CRITICAL SCENARIOS ANALYSES OF A BULK CARRIER IN THE EVENT OF GROUNDING

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ABSTRACT

This study deals with the ship grounding mechanics applied to a bulk carrier. The ship with a forward speed runs aground by the bow on a shoal. In view of the bow crushing damage, a critical situation is met when the collision bulkhead in way of the keel starts being in contact with the seabed. Critical grounding scenarios are determined by a ship grounds on a seabed with a critical initial forward speed till rest while the structural damage does not exceed the critical situation. First, a mathematical model is proposed to analyze the ship grounding and extract the critical initial forward speed. The grounding process can be divided into two phases. The first phase represents the ship change of momentum, and the second phase is the bow sliding over the seabed. During those two phases, the kinetic energy of the ship is dissipated by friction with the seabed, bow structure plastic crushing and trim increase due to the lift of the bow. Then, the mathematical model is modified based on a few time-consuming ship grounding nonlinear FEAs. This modified mathematical model allows fast and versatile analyses of ship grounding. Finally, critical grounding scenarios including ship critical initial forward speed are estimated. The hull girder strength is also reviewed under critical scenarios. The results show that the hull girder strength is sufficient despite the lift of bow and the flooding caused by localized damages.

INTRODUCTION

As a consequence, ship grounding can have significant impacts on human fatalities, environment pollutions, economical costs and reputation of shipping companies. Today, to reduce the ship grounding probability of occurrence to zero is not a realistic approach. However, the consequences must be mitigated. In 2010, a new standard approach was adopted by IMO, the Goal Based Ship Construction Standards (GBS) [1]. For bulk carriers and oil tankers, the standards state that the ship should provide a reasonable level of residual strength after grounding.

In the past, the tearing and crushing of ship bottom have already been extensively investigated as a response to some reported accidental events (e.g. Exxon Valdez - 1989). Double bottom arrangements are provided in SOLAS convention Chapter II-1 [2] Regulation 9. The distance between the inner and outer bottom ensures a safety margin in the event of grounding.

In the case of ship with forward speed grounding on a shoal by the bow, this safety margin is ensured by the location of the collision bulkhead. The distance from the collision bulkhead to the forward perpendicular is provided in SOLAS convention Chapter II-1 [2] Regulation 12.

In this study, the grounding capacity of a ship related to the regulatory position of the collision bulkhead is investigated. First, a critical situation is defined. Then, the ship grounding mechanics proposed by Pedersen [3] are presented. Fig. 1 illustrates the considered grounding scenario. Then, bow crushing FEAs are performed to assess the structure response. Combining the bow structure response to crushing and the grounding mechanics, a mathematical grounding model is developed. This model allows fast and versatile ship grounding analyses. Then, the mathematical model is modified based on the ship grounding FEAs. Finally, critical grounding scenarios are estimated and for the corresponding predicted ship trim

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