Application of Finite Element Simulation of Ship Collision in Maritime Investigation

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ABSTRACT
To solve the controversy of the responsibility in ship-ship collision, a ship-ship collision model was established on the basis of the collision accident of the "Xin Haixin 818" and "Guibei fishing 58013", then using the nonlinear dynamic analysis software AUTODYN to display finite element simulation. In the ship-ship collision simulation, according to the damage extent of the two ships, "Guibei fishing 58013" is regarded as a rigid body in which the overall deformation is smaller, while the larger deformation of "Xin Haixin 818" is a deformable structure. By setting ship motion parameters on multiple conditions, and choosing a reasonable time steps, the intrusion - yield - destruction process of the hull collision region is restored. The comparison of the calculations and the accident scene investigation of the crevasse shape and invasion depth reveal that the model prediction is in good agreement. The quantitative reproduction method of modeling the collision damage process allows maritime authorities to judge collision conditions, and provides a new reference for the maritime ascertaining accident responsibility.

KEY WORDS: Ship collision; collision damage; finite element analysis; dynamic; working condition; maritime survey.

INTRODUCTION
In recent years, in waters near ports, ship collisions have gradually increased due to the large vessel traffic density and human negligence. Collision is a complex nonlinear dynamic response under tremendous impact loads during short periods. Collision usually causes hull structure damage, catastrophic cargo spills, environmental pollution, and other casualties. Nowadays maritime accident research mainly focuses on probability of ship collision, energy in the ship collision, the collision force on the avoidance system and energy absorption of ship and marine structures or collision avoidance system (Liu Jiancheng, Gu Yongning, 2002). The purpose of all of these efforts are to improve ship safety in collision with engineering design, also to provide a scientific basis for post-incident damage assessment and repair decisions. Though there are many tools to predict the outcomes of a collision, they tend to lack a relevant validation. In recent years, with the development of finite element technology and computer hardware, the methods of nonlinear finite element numerical simulation for solving the collision force problem are gradually coming into favor (Wang Zili, Gu Yongning, 2001). This article applies a more mature finite element simulation to ship collision accident investigations, and provides a new reference for the investigation of maritime accidents (Liu Chao, Li Fanchun, 2013).

The Accident Survey
In 2012, the bulk carriers "Xin Haixin 818" (hereinafter referred to as ship X) was sailing in certain waters and collided with a fishing boat "Guibei fishing 58013" (hereinafter referred to as ship G). Soon after the collision ship X sank and the crews were rescued. After the collision, maritime authorities investigated the cause of the accident, and buck-passing started. In order to more clearly understand the structural response in the process of a collision of two ships, and to master the extent of damage of ship X when the ships collided, this article simulates the collision with non-linear implicit dynamic analyses software and dynamically reduces of the collision process.

Finite Element Simulation of Collision
Finite element analysis in this paper uses the ANSYS AUTODYN software; a nonlinear explicit dynamic finite element analysis program. The software AUTODYN can effectively deal with a variety of contact problems, effectively compute large deformations and advanced material constitutive elements. So long as reasonable calculation parameters are selected, it will be able to produce accurate and reliable calculation results for a collision between two ships (Liang Wenjuan,1986).

Overview of Collision
Ship X at full load condition when collision occurred, at that time