

## Fatigue Damage Assessment for Drillship Structure based on Stochastic Method

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### ABSTRACT

TOI drillship, first drillship of DSME, was designed to have more than 25 years' fatigue life against given environmental conditions. Fatigue damage in hull and hull-topside interface structures was assessed based on stochastic method. D-SAFS, developed by DSME, generates stress RAO based on 'Component Based Method'. Structural analyses were carried out for each load component. Resultant stress was combined with wave load analysis results. Whole ship FE models having fine mesh in fatigue sensitive area were used in structural analysis. According to the agreement with Owner the vessel is assumed to spend 20% of her life in North Atlantic and 80% in On-site (Gulf of Mexico or Shetland in Summer Season). Some hot spots did not satisfy design fatigue life of 25 years for given sea states. Through geometry modification, structural reinforcement or improving fabrication method such as grinding, all structural details could satisfy design fatigue life of 25 years.

**KEY WORDS:** Drillship; Fatigue; Component based Method; Stochastic; Interface Structure; stress RAO; Moon Pool

### INTRODUCTION

To verify hull strength of TOI drillship, first drillship of DSME, various kinds of analysis were carried out in DSME according to DNV Offshore Standards and Ship Rules. Global and local design of TOI drillship was determined based on direct calculation for DNV rule and direct wave loads.

Fatigue damage was also assessed for hull & hull-topside interface structure using wave load analysis results based on stochastic method. WADAM developed by DNV was used in wave load calculation.

In traditional stochastic analysis, calculated wave loads are directly transferred to whole ship model. In this method, force equilibrium is automatically obtained if FE model has exact mass distribution.

In this project, D-SFAS, which was developed by DSME and already applied to several past projects, was used in stress RAO generation and damage assessment. Stress RAOs were made based on 'Component Based Method'. In this method structural analyses are carried out for each unit load case and then resultant stress is combined with wave

load analysis results to generate stress RAOs. Therefore, whole FE model can be used instead of whole ship FE model and non-linear effect such as wave elevation can be introduced to some degree (Han, 2005, 2006). Moreover, by introducing larger external panel with non-uniform pressure distribution in this project, the number of structural analysis was significantly reduced without sacrificing accuracy.

Whole ship FE models having fine mesh in fatigue sensitive area were used in structural analysis. For precise inertia load prediction, mass elements were arranged in topside structure. Different steel density was applied along ship length for mass adjustment of hull structure.

Based on calculated stress RAOs and given sea states fatigue damage of considered fatigue sensitive areas was assessed. SN curves in 'Air' and 'in sea water with cathodic protection' were as used according to given environment.

According to the analysis results, some structural members were reinforced or fatigue life improvement techniques such as grinding were introduced to satisfy the design fatigue life of 25 years.

Table 1 Principal Dimension of TOI Drillship

L.O.A.	254.4 Meter
L.P.P.	240.0 Meter
Breadth	38.0 Meter
Depth	19.0 Meter
Draught design	12.0 Meter
Draught Scant.	13.0 Meter

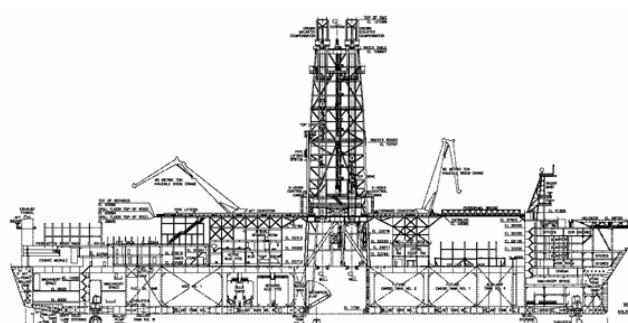


Fig.1 TOI Drillship – General Arrangement