TECH-LINE

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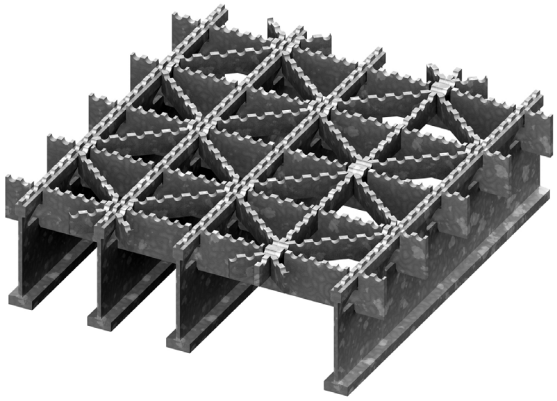
Design Considerations for Welded versus Riveted Open Steel Grid Bridge Decking

AASHTO Design Specifications have several sections that relate to the design and installation of Metal Grid Decks. These metal grid deck systems can be either open steel grid bridge decks with no concrete component, or they can be fully or partially filled with concrete.



Standard 5-Inch 4-Way Welded Open Steel Grid Bridge Decking.

For open grid decks, AASHTO and industry standards call for all grid intersections to be welded. It is clear from the AASHTO reference to welding every intersection that the code is intended for only welded open grid deck systems. There are however open grid bridge decks that are not welded at every intersection but rather are riveted, and these decks have a long record of of durable performance and provide a good solution for the right application. However, the properties of riveted decks and the design assumptions that should be used are not the same as the welded open grids that are covered by the AASHTO design code. In fact AASHTO does not provide any design criteria for riveted metal bridge decks.

Welded style open grids have rigid cross bars that run perpendicular to the main bars and provide significant stiffness in the weak direction facilitating the welded grid network to act like an orthotropic plate. These systems will typically have a load distribution of roughly 2.5 to 4 feet, depending on the grid type and applied load. On the other hand, riveted grids do not provide significant load distribution beyond the area directly under the wheel. At the 2010 Heavy Movable Structures 13th Biennial Symposium a research paper, ***"Heavy Duty Riveted Bridge Deck – AASHTO H20 Loading and Fatigue Testing"*** was presented on this topic by a riveted open grid manufacturer, which showed that load distribution does not extend much beyond the main bars directly beneath the tire patch. This lack of load distribution coupled with a small bottom flange area on the main bars clearly indicates that a riveted grid with similar span capacities to welded open grids would require a much larger bending section modulus to meet both strength and deflection requirements. See the riveted grating load distribution graph (*Figure 1*) from the above referenced paper along with a comparison of span capacities between common welded and riveted systems:

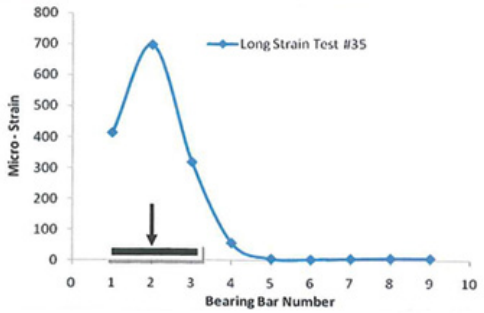


Figure 1: Results are from test on 37R5 Lite 5" x 1/4" riveted steel deck. Maximum response is from the three bearing bars directly under the sumulated tire patch. Main bars are spaced at 5.125" on center.

	S_{top} (in^3/ft)	S_{bot} (in^3/ft)	I (in^4/ft)	W (lb/ft^2)	E (in)	HS20 Max Span, C-C Supports (ft) Stress	Deflection
5-Inch 4-Way (Standard Diagonal Welded Grid)	3.6	4.1	9.6	19.0	41.0	5.2	5.1
5-Inch RB 6.2 (Standard Rectangular Welded Grid)	3.9	4.9	10.9	19.7	38.0	5.2	5.3
37-R-5x1/4 (Heavy Duty Riveted Grating)	6.1	5.3	14.1	29.1	15.0	2.9	3.8
37-R-L-5x1/4 (Lite Riveted Grating) *	4.9	3.1	9.4	21.6	15.0	1.8	3.1

Assumptions:

- Designs are in accordance with AASHTO (17th Edition - 2002) Allowable Stress Design Method
- Main bars are oriented perpendicular to the direction of traffic
- Live Load Distribution Width (E) for Standard Welded Grid per AASHTO 3.27.3.1 (1.25 in * 16 kip axle * 1.3 impact + 2 * 7.5 in main bar spacing)
- Live Load Distribution Width (E) for Riveted Grating per Ohio Gratings Test Report presented at 2010 13th Biennial HMS Symposium, Orlando, FL (*See Figure 1*)
- Flange Width = 7”
- 36 ksi Steel, Steel Strength Stress Limit = 20 ksi
- Punched holes, slots and serrations deducted for Standard Welded Grid, but not deducted for Riveted Grating
- Weights include 7% of bare steel weight for galvanization
- 100% Intermediate Bar Contribution on 37-R-L-5x1/4 Systems

Note:
Section properties are determined by the moment of ineria method. Section properties for Standard Welded Open Grid traditionally include only 50% contribution of supplemental and diagonal bars. Currrent published section properties for Heavy Duty Riveted Grating include 100% contribution of the crimp bar. To make an equivalent comparison, only 50% crimp bar contribution is shown for the riveted grating. There are no published section properties for the Lite Riveted Grating system. Therefore, 100% contribution of the intermediate bar is generously assumed.

As mentioned previously, riveted open grid decks have enjoyed long service lives on many structures - although this is in large part because riveted open grids have typically been used with very short support spacings in the range of 18 to 24 inches. It should also be noted that these older riveted open grid decks generally had main bars spaced about 2.5 inch c/c rather than the wider spaced (about 5 inch c/c) products being promoted today. Welded grids, with their superior load distribution, are typically used on wider girder spacings and have incorporated design improvements to increase their fatigue life beyond what has been demonstrated in past projects. The BGFMA is currently supporting a research project at Oregon State University to quantify the fatigue performance of various weld configurations and cross bar sizes in welded open grids. In addition, this research will also establish an LRFD-based design methodology for this lightweight deck system.

Feel free to contact the Bridge Grid Flooring Manufacturers Association regarding these and other important factors when making an open grid deck selection for your next project.

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