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Analysis of Ship Collision with a Semi-submersible Platform

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ABSTRACT

In this paper, the finite element analysis of collision between a supply vessel and semi-submersible platform is presented. LS-DYNA general-purpose explicit finite element code, which is a product of ANSYS software, is used to model and analyze the non-linear response of the platform due to ship collision. Due to the importance of damage to the platform, the ship hull is assumed rigid. Most probable impact locations and impact geometries are studied based on the dimensions and geometry of the platform and vessel, operational sea-states and relative motions of the vessel and platform. Then, various impact scenarios are considered. The worst impact scenarios are modeled and analyzed. At the end, based on the results, the mechanics of energy absorption and the extent of damage is presented and discussed.

KEY WORDS: Semi-submersible; Ship; Collision; LS-DYNA.

INTRODUCTION

Semi-submersibles are often employed in deep waters and hostile environments instead of drilling rigs as mobile drilling platforms. They can also be used as floating production systems (ABS, 2001).
Ship collision is one of the major hazards to offshore platforms. Columns of floating platforms that play a crucial role in platform's stability are more vulnerable to the collision. In recent years, the growing demand of offshore structures and increasing maritime traffic has increased the risk of collisions. In this regard, several incidents have been reported during the last few years. The most likely events are happened between supply vessels and captive boats servicing the platform during its installation and operation. For example, in United Kingdom Continental Shelf (UKCS**)**, supply vessel collisions, have a rather high probability of occurrence, approximately 17 percent per platform in year (Serco Assurance, 2003). Most of these events have occurred during operational mode of platform. Therefore, collision scenario only deals with platform columns. Local indentation is most likely to occur in members with large diameter/thickness ratio such as semi-sub columns.
Collision response analysis is a non-linear problem. The non-linearity is due to the large excessive plastic deformation associated with the denting processes.
This paper deals with the finite element analysis of collision between a supply vessel and semi-submersible platform .The case study used in this research is a kind of GVA4000 semi-submersible drilling unit, named Iran-Alborz and is going to operate in Caspian Sea in the near future. LS-DYNA general-purpose explicit finite element code, which is a product of ANSYS software, is used to model and analyze the non-linear response of the platform due to collision.

LITERATURE REVIEW

Zayas and Dao (1985) developed a simplified analytical approach and compared the results with experimental results obtained from a 1:6.25 scale model test of SEDCO 711 semi-submersible offshore rig column damaged by ship collision. The column incorporated T-ring circumferential stiffeners, stringers (orthogonal stiffeners) and three internal vertical bulkheads. The simulated collision was the side impact of a ship and analytical approach was found to overestimate the strength of the column.
Dowling, Ronalds, Onourfriou and Harding (1987) examined the consequences of a supply vessel striking the column of a floating rig. Tests were conduced on small-scale shell with ring and/or stringer stiffeners. The tests simulated the effects of accidental loads and then established the reduction in compressive strength induced by the damage. The results were correlated with finite element models and other analytical techniques that in turn have been used to develop design guidance. The effects of scaling however were not examined.
HSE published a report based on UKCS collision incident data up to 2001 that named “Resistance of semi-submersible to collision” (K.W. Consultants, 2002). This report presents a review of the state of guidance relating to the capabilities of semi-submersibles to resist the effect of collision and provides an assessment of the continuing validity of the likely impact energies in the withdrawn department of energy (DEn) 4th edition offshore design guidance note. In this report, the dent assessment of the columns of AkerH_3 and AkerH_4 semi-subs carried out using with finite element analysis. The FE model was created and was solved using ABAQUS Version 6.1. For a column of semi-submersible, the overall contribution of bending deformation to energy dissipation due to lateral collision is less significant. This implies that majority of the response is confined to localized plastic deformation. Therefore, it is not necessary to model the full length of the semi-sub’s columns in order to capture its desired response due to ship impact. In addition, due to the symmetry only one half of column section was modeled with brick elements. Only three bays of the ring-stiffened shell were modeled in the analysis. The ring-stiffeners were represented as rigid members of equivalent stiffness equals to 1000 times the stiffness of the cylindrical shell. The collision was modeled as a crushing of a pipe by a rigid body. The impacting vessel was