시뮬레이션에 의한 허베이스피리트호-삼성바지선 충돌사고 분석

† 김선영*, 이경중*, 박세길*, 김연규*, 이문진*, 손남선*, 공인영*, 김미현*

* 한국해양연구원 해양시스템안전연구소

Analysis of Hebei Spirit Collision Accident by Simulation

† *Sun Young Kim*, Gyeong-Joong Lee*, Sekil Park*, Yeon Gyu Kim*, Nam-Sun Son*, Moonjin Lee*, In-Young Gong*, Mihyun Kim**

* *MOERI/KORDI, 171 Jang-dong, Yuseong-ku, Daejeon 305-343, Korea*

ABSTRACT : *On 7 December 2007, the Hebei Spirit, a 260,000 dwt VLCC, anchored near Korea's Daesan Port, was collided with a passing crane-carrying barge Samsung1, which was under tow of two tugs Samsung T5 and Samho T3. In this study, the behaviour of Hebei Spirit at the time of the accident has been reproduced and analyzed by simulation. This study precedes the study for the investigation of any available countermeasures for Hebei Spirit to prevent the accident. The simulation has been done only for Hebei Spiri and the motion ot Samsung barge is just given with recorded AIS data. Dynamic characteristics of Hebei Spirit have been modeled based on empirical data and her sea trial data. Effects of current, wave and wind are also estimateed using empirical formula. Considering uncertainty of environmental condition and control of Hebei Spirit, simulation has been done by varying engine control method and holding power coefficients of the anchor. Finally, based on simulations, the most plausible scenario on the state of anchor and engine control could cause real accidents.*

KEY WORDS : Hebei Spirtit Collision Accident, Accident Reproduction, Accident Analysis, Simulation

1. Introduction

On 7 December 2007 early in the morning, the Hebei Spirit, a 260,000 dwt VLCC, anchored near Korea's Daesan Port, was collided with a passing crane-carrying barge Samsung 1, which was under tow of two tugs Samsung T5 and Samho T3. An analysis of this accident has been done by simulation to investigate the cause of the accident.

The responsibility of Samsung crane barge and tugboats is evident for the accident but the responsibility of Hebei Spirit for the accident was debatable. Confining to legal liability, the issue is whether Hebei Spirit neglected their precaution or available preventing measures to avoid the collision which are specified in the COLREG or not. In the broad sense of responsibility, however, the issue will be whether Hebei Spirit did their best to avoid the accident or not.

The purpose of this study is to investigate any countermeasure which could be taken by Hebei Spirit at the time of the accident. For this, Hebei Spirit's actions to prevent the accident are analyzed first. Then, any possible countermeasure which Hebei Spirit could take to prevent the collision accident are investigated by simulation. This paper will cover the first topic and second topic will be dealt with on the other paper.

2. Mathematical models

6 DOF motion is applied to generate the motions of a ship. Horizontal(4 DOF : surge, sway, yaw, roll) and vertical (2 DOF : heave and pitch) motions are, however, treated separately. Forces acting on hull, rudder, and propeller as well as thruster effect, interaction forces between ships, wind and wave forces are considered. Hydrodynamic forces due to tidal current are incorporated in the velocity component as speed relative to water. Vertical motions, heave and pitch, due to wave are calculated independently and superposed on maneuvering motions.

† 교신저자 (종신회원), sykim@moeri.re.kr 042)866-3641

3. SIMULATION Modelling

3.1 Environment Modeling

Three dimensional and two dimensional graphic and GIS modeling for simulation area of sea are made to provide a realistic view for an operator during simulation and proper hydrodynamic modeling. Wind and wave data are taken from the meteorological administration. Real time tidal currents are predicted using CHARRY(Currents by Harmonic Response to the Reference Yardstick) model[9].

2.2 Ship Modeling

The hydrodynamic coefficients of Hebei Spirit are estimated from empirical formula. The rpm and speed of Hebei Spirit tanker corresponding to engine telegraph lever are obtained from the engine data of Hebei Spirit.

2.3 Anchor Modeling

The holding power coefficients of Anchor and anchor chain vary with bottom holding quality. In the simulation anchor chain's holding power coefficient is fixed with 1.0. But anchor holding power coefficients are varied to see its effect.

4. Simulation and analysis

4.1 Simulator System

Simulations have been carried out with desktop simulator system. Desktop simulator uses same program with full mission bridge simulator but it does not equip with navigational equipments in the bridge. All the maneuvering devices necessary are replaced by simple conning display and GUI control system. Desktop simulator system consists of simulation control and monitoring system and three-dimensional graphic monitoring system.

4.2 Simulation Conditions

Initial conditions for simulation are set referring weather information from weather center and AIS data from VTS center. Anchor's holding power coefficient depends on bottom quality and holding condition but it is very uncertain. Thus, in the simulation, anchor's holding power coefficients are varied from 3.5 to 10 to see its effects.

Nominal windlass speed of the anchor informed from Hebei Spirit is 9m/min. But similar tankers' windlass speed is 5m/s for let go. So, simulations have been done for these two windlass speed during let go.

4.3 Simulation Scenario

Simulations have been made to reproduce the trajectory of Hebei Spirit. Engine and anchor logger data, which were recorded by Hebei Spirit's crew, are used for a simulation. But there were some doubts on the reliability of recorded time of anchor chain paying out, anchor drop speed and engine command at. So, simulations have been done by varying all these parameters.

4.4 Simulation Results

Fig. 14 shows the simulation results with Scenario SR1-1 which has no control of engine or anchor until 6:00. this simulation is dependent on ship's hydrodynamic characteristic, anchor dynamic modeling and environmental forces by current, wave, wind. Both simulation and AIS data shows a circular trajectory with a center at anchor position. Hebei Spirit rotates continuously clockwise from 4:00 to 5:40.

.....(omission).....

5. Conclusion

Simulations have been made to reproduce the behavior of Hebei Spirit until actual accidents occurred. Simulation predicts the real ship's motion characteristics qualitatively well. However, many uncertainties of environmental data make it difficult to reproduce the real ship's motion more accurately.

Some doubts on the record of engine and anchor manipulation are raised based on simulation data and physical reasoning.

The final purpose of this study is to investigate if there was any feasibile countermeasure which Hebei Spirit could take to prevent the collision accident. This paper describes the first part of this study which include development of simulation system and validation of simulation. The next part will be dealt in other paper.

Acknowledgement

This study was supported by the project "Analysis of Towing Fleet Accident and Its Prevention Technology" sponsored by MOERI/KORDI and the project "Investigation of Collision Accident Between Hebei Spirit and Samsung Barge" sponsored by Daejon District Public Prosecuter's Office.