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TECHNICAL NOTE

On Cold-Formed Steel Construction

CFSEI
COLD-FORMED STEEL ENGINEERS INSTITUTE

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Design of End Posts for Diaphragm Shear Walls: A Perspective

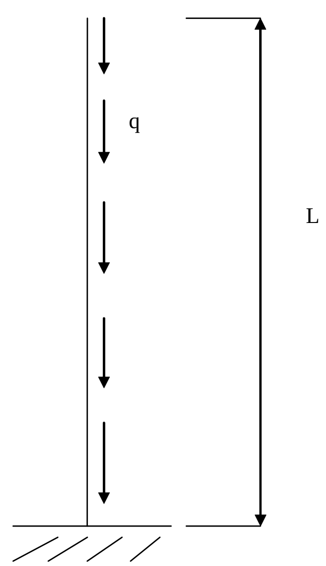
Summary: This Tech Note provides a rational engineering analysis that may replace assumptions that are commonly used and that may be overly conservative. The content of this Tech Note is based upon information in the engineering literature, in particular Timoshenko & Gere, Theory of Elastic Stability and upon engineering judgment.
Note: This Technical Note contains one perspecitve, presented herein by the author, a respected expert in the field of cold-formed steel design, rather than a specific codified design approach. The information contained herein does not necessarily represent the position of the CFSEI; as with any design criteria, Professional Engineers should always use engineering judgment.

INTRODUCTION

For diaphragm shear-wall design the boundary fasteners are typically assumed to contribute equally to the strength of the assembly. That implies that the force in a shear wall post is uniformly distributed along the height of the member. However, shear-wall tests have shown that failure tends to occur at the fasteners near the bottom of the shear wall post. This behavior implies that the force in the post is additive and the applied load to the post increases toward the bottom of the member. Thus an assumed uniform increase of axial load would appear to be a rational assumption.

SINGLE-STORY OR TOP FLOOR FOR MULTI-STORY STRUCTURES

For a single-story or top floor of a multi-story structure application it is assumed that no axial live load is applied to the post. The assumed load path for the lateral wind load is from the top of the wall into the shear wall sheathing. The shear wall sheathing transfers the load to the sheathing-to-post fasteners. The sheathing-to-post fastener force is assumed to be uniformly distributed along the height of the post.



Reference: Timoshenko and Gere, *Theory of Elastic Stability* (page 100, Section 2.12)

q = uniformly distributed load

From Timoshenko and Gere the critical elastic buckling load for the above loading condition is given as

$(qL)_{cr} = (7.837\ E\ I)\ /L^2$

If qL is assumed to be applied as a concentrated load at the top of the column, the elastic buckling load is given by

$P_{cr} = (\pi^2\ E\ I)\ /\ (KL)^2$

For a free-fixed column, as discussed by Timoshenko and Gere, K = 2.0. Therefore the elastic buckling load is

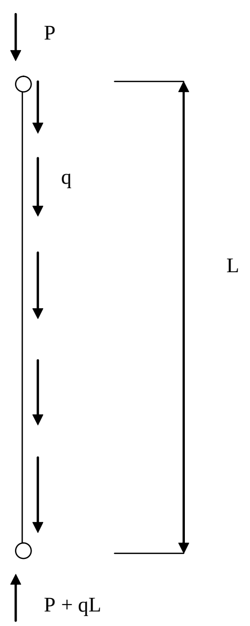
$P_{cr} = (2.47\ E\ I) / (L)^2$

Thus, equating $(qL)_{cr}$ to Pcr results in a critical load that is 3.18 (7.837/2.47) times greater if the load is considered to be uniformly distributed along the member's length.

Therefore, to reflect an increase in available design strength when evaluating AISI S100 Section C4 equations, instead of using the commonly assumed value of K = 1.0, this increase in strength may be recognized through an appropriate assumption for the buckling coefficient, K. For example a K = 0.6 results in an increase buckling load of 2.8 $(1/(0.6)^2)$ which approaches the value of 3.18.

MULTI-STORY STRUCTURES

For a multi-story structure the applied axial load is also imposed on the post. The assumed load path for the lateral wind load is from the top of the wall into the shear wall sheathing. The shear wall sheathing transfers the load to the sheathing-to-post fasteners. The sheathing-to-post fastener force is assumed to be uniformly distributed to each fastener along the height of the post.



Reference: Timoshenko and Gere, *Theory of Elastic Stability* (page 107, Section 2.12)

q = uniformly distributed load. In this case q is the sheathing-to-post fastener force that is assumed to be uniformly distributed to each fastener along the height of the post.

For the above loading condition, Timoshenko and Gere state that an approximation for the critical elastic buckling load, P_{cr}, is obtained by assuming that one-half of the load qL is applied at the top. Thus, to reflect this approximation in design, use the AISI Specification with the design axial load equal to the tributary dead and live loads plus one-half of the shear wall post's axial compression force.

APPLICATION WITH SPECIFICATION

For design, the AISI Specification requires the following:

ASD: $Q \leq R_n/\Omega$

LRFD: $\gamma Q \leq \varphi R_n$

The above discussion pertains to the load side of the design equation. That is, modifications to reflect the appropriate Q value. Thus, the current provisions of the AISI Specification with the stipulated safety factors or phi factors are applicable.

References

1. Timoshenko, Stephen P. & J. Gere, *Theory of Elastic Stability*, McGraw-Hill Companies, 1961.

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