Damage and Residual Strength of Double-Hull Tankers in Grounding

Jeom K. Paik* and Tak K. Lee
Research Institute of Mechanical Technology, Pusan National University, Pusan, Korea

ABSTRACT

This paper will discuss and analyze the mechanics of ships in grounding on rock. A raking damage estimate model in grounding of ships is proposed. The accuracy and applicability of the model are verified by a comparison of experimental results. The progressive collapse analysis of damaged hull sections, under vertical bending moments by use of the ALPS/ISUM computer code, is described. The procedure is applied to the grounding simulation of a double-hull tanker with a transverseless system.

INTRODUCTION

After the Exxon Valdez grounding in 1989, the U.S. Oil Pollution Act of 1990 (OPA90), requiring that all oil tankers operating in U.S. waters must have double hulls by the year 2015, was passed. Although the double-hull concept is not the absolute solution, it is one of the most effective ways of preventing oil pollution in grounding and collision accidents. In this respect, the International Maritime Organization (IMO) has established this requirement in waters throughout the world.

The present paper is concerned with the mechanics of grounding of double-hull tankers. Depending on grounding scenarios, oil spills will possibly occur even though the tanker has double hulls. In a high-energy grounding, both inner and outer bottom plateings will be torn and cargo oils will spill out. In a low-energy grounding, the inner bottom plateings may not have structural damage and oil spills will not occur immediately after the accident. However, the residual strength of the damaged hull section can decrease seriously and the applied loads may be amplified by waves and tides. If the hull girder is broken into two pieces due to lack of residual strength, more oil will be spilled and greater damage will be done to the marine environment.

In this regard, the structural design of double-hull tankers against grounding should be made on the basis of hull collapse as well as grounding damage.

The present paper has three parts. First, a semi-empirical model for estimation of the raking length of the double bottom due to grounding will be described. The amount of oil spills after grounding can be predicted by use of the estimated raking length. Second, the progressive collapse analysis method for the damaged hull section under vertical bending moments will be presented by using the ALPS/ISUM computer code developed by Paik (1993). The ultimate collapse strength of the tank section with grounding will be described. The amount of oil spills after grounding can be predicted by use of the estimated raking length. The ultimate collapse strength of the tank section with grounding damage will be obtained and compared to the design bending moments. Finally, the present procedure is applied to grounding simulation of an AFRAMAX-sized double-hull tanker with a transverseless system. Some design considerations of a tanker against grounding are discussed.