



HEAVY DUTY METAL BAR GRATING MANUAL

FIFTH EDITION

- **Maximum Bearing Bar Depth 5" (127 mm)**
- **Bearing Bar Thickness**
 - Maximum 3/8" (9.5 mm)**
 - Minimum 1/4" (6.4 mm)**



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FOREWORD

The NAAMM Heavy Duty Metal Bar Grating Manual provides architects and engineers with current technical data on heavy duty bar gratings of structural carbon steel and stainless steel. The data includes descriptions of the most frequently used types of gratings, the methods used in their fabrication, dimensional standards, load tables giving allowable uniform and concentrated loads for spans from one foot (305 mm) through eight feet (2440 mm), installation practices, specifications, code of standard practice and glossary. The information is concerned primarily with bar gratings capable of supporting heavy loads. Architects and engineers interested in lighter walkway gratings are referred to the current edition of NAAMM's Metal Bar Grating Manual (ANSI/NAAMM MBG 531).

The first four editions of the manual have been widely used by the design professions. In preparing this fifth edition, the Metal Bar Grating Division of NAAMM has reviewed its contents in detail and has made revisions to reflect current practices. NAAMM believes that the scope of this manual makes it an excellent reference source for those concerned with the design of structures incorporating heavy duty metal bar gratings.

The load tables in this edition are based on the design formulas and procedures found in MBG 534, Metal Bar Grating Engineering Design Manual, which was developed to provide a clearer understanding of the procedures used in the design of grating.

Also included are metric equivalents as an aid to designers who must use the metric system. The system of metric measurement used is from IEEE/ASTM SI 10-2002, "Standard for Use of the International System of Units (SI): the Modern Metric System".

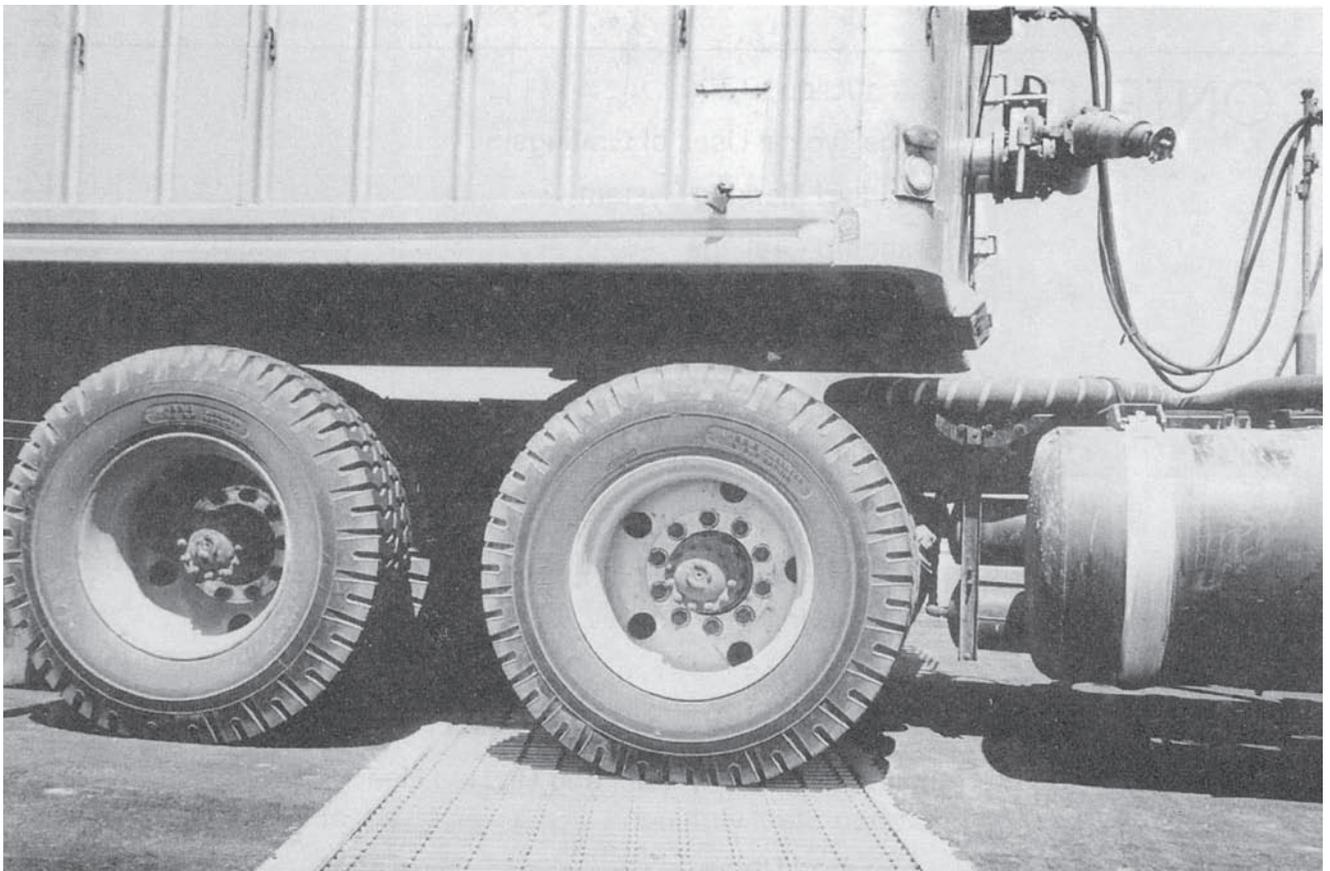
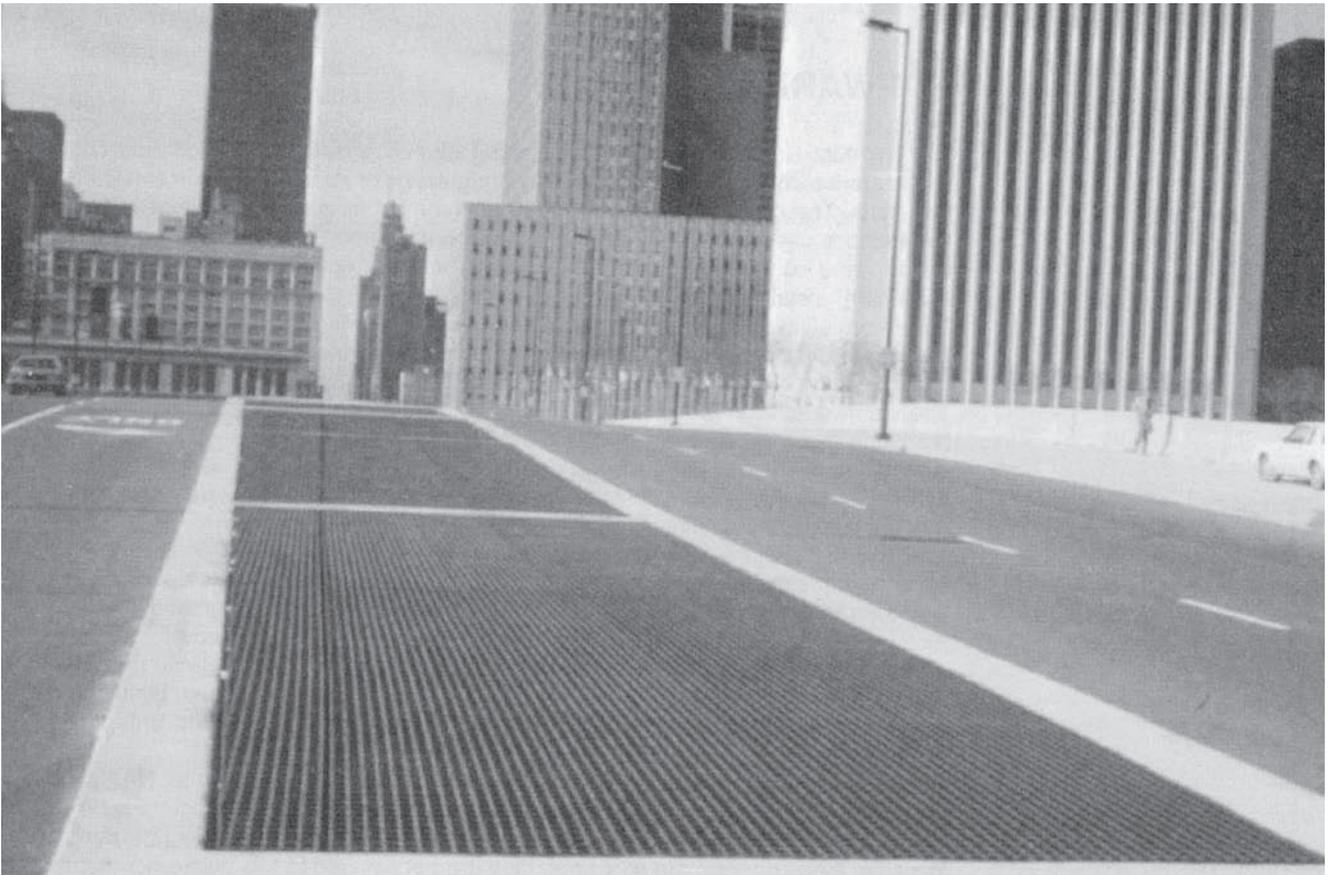
The values stated in inch-pound units are to be regarded as the standard.

This manual presents the common heavy duty gratings manufactured by NAAMM members. NAAMM recognizes the many special designs that embody the use of special steel shapes and/or larger structural members that are used under the same conditions. Because these designs are so varied, they are not covered in this publication but can be manufactured according to the principles within this manual. Consult the manufacturers of these specialty items for technical information.

Changes from the prior version, ANSI/NAAMM MBG 532-00 are indicated by the placement of a vertical line next to the changed item.

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INTRODUCTION

Metal bar gratings, simply defined, are open grid assemblies of metal bars in which the principal load bearing bars run parallel in one direction and are spaced equidistant from each other, either by rigid attachment to cross bars running in a perpendicular direction, or by attachment to reticuline bars extending between them.

There are three types of steel bar gratings – welded, pressure-locked, and riveted. Welded gratings are fabricated by joining bearing bars and cross bars at their intersections by welding. In pressure-locked gratings the cross bars are mechanically locked to the bearing bars by deforming the bars under tremendous hydraulic pressure. For riveted gratings the reticuline bars are joined to the bearing bars at their points of contact by riveting.

Metal bar gratings of all three types provide economical structures with high strength-to-weight ratios for use in many applications, a number of which are listed below. Relatively unrestricted passage of water, light, air, and heat are some of the features which make gratings not only desirable but essential in certain types of construction. Floor gratings permit immediate drainage of water from rain or other sources. They also simplify the ventilation and heating of certain types of industrial buildings.

Floor gratings are capable of supporting both pedestrian and vehicular traffic. Lighter weight gratings are satisfactory for pedestrian traffic; but, where heavy loads, including vehicular traffic, are involved, heavy duty metal bar gratings must be used. Heavy vehicular traffic is encountered in industrial plants with their heavy load carrying lift trucks and on highways and bridges with heavy trucks and tractor-trailers. The metal bar gratings described in this manual are used for these heavy duty applications. The load tables presented are based upon allowable stresses for static loads supplemented by vehicular load tables based upon specific design criteria. The effects of impact and alternative design criteria shall be considered when designing metal bar grating for vehicular traffic.

Metal bar grating for bridge decking has some very specific advantages. Because of its light weight and simple installation, as compared with other surfaces, it permits resurfacing to handle heavier loads without the need for expensive sub-structure work. An additional advantage is that a municipality can carry a stock inventory of grating and replace a bridge surface quickly and economically.

Different applications impose different requirements on gratings. It is important, therefore, that the architect or engineer consult with the manufacturer in the selection of heavy duty metal bar gratings. The members of NAAMM who fabricate such gratings have many years of experience with many types of uses all over the country.

SOME TYPICAL USES FOR GRATINGS

Airplane Landing Mats
Airplane Unloading Ramps
Animal Fences
Areaways
Bar Screens
Boat Landing Ramps
Bridge Centerline Markers
Bridge Flooring
Bridge Sidewalks
Cattle Guards
Concrete Armoring
Concrete Reinforcement
Drainage Pit Covers
Floor Boards

Flooring
Fork Lift Traffic
Freight Car Flooring
Highway Traffic
Hoppers
Machine and Motor Bases
Machinery Safety Guards
Machinery Support Trenches
Material Screens
Mezzanine Floors
Missile Protection
Mooring Docks
Parapet Screens
Partitions
Platforms

Pressure Vessel Internal Trays
Racks and Shelving
Railway Crossings
Ramps
Stacked Parking Areas
Stage Supports
Trap Doors
Trash Racks
Trench Covers
Truck Beds
Vault Covers
Vehicular Traffic Support
Wash Racks
Window Guards

**STANDARD
MARKING
SYSTEM**

The marking system described here is the industry standard for identifying various types of bar grating. Manufacturers shall correlate their individual marking systems with this standard.

The standard marking system for metal bar grating, as illustrated on the facing page, identifies five characteristics of the grating in the following order:

1 TYPE OF GRATING

The type of grating shall be indicated by a letter, as follows:

- W Welded
- P Pressure-locked
- R Riveted

(See Glossary for definitions of types)

2 BEARING BAR SPACING

Bearing bar spacing shall be designated by a number which indicates sixteenths of an inch.

For welded or pressure-locked grating this is the distance, in sixteenths of an inch, **center-to-center** of bars.

For riveted grating it is the distance, in sixteenths of an inch, **between bearing bar faces**.

3 CROSS BAR OR RIVET SPACING

Cross bar or rivet spacing shall be designated by a number which indicates inches.

For welded or pressure-locked grating this is the distance, in inches, center-to-center of cross bars. For riveted grating it is the distance in inches center-to-center of rivets, measured along a single bearing bar.

In addition to spacings covered in this manual, consult individual manufacturers for other spacings available.

4 SIZE OF BEARING BARS

(COVERED IN THIS MANUAL)*

The size of bearing bars shall be expressed in inches of depth and thicknesses as follows:

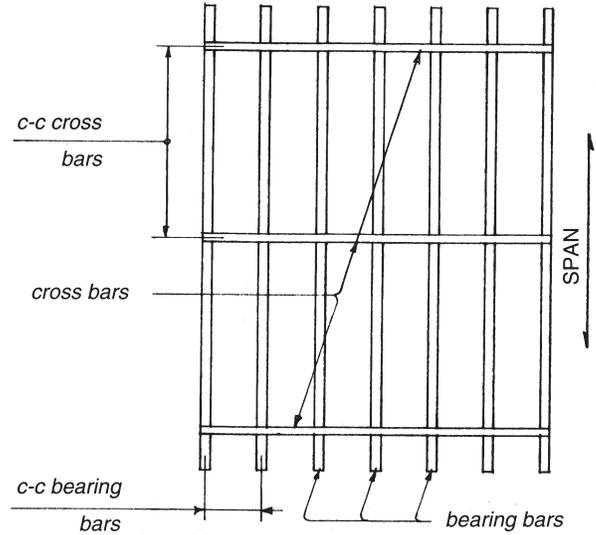
1 x 1/4	1-1/4 x 1/4	1-1/2 x 1/4	1-3/4 x 1/4
1 x 3/8	1-1/4 x 3/8	1-1/2 x 3/8	1-3/4 x 3/8
2 x 1/4	2-1/4 x 1/4	2-1/2 x 1/4	3 x 1/4
2 x 3/8	2-1/4 X 3/8	2-1/2 X 3/8	3 X 3/8
3-1/2 X 1/4	4 x 1/4	4-1/2 x 1/4	5 X 1/4
3-1/2 X 3/8	4 X 3/8	4-1/2 X 3/8	5 X 3/8

Note: The use of bearing bars larger than 5 x 3/8 is not addressed in this manual.

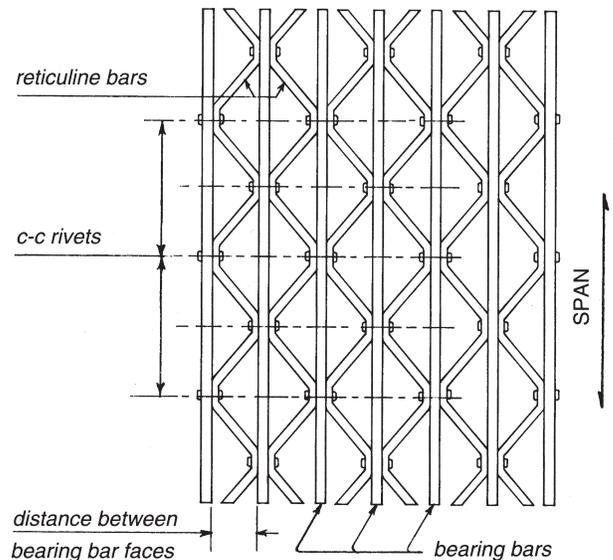
5 MATERIAL

Grating material shall be designated by name, such as "steel" or "stainless steel."

*Equivalent bearing bar sizes in millimeters are obtained by a multiplication factor of 25.4.



**WELDED OR
PRESSURE-LOCKED GRATING**



RIVETED GRATING

MARK

DESCRIPTION OF GRATING DESIGNATED

W-22-4 (3 X 1/4) STEEL

W welded
22 bearing bars spaced 1 3/8 in. (34.9 mm) on center
4 cross bars spaced 4 in. (101.6 mm) on center
(3 x 1/4) bearing bar size, 3 in. x 1/4 in. (76.2 mm x 6.4 mm)
STEEL material

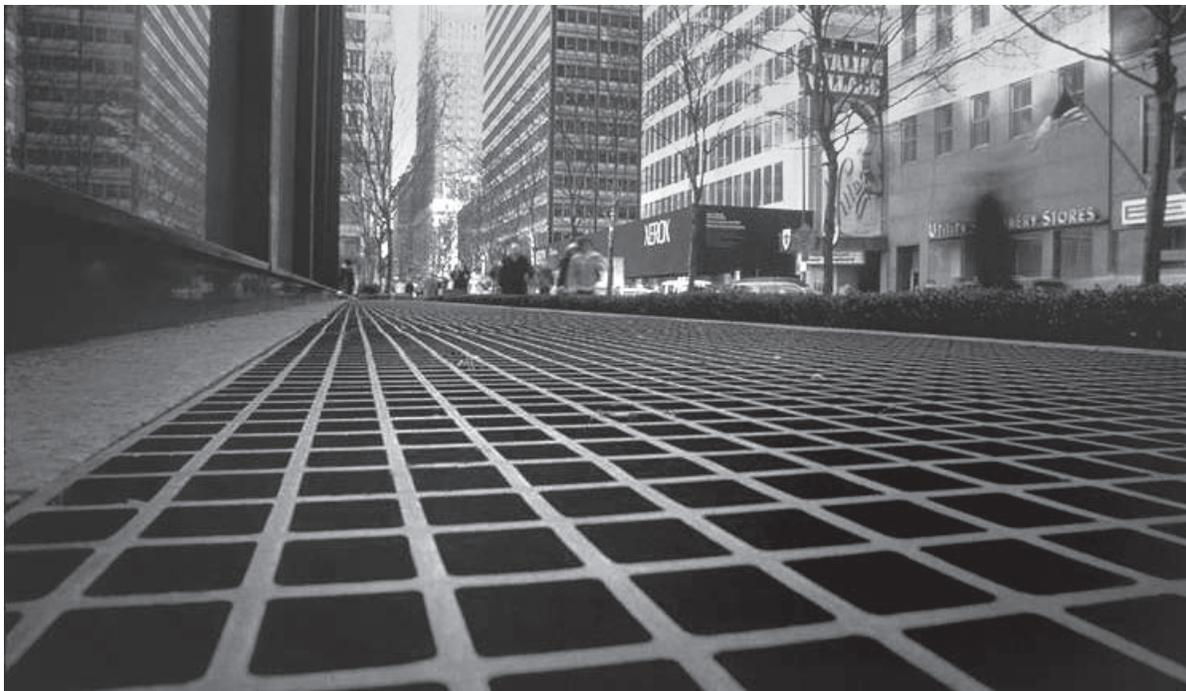
**P-38-4 (4 X 3/8) STAINLESS
STEEL**

P pressure-locked
38 bearing bars spaced 2 3/8 in. (60.3 mm) on center
4 cross bars spaced 4 in. (101.6 mm) on center
(4 x 3/8) bearing bar size, 4 in. x 3/8 in. (101.6 mm x 9.5 mm)
STAINLESS material
STEEL

R-37-5 (3 X 1/4) STEEL

R riveted
37 bearing bars spaced 2 5/16 in. (58.7 mm) between faces
5 rivets spaced 5 in. (127 mm) on center
(3 x 1/4) bearing bar size, 3 in. x 1/4 in. (76.2 mm x 6.4 mm)
STEEL material

NOTE: Any special requirements, such as reversible design or serrated bars, shall be additionally specified. Different bearing bar and cross bar spacings are available.

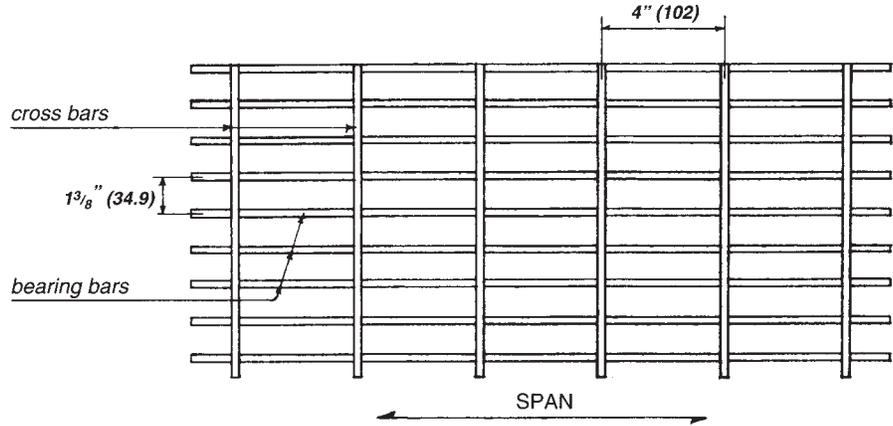


HEAVY DUTY WELDED GRATING

**STANDARD
GRATINGS**

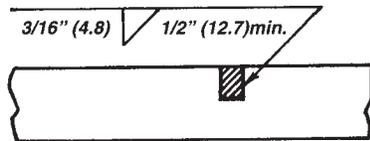
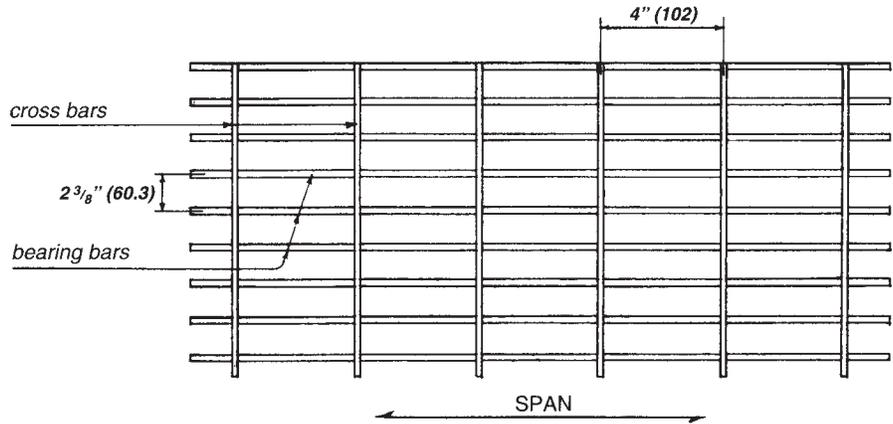
See GLOSSARY OF TERMS for definitions of *Welded, Pressure-locked, and Riveted Gratings*

**WELDED
Mark W-22-4**



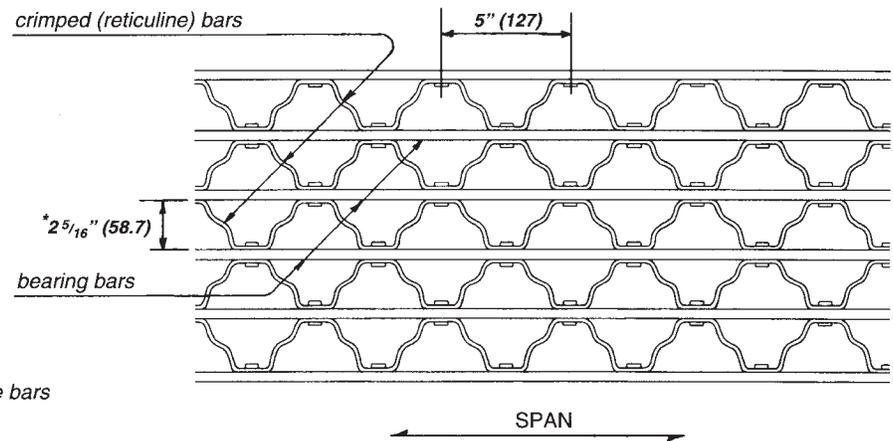
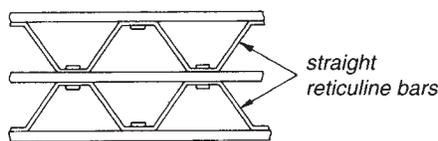
**PRESSURE-LOCKED
Mark P-38-4**

Pressure-locked grating cross bars shall be welded to the first and last bearing bars.



**RIVETED
Mark R-37-5***

Riveted grating shall be furnished with either straight or crimped reticuline bars.



***Note that riveted grating marking indicates space between bearing bars**

MINIMUM STANDARD SIZES

CROSS BARS *and* RETICULINE BARS

All cross bars and reticuline bars shall be sized in accordance with this section. The minimum size of cross bars and reticuline bars shall be based on the type of grating system and the size of bearing bar used. Cross bars used in W type grating systems shall comply with the minimum sizes given in Table No.1. Cross bars used in P type grating systems shall comply with the minimum sizes given in Table No. 2. Reticuline bars used in R type grating systems shall comply with Table No. 3.

Table No. 1 — WELDED — (W)

Bearing Bars			Cross Bars	
Thickness	Depth	Center to Center	Minimum Cross Sectional Area	Weight
in. (mm)	in. (mm)	in. (mm)	in. ² (mm ²)	lb./ft. (kg/m)
1/4 (6.4)	5 (127) or less	1 3/8 (34.9) or less	0.062 (40)	.211 (.314)
1/4 (6.4)	5 (127) or less	more than 1 3/8 (34.9)	0.076 (49)	.259 (.385)
3/8 (9.5)	2 1/2 (63.5) or less	1 3/8 (34.9) or less	0.085 (55)	.290 (.432)
3/8 (9.5)	more than 2 1/2 (63.5)	all spacings	0.150 (97)	.511 (.760)

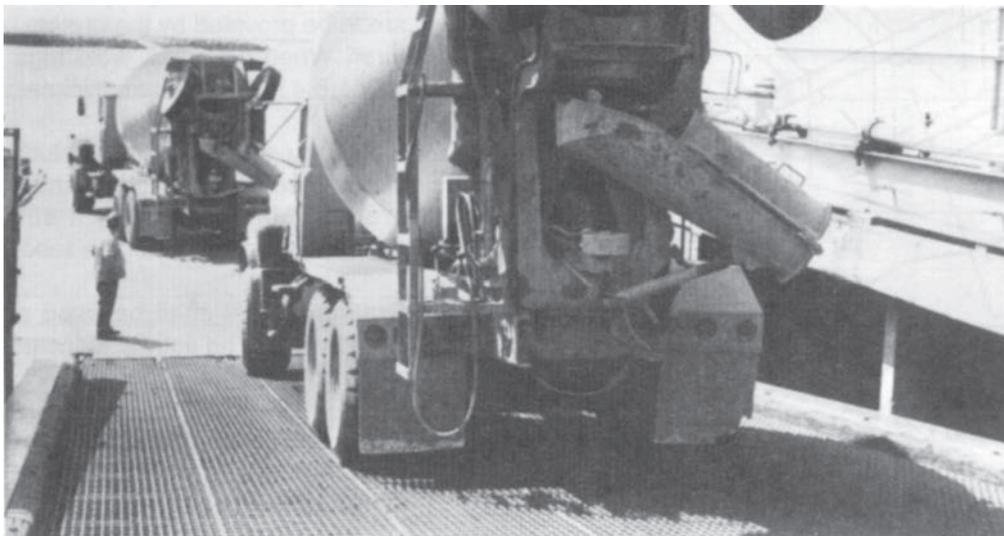
Table No. 2 — PRESSURE-LOCKED — (P)

Bearing Bars		Cross Bars
Thickness	Depth	Minimum Thickness
in. (mm)	in. (mm)	in. (mm)
1/4 (6.4)	2 (50.8) thru 5 (127)	3/16 (4.8)
3/8 (9.5)	2 (50.8) thru 5 (127)	1/4 (6.4)

Cross bars and reticuline bars shall provide the spacing and bracing for the bearing bars and are essential for the stabilization of the grating and the effective distribution of the load across the grating. The satisfactory performance of the grating is dependent on the integrity of the welded, pressure-locked or riveted joints and the use of cross bars or reticuline bars of a size adequate to perform their function.

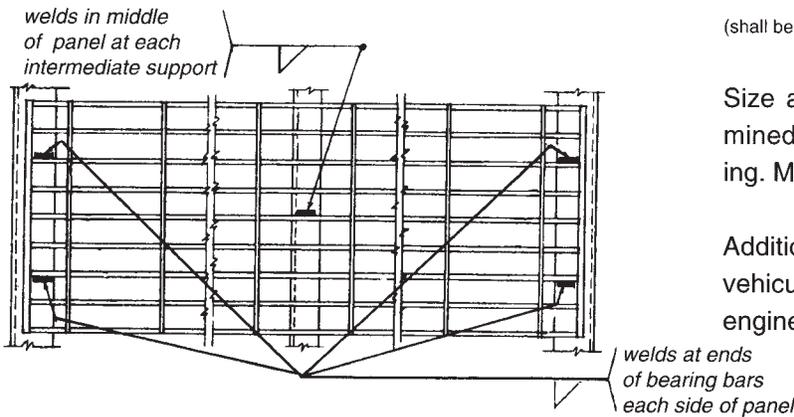
Table No. 3 — RIVETED — (R)

Bearing Bars	Reticuline Bars	Rivets
Depth	Minimum Size	Minimum Diameter
in. (mm)	in. (mm)	in. (mm)
2 (50.8) thru 5 (127)	1 1/2 x 3/16 (38.1 x 4.8)	3/8 (9.5)



HEAVY DUTY WELDED GRATING

IMPORTANT: All gratings shall be anchored firmly to their supports by positive means.

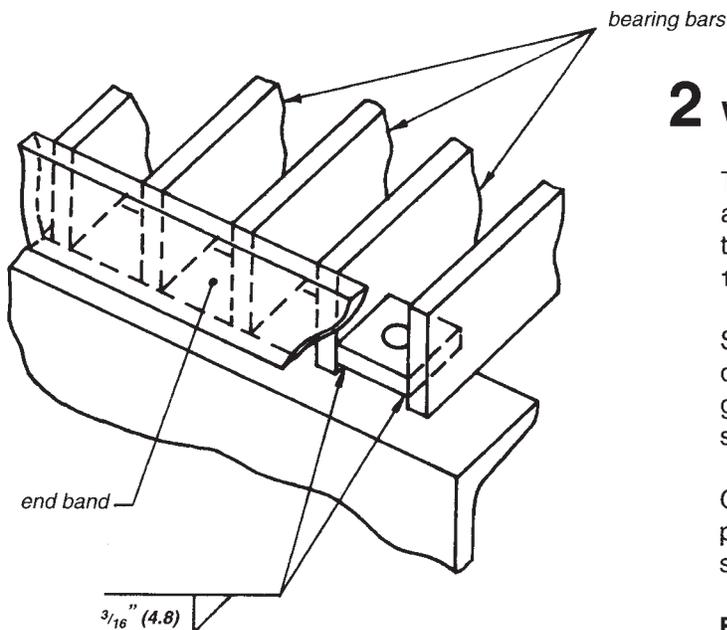


1 WELDED ANCHORAGE

(shall be performed by installing activity)

Size and pattern of welds shall be determined by application and/or size of grating. Minimum pattern shall be as shown.

Additional welding to supports required for vehicular traffic shall be considered by the engineer.



2 WELD LUGS

The designer shall specify when weld lugs are to be provided by the grating manufacturer. When provided, weld lugs shall be $\frac{1}{4}$ in. (6.4 mm) minimum thickness.

Size and pattern of bolts or studs shall be determined by application and/or size of grating. Minimum pattern shall be as shown in welded anchorage (above).

Grating panels shall be used as a template by installing activity to locate holes or studs on structural supports.

Bolts, studs and miscellaneous hardware are not supplied by the grating manufacturer.

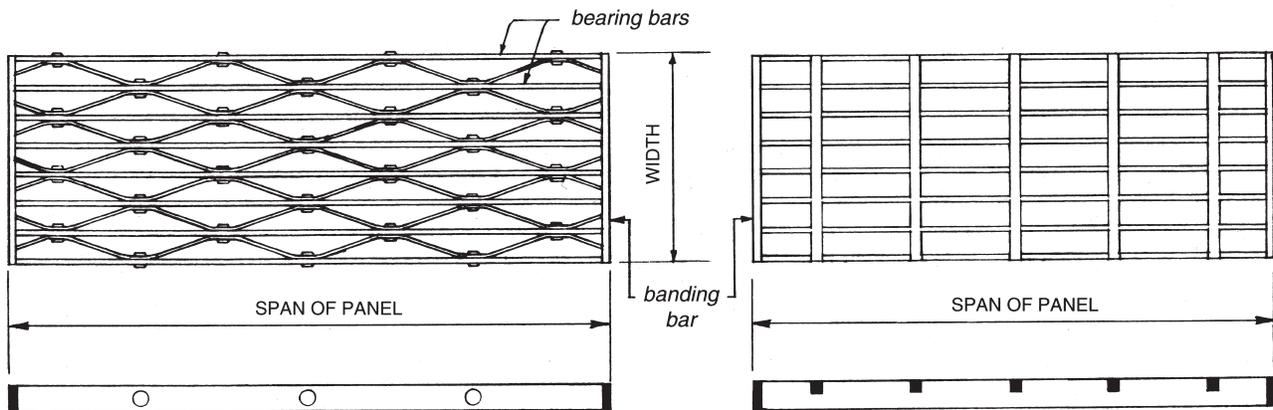
GENERAL REQUIREMENTS FOR GRATING INSTALLATION

Gratings shall be installed with cross bars on top.

Bearing bars shall be notched at supports only when the system has been designed for such modification and is specified by the design engineer and/or indicated on the plans.

Metal shall be used for all grating supports.

- ★ 1 in. (25.4 mm) minimum bearing surface shall be provided for bearing bar depths up to 2 1/4 in. (57.2 mm), and 2 in. (50.8 mm) minimum bearing surface shall be provided for depths of 2 1/2 in. (63.5 mm) and over at each end of span.

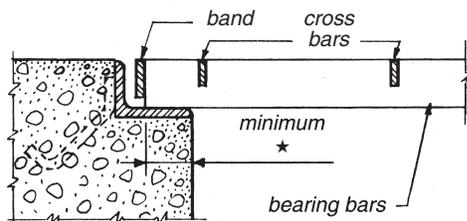


SPAN of panel is measured parallel to the bearing bars.

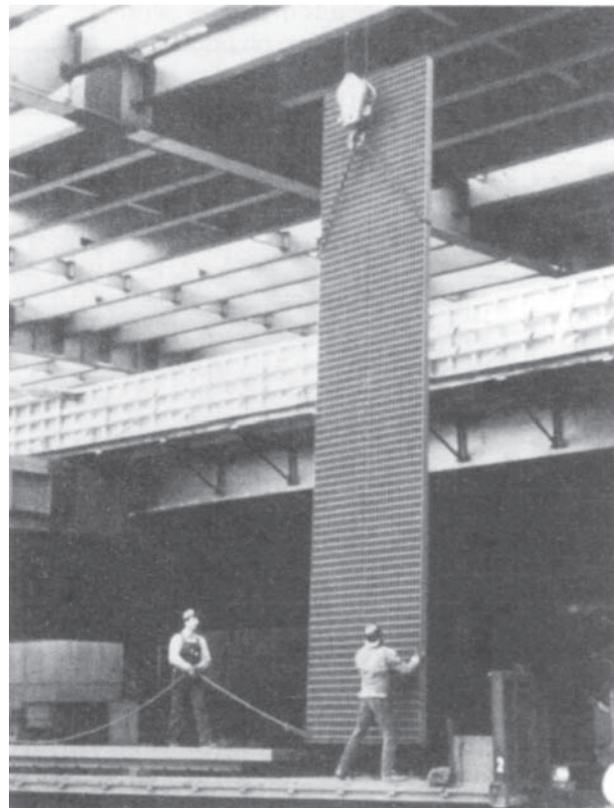
WIDTH of panel is measured perpendicular to the bearing bars, even if this dimension exceeds the panel span.

SUPPORT and BANDING of TRENCH GRATING

Each end of a metal bar grating panel installed in a trench shall be supported on an angle or other shape whose inside vertical dimension equals that of the bearing bar.

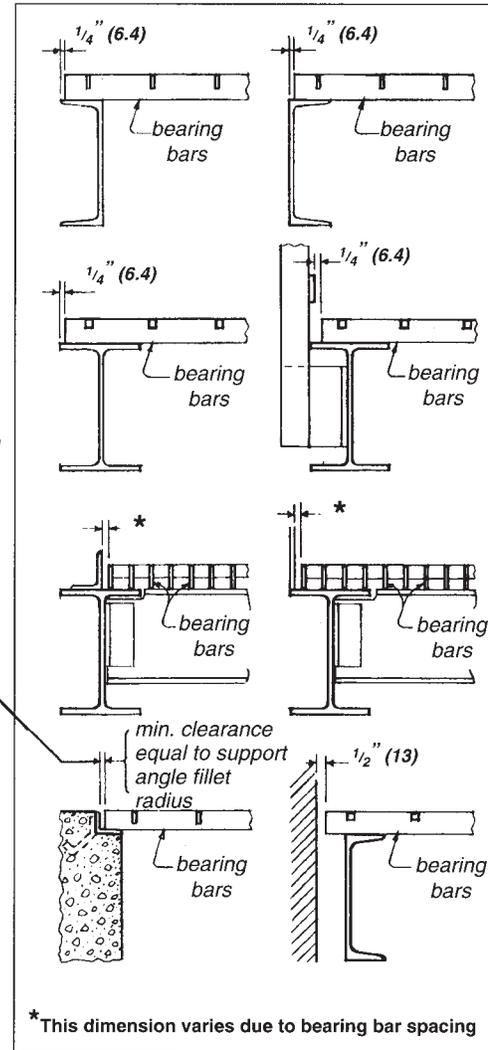
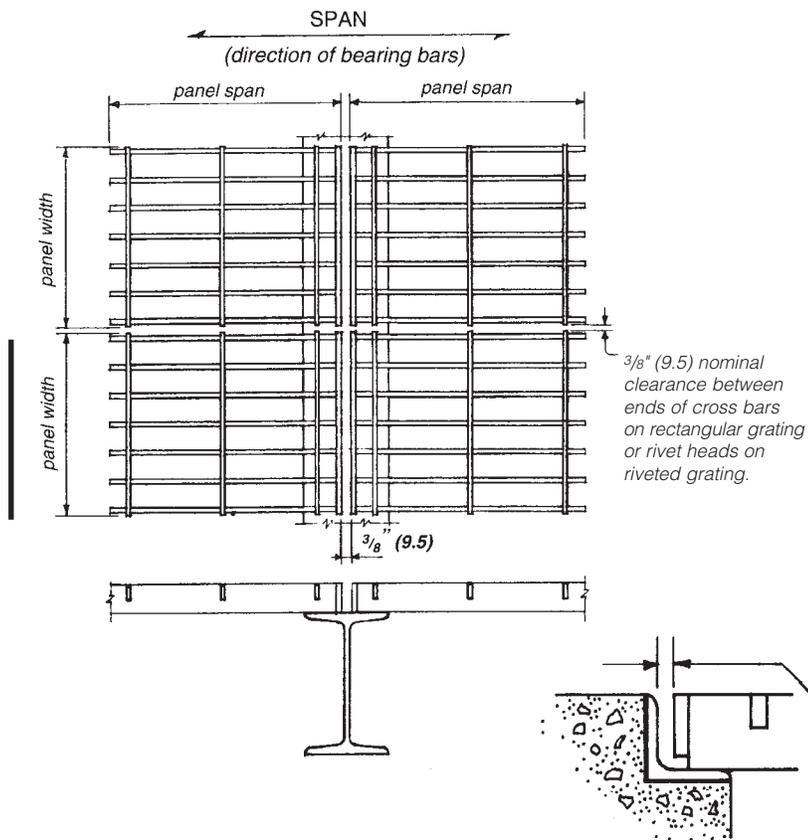


Specify banding on all gratings subject to rolling loads. Full depth band is supplied by manufacturer for all banded grating unless owner or specifier states clearly that shallow banding shall be provided. For trench grating, banding bar shall be 1/4 in. (6.4 mm) to 1/2 in. (12.7 mm) less than depth of grating to permit drainage.



HEAVY DUTY WELDED GRATING

**STANDARD
INSTALLATION CLEARANCES**

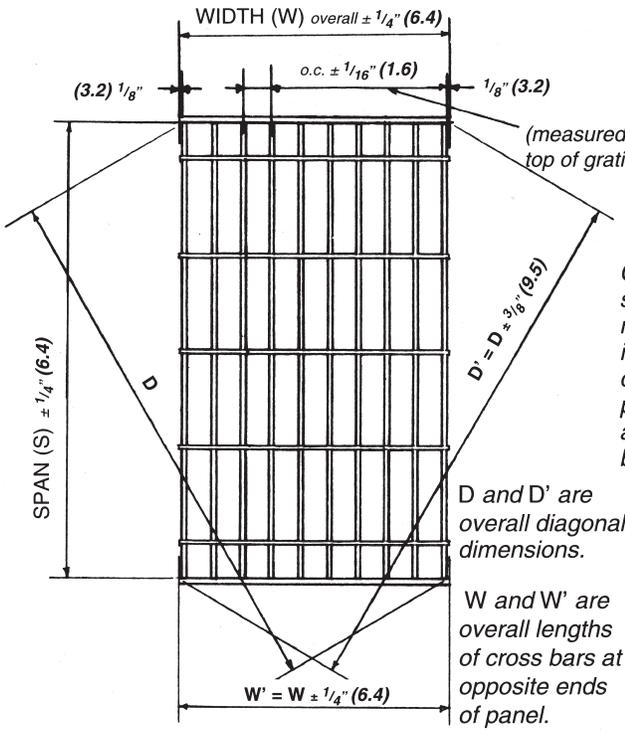


Clearances shall be as shown, but shall be permitted to vary in accordance with dimensional tolerances shown on page 11.

Heavy duty grating shall be designed to have structural support under each bearing bar at cut-outs.

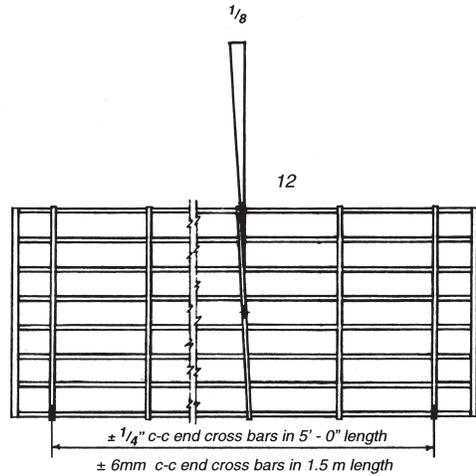


HEAVY DUTY RIVETED GRATING

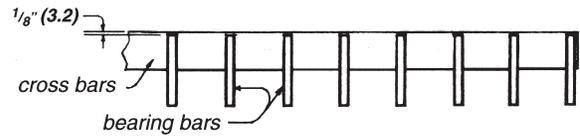


overall dimensions and squareness

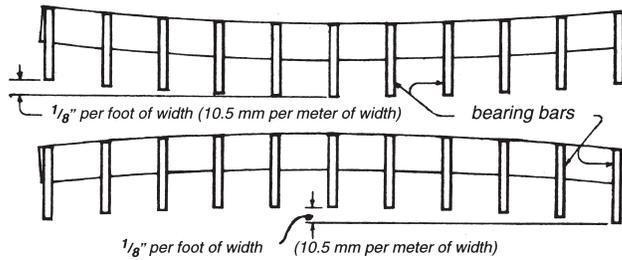
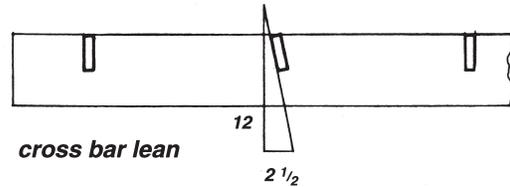
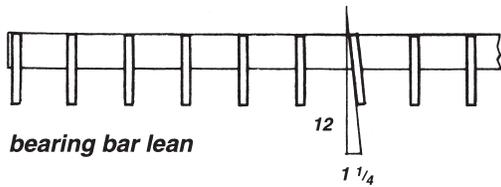
Cross bar shall not vary more than $1/8$ in 12 in either direction from perpendicular alignment with bearing bars.



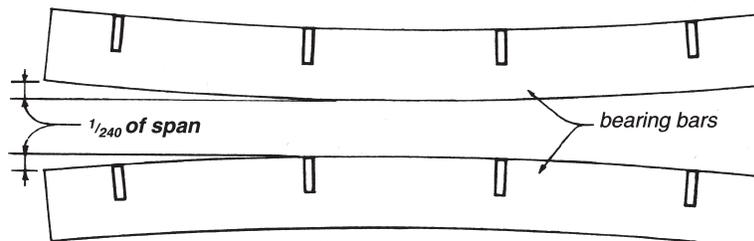
cross bar alignment and spacing



cross bar location



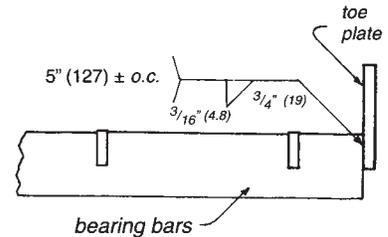
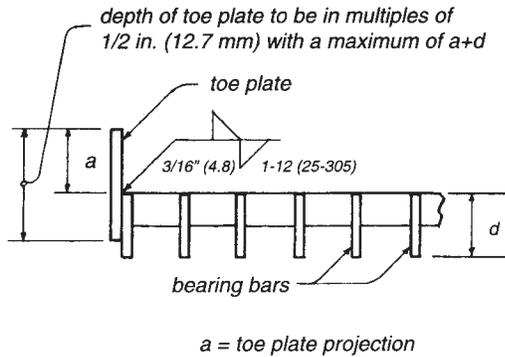
transverse bow (before fastening to supports)



longitudinal bow (before fastening to supports)

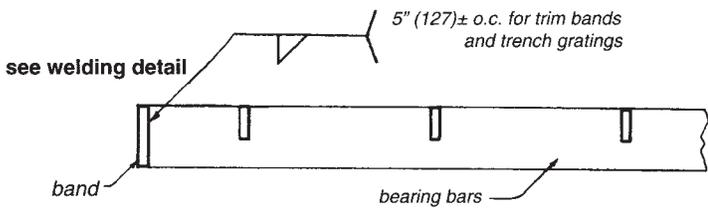
**WELDING OF
TOE PLATES AND BANDING**

TOE PLATES

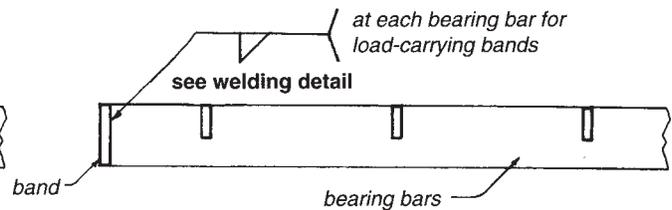


BANDING

Minimum thickness = 1/4 in. (6.4 mm)
For standard banding, band bar shall be same depth as bearing bars.

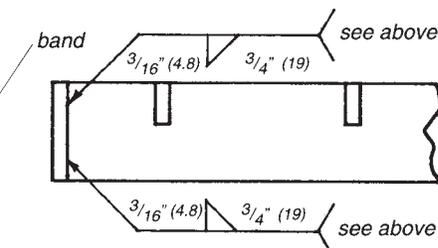
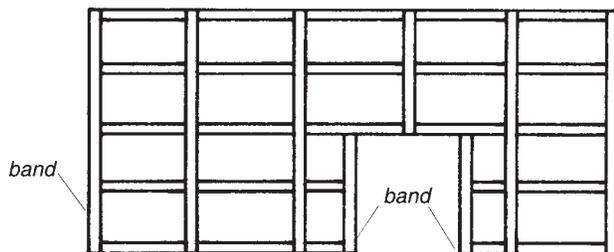


STANDARD TRIM BAND



LOAD BANDING
(shall be specified)

For trench grating, banding bar shall be 1/4 in. (6.4 mm) to 1/2 in. (12.7 mm) less than depth of grating to permit drainage. Full depth band shall be supplied by manufacturer for all banded grating unless owner or specifier states clearly that shallow banding shall be provided.



WELDING DETAIL

For depth less than 2-1/2 in. (63.5 mm), weld one side at top.

For depth 2-1/2 in. (63.5 mm) or greater, weld one side at top, opposite side at bottom; or weld exceeding one-half depth on one side only.

Banding heavy duty metal bar gratings at panel ends and cut-outs improves durability while enhancing appearance. By increasing transverse stiffness, banding distributes and absorbs impact at the primary point of contact. Where light vehicular traffic flow is parallel to the bearing bars, standard banding is sufficient. For heavy, high speed or multi-directional traffic, load carrying banding shall be designed for the effects of impact and fatigue. Structural support shall be provided for all cut-outs accessible to vehicular traffic.

INFORMATION TO BE PROVIDED
when specifying or purchasing METAL BAR GRATING:

Description of grating (see standard marking system, page 4 of this Manual)

A drawing, showing: area to be covered (including all cutouts)
span (direction of bearing bars)
method of support (including locations of weld lugs if specified)
all critical dimensions
(indicate whether clearances are taken into account)
serrated or plain surface

Type of anchorage : (see page 8 of this Manual)

Finish: Steel gratings—manufacturer's standard paint or galvanized

Shipping instructions

REFERENCES

The references on this page are not a part of this standard since they were not approved by a consensus group, and some authorities do not recognize any document containing references which have not had consensus approval. However, NAAMM feels that the information contained in these references is of benefit to the users of this Heavy Duty Metal Bar Grating Manual.

NAAMM STANDARD MBG 533 - Welding Specifications for Fabrication of Steel, Aluminum and Stainless Steel Bar Grating

This Standard covers fillet welding requirements as they apply to bar grating but not high stress structural welds. Welder qualification forms are included.

NAAMM STANDARD MBG 534 - Metal Bar Grating Engineering Design Manual

This Standard was developed to provide a clearer understanding of the procedures used in the design of grating and in the development of load tables.

STANDARD SPECIFICATIONS

for Heavy Duty Metal Bar Grating

I. SCOPE

These specifications apply to heavy duty metal bar grating as hereinafter defined and described.

II. DEFINITIONS

a) Heavy duty metal bar grating is an open grid of metal bars. The bearing bars, which have a cross-sectional depth not less than two times their width, are held at regular parallel spacing, either by:

1. Straight, sinuous or corrugated cross bars having their longitudinal axis perpendicular to the bearing bar and being connected to them by welding, forging or mechanical locking, or by
2. Reticuline bars alternately contacting adjacent bearing bars and riveted to them at regular intervals.

b) Definitions of other terms shall conform to those given in the Glossary of Terms in the Heavy Duty Bar Grating Manual.

III. MATERIALS

a) Steel Gratings

Steel used in bearing bars, cross bars and reticuline bars of rectangular section shall conform to ASTM A 1011/A 1011M, Commercial Steel (CS Type B) for hot rolled carbon steel sheet and strip and ASTM A 36/A 36M for structural steel bars.

Cross bars made of wire rod shall conform to ASTM A 510 (A 510M) for carbon steel wire rods and coarse round wire, except that permissible tolerance on diameter of coarse round wire shall be ± 0.005 in. (± 0.13 mm). Combinations of these steels are not prohibited from being welded together.

Rivets shall be of a steel as prescribed in ASTM A 575, 1/4 In. (6.4 mm) minimum diameter, flat head type.

b) Stainless Steel Gratings

Stainless steel used in bearing bars, cross bars and reticuline bars shall be Type 304, 304L, 316, or 316L alloy conforming to ASTM A 666.

Rivets shall be of a Type 300 series alloy as prescribed in ASTM A 493.

IV. SIZE OF MEMBERS

a) All bearing bars shall be of nominal size as shown in the Load Tables of the Heavy Duty Metal Bar Grating Manual.

b) All materials shall be in accordance with the ASTM A6/A6M tolerances.

c) Banding Bars shall have a minimum thickness of 1/4" (6.4 mm).

V. FABRICATION

a) All tolerances shall be within the limits shown on page 11 of the Heavy Duty Metal Bar Grating Manual.

b) Banding and toe plates, when specified, shall be attached by welding as shown on page 12 of the Heavy Duty Metal Bar Grating Manual.

c) Unless specifically ordered otherwise, no welds anywhere on the grating will be ground.

d) Finishes: steel gratings, unless specified to be galvanized or unpainted, shall have all surfaces painted with one shop coat of manufacturer's standard paint, applied in accordance with the manufacturer's standard practice. One shop coat of manufacturer's standard paint is design to protect the grating from the elements during transit. Grating stored at the jobsite shall be covered or under a roof. Required covering is not the responsibility of the grating supplier. Gratings specified to be galvanized shall have their exposed surfaces zinc-coated by the hot dip process after fabrication, with a coating of not less than 1.8 oz/ft² (550 g/m²) of coated surface.

VI. ANCHORAGE

Unless otherwise specified, gratings shall be welded to their supports as specified in accordance with page 8 of the Heavy Duty Metal Bar Grating Manual.

If weld lugs are required they shall be so specified and shall be welded to the grating by the manufacturer where specified in accordance with the provisions for weld lugs on page 8 of the Heavy Duty Metal Bar Grating Manual.