



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



عنوان درس:

طراحی پیشرفته سازه های فولادی

Advanced Design of Steel Structures

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فصل چهارم

طراحی تیر ستونها

Chapter 4:

Design of Beam-Columns

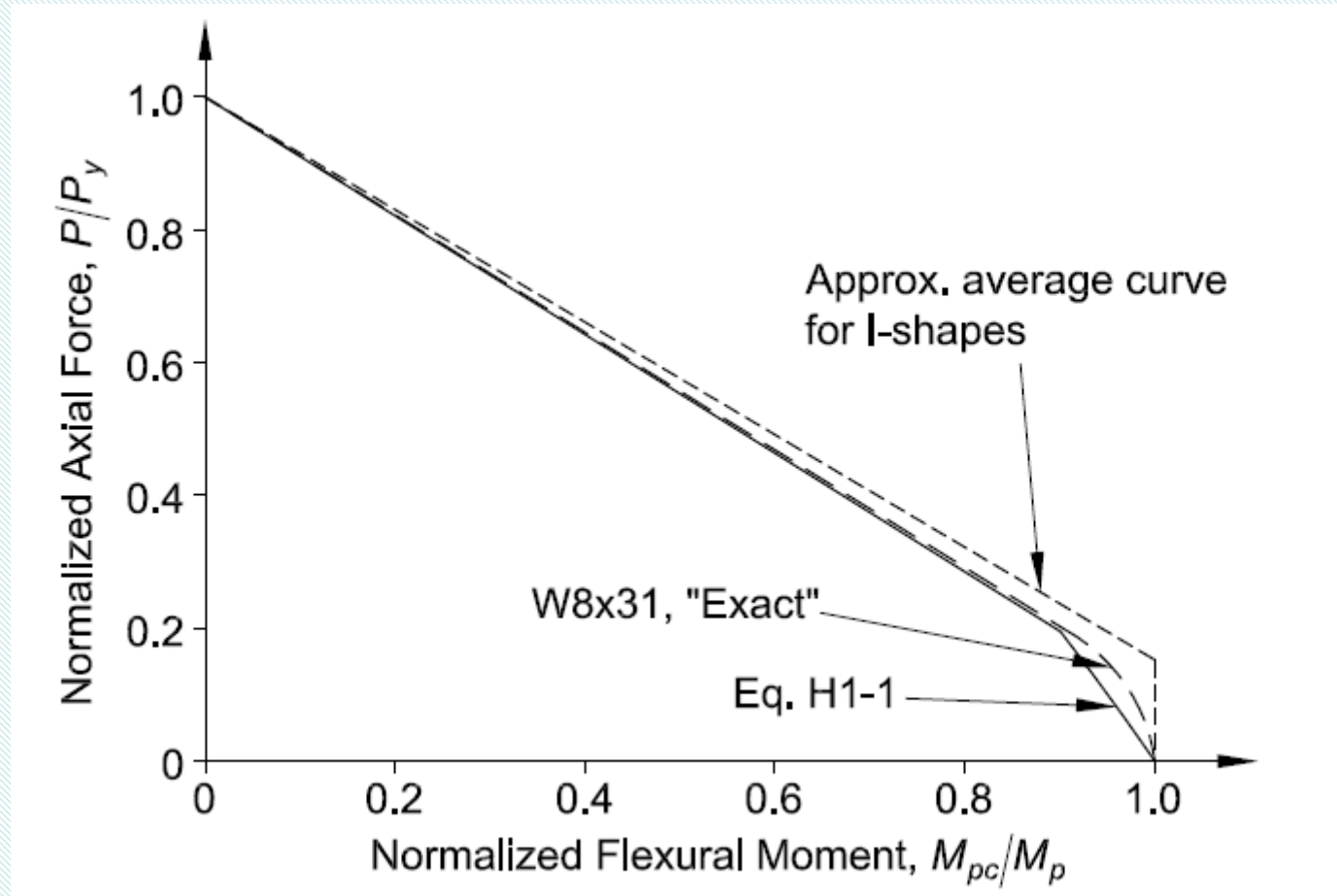


DESIGN OF MEMBERS FOR COMBINED FORCES

ارائه مثال



➤ DESIGN OF MEMBERS FOR COMBINED FORCES





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1.

DOUBLY AND SINGLY SYMMETRIC MEMBERS SUBJECT TO FLEXURE AND AXIAL FORCE

Doubly and Singly Symmetric Members Subject to Flexure and Compression

The interaction of flexure and compression in doubly symmetric members and singly symmetric members constrained to bend about a geometric axis (x and/or y) shall be limited by Equations H1-1a and H1-1b.

User Note: Section H2 is permitted to be used in lieu of the provisions of this section.

(a) When $\frac{P_r}{P_c} \geq 0.2$

$$\frac{P_r}{P_c} + \frac{8}{9} \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}} \right) \leq 1.0 \quad (\text{H1-1a})$$

(b) When $\frac{P_r}{P_c} < 0.2$

$$\frac{P_r}{2P_c} + \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}} \right) \leq 1.0 \quad (\text{H1-1b})$$



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For design according to Section B3.1 (LRFD):

P_r = required axial strength, determined in accordance with Chapter C, using LRFD load combinations, kips (N)

$P_c = \phi_c P_n$ = design axial strength, determined in accordance with Chapter E, kips (N)

M_r = required flexural strength, determined in accordance with Chapter C, using LRFD load combinations, kip-in. (N-mm)

$M_c = \phi_b M_n$ = design flexural strength determined in accordance with Chapter F, kip-in. (N-mm)

ϕ_c = resistance factor for compression = 0.90

ϕ_b = resistance factor for flexure = 0.90



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2. Doubly and Singly Symmetric Members Subject to Flexure and Tension

The interaction of flexure and tension in doubly symmetric members and singly symmetric members constrained to bend about a geometric axis (x and/or y) shall be limited by Equations H1-1a and H1-1b,

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For doubly symmetric members, C_b in Chapter F is permitted to be multiplied by

$\sqrt{1 + \frac{\alpha P_r}{P_{ey}}}$ for axial tension that acts concurrently with flexure,

where

$$P_{ey} = \frac{\pi^2 EI_y}{L_b^2} \quad (H1-2)$$

$\alpha = 1.0$ (LRFD); $\alpha = 1.6$ (ASD)



The lateral-torsional buckling modification factor

$$C_b = \left(\frac{12.5M_{max}}{2.5M_{max} + 3M_A + 4M_B + 3M_C} \right) R_m \leq 3.0 \quad (C-F1-3)$$

For single curvature bending

$$R_m = 1.0$$

For reverse curvature bending

$$R_m = 0.5 + 2 \left(\frac{I_{y \text{ Top}}}{I_y} \right)^2 \quad (C-F1-4)$$

where

$I_{y \text{ Top}}$ = moment of inertia of the top flange about an axis in the plane of the web, in.⁴ (mm⁴)

I_y = moment of inertia of the entire section about an axis in the plane of the web, in.⁴ (mm⁴)

M_{max} = absolute value of maximum moment in the unbraced segment, kip-in. (N-mm)

M_A = absolute value of moment at quarter point of the unbraced segment, kip-in. (N-mm)

M_B = absolute value of moment at centerline of the unbraced segment, kip-in. (N-mm)

M_C = absolute value of moment at three-quarter point of the unbraced segment, kip-in. (N-mm)



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3. Doubly Symmetric Rolled Compact Members Subject to Single-Axis Flexure and Compression

For doubly symmetric rolled compact members, with the effective length for torsional buckling less than or equal to the effective length for y-axis flexural buckling, $L_{cz} \leq L_{cy}$, subjected to flexure and compression with moments primarily about their major axis, it is permissible to address the two independent limit states, in-plane instability and out-of-plane buckling or lateral-torsional buckling, separately in lieu of the combined approach provided in Section H1.1,

where

L_{cy} = effective length for buckling about the y-axis, in. (mm)

L_{cz} = effective length for buckling about the longitudinal axis, in. (mm)

For members with $M_{ry}/M_{cy} \geq 0.05$, the provisions of Section H1.1 shall be followed.



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- (a) For the limit state of in-plane instability, Equations H1-1a and H1-1b shall be used with P_c taken as the available compressive strength in the plane of bending and M_{cx} taken as the available flexural strength based on the limit state of yielding.

$$\frac{P_u}{P_{cx}} \leq 0.5 \rightarrow \frac{P_u}{0.5 P_{cx}} + \frac{M_{ux}}{\phi_b M_p} \leq 1.0, \quad \phi_b = 0.9$$

$$\frac{P_u}{P_{cx}} \geq 0.5 \rightarrow \frac{P_u}{P_{cx}} + \frac{1}{9} \times \frac{M_{ux}}{\phi_b M_p} \leq 1.0, \quad \phi_b = 0.9$$

$$P_{cx} = \phi_c P_{nx}, \quad \phi_c = 0.9$$



$$(\lambda = \lambda_x)$$



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(b) For the limit state of out-of-plane buckling and lateral-torsional buckling

$$\frac{P_r}{P_{cy}} \left(1.5 - 0.5 \frac{P_r}{P_{cy}} \right) + \left(\frac{M_{rx}}{C_b M_{cx}} \right)^2 \leq 1.0 \quad (\text{H1-3})$$

where

P_{cy} = available compressive strength out of the plane of bending, kips (N)

C_b = lateral-torsional buckling modification factor determined from Section F1

M_{cx} = available lateral-torsional strength for major axis flexure determined in accordance with Chapter F using $C_b = 1.0$, kip-in. (N-mm)

$$P_{cy} = \phi_c P_{ny} \quad , \quad \phi_c = 0.9$$

$$\lambda = \lambda_y$$

$$M_{cx} = \phi_b M_{nx} \quad , \quad \phi_b = 0.9$$

$$C_b = 1.0$$



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4.

H2. UNSYMMETRIC AND OTHER MEMBERS SUBJECT TO FLEXURE AND AXIAL FORCE

This section addresses the interaction of flexure and axial stress for shapes not covered in Section H1. It is permitted to use the provisions of this Section for any shape in lieu of the provisions of Section H1.

$$\left| \frac{f_{ra}}{F_{ca}} + \frac{f_{rbw}}{F_{cbw}} + \frac{f_{rbz}}{F_{cbz}} \right| \leq 1.0 \quad (\text{H2-1})$$

where

f_{ra} = required axial stress at the point of consideration, determined in accordance with Chapter C, using LRFD or ASD load combinations, ksi (MPa)

F_{ca} = available axial stress at the point of consideration, ksi (MPa)

f_{rbw}, f_{rbz} = required flexural stress at the point of consideration, determined in accordance with Chapter C, using LRFD or ASD load combinations, ksi (MPa)

F_{cbw}, F_{cbz} = available flexural stress at the point of consideration, ksi (MPa)

w = subscript relating symbol to major principal axis bending

z = subscript relating symbol to minor principal axis bending



حل مثال برای فصل ۳ و ۴