Allowable Bending Stress of Steel Pipes

S. K. CHAKRABARTI

Allowable bending stresses are not as clear for steel pipes as for steel I-sections given in the AISC *Manual of Steel Construction*. The following is from the 8th edition of the manual:

Section 1.5.1.4 states that the diameter-thickness ratio of hollow circular sections shall not exceed $3300/F_y$, $F_b = 0.66F_y$. Lateral torsional buckling need not be investigated as plastic moment capacity will develop before lateral torsional buckling. The allowable stress for circular tubes loaded in bending with $3300/F_y < D/t < 13000/F_y$ shall be added to the text.

Allowable axial stress as the criteria for allowable bending stress for thin circular tubes will always be safe, since elastic buckling due to bending stress is in the range of 0.11 to 0.88 times the elastic buckling due to axial compression. This depends on the R/t ratio, see Fig. 1, where R is the inside radius plus one-half the wall thickness, and t is the wall thickness of the tube.²

Example

Pipeline carrying water under pressure on equidistant multiple supports: Pipe OD = 18 in., t = 0.1345 in., $F_y = 36$ ksi, l = 20 ft = 240 in., weight of water and pipe = 150 #/ft.

Bending moment:

$$M = wl^2/12 = 150 \times 400 \times 12/12 = 60,000$$
 psi

Section modulus:

$$S = 0.091875[(O.D.)^{4} - (I.D.)^{4}]/(O.D.)$$

= 0.091875[18⁴ - 17.731⁴]/18 = 33.46 in.³
 $f_{b} = 60,000/33.46 = 1.8$ ksi
 $D/t = 18/0.1345 = 133.83$

Then $D/t > 3300/F_y$, therefore F_b does not equal 0.66 F_y , $D/t < 13,000/F_y$, check Eq. C3-3: $F_b = F_a = 662/(D/t) + 0.4F_y = 662/133.83 + 14.4 = 19.3$ ksi.

$$f_b = 1.8 \text{ ksi} < 19.35 \text{ ksi}$$
 OK

REFERENCES

- 1. American Institute of Steel Construction, *Manual of Steel Construction*, 8th ed., Chicago: AISC, 1980.
- Troitsky, M.S., D.Sc., *Tubular Steel Structures—Theory* and Design, Cleveland, Ohio: The James F. Lincoln and Welding Foundation, April 1982.



Figure 1

S. K. Chakrabarti is an engineer in South San Francisco, California.