

# One Engineer's Opinion

W. A. MILEK

QUESTION: The AISC Specification in Section 1.5.1.4.3 indicates an allowable bending stress equal to  $0.75F_y$  for solid square bars and solid rectangular sections bent about their weak axis. The Specification does not include provisions for such sections bent about their strong axis except that Section 1.5.1.4.6b indicates an allowable compression bending stress of  $0.6F_y$  for members, not specifically covered in other sections, providing they are braced at intervals not exceeding  $76.0b_f/\sqrt{F_y}$ . Assuming there is a certain similarity between an overall cross-section shape between rectangular box sections and solid rectangular sections, is it permissible to use a bracing spacing of  $2500b/F_y$  for solid rectangular bars rather than the much more restrictive  $76b_f/\sqrt{F_y}$  for bars bent about their strong axis and stressed to  $0.6F_y$ ? Also, what is the required spacing of bracing for bars bent about their strong axis and stressed to less than  $0.6F_y$ ?

Answer: The use of solid rectangular steel cross-sections as bending members is an infrequently encountered condition; consequently, it was felt that complete coverage in the Specification was not warranted.

A solid rectangular section stressed in bending about its strong axis is not comparable to a rectangular box section bent about its strong axis, therefore the criteria for spacing of lateral bracing,  $2500b/F_y$ , does not apply.

With a solid bar, the material most remote from the center of the section is the material that most significantly contributes to the torsional strength. The material toward the center of the section may be highly stressed in bending and thus contributing to the tendency to buckle laterally but it does not contribute proportionately to the torsional resistance to buckling.

On the other hand, with a box section, the material that provides the bending strength of the member is distributed where it is also most effective in resisting torsion and lateral buckling.

In the Commentary to the Specification (p. 5-126) a method is indicated which may be used to determine the allowable bending stress, taking into account unbraced length in solid rectangular cross sections subject to bending about their strong axis. By equating the elastic buckling stress for a rectangular beam (CRC Formula 4.3) to the elastic buckling stress for a column of equivalent  $l/r$  (CRC Formula 4.6) the expression

$$(l/r)_{\text{equiv}} = \sqrt{(5.1S_x)/I_y}$$

may be derived.

If the depth of the bar is expressed in terms of the width multiplied by coefficients ( $d = nb$ ) and substituted in the expressions for  $S_x$ ,  $J$  and  $I_y$  the resulting expression after substitution and reduction is

$$(l/r)_{\text{equiv}} = 2.258 \sqrt{l/b} \times \sqrt{\frac{n^2}{\sqrt{n(n-0.63)}}}$$

The values of the second radical for various values of  $n$ , the depth to width ratio of the cross-section, may be readily calculated. Several cases are tabulated below:

$n$	$\sqrt{\frac{n^2}{\sqrt{n(n-0.63)}}$	$n$	$\sqrt{\frac{n^2}{\sqrt{n(n-0.63)}}$
2	1.55	6	2.52
3	1.84	8	2.89
4	2.09	10	3.21

Using this information and allowable stresses for columns appropriate to various  $(l/r)$ 's and grades of steel from Appendix A of the Specification, the relationship may be used in two ways. Given a calculated bending stress the required spacing of bracing may be determined or given a spacing of bracing in terms of  $l/b$ , the allowable stress may be determined.

In Figure 1, curves of allowable stress versus  $l/b$  are plotted for several depth to width ratios. The values presented would be conservative for most practical cases since the procedure used assumes simple support at points of lateral bracing. Usual details for providing lateral support to solid rectangular bending members would provide more than simple support.

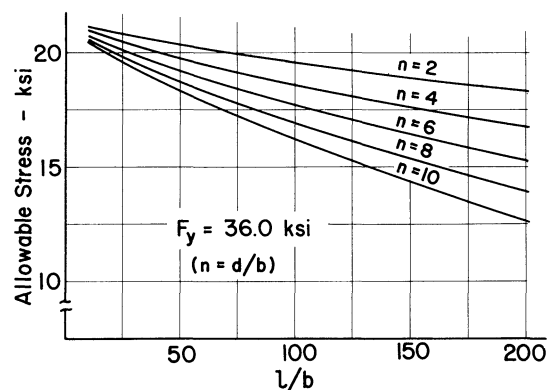


Figure 1

W. A. Milek is Director of Engineering and Research, American Institute of Steel Construction, New York, N. Y.