Supporting Force Distribution and Bottom Strength under Launching Condition

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ABSTRACT

In this paper, a whole ship FEM model is used to investigate the wood-block supporting force (WSF) distribution under the launching condition. The influences of weight distribution, transverse bulkhead and spring distribution of the woodblocks are evaluated. The results show that the error caused by the linear assumption for the supporting force is too large. The overhanging of the weights from the fore end of woodblocks has significant influence on WSF. The soft supporting of the sea-extending sliding way and the tide height can reduce WSF. Based on the investigation by the whole ship FEM model, the simple method to determine the WSF distribution, the method to calculate the in-plane stress of bottom plating, and the simple method to evaluate the strengths of floors are proposed.

KEY WORDS: woodblock; supporting force; launching.

INTRODUCTION

Launching is the first time for a ship to expose to the severe loading condition which may be the severest in her life. Conventionally, the local strengths of the bottom plates, floors, girders and longitudinals under the pressure from woodblocks are confirmed. For the ships with very thin form at lower part of stern and large weight distribution at stern such as pure car and track carrier (PCTC), however, the overhanging weight of the stern results in the large bending moment at the fore end of woodblocks. This large bending moment causes large woodblock supporting force (WSF) by which the double bottom is deformed. As shown in Fig.1, this deformation may lead to high in-plane compressive stress in bottom plates. For PCTC, this compressive stress becomes very severe. In order to evaluate the strengths against the compressive stress, it is necessary to know WSF and its distribution. In practical strength confirmation in shipyards, the linear assumption is commonly adopted for the sake of the simplicity. It is well known that the distribution is not exactly linear because the ship girder is not a rigid body. Since it is difficult to measure the distribution, it is considered that the whole ship FEM is the best available method. Using this model, the influences of bulkhead, overhanging weight, and supporting stiffness of woodblock and sliding way can be investigated.

The whole ship FEM model is time-consuming. In practical design work, a simple and quick method with acceptable accuracy is necessary. Here the beam model, grid model and hand-calculation model are compared with FEM model.

The other problem is how to evaluate the strengths of the bottom plates, floors and longitudinals caused by the double bottom deformation. Of course, after knowing WSF, it is not difficult to calculate the double bottom structure by FEM. In practice, however, it is desirable to confirm the strengths by simple model. In this study, based on the investigation by FEM, a simple model is proposed.

CALCULATION MODELS

In the calculation of the supporting force during launching, the simplest method is to assume the distribution to be linear. This assumption implies that the ship is considered as the rigid beam supported by the uniform supporting woodblocks. In fact, the ship is not rigid. Not only it deforms as an elastic beam along longitudinal direction, but also its double bottom deforms much. Only the whole ship FEM model shown in Fig.1 can represent all these actual deformations. Calculation for the FEM model is carried out for the port side of a PCTC. The principle dimension is $L_{pp}=170.00m$, $B=32.20m$, $D_s=34.80m$. Shell elements are used in FEM model. Floor to floor is divided to be one element generally. To the bottom structure, however, in order to investigate the supporting forces on every frame and longitudinals, the mesh size is one-frame $\times$ one longitudinal. The supporting woodblocks are modeled as the springs. Because the springs are fixed on the ground, there is no need to introduce the restraint condition in vertical direction. In longitudinal and transverse directions, only the rigid body movement of ship is needed to be restrained. FEM model is the most reliable. It is, however, time-consuming and needs numerical techniques. In practice, it is necessary to find a simple and quick method to confirm the strengths. The beam model shown in Fig.2, considers the ship as an elastic beam with varying cross-section supported by springs of woodblocks. The calculation by this model can