

Program: RFEM 6, RF-STEEL AISC

Category: Design Check

Verification Example: 1018 – Compression and Bending Design According to AISC

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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 $P-\delta$ 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

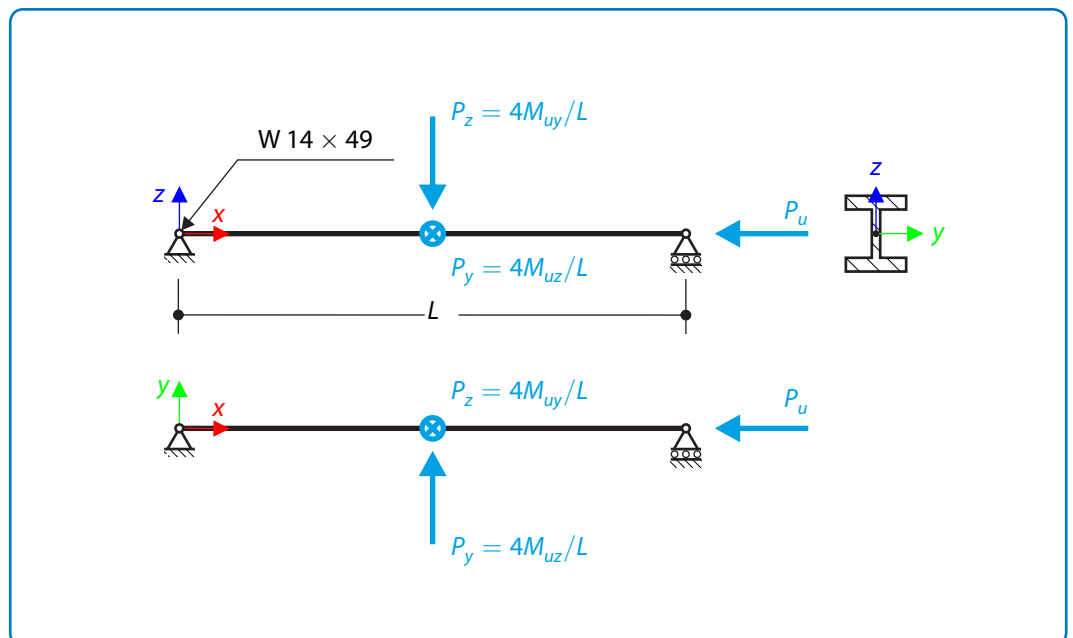


Figure 1: Column loading and bracing for LRFD.

AISC Solution

The effective length of the member is

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$$L_{cx} = L_{cy} = KL = 1 \cdot 14.000 = 14.000 \text{ ft} \quad (1018 - 1)$$

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 [[error 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 6 Settings

- Modeled in RFEM 6.02.0017
- 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	272.052 [kip·in]	273.000 [kip·in]	0.997
	ASD	181.010 [kip·in]	181.000 [kip·in]	1.00
H.5B* (HSS 5×0.250)	LRFD	206.604 [kip·in]	197.000 [kip·in]	1.049
	ASD	137.46 [kip·in]	131.000 [kip·in]	1.049
H.6 - Normal Stress (W 10×49)	LRFD	40.939 [-]	40.400 [-]	1.013
	ASD	27.293 [-]	26.900 [-]	1.015
H.6 - Shear Stress (W 10×49)	LRFD	11.283 [-]	11.400 [-]	0.990
	ASD	7.522 [-]	7.560 [-]	0.995

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 Sect. H3.1 [1].

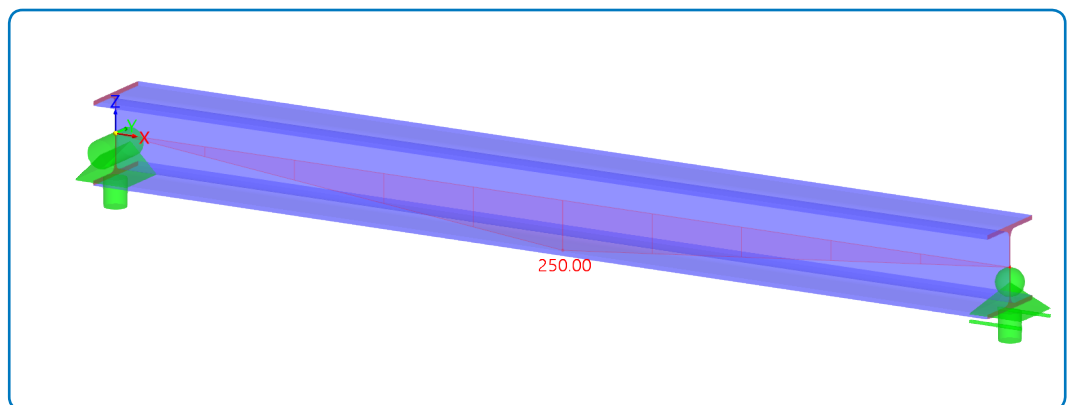


Figure 2: RFEM 6 Results - Moment M_y about the y-axis (LRFD)

References

- [1] AMERICAN INSTITUTE OF STEEL CONSTRUCTION, *Specification for Structural Steel Buildings*. 2016.