Grating Design Data

**DESIGN NOMENCLATURE**

- **b** = thickness of rectangular bearing bar, inches
- **d** = depth of bearing bar, inches
- **Abw** = center to center distance between bearing bars in welded and press-locked gratings, inches
- **C** = concentrated load at midspan = \(4F_{Sw}/L\) pounds per foot of width (pfw)
- **Dc** = deflection under concentrated load = \(CL^3/48EI_w\) inches
- **Dw** = deflection under uniform load = \(5UL^4/12(384)EI_w\) inches
- **E** = modulus of elasticity, pounds per square inch (psi)
  - Steel: \(E = 29,000,000 \text{ psi} = 29 \times 10^6\)
  - Stainless Steel: \(E = 28,000,000 \text{ psi} = 28 \times 10^6\)
  - Aluminum: \(E = 10,000,000 \text{ psi} = (10)^7\)
- **F** = allowable fiber unit stress, psi
  - ASTM A-1011: \(F = 18,000 \text{ psi} \) (Steel, Carbon Hot Rolled Sheet and Strip, Commercial Quality AISI 1020)
  - ASTM A-36: \(F = 20,000 \text{ psi} \) (Structural Steel (Bars only))
  - ASTM A167: \(F = 20,000 \text{ psi} \) (Type 304 and 316, Stainless Steel)
  - ASTM A167: \(F = 16,500 \text{ psi} \) (Type 304L and 316L, Stainless Steel)
  - ASTM B-221: \(F = 12,000 \text{ psi} \) (6061-T6 Alloy)
  - ASTM B-221: \(F = 10,000 \text{ psi} \) (6063-T6 Alloy)
- **Ib** = moment of inertia of a rectangular bar = \(bd^3/12\) in\(^4\)
- **Iw** = moment of inertia of grating per foot of width = \(Kbd^3/12\) in\(^4\)
- **K** = number of bearing bars per foot of grating width = \(12/A_w\)
- **L** = span of grating between reaction points, inches
- **Mw** = maximum bending moment of grating per foot of width = \(FS_w = UL^2/96\) in-lbs
- **Mc** = maximum bending moment under concentrated load = \(FS_c = CL/4\) in-lbs
- **Sw** = section modulus of a rectangular bar = \(bd^2/6\) in.\(^3\)
- **Sw** = section modulus per foot of grating width = \(Kbd^2/6\) 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

**Awb** = 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

**Sw** = section modulus of grating per foot of width = \(Kbd^2/6 = 10.105 \times 0.1875 (1.5)^2/6 = 0.711\) in.\(^3\)

**Iw** = moment of inertia of grating per foot of width = \(Kbd^3/12 = 10.105 \times 0.1875 (1.5)^3/12 = 0.533\) in.\(^3\)

**Mw** = maximum bending moment for grating per foot of width = \(FS_w = 18,000 \times 0.711 = 12,800\) in.-lbs.

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

- **C** = allowable load = \(4M_w/L = 4 \times 12,800/54 = 948\) pfw
- **Dc** = deflection = \(CL^3/48EI_w = 948 \times 54^3/(48 \times 29 \times 10^6 \times 0.533) = 0.201\) inches

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

- **U** = allowable load = \(96M_w/L^2 = 96 \times 12,800/54^2 = 421\) psf
- **Du** = deflection = \(5UL^4/4608EI_w = 5 \times 421 \times 54^4/(4608 \times 29 \times 10^6 \times 0.533) = 0.251\) inches
Grating Design Data

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\text{w} = bearing bar spacing = 1.1875 inches
K = number of bearing bars in panel width = 12/A\text{w} = 12/1.1875 = 10.105
F = allowable fiber stress = 12,000 psi
E = 10,000,000 psi
S\text{w} = section modulus of grating per foot of width = Kbd^2/6 = 10.105 x 0.1875 (1.5) = 0.711 in^3
I\text{w} = moment of inertia of grating per foot of width = Kbd^3/12 = 10.105 x 0.1875 (1.5)^2 = 0.533 in^4
M\text{w} = maximum bending moment for grating per foot of width = FS\text{w} = 12,000 x 0.711 = 8,532 in-lbs

Allowable Uniform Load and Deflection for 19-SI-4-64:
U = allowable load = 96M\text{w}/L^2 = 96 x M\text{w}/60^2 = 96 x 12,000 x 0.711/60^2 = 227.5 psf
D\text{u} = deflection = 5UL^4/4608EI\text{u} = 5 x 227.5 x 60^4/(4608 x 10 x 10^6 x 0.533) = 0.6 inches

Deflection is directly proportional to load (actual load/allowable load):
D\text{actual} = D\text{u} x U\text{actual}/U\text{allowable} = 0.6 x 225/227.5 = 0.5934 inches
Deflection is 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\text{u} = .25 inches, then I\text{w} required = 5UL^4/4608EI\text{w} = 5 x 225 x 60^4/(4608 x 10 x 10^6 x .25) = 1.2656 in^4

Using a larger size: 19-SI-4-94 (Rectangular bar equivalent = 2-1/4 x 3/16)
I\text{w} = K x 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\text{w} = 5 x 512 x 60^4/(4608 x 10 x 10^6 x 1.799) = 0.40 inches

Deflection is directly proportional to load (actual load/allowable load):
D\text{u} = D\text{u} x U\text{actual}/U\text{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

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<thead>
<tr>
<th>I-Bar Size</th>
<th>Bar Size</th>
<th>Area (in2)</th>
<th>Weight (plf)</th>
<th>I (in4)</th>
<th>S (in3)</th>
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</table>

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.