

**ANALYSIS OF CORRUGATED WEB BEAM TO COLUMN EXTENDED
END PLATE CONNECTION USING
LUSAS SOFTWARE**

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ABSTRACT

Bolted extended end plate connections are commonly used in rigid steel frame. Inappropriate or inadequate connections of beam and column are hazardous and can lead to collapses and fatalities. Although laboratory testing is more accurate in analyzing the connection, but unfortunately it is time consuming and quite expensive. Thus, this project is intended to develop a Finite Element Analysis (FEA) approach as an alternative method in studying the behavior of such connections. The software being used is LUSAS 13.5 and the model used was an extended end plate, welded to the end of a corrugated web beam and then bolted to the column-flange. This type of connection will cause the column to bend about its major axis, and affect the end plate, bolts and corrugated web beam. Therefore, the analysis will be much more difficult as compared to plain web beam. The moment-rotation ($M-\phi$) response of the joint was plotted in term of a $M-\phi$ curve, and then, it was superimposed with the curve taken from an existing experimental result. It was found that the two curves shared the same stiffness at the elastic stage of the loading and they started to diverge as the connection became plastic. However, the LUSAS moment of resistance is 50% more than that obtained in the experiment. Further investigations are necessary to improve the finite element prediction.

ABSTRAK

Sambungan rasuk kepada tiang dengan menggunakan skrew dan plat hujung adalah satu perkara biasa dalam sambungan kerangka besi. Ketidaksesuaian dan kelemahan sambungan rasuk dan tiang adalah berbahaya, dan boleh mengakibatkan keruntuhan kerangka dan kemalangan jiwa. Walaupun ujikaji makmal merupakan kaedah yang tepat untuk menganalisa jenis sambungan tersebut, tetapi ia memakan masa yang lama dan memerlukan kos yang lebih tinggi. Oleh itu, projek ini bertujuan untuk membangunkan analisis unsur terhingga sebagai salah satu alternatif dalam mengkaji kelakuan sebenar sambungan tersebut. Perisian yang digunakan bagi analisis unsur terhingga ini adalah LUSAS 13.5 dan komponen-komponen yang terlibat dalam sambungan tersebut adalah; plat hujung yang dikimpal kepada hujung rasuk yang 'corrugated' dan kemudiannya diskrewkan pada bebibir tiang. Sambungan jenis ini akan menyebabkan tiang melentur pada paksi major dan memberi kesan kepada plat hujung, skrew dan rasuk yang 'corrugated' tersebut. Analisis ini adalah lebih kompleks berbanding dengan rasuk biasa. Tindakbalas momen-putaran ($M-\phi$) sambungan tersebut diplotkan dalam bentuk lengkungan $M-\phi$, yang kemudiannya di'super-impose' dengan lengkungan $M-\phi$ ujikaji. Hasilnya didapati, 2 lengkungan tersebut berkongsi nilai kekuatan yang sama pada tahap elastik beban dan kemudiannya berpecah apabila sambungan mula bersifat plastik. Walaubagaimanapun, keputusan momen kapasiti LUSAS adalah 50% melebihi momen kapasiti ujikaji. Oleh itu, lebih banyak penyelidikan diperlukan di masa hadapan untuk memperbaiki keputusan analisis unsur terhingga ini.

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CHAPTER 1

INTRODUCTION

1.1 PROBLEM BACKGROUND

To date, the experimental approach to study the behaviour of connection in steel structures will certainly remain the most popular for still some years but because of the highly cost involved, researchers are increasingly looking for less costly but acceptable alternatives. The most obvious alternative is modeling by the finite element method. Due to the highly complex nature of connections and the large number of parameters involved, numerous tests are required before an adequate set of empirical formulae is developed for the design of a specific type of connection. It appears to be more rational and more economical to develop numerical models to play with the various parameters and to check the accuracy of the numerical models against the results of an appropriate number of experimental tests. Not only are experimental tests needed to validate the models but they are also required for calibration purposes.

1.2 PROBLEM STATEMENT

Accurate analysis of the connection is difficult due to the number of connection components and their inherit non-linear behaviour. The bolts, welds, beam and

column sections, connection geometry and the end plate itself can all have a significant effect on connection performance. Any one of these can cause connection failure and some interact. The most accurate method of analysis is of course to fabricate full scale connections and test these to destruction. Unfortunately this is time consuming, expensive to undertake and has the disadvantage of only recording strain readings at pre-defined gauge locations on the test connection. A three dimensional materially static non-linear finite element analysis approach has therefore been developed as an alternative method of connection appraisal. For this research, extended end plate and corrugated web beam will be used, since not much research is done on such connections.

1.3 OBJECTIVES OF THE STUDY

The main objective of this research is to study the moment-rotation behaviour of corrugated web beam to column connections. A static non-linear finite element analysis will be used to model and analyze the bolted connection. Extended end plate and non linear elastic-plastic behaviour will be considered in the analysis. The moment-rotation curve plotted from the result will be compared with the relevant data available from experimental testing.

1.4 SCOPE OF THE STUDY

There are various types and shape of connection in structural steelwork. This study focused mainly on extended end plate bolted connection and corrugated web beam, particularly, trapezoidal web beam. The plate has 8 holes and M20 bolts will be used. The column size is 305x305x118 UC (S275) and its length is 3 m and the beam size is 400x140x39.7/12/4 – 1.5m, Flange – S355, Web - S275. A static point load was applied incrementally at the end of the cantilever beam. LUSAS software [1] will be used to model the connections. The result from the finite element analysis, mainly moment-rotation curve, will be compared with the existing experimental result.

1.5 SIGNIFICANCE OF RESEARCH

Research significance to be obtained from this study will be the results and analysis of the behavior of beam to column connection, when extended end plate and corrugated web beam is used. It is necessary to compare the moment –rotation curve of the result from the finite element analysis and experimental testing. The aim was to determine the accuracy of the analytical method and to verify the strength of the corrugated web beam as compared to a plane web. Corrugated web beam is still new in the industry, so if much research is done on it, more application of it can vary our steel industry products.