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Grid Reinforced Concrete Deck Attachment

Deck attachment should be designed to adequately resist horizontal shear forces. While welding steel grid members to supports remains an attachment option (see Figure 1) it is recommended that headed shear studs be used for Grid Reinforced≠Deck attachment.

Shear stud design for a Grid Reinforced Concrete Deck is governed by AASHTO Articles 10.38.2 and 10.38.5.

If the deck profile is such that the grid panels can rest directly on supporting members, attachment is straightforward. Panels are positioned on the bridge, applicable cross bar splices are made and field installed concrete form pans at panel joints are inserted. Headed studs are then placed through the grid and welded directly to supporting members, (see Figure 2) using automatic equipment. (A minimum clearance between grid members is required for welding equipment. In some instances grid cross bars can be omitted to provide adequate clearance. Please consult the BGFMA about specific flooring designs.)

A small amount of tack welding of panels to supports may be. required to prevent panel movement prior to concrete placement, especially if it is anticipated that construction equipment will be placed on the unfilled grid.

Small diameter backing rod or other suitable material can be used to prevent seepage if small gaps exist. between the grid and supports.

Adjustable Deck Elevation

It is often necessary to hold the grid panels at varying heights above the bridge supporting members, especially on deck replacement projects where existing framing will remain and an improved roadway cross slope is a requirement, or on new construction to clear cover plates of varying thicknesses. One method to provide this adjustability is to use an assembly of steel support plates, threaded rods or bolts, and nuts (see Figure 3). Typically, the threaded rod/plate assembly is designed only to support the dead load of the grid and the wet concrete. *Any, construction loads placed on the grid before concrete is poured must be accounted for in the design of the support assembly.* Sample calculations for the design of a support system are provided on page 4.

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Suggested construction sequence

A suggested sequence incorporating an adjustable support mechanism is described below

In the grid manufacturer's shop a support plate (with drilled or punched hole) is welded into the grid, with a nut tacked to the bottom of the plate. At the site, before the panel is placed onto the bridge, a threaded bolt is inserted through the plate and nut, and allowed to extend below the bottom of the grid to the approximate haunch height. After the panel is in place, the elevation is adjusted by turning the threaded bolt. Once all panel elevations are properly established, a sufficient number of threaded bolts are tack welded to the framing members to prevent any movement of the panels. The deck is now ready for placement of headed shear studs and concrete. This procedure is applicable for full depth, half depth or exodermic systems.

Alternate systems have been used, depending on certain site parameters, grid design and/ or contractor preference. For example, the following methods have been used:

- continuous angle supports, welded to both sides of stringer flanges
- steel shims
- field installed support plates, used in conjunction with double nuts and threaded rods welded to supports.
- steel straps placed across the top flange of supporting members; angles which support the grid are then bolted or welded to those steel straps. This method allows deck attachment without any welding to supports and can be designed to permit traffic on the deck prior to filling with concrete.

Each method provides for the required adjustability.

Forming a haunch

A variety of methods have been used to contain the concrete above supports. The simplest is to construct wood forms after the deck is in place. In circumstances where there is no access beneath the deck during construction, other methods have been used:

- a foam backer rod can either be glued in place prior to placing the deck, or inserted on top of steel framing after panels are in place. Backer rod is usually used for smaller haunches.
- preformed sheet metal pans have been tack welded to the top of steel framing members before the deck has been positioned; sheet metal screws can then be used to attach the form pans of the grid to the preformed haunch pans.
- if the deck is supported by continuous angles, those angles also serve to form the haunch

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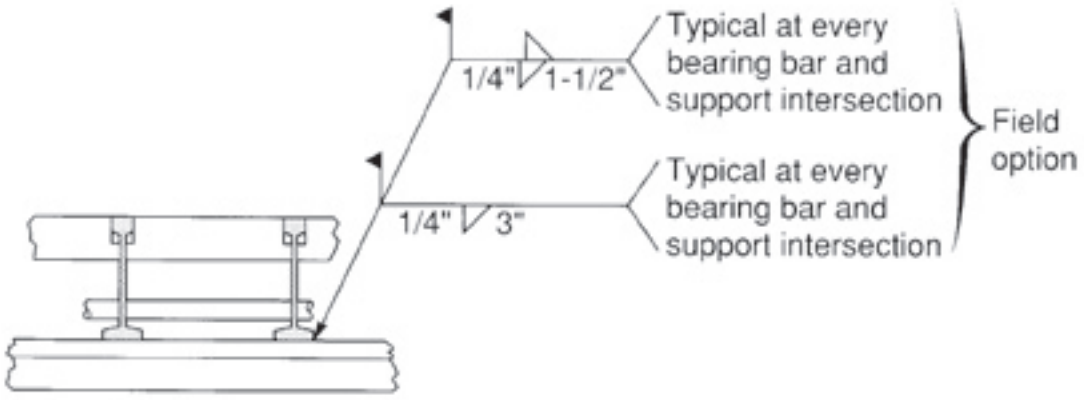

Figure 1:
Grid rests directly on supports; attachment by field welding. may be used for any full-depth or half-filled system

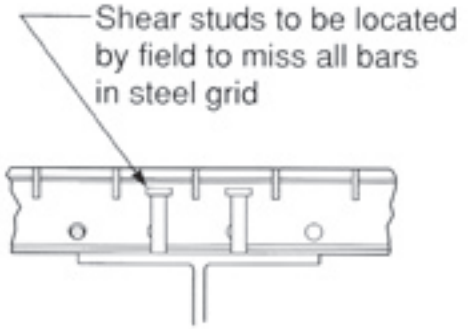

Figure 2:
Grid rests directly on supports; after panel erection, shear studs are positioned and welded. Grid panels are not directly welded to supports. This attachment method is applicable to full-depth, half-filled and exodermic decks. Small diameter backer rod may be used to prevent grout seepage.

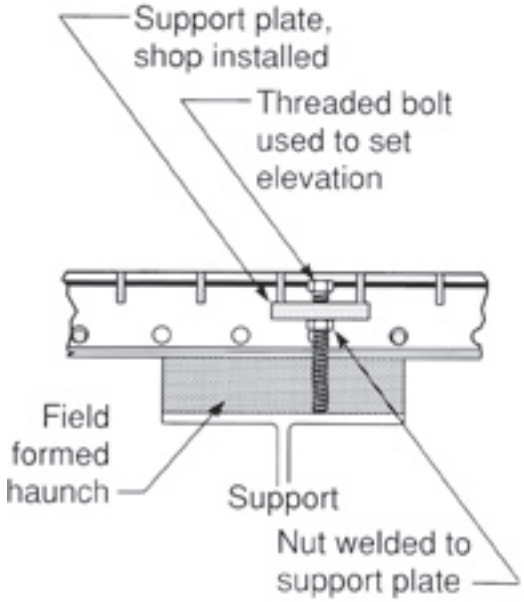

Figure 3:
Shop installed support plate with nut and threaded bolt provides required adjustability. Headed shear studs (not shown for clarity) positioned and welded after grid erection. Haunch is typically field formed. Attachment is applicable to full-depth, half-filled and exodermic decks.

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Sample calculation of threaded support bolts

Assumptions:

- 5-3/16" grid with main bars 5.58#/LF spaced 8" c/c with one supplementary bar, 2 x 3/16" cross bar spaced 4" c/c and 5/8" Ø bottom cross bar spaced 8" c/c. Self weight of grid 16 #/ft^2, self weight of grid with normal weight concrete and 2" overfill 99#/ft^2. All steel Grade 50.
- girder spacing 8'-2" c/c
- threaded studs 3/4" Ø with a minimum F = 50 ksi, to allow adjustment of grid to desired elevation above stringers
- threaded studs support dead load of grid and wet concrete, including integral overfill

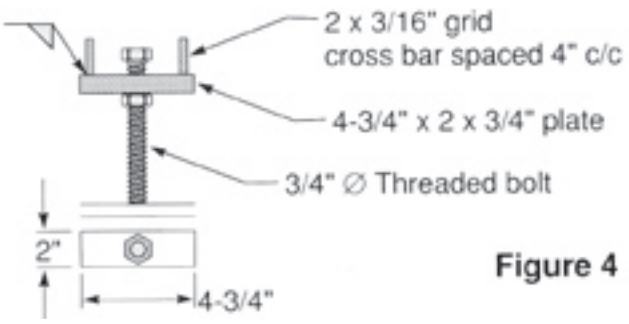

Figure 4

Strength of 3/4" threaded stud under compression:

• radius of gyration = r = d/4 = 0.75/4 = 0.1875

• compute strength as column:

F_a = 23,580 - 1.03 (k I / r)^2 (1983 AASHTO Manual, Maintenance of Bridges)

Fa = 23,580- 1.03 (0.65 x 6* /0.1875)^2 = 23,134 psi, or 23.134 ksi (* assume 6" maximum unbraced length)

23.134 x 0.4418 (area of stud) = 10.22 kips/stud

For supporting dead load only:

Steel grid and concrete = 99#/SF and girder spacing = 8.167'; 8.167 ft x 0.099 kips = 0.809 kips/ft/girder

Design of support plate:

Assume simple span (conservative) and assume effective width = 2" - 0.875" (deduction for hole) = 1.125"

S = (0.75)^2 x 1.125/6 = 0.1055 in^3

Moment capacity = 0.1055 x 0.55 x 36 = 2.1 in-kips; therefore, 2.1/0.809 = 2.6' or 31", maximum spacing for 4-3/4" x 2" x 3/4" bar. Therefore, try placing plates 24" c/c.

Check stud:

3-1/12 x 0.809 = 2.1 kips, < 10.22 kips/stud OK

Check cross bar:

uniform load = 0.809 kips/ft/2/12 in/ft = 0.0337 kips/in; (two cross bars carry load)

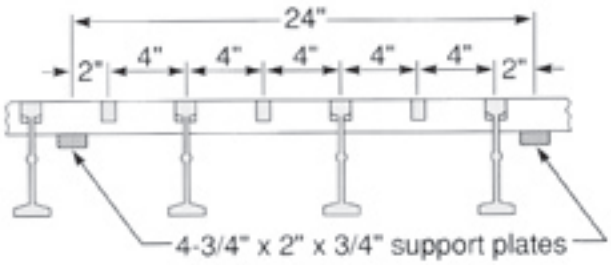

Figure 5

Since plates are welded, assume cross bar end condition is fixed-fixed. Because load is short term, ie, when concrete cures load is carried by haunch, use operating allowable stress for flexure and shear, or 37.5 ksi. (0.75 F_y = 0.75 x 50)

Section property of cross bar at supplementary bar or main grid I-beam = b h^2/6 = 0.1875 x (1)^2/6 = 0.03125 in^3

Moment at 2" from centerline of plate
= w/12 (6 L x L^2 -6 x^2)
= 0.0337/12 [6 x 24 x 2 - (24)^2 -6(2)^2] = 0.876 in-kips

Stress = 0.876/0.03125 = 28 ksi <37.5 ksi

Shear = 24 x 0.809/(12 x 2) x 0.5 = 0.405 kips

Operating shear capacity = 0.45 x 50 x 1 x 3/16 = 4.22 kips > 0.405 kips OK

Summary:

Use one 3/4" Ø stud at 24" c/c. Support plate is 43/4" x 2" x 3/4", A36 steel. Spacing and dimensions are for each girder.