DESIGN NOMENCLATURE

b = thickness of rectangular bearing bar, inches

d = depth of bearing bar, inches

A_w = center to center distance between bearing bars in welded and press-locked gratings, inches

C = concentrated load at midspan = $4FS_w/L$ pounds per foot of width (pfw)

D_c = deflection under concentrated load = $CL^3/48\ EI_w$ inches

D_u = deflection under uniform load = $5UL^4/12(384)EI_w$ inches

E = modulus of elasticity, pounds per square inch (psi)
- Steel: E = 29,000,000 psi = 29 $(10)^6$
- Stainless Steel: E = 28,000,000 psi = 28 $(10)^6$
- Aluminum: E = 10,000,000 psi = $(10)^7$

F = allowable fiber unit stress, psi
- ASTM A-1011: F = 18,000 psi (Steel, Carbon Hot Rolled Sheet and Strip, Commercial Quality AISI 1020)
- ASTM A-36: F = 20,000 psi (Structural Steel (Bars only))
- ASTM A167: F = 20,000 psi (Type 304 and 316, Stainless Steel)
  F = 16,500 psi (Type 304L and 316L, Stainless Steel)
- ASTM B-221: F = 12,000 psi (6061-T6 Alloy)
  F = 10,000 psi (6063-T6 Alloy)

I_b = moment of inertia of a rectangular bar = $bd^3/12$ in^4

I_w = moment of inertia of grating per foot of width = KI in^4

K = number of bearing bars per foot of grating width = $12/A_w$

L = span of grating between reaction points, inches

M_b = maximum bending moment of bearing bar, in-lbs

M_w = maximum bending moment of grating per foot of width, in-lbs

M_u = maximum bending moment under uniform load = $FS_w = UL^2/96$ in-lbs

M_c = maximum bending moment under concentrated load = FS_w = CL/4 in-lbs

S_b = section modulus of a rectangular bar = $bd^2/6$ $in.^3$

S_w = section modulus per foot of grating width = KS_b $in.^3$

U = uniform load = $96fS_w/L^2$ psf = $96M/L^2$ pounds per square foot (psf)

SAMPLE CALCULATION: STEEL

Type of Grating = 19-W-4-63 welded carbon steel grating

Size of Bar = 1-1/2 x 3/16

Span = 54 inches

A_w = bearing bar spacing = 1.1875 inches

K = number of bearing bars in panel width = $12/A_w$ = 12/1.1875 = 10.105

F = allowable fiber stress = 18,000 psi

E = 29,000,000 psi

S_w = section modulus of grating per foot of width = $Kbd^2/6$ = 10.105 x 0.1875 $(1.5)^2/6$ = 0.711 $in.^3$

I_w = moment of inertia of grating per foot of width = $Kbd^3/12$ = 10.105 x 0.1875 $(1.5)^3/12$ = 0.533 $in.^3$

M_w = maximum bending moment for grating per foot of width = FS_w = 18,000 x 0.711 = 12,800 in.-lbs.

Allowable Concentrated Load and Deflection for 19-W-4-63:

C = allowable load = $4M_w/L$ = 4 x 12,800/54 = 948 pfw

D_c = deflection = $CL^3/48EI_w$ = 948 x 54^3/(48 x 29 x 10^6 x 0.533) = 0.201 inches

Allowable Uniform Load and Deflection for 19-W-4-63:

U = allowable load = $96M_w/L^2$ = 96 x 12,800/54^2 = 421 psf

D_u = deflection = $5UL^4/4608EI_w$ = 5 x 421 x 54^4/(4608 x 29 x 10^6 x 0.533) = 0.251 inches

SAMPLE CALCULATION: ALUMINUM

For a span of 5'-0", the minimum size bearing bar to sustain 225 psf load is:

Type of Grating = 19-SI-4-64 aluminum swage-locked grating

Size of I-Bar = 1-1/2 x 1/4

Equivalent Rectangular Bar for calculation purposes = 1-1/2 x 3/16 (see note 3)

Span = 60 inches

A_w = bearing bar spacing = 1.1875 inches

K= number of bearing bars in panel width = $12/A_w$ = 12/1.1875 = 10.105

F= allowable fiber stress = 12,000 psi

E= 10,000,000 psi

S_w = section modulus of grating per foot of width = $Kbd^2/6$ = 10.105 x 0.1875 $(1.5)^2/6$ = 0.711 in^3

I_w = moment of inertia of grating per foot of width = $Kbd^3/12$ = 10.105 x 0.1875 $(1.5)^3/12$ = 0.533 in^3

M_w = maximum bending moment for grating per foot of width = FS_w = 12,000 x 0.711 = 8,532 in-lbs

Allowable Uniform Load and Deflection for 19-SI-4-64:

U = allowable load = $96M_w/L^2$ = 96 x $M_w/60^2$ = 96 x 12,000 x $0.711/60^2$ = 227.5 psf

D_u = deflection = $5UL^4/4608EI_g$ = 5 x 227.5 x $60^4/(4608 \times 10 \times 10^6 \times 0.533)$ = 0.6 inches

Deflection is directly proportional to load (actual load/allowable load):

$D_{actual} = D_u \times U_{actual}/U_{allowable}$ = 0.6 x 225/227.5 = 0.5934 inches

D_{actual} = 0.5934 inches > recommended limitation of deflection = L/240=.25 inches

Try a grating with a larger moment of inertia to reduce deflection:

19-SI-4-64 (1-1/2 x 3/16 equivalent rectangular bar):

If D_u = .25 inches, then I_w required = $5UL^4/4608ED_u$ = 5 x 225 x $60^4/(4608 \times 10 \times 10^6 \times .25)$ = 1.2656 in^4

Using a larger size: 19-SI-4-94 (Rectangular bar equivalent = 2-1/4 x 3/16)

$I_w = K \times I_b$ = 10.105 x 0.1780 = 1.799 in^4

Allowable Uniform Load and Deflection for 19-SI-4-94:

U = allowable load = 512 lbs

D = deflection = $5UL^4/4608EI_g$ = 5 x 512 x $60^4/(4608 \times 10 \times 10^6 \times 1.799)$ = 0.40 inches

Deflection is directly proportional to load (actual load/allowable load):

$D_u = D_u \times U_{actual}/U_{allowable}$ = 0.40 (225)/512 = 0.176 inches **OK** deflection < L/240 (.25 inches)

Notes:

1) For additional information, see NAAMM's MBG-534, Engineering Design Manual
2) Uniform loads in these examples and in the standard load tables include the weight of the gratings. In designing for uniform loads, the weight of the grating, as well as any other dead load, must be added.
3) Aluminum I-Bar Grating Design Information

I-Bar Size	Comparable Rectangular Bar Size	Area (in2)	Weight (plf)	I (in4)	S (in3)
1" x 1/4"	1" x 3/16"	.120	.144	.0156	.0313
1-1/4" x 1/4"	1-1/4" x 3/16"	.150	.180	.0305	.0488
1-1/2" x 1/4"	1-1/2" x 3/16"	.180	.216	.0507	.0703
1-3/4" x 1/4"	1-3/4" x 3/16"	.210	.252	.0837	.0957
2" x 1/4"	2" x 3/16"	.240	.288	.1250	.1250
2-1/4" x 1/4"	2-1/4" x 3/16"	.270	.324	.1780	.1582
2-1/2" x 1/2"	2-1/2" x 3/16"	.300	.360	.2441	.1953

This table is to be used by engineers to select aluminum I-bar sizes through hand calculations. In most cases, the Load and Span tables in the front of this catalog can be used for product selection.

OTHER CALCULATIONS

For partially distributed uniform loads, forklift and other wheeled loads (carts, pallet jacks, etc.), and other load calculations, contact AMICO-Klemp®'s engineering departments for assistance.

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