ABSTRACT

Jack-up drilling rigs are widely used in offshore oil and gas exploration industry. It is originally designed for use in the shallow waters; there is growing demand for their use in deeper water depth and harsher environmental conditions. In order to extend the operating range of jack-up units, it has to be designed reliable analysis as well as eliminating excessive conservatism. Jack-up drilling rigs have been designed by using allowable stress design approach. Recently, the class rule has developed specific regulation based on the load and resistance factor design method based on the reliability foundation. This method is statistically based method which utilizes concepts of limit state design. It uses factored loads and employs resistance factors to account for uncertainty in the loads and computed strength of the leg components in jack-up drilling rig. In order to compare the two methods (ASD-Allowable Stress Design and LRFD-Load & Resistance Factored Design), lattice leg structure was calculated using ASD and LRFD at different environmental load to dead load ratios in order to compare the load to capacity ratios of each method at these varying ratios.

KEY WORDS: Allowable Stress Design, Load & Resistance Factored Design, Leg Structure, Jack-up Drilling Rig, Capacity Ratio

INTRODUCTION

The jack-up rigs have been generally used in offshore oil and gas exploration industry (Martin, Williams, Richard, Thompson, Guy, Houlsby, 1997). It is originally designed for use in the shallow water; there is growing demand for their use in deeper water depth over 150m and harsher environmental conditions such as North-SEA (Tan, Lu, 2003). The jack-up unit design has traditionally been performed using allowable stress design (ASD) in which all uncertainty in loads and material resistance is combined in a factor of safety. In 1989, work began on an entirely new specification in which the uncertainty in load(s) is represented by a load factor(s) which generally has a value greater than one, and the uncertainty in material resistance(s) is represented by a resistance factor(s) which generally has a value less than one. The AISC Load and Resistance Factor Design (LRFD) Specification was approved for use offshore industry in 1994. Due to the differences between the offshore structural design process by ASD and LRFD, some of classifications (API, SNAME, AISC) sponsored development of this training course to present the fundamentals of LRFD to offshore design engineers, geotechnical engineers, engineering geologists and others who are responsible for design of top side structures using the LRFD Specification. This criterion focuses on the load-carrying capacity aspects of structure design. LRFD and ASD loads are not directly comparable because they are used differently by the load-carrying capacity aspects of structure design. LRFD and ASD loads are generally compared to members or components allowable values that are less than the full strength of the members whereas ASD loads are compared to members or components allowable values that are less than the full strength of the member or component. In order to determine which design philosophy is more or less demanding (i.e. results in larger members), it is necessary to "unfactor" the load combinations using the material specific strength and allowable stress requirements. Also, there are times when engineer will know the capacity of a member relative to a limit state and want to know what actual loads. The objectives of this paper are to provide the basis for understanding of the;

• Differences between ASD and LRFD for jack-up unit design
• Benefits of LRFD for jack-up unit design

At the beginning, a brief review is made on previous research works related to comparative study of between ASD and LRFD for the offshore steel based structures. Martin S. Williams et al. (1999) performed nonlinear FEM analyses using a two-dimensional model to investigate dynamic response for offshore jack-up unit. It is shown that the accurate non-linear modeling of both the legs and the spudcan footings has a significant effect on the rig dynamics. The widespread practice of modeling the footings as simple pinned supports may be non-conservative for some sea states. D.R. Lewis et al. (2006) presents an approach that addressed some of the more important parameters for Gulf of Mexico site assessment using the Society of Naval and Marine Engineers (SNAME) Technical and Research Bulletin 5-5A, “Guidelines for site specific assessment of mobile jack-up units” (Bulletin 5-5) for site assessment. The application of the recommendations in the research is aimed at providing a consistent approach for Gulf of Mexico site assessment when these units are manned. A.C. Morandi et al. (1999) describes a comparative study on the structural reliability of a sample jacket and a sample jack-up rigs. The methodology adopted in outlines and results obtained presented with