

## 1034 – 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  $P-\delta$  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 14x49	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

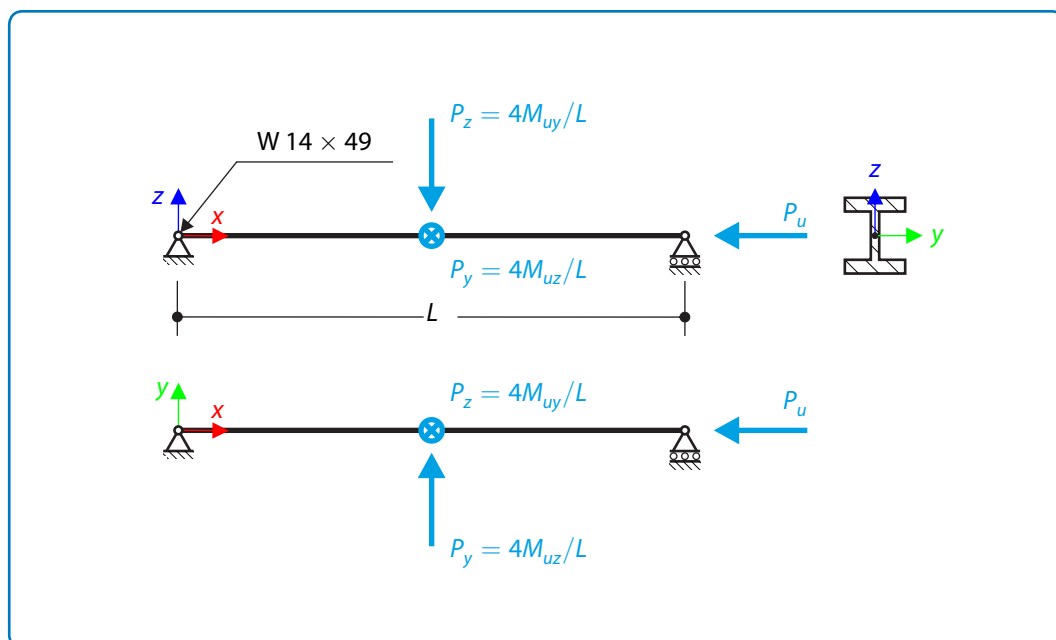


Figure 1: Column loading and bracing for LRFD.

### AISC Solution

The effective length of the member is

**Verification Example: 1034 – Compression and Bending Design According to AISC**

$$L_{cx} = L_{cy} = KL = 1 \cdot 14.000 = 14.000 \text{ ft} \quad (1034 - 1)$$

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

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

Because both  $P_u / P_c \geq 0.200$  and  $P_a / P_c \geq 0.200$ , with respect to Eq. H1-1a in [2], 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 6.08.0010
- Isotropic linear elastic model is used
- Shear stiffness of members is activated

**Results**

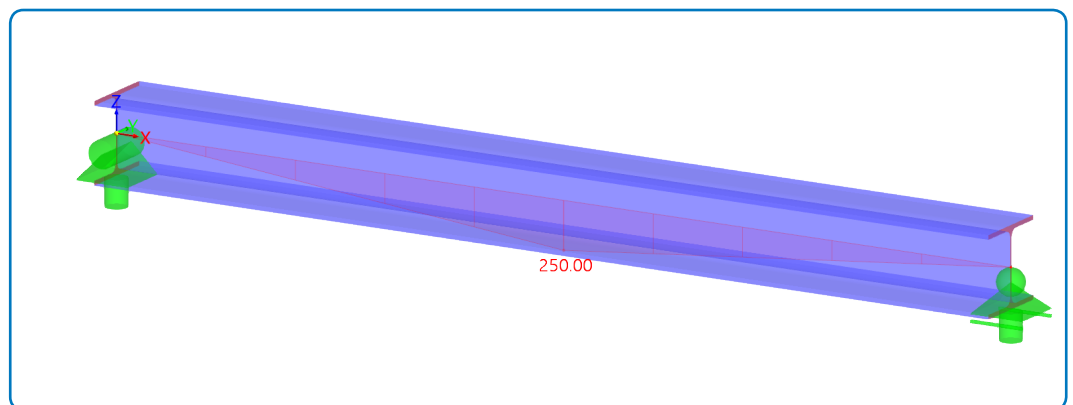
Design	AISC Solution [-]	RFEM Solution [-]	Ratio [-]
LRFD	0.928	0.928	1.000
ASD	0.931	0.932	0.999

### 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]	0.954
	ASD	137.46 [kip·in]	131.000 [kip·in]	0.953
H.6 - Normal Stress (W 10×49)	LRFD	40.939 [-]	40.400 [-]	0.987
	ASD	27.293 [-]	26.900 [-]	0.986
H.6 - Shear Stress (W 10×49)	LRFD	11.279 [-]	11.400 [-]	0.990
	ASD	7.519 [-]	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 [2].



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

## References

- [1] AMERICAN INSTITUTE OF STEEL CONSTRUCTION, *Design Examples V16 - Companion to the AISC Steel Construction Manual*.
- [2] AMERICAN INSTITUTE OF STEEL CONSTRUCTION, *Specification for Structural Steel Buildings*. 2022.