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Experimental and numerical investigation of geometric SCFs in internally ring-stiffened tubular KT-joints of offshore structures

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Abstract

Although the tubular KT-joints are quite common in offshore structural design and despite the crucial role of stress concentration factors (SCFs) in evaluating the fatigue performance of tubular joints, the SCF distribution in internally ring-stiffened KT-joints has not been investigated so far and no design equation is currently available to determine the SCFs for this type of joint. In the present paper, results of experimental and numerical investigations of the SCF distribution in internally ring-stiffened tubular KT-joints are presented. In this research program, experimental study has been followed by a set of parametric stress analyses for 118 steel ring-stiffened KT-joints subjected to balanced axial loads. The analysis results are used to present the general remarks on the effect of geometrical parameters on the SCF distribution along the weld toe, and to establish a new set of SCF parametric equations for the fatigue design of internally ring-stiffened KT-joints.

1- Introduction

Offshore jacket-type platforms are mainly fabricated from tubular members by welding one end of the branch member (brace) to the undisturbed surface of the main member (chord), resulting in what are known as tubular joints. The static and fatigue strength of tubular joints are the governing factors in the design of offshore steel structures.

Significant stress concentrations at the vicinity of the welds are considerably detrimental to the fatigue performance of the joints. Since offshore structures are subjected to cyclic wave loading, it is imperative that these structures be designed for long fatigue life. Hence, it is important to accurately determine the magnitude of stress concentration and to reduce it to a reasonable level. In the design practice, a parameter called the stress concentration factor (SCF) is used to evaluate the magnitude of the stress concentration. The SCF is the ratio of the local surface stress to the nominal direct stress in the brace and its value depends on the joint geometry, loading type, weld size and type, and the considered location around the weld.

If the capacity of a joint is found to be inadequate during the design stage, e.g. the chord thickness requirement is beyond the forming limits of fabricators, it can be enhanced by introducing stiffeners to the inside of the chord as this is an efficient method to reduce stress concentration, increase load-carrying capacity and fatigue life of joint, decrease the bending stress in tube walls, and avoid attraction of additional wave forces and corrosion attack. These types of joints are called internally ring-stiffened joints (Fig. 1).