Comparative Study on the Effect of the Cross Tie on Sloshing Loads of a VLCC

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ABSTRACT

This paper presents comparison of pressures due to liquid sloshing in a VLCC cargo hold between experimental results and numerical results. DSME’s typical double hull VLCC has a single horizontal cross tie in center tanks. However the conventional cross tie system include difficulties at construction stage and local fatigue damage. For these reasons, DSME developed a new type of mid ship section of VLCC. The cross-tie in the center tanks is removed and the depth of vertical web and stringer is increased. To investigate the effect of internal structure, i.e. cross tie, on sloshing loads of a VLCC, a systematic model tests are carried out using 6-DOF motion platform at PNU. These experimental results, both with and without cross-tie, are compared with results of numerical simulations using a commercial CFD program, STAR-CCM+. The tank model with simplified internal structures is manufactured from acrylic to the scale of 1:50. To compare experimental and numerical results, test conditions are based on regular harmonic motions. It is conclude that the proposed tank configuration without the cross-tie would be acceptable for a VLCC center tank.

KEY WORDS: VLCC, Internal member, Cross-tie, Impact pressure, Sloshing

INTRODUCTION

In ordinary double hull VLCC, one row of cross-tie is arranged in the center tanks in order to prevent damage on inner wall due to the various loads and stresses. However, cross-tie has some problems. The cross-tie structure is difficult to be constructed and require dangerous jobs of workers at shipyard. So, DSME has developed a new type of mid ship section of VLCC to increase productivity and structural integrity. The cross-tie in the center tanks is removed and the depth of vertical web and stringer is increased in the developed design. To evaluate the safety of the new cargo hold, the evaluation of cross-tie’s effect on sloshing loads was required.

Many sloshing studies have been performed, but sloshing studies for tank with internal structures as cross-tie have not been performed. Several studies for sloshing phenomena on LNGC tank can be found in Faltinsen et al.(2000), Pastoor et al.(2004, 2005), and many researchers(Kim et al, 2001, 2009; Gavory et al. 2009). References for the general procedure for estimating sloshing load on LNGC tank with experiment can be found in guidance notes of ABS(2006), BV(2009), DNV(2006) and LR(2008). Recently many experimental and numerical studies for sloshing phenomena have been performed, but not for tanks with internal structures such as cross-tie.

In this study, experimental and numerical studies were carried out. In order to evaluate the effect of the cross-tie on sloshing loads, regular wave conditions were selected based on natural periods of sloshing and ship motion. And several filling levels were investigated in this study. In the experimental study, model tanks are referred to VLCC Cargo tank and the scale is 1/50. However, the VLCC cargo tank of full scale is considered for the sloshing analysis to compare CSR rule values in numerical study. The model tests were carried out using 6-DOF motion platform at PNU (Pusan National University). And the numerical sloshing analysis were carried out using a commercial CFD program, STAR-CCM+ based on the ABS analysis procedure. This study presents the comparative results on effect of cross-tie on sloshing loads of VLCC between experimental and numerical study.

EXPERIMENTAL STUDY

The 6-DOF sloshing motion platform was used for model tests. Fig. 2 shows the 6-DOF motion platform at PNU, Korea. The facility is