Implementation of Reinforced Concrete Floor Beams and Plates in a 5-Storey Hospital Building Construction Project

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Abstract. Hospitals are health care institutions that provide a full range of individual health services and provide inpatient, outpatient and emergency services. The comprehensive health services referred to in this case include promotive, preventive, curative and rehabilitative.[1] The construction of the new building at PKU Muhammadiyah Blora Hospital will be the center of the physiotherapy clinic, pharmaceutical satellite, commercial area, drop off, ICU, inpatient, office. The existence of the new building is a step to improve the quality of health services for patients. The new hospital building is located to the east of the main building in the PKU Muhammadiyah Blora Hospital complex. The work observed is the work of beams and reinforced concrete floor slabs. This work has several steps of workmanship. The work on the beams and floor slabs must complete the reinforcement and formwork simultaneously first, then the casting can be done.

Keywords: beam, floor slab, reinforced concrete, hospital

1. Introduction

Hospitals are health care institutions that provide a full range of individual health services and provide inpatient, outpatient and emergency services. The comprehensive health services referred to in this case include promotive, preventive, curative and rehabilitative. [1] PKU Muhammadiyah Blora Hospital has had its first building with a capacity of 86 beds, located on the Blora - Cepu national road precisely on Jalan Raya Blora - Cepu Km. 3 Jepon - Blora, making it easy to reach. PKU Muhammadiyah Blora Hospital is owned by Muhammadiyah Foundation represented by Muhammadiyah Blora Branch. Currently, PKU Muhammadiyah Blora Hospital is carrying out the construction of a 5-story building. The construction of the new 5-story building at PKU Muhammadiyah Blora Hospital is a strategic step to improve the quality and capacity of health services. With more complete and modern facilities, the hospital is expected to provide faster, more effective, and more comfortable services for the people of Blora. In addition, the construction of this new building also shows the commitment of PKU Muhammadiyah Hospital in supporting government programs to improve the health status of the community.

Construction is an order or arrangement of the elements of a building where each part is positioned according to its function. Because of this, good project management is needed in order to

achieve a good construction project as well. Infrastructure development carried out by a city in addition to aiming to improve the welfare of the community also has the potential as an alternative to national economic, environmental and social recovery. Infrastructure development is one of the government's efforts to accommodate the needs of citizens in Indonesia.[2]

2. Methods

2.1 Beam

a. Preparation
   Beam preparation work is the initial stage in beam work to ensure that all elements required for the work are ready to be done.
b. Scaffolding Installation
   The installation of scaffolding in beam work is an important stage in reinforced concrete construction. Scaffolding serves as a temporary structure that supports beam formwork, reinforcement, and workers during the casting process.
c. Bodeman Installation
   Bodeman installation is the step of installing the beam formwork foundation which is carried out before reinforcement. Bodeman serves to adjust the elevation and plate to facilitate reinforcement and formwork construction later.
d. Beam Reinforcement
   The process of forming and reinforcing beams in this project is to cut and bend the reinforcement.
e. Beam Formwork Installation
   Formwork is an important role holder in a structural work because it will determine the shape and strength of reinforced concrete.

2.2 Floor Plates

a. Preparation
   Floor slab preparation is an important stage in reinforced concrete construction. Careful preparation will ensure the quality and strength of the resulting floor slab.
b. Scaffolding Installation
   The installation of scaffolding for floor slab work is an important stage in reinforced concrete construction. Scaffolding serves as a temporary structure that supports the formwork (mold) of the floor slab, reinforcement, and workers during the casting process.
c. Floor plate formwork installation
   Installation of floor slab formwork is an important stage in reinforced concrete construction. Formwork serves as a temporary mold to form the floor slab according to the planned design.
d. Floor Plate Reinforcement
   The floor slab reinforcement process is carried out in accordance with the planned working drawings, related to the distance and size of the reinforcement.

After these two jobs are completed, continue with the following jobs simultaneously:

a. Concreting Beams and Floor Plates
   Concreting the floor plates and beams is carried out after ensuring that the reinforcement and formwork are installed firmly, stably, and in accordance with the planned dimensions. Before casting, a slump test is carried out to ensure that the concrete used meets the required technical and quality standards and to make test samples for testing the strength of the concrete. The quality of concrete used in casting is K-300 concrete. Reinforced concrete materials shall comply with the requirements set forth in the SNI. [3][4][5]
b. Concrete Treatment (Curing)
   Treatment of concrete or curing is carried out after the concrete reaches final setting or the concrete has hardened.
c. Dismantling of Scaffolding
   The dismantling of scaffolding for floor slabs and beams is the stage of releasing the scaffolding task from holding the floor slab load which must be done carefully to ensure that the concrete

structure remains intact and undamaged.

d. Formwork Demolition

The removal of floor slab and beam formwork is the final stage in reinforced concrete construction of beams and floor slabs that must be done carefully to prevent damage to the concrete.

3. Result and Discussion

3.1. Project Data

PKU Muhammadiyah Blora Hospital Construction Project, has the following project technical data:

a. Project Name : Construction of 5 (Five) Floor Building of PKU Muhammadiyah Blora Hospital
b. Project Location : Jalan Raya Jepon, Palkembar, Seso, Kec. Jepon, Blora Regency, Central Java.
c. Project Owner : PKU Muhammadiyah Blora Hospital
d. Implementing Contractor : PKU Muhammadiyah Blora Hospital (SWAKELOLA)
e. Number of Floors : 5 Floors
f. Concrete Quality : K-300

3.2. Execution Of Floor Beam and Slab Works

The implementation of construction, especially in the work of beams and floor slabs that have been observed during the work carried out on the upper structure of the 5-storey hospital building, has several stages as follows:

a. Beam
   a) Preparation
   b) Scaffolding Installation
   c) Bodeman Installation
   d) Beam Reinforcement
   e) Formwork Installation
b. Floor Plates
   a) Preparation
   b) Scaffolding Installation
   c) Formwork Installation
   d) Floor Plate Reinforcement

After these two jobs are completed, the following jobs are continued simultaneously:

1) Casting of Floor Beams and Plates
2) Concrete Curing
3) Dismantling of Scaffolding
4) Formwork Dismantling

Beam

a. Preparation

Beam preparation work is the initial stage in beam work to ensure that all elements required in the work are ready to be done. Here are the steps in beam preparation work:

a) Understanding Working Drawings

At the initial stage, the technical team understands the working drawings so that the technical team can provide clear and detailed directions to the implementation team in the field. The main objective is to ensure that everyone understands the design, technical specifications, and construction details that must be followed according to the specified working drawings.Idetifikasi Kebutuhan Material

b) The beam specifications used in the project are:

Concrete quality	: K300
Quality of main reinforcement (Fy)	: 420 MPa
Quality of stirrup reinforcement (Fy)	: 280 MPa
Thickness of concrete blanket	: 2.5 cm

Reinforcement : D22 screw iron, D10 plain iron

The materials needed in this work are D22 threaded iron, D10 plain iron, bendrat wire, 8mm thick plywood, wooden blocks, 2.5cm thick decking concrete and scaffolding.

b. Scaffolding Installation

The installation of scaffolding in beam work is an important stage in reinforced concrete construction. Scaffolding serves as a temporary structure that supports beam formwork, reinforcement, and workers during the casting process. The following are general steps in installing scaffolding for beam work:

a) Determine the type of scaffolding that matches the load and dimensions of the beam.
b) Draw a detailed scaffolding installation plan.
c) Make sure the area under the scaffolding is level, strong, and free of obstructions.

c. Bodeman Installation

Bodeman installation is the step of installing the beam formwork foundation which is carried out before reinforcement. Bodeman serves to adjust the elevation and plate so as to facilitate reinforcement and formwork construction later.

a) Preparation:
- Make sure the scaffolding that will support the formwork is installed firmly and stably.
- Prepare bodeman material, which is in the form of wood or strong boards.
- Prepare tools such as nails, hammer, waterpass, and meter.

b) Installation of Supports:
- Install the vertical supports that will support the bodeman.
- Set the height of the support according to the planned beam elevation according to the working drawings.

c) Bodeman Installation:
- Place the bodeman on the support.
- Make sure the bodeman is level and straight using a waterpass.
- Tie the bodeman firmly to the support using nails or clamps.

d) Tember Installation:

Install buckets on the left and right sides of the bodeman, which serve to keep the bodeman from shifting.

e) Inspection:

Recheck the installation of the bodeman to ensure that everything is installed correctly and firmly. Ensure that the dimensions and elevation of the bodeman are in accordance with the plan drawings.

d. Beam Reinforcement

The beam reinforcement process is carried out in several steps, namely:

a) Planning: Determining the number, size, and type of reinforcement required based on structural calculations.
b) Cutting and Bending: Cutting and bending the reinforcement according to the planned shape and size.
c) Installation of Main Reinforcement: Installing longitudinal reinforcement at the bottom and top of the beam.
d) Installation of stirrups: Installing stirrups with the appropriate spacing according to the structural calculations.
e) Tying: Tying the main reinforcement and stirrups using bendrat wire.
f) Inspection: Rechecking the reinforcement installation to ensure it is in accordance with the working drawings.

Beam reinforcement is carried out using main reinforcement, namely D22 screw iron and stirrup reinforcement using D10 iron with a distance between stirrups in accordance with the specifications specified in the working drawings, namely 100 mm in the pedestal (1/2L) and

150 mm in the field (2/4L). Tying the reinforcement connection (overstek) along a minimum of 88 mm or 4D, and tying each meeting between the main reinforcement and stirrups using bendrat wire, ensuring that the bond is strong and not easily separated.

e. Formwork Installation

Prior to the installation of the beam formwork, decking concrete was installed first. Decking concrete serves to maintain the distance between steel reinforcement and formwork, so that a concrete blanket is formed that protects the reinforcement from corrosion and ensures the strength of the beam structure. The decking concrete used in the beam work in this project is 2.5cm thick. The formwork materials used were 8mm thick plywood and wooden beams. After installing scaffolding, bodeman and reinforcement, formwork installation is carried out by :

a) Install the beam side formwork, using 8mm thick plywood.
b) Ensure the side formwork is tight and strong.
c) Providing additional reinforcement using wooden blocks.
d) Rechecking the formwork installation to ensure everything is installed correctly and firmly.
e) Ensuring the dimensions and elevations of the formwork are in accordance with the specified working drawings.
f) Ensuring there are no gaps in the formwork that could cause concrete leakage.

Floor Plates

a. Preparation

Floor slab preparation is an important stage in reinforced concrete construction. Careful preparation will ensure the quality and strength of the resulting floor slab. The following are the steps to prepare the floor slab work:

a) Understanding Working Drawings

At the initial stage, the technical team understands the working drawings so that the technical team can provide clear and detailed directions to the implementation team in the field. The main objective is to ensure that everyone understands the design, technical specifications, and construction details that must be followed according to the specified working drawings.

b) Identification of Material Requirements

The materials used in the floor slab work are D22 usir reinforcing iron, D10 plain iron, decking concrete, 8mm thick plywood, wooden beams, scaffolding. In addition, the main reinforcement and stirrups are needed which have been cut and bent according to size.

b. Scaffolding Installation

The installation of scaffolding for floor slab work is an important stage in reinforced concrete construction. Scaffolding serves as a temporary structure that supports the formwork (mold) of the floor slab, reinforcement, and workers during the casting process.

a) Installation is carried out with the following steps:
b) Determine the type of scaffolding size that matches the load and dimensions of the floor slab.
c) Make a detailed scaffolding installation plan drawing, including the distance between support poles, horizontal beams, and foundation boards.
d) Ensure the area under the scaffolding is level, strong, and free of obstructions.
e) Rechecking all parts of the scaffolding to ensure the installation is correct and strong.
f) Ensure there are no loose parts or potential accidents.

c. Formwork Installation

Installation of floor slab formwork is an important stage in reinforced concrete construction. Formwork serves as a temporary mold to form the floor slab according to the planned design. The following are general steps in the installation of floor slab formwork:

a) Ensure that the floor slab working drawings are complete and in accordance with the structural design and check the details of the slab dimensions, elevations, and reinforcement.
b) Prepare formwork materials such as plywood with a thickness of 8mm, wood, beams, and

nails and make sure the formwork materials are in good condition and strong.
c) Prepare tools such as saws, hammers, waterpasses, meters, and angle gauges.
d) Install wooden blocks on the scaffolding as the main support for the formwork.
e) Make sure the wooden beam is flat and strong.
f) Set the distance between the beams according to the thickness of the plywood and the concrete load.
g) Install the plywood sheets on top of the previously prepared wooden blocks and make sure the plywood is tight and flat.
h) Use nails to fasten the plywood to the wooden blocks.
i) Recheck the formwork dimensions to ensure they are in accordance with the working drawings.
j) Ensure that the floor slab thickness of 13 cm is met according to the specified working drawings.
k) Check the stability of the formwork and scaffolding, make sure there are no loose or potentially collapsed parts.
l) Finally, check if there are any gaps in the formwork that could cause concrete leakage until it is confirmed that everything is safe for the process.

d. Floor Plate Reinforcement

The process of reinforcing the floor slab for a 13cm thick plate is carried out in accordance with the working drawings, namely using D10 size reinforcement which will be arranged in 2 layers of distance with a crossed position. To provide distance between layers, chicken feet or commonly called chicken claws with a height of 6 cm are used. Decking concrete is also used, to maintain the distance between reinforcement and formwork. The thickness of the decking concrete used in this project is 2.5cm. The following are the detailed steps for the implementation of floor slab reinforcement:

a) Determine the number, size, and type of reinforcement required based on the structural working drawings.
b) Cut and bend the reinforcement according to the planned shape and size.
c) Installing reinforcement in accordance with the pattern and distance specified in the working drawings, in this project a distance of 20cm is used with a crossing or zig-zag pattern between the first and second layer of reinforcement.
d) Installing reinforcing bars (chicken feet / chicken claws) on top of the main reinforcement with a distance of 6cm.
e) Tying the main reinforcement and reinforcement using bendrat wire so that it does not shift when casting concrete.
f) Installing 2.5cm thick decking concrete with a distance of 1m between decking concrete to maintain the distance between the reinforcement and formwork, so that a concrete blanket is formed that protects the reinforcement from corrosion.
g) Recheck the reinforcement installation to ensure it is in accordance with the working drawings and technical specifications.

After these two works are completed, the following works are continued simultaneously:

Casting Beams and Floor Plates

The casting of floor plates and beams is carried out after ensuring that the reinforcement and formwork are installed firmly, stable, and in accordance with the planned dimensions. The quality of concrete used in casting is K-300 concrete. This casting slump test meets the specified requirements of ±10. The planned thickness of the floor slab is 13cm.

The required castings are required:

- On the 2nd floor a concrete volume of 195$m^3$is required with a tolerance of 5%.
- On floors 3-5 it takes as much as 190$m^3$with a tolerance of 5%.
- Casting is done using ready mix with a ready mix volume of 3m^3 and 7m^3.

For time and work efficiency, a concrete pump is used. Concrete pump or concrete

pump is a very important tool in the construction of multi-storey buildings. This tool is used to move liquid concrete from the mixer truck to hard-to-reach casting locations, such as the top floor of the building. With the help of a concrete pump, it is possible to cast concrete quickly and efficiently, saving time and labor. Concrete pumps with booms (arms) can reach high casting sites that are difficult to access manually. In addition, vibrators are also used to remove air voids and increase density, vibrators help concrete achieve optimal compressive strength. The following is the floor slab casting process :

a. Casting Preparation:
    a) Make sure the formwork is strong, stable, and according to dimensions.
    b) Check the reinforcement, concrete decking and chicken legs are installed according to the working drawings (distance, size, bond).
    c) Prepare concrete pump, vibrator, and other auxiliary tools.
    d) Clean the casting area, and prepare access used during casting.
    e) Perform a slump test to measure the consistency of the concrete whether it is in accordance with the specified requirements.
    f) Make concrete samples for compressive strength test.
b. Casting Process of Floor Plates and Beams
    a) A concrete plant, also known as a batch plant or batching plant or a concrete batching plant, is equipment that combines various ingredients to form concrete.
    b) Pour the concrete evenly, starting from hard-to-reach areas or corners.
    c) Use a vibrator to remove air voids, compacting evenly.
    d) Use a leveling rod to level the concrete surface according to elevation.
    e) Perform finishing if required.
    f) Make castings without long pauses to avoid cold joints.

Concrete Treatment (Curing)

Curing is done after the concrete reaches final setting or the concrete has hardened. The purpose of this concrete treatment is so that the hydration process does not experience problems, for example cracks occur due to evaporation of water too quickly. Concrete curing can be done by watering using a water hose, the method is to wet the surface of the column using a roll evenly.

Curing of this concrete can be done for approximately 7 consecutive days, twice a day or according to the weather. If the weather is very hot, curing is done more than usual. This is done with the aim of inhibiting water evaporation and helping to maintain moisture in the concrete. A concrete plant, also known as a batch plant or batching plant or a concrete batching plant, is equipment that combines various ingredients to form concrete.

Scaffolding dismantling

The dismantling of scaffolding for floor slabs and beams is the stage of releasing the scaffolding task from holding the floor slab load which must be done carefully to ensure that the concrete structure remains intact and undamaged. The dismantling of scaffolding is usually done after the age of the concrete reaches 21-28 days for floor slabs and beams, ensuring that the concrete has reached sufficient strength to support its own weight. Dismantling starts from the top of the scaffolding and gradually works its way down. This helps reduce the risk of damage to the concrete structure. After that, the surrounding area is cleaned of any remaining scaffolding material that may be left behind.

Formwork Dismantling

The removal of floor slab and beam formwork is the final stage in the reinforced concrete construction of beams and floor slabs that must be done carefully to prevent damage to the concrete. The following is what needs to be considered:

a. The timing of formwork removal is highly dependent on the concrete strength that has been achieved.

b. The strength of the concrete can be tested by conducting a compressive strength test on concrete samples made during casting.
c. The applicable standards and regulations will specify the minimum strength that must be achieved before the formwork can be removed.
d. In this project, floor slab and beam formwork is usually removed after the concrete has aged 21-28 days.
e. However, this time may change depending on weather conditions, and loads acting on the structure.
f. In certain conditions, the dismantling can be done sooner or longer, but provided that the concrete strength has met the requirements.

The following is the formwork dismantling process:

a. Before removal, conduct a visual inspection of the concrete surface to ensure there are no cracks or damage.
b. Check if the concrete is hard enough and not easily damaged.
c. Prepare the necessary tools, such as rubber hammers, crowbars, and other tools.
d. Make sure the tools are in good condition and safe to use.
e. Make sure the area under the formwork is free from people and goods.
f. Prepare temporary supports if needed to maintain structural stability after the formwork is removed.
g. Use appropriate Personal Protective Equipment (PPE), such as helmets, safety shoes, and gloves.
h. Remove all fastenings such as nails or bolts in the formwork before attempting to lift it.
i. Use a crowbar to pry the bottom of the formwork loose from the concrete.
j. After the formwork is successfully removed, check the concrete surface thoroughly. If cracks or damage are found, make repairs immediately. Then clean the remnants of the formwork that stick to the concrete and tidy up the formwork again in the place provided.

4. Conclusions

Based on the implementation of field work practice activities for 2 months, the author gained a lot of experience and knowledge from these work practices, some conclusions are as follows:

a. Observations made in the field practicum, namely the structural work of beams and floor slabs in a PKU Muhammadiyah hospital building located in Blora, Central Java, which starts from preparation to dismantling the formwork.
b. The concrete used is concrete with a quality of K-300 kg/cm2.
c. In addition, it is important to note that there are many different types of concrete that can be used in the construction of a concrete batching plant, including stationary concrete batching plants and mobile concrete batching plants.
d. The equipment used is adequate and complete so that the work carried out can run well.
e. The work system carried out for each job is good enough so that it can optimize the work deadline in the project.
f. Errors and also problems made by workers can hinder a smooth development in the project.
g. The implementation of the project in the field is quite good, because those who are obliged to carry out and supervise a job are always at the location, so that the quality and quantity of work completion is in accordance with what was previously planned.

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