Program: RFEM 6, RF_STEEL AISC

Category: Design Check

Verification Example: 1003 – W-Shape Pinned Column Design According to AISC

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Description

An ASTM A992 14×132 W-shape column is loaded with the axial compression forces given. The column is pinned top and bottom in both axes. Determine whether the column is adequate to support the loading shown in Figure 1 based on LRFD and ASD, see [1].

Material	Steel	Modulus of Elasticity	E	29000.000	ksi
		Yield Strength	F_y	50.000	ksi
Geometry	Beam	Length	L	30.000	ft
Load		Dead	P_D	140.000	kips
		Live	P_L	420.000	kips

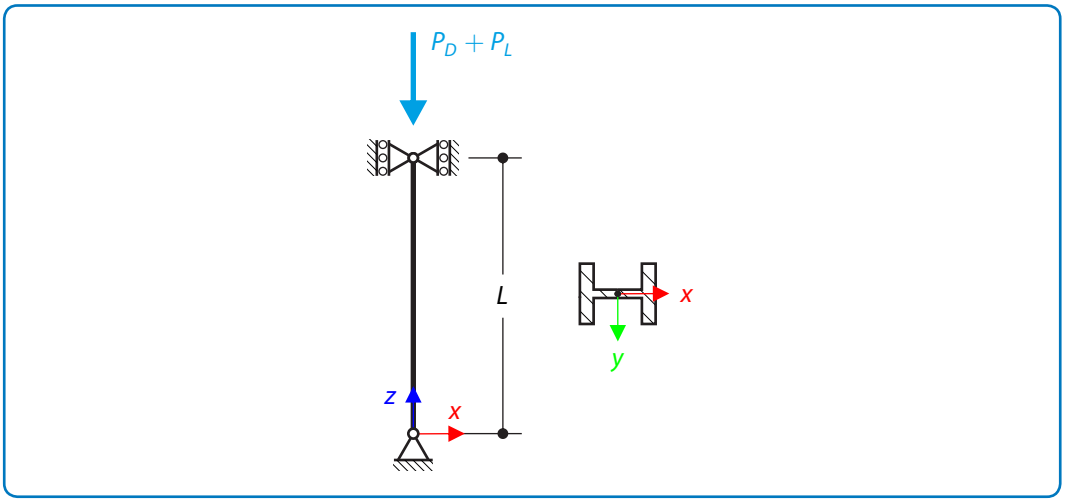

Figure 1: Column Loading and Bracing

Taking into account self-weight, determine the available strength in axial compression of the column according to [[error 1]].

AISC Solution

From ASCE/SEI 7, Chapter 2, the required compressive strength is

LRFD	ASD
$P_u = 1.2 \cdot 140 + 1.6 \cdot 420 = 840.000$ kips	$P_a = 140 + 420 = 560.000$ kips

From AISC Specification Commentary Table C-A-7.1, for a pinned-pinned condition

$$K_x = K_y = 1$$

Therefore, the effective length is

$$L_c = K_x L_x = K_y L_y = 1 \cdot 30.000 = 30.000 \text{ ft} \quad (1003 - 1)$$

Because the unbraced length is the same in both the x–x and y–y directions and r_x exceeds r_y for all W-shapes, y–y axis bucking will govern.

Enter AISC Manual Table 4-1a with an effective length $L_c = 30.000$ ft, and proceed across the table until reaching the least weight shape with an available strength that equals or exceeds the required strength.

From AISC Manual Table 4-1a, the available strength for a y–y axis effective length of 30.000 ft is

LRFD	ASD
$\phi_c P_n = 893.000 > 840.000$ kips	$P_n/\Omega_c = 594.000 > 560.000$ kips

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 [kips]	RFEM Solution [kips]	Ratio [-]
LRFD	893.000	893.202	1.000
ASD	594.000	594.280	1.000

Available Strength

Example (Shape)	Design	RFEM Solution [kips]	AISC Solution [kips]	Ratio [-]
E.1B W 14×90	LRFD	903.663	903.000	1.001
	ASD	601.240	601.000	1.000
E.1C W 14×132	LRFD	893.202	892.000	1.001
	ASD	594.280	598.000	0.994
E.1D W 14×90	LRFD	927.459	927.000	1.001
	ASD	617.072	617.000	1.000
E.2 WF (Slender Web)	LRFD	498.036	500.000	0.996
	ASD	331.361	332.000	0.998
E.3 WF (Slender Flange)	LRFD	317.457	318.000	0.998
	ASD	211.216	211.000	0.999
E.4A W 14×82 (Col. B-C Fixed)	LRFD	940.158	940.000	1.000
	ASD	625.521	626.000	0.999
E.4B W 14×82 (Col. A-B Pinned)	LRFD	861.192	861.000	1.001
	ASD	572.982	573.000	1.001
E.5 LL 4×3.5×0.375 (0.75" Gap)	LRFD	126.951	128.000	0.992
	ASD	84.465	85.000	0.994
E.6 LL 5×3×0.25 (0.75" Gap)	LRFD	66.626	67.500	0.987
	ASD	44.329	44.900	0.987
E.7 (WT 7×34)	LRFD	128.491	128.000	1.000
	ASD	85.490	85.000	1.006
E.8 (WT 7×15)	LRFD	36.608	36.600	1.000
	ASD	24.357	24.400	0.998
E.9 (HSS 12×10×0.375)	LRFD	555.607	556.000	0.999
	ASD	369.665	370.000	0.999
E.10 (HSS 12×8×0.188)	LRFD	151.376	151.000	1.002
	ASD	100.716	101.000	0.997

Example (Shape)	Design	RFEM Solution [kips]	AISC Solution [kips]	Ratio [-]
E.11 (10X Std. Pipe)	LRFD	221.966	221.000	1.004
	ASD	147.682	147.000	1.005
E.12 (Built-up Unequal Flange)	LRFD	276.413	280.000	0.987
	ASD	183.907	186.000	0.989

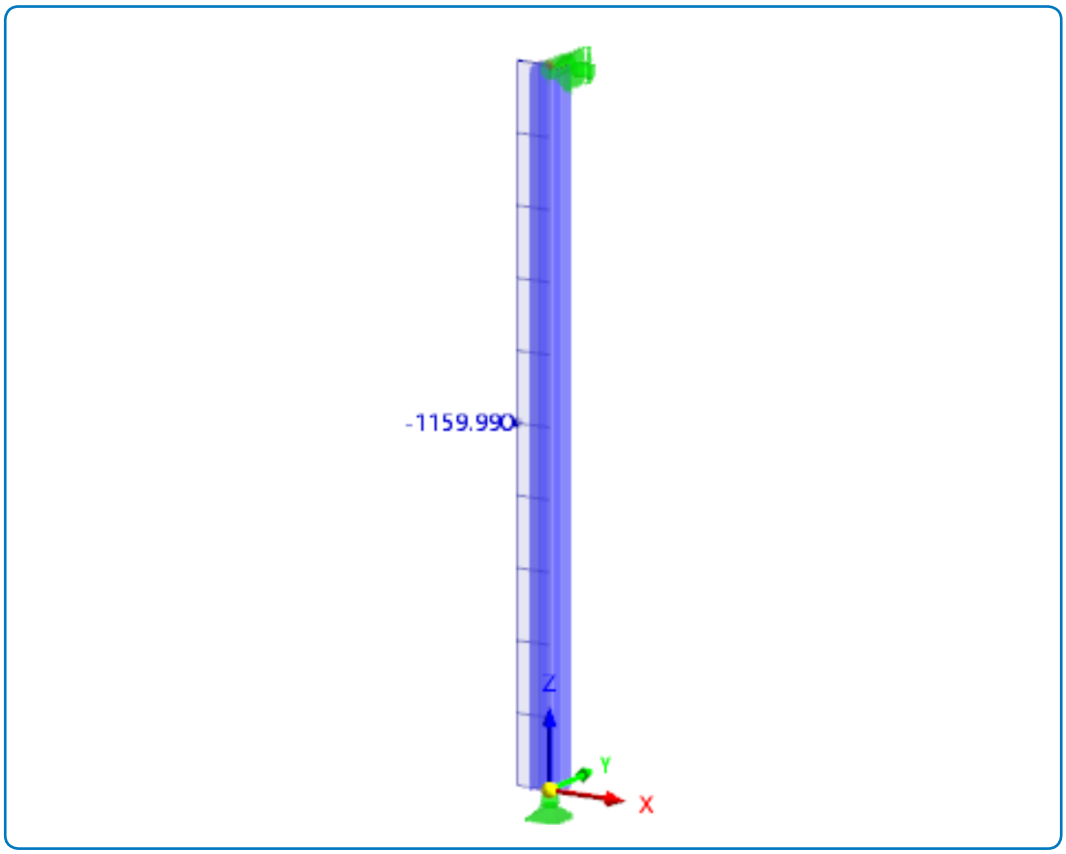

Figure 2: RFEM 6 results - Axial Forces (LRFD)

References

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