NONLINEAR FINITE ELEMENT MODELING FOR STEEL BEAM-COLUMN CONNECTION ATTACHED WITH TOP AND SEAT ANGLE

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To my beloved mother and father

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ABSTRACT

Two types of connection are generally considered in the design of steel structures in practice. These are classified as completely rigid (fixed) and simple (pin) connections. In theory, completely rigid connections cannot undergo rotation and simple connections cannot transfer moment. Nevertheless, in reality, rigid connections have a relative flexibility which makes them to rotate and simple connections have some reserve capacity to transfer moments. However, in an effort to increase the amount of data on the rotational stiffness of top and seat angle available to researchers, this thesis presents the modeled and non linear analysis of different theoretical top and seat angle connections. The finite element modeling software, ABAQUS, is used to create moment-rotation curves for these theoretical connections such as top and seat angle connection with bracket and top and seat angle connection with gusset plate. To demonstrate finite element mode ling's ability to accurately predict the response of the theoretical connections, the results of several experiments performed on top and seat connections are reproduced in ABAQUS. The result of this study shows that initial stiffness of top and seat angle connection increased when attached bracket or gusset plate in connection zone. It is also found that this type of connection can be classified as rigid connection.

ABSTRAK

Secara umumnya dua jenis sambungan selalu dianggap dalam rekabentuk struktur keluli, iaitu sambungan sepenuh tegar dan sambungan mudah. Secara teori, sambungan tegar sepenuhnya tidak boleh mengalami putaran dan sambungan mudah tidak boleh memindahkan momen. Walau bagaimanapun, dalam keadaan sebenar, sambungan tegar mempunyai kebolehlenturan bandingan yang membuatkan ia bolelh berputar dan sambungan mudah berkemampuan untuk memindahkan momen. Dalam usaha untuk meningkatkan penghasilan data bagi kekukuhan putaran sesiku atas dan pelapek oleh penyelidik, tesis ini membentangkan permodelan dan analisis bukan linear terhadap pelbagai jenis sambungan sesiku atas dan pelapek. Model perisian unsur terhingga ABAQUS digunakan bagi mewujudkan lengkung momen-putaran untuk sambungan ini secara teori, khususnya untuk sambungan sesiku atas dan pelapek dengan braket dan sesiku atas dan pelapek bersama plat gaset. Bagi menunjukkan keupayaan permodelan kaedah unsur terhingga dapat meramal dengan tepat ke atas sambungan, hasil daipada beberapa ujikaji yang dijalankan ke atas sambungan sesiku atas dan pelapek sedia ada dihasilkan dan diramal semula menggunakan perisian ABAQUS. Hasil penyelidikan ini menunjukkan kekukuhan permulaan bagi sesiku pelapek dan atas dapat ditingkatkan dengan menggunakan braket atau plat gaset sebagai alat tambahan kepada sesiku pelapek dan atas sedia ada. Jenis sambungan ini juga didapati boleh dikelaskan sebagai sambungan tegar.

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A= Cross sectional area of the beam

b_f= Width of flange

CoF= Coefficient of friction

d= Depth of the beam section

DoF= Degree of freedom

FEM= Finite element modeling

h= Height of the beam web

I_x= Moment of inertia about the x-axis

L= Length of the beam

M_p= Plastic moment of the beam

PR= Partially restrained

r_x= Radius of gyration about x-axis

R_y= Ratio of expected yield stress to specified minimum yield stress

S_x= Elastic section modulus about the x-axis

t_f= Thickness of flange

t_w= Thickness of web

Z_x= Plastic section modulus about the x-axis

Θ= Rotation

t= thickness

e=load distance in seat angle

CHAPTER 1

INTRODUCTION

1.1 Introduction

In the structural analyses, some assumptions are supposed for process facility in the design phase. One of those is semi-rigid connections (partially fixity or restrained) which are assumed rigid or pinned connections in peculiar to structure. Actually, rigid and pinned connections may be evaluated as a specific case of semi-rigid connections. Frame system supports are assumed to be fixed, but if those are constructed on elastic foundations, they should consider as semi-rigid. In addition to this, beam to-column connections in prefabricated structure are taken for granted as pinned connection though they are actually semi-rigid. Furthermore, steel brace connection to reinforced concrete (RC) frames in steel braced RC buildings and truss element connection to joints in truss systems are assumed pinned connection. These connections, which are stated above, are actually semi-rigid and their existence in structural analysis provides more realistic and reliable results.

The advantages of semi rigid connection are more than rigid or pinned connection. However, this type of connection does not generally used because of the difficulties to analyze and model. The advantages are listed as providing adequate lateral bracing for wind loads in low rise building, making bracing element unnecessary; optimizing the bending moment due

to connection's restrain and minimizing steel weight and overall cost saving (Md Tahir, 1997).

1.2 Problem statement

In the some of the country connection of steel beam to steel column using top and seat angle connection is common. Also in the some cases when shear force increased using stiffener under the seat angle for resistant in front of shear forces. However this type of connections assuming pinned connection and using in frame with simple support with brace. In this especial case there are to plates that connected braces to beam and column one of them is top of the beam and the other one is under of the beam. Plates welded to both of the beam and column (figure 1.1 to 1.3) then the behaviour of connection could be changed.

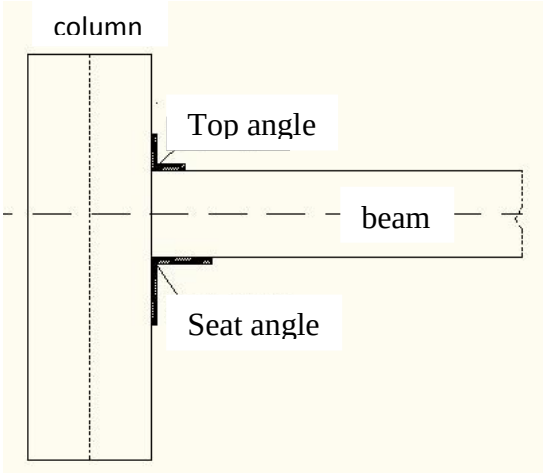

Figure 1.1: top and seat angle

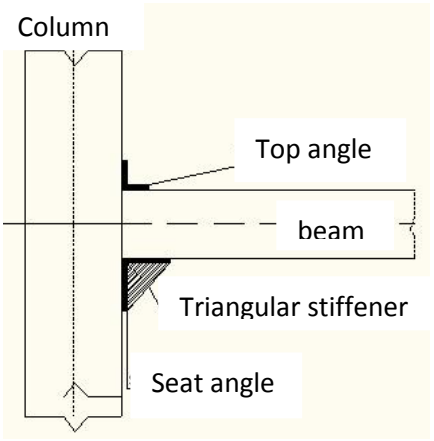

Figure 1.2: top and seat angle with stiffener

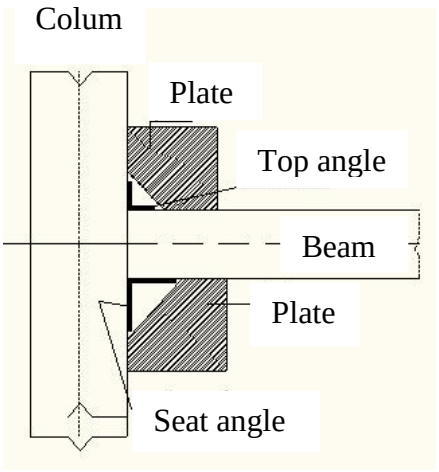

Figure 1.3: top and seat angle with plate

1.3. Research objective

The specific objectives of this study are as follows:

- To determine the moment-rotation curve characteristic of the top and seat angle steel beam to steel column connection obtained from ABAQUS analysis.

- To determine the moment - rotation curve characteristic of the top and seat angle connection while gusset plate of the braces welded to beam and column obtained from ABAQUS analysis.
- To determine different of specimens between moment-rotation curves that obtained from ABAQUS analysis.
- To determine the accuracy of the analysis result from ABAQUS by comparing them with result obtain from full scale laboratory test.

1.4. Research scope

The connection of steel beam to column is modelled using finite element software, ABAQUS. The research is focused on the top and seat angle connection with gusset plate in connection zone and also top and seat angle connection attached with bracket in sea angle. The results that obtain from ABAQUS for different specimens are compared together and also top and also with result obtained from laboratory test.

1.5 Significant of study

Typically, the behaviour of semi-rigid connections relates to the performance on sub-assemblage frame of beam-to-column connection. In semi-continuous construction design, semi-rigid connection developed an end restrain leading to reduction on beam moment which resulted to lighter beam in many cases (Md Tahir, 1997). The amount of restrain developed from the semi-rigid connections depends on the stiffness of the connection. The term stiffness in each connection nodes can be either modelled as pinned, rigid or semi-rigid case. This leads to the simplicity and effectiveness of the structural analysis. For example, if the stiffness of the connection is equal to zero, the analysis is modelled as pinned joint.

However, if the connection stiffness is too stiff and approaches infinity, the connection can be modelled as rigid connection.

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