Program: **RFEM 5, RF-STEEL AISC**

Category: **Design Check**

Verification Example: **1004 – AISC F.1-1A - W-Shape Flexural Member Design**

1004 – AISC F.1-1A - W-Shape Flexural Member Design

Description

Consider an ASTM A992 W 18×50 beam forspan and uniform dead and live loads as shown in Figure 1. The member is limited to a maximum nominal depth of 18 in. The live load deflection is limited to $L/360$. The beam is simply supported and continuously braced. Verify the available flexural strength of the beam selected based on LRFD and ASD, see [1].

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 18×50	Length	L	35.000	ft
Load		Dead	w_D	0.450	kip/ft
		Live	w_L	0.750	kip/ft

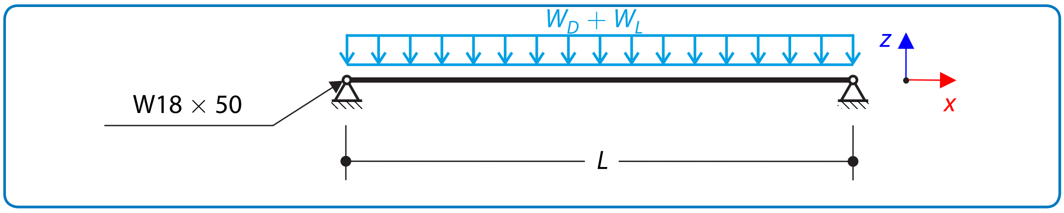

Figure 1: Beam Loading and Bracing

AISC Solution

Per AISC Manual Table 3-23, Case 1, M_u and M_a are computed

LRFD	ASD
$\omega_u = 1.740$ kip/ft $M_u = (\omega_u L^2)/8 = 266.000$ kip · ft	$\omega_a = 1.200$ kip/ft $M_a = (\omega_a L^2)/8 = 184.000$ kip · ft

As the maximal deflection equals

$$\Delta_{\max} = \frac{L}{360} = 1.170 \text{ in} \tag{1004 – 1}$$

the Required Moment of Inertia for Live-Load Deflection Criterion of $L/360$ is

$$I_{x,\text{reqd}} = \frac{5 \cdot \omega_L L^4}{384 \cdot E\Delta_{\max}} = 746.000 \text{ in}^4 \tag{1004 – 2}$$

Select the W 18×50 from AISC Manual Table 3-3, for which

$$I_x = 800.000 > 746.000 \text{ in}^4$$

Per the User Note in AISC Specification Section F2, the section is compact. Because the beam is continuously braced and compact, only the yielding limit state applies.

From AISC Manual Table 3-2, the available flexural strength is

LRFD	ASD
$\phi_b M_n = \phi_b M_{px} = 379.000 > 266.000$ kip·ft	$P_n/\Omega_t = 252.000 > 184.000$ kip·ft

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 [kip·ft]	RFEM Solution [kip·ft]	Ratio [-]
LRFD	378.753	379.000	0.999
ASD	251.998	252.000	1.000

Available Flexural Strength

Example (shape)	Design	RFEM Solution [kip·ft]	AISC Solution [kip·ft]	Ratio [-]
F.1-1B (W 18×50)	LRFD	378.753	379.000	0.999
	ASD	251.998	252.000	1.000
F.2-1A (C 15×33.9)	LRFD	137.161	137.000	1.001
	ASD	91.258	91.300	0.999
F.2-1B (W 15×33.9)	LRFD	137.161	137.000	1.001
	ASD	91.258	91.000	1.003
F.3A (W 21×48)	LRFD	397.954	398.000	0.999
	ASD	264.773	265.000	0.999
F.3B (W 21×48)	LRFD	397.954	398.000	0.999
	ASD	264.773	265.000	0.999
F.4 (W 24×55)	LRFD	502.503	503.000	0.999
	ASD	334.334	334.000	1.001
F.5 (W 12×58)	LRFD	121.876	122.000	0.999
	ASD	81.088	81.400	0.996
F.6 (HSS 3-1/2×3-1/2×1/8)	LRFD	7.238	7.210	1.004
	ASD	4.815	4.790	1.005
*F.7A (HSS 10×6×0.188)	LRFD	61.859	59.700	1.036
	ASD	41.157	39.700	1.037

Example (Shape)	Design	RFEM Solution [kip·ft]	AISC Solution [kip·ft]	Ratio [-]
*F.7B (10×6 ×0.188)	LRFD	61.859	59.800	1.034
	ASD	41.157	30.800	1.034
F.8A (8×8×0.188)	LRFD	46.086	46.300	0.995
	ASD	30.663	30.800	0.996
F.8B (8×8×0.188)	LRFD	46.086	45.400	1.015
	ASD	30.663	30.200	1.015
F.9A (Pipes 8 x-Strong)	LRFD	81.376	81.400	0.999
	ASD	54.142	54.100	1.001
F.9B (Pipes 8 x-Strong)	LRFD	81.376	81.400	0.999
	ASD	54.142	54.100	1.001
F.10 (WT 5×6)	LRFD	7.32	7.32	1.000
	ASD	4.870	4.870	1.000
F.12 (BAR 5 in×3 in)	LRFD	50.625	50.800	0.997
	ASD	33.683	33.800	0.997
F.13 (Round 1 in)	LRFD	0.424	0.425	0.998
	ASD	0.282	0.283	0.997
F.15 (IS 66/14/0.5/2/0)	LRFD	7895.570	7880.000	1.002
	ASD	5253.210	5250.000	1.001

Remark

*Note: When calculating the flange width *b* in RFEM, it is the clear distance between webs minus the inside corner radius on each side. Alternatively, in problems F.7A,B, the flange width is taken as the corresponding outside dimension minus three times the design thickness (AISC B4.1b.(d)).

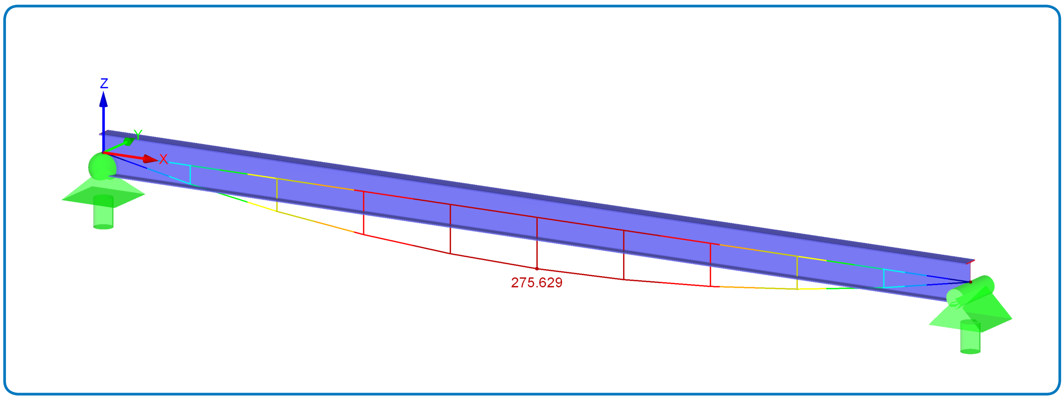

Figure 2: RFEM 5 results - M_y Moment about y-axis (LRFD)

References

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