Changes in the implementation of concrete in situ work method to a precast method

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Abstract. Sulfur Jetty Development Project and TUKS Oil and Gas Dredging Project The Balikpapan RDMP RU V Project is located in Balikpapan City, East Kalimantan. In this project there are 2 (two) main work scopes, namely sulfur jetty work and dredging work. Like other projects, an engineering review of the design drawings, work volumes, work methods, and work schedules is also carried out. The purpose of this engineering review is to evaluate whether the change in the method of implementation of concrete works in Situ to Precast can maximize the work in accordance with the concepts of quality, time and cost. For this reason the submission of the amendment to PERTAMINA was accompanied by several technical reasons that affected the work. For the method change, a number of processes were carried out such as the submission of design changes, changes in work methods, the process of calculating the structure and several other matters related to the quality of the structure due to changes in the method of implementation. From the results of the calculation of the structure has adjusted to the needs in accordance with the initial plan, by changing the installation method but still maintaining the strength of the structure in accordance with the initial plan. With this Precast method, the construction process is relatively safer and measurable in terms of cost and time.

Keywords: work methods, precast, in-situ, jetty.

1. Introduction

Sulfur Jetty Development Project and TUKS Oil and Gas Dredging Project The Balikpapan RDMP RU V Project is located in Balikpapan City, East Kalimantan. This project began on April 24, 2019 with a work plan completed on July 15, 2020 with a maintenance period until July 14, 2021. In this project there are 2 (two) main work scopes, namely: 1. Sulfur jetty work (consisting of preparatory work, jetty construction work, additional structural work, mooring dolphin work, tower conveyor foundation work, foundation work for demolition of existing jetty and navigation aids) and, 2. Dredging work (consisting of preparatory work and dredging work).

Similar to others projects, an engineering review of the design drawings, work volumes, work methods and a work schedule performed [1]. This engineering review is carried out to ensure that the design drawings, volume of work, work methods and work schedules are in accordance with the conditions in the field. In addition, an engineering review can be carried out to maximize the work
methods so that the project objectives in this case cost, quality, time can be achieved properly. When conducting an engineering review, it was found that the concrete pier structure works found conditions requires changes in the method of implementation from the initial plan in situ to precast [2,3].

Based on the explanation above and the problems above, the objectives and benefits of this study are as follows:

1. the reliability of the initial design at the time of the tender with the actual conditions
2. Does the change in the method of implementation that will be carried out from the in situ casting method to precast, needs an engineering review to ensure changes in the work methods to be carried out can maximize the work in accordance with quality, time and cost?

The purpose of this engineering review is to evaluate whether changing the method of implementation on in situ concrete work into precast can maximize work in accordance with the concepts of quality, time and cost.

2. Engineering Review

After the project is obtained then the project team conducts an engineering review of all design drawings, implementation methods and others. Engineering review is carried out to ensure tender documents are in accordance with conditions on the ground and if any discrepancies are found, changes can be made immediately and consulted with PERTAMINA. In this case, there are conditions that need to be adjusted where at the time of the tender the in-situ casting method is adjusted to the precast casting method. This was done because from the results of the engineering review it was found that conditions in the field were not appropriate if the in-situ casting method was still applied [5,6,7]. For this reason, the proposed amendment to PERTAMINA was accompanied by several technical reasons that affected the work. For the method change, several processes are carried out, such as the submission of design changes, changes in work methods, the structure calculation process and several other things. Some points to consider when reviewing engineering are as follows:

1. Bill of Quantity (BoQ), tender drawings and methods of the Guidebook and Project Implementation (BP3)
2. Existing Conditions
3. Submission of design changes and implementation methods

2.1. BoQ, Tender Drawings and Methods of the Guidebook and Project Implementation (BP3)

BoQ and tender drawings still use the in situ casting method so that the Budget Plan (RAB) and the calculation of the Implementation Budget (RAP) use the in situ concrete casting method. The work items at the time of the tender were still in the form of cast in situ work, there were formwork and cleaning work [8] & [9]. Thus, the initial assumption when bidding for the calculation of this work is the cast in situ work. The working method of casting pier work in initial planning refers to contract data, BoQ and initial drawings, namely in situ concrete, which is done manually [10] & [11]. Starting from the installation of support and beam girders by using WF steel section that is welded to the pile, installation of the suri-tiled and tiled from formwork. The method of working with in situ casting, starting from the installation of welded WF iron to steel pipe piles, girder manufacturing, installation of suri, cleaning and then casting with a concrete pump.

Observing and seeing the conditions in the field of method changes are needed so that quality control and time can still be done. Accompanied by several technical reasons which are more feasible to be carried out with this method. These considerations still consider quality, time and cost. The reason for submitting changes to the work method is because casting with the cast in situ method with a bottom beam elevation of +3.3 will experience difficulties. Especially in terms of Human, Safety and Environment (HSE) with the following data:

| Description                        | Value |
|------------------------------------|-------|
| Top of Concrete Elevation          | +3.3 m from the LWS |
| HWS elevation at the highest tide  | +3.27 m |
| Elevation of formwork suri= 3.30 - 0.20 | +3.10 m |
| WF scaffolding bottom elevation (WF 150)= 3.10 - 0.15 | +2.95 m |
From this condition, the scaffolding and beams will often be submerged in seawater at high tide and it can last for several hours every day according to the existing tidal conditions. On the other hand Pertaminaworks with HSE requirements in the highrisk category. Working in the depths of sea water using diving equipment causes the production capacity produced is very small. It is also necessary to meet other work requirements in the form of submission of Job Safety Analysis (JSA) and permits for work in water. Control of work time cannot be measured because the installation of scaffolding and formwork can only be done at low tide, and the time is also limited. This condition certainly affects the completion time of the work. Production costs increase due to small production capacity, especially in terms of wages and tools. Not to mention considering the potential fines if there is a delay.

2.2. Existing Conditions

![Figure 1. Existing Conditions](image)

Submission of design changes and the method of implementation will be carried out for a number of technical reasons that support by conducting several reviews, including:

2.2.1. Submission of design changes
Submission of a precast image is submitted in the form of a shop drawing together with the calculation of the precast structure of the jetty. This shop drawing has been adjusted to the size and shape of the structural calculations. After making the shop drawing, the Building Information Modelling (BIM) modelling is done. The headstock will be installed after the steel pipe is erected at the location as planned. The installation of the headstock is done by lifting gear (crane barge) that has received approval and calculation of the lifting gear.

2.2.2. Precast structure calculation
Calculations are carried out to ensure the feasibility of these changes and are subsequently submitted to Pertamina as the project owner.

2.2.3. Submission of conveyance and lifting methods
A lifting plan document must be submitted to obtain a work permit related to lifting equipment and conveyances. This document contains the procedures, methods and data needed for the lifting and
transporting process. This lifting plan document consists of a flow chart, scope, tools and materials, labor, precast placement layout, lifting plan, and work procedures and methods. For the calculation of conveyance and lifting equipment, a calculation is done by looking at the bar chart (load chart) so that the safety (safety) of the appointment process is still maintained. The risk of a crane can be detected from the start, the size of the crane needed to lift the existing precast concrete will be known. This calculation is a standard calculation on oil and gas projects.

3. Stages of Engineering

The contractor's obligation to complete the work on time, quality and costs cannot be avoided because it is a contractual obligation. In the process of fulfilling contractual obligations so that the project can run according to the contract, the Sulfur Jetty Development Project and TUKS Migas Oil and Dredging Works, Pertamina Balikpapan, need an engineering review. For this reason, the methodology needed to be implemented and carried out in accordance with the specifications and rules set out in Pertamina projects is formulated. So that from the experience that can be made flowchart or the steps of the process of engineering review.

The methodology in the engineering review process must be in accordance with the rules of technical calculation with standards that refer to SNI, ACI or BS, as standard calculations in civil engineering and as a national reference standard in Indonesia.

4. Case Description

After the project is obtained then the project team conducts an engineering review of all design drawings, implementation methods and others. Engineering review is carried out to ensure tender documents are in accordance with conditions on the ground and if any discrepancies are found, changes can be made immediately and consulted with Pertamina. In this case there are conditions that need to be adjusted where at the time of the tender the in situ casting method is adjusted to the precast casting method. This was done because from the results of the engineering review it was found that conditions in the field were not appropriate if the in situ casting method was still carried out. For this reason, the proposed amendment to PERTAMINA was accompanied by several technical reasons that affected the work. For the method change, several processes are carried out, such as the submission of design changes, changes in work methods, the structure calculation process and several other things.

4.1. Bill of Quantity

BoQ (Bill of Quantity) is a list of work items to be carried out on a project. During the tender period, the BoQ used was concrete structure work using the in situ casting method. Based on the BoQ tender it can be concluded that at the time of the tender the design that had been used as a design with an in situ casting method. Then after an engineering review, it was found several things that would be an obstacle if the in situ casting method was still carried out related to some existing rules in the oil and gas sector project. These rules refer to the regulations regarding HSE which must be met as a safety and safety standard for work and production processes.

Table 1 Tender’s BOQ

| No. | Work Package                                      | Unit  | Volume       |
|-----|--------------------------------------------------|-------|--------------|
| 1   | Refining of concrete pole 3.5 m                  | kg    | 73030.18     |
| 2   | HDPE pole protection                             | m³    | 1642.97      |
| 3   | Coating 3 layer of polyethylene 2.5 mm (pile φ 1016) | m'    | 7148.35      |

| Pier Work                                      | Unit  | Volume       |
|------------------------------------------------|-------|--------------|
| 1     | Single pier (2000 x 2000 x 1000)                | m³    | 324.00       |
| 2     | Refining single pier (2000 x 2000 x 1000)       | kg    | 61800.18     |
| 3     | Framework installation (2000 x 2000 x          | m²    | 972.00       |


4.2. Tender Drawings
In each process of calculating costs and making methods at the time of tender, existing documents will always be a reference. The tender documents will be mutually binding and must be examined one by one so that the calculation of the costs becomes more optimal and competitive. Included in this case is the tender drawing (drawing), the tender team can study the existing drawings both in terms of size, shape and material that we will use on the project. The image is very influential for the tender team to be able to get the calculations that will be offered at the time of the tender. From the picture obtained as a tender document, the tender team can calculate, among others, the coefficient of the material to be used, the effective implementation method, and the use of equipment that is efficient and appropriate. From the existing tender images combined with field conditions.

![Figure 2 Tender’s Drawings](image)

4.3. *The method of work is in accordance with the tender documents*
Work methods of structural work are prepared using flow charts as follows:
5. Case Analysis

With the initial design and BoQ as stated in the contract, and concrete work is quite difficult to do under these conditions, it is necessary to make changes to the method. The submission of the design and implementation changes will be carried out with several supporting technical reasons.

5.1. Approval of design changes and BIM

Submission of a precast image is submitted in the form of a shop drawing together with the calculation of the precast structure of the jetty. Filing documents are adjusted to the size and shape of the structural calculations. Next is BIM modelling. One example of beam modelling is the headstock and plank fender. In this modelling we can see the shape and size of the precast that we will do very accurately. It also obtained weight from the precast unit. Its usefulness can later be used as a reference in calculating material requirements and the implementation process in the field, such as lift and transport permits at the time of fabrication, delivery and at the time of installation. The permit document is submitted every time you start work. Work will be terminated if the document requirements are incomplete.

Due to the change from in situ to precast for the upper structure of the jetty, the calculation and review of the existing design needs to be done. Calculations are carried out with third parties in this case structural experts from UNIBA who are competent and able to carry out structural calculations. After that the calculation is submitted to Pertamina as the project owner. The calculation document received a review from Pertamina and was approved.
5.2. Submission of lifting and conveying methods  
To get a work permit related to lifting equipment and conveyance, a lifting plan document must be submitted containing the procedures and methods as well as the data needed for the lifting and transport process. This Work Method is submitted as technical completeness of the work in the field by PT. AdhiKarya (Persero) Tbk, in commencing implementation of work, particularly in the Precast Handling Material Work Area of the Sulphur Jetty Development Project and the Oil and Gas TUKS Dredging Work of the RU V - Balikpapan RDMP project. The purpose of making this implementation method as a reference for the implementation of precast material handling work in the field in order to get results and quality that is appropriate. In this method of implementation the fieldwork system is listed which will be used from the beginning of the activity to completion.
5.3. Methods of Execution of Upper Structure Work

This method of implementation was proposed as technical completeness of the work in the field by PT. AdhiKarya (Persero) Tbk, in starting a work implementation, especially in structural work on sulphur jetty, southern dolphin mooring, north mooring, jetty extension and tower conveyor area Sulphur Jetty Development Project and Oil and Gas TUKS Dredging Work RU V - Balikpapan RDMP project. The implementation method includes a field work system that will be used starting from the beginning of the activity to completion, which consists of site management to work quality control and related elements during the work, so that what is being targeted and the plans that have been set can be implemented properly.

There are several things that need to be considered when starting the implementation of this precast installation work. Externally the thing that must be prepared is to inspect the equipment (in this case the lifting gear or lifting gear used), the submission of precast work methods that have been adjusted to the design size and structure calculations and the submission of JSA to detect and identify possible
risks that will occur on this work. Internally is the preparation of wage needs, tools and materials
needed for the implementation of work in the field, mobilization of lifting gear equipment needed for
the execution of work and preparation of locations and stockyards for installation work. Some
documents that must be prepared are shop drawing precast, calculation of the structure of the sulphur
jetty. The implementation of work in the field can be explained as follows:

![Precast Flow Chart](image)

6. Quality Evaluation
In accordance with the specified specifications, if the work is done by casting in situ the quality of
cement is set at $f'c = 33$ Mpa (K-400) whereas if using the precast method, the required concrete
quality is $f'c = 41$ Mpa (K-500). In the structure calculation document, the calculation is carried out in
accordance with the requirements of concrete quality of $f'c = 41$ MPa. So the quality of the concrete
quality increases due to changes in work methods.
7. Time Evaluation
From the evaluation results of the project implementation time, the effect of the change in casting in situ to precast has accelerated for 56 days. This time evaluation is done by comparing the initial schedule of in situ casting work to precast. Changes in this method have a significant impact on time because the procurement of precast concrete can be done at the beginning of the work together with the erection work. Risks to the addition of execution time can also occur if you continue to use in situ casting methods related to production capacity which is affected by tidal conditions.

8. Cost Evaluation
From the results of evaluating the cost of project implementation, the influence of the change in casting in situ to precast obtained a reduction in production costs on this work item by Rp. 840,498,297.31. This cost evaluation is done by comparing the implementation costs between in situ casting works (Rp. 24,020,892,448.07) to precast (Rp. 23,180,394,150.31) related to the use of tools, materials and labor combinations. For the record, the composer did not compare the effects of general field costs directly given the large scope of work other than casting work.

9. Conclusions and Recommendations
Based on the results of research that has been done can be concluded the initial design at the time of the tender was not entirely in accordance with the conditions on the ground so an engineering review was needed so that this work could be carried out properly. Engineering review in the case of changing the method of implementation from the in situ casting method to precast it is necessary to maximize the work in accordance with quality, time and cost. In the Sulphur Jetty Development Project and the TUKS Oil and Gas Dredging Project of the RU V Balikpapan RDMP Project, in concrete quality, based on the specifications, there was an increase in quality from the original f’c = 33 Mpa (K-400) to f’c = 41 Mpa (K-500). When there is an acceleration of 56 days to complete the work and the cost is obtained a reduction in production costs on this work item by Rp. 840,498,297.3.

There are several recommendations for further research, as follows:
1. Every change in work method should always be accompanied by an evaluation of quality, time and cost as a basis for decision making.
2. Good administrative requirements are needed for submitting changes to work methods.
3. Each service provider should make technical standards for each method of implementation, so that in planning and implementation can get a good and efficient method.

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