

Non-Linear Analysis and Redundancy Approach for Analysing Offshore Steel Structures During Ship Impact

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ABSTRACT

This paper outlines the general approach to analyse fixed offshore steel platforms for accidental ship impact. The objective is not to design the platform to resist the ship impact but rather to absorb the impact energy. The approach is to utilise non-linear behaviour of the steel materials and system redundancy of the structures in assessing the platform integrity. A series of plastic hinges and member damages are allowed during the impact, however there should be no danger of platform collapsing. The structure should be able to withstand a specified weather window so that the damage members could be repaired if necessary within a reasonable time.

Key words: non-linear, redundancy, ship impact,

1.0 INTRODUCTION

Ship impact may be classified as ill defined loading in term of offshore platform design. The intensity of the loading is varies and dependent on ship approach speed and mass. The procedures of how to approach offshore platform to minimise risk of colliding are well established for most of the platform operators. However accidental of ship colliding with offshore platform did happen, normally due to the human error or ship mechanical failure. For this reason codes of practise and authority require platforms to be designed for the ship impact loading.

The use of barge bumper or fender with mechanical absorber to safeguard the platform is a long practise for certain platform operators. This method is proven to be effective in term of absorbing the impact energy resulting from the ship impact. These devices are normally located at splash zone area (normally between elevation (+)3.0m to elevation (-)3.0 below mean sea level), thus attracting sizeable magnitude of current and wave loading. This additional loading will definitely requires more steel and piling to be added to the structures which will increase the capital investment of the offshore platform. Periodical inspection and maintenance of these devices against corrosion and damages will add to the life cycle cost of the platform.

With the uncertainty of the crude oil price world wide, the operators ever since looking for alternative approach or improvement in design which could save the initial capital investment and life cycle cost of the offshore platform without sacrificing the safety and operability.

One of the approach is to provide minimal or no protection at all against the ship impact. This is possible using non-linear approach and system redundancy in analysing the offshore steel structures

2.0 OBJECTIVES

The objectives of the impact assessment are :

- To perform an analysis to determine maximum energy levels that can be absorbed, thus obtaining an indication for non-linear, ultimate strength of the structures.
- The structure shall satisfy the ship impact criteria with a minimum penalty, i.e. 4 MJ (to be absorbed without the risk of progressive collapse).
- Where local damage may occur, progressive collapse shall be avoided.
- The structure has sufficient post impact strength to safely resist a mild (5 yr) storm. This will ensure that there will be adequate time (initially assumed one year) for carrying out offshore repairs.

The boat impact and reserve strength of the damaged structure will be assessed using a suitable non-linear program. The program has the capability to analyse non-linear structures and members with local damage, in addition it is ideally suited using the restart technique to check the post-impact case for progressive collapse.

3.0 DESIGN CRITERIA

3.1 Energy Level

Depending on geographical location, the energy level of 4.0 MJ considered in the analysis is normally sufficient to account for the