

**FINITE ELEMENT INVESTIGATION ON THE STRENGTH OF
SEMI-RIGID EXTENDED END PLATE STEEL CONNECTION
USING LUSAS SOFTWARE**

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NOVEMBER 2007

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SEMI-RIGID EXTENDED END PLATE STEEL CONNECTION
USING LUSAS SOFTWARE**

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A project report submitted in fulfillment of the
requirements for the award of the degree of
Masters of Engineering (Civil - Structure)

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ABSTRACT

This paper discusses on the use of LUSAS software to investigate the behaviour of semi-rigid extended end plate bolted connection using trapezoidal web profiled beam. To understand the real behavior of the semi-rigid connection, laboratory test is the most accurate approach, but it is expensive and time consuming. With the development of the fields of numerical analysis and computer technology, modeling by finite element method using software maybe a possible the alternative to the expensive laboratory test. LUSAS Version 13.5 software has been used for modeling and analyzing the connection of two specimens with different dimensions. The results of analysis are compared with the existing experimental data to determine the accuracy of the analysis prediction. This research focused more on the parameter and comparison of the shape of moment-rotation curve, moment resistance, and the mode of failure for each specimen. The analysis shows that, the mode of failure and the shape of moment-rotation curve from the finite element model are almost similar with the experimental results. However, the percentage difference of the predicted moment resistance value is very high and not in reasonable range. From this study, it can be concluded that the finite element analysis still need to be revised to be used as tool to analyze the behaviour of extended end plate beam-to-column bolted steel connection

ABSTRAK

Kertas kajian ini membincangkan tentang penggunaan perisian LUSAS bagi mengkaji sifat sambungan separa tegar plat hujung memanjang menggunakan rasuk web berprofil trapezoid. Bagi memahami sifat sebenar sifat sambungan separa tegar, ujian makmal merupakan cara yang paling tepat, tetapi ia melibatkan kos yang tinggi dan mengambil masa. Melalui bidang analisis numerikal dan teknologi komputer yang semakin berkembang, pemodelan dengan kaedah unsur terhingga menggunakan perisian mungkin menjadi alternatif lain kepada ujian makmal yang mahal. Perisian LUSAS versi 13.5 telah digunakan untuk membina model dan menganalisis sambungan bagi dua spesimen dengan dimensi yang berbeza. Keputusan analisis yang diperolehi telah dibandingkan dengan data ujian makmal sedia ada bagi mendapatkan ketepatan analisis. Kajian ini lebih tertumpu kepada parameter dan perbandingan bentuk lengkungan momen-putaran, rintangan momen, dan mod kegagalan bagi setiap spesimen. Perbandingan menunjukkan bahawa, mod kegagalan dan bentuk lengkung momen-putaran daripada model unsur terhingga adalah hampir sama dengan keputusan ujian makmal. Namun begitu, perbezaan peratusan bagi nilai rintangan momen adalah sangat tinggi dan tidak berada dalam julat yang boleh diterima. Daripada kajian ini, dapat dirumuskan bahawa analisis unsur terhingga masih perlu kajian lanjut untuk kegunaan bagi menganalisis sifat sambungan keluli berbolt plat hujung memanjang rasuk ke tiang.

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LIST OF SYMBOLS

M	-	Moment
Φ	-	Rotation
w	-	Uniform Distributed Load
l	-	Length
M_p	-	Fully Plastic Moment of Beam
Φ_p	-	Beam Rotation at Beam Moment – M_p
H	-	Height
D	-	Depth
Σ	-	Stress
P	-	Force
A	-	Area
K	-	Spring Stiffness
X	-	Translation in X direction
Y	-	Translation in Y direction
Z	-	Translation in Z direction
θ_x	-	Rotation in X direction
θ_y	-	Rotation in Y direction
θ_z	-	Rotation in Z direction
F	-	Loading for Half Model
$M_{fullmodel}$	-	Moment of Full Model
$M_{halfmodel}$	-	Moment of Half Model
dX_i	-	Displacement in Global X direction for Node i
dY_i	-	Displacement in Global Y direction for Node i
FY_i	-	Loading in Global Y direction for Node i
ΔX	-	Displacement in X direction
ΔY	-	Displacement in Y Direction
M_r	-	Resistance Moment

CHAPTER 1

INTRODUCTION

1.1 Introduction

In Malaysia, there is an increase in the use of steel for construction projects, especially in buildings such as industrial buildings, commercial buildings, residential buildings, even in sport infrastructure. Structural steel is very desirable in modern construction because of its unique attributes. It possesses attributes such as strength, stiffness, toughness and ductility. Steel is also widely used because of its prefabricated sections. Those sections are manufactured in the factory and combined or constructed on site. Therefore the time of construction works can be reduced because there is no need to build moulds as in the construction of the reinforced concrete. Moreover, in the construction of reinforced concrete structures, the concrete require a few days to gain strength before further construction can be continued. But this problem will not occur if the construction uses structural steel. Therefore, the construction speed will be faster, which may indirectly reduce the cost of the construction.

Steel structures typically consist of basic components such as tension members, compression members, bending members, combined force members and connections. In a building structure, steel connection forms a very important position because it provides strong link between the other principal structural elements so that these components can work together properly. Therefore, accurate details, behaviours and specifications of connections are required to ensure building's stability and safety.

1.2 Problem Statement

Semi-rigid extended end plate connection represents various complexity and undefined problems with many of parameters affecting its structural behaviour. To understand the true behaviour of steel connections, many researchers depend mainly on the results from the laboratory experiment work and testing. However, the experimental method is highly costly and timed consuming. Therefore, analysis and design using finite element software is more preferable.

1.3 Research Objective

The purpose of this research is to determine the moment-rotation curve characteristic of the extended end plate steel beam to column connection obtained from LUSAS software analysis ^[1]. Secondly, it is to determine the accuracy of the analysis result by comparing them with the result obtain from a full scale laboratory test.

1.4 Research Scope

In this research, the connection of steel beam connection will be modeled using finite element software; LUSAS. The research is focused on the extended end plate connection and this modeling is conducted by connecting the end-plate of beam to the flange of column by three pairs of high-strength steel bolts. The dimension of the model and the comparison of the analysis results are referred from research paper work reported by Md. Tahir et al ^[2].