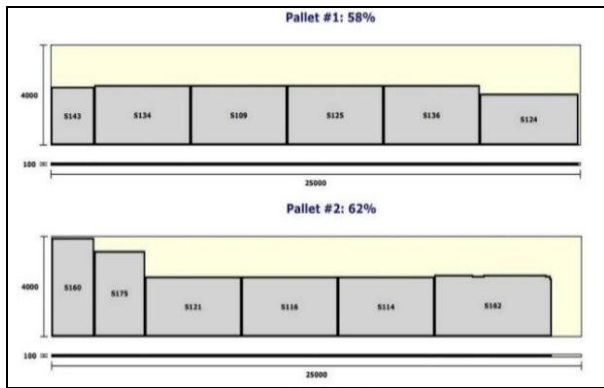


Fig -5: Pallet arrangement for typical slabs

2.5 Lifting Anchor

Lifting anchors is a tool used for assigning hooks for lifting and handling of precast elements. The location of hooks is assigned based on the element weight and properties and hooks for all elements can be assigned together automatically. Grade, type, diameter, embedded length and other details of anchors needs to be provided as input and based on it the lifting hooks will be assigned to each element. Time optimization approximately 50% on comparison with conventional method.

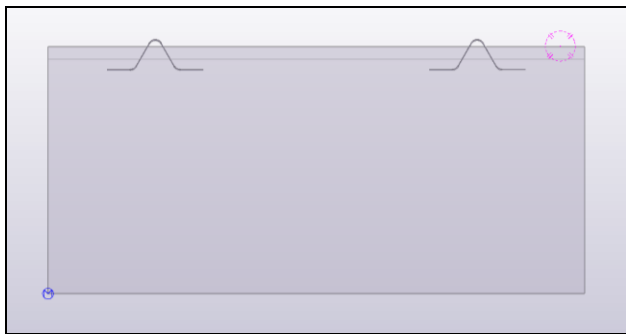


Fig -6: Lifting Hooks in wall

2.6 Crane Manager

Crane check helps to assign the suitable crane for erection based on the model. It is available only in crane manager role. With the help of crane check, we can check number of elements that can be erected with the selected crane placed at specified locations for the assigned crane, lifting area and rigging details (such as hook weight, capacity, jib length, limit ratio, etc.). It performs checks for each configuration and thus optimum configuration can be selected which allows lifting of majority of elements. Crane model can be assigned using the components MCTM, MCCM and Tower Crane. The drawings of the appropriate configuration can be created along with lifting plan, lifting view and other lifting details. Time optimization nearly 45%-50%.

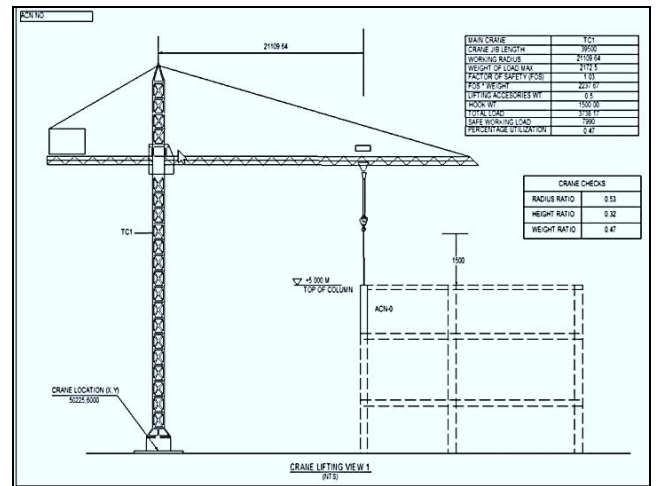


Fig -7: Crane lifting view

2.7 Stacker

Stacker is a tool which is used to plan the arrangements of elements in the trucks/ trailer. Based on the delivery dates of elements, stack plan can be obtained, and it can also be exported to pdf. For stacking planning, import the elements to stacker and give information like maximum capacity, stack model and custom model. Elements need to be arranged manually in the stacker (even in real time model of trucks) and it will notify when maximum load capacity is exceeded. Details about how many elements can be transported in a trip, number of trips required to transport elements needed for erection and other necessary information regarding transportation can be obtained. Time optimization upto 50%.

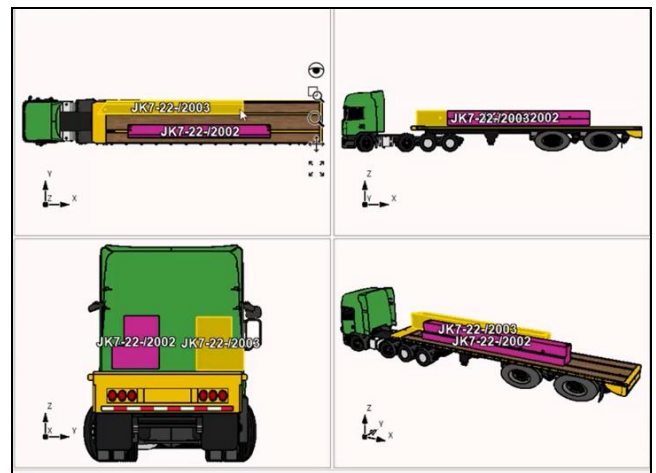


Fig -7: Stack plan for beams

2.8 Task Manager

Task manager enables the users to create and store schedules and it links the elements to the corresponding tasks. The tasks can be either created in Task manager or the

tasks can be imported from other project management tools such as Primavera P6 or MS Project. It incorporates time-sensitive data into 3D models and controls the schedule at various stages throughout the project. Time optimization nearly 80%.

Model and the related information can be exported to different formats including IFC, pdf, drawings, etc. Time optimization approximately 90%.

3. CONCLUSIONS

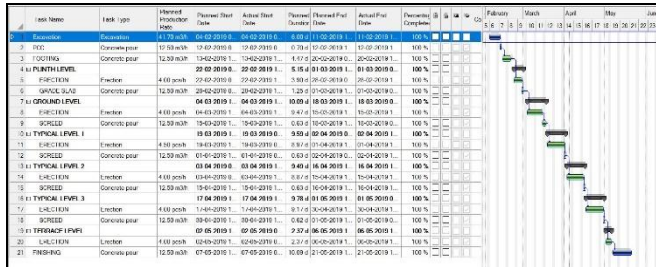


Fig -8: Schedule using Task Manager

2.9 Project Status

Progress status tool helps to visualize the progress of the project according to the production/ erection dates. By fixing the review date, we can track the progress of work on each day as well as delays in work can also be monitored easily. The review dates can be adjusted to check the progress at any span of project duration. Progress monitoring using project status with the help of object representation is shown below. Time optimization nearly 80% and helps for speedy construction.

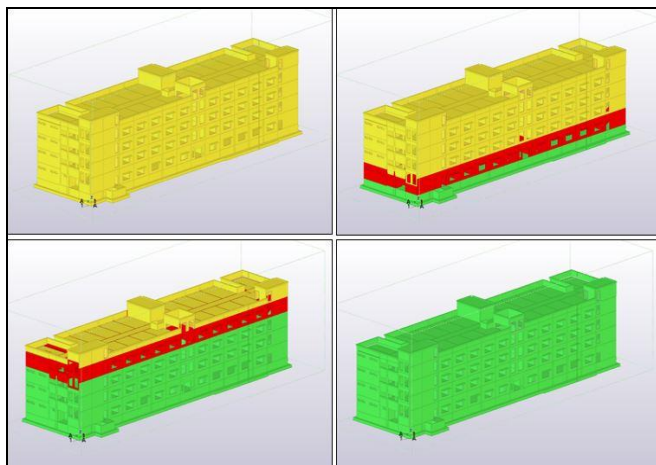


Fig -9: Progress Monitoring

2.10 Drawings

The software enables to extract the shop and form drawings from the model automatically and the production data can also be exported to other formats like BVBS, unitechnik or Elematic as well as data can be directly transferred to rebar manufacturing machinery and to different precast and rebar production management software. Cast unit drawings give a better understanding of the production of elements.

The conventional method of planning is based on the experience of planner whereas software for planning is based on the model. BIM software benefits precast construction planning especially in production planning, saves time in the planning process, preventing human errors in information transfer between detailing and production and tracking of projects. Some of the key aspects in Tekla over conventional method are:

- The planning process is dependent on the model as well as it saves time in planning.
- Progress monitoring and tracking are easy as they can be tracked with the help of the model by the collaboration of site engineers and planner.
- Model can be used for storing information and can be utilized when needed, using various tools available or by exporting to other formats.
- Trimble Connect is a cloud-based platform which enables all the stakeholders to track the progress and for discussions.
- Model-based quantity estimation, optimized pallet calculation, and stacker, crane assignment based on the model, drawings for automated production and progress monitoring and tracking are some of the features of the software.
- Optimization of time and resources is a key benefit of Tekla. Up to 85% of time optimization for planning can be obtained using Tekla for precast projects.
- In UK 25% of construction is in precast, 40-50% in North European countries, whereas in India, only 2% of construction is in precast. Hence, the awareness of technology needs more encouragement to meet the global benchmark.
- Build once, build right, build to last.

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REFERENCES

- [1] Dong Wang, Guiwen Liu, Kaijian Li, Tongjing Wang, Asheen Shrestha, Igor Martek and Xiaobo Tao (2018), "Layout Optimization Model for the Production Planning of Precast Concrete Building Components, Sustainability 2018, 10,1807; doi:10.3390/su10061807
- [2] Kuo-Chuan Shih and Shu-Shun Liu (2010), "An Optimization Model for Precast Project Planning using Group Concepts", Journal of the Operations Research Society of Japan, volume 53, No. 3, pp.189-206
- [3] S. Madhu Anand (2016), "Architectural Precast Façade Construction for High Rise Buildings- Construction Method Approach", International Journal of Research in Engineering and Technology, volume 05, special issue 20
- [4] Shreyanka S. Murai and Ashwin M. Joshi (2018), "Precast Construction Methodology in Construction Industry"
- [5] TEKLA structures for precast, User Assistance-<https://teklastructures.support.tekla.com>
- [6] An Overview of Construction of Buildings in Precast Concrete [masterbuilder-https://www.masterbuilder.co.in/an-overview-ofconstruction-of-buildings-in-precast-concrete/](https://www.masterbuilder.co.in/an-overview-ofconstruction-of-buildings-in-precast-concrete/) D. Kornack and P. Rakic, "Cell Proliferation without Neurogenesis in Adult Primate Neocortex," Science, vol. 294, Dec. 2001, pp. 2127-2130, doi:10.1126/science.1065467.

BIOGRAPHIES

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