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# Design Process of Lifting Crane Capacity of 300 Kilogram at PT. Pelabuhan Indonesia

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## ABSTRACT

*Indonesia has long coastal line surrounding the country, so it becomes a maritime country. Due to this situation, the country was endowed to numerous trading via sea by utilizing numerous harbors. In harbors, there were several activities specifically about heavy equipment lifting and loading. To uplift the heavy equipment, it is necessary to develop such tools which capable to result the lifting force. Lifting crane which extensively used for heavy equipment lifting is designed to tackle that problem. The design process of lifting crane involves several efforts of planning, design process, and numerical simulation. The planning step used initial and conceptual criteria based on references. Afterwards, the design process was developed by using computer aided design of Solidworks. The numerical simulation was carried out by using ANSYS R2 2020. The design process of lifting crane has successfully done which present a comprehensive framework to model the lifting crane of capacity 300 kilograms. The resulted design of lifting crane also meets with the safety requirement for heavy equipment lifting and loading. Therefore, the result of this research would facilitate PT. Pelabuhan Indonesia to improve the lifting crane tool with high safety and robust loading capacity.*

***Key Words:*** Lifting Crane, Design Process, Capacity 300 Kilogram

## 1. INTRODUCTION

Indonesia, well-known as maritime country, has a profound history of sailing and trading through sea using vessels viz. boat and ship. Based on that aspect, the trading activity through sea remains until nowadays and plays vital role of Indonesia's economy. To handle the trading activity, it is clearly needed numerous harbors to load and pack things, containers, and so on [1]. One of the foremost harbor organizers in Indonesia is PT. Pelabuhan Indonesia which rules several harbors in each area of Indonesia. In general, many activities have evolved in harbors such as container loading and packing which utilized lifting crane. This tool functioned to transship maintenance tool, gearbox oil, and other things to the RTGC (Rubber Tyred Gantry Crane). Due to the specific structure of lifting crane, it is necessary to design a lifting crane to hoist many things in harbor [2].

Lifting crane, also extensively known as mobile crane, is used generally for heavy lifting equipment in construction and harbors. It also becomes a safety factor during lifting and loading activity of things and containers. Lack of planning and development of good lifting crane is one of primary causes of crane-related accidents and malfunctions [3]. Moreover, it is a big challenge for engineers to design complete lifting crane with good requirements such as crane model, length, and intended load for crane operations. These parameters are very pivotal to create robust lifting crane which can lifting and moving the heavy equipment smoothly and safely [4].

At present, lifting crane in PT. Pelabuhan Indonesia still need to develop to assist every activity related loading and packing things in harbors. In this view of this situation, in this paper, the design process of lifting crane with load capacity of 300 kilogram is proposed. The design process involves several attempts in planning, design, and numerical simulation of the lifting crane. The result lifting crane design which functions by transmission and another parts is highly compelled to solve technical problem of heavy equipment movement in PT. Pelabuhan Indonesia.

## 2. EXPERIMENTAL METHOD

The experimental method in this research is utilize the design process to study lifting crane tool. The design process involves several steps such as planning, design process, and numerical simulation. The design process of this research is clearly depicted in Figure 1.

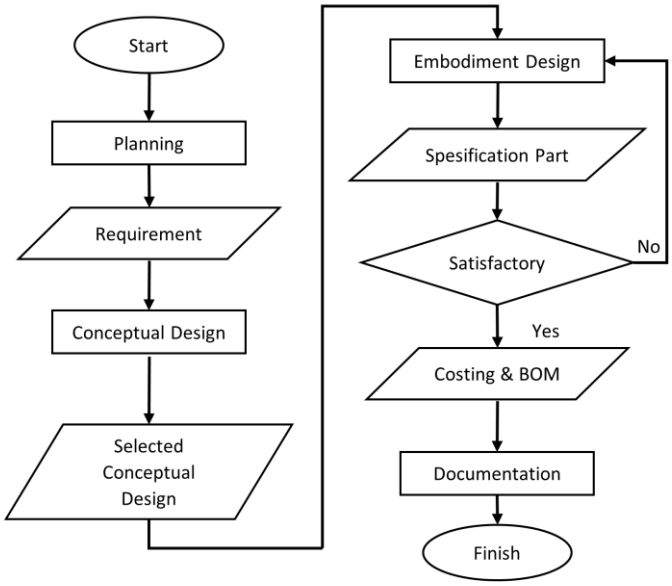


**Figure 1. Flow Chart Diagram of Design Process**

### 2.1. Initial and Conceptual Planning

In the initial planning, there were several attempts to conduct primary and secondary study for obtaining data and information about the idea of lifting crane design. Besides, the initial planning also involves the step of lifting crane sketch which ascribed from references. Moreover, conceptual planning caters to the lifting crane design, specifically about main and supplements functions. The material components selection is also carried out based on standard in references.

### 2.2. Details of Design

The details of design consist of calculation, ergonomic parameter, and other analysis of lifting crane. The detail of design is acquired from several attempts of modelling and simulation to obtain the specific data design of lifting crane. Computer aided engineering application (Solidworks) has been utilized to undergo this detail of design processing.

### 2.3. Numerical Simulation

The numerical simulation is carried out to assess the load capacity of lifting crane using mockup simulation from the design. The process involves ANSYS R2 2020 by using static structural method.

## 3. RESULTS AND DISCUSSION

### 3.1. Conceptual Design

The conceptual design results include the lifting crane specification of main, supplements, and morphology functions. It is depend to the necessity of lifting crane for uplift and down lift heavy equipment of maintenance tool, gearbox oil, and another supported things which is very pivotal in RTGC (Rubber Tyred Gantry Crane)[5, 6]. The conceptual design of lifting crane is depicted in Figure 2.

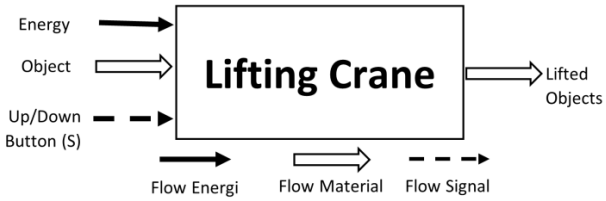


**Figure 2. Conceptual Design of Lifting Crane Function**

Meanwhile, the part functional diagram is shown in Figure 3. The design of lifting crane consists of several parts which have their own function. It is useful for circling the direction of boom to make sure of the position of equipment[7]. Furthermore, the part of lifting crane also capable to uplift the equipment smoothly and safely.



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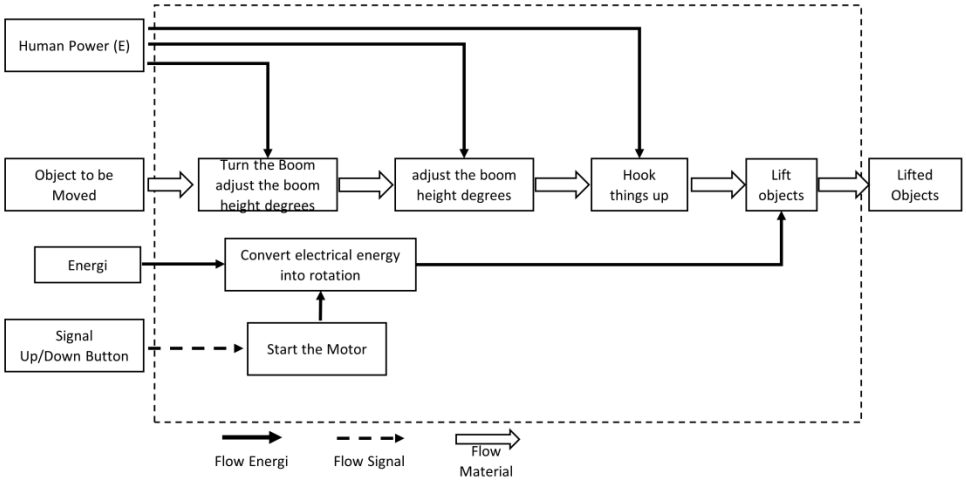


**Figure 3. Part Functional Diagram**

### 3.2. Lifting Crane Design

The process of lifting crane design contained the design result images which were drawn by using three-dimensional modeling method of Solid works. Numerous steps have been taken consist of creating each component until assembling process of lifting crane drawings[8, 9]. The isometric vision of lifting crane is clearly depicted in Figure 4.

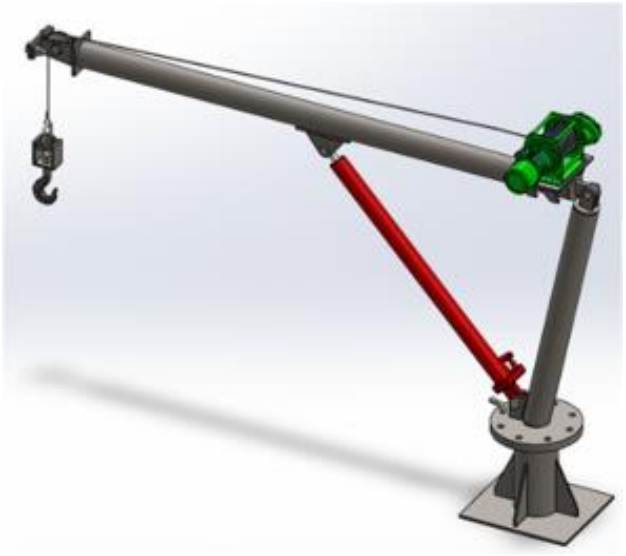

**Figure 4. Three-dimensional Model of Lifting Crane**

The lifting crane has the main specification as shown in Table 1.

**Table 1. Specification of Lifting Crane**

| No | Parameter | Specification |
|---|---|---|
| 1 | Capacity | 300 - 500 Kg |
| 2 | Material | Mild Steel ASTM A36 and Stainless Steel SS400 |
| 3 | Maximum Length | 2 meters |
| 4 | Maximum Height | $45^{o}$ |
| 5 | Motor Power | 1,6 kW |
| 6 | Lifting Velocity | 7,85 m/min |
| 7 | Motor Type | 3 Phase |
| 8 | Number of Motor | 1 piece |
| 9 | Wire Rope Type | 6x19 + IWRC Single; L= 30 meters |
| 10 | Weight | 5 Ton |



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### 3.3. Numerical Simulation

The assembly process of lifting crane part has been calculated by using static structural method which utilized freedom parameter and portrayed in Figure 5.

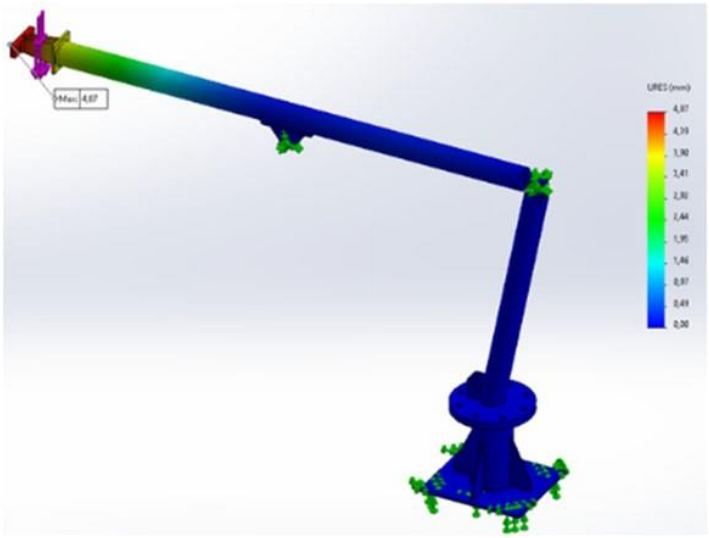

**Figure 5. Numerical Analysis Model of Lifting Crane**

The numerical analysis results showed that von-mises stress is about 158 MPa. It also happens the concentration of stress inside circular tube plates which installed on hydraulic actuator pillar[10]. The stress is normally accepted due to limitation standard of permission stress. The concentration stress barely happened due to sparse mesh adjustment. The normal stress is about 91 MPa. Apparently, the deformation also happened about 4,87 millimeters in the end-part of pulley and shaft assembly[11, 12]. This deformation still exists at the minimum value of permission deformation. From this numerical simulation, it resulted that the design structure of lifting crane has passed the safety criteria and will be useful to heavy equipment lifting.

## 4. CONCLUSION

The design process of lifting crane with a capacity of 300 kilogram has been successfully done by the final results of documentation in the 3D modeling forms, working drawings and final specifications of the equipment. This lifting crane will be installed on a Rubber Tire Gantry Crane (RTGC) trolley using the welding method. The design of the lifting crane has been adapted to the needs and current conditions in the field, so it is hoped that this tool can assist in the RTGC maintenance process. A lifting crane with an electric motor driving power can carry a load of 300 kg in a relatively fast and safe manner. Therefore, this lifting crane design will be implemented in PT. Pelabuhan Indonesia to make the heavy lifting equipment movement more safely.

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