Optimality Considerations in Using Slender Cross Section for Steel Columns under Pure Compression

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Design for steel compression members can be made by either allowing or restricting the possible occurrence of the local buckling of component plates. Generally it is common practice to restrict the local buckling by specifying the maximum width-thickness ratios for component plates to keep the design process simple. Most hot rolled sectioned used in design of structures fall in to this category. However when built–up sections are used the designer may permit the local buckling by specifying the higher width–thickness ratio (b/t). In British Standard Structural use of steel work in building (BS 5950-1., 2000) specifications, widely used for design of steel buildings in Sri Lanka, classifies the steel cross sections as Class 1 plastic, Class 2 compact, Class 3 semi-compact and Class 4 slender. Only in Class 4 slender sections the load carrying capacity of the section is reduced due to local buckling.

An efficient design may be obtained by allowing the possible local buckling of component plates and thus enlarging the freedom for the determination of cross-sectional shapes with arbitrary selections of width-thickness ratio. The objective of this paper is to see that permitting the local buckling of component plates gives an efficient design for columns.

The design method of BS 5950-1., 2000 was initially compared with the limited experimental data from Usami T. et al. (1982), which includes the experiments of the built-up box shaped columns of the HT 80 steel grade.

Optimizations for steel compression members were performed, focusing mainly on whether allowing the local buckling of component plates will bring benefits for efficient design or not. Ultimate strengths were found for cross sections by varying width-thickness ratio (b/t) while having the same gross sectional area and member length to ensure constant weight of material for that particular member and plotted. This was repeated for different L^2/A ratios, where L is member length and A is gross sectional area. This study was limited to welded box sections under pure compression.

Comparison of design method with the test data available indicates that the design method has sufficient accuracy for the ultimate strength of the column. The optimization study indicates that there exists a range where allowing local buckling produce economical benefits for ultimate strength.