Faculty of Engineering
Structural Engineering Department

THE ULTIMATE CAPACITY OF MULTI-PLANAR TUBULAR KK-JOINTS IN OFFSHORE STRUCTURES

By

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B. Sc. (Honors) Civil Engineering - Structural Department
Ain Shams University - June 2000

A Thesis

Submitted in Partial Fulfillement for the Requirements
Of the Degree of Master of Science
in Civil Engineering

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Cairo – 2008

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Abstract of M.Sc. Thesis submitted by:

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2) Dr. Sherif M. Ibrahim

Registration Date: 14/07/2003
Examination Date: 03/06/2008

ABSTRACT

This research is concerned with the ultimate capacity of multi-planar tubular KK-joints in offshore structures under balanced axial loading. The effect of axially loaded chord under tension and compression is also covered in this research.

In this study a non-linear finite element model that takes into consideration both geometrical and material nonlinearities is presented to determine the ultimate capacity for three groups of unstiffened multi-planar tubular KK-joints.

Each group includes 48 specimens. The first group is investigated under no axial loading in chord, the second group is investigated under pre-loaded axial compression in chord and the third group is investigated under pre-loaded axial tension in the chord. The effect of varying the chord wall thickness, the brace diameter and the brace wall thickness on the ultimate capacity of joints is studied. One chord diameter for all the specimens was considered. In addition, different failure modes of joints are clearly detected. It was found that the increase of β (brace diameter to chord diameter) and γ (chord radius to chord wall thickness) increases the ultimate capacity while increasing τ (brace wall thickness to chord wall thickness) has no effect on the joint strength. Also the joint strength decreases when the chord is axially loaded under compression while increases slightly when the chord is axially loaded under tension. Finally the general mode of failure was found to be chord bending (buckling) at the brace chord intersection zone.

All the results were compared with the design equations in API (Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design, 2005). It was found that the design equations in the API are under predicting the ultimate capacity of multi-planar KK-Joints that failed under chord buckling even after eliminating all factors of safety except for the cases failed by brace local buckling.

A total of 108 joints with three different methods for reinforcing the chord member were investigated either using thick walled section (defined as CAN in offshore structures) at the brace/chord intersection, one internal annular ring stiffener inside of the chord member at the centre of the compression brace and two internal annular ring stiffeners, one at the centre of the compression brace and the other one at the centre of the tension brace. It was concluded that the ultimate capacity of joints stiffened with CAN achieved greater capacity than joints stiffened with annular ring stiffeners for $\beta=0.4$ and 0.6 while for $\beta=0.22$ joints with two internal ring stiffeners achieved higher capacities than CANNED joints.

Keywords: Offshore structures, tubular joints, ultimate capacity, multi-planar KK-joints, ring stiffened KK-joints.

ACKNOWLEDGMENT

First and foremost, praise and thanks to Almighty Allah, the Most Gracious, the Most Merciful, and peace be upon His Prophet.

I would like to express my deepest gratitude and appreciation to my supervisor, Prof. Dr. Abdelrahim K. Dessouki for his invaluable guidance, support and encouragement.

I also greatly appreciate the help, guidance and support provided by Dr. Sherif M. Ibrahim throughout all stages of research.

Finally I would like to express my heartfelt appreciation to my father, my beloved mother, my dear wife and the whole family for lots of support and encouragement.

STATEMENT

This dissertation is submitted to Ain Shams University – Faculty of Engineering for the degree of Master of Science in Structural Engineering.

The work included in this thesis has been carried out by the author in the Department of Structural Engineering, Ain Shams University, from August 2003 till May 2008.

This thesis was not submitted for a degree or a qualification at any other university or institution.

Date : 03/06/2008

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