Chapter H Design of Members for Combined Forces and Torsion

This chapter addresses members subject to axial force and flexure about one or both axes, with or without torsion, and to members subject to torsion only.

H.1 MEMBERS SUBJECT TO FLEXURE AND AXIAL FORCE

For members subject to flexure and axial force,

\[ \frac{P}{P_r} + \frac{M_{xy}}{M_{xy}^r} + \frac{M_{yz}}{M_{yz}^r} \leq 1.0 \quad (H.1-1) \]

where all terms are positive, and

- \( x \) = subscript for major principal axis bending
- \( y \) = subscript for minor principal axis bending
- \( P_r \) = required axial strength
- \( P_c \) = available axial strength determined in accordance with Chapter D for axial tension and Chapter E for axial compression
- \( M_r \) = required flexural strength
- \( M_c \) = available flexural strength determined in accordance with Chapter F

H.2 MEMBERS SUBJECT TO TORSION

The available torsional strength of members is the least of the available strengths for the limit states of rupture, yielding, and buckling. The available torsional strength (\( \delta T \) for LRFD and \( T_r / \Omega_r \) for ASD) shall be determined in accordance with this Section and Sections H.2.1, H.2.2, H.2.3, or H.2.4, where \( T_r \) is the nominal torsional strength and \( \Omega_r \) for LRFD and \( \Omega_r \) for ASD.

<table>
<thead>
<tr>
<th>LIMIT STATE</th>
<th>( \delta T )</th>
<th>( \Omega_r )</th>
</tr>
</thead>
<tbody>
<tr>
<td>building-type structures</td>
<td>0.75</td>
<td>1.95</td>
</tr>
<tr>
<td>bridge-type structures</td>
<td>0.90</td>
<td>1.65</td>
</tr>
</tbody>
</table>

For the limit state of torsional rupture, the shear stress \( F_s \) corresponding to the torsional strength is

For unwelded members

\[ F_s = F_{su} / k_t \quad (H.2-1) \]

For welded members

\[ F_s = F_{su} (1 - A_{wz} / A_g) / k_t + F_{sw} A_{wz} / A_g \quad (H.2-2) \]

For the limit states of shear yielding and shear buckling, the shear stress \( F_s \) corresponding to the torsional strength is

LIMIT STATE | \( F_s \) | \( \lambda \)
---|---|---
yielding | \( F_{sy} \) | \( \lambda \leq \lambda_1 \)
inelastic buckling | \( B_s - 1.25D_s \lambda \) | \( \lambda_1 < \lambda < \lambda_2 \)
elastic buckling | \( \pi^2 E \) \( (1.25\lambda)^2 \) | \( \lambda \geq \lambda_2 \)

where

\[ \lambda_1 = \frac{B_s - F_{su}}{1.25D_s} \]

\[ \lambda_2 = \frac{C_s}{1.25} \]

Buckling constants \( B_s \), \( D_s \), and \( C_s \) are given in Table B.4.1 or B.4.2.