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Discrete Event/Discrete Time Simulation of Block Erection by a Floating Crane Based on Multibody System Dynamics

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ABSTRACT

In this paper, the discrete event/discrete time simulation of the block erection by a floating crane is performed for the purpose of estimating the motion of the floating crane and the block and also calculating the tension of the wire rope between the two. At this time, the dynamic equations of motion of the floating crane and the block are set up for considering the 6-degrees-of-freedom floating crane and the 6-degrees-of-freedom block based on multibody system dynamics. The nonlinear terms in the equations of motion are considered. In addition, the nonlinear hydrostatic force, the linear hydrodynamic force and the wire rope force are considered the external forces. Finally, we analyze the engineering effects of erecting the block by using the floating crane.

KEY WORDS: Discrete event/discrete time simulation; modeling & simulation; block erection; floating crane; multibody system dynamics

INTRODUCTION

Background of This Study

A floating crane is a crane-mounted ship as shown in Fig. 1. and is used to erect or to transport heavy blocks or cargos. Because a floating crane in shipyards is a barge ship, a flat-bottomed boat, it is not self-propelled and must be towed by tugboats. A floating crane is able to lift about 3,600 tons of weight by buoyancy force as well as by the force of structural stiffness. For improving the efficiency of production in shipyards, the floating crane is used more often today.
The stability of the floating crane is important because it is operated in the sea. Now, the operation by the floating crane does not allowed in the heavy sea. In addition, new methods of operation the floating crane are avoided, if the stability is not guaranteed. So, the engineer planning these methods of operation must estimate the dynamic motion of the block suspended by the floating crane and calculate the tension of the wire rope between the floating crane and the block. At this time, the following facts should be considered. First, the motions of the floating crane and the heavy cargo affect each other because there is a constraint force between them through the wire rope. In addition, the wire rope between the two is extensible, so dynamic effects should also be considered. The floating crane moves in large amplitude in a heavy wave and the large movement cause the large amplitude motion of the heavy cargo.

Fig. 1. Floating cranes used in major shipyards (Cha, 2008)

Related Works

Chang, Rhee, Pyun, Park, Hwang, Kim, and Ahn (1986) set up the equation of motion of the cargo suspended by two floating cranes by using the Lagrange equation. The hydrodynamic interaction between the two floating cranes and the interaction between the cargo and the two floating cranes are considered. The 6-degrees-of-freedom motions of the floating cranes, the 6-degrees-of-freedom cargo, and the extensible wire rope are considered in the equation of motion. The infinitesimal terms are eliminated by assuming the motions have sufficiently small amplitudes. They assumed that the tension of wire rope is vertical to the ground and the hydrostatic force is proportional to the motion of the floating cranes.
Jiang (1991), Jiang, Schellin, and Östergaard (1990), and Schellin and Jiang, and Östergaard (1993) set up the equation of motion for considering the 6-degrees-of-freedom floating crane and the translational motions of the 3-degrees-of-freedom cargo along the X, Y, Z axes. The interaction between the floating crane and the cargo is considered, and the wire rope is extensible. The hydrostatic and hydrodynamic forces, the viscous damping force, the mooring force,