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JUDUL : **FINITE ELEMENT ANALYSIS ON THE STRENGTH OF FLUSH ENDPLATE CONNECTION WITH TRAPEZOID WEB PROFILE BEAM USING LUSAS SOFTWARE**

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FINITE ELEMENT ANALYSIS ON THE STRENGTH OF FLUSH ENDPLATE CONNECTION WITH TRAPEZOID WEB PROFILE BEAM USING LUSAS SOFTWARE

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A project report submitted in partial fulfillment of the
requirements for the award of the degree of
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NOVEMBER 2007

I declare that this thesis entitled "*Finite Element Analysis on the Strength of Flush Endplate Connection With Trapezoid Web Profile Beam Using LUSAS Software*" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Ayahanda, bonda dan adik-adik tercinta
Pengorbanan dan kasih sayang
Menjadi dorongan

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ABSTRACT

Conventional design for steel constructions utilize simple or full strength connection between beam to column connections. However, a majority of the actual connections show a partial strength behaviour. Lack of use of partial strength design is mainly due to lack of understanding of their behaviour, and full scale laboratory tests have been done for this reason. However, full scale tests are expensive and time consuming, and finite element modeling using existing software is a preferred alternative. The flush endplate is used in this research for the partial strength connection, with Trapezoid Web Profiled steel section as beam and hot rolled UC section as column. Three dimensional finite element model of flush endplate connection has been developed and analyzed using LUSAS, to develop the moment-rotation relationship of the connection and to determine its moment resistance. Validation of the finite element result was done by comparing them with existing experimental results. It was found that the finite element moment resistance, M_R, was 28.17% more than the test result. The moment-rotation (M-Φ) of both methods show similar characteristics. The modes of failure for both experimental and finite element models are also similar.

ABSTRAK

Rekabentuk struktur keluli biasanya dilakukan dengan menggunakan sambungan mudah atau sambungan tegar bagi sambungan di antara rasuk dan tiang. Bagaimanapun, kebanyakan kelakuan sambungan sebenar adalah separa tegar. Kekurangan penggunaan sambungan separa tegar di dalam rekabentuk sambungan keluli adalah disebabkan oleh kurangnya pemahaman mengenai kelakuan sambungan itu sendiri, dan ujikaji makmal berskala penuh telah dijalankan untuk tujuan itu. Ujikaji makmal berskala penuh adalah mahal dan mengambil masa yang panjang, oleh itu permodelan menggunakan kaedah unsur terhingga menggunakan perisian sedia ada lebih digemari. Sambungan keluli jenis plat hujung sedatar telah diambil sebagai sambungan di dalam projek ini, di samping rasuk berprofil trapezoid. Model unsur terhingga tiga dimensi telah dibina menggunakan perisian LUSAS, untuk mendapatkan lengkung momen-putaran dan rintangan momen bagi sambungan tersebut. Keputusan daripada analisis LUSAS telah dibandingkan dengan keputusan makmal untuk menentukan keberkesanan analisis menggunakan kaedah unsur terhingga bagi sambungan ini. Didapati bahawa momen rintangan bagi kaedah unsur terhingga adalah 28.17% lebih tinggi daripada keputusan makmal. Graf momen-putaran (M-Φ) bagi ujikaji makmal dan analisis unsur terhingga menunjukkan ciri-ciri yang hampir sama. Mod kegagalan model yang diperolehi melalui kedua-dua kaedah juga adalah serupa.

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M_R	-	Moment resistance
M	-	Bending moment
Φ	-	Rotation
M-Φ	-	Moment-rotation
TWP	-	Trapezoid Web Profiled
$S_{j,ini}$	-	Initial stiffness
p_y	-	Design strength
k_c	-	Elastic spring stiffness
P	-	Applied load
dX	-	Displacement in X direction
dY	-	Displacement in Y direction

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Steel construction holds substantial advantages over reinforced concrete construction. These advantages can be based on factors such as flexibility, durability, quality and economy. The flexibility of steel construction can be discussed as its ability to be customized to suit the construction requirements, regardless of the size of the structure to be constructed.

Steel is also more durable compared to reinforced concrete, in the sense that it can better withstand chemical and environmental attacks. Steel maintenance primarily focuses on corrosion whereby for reinforced concrete wider range of maintenance is needed. The quality of steel is also generally of higher standard, because they are manufactured in factories where the quality is controlled.

Although the cost of steel is high, fast erection and elimination of falsework will provide a reduction in overall cost of construction. Also, because steel is lightweight, it is the most suitable material for high rise constructions.

Steel structures are built using many components, such as tension members, compression members, bending members, combined force members and connections [1]. Amongst the said components, connections are the most critical. Most steel structure failures are caused by inadequate and poorly designed connections, while failure due to main structural members is rare.

Conventional steel constructions utilize pinned or rigid connection between beam to column connections, where only nominal moment is designed to be transferred from the beam to the column for the former, and full moment transfer is designed for the latter.

Another type of connection can be designed for beam to column connections in steel construction, where it utilizes a condition between simple and rigid connection design. This type of design is known as semi rigid or partial strength connection design. However, as opposed to conventional design, the value of the moment resistance, M_R, of the connection must be known prior to designing using the semi rigid design.

Expensive laboratory work and testing is needed to determine the value of moment resistance for a specific connection and also to understand its behaviour, particularly the mode of failure. This experimental method is not only costly, but also time consuming. An alternative method is modelling of the connections by finite element method using computer software. Because of the developments in the fields of finite element analysis and computer technology, this method is not only

made possible, it is also more economical, less time consuming, and various types of connections can be modeled with relative ease.

1.2 Problem Statement

A semi rigid bolted flush endplate connection represents various complexity and undefined problems with many parameters affecting its behaviour and structural capacity. It is costly and time consuming to undertake laboratory testing to understand the real behaviour of the connection. To save time and cost, finite element analysis is an ideal approach in order to understand the characteristics of semi rigid flush endplate connections, such as moment resistance and mode of failure. However, the accuracy of the analytical results from finite element analysis needs to be validated by comparisons with the results of full scale laboratory tests.

1.3 Research Objective

The objective of this research is to model a flush endplate connection using finite element method. From the results of the analysis, the moment-rotation (M-Φ) curve of the connection is to be plotted in order to determine the moment resistance (M_R) of the connection. Furthermore, comparisons need to made between the analytical results and the results obtained from full scale laboratory tests in order to determine its accuracy.

1.4 Research Scope

In this research, a semi rigid beam to column connection will be analyzed using finite element analysis software, LUSAS 13.57 [2]. This research is focused on a bolted flush endplate connection, and it is modeled by connecting the endplate of a trapezoid web profiled beam to the flange of an I section column. The dimensions for the model will follow the dimensions used in the full scale laboratory test, conducted by M. Md. Tahir et al. [3], in which the comparisons will also be referred to.