# I - 696 Comparison of Real Connection Tests Data with EC3 Code

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## Introduction

Despite of recognition of semirigidity of steel connections, AISC described different types of connections with general term (ASD and LRFD specifications). Later European Code 3 provided a non-dimensional system of classification clearly demarcating the boundaries between the different families of connections. In this study, using the data-base compiled by Kishi and Chen (1986), a verification on the level of rigidity of different connections was made by comparing the real tests data with reference to EC3 code.

## Eurocode 3

Eurocode 3, likewise to AISC, mentioned three types of connection viz., i) rigid ii) semirigid and iii) nominally pinned or flexible. Recognizing the wide variation of semirigid action depending upon the type of structure, EC3 provided two different classification system both for braced and unbraced frame (Fig. 1).

Moment axis is nondimensionalized with reference to the full plastic moment of the connected beam ($M_p$) i.e., $\overline{m}=M/M_p$ and the rotation axis is nondimensionalized with reference to the plastic rotation ($\theta_p$) i.e., $\overline{\theta}=\theta/\theta_p$ with $\theta_p=M_p/(EI/L_b)$ where $L_b$ and EI are the length and the bending rigidity of the connected beam respectively. Boundary line between semi-rigid and rigid region consists of a tri-linear line and for semirigid to flexible region the code divided the region by an axially bilinear leaned line. The numerical values for the boundaries, regarding the stiffness, have been chosen in order that the drop in carrying capacity, due to semi-rigid action, will not be more than 5% (in terms of Euler buckling load). The boundary between semi-rigid and flexible connection is i) 0.5 $EI_b/L_b$ in terms of stiffness and ii) 0.25 $M_p$ in terms of strength.

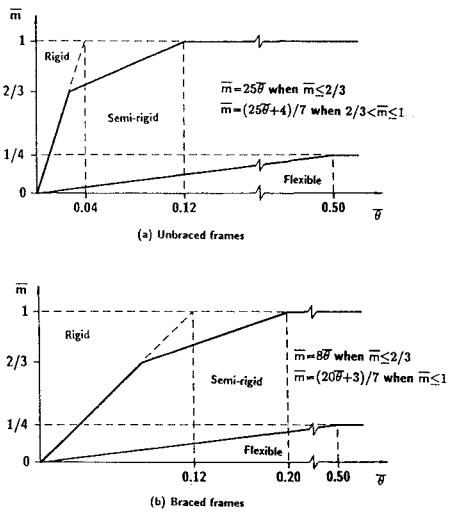



Figure 1. EC3 Classification System

## Superimposition of Real $M-\theta_r$ curves on EC3 Diagram

Non-dimensional $M-\theta_r$ curve of real test data were superimposed on the EC3 classification diagram (Figure 2.a to 2.g). Conversion of real beam $M-\theta_r$ curve into a non-dimensional one is executed by assuming the connected beam length $L_b$=300 inch and un-altering the beam sections.

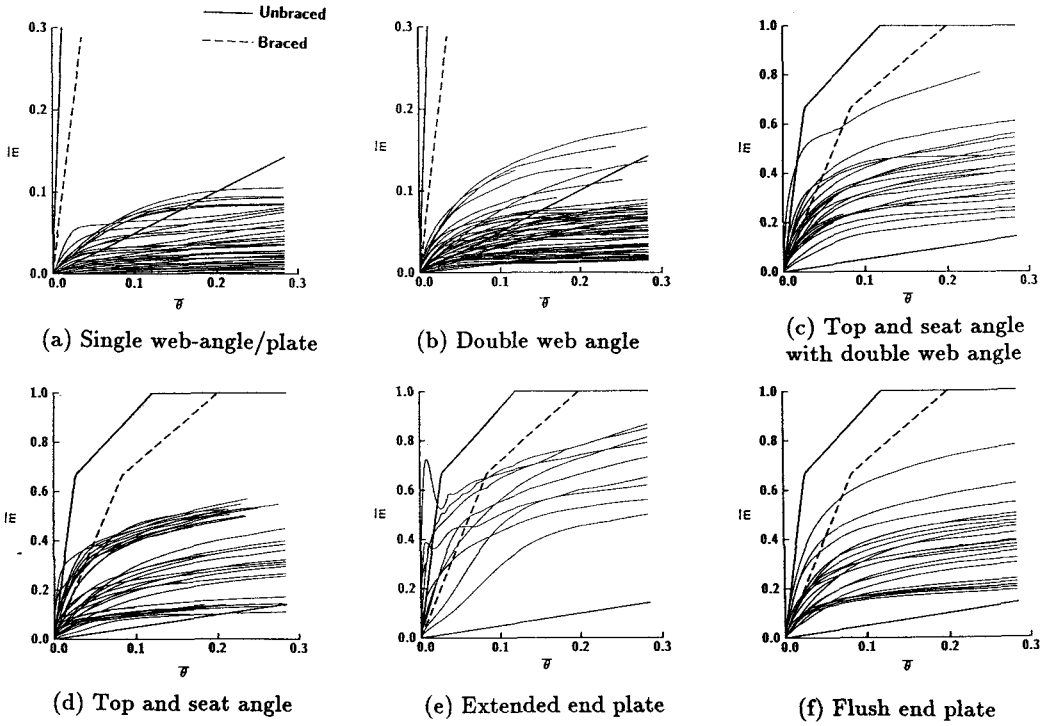
**Single Web-Angle/Single Plate Connections :** A significant number of $\overline{m}-\overline{\theta}$ curves initially lie in the semi-rigid region and then with rotation increment the curves enter into flexible region, which implies that at the beginning of loading the connections behave like a semirigid connection but later, with increasing load the behavior changes into flexible connection (Fig. 2.a).

**Double Web Angle Connections :** Even though the level of rigidity is greater than that of Single Web Angle/Single Plate Connections, very few $\overline{m}-\overline{\theta}$ curves absolutely lie in the semirigid zone (Fig. 2.b). There are a significant number of connections having limited rotational capacity.

**Top and Seat Angle with double Web Angle Connections :** Some connections are purely semirigid but some display a high stiffness at initial level of rotation then dissipating the stiffness, $\overline{m}-\overline{\theta}$ curves enter into the semirigid region. The moment capacity varies from 1/5 $M_p$ to 4/5 $M_p$ while the rotation capacity is sufficient.

**Top and Seat Angle Connections :** The moment-rotation characteristics are almost same as that of previous connections (Fig 2.d). These types of connection clearly display a comparatively low level of rotational capacity and moment capacity . The moment capacity ranges from 1/10 $M_p$ to 1/2 $M_p$.

**Extended End Plate connections :** This is the stiffest connection among the seven type of connections (Fig. 2.e). Even then $\overline{m}-\theta$ figure meagerly justify that it's a pure rigid connection. The moment capacity is quite high ranging from 2/5 $M_p$ to 9/10 $M_p$ , provided rotation capacity is sufficient.



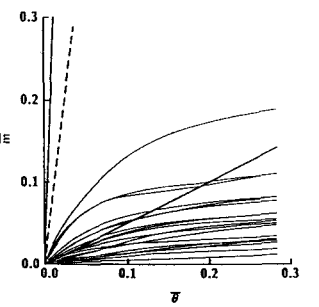

(a) Single web-angle/plate (b) Double web angle (c) Top and seat angle with double web angle

(d) Top and seat angle (e) Extended end plate (f) Flush end plate

Figure 2. Superimposition of $M-\theta_r$ curves on EC3 diagram

**Flush End Plate Connections :** With few exceptions, this connection is a good representative of semirigid connection (Fig. 2.f).

**Header Plate Connections :** The distribution of $\overline{m}-\theta$ curves display a more or less same characteristics with that of Double Web Angle connections (Fig. 2.g). Only the difference is that there is no curve having limited rotational capacity.




(g) Header plate

## Conclusion

From this study it reveals that the connections bear a mixed characteristics either of i) semirigid-flexible or ii) rigid-semirigid connections. Single web-angle/plate, Double web-angle connections fall in the 1st category while Extended end-plate connections fall in the 2nd. Top- and seat-angle connections lie in the midway.

## References

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