Analysis of the Effectiveness of the Skip-Floor Method in Accelerating Construction Execution through Modeling Using Tekla Structures Software

Agnes Louisa Debora[1], Pinondang Simanjuntak[2], Candra C. Purnomo[3]
[1]*Civil Engineering Department, Faculty of Engineering, Christian University of Indonesia*
[2]*Civil Engineering Department, Faculty of Engineering, Christian University of Indonesia*
[3]*Civil Engineering Department, Faculty of Engineering, Christian University of Indonesia*

ABSTRACT: *In the implementation of construction projects, delays often occur due to various factors, including limited manpower, project complexity, and ineffective scheduling. One of the methods that can be applied to overcome these delays is the skip floormethod, which allows the construction of upper floors to continue even if the lower floors have not been completed. This research focuses on analyzing the effectiveness of the skip floormethod in accelerating the construction process of the Hospital in Juanda project. The study was conducted using several data collection techniques, including interviews, direct observations, literature studies, and structural modeling with Tekla Structures software. The results show that the application of the skip floormethod significantly improves project efficiency by reducing idle time between floors and enabling simultaneous work on non-consecutive floors. Additionally, this method supports timely project completion, minimizing potential operational losses for the project owner. The research is expected to serve as a reference for future construction projects facing similar delays.*

Keywords: *Skip-floor Method, Construction Management, Project Acceleration, Tekla Structures, Time Efficiency*

I. INTRODUCTION

In the execution of a construction project, an effective management mechanism is essential to process raw materials as inputs into a finished building. Construction management serves as a key tool to improve the effectiveness, productivity, and efficiency of each project activity. The primary parameters considered in this management process are time and cost at every project stage. Overall, construction management refers to a process that includes planning, execution, and supervision of the project from the initial stage to completion, ensuring that resources are utilized efficiently and optimally.

In practice, several factors such as technical aspects, resource availability, and environmental conditions play a significant role in determining the appropriate construction methods. However, the incorrect selection of methods still frequently occurs, often resulting in project delays. These delays can lead to increased costs, reduced work quality, and dissatisfaction among project stakeholders.

One of the construction projects facing such challenges is the development of a hospital in Juanda, Indonesia. The hospital is designed as a healthcare facility focusing on cardiovascular and vascular medicine services and is expected to manage complex medical cases. As an institution committed to innovation in healthcare services, the timely completion of this project is crucial to delivering optimal benefits to the surrounding community.

During its implementation, the hospital project experienced delays that potentially impact the completion timeline and the hospital's operational schedule. To address this issue, an effective and efficient acceleration method is required. One method that can be applied is the skip floor technique, which allows construction work on upper floors to proceed even though the

lower floors have not been fully completed. This approach reduces waiting time within the casting cycle, thereby enabling the building process to progress more efficiently.

This study aims to analyze the effectiveness of the skip floor method in accelerating the completion of the hospital construction project. By identifying the advantages and challenges of applying this method, this research is expected to provide valuable recommendations for other construction projects facing similar delays.

II. LITERATUR REVIEW

Previous studies

This research refers to several previous studies that serve as the foundation and reinforcement in analyzing the effectiveness of the skip floor method in the construction project of Hospital. Although no prior research was found with an identical title and scope, related studies provide a deeper understanding of the application of the skip floor method from various construction perspectives.

A study conducted by **Liu Jianxin, Shen Jie, and Zhu Meichun (2014)** explored the seismic performance of skip floorstaggered shear wall structures in high-rise buildings. This research focused on the structural resistance to seismic loads using a skip floor system adapted for shear walls. The study proved that the skip floor structure could be efficiently applied while maintaining earthquake resistance. Unlike this study, the present research focuses on the application of the skip floor method to beams and slabs in conventional construction as a means to accelerate project completion, without addressing seismic resistance.[1]

Additionally, research by **Kim Yong-gu and Na Woon (2013)** discussed the use of the skip floor method in combination with Semi-CFT (Concrete Filled Tube) columns. The study demonstrated that integrating the skip floor method with Semi-CFT structures not only enhances strength and stiffness but also significantly shortens the construction timeline of high-rise buildings. In contrast, the current study examines the application of the skip floormethod in conventional construction settings without utilizing Semi-CFT columns, focusing solely on its effectiveness in accelerating project timelines.[2]

Meanwhile, **Twinsy P. Modi and Atul K. Desai (2017)** investigated the wind effects on tall buildings utilizing the skip floor method through simulations using ANSYS Fluent software. Their study highlighted the importance of considering wind loads in buildings that implement the skip floor technique. However, the current research specifically focuses on time efficiency and project management aspects, without addressing structural wind load impacts.

In summary, previous studies predominantly discuss the skip floor method in terms of structural performance, seismic resistance, and wind effects. In contrast, this research emphasizes the effectiveness of the skip floor method as a construction acceleration strategy on conventional projects and analyzes its impact on project time management.

Skip-Floor Method

The Skip Floor method is an innovative construction technique commonly used in high-rise building projects, where construction activities are performed by deliberately skipping one or several floors in an alternating sequence. This method allows construction work to proceed simultaneously on multiple non-consecutive floors, thereby accelerating the overall building process. By implementing this technique, the project can significantly reduce idle time and optimize the use of manpower and materials, leading to improved construction efficiency and faster project completion.

The primary advantage of the Skip Floor method lies in its ability to minimize waiting periods between floors, which are typically required in conventional construction sequences. This technique enables continuous workflow and parallel activities that contribute to a shortened project duration, making it particularly beneficial for projects facing tight schedules or delays.[2]

Project Time Management

Project time management is defined as the process of planning, organizing, and controlling the project schedule. Time management is essential to ensure that the project can be completed on time. The time management system focuses on the successful execution of project planning and scheduling. Within this planning and scheduling framework, specific guidelines are provided to

ensure project activities can be completed more quickly and efficiently.

Project Scheduling

Project scheduling is the chronological sequence of project operations that serves as the primary guideline during project implementation. At this stage, a list of tasks must be created according to activity units that can be managed simultaneously. The purpose of breaking down the scope of activities and organizing their sequence is to improve the accuracy of project completion time estimates.

Project Delays

Construction project delays are defined as situations where the project completion time exceeds the schedule stipulated in the contract. Failure to meet the planned duration is considered a project delay, which occurs when activities along the critical path are postponed for various reasons. Such delays not only cause material and financial losses for contractors but also extend the overall project duration. Additionally, delays can damage the contractor's reputation and reduce opportunities to secure future projects.[3]

The causes of project delays can generally be grouped into four main factors: resource factors, managerial and inspection factors, planning factors, and financial factors. Contractors must be able to carefully plan and schedule the project implementation from start to finish. Ineffective management, insufficient supervision, and financial problems are often the primary causes of delays.

The impact of project delays can create a domino effect, harming not only the current project but also other related projects. According to literature analysis, these impacts include wasted time and costs, reduced work quality, contract violations, and delays in other projects.[4]

Project Acceleration

Project acceleration is an effort to complete the project faster than the initially planned schedule without compromising quality, safety, or project scope. Acceleration is typically implemented to overcome project delays, meet tight deadlines, or respond to changing stakeholder demands. Acceleration methods may include adding resources (such as labor or equipment), optimizing schedules, or applying more efficient construction techniques.

Project acceleration often involves crashing, which is the technique of adding resources to shorten the duration of critical activities. Project acceleration must be carefully planned to avoid cost overruns or reduced quality.[5]

Project Success

The success of project management, which refers to effectively managing a project from initiation to completion, is often considered a subjective concept. This is due to differing interpretations among project stakeholders regarding what constitutes a successful project. For example, project implementers often define success as the team's ability to execute the project according to the predetermined plan and objectives. A project is considered successful if it is completed on time, within scope, and within the allocated budget. Sometimes, success is viewed from a narrow perspective, such as the career achievement of the project manager. On the other hand, users or stakeholders may view success based on their level of satisfaction with the project outcome.[6]

Project success can generally be classified into three categories: execution success, outcome success, and overall project success. Ideally, an organization aims for overall project success, which satisfies all involved parties. The main challenge is achieving project objectives while acknowledging existing constraints. Project success is influenced by various factors, including organizational governance, project managers, project teams, the specific project undertaken, project management stages, external influences, and project management methodologies.

Tekla structures

Tekla Structures is a BIM-based software that assists in managing and processing construction data accurately and in detail. Tekla Structures features modeling, drawing, reporting, and scheduling capabilities that facilitate construction management activities. This software also provides structural detailing clarity, enabling the creation of comprehensive concrete models, including reinforcement.[7]

The steps involved in modeling using TeklaStructures are as follows:

a. Basic settings configuration.
b. 3D modeling.
c. 3D reinforcement detailing.
d. Clash detection and checking.
e. Final model verification.

III. METHODOLOGY

This study uses a descriptive qualitative method with a case study approach, with a focus on the construction of the Hospitalbuilding. The purpose of this study is to analyze the effectiveness of the skip-floor method in accelerating the implementation of construction. Several data collection techniques are used to support the analysis, as described below:

Discussion and Interview

Data were collected through direct interviews and discussions with key stakeholders in the project, specifically the project owner and the contractor. Semi-structured interviews were conducted to explore the background behind the adoption of the skip-floor method, on-site challenges, and its impact on project acceleration. The information obtained from these interviews served as a foundation for understanding the project's actual conditions and technical considerations.

Field Observation

Direct observations were carried out at the construction site to examine the actual implementation of structural work using the skip-floor method. Through these observations, the researcher was able to assess how the construction sequence was executed, identify field challenges, and evaluate the alignment between the planned schedule and on-site progress.

Literature Review

This research is also supported by a literature review involving books, journals, academic articles, and other relevant references related to construction management and the skip-floor method. The purpose of the literature study is to strengthen the theoretical foundation of the research and to compare the findings with those from similar projects.

Structural Modeling

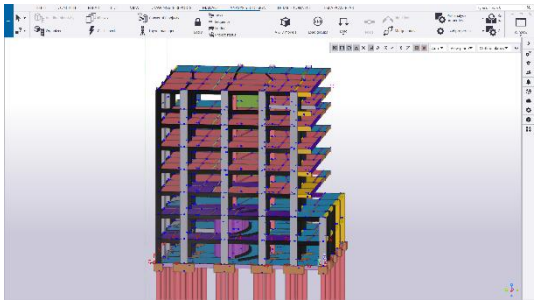
In addition to field data collection, the study incorporates structural modeling using Tekla Structures software. Technical data from the project, such as construction drawings and project schedules, were input into the software to develop a 3D structural model and a 4D schedule simulation. This modeling aims to visualize the construction sequence under the skip-floor method and to analyze its impact on the project timeline more accurately.

IV. ANALYSIS AND DISCUSSION

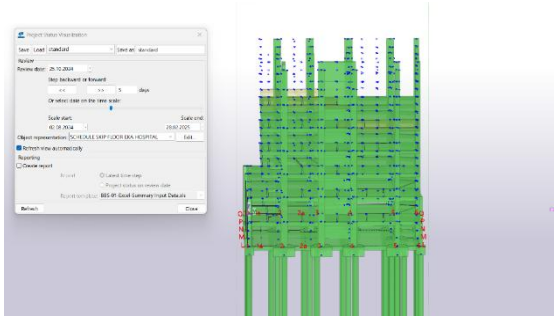
Skip-Floor Modeling Using Tekla Structures

To facilitate a better understanding of how the skip-floor method is implemented in the Hospitalbuilding construction project, structural modeling and schedule input were carried out using the Tekla Structures application. This modeling aims to visualize the sequence of beam and slab casting activities, including the skipped floors and the prioritized floors in accordance with the project acceleration plan. Through visual simulation in Tekla Structures, the relationship between floors and the impact of applying the skip-floor method on the project timeline can be presented more systematically and clearly understood by all parties involved.

The data input process in Tekla Structures begins with the detailed modeling of the building structure based on the available construction drawings. Each structural element, such as beams and slabs, is then classified according to work zones and floor sequence. Once the structural model is completed, the casting schedule prepared in the project baseline is imported into Tekla Structures using integrated scheduling data, such as files from Excel. Each stage of work is linked to its execution time, forming a 4D simulation that visually displays project progress. With this method, the skip-floor process can be analyzed more accurately to ensure the effectiveness of the project acceleration strategy.



Pictures 4.1 Modeling structures using Tekla Structures



Pictures 4.2 Project Status Visualization

Effectivity of Skip-Floor Method

The implementation of the skip-floor method in the construction of the Hospital building aimed to address delays caused by limited manpower, technical difficulties in the spiral ramp construction, and the need to prioritize acceleration in the tower section, which was designated as the main focus. This method allows construction on upper floors to proceed even if the lower floors are not yet fully completed, thereby reducing waiting time within the casting cycle.

Based on structural modeling and field analysis, the application of the skip-floor method had a positive impact on accelerating the project. With this method, structural work that was previously at risk of delay could continue in alignment with the revised schedule. The rescheduling process, supported by Tekla Structures and the Task Manager feature, enabled greater flexibility and control in execution, even with changes in the sequence of work.

In addition to time savings, the application of the skip-floor method also proved efficient in meeting the needs of the project owner. If the project were to experience prolonged delays, it would not only affect construction progress but could also postpone the planned operational schedule of the hospital. A delayed opening would result in financial losses for the owner, both from stalled investments and lost revenue potential due to postponed service availability. By accelerating the construction process through the skip-floor method, the project can be completed more quickly, ensuring that the operational timeline remains on track and minimizing the owner's financial losses.

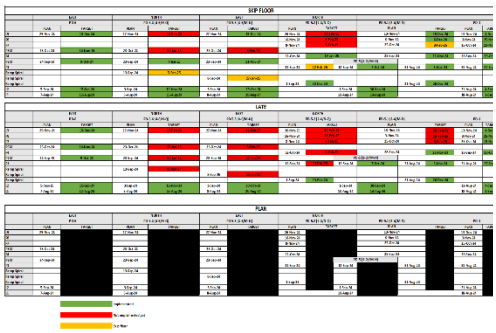
Nevertheless, the implementation of the skip-floor method requires particular attention to quality control and safety measures. Since the work is conducted out of sequence, tighter supervision is necessary to maintain construction quality and to minimize the risk of workplace accidents. With effective field management supported by the Task Manager system, these challenges can be addressed efficiently.

Overall, the skip-floor method has proven to be an effective and efficient solution in theHospital project—not only in accelerating project execution but also in reducing the risk of financial loss for the owner due to operational delays. The experience of implementing the skip-floor method in this project is expected to serve as a reference for similar construction projects facing structural work delays.

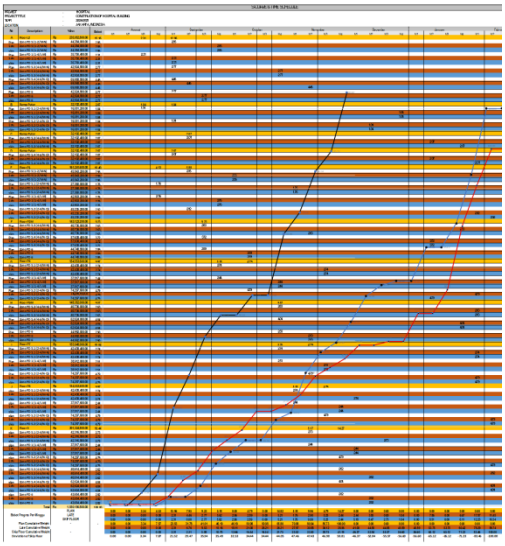
Following the application of the skip-floor method, a significant change was observed in the project's S-curve graph. Before the method was applied, the graph indicated slow work progress and weekly achievements that failed to align with the expectations set in the original plan. This condition illustrated that the construction activities were encountering substantial delays, posing a risk to the overall project completion timeline if no corrective action was taken.

However, after the skip-floor method was implemented and the work schedule was revised to reflect actual site conditions, the S-curve began to show a more positive trend. Construction progress improved week by week, as reflected in the increasing volume of completed work that approached the planned targets. The previously flat

curve began to take on a steeper shape, indicating accelerated work performance. This demonstrates that the skip-floor method effectively enhanced the pace of project completion, which had previously fallen behind. The shift in the curve also highlights the positive impact of adjusting the execution method, allowing the project to close the gap with its targeted completion timeline



Pictures 4.3 Project Scheduling



Pictures 4.4S-Curve Project

V. CONCLUSION

Based on the results of the research and analysis conducted on the Hospitalbuilding construction project, the following conclusions can be drawn:

1. By applying the skip-floor method, the work cycle in the project is no longer bound by the conventional floor sequence, where typically upper floors must wait for the completion of lower floors. The implementation of the skip-floor method breaks this waiting pattern, allowing work to be carried out in parallel on the higher floors without significant obstacles. This provides considerable time savings and enables more flexible execution in resource management. By eliminating the waiting time between floors, the project can maximize the productivity of labor and heavy equipment, which might otherwise be idle due to delays on lower floors. This advantage is one of the main reasons why the skip-floor method is considered effective for multi-story projects that require acceleration.

2. After applying this method, the project's S-curve graph shows significant progress acceleration compared to the previous condition. The project's S-curve, which previously indicated slow and stagnant progress, began to show a sharp increase after the skip-floor method was implemented. The graph, which initially illustrated project delays, began to move closer to the revised project schedule. This change is concrete evidence that the application of the skip-floor method successfully improved the project's progress rate. The S-curve, which increasingly aligns with the target schedule, indicates that the weekly work volume has increased, enabling the project's progress to catch up with the plan. Therefore, the implementation of this method is effective in addressing pending and unfinished work that was not completed according to the planned schedule and significantly improves the speed of construction execution in the field.

3. With the acceleration provided by the skip-floor method, the hospital's operational schedule can still proceed as planned, thereby minimizing the potential financial losses due to delays. The acceleration resulting from the skip-floor method not only positively impacts project progress but also directly benefits the interests of the project owner. The

hospital's pre-planned operational schedule can continue on time, preventing delays in opening hospital services to the public. If the project experiences prolonged delays, the potential financial losses for the owner will increase, whether from delayed operational revenue, additional overhead costs, or lost business opportunities. Therefore, the acceleration achieved through the skip-floor method becomes a crucial factor in reducing these financial impacts and ensuring that the project continues to deliver maximum benefit to the owner.

4. Utilizing the Tekla Structures application can help simplify the understanding of the skip-floor method implementation process and support rescheduling, work control, and real-time, visual progress monitoring. The use of Tekla Structures in this project provides significant benefits in visualizing the detailed and systematic process of applying the skip-floor method. With accurate modeling that is integrated with the project schedule, the entire project team can more easily understand the work sequence, skipped floors, and the interconnection between construction activities. Moreover, Tekla Structures allows quick work rescheduling and adjustment to actual field conditions. Work control becomes more effective because project progress can be monitored in real-time through visually displayed 4D simulations. With the integrated Task Manager feature, this system also facilitates task distribution, work allocation, and resource management in a more structured manner. The use of Tekla Structures in this project has proven to support the understanding of how project acceleration is achieved using the skip-floor method in theHospitalbuilding construction project.

REFERENCES

[1] J. X. Liu, H. N. Wang, P. Li, and M. C. Zhu, "Experiment study and nonlinear analysis of a new skip-floor staggered shear wall structure for high-rise buildings," in *Applied Mechanics and Materials*, 2013, pp. 131–137. doi: 10.4028/www.scientific.net/AMM.351-352.131.

[2] K. Yong-gu and N. Woon, "대한민국특허청(KR) (12) 공개특허공보(A)," 2013.

[3] D. M. Wirabakti, R. Abdullah, and A. Maddeppungeng, "STUDI FAKTOR-FAKTOR PENYEBAB KETERLAMBATAN PROYEK KONSTRUKSI BANGUNAN GEDUNG."

[4] R. P. Agritama, M. Huda, and T. S. Rini, "FAKTOR – FAKTOR YANG MEMPENGARUHI KETERLAMBATAN PROYEK KONSTRUKSI DI SURABAYA," *axial :jurnalrekayasa dan manajemenkonstruksi*, vol. 6, no. 1, 2018, doi: 10.30742/axial.v6i1.472.

[5] C. Reynaldi and A. Sutandi, "ANALISIS PERCEPATAN PROYEK MENGGUNAKAN METODE TIME COST TRADE OFF - STUDI KASUS APARTEMEN COLLINS BOULEVARD," *JMTS: Jurnal Mitra Teknik Sipil*, 2022, doi: 10.24912/jmts.v5i2.16450.

[6] A. P. Pratama, "FAKTOR-FAKTOR YANG BERPENGARUH TERHADAP KEBERHASILAN PROYEK PEMBANGUNAN UNDERPASS BULAK KAPAL," *SistemInfrastruktur Teknik Sipil (SIMTEKS)*, vol. 3, no. 1, 2023, doi: 10.32897/simteks.v3i1.2603.

[7] G. A. Diputra, A. A. Wiranata, and A. Kharisma, "Perbandingan Bill of Quantity (BOQ) Antara DokumenKontrakDengan Hasil Perhitungan Tekla Structures (Studi Kasus: Proyek Gedung Mall Di Pulau Jawa)," *JurnalSpektran*, vol. 11, no. 1, 2023.