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A HIERARCHICAL SIMULATION MODEL FOR WORKLOAD ANALYSIS OF SHIP BLOCK ERECTION PROCESS

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ABSTRACT

In shipbuilding, large blocks are erected and welded in a dry dock to form a ship. Due to limited number of docks, which is major facility constraint in a shipyard, block erection process is typically considered as the bottleneck of the whole shipbuilding process. A complex erection network plan should be established for block erection which indicates the erection orders as well as the schedule of each erection event. Besides, each erection event consists of several sub-processes, which leads to high dependency of block erection on erection network. In this research, a hierarchical simulation model is suggested to precisely predict the workload of block erection considering the workload of each sub-processes included. By applying proposed model in erection network simulation, more accurate workload of block erection could be calculated.

1 INTRODUCTION

Generally, shipbuilding process is divided into several major processes such as steel cutting, assembly, painting, outfitting and block erection. Among them, typically, block erection process is considered as the bottleneck process due to limited number of docks, which is major facility constraint in a shipyard (Lim et al., 2016). During the block erection process, pre-erected massive blocks which have been arranged near the launching place-typically a dry dock, are lifted to the dry dock and welded to other blocks (Tokola et al., 2013). Since the block erection process is the bottleneck of the whole shipbuilding, the production plan before block erection process is scheduled backward based on start date of block erection. In order to conduct block erection, an erection network plan should be established. Erection network is a complex network that shows the erection orders as well as the schedule of erection events considering their geometrical position and constraints. In order to improve the quality of the erection network plan, workload of erection process should be calculated accurately and the workload of sub-processes should be considered as well. Therefore, in this research, a hierarchical simulation model is proposed to predict the workload of block erection process more accurately in simulation, which is able to consider the workload of sub-processes included in block erection.

2 BLOCK ERECTION NETWORK

An erection network plan is necessary for block erection, which contains the erection orders as well as the schedule of erection events. Each erection event consists of several sub-processes such as scaffolding, clamping, preparation, welding, grinding, correction and inspection. During an erection event, scaffold should be installed first for workers to conduct welding, then welding machine and other required materi-

als should be well-prepared, after welding, welding lines should be carefully ground. Then the deformation of the hull due to welding should be corrected and finally erection event needs to get inspected.

During the block erection, there are mainly two kinds of facilities, one is welding machine for block welding and another one is Goliath crane for block lifting as well as transportation. So, in order to calculate the workload of block erection process accurately, facility workload during each erection event in erection network should be included.

3 A HIERARCHICAL SIMULATION MODEL FOR BLOCK ERECTION

In order to predict the workload of block erection using discrete event simulation, hierarchical structure of erection network should be taken into consideration. There has been a research on shipyard simulation model based on MRA(Multi Resolution Architecture) methodology that can express hierarchical structure of product, process and human resource (Woo et al., 2016). So, a hierarchical simulation model with two hierarchical structure based on above-mentioned model is proposed for block erection simulation. As for block erection process, the first hierarchy of the model will be erection network composed of multiple erection events and the second hierarchy will be sub-processes of each erection event. As for the facility constraint in this research, we only consider the erection block movement using Goliath crane due to the large size and limited quantity of Goliath crane.

4 CONCLUSION

Block erection process is composed of a series of erection event forming a complicated erection network and each event also consists of several sub-processes, which indicates that block erection process has a hierarchical structure. In order to predict the workload of the whole block erection process, workload of each sub-process should be considered. So, this research suggests a hierarchical simulation model for more accurately predicting the workload of block erection process, which is able to consider workload of sub-processes as well. Based on the hierarchical simulation model, a hierarchical production plan can be simulated to verify the schedule as well as workload in the near future. Besides, with further improved hierarchical simulation model, outfitting process of constructing an offshore plant can be simulated, which is the core and also the bottleneck process for offshore plan construction.

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