Numerical Simulation of Green Water Incident on Bow Deck

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ABSTRACT

The importance of predicting the effect due to green water on a ship bow becomes decisive in designing a modern ship. In order to predict the green water impact on the bow structure efficiently, various numerical methods have been checked and compared to develop the desired numerical simulation technique. The Marker-density method has been applied to capture the extremely complicate free-surface with breaking on it, associated with the differentiated nonlinear governing equations.

For a specific case, the green water phenomena on a model ship with wedge type bow structure have been simulated in this paper.

KEY WORDS: Green water phenomenon; numerical simulation; Marker-density method; ship bow design.

INTRODUCTION

In rough sea conditions, the bow deck of a ship is apt to be damaged by the green water impact. The green water impact can also damage the bow structure. The green water phenomenon often occurs when compact masses of water rush onto the deck of a ship (Faltinsen, 2002). Flows with increasing speed can be generated and swept over superstructures and equipments. The complexity of the phenomenon makes it difficult to interpret how the hull affects the behavior of the water on deck. For an instance O’Dea and Walden (1984) observed through experiments that an increased flare reduced the deck wetness in regular waves. Green water phenomenon has been also considered to be an important problem for the safety and operability of naval and merchant vessels. Tan (1969) noted that shipping of water was the most important reason for changing courses and speeds for Dutch merchant ships in order to avoid serious damages to the ships or their deck loads. Many cases of structural damages caused by the green water have been reported in the past. The widely known accident with M.V. Derbyshire has once shown the destructive force of green water loading and its fatal consequence; see for example Faulkner (2001). The casualty of Derbyshire in 1980, which resulted in total loss of the ship, is one of casualties related to the green water (Shin, 2005). Tankers usually have decks almost empty but FPSO decks per definition carry a lot of sensitive equipments. Because FPSOs are generally connected to their mooring system with a rotating turret at the bow, important equipments are often present close to the bow. Consequently green water can cause damage to those equipments, such as fluid swivels, piping, turret structure, control valves, emergency systems, fire detection/protection...