Approximate Plastic Modulus of Wide Flange Beam Sections

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New preliminary design rules are presented for use with the AISC LRFD Manual. The use of preliminary design rules for AISC has been treated elsewhere.[1,2] A simple and easy rule to use for estimating plastic section modulus of braced wide flange beams is presented here.

$Z_x = (D \times W)/9$

Z_x = plastic section modulus about major axis, in.^{3}

D = nominal depth of beam, in.

W = beam weight, lbs/ft.

Example 1: Find the plastic modulus of a W16×31

Solution

$Z_x = (D \times W)/9 = (16 \times 31)/9 = 55.1$ in.^{3}
(LRFD = 54.0 in.^{3} error = 2%)

Example 2: Given an ultimate moment of 2000 kip-ft and A-572 F_y = 50 ksi steel, find the approximate weight of the 33 in. beam required.

Solution

Z_x req $= 2000 \times 12/(0.9 \times 50) = 533.3$ in.^{3}

$W = (9 \times Z_x)/D = (9 \times 533.3)/33 = 145.5$ lbs/ft
(Use a W33×152)

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DISCUSSION

The 52 most economical beam shapes, i.e., the sections (W6×9 through W36×300) listed as bold-faced in the Load Factor Design Selection Table, were examined. Thirty-nine of the shapes had an estimated plastic section modulus which was within 5 percent of the plastic section modulus listed in the Properties and Dimensions Tables; none had a difference in excess of 10 percent. The biggest difference corresponds to W12×58, which is 10 percent.

All 187 shapes (W4×13 through W36×300) listed in the table were also examined. Sixty-nine had a difference less than 5 percent and 132 have a difference that does not exceed 10 percent. All of the shapes in the W16 series and larger have a difference that does not exceed 10 percent.

The shapes that have an error in excess of 15 percent belong to heavy column sections in the W12×136 or greater and W14×193 or greater. The error comes from the difference between the nominal depth and the real depth. If the actual depth is used, the error reduces significantly. The biggest discrepancy corresponds to W14×730 for which the Z_x is underestimated by 32 percent. If the depth is taken as 22.5 inches, the Z_x is overestimated by 10 percent.

It is recommended that the actual section properties be used in checking the trial section for conformance to the plastic design or LRFD requirements.

REFERENCES

1. Edwin A. Lampitt, "Approximate Stiffness and Bending Strength for Compact-rolled Sections," AISC *Engineering Journal,* 2nd Quarter, 1985.
2. I-Chen Huang, Discussion of the above-mentioned paper, AISC *Engineering Journal,* 3rd Quarter, 1986.