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Offshore Structures: Adequate Margins

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Abstract

This paper will focus on the design and assessment aspects of fixed steel platforms - the existing target design levels coupled with the strategy and implicit as well as explicit design margins within. Additionally, correlations will be made to the floating facilities and the design points and margins inherent within these codes.

Recent experience, from Hurricane Andrew to Hurricane Katrina, has proven valuable in the performance of various catetogories of offshore platforms. The observed behavior of these platforms provides a basis for qualititative assessment of the performance of the facilities relative to the underlying design premises, design codes and the robustness of the codes themselves.

Whether working with allowable stress codes or partial factor codes, the underlying process for both can be referenced to allowable stress codes. Starting with the underlying premise of elastic component design with components exposed to a design target, often 100 year criteria, the codes have target design limits, allowable stress levels, that are some percentages of yield and ultimate. These ratios are explicitly understood by code developers. In addition, there are frequently additional margins that are explicitly included and implicit margins (differences between miminum design strength of material and actual design strength, system behavior, etc)that contribute to the overall strength and resistance of a facility.

This paper will examine the relationship of design levels and expected/observed failure levels and the ratio between them. Frequently structures designed to the 100 year design point do not "fail" until loads in the 400 year or greater range are experienced.

In addition to relating design points to capacity points, observations regarding subsystems, for example equipment skids and drilling rigs, will be made with correlation to the design point and capacity points.

Introduction

In the past 50 years, offshore design practice has matured from an extension of land based structural design in a frontier area to a somewhat mature structural design practice with a substantial amount of innovations to form a robust practice. While much of offshore structural design still parallels land practice, the uniqueness of the wind, wave and current environment with difficulty in accurately predicting the likelihood of these forces has led to misunderstandings. Due to the foresight the offshore design pioneers and subsequent code developers, the underlying practices and strategies have provided a successful framework that has served the industry well, even in times of severe hurricanes.

The use of design points and design margins is one of the misunderstood concepts. It has not been uncommon in the past 18 months to hear about the “undersdesign” of offshore structures compared to land structures. Individual values of wind speeds or another value have been frequently taken out of context. Likewise, the 100 year force level as a design point has been written about as if a facility will fail at that level.

Through the wise use of design margins, structures designed to 100 year force levels will frequently survive storms of 400-900 year retrun period magnitudes or greater provided the deck elevations are sufficiently high and in excess of 250 year return period storms if decks are somewhat low.

Design Codes

Design codes have been utilized by both the engineering community and societies to insure baseline performance of facilities that meets societal needs. Codes have been developed to help meet socital expectations that the features of a structural design – serviceability, safety and economy – are sufficiently balanced. In recent times, design codes have been a principal means of transferring research, technology development information and lessons learned from the knowledge of a few to general practice. Codes generally develop once an area has matured to a level that adequate knowledge has been gained to allow for standards of practice to be conveyed. Many codes are today legal documents to which facilities, products, etc. must adhere.

The concept of design point is built around the need to have defined conditions upon which the design of a structure is based. The defined conditions have been developed to