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SCF Equations for TK Square-to-Round Tubular Joints

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ABSTRACT

A parametric stress analysis of TK square-to-round tubular joints, subjected to axial loads, and in-plane and out-of-plane bending moments, has been performed using the finite element technique in order to provide useful information for using such sections in the design of complex structures. Two types of axial loading and in-plane bending, and one type of out-of-plane bending were analysed. The results of this analysis are presented as a set of equations expressing the stress concentration factor as a function of the relevant geometric parameters for various loading conditions. Although the equations obtained are useful for estimation of stress concentration factors, further work, including experimental verification, should be carried out to study the said type of joint in detail before the equations can be presented for practical use. A comparison is made between the results obtained for square-to-round tubular joints and those obtained for round-to-round tubular joints by other researchers. The stress concentration factors for round-to-round tubular joints are generally lower than those of the corresponding square-to-round tubular joints.

NOMENCLATURE

d : depth and width of brace
D : diameter of chord
g : distance between intersections of braces 1 and 2 with chord in plane of joint
g_1, g_2 : distance between intersections of braces 1 and 3 with chord, and braces 2 and 3 with chord, respectively, in plane of joint
L : length of chord under study
SCF : stress concentration factor
t : thickness of brace
T : thickness of chord
$\sin\theta$: sine angle of inclination of braces 1 and 2 with respect to chord

INTRODUCTION

The fatigue life of round-to-round tubular joints has been widely studied (UEG, 1985), mainly because circular hollow sections (i.e., pipe sections) are commonly used to fabricate fixed offshore jackets that are subject to cyclic loadings consisting of wave and current forces. On the contrary, literature on the fatigue life of square-to-square and square-to-round tubular joints is not widely available because square hollow sections are seldom employed to fabricate complex structures that are subject to cyclic loadings. Attempts made by Soh et al. (1990) to reduce the cost for fabricating a conventional offshore platform (as shown in Fig. 1) by modifying the conductor guide design (as shown in Fig. 2) reveal the necessity for a better understanding of the fatigue life of square-to-square and square-to-round tubular joints. This necessity is due to the usage of square hollow sections in the proposed conductor guide design. However, the fatigue life of unreinforced tubular joints is closely related to the stress concentration factors of the joints. Thus, the fatigue life of square-to-square and square-to-round tubular joints can be studied only if the stress

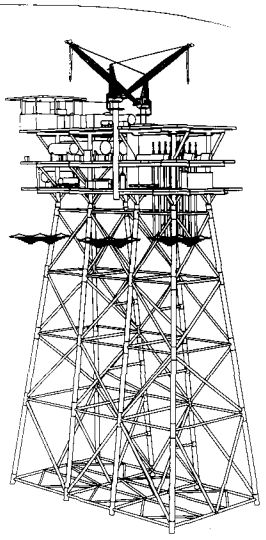

Fig. 1 Typical fixed offshore platform

concentration factors for various configurations of these joints, subjected to various loading conditions, are available. Soh and Soh (1989, 1990, 1991) have obtained a set of parametric equations for estimating SCFs for T/Y and K square-to-square and square-to-round, and DT/X square-to-round tubular joints subjected to axial loads and in-plane and out-of-plane bending moments. This paper describes a similar study carried out to obtain a set of parametric SCF equations for TK square-to-round tubular joints.

Fig. 3 shows a typical TK square-to-round tubular joint. It is important to note that only one-half of the joint was considered for analysing axial loads or in-plane bending moments but not out-of-plane bending moments. This is because both axial loads and in-plane bending moments are symmetrical about the plane of geometrical symmetry of the joint but not all types of out-of-plane bending moments. Thus, out-of-plane bending moments were analysed using the complete joint.

A parametric stress analysis of TK square-to-round tubular joints, subjected to axial loads, and in-plane and out-of-plane bending moments was performed using a well-established finite element software package, called PAFEC (1989), which runs on a

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KEY WORDS: Offshore platform, tubular joint, stress concentration factor, fatigue life, hot spot stress, brace-to-chord intersection, finite element method.