VI

ABSTRACT

Majority of the structural members of a metal building system are subjected to considerable restraints under the working conditions, either inherent in the construction of the system or deliberately applied as a precaution against buckling. These restraints have the effect of increasing the stability of these structural members.

It is understood that an elastic lateral brace (by means of secondary elements like purlins/girts with metal sheeting and flange braces, etc) restricts the lateral buckling of web tapered I-members in a metal building frame and improves the elastic buckling strength. However, studies of the effects of elastic restraints on the flexural - torsional buckling of web tapered I-beams do not appear to have reported, and it seems extending research findings relevant to buckling of the restrained beams and columns to web tapered I-members needs further investigations.

There may be situations in design practice, where the effect of continuity is drastically diminished, especially when the lateral supports have inadequate stiffness and/or are improperly applied to the web tapered I-members. In these cases the usual design practice is to ignore the effect of continuity due to lateral restraints.

This research proposes a method to determine the optimum stiffness of the lateral restraints for the web tapered I-beams, validity of the lateral bracing requirements of the prismatic members to the web tapered I-members and the utilization of the available lateral
stiffness by considering the improvement in the strength of the web tapered I-members than ignoring the effect of the lateral stiffness which is available in the metal building systems using finite element modeling and analysis.

This Research proposes a 3D finite element modeling and analysis using the ABAQUS software to investigate the effect of the elastic lateral bracing stiffness on the inelastic flexural –torsional buckling of the web tapered I-beams with an elastic lateral restraint at mid span of the compression flange with simply supported boundary condition and subjected to pure moment.

The developed equations/tables are convenient for the structural engineers to determine the optimum lateral brace stiffness for the compression flange of the web tapered I-beams and also to determine the improvement in the strength of the web tapered I-beams with the known lateral brace stiffness.

It is demonstrated that, according to the considered models with analysis in this research, the AISC Appendix 6 stability bracing requirements for the nodal type lateral braces for strength and stiffness of the prismatic beams are applicable to web tapered I-members. The lateral brace stiffness reductions are in the range of 18.21 % (minimum) and 65.22% (maximum) and the lateral brace strength requirements are increased to a maximum of 36.5% and the reduction in the lateral brace strength requirements are 42%. Though
there is an increase in lateral brace strength requirements, but still the strength requirements are less than the traditional rule of 2%.

The lateral brace stiffness and lateral brace strength requirements are assessed for the capacity of the members which are at 90% of the member capacity with rigid lateral bracing system and limiting the lateral deflection at brace point as $L_b/240$. A reduction to the tune of 20% is recommended for the nodal lateral bracing stiffness and an increase to the tune of 35% is recommended for the nodal lateral bracing strength requirements of AISC.

A proposal is made to include the warping restraint /flexural stiffness of the inside flange of the members. Therefore it is also recommended to include the above mentioned parameters as a part of the codal provisions to minimize the nodal lateral bracing stiffness requirements.