TITLE; A SLACK MOORING FOR A LARGE SHIP UNDER BEAM SEAS IN PORT

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OBJECTIVE

As an empirical and traditional ship mooring method, a pretension mooring (a hard mooring) or slack mooring (without pretension in mooring line) is performed for large ship or small ship, respectively. However, the slack mooring is applied to a large ship under beam seas in port to avoid large roll and sway motions, and excessive loads in mooring lines and fenders. In this study, the mechanism and validity of the slack mooring for large ship is investigated by a physical model test and a numerical simulation method of the moored ship motions and mooring loads under beam seas.

METHODOLOGY

The target large ship is about 100kDWT class bulk carrier (Length=277m, Breadth=49m, Depth=27m, draft =11.43m (in full loaded), =9.43m (in ballast), KG =21.1m (in full loaded), =13.24m (in ballast), Displacement= 104,953ton (in full loaded), =83,643ton (in ballast) in full loaded and ballast conditions. The pretension of the actual ship is given at 10tons (100kN) for each line, and is not applied in the slack mooring. Four pieces buckling type fenders are installed at the breasting dolphin. A pneumatic type fender (air fender) is considered as an alternative fender type. The scale factor of the physical model test is established as SF=1/100. Figure 1 shows the set-up of the physical model test for the moored large ship in full loaded condition in which the gravity center of the ship is located above the fender installation level. As shown in Figure 1, the test is conducted at a two dimensional water tank (38m long x 1m wide) in beam seas, and the water depth is modeled as 0.14m. The wave condition is arranged as 0.6 - 2.0s in wave periods, and fixed as 0.01m in wave height. The measuring items are wave elevations, ship motions in 2D (namely: sway, heave and roll motions), mooring loads in lines and fenders. The numbers of mooring lines and fenders in model are two, respectively, and the spring constants are modeled by using the Froude law.

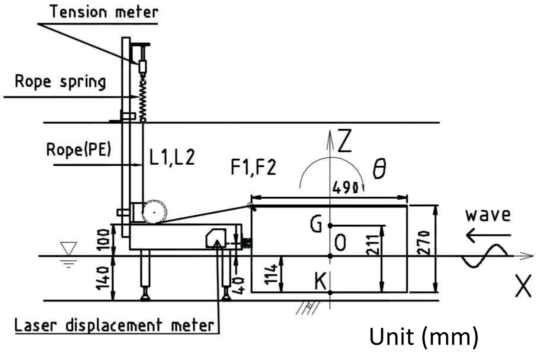


Figure 1 - Physical Model Test of Moored Large Ship in Full Loaded Condition

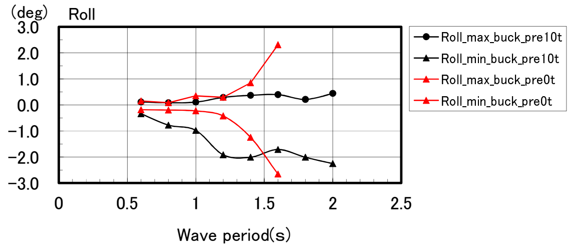
MAIN RESULTS AND CONCLUSIONS

The main results and conclusions in this study are summarized as below:

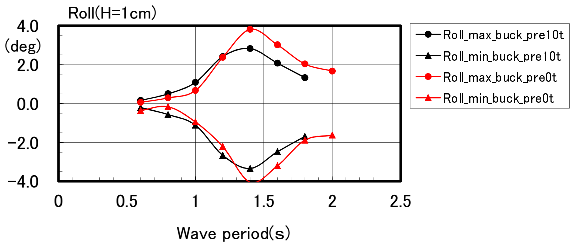
(1) As shown in Figure 2, the roll motion is amplified by not only the resonance effect but also a combined condition with a gap of space between ship's G and the fender installation level. In addition, the line tension and fender reaction force also affect to the large roll motion.

(2) As shown in Figure 3, the slack mooring combined with air fender is effective on reduction of the large roll motion under beam seas, in case there is the gap between ship's G and the fender installation level.

(3) As shown in Figure 4, the mechanism and validity of the slack mooring for large ship is confirmed through the numerical simulation method of the ship motions.



(a) at full loaded condition



(b) at ballast condition

Figure 2 - Maximum and Minimum Values of Physical Model Test Results in Roll

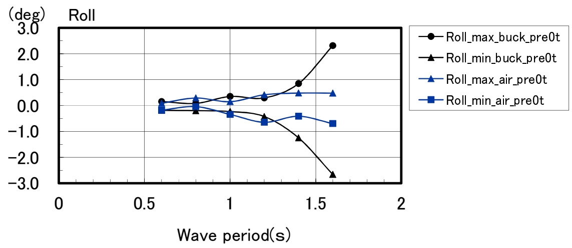


Figure 3 - Maximum and Minimum Values of Physical Model Test Results in Roll without Pretention at Full Loaded Condition

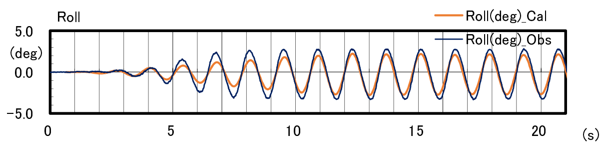


Figure 4 - Reproduction of Moored Ship Motions in Roll at T=1.4s with Pretension at Ballast

REFERENCES

Kubo, Saito, Sakakibara, et. al., (2000): A Study on Suitable Mooring System for Large and Small Ships under Waves and Wind, Coastal Engineering 2000, ASCE, Sydney, pp. 3629-3642.