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Int. J. Nav. Archit. Ocean Eng. (2014) 6:236~244
http://dx.doi.org/10.2478/IJNAOE-2013-0175
pISSN: 2092-6782, eISSN: 2092-6790

Damage scenarios and an onboard support system for damaged ships

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ABSTRACT: *Although a safety assessment of damaged ships, which considers environmental conditions such as waves and wind, is important in both the design and operation phases of ships, in Korea, rules or guidelines to conduct such assessments are not yet developed. However, NATO and European maritime societies have developed guidelines for a safety assessment. Therefore, it is required to develop rules or guidelines for safety assessments such as the Naval Ship Code (NSC) of NATO. Before the safety assessment of a damaged ship can be performed, the available damage scenarios must be developed and the safety assessment criteria must be established. In this paper, the parameters related to damage by accidents are identified and categorized when developing damage scenarios. The need for damage safety assessment criteria is discussed, and an example is presented. In addition, a concept and specifications for the DB-based supporting system, which is used in the operation phases, are proposed.*

KEY WORDS: Ship safety assessment; Damage scenarios; Collision; Grounding; Damage safety criteria; Behavior simulation.

INTRODUCTION

In the last decade, ships have become larger and more diversified, however, ship accidents, such as collisions and groundings, continue to occur regardless of how a ship is designed, constructed, and operated. Therefore, damage safety has become a major issue from a design and operation viewpoint. The International Maritime Organization (IMO) also requires the use of goal-based standards (GBSs) to ensure safety against major hull damages. Classification rules, such as DNV and ABS, have been established regarding the extent and location of deterministic damage due to collision and grounding (Choung et al., 2011). Chapter II-1 of SOLAS contains a regulation regarding IMO's probabilistic damage stability requirements (IMO, 2009).

There are some safety standards or codes for naval ships such as the Naval Ship Code. This code requires adequate reserve of buoyancy and stability in all foreseeable intact and damage conditions, and also describes operational and environmental limitations (NSA, 2012). In Korea, ships including navy are designed and constructed in compliance with the guidelines of design and construction based on empirical data, which guidelines do not require damage safety assessments that consider environmental conditions such as waves and wind. In particular, in the operation phase, it is important to know whether a ship is safe in case of damage in waves. Therefore, damage safety should be considered from the design phase, and guidelines to assess damage safety are necessary.

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Generally, there are two methods to ensure safety: preventing the accidents from occurring and mitigating the damage caused by accidents. The former is only available in the operation phase, whereas the latter is available in both the operation and design phases. Therefore, to increase the safety of damaged ships, designers focus more on damage mitigation than accident prevention. Focusing on damage mitigation requires prediction of the damage stability, the structural integrity, and the motion analysis for damaged ships in waves (Lee et al., 2004). Furthermore, pertinent damage scenarios must be developed prior to the damage safety assessment. However, there are insufficient data and guidelines for developing such scenarios. Instead, damage scenarios are developed from the discussion and agreement among designers, owners, or authorities, but are not always available.

This paper proposes a set of parameters that should be considered when developing the damage scenarios as well as the methods for assessing damage safety.

DAMAGE SCENARIOS ON SHIPS

Definition of damage scenarios

When a ship accident occurs because of several causes, both the hull and structures are damaged. These damages cause the ship to flood, which can lead to sinking, capsizing, or breaking up, as shown in Fig. 1.

In general, larger ships have sufficient strength to resist a considerable amount of structural failure. Even on smaller ships, the margin of strength can typically be augmented by executing appropriate measures after the damage occurs. Therefore, some types of structural failure can be considered minor damage compared to flooding. However, structural failure can be more critical in the case of grounding because statistically, the damage caused by grounding has major effects on the midship region (Zhu et al., 2002).

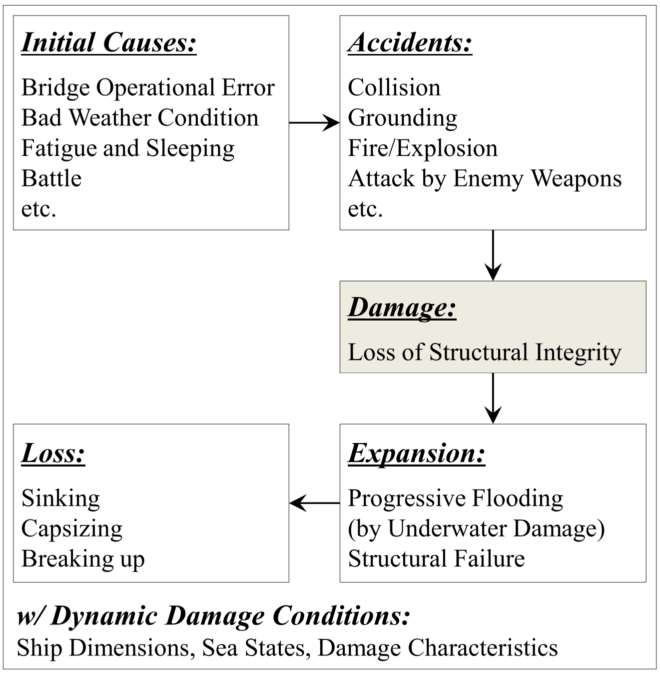

Fig. 1 Structural links of damage scenarios.

Damages can be defined as a function-failed condition of ships caused by these accidents. Accidents can be caused by operational errors, crew fatigue, sleeping, bad weather, or battle, and there are numerous potential accident categories. However, statistically, collision and grounding are the most common accidents (HARDER, 2003), and attack by enemy weapons are the most common accidents for naval ships. Therefore, in this study, damages are defined as hull damages caused by these three accident types. The definition of damage scenarios is a limited set of conditions, which comprise the ship dimensions, sea states,