Experimental Study on Automatic Installation System of Offshore Breakwaters

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ABSTRACT

The authors have developed an automatic installation system for offshore breakwaters intended to save labor during breakwater installation, and improve worker safety. This system includes programs that manage installation work using two associated units: a tugboat support system and an anchor wire system. In this paper, an outline of the automatic installation system is provided, and experimental results for the tugboat support system are described and validated.

KEY WORDS: Caisson, Offshore construction, Installation work, Winch, Automatization, Measuring execution, Caisson motion

INTRODUCTION

Recently in Japan, ports have been constructed at locations directly facing the Pacific Ocean under severe wave conditions. The installation of caissons for a breakwater is sometimes interrupted or suspended by wave conditions. During this installation process, winches are hand-operated by several operators under sometimes dangerous conditions due to the operator's proximity to the winches and wires. Therefore, it would be desirable to improve these working conditions in order to maintain the safety of workers on the caisson. Moreover, since the present caisson installation process depends substantially on the intuition and experience of skilled workers, new installation methods will be needed to prepare future decreases in the labor force.

Based on these needs, the authors developed an automatic installation system that enables automatic construction of offshore breakwaters, for the purpose of reducing labor during caisson installation, and improving the safety of workers. This automatic installation system consists of an Engineering Work Station (EWS, Toshiba AS4/50G/X) with A/D and D/A converters, winches operated by control signals from the EWS, and an observation system used to measure wave height, caisson motion, and so on. As a caisson is installed, the automatic installation system obtains data on caisson position and motion, wave height, and wire tension and displacement, then uses this data to predict the motions of the caisson, using the EWS on the working craft. The system then outputs control signals to each of the winches from the EWS, causing the caisson to move to the optimum position for installation. The computer system includes programs allowing installation work to be performed using two associated units: a tugboat support system and an anchor wire system.

At present, model experiments for the tugboat support system have already been carried out. In the present paper, an outline of the automatic installation system is provided, and experimental results for the tugboat support system are described and validated. (Shiraishi et al. (1994), Shiraishi et al. (1995), Yoneyama et al. (1995)).

CURRENT METHOD OF INSTALLATION FOR BREAKWATER CAISSONS

Wave Conditions during Caisson Installation

The actual caisson installation process is strongly influenced by wave conditions. Below, we plot the wave conditions for sixteen construction projects conducted in five ports facing the Pacific Ocean.

Figure 1 shows the relation between significant wave height and period during caisson installation process. Closed circles and open triangles show the wave conditions when installations were carried out