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ANALYSIS OF THE INSTALLATION METHOD OF HALF SLAB PRECAST ON KARANG SINGA BEACON TOWER BUILDING

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ABSTRACT

Innovation in construction methods is increasingly needed, especially in projects in extreme geographical conditions. This study analyzes the effectiveness of the precast half slab installation method in the Liang Liang Coral Beacon Tower Construction project in the Riau Islands, which is located ±4 nautical miles from Bintan Island, so that it does not allow the application of conventional casting. The half slab precast method was chosen to overcome the limitations of the working area, weather risks, and the need to accelerate construction time. The analysis was carried out through the stages of half slab design planning, fabrication, material distribution using a service barge, to the erection process using a crawler crane. The technical data of the half slab includes the configuration of HS1, HS2, and HS3 with a thickness of 200 mm and a concrete topping of 150 mm. The results of the analysis showed that the precast half slab met the technical requirements based on SNI 2847:2013 and the PCI Design Handbook, both in terms of lifting load capacity, bending moment control, and deformation during installation. The installation method has also proven to be efficient in terms of time and cost because it minimizes the use of formwork, reduces the risk of wet work at sea, and accelerates the implementation of erections. This study concludes that the half slab precast method is an effective and efficient solution for floor structure work in offshore projects, especially in locations with limited access and challenging environmental conditions.

Keywords: half slab, precast concrete, Beacon tower

INTRODUCTION

The construction industry is currently experiencing rapid development in line with increasing demands on the effectiveness, efficiency, and quality of building products. Various innovations in project implementation methods continue to emerge, ranging from conventional methods such as cast-in-situ to modern technologies such as precast concrete that offer better quality control and faster processing time (Suryanto, 2018; Hadi & Cahyono, 2021).

Conventional casting methods are still widely used in various projects due to their flexibility. However, this method has several obstacles such as the need for large labor, the use of large quantities of formwork, dependence on weather conditions, and longer processing time (Afandi, 2004). In addition, the quality of concrete surfaces is greatly influenced by the skills of field workers so it is not always consistent.

In contrast, precast concrete systems offer significant advantages because their production processes are carried out in a more controlled factory environment. Precast products have more stable quality, are not affected by the weather, and have gone through laboratory testing before being sent to the project site. These advantages make precast methods, including half slab precast, the right choice for projects with difficult mobilization or extreme geographical conditions (Dwiatmoko et al., 2021; Fathurohman & Firmanto, 2020).

The Karang Singa Beacon Tower Construction Project in the Riau Islands is one example of a project that faces complex geographical challenges. It is located in the waters ±4 nautical miles north of Bintan Island, on a coral cluster in the waters of the Singapore Strait. The location conditions are far from the mainland and the lack of adequate work areas make conventional casting methods ineffective in the field. In addition, safety factors and the potential for weather disturbances further increase the risk of cast in situ work.

Considering these conditions, the use of **the half slab precast** method is a more appropriate alternative solution. This method combines the bottom precast plate with an on-site cast concrete topping, thus still providing high quality while allowing for faster work and reduced risk of installation failure at marine sites. The use of half slab precast in this project must also be analyzed in terms of time effectiveness and cost efficiency to ensure that this method delivers optimal results in challenging geographical conditions.

Based on this background, this study was conducted to analyze the effectiveness of the precast half slab installation method in the Liang Coral Beacon Tower project, especially related to the installation process, equipment needs, work safety, and time and cost efficiency in offshore projects.

LITERATURE REVIEW

Floor Plates

Floor plates are an important structural element of horizontal structures in construction, serving to withstand loads and distribute them evenly. The floor plate should be designed to be of an appropriate thickness to withstand fixed loads such as occupants, furniture, and its own weight. Design criteria include consistent rigidity, flatness, and height. Dynamic loads such as earthquakes and winds are not usually taken into account in thickness planning

The floor plate also serves as a horizontal diaphragm or structural stiffener, playing a role in supporting the rigidity of the portal beam. Floor plates are divided into two types: one-way and two-way. One-way plates are only supported on two opposite sides with a length ratio of more than twice the width, while two-way plates are supported on all sides with a ratio of less than two. This study discusses conventional plate construction methods and precast half slabs, emphasizing differences in structural approaches and their effectiveness.

Precast Concrete

Precast concrete (precast concrete) is concrete that is molded off-site to a predetermined size, allowing for cost reduction and accelerated execution time.

Half Slab Precast

Half slab precast is a floor slab system that combines precast concrete with cast concrete on site. The lower part is composed of precast concrete, while the upper part is filled with cast concrete in situ. This method overcomes construction challenges such as heavy transportation loads and difficulties in connecting repeats between plates (Nugroho, 2016).

Although many planners adopt a precast half slab of a monolith system, its application to two-way slabs can raise concerns regarding potential strength degradation and the risk of cracking. Plate panel sizes exceeding 35 m² with a length and width ratio of less than 1/2 or above 2 (SNI-2847-2013, article 13.6.1.2) usually require the division of half slab components taking into account the available lifting equipment capacity.

Job Productivity

Productivity in construction is measured as the ratio of output to resource input. This reflects work efficiency, where high productivity means work is done more effectively, contributing to better scheduling.

Factors that affect productivity include:

1. Education
2. Health
3. Work environment

4. Weather
5. Managerial factors
6. Equipment used

Productivity can be analyzed through field observation or literature studies to obtain coefficient values from references.

Heavy Equipment Used

The use of heavy equipment plays an important role in the efficiency of project execution, even though precast elements are produced in factories. Selecting the right machine can improve cost and time efficiency.

The heavy equipment used includes:

1. Service Barge

A service barge is a vessel designed to transport goods in waters, especially in areas that are difficult to reach by large ships or land. They facilitate the transportation of construction materials in locations that are not easily accessible by land. These barges have a large payload capacity and are often used in construction projects in the waters.

2. Crawler Crane

Crawler cranes are a type of crane that moves with steel tracks, allowing movement in difficult terrain. These cranes are used for large projects that require high lifting capacity. They offer great stability and lifting ability, even on soft or muddy terrain.

3. Tug Boat

Tug boats are used to pull barges or rafts carrying construction materials. The advantages of tug boats include strong traction, maneuverability, and the ability to operate in a variety of weather conditions. Tug boats improve the efficiency and safety of construction material transportation.

Thus, the selection of the right heavy equipment is key in increasing the productivity and efficiency of construction projects.

RESEARCH METHODS

Desain Half Slab Precast

The design of a precast half slab is designed with several factors in mind, especially during the lifting and stacking process. Based on the PCI Design Handbook 7th Edition, the lifting is planned using four lifting points to withstand the self-load of the precast plate. The maximum moment that occurs during lifting is:

+Mx = -Mx = 0.0107 wa2b
+My = -My = 00107 wab2

During lifting, several factors must be considered, including the need for lifting reinforcement.
The lifting reinforcement requirement can be calculated by the formula:

$$\rho = \frac{1}{m}(1 - \sqrt{1 - \frac{2mxRn}{Fy}}$$

According to SNI 2847:2013 Article 10.5.1, the lifting reinforcement must meet the minimum conditions that have been set.

Method of Half Slab Precast Implementation

The process of implementing half slab precast involves several stages, namely:

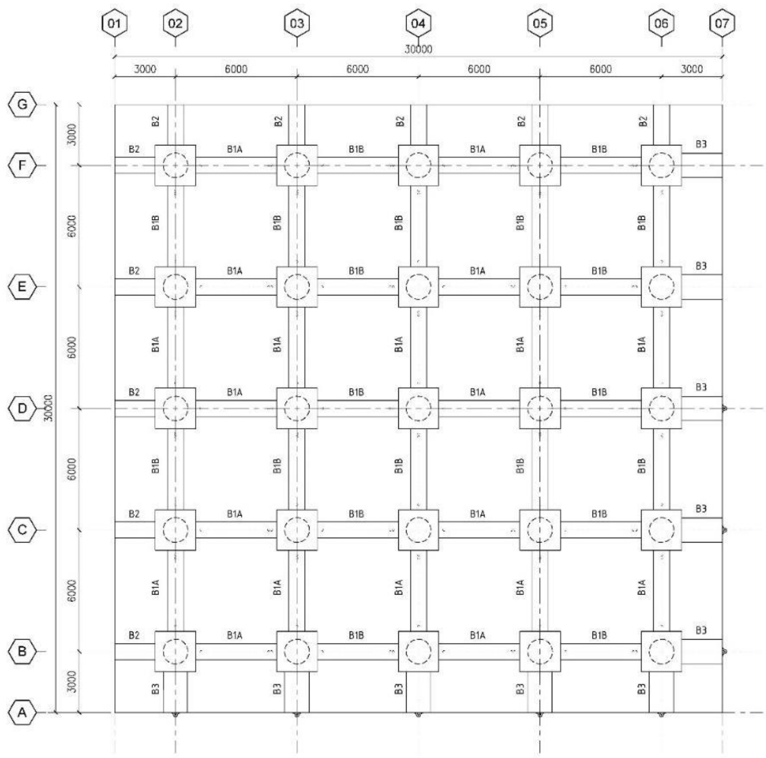
1. Calculation of Half Slab Precast Design: The design of the precast half slab is designed in accordance with SNI 2847:2013 and PCI 7th Edition. Control of the existing beams is carried out to ensure compatibility with the new design.
2. Precast Slab Order: Due to land constraints at the project site, precast slabs are ordered from suppliers that match the design calculations.
3. Precast Slab Fabrication: Fabrication is done in the factory to ensure quality and conformity with design specifications.

4. Delivery of Precast Slabs to Project Sites: Precast slabs are shipped using trucks. The supplier conducts a survey of transportation routes to ensure safety during transportation. During the conveying and lowering process, the position of the precast plate must correspond to the pre-planned lifting point to prevent cracking or damage. Tower cranes are used to unload plates at the project site.
5. Precast Slab Stacking at Project Site: The stacking process requires a large amount of land. The number and height of the pile are controlled to ensure stability and safety.
6. Precast Slab Installation: After the casting of the beams, columns, and scaffolding installation is complete, the precast plates are installed using a tower crane.
7. Precast Inter-Slab Splicing: The connection between precast plates is done with wet splicing. The reinforcement provided is an extension of the reinforcement of the precast element and is joined with concrete or grouting. The quality of the grouting concrete must be at least the same as the casting concrete to ensure the strength of the joints.

DATA ANALYST AND DISCUSSION

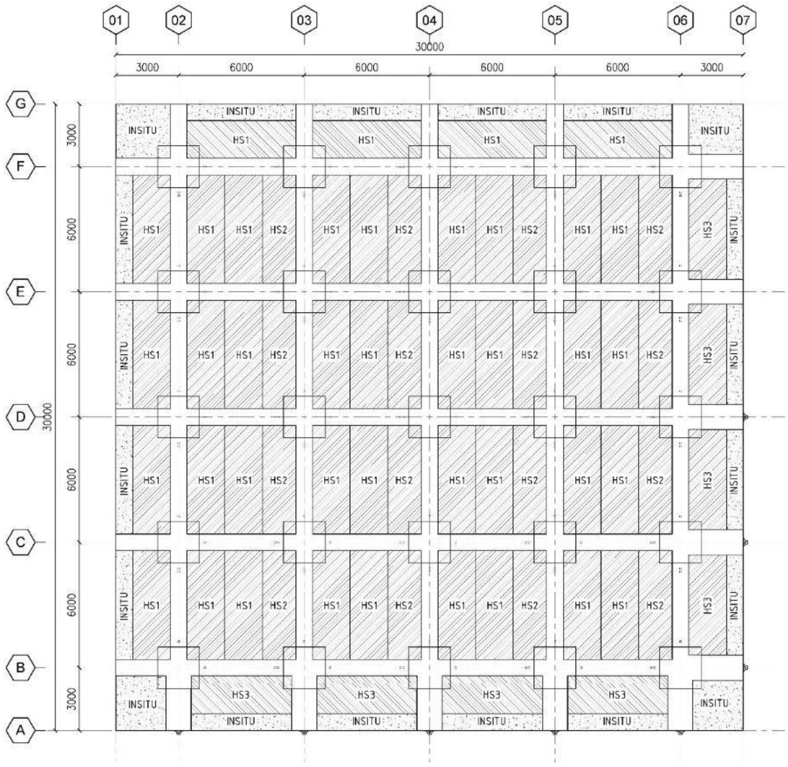
Data Collection

From the results of data collection, the width of the platform can be obtained, which is 30x30 meters (m), with the design and configuration of the lower structure as follows:



Half Slab Design

The design of precast plates is carried out to determine the dimensions of efficient precast plates by adjusting the bottom structure that has been designed, with the results of the illustration of dimension planning as follows:



HS1 = HALF SLAB 1800x5200x200mm
HS2 = HALF SLAB 1600X5200 x200mm
HS3 = HALF SLAB 1800X4800 x200mm

Precast Plate Analysis

Precast plate analysis was carried out to determine the dimensions of the precast plate that are safe to accept the calculated load capacity and the rebate diameter, with the results of the analysis as follows:

4.3.1 Data Half Slab

Table 1

NO	TYPE	DIMENSION	SUM
1	HS1	1800x5200x200mm	40
2	HS2	1600X5200 x200mm	16
3	HS3	1800X4800 x200mm	8

Table 2

Tipe Half-Slab		**HS 180.520**	
Structural Materials			Mpa
Compressive strength of concrete,	fc' =	41	Mpa
Quality concrete age 3 days (when lifting)	fci' =	20.91	Mpa
Quality concrete age 10 days (before overtopping)	fci' =	32.8	Mpa
Steel melting stress (deform for bending reinforcement,	fy =	420	Mpa
Steel (plain) melting stress for sliding reinforcement,	fy =	240	
Dimensions of Precast Plates			
Plate width,	Ix =	1800	
Panjang half-slab,	Y =	5200	
Precast plate height,	h1 =	200	
Tinggi over topping,	h2 =	150	
The height of the plate after composite,	htot =	350	
The diameter of the reinforcement (deform) in the direction Iy used,	db =	19	
The diameter of the reinforcement (deform) of the Ix direction used,	db =	19	
Thick net concrete blanket,	ts =	100	

mmmmmmmmmmmm

Mm

4.4.

Installation Method of Half Slab Precast

The precast half slab installation method involves several stages and techniques to ensure proper and safe installation. Here is the order in which the installation work was performed:

a. Precast Installation Job Sequence

- **Material Mobilization:** Before the erection of the beam, the mobilization of precast beam material is carried out using *a service barge*. Materials are placed in a predetermined development area.
- **Erection Approval:** Precast installation must obtain approval from a supervisory consultant. The consultant must ensure that the quality of the concrete is up to standard and the installation point is correct according to the plan drawing.

- **Precast Headstock Installation:** Prior to the installation of the precast beam, the precast headstock is installed in a pre-defined area. Installation follows the block code listed in the plan drawing.
- **Precast Beam Mounting:** After the precast headstock is installed, the precast beam installation is carried out with the help of *a boring barge*. The beams are adjusted to the existing plan drawings.
- **Floor Plate Installation:** After the precast beam is installed, the precast floor plate and *in-situ floor plate* are installed using a crane barge. Steel interlock wire is used to ensure that the plate does not move during the erection process.
- **Erection Plate:** The plate is lifted to the installation location as per the drawing of the plan. This process is done carefully to prevent position shifts.
- **Formwork and Casting:** After the installation of the precast beams, the formwork is installed for the platform casting stage. Casting is carried out at the project site with the help of *a concrete mixer* and *concrete bucket.*

b. Distribution of Precast Half Slab Plates

- **Marking and Delivery:** Half slab precast is marked with a code as per placement in the field. After that, the plates are ready to be delivered to the project site.
- **Distribution:** The distribution of the precast half slab is carried out with *a 120 ft service barge*. During shipping, care is needed to prevent deformation or damage. Plates that have been deflected or damaged must be replaced.
-

c. Installation of Precast Half Slab Plates

- **Lifting to Structure:** Half slab precast is lifted onto the structure by using *a crawler crane*. After reaching the structure, the panels are directly placed as per the drawing design.
- **Adjustment:** After being placed on the beam, the precast half slab is adjusted so that the placement matches the drawing design.
- **Overtopping Casting:** Once all the binding irons are installed, the final stage is overtopping casting along the already installed area.

By following this installation method, it is hoped that the construction of precast half slab can be carried out efficiently and meet the set quality standards.

CONCLUSION

1. The use of the half slab precast method in the Liang Coral Beacon Tower project is the right technical decision considering the location conditions are in the waters ±4 nautical miles from Bintan Island, so conventional casting work cannot be carried out safely and effectively.
2. The half slab design consisting of HS1, HS2, and HS3 types has met the capacity requirements based on SNI 2847:2013 and the PCI Design Handbook. Load control, bending moment, and slab deformation indicate that the panels are safe during fabrication, transport, and installation.
3. The fabrication process in the factory provides a more controlled quality of concrete and minimizes the risk of damage due to marine weather. Distribution using service barges and installation with crawler cranes proved to be effective for project terrain conditions.
4. The precast half slab installation method provides increased time and cost efficiency compared to the in situ cast method. Field work becomes faster, the use of formwork is significantly reduced, and the risk of casting failure can be minimized.
5. Overall, half slab precast is able to meet the aspects of safety, structural quality, and implementation effectiveness. This method is highly recommended for offshore construction projects or regions with limited land access and harsh environmental conditions.

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