STATIC STRENGTH OF TUBULAR DT JOINTS USING LUSAS FINITE ELEMENT SOFTWARE

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STATIC STRENGTH OF TUBULAR DT JOINTS USING LUSAS FINITE ELEMENT SOFTWARE

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A project report submitted in partial fulfillment of requirement for the award of the degree of Master of Engineering (Civil – Structure)

Fakulti Kejuruteraan Awam
Universiti Teknologi Malaysia

APRIL 2005

"I declare that this project report entitled " Static Strength of Tubular DT Joints Using LUSAS Finite Element Software" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree"

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DEDICATION

To father and mother

Thank you for your support

&

To sisters and brothers

thank you for eveything

ACKNOWLEDGEMENT

Alhmadulilah, Praise to Almighty Allah for the blessing and His permission, I am able to complete my master project.

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ABSTRACT

Structural tubular are widely used in the construction of offshore structures. As these structures are located in hostile environment, these joints represent structural weak spots and so it is desirable to develop reliable methods of determining their static collapse loads. This studies focus on the analysis of static strength of tubular DT joints under brace compression loading by using LUSAS finite element software. The numerical static strength result is compared with an experimental test result obtained from the literature. The value of the static strength obtained in this work is 56% lower than that of the experimental test. A parameter study was performed to study the effect of the geometric parameters α, β, γ and τ as well as the effect of the yield strength σ_y on the static strength of DT joint model. Finally, a simple equation relating the static strength to the above parameters is proposed.

ABSTRAK

Struktur sambungan tubular lazimnya digunakan untuk pembinaan struktur lepas pantai. Oleh kerana struktur ini terletak di persekitaran yang agresif, ia akan menyebabkan sambungan tubular struktur tersebut menjadi lemah. Oleh itu, satu kaedah yang baik adalah perlu untuk menentukan beban kegagalan statik bagi sambungan tersebut. Oleh itu kajian ini tertumpu kepada analisis kekuatan statik bagi sambungan DT bila brace dikenakan beban mampatan dengan menggunakan perisian LUSAS. Nilai kekuatan statik ini kemudiannya telah dibandingkan dengan keputusan ujian makmal yang diperolehi daripada literatur. Dalam kajian ini, nilai kekuatan statik yang diperolehi adalah 56% lebih rendah daripada nilai ujian makmal. Kajian parameter telah dijalankan untuk mengkaji kesan parameter geometri α, β, γ dan τ serta juga kesan kekuatan alah σ_y kepada kekuatan statik sambungan model DT tersebut. Akhirnya, satu formula mudah yang menghubungkan kekuatan statik sambungan DT dengan parameter-parameter di atas telah dicadangkan.

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D	=	Chord outer diameter
d	=	Brace outer diameter
T	=	Chord thickness
T	=	Brace thickness
L	=	Total chord length
l	=	Total brace length
σ_y	=	Yield strength
N	=	Newton
α	=	Length parameter (2L/D)
β	=	Diameter ratio (d/D)
γ	=	Chord radius to thickness ratio (D/2T)
τ	=	Wall thickness ratio (t/T)

CHAPTER I

INTRODUCTION

1.1. Introducing to The Tubular Structure

Tubular members are widely used in both onshore and offshore structures. Their attributes such as the high strength-to-weight ratio, low drag coefficient, and the ability to use their internal space have made them particularly useful in the offshore industry over many years. A typical example of the use of tubular members in an offshore situation is the fixed offshore platform (see Figure 1.1), where tubular members form a space frame to support the topside structure. Tubular connection design is a major factor in the design of a structure and can even be the limiting factor in terms of the strength of the structure.

Circular hollow sections are widely used in the construction of offshore structures in Malaysia. These sections offer many advantages over other sections. The sections have the ability to distribute load consistently. From the architect point of view, it has a minimum amount of surface area to unclean matter effect, rust and other spoil. With a circular form, it has an advantage in reducing the effect of wind, wave and blast loadings.

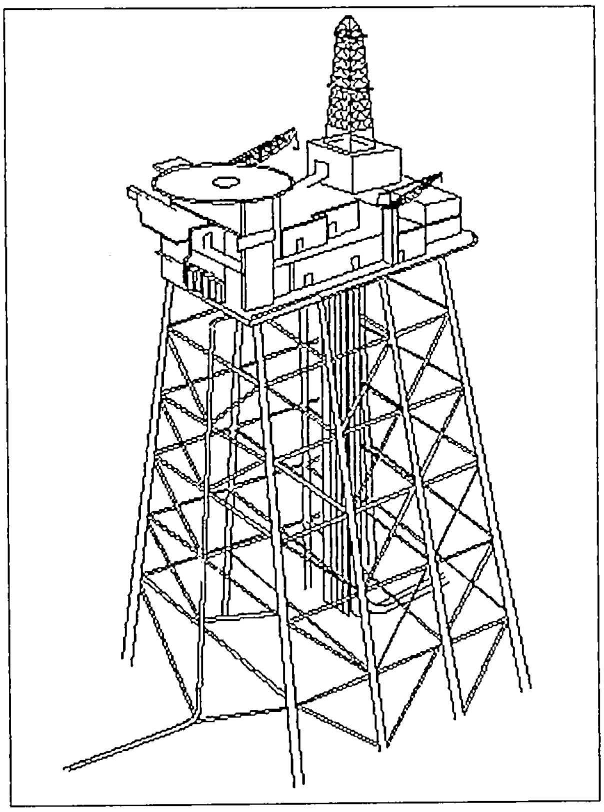

Figure 1.1: A typical jacket structure [1]

1.2. Problem of Study

Structural tubular joints are widely used in the construction of offshore structures. As these structures are located in hostile environment, these joints represent structural weak spots and so it is desirable to develop reliable methods of determining their static collapse loads.

It is impractical to test actual joints due to their massive sizes and also in view of the associated testing costs. Testing small-scale steel joint models of various shapes was widely carried out in the past. However, the manufacture of these joint models needs highly skilled welders and the exact shape of fillet welds is not repeatable.

An attractive alternative is to carry out finite element analysis using a suitable software to obtain the static strength results. If the results are good, this method can be used to performed a parameter study to investigate the effect various geometric parameters on a joint static strength.

1.3. Objectives of Study

The static strength of tubular DT joints will be studied using LUSAS finite element software [2]. Objectives of the study are:

a) to create a good finite element DT joint model.
b) to carry out a mesh convergence study.
c) to define the maximum load attained during the elastic plastic response of the joint.
d) to compare the static strength results of tubular DT joint between finite element software and previous experimental test.
e) to performed parameter study to investigate the effect of the various geometric parameters on the static strength of DT joints.
f) to develop a simple formula to calculate the static strength of DT joints.

1.4. Scope of Study

The LUSAS finite element software will be used to determine the static strength of tubular DT joint. In this study, the static strength of a tubular DT joint is defined as the maximum load attained during the elastic plastic response of the joint and this is shown in Figure 1.2. Data for the analysis are taken from a previous experimental testing on a similar DT joint performed by Kang et al.[3].

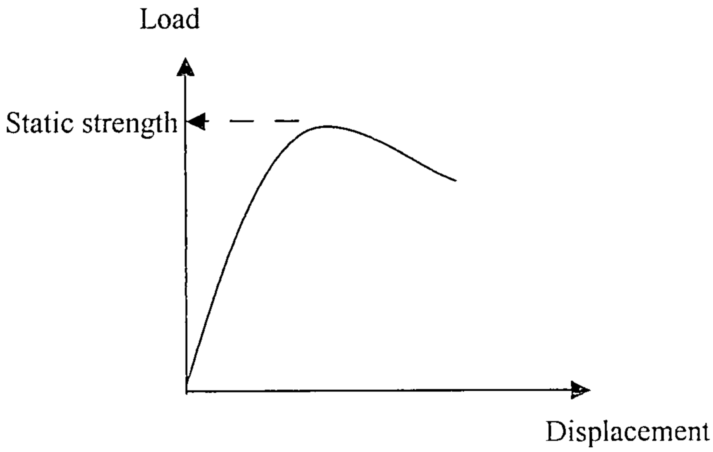

Figure 1.2: An elastic plastic response of the joint

To obtain the static strength by using LUSAS software, the dimensions of the DT joint finite element model had been based on the dimensions and data of the actual joint test performed by Kang et al.[3]. Before the comparison of the static strength result predicted by the LUSAS software and that of the actual test, a mesh refinement was conducted by performing non-linear analysis of the DT joint model under brace compression loading using different element density applied to the chord area near the brace wall.

CHAPTER II

REVIEW OF LITERATURE

2.1. Introduction

Tubular joint constitute one of the main problems and high cost areas in the design, construction and maintenance of steel structures and have been the subject of considerable research effort. The Department of Energy commissioned a study in 1980 of the various design documents, with particular emphasis on the static strength of tubular joints [4].

2.2. Tubular Structure

A tubular structure consists of a framework of hollow pipes made from steel. There are two types of hollow section used, circular and rectangular. However, circular hollow sections are more generally used in offshore structure construction. It is because these sections have a small surface area, can minimise the wind and wave load and also have a high ecstatic value.

2.3. Tubular Joint

A tubular joint is a joint between the brace and the chord. Figure 2.1 shows the various types of joint widely used for offshore construction work.

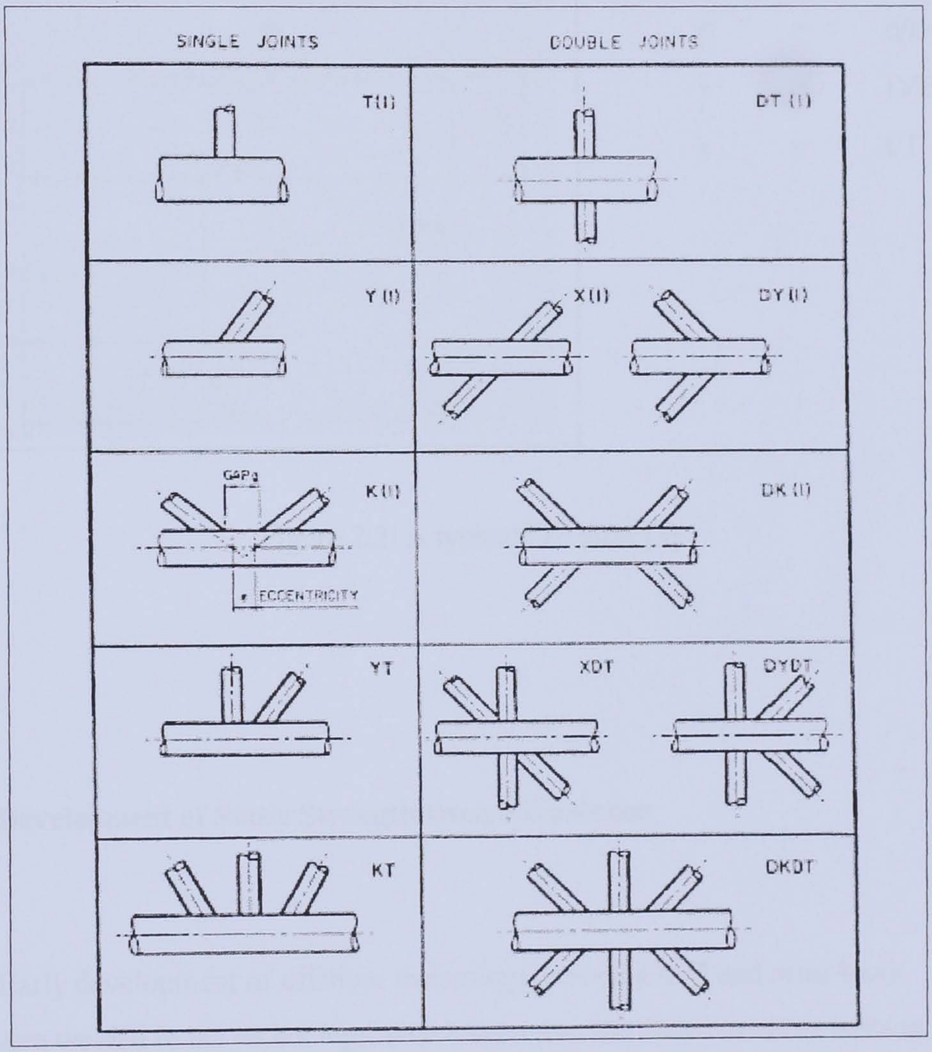

Figure 2.1: Various types of tubular joint [5]