TECHNICAL
DATA SHEET

Spring 1997

Design of Grid Reinforced Concrete Bridge Decks Using AASHTO's 16th Edition

The information contained in this Technical Data Sheet describes how Grid Reinforced Concrete Decks are designed in Accordance with AASHTO's 16th Edition. It revises some information contained in a prior Technical Data Sheet entitled DESIGN METHODOLOGY.

A BGFMA Technical Data Brief entitled "Design of Grid Reinforced Concrete Bridge Decks Based on Orthotropic Plate Model and Load and Resistance Factor (LRFD) Theory" is also available.

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Section Modulus

The section modulus of any of the three deck types is determined by first breaking the I-beam or Tee into component shapes, either rectangular, square or triangular. (See sample drawing of 5-3/16" I-beam.) The area of the fabrication slots are then deducted, if they are in the tension zone. Slots in the compression region are ignored. Concrete is transformed by using the appropriate modular ratio. The neutral axis, N.A., is computed by taking the first area moment of all components about an assumed N.A. (at a distance "x" from the bottom). Knowing the location of the N.A., moment of inertia and section modulus can be computed.

(Note: Size and shape of fabrication slots vary from one manufacturer to another. Therefore, section properties shown in **BGFMA** literature are to be considered minimums; the difference due to differing slot configurations between manufacturers is negligible.)

In all systems, concrete below the neutral axis is ignored in the positive moment region. No concrete is considered in the negative moment region in half filled or exodermic systems; in exodermic decks, rebar is considered in the negative moment region. A concrete overlay, whether separately applied or integrally overpoured, is counted in compression, less 1/2", which is sacrificial.

Moment

For cast-in-place installations, the self weight of the grid and the dead load of the wet concrete are carried by the steel alone; therefore, only steel section properties are considered. Live load is carried by the composite section of the steel and concrete.

Span length is as defined by AASHTO 3.24.1.2b. Moment of the decking system is calculated as follows:

Case A: Main reinforcement transverse to traffic - AASHTO Article 3.24.3.1.

Case B: Main reinforcement longitudinal to traffic - AASHTO Article 3.24.3.2.

A continuity factor of 0.8 is used in moment calculations.Design tables shown in Technical Data Sheets entitled Product Specifications have been generated based upon the AASHTO Articles described.

Determination of Effective Width of Slab

The AASHTO rules for determining participation of deck as top flange of supporting member, Article 10.38.3, apply to steel grid bridge deck, ie, the lesser of

a. 12t, where t = thickness of slab
b. center to center of supports
c. 1/4 span of stringer or girder

For exodermic and half depth decks, t = the overall deck thickness. For example, for an 8-3/4" exodermic deck consisting of a 4-1/4" grid and a 4-1/2" concrete component, t = 8-1/4" (1/2" sacrificial).

Design Example

This sample design is for a 4-1/4" full depth Grid Reinforced Deck. A36 steel is used, main grid I-beams are spaced 6" c/c and are oriented transverse to traffic. Stringer spacing is 7.5' and the stringer flange is 12"; therefor S = 7.5 – 0.50 (or 7.0'). In this example a 1-3/4" integrally poured overfill is used; 1-1/4" is counted in determination of section properties and the top 1/2" is considered sacrificial. n = 8.

The net section properties, in inches³/ft are:
Top Steel = 2.924 Bottom Steel = 3.348

The composite section properties in inches³/ft with n = 8 are:
Positive: S_t = 60.468 (conc) S_b = 4.784 (steel)
Negative: S_t = 3.055 (steel) S_b = 50.095 (conc)

The theoretical dead load of steel grid and concrete, including 1-3/4" overfill, is 82.8 lb/f².

The grid floor is continuous over three or more supports, so the design moments are calculated using a continuity factor of 0.8. An impact factor of 0.3 is used. Thus:

$M_{LL} + I = \frac{(7.00+2)}{32} 16 \times 1.3 \times 0.8 = 4.680$ k-ft/ft

$M_{DL} = (0.062 \times 7.00^2/8)0.8 = 0.304$ k-ft/ft

$M_{WS} = (0.021 \times 7.00^2/8)0.8 = 0.103$ k-ft/ft

The stresses are calculated as follows:

Positive:

Steel:
$f_{LL} + I = 4.680 \times 12/4.784 = 11.739$
$f_{DL} = 0.304 \times 12/3.348 = 1.090$
$f_{WS} = 0.103 \times 12/4.784 = 0.258$
f_{steel} (ksi) = 13.087

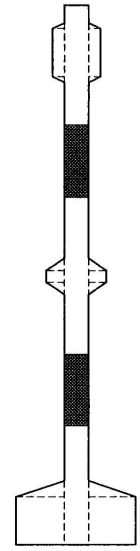
Concrete:
$f_{LL} + I = 4.680 \times 12/60.468 = 0.929$
$f_{WS} = 0.103 \times 12/60.468 = 0.020$
f_{conc} (ksi) = 0.949

Negative:

Steel:
$f_{LL} + I = 4.680 \times 12/3.055 = 18.383$
$f_{DL} = 0.304 \times 12/2.924 = 1.248$
$f_{WS} = 0.103 \times 12/3.055 = 0.405$
f_{steel} (ksi) = 20.036

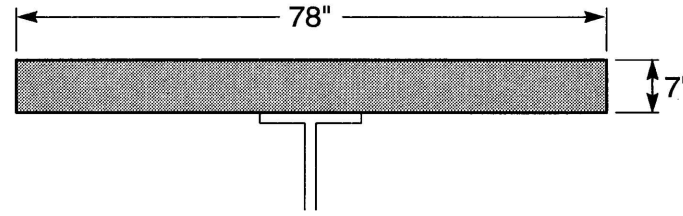
Concrete:
$f_{LL} + I = 4.680 \times 12/50.095 = 1.121$
$f_{WS} = 0.103 \times 12/50.095 = 0.025$
f_{conc} (ksi) = 1.146

All stresses meet the allowable limits of 1.600 ksi for concrete and 20 ksi for A36 steel. The design is therefore satisfactory.



Component Shapes

In determination of deck section modulus, steel members are broken down into component shapes. Here a 5-3/16" I-beam is shown. Black areas represent fabrication slots.



Determination of Effective Width of Slab Using a Grid Reinforced Concrete Bridge Deck

7" deck, 5-3/16" grid + 1-13/16" overfill,

less 1/2" sacrificial wearing course

therefore, t = 6.5" and 12t = 78"

The above formula is applicable for full and half depth designs with overall deck thickness (from bottom of steel grid I-beam to top of overfill) of 7".

Note: 78" effective width assumes 1/4 of stringer length, and c/c of stringers, exceeds 78".

Area of Reinforcement

All cross bars are counted across the entire 78" width in positive moment.