International Journal of Offshore and Polar Engineering
Vol. 11, No. 2, June 2001 (ISSN 1053-5381)

Experimental Study on the Collision Strength of VLCC Side Structures

Tak K. Lee*, Jae D. Kim and Byung C. Shin
Korea Institute of Machinery & Materials, Taejon, Korea

Tae B. Chun
Korea Research Institute of Ships and Ocean Engineering, Taejon, Korea

ABSTRACT

The aims of this study are to obtain the experimental data on the structural behavior of 2 types of side structures, standard VLCC and VLCC with additional side stringers, during ship-ship collision, and to investigate the internal mechanics related to the structural deformation of the struck ship. Two quasi-static collision tests were carried out on the models of side structures, which are a part of the double hull. As the bow of the striking ship is assumed to be rigid, the energy absorption capacity of 2 designs was studied. The contribution of various structural components, such as outer/inner shell plating, web frame, side stringer, etc. is discussed. Especially, the distribution of strain on the side shell plating during collision was collected in order to verify the usefulness of the numerical analysis by FEA codes.

INTRODUCTION

The *Exxon Valdez* accident created public sensation over the need for environmental protection, especially accidental oil spills. Since most of accidents like the *Exxon Valdez* grounding are caused by human errors (Ohtsubo et al., 1997), it is essential to prevent the accidents themselves by reducing human errors. Unfortunately, eliminating human error is impossible. Consequently, it is very important to design the ship structure that can prevent and/or minimize the oil outflow even though the accident occurs.

Following the *Exxon Valdez* grounding in 1989, several big projects on the collision and grounding of tankers have been carried out, and new regulations such as the Oil Pollution Act of 1990 (OPA90) issued by the U.S. government and IMO (Ohtsubo et al., 1994). The OPA90 requires that all oil tankers operating in U.S. waters must have double hulls by 2015. Although the double-hull structure is one of the most effective ways of preventing oil pollution in grounding and collision accidents, hull weight and the number of structural members of the structure are very much increased compared with the single hull. Also, it takes much time to build a double-hull VLCC.

In this regard, many researchers have studied to solve the above problems, and suggested several alternative structural designs with the same and/or better crashworthiness against collision and grounding than the double-hull structure. Several studies on this subject have provided useful data (Amdahl and Kavlie, 1995; Kitamura, 1996; Kuroiwa, 1996). However, there is no rational approach to correctly evaluate alternative designs, and only a few simplified methods applicable to specific types of accidental scenarios and structural arrangements have been proposed. In order to compare the crashworthiness of various structural configurations, and to verify several proposed evaluation methods, more basic research in this field is needed.

This paper is concerned with the collision behavior of the side structure of double-hull tankers. The structural damage mechanism concerning the ship collision is quite complex, and simulating the damage response by an analytical approach only is difficult. Thus, most research on this subject has employed the experimental and/or numerical approach. In this regard, collision tests were carried out on 2 types: side structure of a standard VLCC and of a VLCC with additional side stringers. The aim of the present tests is to obtain the data on the structural behavior of the structures during collision, and to confirm the effectiveness of additional side stringers, as well as to obtain data for the strain history in outer shell plating.

COLLISION TESTS

General

In order to investigate the characteristics of the penetrating process for VLCC side structures, collision tests were conducted. A

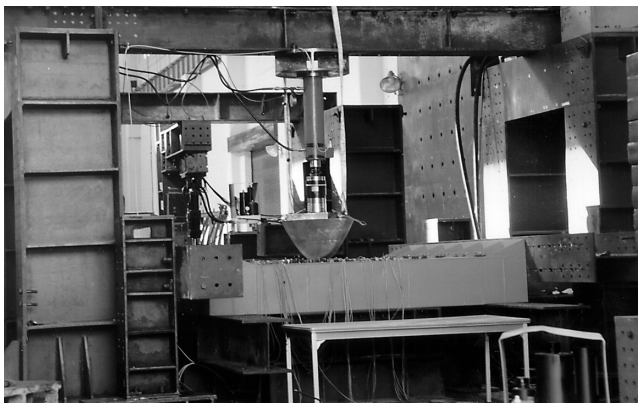

Fig. 1 Schematic view of test setup

*ISOPE Member.

Received March 11, 1999; revised manuscript received by the editors January 9, 2001. The original version (prior to the final revised manuscript) was presented at the Ninth International Offshore and Polar Engineering Conference (ISOPE-99), Brest, France, May 30-June 4, 1999.

KEY WORDS: Ship-ship collision, side structure of VLCC, additional side stringer, quasi-static test, strain measurement.