1006 – Compression and Bending Design According to AISC

Description

Using AISC Manual tables, see [1], determine the available compressive and flexural strengths and if the ASTM A992 W14x99 beam has sufficient available strength to support the axial forces and moments shown in Figure **1**, obtained from a second-order analysis that includes P-δ effects. The unbraced length is 14.000 ft and the member has pinned ends.

Material		Modulus of Elasticity	E	29000.000	ksi
		Yield Strength	F_y	50.000	ksi
		Ultimate Strength	F_u	65.000	ksi
Geometry	Beam W 14×49	Length	L	14.000	ft
Load		LRFD	P_u	400.000	kips
			M_{uy}	250.000	kip·ft
			M_{uz}	80.000	kip·ft
		ASD	P_u	267.000	kip·ft
			M_{ay}	53.300	kip·ft

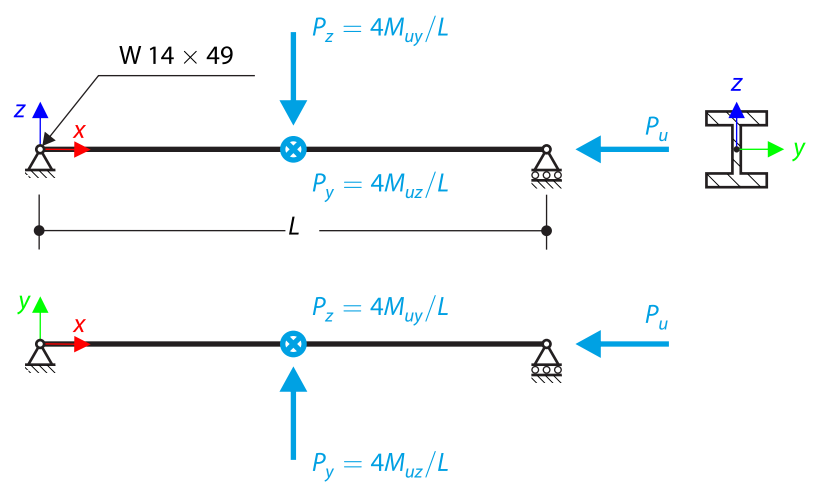

Figure 1: Column loading and bracing for LRFD.

AISC Solution

The effective length of the member is

$$L_{cx} = L_{cy} = KL = 1 \cdot 14.000 = 14.000 \text{ ft} \qquad (1006-1)$$

For $L_c = 14.000$ ft, the available axial and flexural strengths from AISC Manual Table 6-2 are

LRFD	ASD
$P_c = \phi_c P_n = 1130.000$ kips	$P_c = P_n/\Omega_c = 750.000$ kips
$M_{cx} = \phi_b M_{nx} = 642.000$ kip·ft	$M_{cx} = M_{nx}/\Omega_b = 427.000$ kip·ft
$M_{cy} = \phi_b M_{ny} = 311.000$ ksi	$M_{cy} = M_{ny}/\Omega_b = 207.000$ kip·ft
$P_u/P_c = 400.000/1130.000 = 0.354$	$P_a/P_c = 267.000/750.000 = 0.356$

Because both $P_u/P_c \geq 0.200$ and $P_a/P_c \geq 0.200$, with respect to Eq. H1-1a in [1], there is

LRFD	ASD
$\frac{P_r}{P_c} + \frac{8}{9} \cdot \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) = 0.928 \leq 1.000$	$\frac{P_r}{P_c} + \frac{8}{9} \cdot \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) = 0.932 \leq 1.000$

RFEM 5 Settings

- Modeled in RFEM 5.14.03
- Isotropic linear elastic model is used
- Shear stiffness of members is activated

Results

Design	AISC Solution [-]	RFEM Solution [-]	Ratio [-]
LRFD	0.928	0.928	1.000
ASD	0.931	0.932	0.999

Available Flexural Strength

Example (shape)	Design	RFEM Solution [Units]	AISC Solution [Units]	Ratio [-]
H.1A (W 14×99)	LRFD	0.928 [-]	0.928 [-]	1.000
	ASD	0.931 [-]	0.931 [-]	1.000
H.5A (HSS 6×4×0.250)	LRFD	271.499 [kip·in]	273.000 [kip·in]	0.995
	ASD	180.638 [kip·in]	181.000 [kip·in]	0.998
H.5B* (HSS 5×0.250)	LRFD	206.195 [kip·in]	197.000 [kip·in]	1.047
	ASD	146.434 [kip·in]	131.000 [kip·in]	1.118
H.6 - Normal Stress (W 10×49)	LRFD	0.910 [-]	0.8977 [-]	1.014
	ASD	0.910 [-]	0.899 [-]	1.012
H.6 - Shear Stress (W 10×49)	LRFD	0.420 [-]	0.422 [-]	0.995
	ASD	0.420 [-]	0.420 [-]	1.000

Remark

*Note: The torsional constant *C* is calculated in RFEM using a more conservative approach. This results in a slight difference when comparing values. This conservative approach is referred to under Eq. H3-5 in [1].

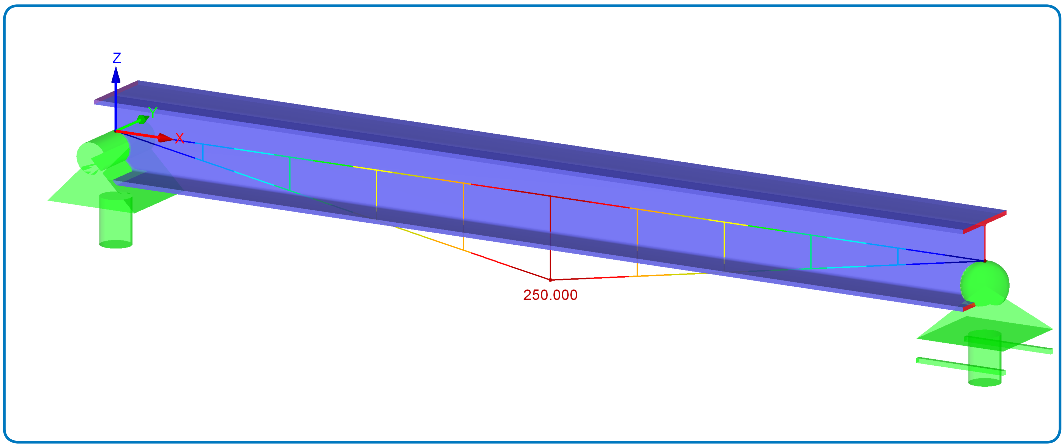

Figure 2: RFEM 5 Results - Moment M_y about the y-axis (LRFD)

References

[1] AMERICAN INSTITUTE OF STEEL CONSTRUCTION, *Specification for Structural Steel Buildings*. 2015.