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

MOHD MAIZIZ BIN FISHOL HAMDI

Faculty of Civil Engineering
Universiti Teknologi Malaysia

NOVEMBER 2007

UNIVERSITI TEKNOLOGI MALAYSIA

DECLARATION OF THESIS / UNDERGRADUATE PROJECT PAPER AND COPYRIGHT

Author's full name : **MOHD MAIZIZ BIN FISHOL HAMDI**

Date of birth : **18 DECEMBER 1983**

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

Academic Session: **SESSION 2007/2008**

I declare that this project report is classified as :

☐	**CONFIDENTIAL**	(Contains confidential information under the Official Secret Act 1972)*
☐	**RESTRICTED**	(Contains restricted information as specified by the organization where research was done)*
☑	**OPEN ACCESS**	I agree that my thesis to be published as online open access (full text)

I acknowledged that Universiti Teknologi Malaysia reserves the right as follows:

1. The project report is the property of Universiti Teknologi Malaysia.
2. The Library of Universiti Teknologi Malaysia has the right to make copies for the purpose of research only.
3. The Library has the right to make copies of the project report for academic exchange.

Certified by :

SIGNATURE	**SIGNATURE OF SUPERVISOR**
MOHD MAIZIZ BIN FISHOL HAMDI **(831218-03-6071)**	**PM DR. SARIFFUDDIN SAAD** **NAME OF SUPERVISOR**
Date : **22 NOVEMBER 2007**	Date : **22 NOVEMBER 2007**

NOTES : * If the thesis is CONFIDENTAL or RESTRICTED, please attach with the letter from the organization with period and reasons for confidentiality or restriction.

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

MOHD MAIZIZ BIN FISHOL HAMDI

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

Faculty of Civil Engineering
Universiti Teknologi Malaysia

NOVEMBER 2007

"I hereby declare that I have read this project report and in my opinion this project report is sufficient in terms of scope and quality for the award of Master of Civil Engineering – Structure."

Signature	:	.....
Supervisor	:	**PM DR. SARIFFUDDIN SAAD**
Date	:	**22 November 2007**

"I decalre that this report entitled '*Finite Element Investigation on the Strength Semi-Rigid Steel Connection Using LUSAS Software*' is the results of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature	:	.....
Name	:	**MOHD MAIZIZ BIN FISHOL HAMDI**
Date	:	**22 NOVEMBER 2007**

ACKNOWLEDGEMENTS

First of all, I would like to thank my supervisor, PM Dr. Sariffuddin Saad for his useful advice and guidance in this research study. Thank you very much for your support and kindness.

I would also like to thank my friends who has provided assistance to me at various occasions. Thank you for all your support and encouragement.

Last but not least, my most heartfelt appreciation goes to my parents, brother and sister who had persistently giving me invaluable spiritual motivation and inspiration.

Of course, to those who have involved directly or indirectly in completing this project, I would like to say thank you too.

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 expansive 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 expansive 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 berprofail 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.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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
θx	-	Rotation in X direction
θy	-	Rotation in Y direction
θz	-	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].