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Determination of optimal safety factors for tubular Y- joint of jacket-type offshore platforms based on reliability analysis

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Abstract

Tubular joint is one of the most sensitive parts of jacket structure. Lack of enough accuracy in its design would lead to irreparable damage to the entire structure.Given the uncertainties in the manufacturing process, parameters such as resistance and load are structural members of random variables and cannot have absolute safety (zero failure probability).Therefore, the standard design should have a performance with a reasonable probability of failure. Reliability analysis is the ability of the structure to perform its design objectives specified in the lifetime of the structure. Failure of large structures, such as jacket platforms, often happens in welded tubular joints.Therefore, estimating the reliability of offshore platform joints that involve different failure modes is important and necessary. Depending on the linearity or non-linearity limit of the state function, diffrent methods of analysis are used.One important application of reliability methods is to calibrate the safety factor in the design process to achieve a sustainable level of safety. Considering the approach of calibration code, the probability of failure or safely level of the structure can be restricted.

Keywords: Reliability, Safely factors, Tubular joints, Code calibration.

1. INTRODUCTION

Nowadays, there are offshore platforms in many oil-rich parts of the world and Iran; though their useful life of exploitation has ended, there are still reserves of hydrocarbons in these reservoirs. Developing a regular schedule for intelligent maintenance and inspection of such platforms reveals the necessity for analyzing their safety. Failure of such structures is mainly due to a fatigue crack growth in welded joints and insufficient material strength. Numerous uncertainties involved in the analysis of fatigue, loss of national wealth resulting from the destruction of a platform, and existence of failure modes are among the fundamental reasons which necessitate checking the reliability of offshore platforms.

To date, great deal of research has been done on the reliability of offshore platforms. In this regard, reliability analysis of offshore structures was initially proposed to investigate the fatigue issue [1]. This can be due to the random nature of sea and fatigue loading. In addition to examining the reliability of fatigue, in order to determine the ultimate capacity, reliability of structures in stormy sea conditions was, also, investigated [2]. Initially, due to the complexity of structures, calculation of structural reliability was associated with some simplifications [3]. Gradually, with advances in software and hardware, attempts were made to investigate soil resistance in reliability calculation or failure probability of the platform while determining the effects of random loading factors such as wave height, wave period, wind speed, and flow velocity, as well as resistance parameters such as yield stress [4]. Other studies, which have been continued to this day, have considered the structural system with a large number of failure modes rather than structures with one dominant failure mode; researchers are often looking for the influence of these moods on the probability failure of the members [5, 6]. However, in reliability analysis, there is not a mechanical interaction between different failure modes.

With all these in mind, this paper, firstly, briefly presents the basic concepts of reliability such as safety areas, reliability index, and model uncertainty. Then, it proceeds to determine the ultimate static strength of a tubular Y-joint using some forms of regulations. Next, it continues to determine safety values and optimal safety factor for the joints of the study using the recommended limit values for probability of failure.