ALLOWABLE STRESS DESIGN FLOWCHART

FOR
AISC MANUAL OF STEEL CONSTRUCTION, NINTH EDITION

PART I
DESIGN REQUIREMENT FOR BEAM-COLUM

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S-Y. Chen, December 1997, *Using Genetic Algorithms for the Optimal Design of Structural Systems*, Dissertation for Doctor of Philosophy, Department of Civil Engineering, Arizona State University.

DESIGN REQUIREMENET FOR BEAM-COLUMN AND OTHER FLEXURAL MEMBERS

0. Units : ksi (klb-in)

1. Applicable Range :

$$\frac{h}{t_w} \le \frac{970}{\sqrt{F_y}}$$

2. Allowable Stress

2.1 Normal Stress : member in the structure should be proportioned to satisfied the following (Ch H1.). For details of calculating the normal allowable stress, see Appendix A.

(1) Bending with Axail Compression

In general
$$\begin{cases} \dfrac{f_a}{F_a} + \dfrac{C_{mx} \cdot f_{bx}}{\left(1 - {f_a}/{F'_{ex}}\right) \cdot F_{bx}} + \dfrac{C_{my} \cdot f_{by}}{\left(1 - {f_a}/{F'_{ey}}\right) \cdot F_{by}} \le 1.0 \\ \dfrac{f_a}{0.6 \cdot F_y} + \dfrac{f_{bx}}{F_{bx}} + \dfrac{f_{by}}{F_{by}} \le 1.0 \end{cases} \qquad \text{(H1-1 \& H1-2)}$$

If ${f_a}/{F_a} \le 0.15 \Rightarrow \dfrac{f_a}{F_a} + \dfrac{f_{bx}}{F_{bx}} + \dfrac{f_{by}}{F_{by}} \le 1.0$ (H1-3)

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(2) Bending with Axial Tension

$$\frac{f_a}{F_t} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} \le 1.0 \qquad \text{(H2-1)}$$

where $$F_e^{'} = \frac{12 \cdot \pi^2 \cdot E}{23 \cdot \left(K \cdot l_b / r_b\right)^2}$$

C_m WITH sidesway $C_m = 0.85$

BRACED AGAINST sidesway
- NO transverse loading : $C_m = 0.6 - 0.4 \cdot \frac{M_1}{M_2}$
- WITH transverse loading
  - NO rotations, both ends : $C_m = 0.85$
  - WITH rotations, both ends : $C_m = 1.0$

C_m can be conservatively taken as 1.0

2.2 Shear Stress :

$$\frac{f_{vx}}{F_{Vx}} + \frac{f_{vy}}{F_{Vy}} \le 1.0$$

For shear in the y direction of W and C sections

$$\frac{h}{t_w} \le \frac{380}{\sqrt{F_y}} \Rightarrow f_v = \frac{V}{\sum d \cdot t_w} \; ; \; F_v = 0.4 \cdot F_y \qquad \text{(F4-1)}$$

$$\frac{h}{t_w} > \frac{380}{\sqrt{F_y}} \Rightarrow f_v = \frac{V}{\sum h \cdot t_w} \; ; \; F_v = \frac{F_y}{2.98} \cdot C_v \le 0.4 \cdot F_y \qquad \text{(F4-2)}$$

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All other conditions

$$\Rightarrow \qquad f_v = \frac{V}{\sum d \cdot t_w} \;;\; F_v = 0.4 \cdot F_y$$

where $\begin{cases} \frac{a}{h} \le 1.0 \Rightarrow k_v = 4.0 + \frac{5.34}{\left(a/h\right)^2} \\ \frac{a}{h} > 1.0 \Rightarrow k_v = 5.34 + \frac{4.0}{\left(a/h\right)^2} \end{cases}$; and $\begin{cases} C_v = \frac{45000 \cdot k_v}{F_y \cdot \left(h/t_w\right)^2} & when \;\; C_v \le 0.8 \\ C_v = \frac{190}{h/t_w} \cdot \sqrt{\frac{k_v}{F_y}} & when \;\; C_v > 0.8 \end{cases}$

3. Design Requirement & Serviceability Design Consideration
   (1) Maximum Deflection, for beams and girders supporting floors, roofs and plastered ceilings under maximum live-load

   $\frac{\Delta}{l} \le \frac{1}{360}$ (Ch L3.1.)

   (2) Minimum ratio of depth to length, for beams and girders in floors

   $\frac{d}{l} \ge \frac{F_y}{800}$ (Ch C-L3.1.)

   (3) Minimum ratio of depth to length, for roof purlins, except for flat floor

   $\frac{d}{l} \ge \frac{F_y}{1000}$ (Ch C-L3.1.)

   (4) Minimum ratio of depth to length, for beams supporting large floor area

   $\frac{d}{l} \ge \frac{1}{20}$

   (5) Minimum Slenderness Ratio

   Design based on compressive force : $\frac{Kl}{r} \le 200$ (Ch B7.)

   Design based on tensile force : $\frac{l}{r} \le 300$ (Ch B7.)

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4. Stiffener
   See Appendix B for details.

5. Bearing Plate
   See Appendix C for details.

6. Cover-Plated Beam or Stiffened Beam
   (To be finished)

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