## SECTION 3

**Bridge Decks**

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<th>Page No.</th>
</tr>
</thead>
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<td>3.2</td>
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<td>3.3</td>
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<td>3.7</td>
</tr>
<tr>
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<td>3.8</td>
</tr>
<tr>
<td>3-3</td>
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<td>3.12</td>
</tr>
<tr>
<td></td>
<td>Plank Example</td>
<td>3.14</td>
</tr>
</tbody>
</table>
3-1 Introduction to Rating Bridge Decks

This section covers the rating of bridge decks.

Reinforced concrete decks supported by longitudinal girders, with main reinforcement placed perpendicular to traffic, and asphalt filled metal plank decks placed perpendicular to traffic will be rated with the CDOT computer programs discussed in subsections 3-2 and 3-3.

When design plans are available, use the applicable concrete strength and steel yield stress or use the values shown in table 100-1 (Year of Construction - Allowable Bending Stress Table) for the appropriate year of construction. See Subsection 100-4.

When plans are not available for a concrete deck, and the deck shows no signs of failure, then the assignment of rating values will not be required. However, if the condition of the deck indicates probable failure, then rating values shall be assigned as stipulated in subsection 600-5. The rater shall indicate on the rating summary sheet that plans are not available for the deck.

Transverse nail laminated and transverse plank timber decks are to be rated using the guidelines in Section 300, Timber Bridges.

All other types of bridge decks will be rated in compliance with the applicable guidelines within this manual and the AASHTO code. Hand computations will be acceptable.

For reinforced concrete slabs with main reinforcement parallel to traffic, see Section 600 - Concrete Bridges, for rating directions.
3.2 Concrete Slab Rating

Reinforced concrete deck slabs meeting the following conditions shall be rated with the SLAB computer program by the load factor method using current AASHTO Specifications:

A. The slab must be supported by longitudinal girders or stringers with the main slab reinforcement placed perpendicular to the girders or for skews less than or equal to 20°.

Skew is defined as the deviation in degrees of the reinforcement from perpendicular to the girders. The reinforcement may have a different skew than the structure.

B. The slab must be continuous over three or more supports. See the current Staff Bridge Design Memo 601 for descriptions of effective span and general deck slab design information.

A load factor rating example is shown in this subsection.

Description of Input for Concrete Slab Rating Program

<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
<th>Units</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Load Type</td>
<td>One Numeric Character</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 = Colorado Trucks (use for bridges carrying Colorado Highways, i.e. SH287)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 = Interstate Trucks (use for bridges carrying Interstate Highways, i.e. I70 or I25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 - 8</td>
<td>Structure Number</td>
<td>Seven Alpha or Numeric Characters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use the Colorado structure number or other designation for the structure such as county or city structure number.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 - 11</td>
<td>Rater</td>
<td>Three Alpha or Numeric Characters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Used to designate who the rater is. Typically the initials are used.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 - 14</td>
<td>Highway Number</td>
<td>Three Alpha or Numeric Characters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Used to designate the Highway Number (i.e. I70 = 70 or SH287 = 287).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 - 20</td>
<td>Batch ID</td>
<td>Six Alpha or Numeric Characters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The Batch ID is assigned by the Staff Bridge BRIAR Unit and uniquely identifies the structure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 - 41</td>
<td>Comments</td>
<td>21 Alpha or Numeric Characters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Any additional information needed to define the slab (i.e. 70 Degree Skew).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.2 Concrete Slab Rating

<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
<th>Units</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>42 - 46</td>
<td>Effective Span Length (feet)</td>
<td>Five Numeric Characters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The effective span length input as an integer to three decimal places, see the drawings below. The rater shall exercise care in determining the effective span length for slabs having main reinforcement placed at angles other than 90 degrees measured from the centerline of girder. For these cases, the effective span shall be the distance calculated parallel to the main reinforcing steel.</td>
<td></td>
<td>Use all decimal places even if they are zeros because the program does not recognize blank input as a zero.</td>
</tr>
</tbody>
</table>

47 - 51 Actual Slab Thickness (inch) Five Numeric Characters
The actual slab thickness input as an integer to three decimal places, see the drawing on the following page.

52 - 56 Distance to Top Reinforcing Steel (inch) Five Numeric Characters
The distance from the from the bottom of the slab to the center line of the top reinforcing steel as an integer to three decimal places, see the drawing on the following page.

57 - 59 Top Reinforcing Steel Area (sq.in.) Three Numeric Characters
The area of the top reinforcing steel over the girders as an integer to two decimal places, see the drawing on the following page.
### Concrete Slab Rating

<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
<th>Units</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 - 63</td>
<td>Bituminous Overlay</td>
<td>(inch)</td>
<td>Four Numeric Characters</td>
</tr>
<tr>
<td></td>
<td>The average asphalt thickness as an integer to two decimal places, see the drawing below.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64 - 67</td>
<td>$f'_c$ for Concrete</td>
<td>(psi)</td>
<td>Four Numeric Characters</td>
</tr>
<tr>
<td></td>
<td>The value of concrete strength is from the plans or table 1-1 (Year of Construction - Allowable Bending Stress Table) for the appropriate year of construction.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>68 - 72</td>
<td>$F_y$ for Reinforcing Steel</td>
<td>(psi)</td>
<td>Five Numeric Characters</td>
</tr>
<tr>
<td></td>
<td>The value of steel yield stress is from the plans or table 1-1 (Year of Construction - Allowable Bending Stress Table) for the appropriate year of construction.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>73 - 74</td>
<td>Leave Blank for Load Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>For a load factor analysis, the rater shall leave &quot;N&quot; blank for program input.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75 - 77</td>
<td>Distance to Bottom Steel</td>
<td>(inch)</td>
<td>Three Numeric Characters</td>
</tr>
<tr>
<td></td>
<td>The distance from the bottom of the slab to the center line to the bottom reinforcing steel, taken at a point midpoint between the girders shown as an integer to two decimal places. see the drawing below.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>78 - 80</td>
<td>Bottom Reinforcing Steel Area</td>
<td>(sq.in.)</td>
<td>Three Numeric Characters</td>
</tr>
<tr>
<td></td>
<td>The area of the bottom reinforcing steel midpoint between the girders shown as an integer to two decimal places. see the drawing below.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Typically the bottom and top steel areas are the same.*
3.2  Concrete Slab Rating

Description of **Output** for Concrete Slab Rating Program

I. **Input Data**

   The input data coded by the rater is printed. The reported value of N is the calculated value for load factor analysis.

II. **Output Results**

   A. Total dead load moment for the portion being analyzed.
   
   B. Live load plus impact moment due to HS 20 loading.
   
   C. Gross vehicle weight of HS 20 truck.
   
   D. Calculated concrete and reinforcing steel stresses based on a HS20 vehicle.
   
   E. Total member capacity at inventory and operating level.
   
   F. Member capacity for live load plus impact at inventory and operating level.
   
   G. Ratings in tons at inventory and operating level.
   
   H. Ratings for posting vehicles when operating rating is less than 36.0 tons. The program analyzes either the Colorado Legal Loads or the Interstate Legal Loads depending on user input. Ratings for posting vehicles are determined from the operating capacity.
3-2 Concrete Slab Rating

**Guideline for Rating Cantilever Portions of Concrete Bridge Decks**

Usually, deck overhangs at the exterior girder do not control the slab rating. However, the rater should use judgment in determining if the overhang should be rated. A criteria that may be used is:

Rate the cantilever portion of the concrete bridge deck if the wheel load can be applied outside the exterior girder by a distance equal to or greater than the distance from the bottom of the slab to the centerline of the top reinforcement, see the following drawing.

---

**Notes**

- The Edge Distance is per AASHTO 3.24.2.1 and is equal to 1 foot.
- If X is greater than a then consider rating the overhang.
- See also AASHTO 3.24.5.1

*Not to Scale*
### CONCRETE SLAB RATING

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>INPUT</th>
<th>UNITS</th>
<th>CARD IMAGE COLS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOAD TYPE:</td>
<td>2</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1 = Colo. Trucks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 = Interstate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STRUCTURE NUMBER:</td>
<td>E-17</td>
<td>2</td>
<td>-8</td>
</tr>
<tr>
<td>RATER:</td>
<td>MAN</td>
<td>9</td>
<td>-11</td>
</tr>
<tr>
<td>HIGHWAY NUMBER:</td>
<td>7</td>
<td>12</td>
<td>-14</td>
</tr>
<tr>
<td>BATCH I.D.:</td>
<td>H3002</td>
<td>15</td>
<td>-20</td>
</tr>
<tr>
<td>COMMENTS:</td>
<td>MEDIAN, CLOSE</td>
<td>21</td>
<td>-41</td>
</tr>
<tr>
<td>EFFECTIVE SPAN LENGTH:</td>
<td>6.7</td>
<td>FEET</td>
<td>42 - 46</td>
</tr>
<tr>
<td>ACTUAL SLAB THICKNESS:</td>
<td>0.0</td>
<td>INCHES</td>
<td>47 - 51</td>
</tr>
<tr>
<td>Distance to Top Reinforcing Steel</td>
<td>6.3</td>
<td>INCHES</td>
<td>52 - 56</td>
</tr>
<tr>
<td>Top Reinforcing Steel Area:</td>
<td>0.6</td>
<td>In2/Ft</td>
<td>57 - 59</td>
</tr>
<tr>
<td>ASPHALT OVERLAY:</td>
<td>0.4</td>
<td>P.S.I.</td>
<td>60 - 63</td>
</tr>
<tr>
<td>Concrete Strength (ft’c):</td>
<td>0.40</td>
<td>P.S.I.</td>
<td>65 - 67</td>
</tr>
<tr>
<td>Steel Yield Strength (Fy):</td>
<td>0.60</td>
<td>P.S.I.</td>
<td>68 - 72</td>
</tr>
<tr>
<td>Leave Blank for Load Factor:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance to Bottom Reinforcing Steel:</td>
<td>1.61</td>
<td>INCHES</td>
<td>75 - 77</td>
</tr>
<tr>
<td>Bottom Reinforcing Steel Area:</td>
<td>0.61</td>
<td>In2/Ft</td>
<td>78 - 80</td>
</tr>
</tbody>
</table>

![Diagram of bridge components](image)
3-2 Concrete Slab Load Factor Rating Example

Computer Program Output

SLAB RATING Version 1.0
DATE: 95/03/21

STRUCTURE NO. E-17-HY RATER: MAN STATE HWY NO. = 70
BATCH ID= H73002 DESCRIPTION: MEDIAN CLOSURE
LOAD FACTOR RATING-COMP STEEL NOT USED---LOAD FACTOR RATING

INPUT DATA

EFF. SPAN(FT)= 9.667 EFF. DEPTH(INS)= 6.188
REINF.(SQ.IN)= .61
SLAB TK(IN)= 8.000 WEARING SURFACE(INS)= 4.00
CONC. STRENGTH(PSI) INV= 4500. OPER= 4500.
STEEL YIELD (PSI) INV=60000. OPER=60000.
N= 8.
D1= 1.81 AS1= .61

DEAD LOAD MOMENT 1.38 K-FT
LL+I MOMENT 6.07 K-FT
GROSS WEIGHT 36.0 TONS

<table>
<thead>
<tr>
<th></th>
<th>INVENTORY</th>
<th>OPERATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTUAL CONCRETE STRESS (PSI)</td>
<td>1500.48</td>
<td>2325.40</td>
</tr>
<tr>
<td>ACTUAL REINF. STEEL STRESS (PSI)</td>
<td>27987.38</td>
<td>43374.04</td>
</tr>
<tr>
<td>ACTUAL COMP. STEEL STRESS (PSI)</td>
<td>612.67</td>
<td>949.50</td>
</tr>
<tr>
<td>MEMBER CAPACITY (K-FT)</td>
<td>15.89</td>
<td>15.89</td>
</tr>
<tr>
<td>MEMBER CAPACITY (LL+I) (K-FT)</td>
<td>14.09</td>
<td>14.09</td>
</tr>
<tr>
<td>RATING (TONS)</td>
<td>38.60</td>
<td>64.33</td>
</tr>
</tbody>
</table>

Manual calculations to convert from U.S. Tons to Metric Tons

Inventory = 38.60 * 2000 / 2204.6 = 35.0 metric tons

Operating = 64.33 * 2000 / 2204.6 = 58.4 metric tons
1300-2 Concrete Slab Load Factor Rating Example

Given Information:

Structure Number: E-17-HY	LOAD TYPE: L \_t : = 2
Rater: MAN	1 = Colorado Trucks
Highway Number: 70	2 = Interstate Trucks
Batch I.D.: H73002	Effective Span Length (feet) = L : = 9.667
Comments: Median Closure	Actual Slab Thickness (inches) = T : = 8.000
Asphalt Thickness (inches) = HMA : = 4

Reinforcing Steel:

Area (in\(^2\)/ft) Location from the bottom of the slab (inches)

Top Mat Over the Supports = A \_t : = 0.61	Top Mat Location = D \_t : = 6.188
Bottom Mat Between the Supports = A \_b : = 0.61	Bottom Mat Location = D \_b : = 1.81

Reinforcing Steel Yield Strength (psi) = f \_y : = 60000
Concrete Compressive Strength (psi) = f \_c : = 4500

Calculations:

Deadload:

Distributed Deadload:

Concrete:

\[ W \_c = \frac{T}{12} \times 150 \]
\[ W \_c = 100 \]

Asphalt:

\[ W \_a = \frac{\text{HMA}}{12} \times 144 \]
\[ W \_a = 48 \]

Total (lbs/foot) =

\[ W = W \_c + W \_a \]
\[ W = 148 \]

Deadload Moment (ft-k):

\[ M \_dl = \frac{W \cdot L^2}{8} \times 0.8 \times \frac{1}{1000} \]
\[ M \_dl = 1.383 \]

Note: 0.8 is the Continuity Factor

Live Load Moment:

\[ M \_ll = 16 \times \frac{L + 2}{32} \times 0.8 \times 1.3 \]
\[ M \_ll = 6.067 \]

Note: 1.3 is the impact factor
The live load formula is from AASHTO 3.24.3.1
1300-2 Concrete Slab Load Factor Rating Example (Continued)

Resisting Moment over the Support (ft-kips):

Steel Tension (pounds) = \( T_t = A_t f_y \)
\[ T_t = 3.66 \times 10^4 \]

Concrete Compression Block (inches) = \( a_t = \frac{T_t}{(0.85 f_c^{12})} \)
\[ a_t = 0.797 \]

Strength Reduction Factor: \( \phi = 0.9 \)

\[
M_u = \phi \left( T_t \left( \frac{1}{D_t - \frac{a_t}{2}} \right) \right) \frac{1}{1000}
\]
\[ M_u = 15.892 \]

Final Rating:

Inventory Rating (metric tons) = \( \frac{M_u - 1.3 M_{dl}}{2.17 M_{ll}} \cdot \frac{36}{2204.6} \cdot 2000 \)
\[ = 34.963 \]

Operating Rating (metric tons) = \( \frac{M_u - 1.3 M_{dl}}{1.3 M_{ll}} \cdot \frac{36}{2204.6} \cdot 2000 \)
\[ = 58.361 \]
The Plank Rating Program investigates corrugated metal flooring based on a one-inch strip transverse to traffic. Currently, the Plank Rating Program will only produce a working stress rating which satisfies the AASHTO specifications, except the program assumes a 20-inch by 20-inch tire contact area. However, the program can be used to generate the Deadload and Liveload Moments. The values produced by the program can then be used to generate a Load Factor Rating using the appropriate factors and formulas. The hand calculation rating analysis in this subsection illustrates the methods used by the program except for the final step which produces a Load Factor Rating.

### Description of **Input** for the Plank Rating Program

<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
<th>Units</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 7</td>
<td>Structure Number</td>
<td>7</td>
<td>Alpha or Numeric Characters</td>
</tr>
<tr>
<td></td>
<td>Use the Colorado structure number or other designation for the structure such as the county or city structure number.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 - 10</td>
<td>Rater</td>
<td>3</td>
<td>Alpha or Numeric Characters</td>
</tr>
<tr>
<td></td>
<td>Used to designate who the rater is. Typically the rater’s initials are used.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 - 13</td>
<td>State Highway Number</td>
<td>3</td>
<td>Alpha or Numeric Characters</td>
</tr>
<tr>
<td></td>
<td>Used to designate the highway number (i.e. I70 = 70, SH287 = 287, CR113 = 113).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 - 19</td>
<td>Batch I.D.</td>
<td>6</td>
<td>Alpha or Numeric Characters</td>
</tr>
<tr>
<td></td>
<td>The Batch I.D. is a 6 digit Alphanumeric code assigned by the Staff Bridge BRIAR unit which uniquely identifies the structure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 - 40</td>
<td>Comments</td>
<td>21</td>
<td>Alpha or Numeric Characters</td>
</tr>
<tr>
<td></td>
<td>Any additional comments needed to define the plank or the structure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41 - 44</td>
<td>Span Length</td>
<td></td>
<td>Numeric Characters</td>
</tr>
<tr>
<td></td>
<td>Input the span length as an integer to 2 decimal places, see the drawing below.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Use all decimal places even if they are zeros because the program does not recognize blank input as zeros.*
3-3  Corrugated Steel Plank Rating

45 - 48  Section Modulus (in$^3$/in)$^3$4 Numeric Characters
Input the section modulus as an integer to 3 decimal places.

49 - 51  Weight of Plank (lb/ft$^2$) 4 Numeric Characters
Input the weight of the plank as an integer to 1 decimal place.

51 - 54  Leave Blank 4 Numeric Characters
This field is normally used for the inventory stress of a Working Stress Rating. However for a Load Factor Rating, leave this field blank.

55 - 57  Steel Yield Strength (ksi) 4 Numeric Characters
This field is normally used for the operating stress of a Working Stress Rating. However for a Load Factor Rating, input the steel yield strength as an integer to 1 decimal place.

58 - 61  Asphalt Thickness (inch) 4 Numeric Characters
Input the asphalt thickness as an integer to 2 decimal places, see the drawing below.

Description of Output for the Plank Rating Program

I.  INPUT DATA
The input data coded by the rater is printed.

II. OUTPUT RESULTS
A. Live load plus impact moment due to HS 20 loading.
B. Dead load moment for the strip being analyzed.
C. Capacity for live load plus impact at inventory level.
D. Capacity for live load plus impact at operating level.
E. Inventory rating in tons.
F. Operating rating in tons.
G. Posting ratings based on the Colorado legal loads when operating rating is less than 36.0 tons.

*The Plank Rating Program will be updated to produce a Load Factor Rating directly at a future date. When the update is accomplished, this section of the rating manual will be reissued.*
### CORRUGATED STEEL PLANK RATING

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>INPUT</th>
<th>UNITS</th>
<th>CARD IMAGE COLS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRUCTURE NUMBER</td>
<td>1, F, 1, J</td>
<td>IN</td>
<td>1 - 7</td>
</tr>
<tr>
<td>RATER</td>
<td>M, A, N</td>
<td></td>
<td>8 - 10</td>
</tr>
<tr>
<td>STATE HIGHWAY NUMBER</td>
<td>1, 7, 0</td>
<td></td>
<td>11 - 13</td>
</tr>
<tr>
<td>BATCH I. D.</td>
<td>1, F, 1, J</td>
<td></td>
<td>14 - 19</td>
</tr>
<tr>
<td>COMMENTS</td>
<td>1, F, 1, J</td>
<td></td>
<td>20 - 40</td>
</tr>
<tr>
<td>SPAN LENGTH</td>
<td>1, 4, 3, 5</td>
<td>IN</td>
<td>41 - 44</td>
</tr>
<tr>
<td>SECTION MODULUS</td>
<td>1, 0, 3, 5</td>
<td>IN3/IN</td>
<td>45 - 48</td>
</tr>
<tr>
<td>WEIGHT OF PLANK</td>
<td>1, 0, 6</td>
<td>PSF</td>
<td>49 - 51</td>
</tr>
<tr>
<td>INVENTORY STRESS</td>
<td></td>
<td>KSI</td>
<td>52 - 54</td>
</tr>
<tr>
<td>OPERATING STRESS (\sigma_y)</td>
<td>1, 5, 0</td>
<td>KSI</td>
<td>55 - 57</td>
</tr>
<tr>
<td>ASPHALT THICKNESS</td>
<td>1, 5, 0</td>
<td>IN</td>
<td>58 - 61</td>
</tr>
</tbody>
</table>

![Diagram](image)

- **Span Length**
- **Top of asphalt**
- **asphalt thickness**
- **H/2**
1300-3 Corrugated Steel Plank Rating Example

Computer Program Output

STEEL BRIDGE PLANK RATING
DATE: 3/21/95

STRUCTURE NO: F-11-Q
RATER: MAN
BATCH ID: F11Q
STATE HWY NO: 70
COMMENT: FRONTAGE ROAD

NET SPAN LENGTH (IN) = 43.55
SECTION MODULUS (IN^3/IN) = .335
PLANK WEIGHT (PSF) = 10.5
INVENTORY STRESS (KSI) = .0
OPERATING STRESS (KSI) = 45.0
ASPHALT THICKNESS (IN) = 5.00

LL-1 MOMENT (IN-K) = 6.978
(LL MOMENT BASED ON A WHEELPRINT 20IN X 201N)
DL MOMENT (IN-K) = .093
INVENTORY LL-1 MOMENT CAPACITY (IN-K) = -.093
OPERATING LL-1 MOMENT CAPACITY (IN-K) = 14.982

INVENTORY RATING (TONS) = -.48
OPERATING RATING (TONS) = 77.29

Note: The computer program is only being used to generate the Live Load and Dead Load Moments. The moment rating can then be determined from the computer values by using the appropriate Load Factor formulas and factors.

Manual calculations to produce a Load Factor rating in Metric Tons

Resisting Moment Capacity = Fy*S = 0.335 * 45 = 15.075 in-kips/in

Inventory = \(\frac{15.075 - 1.3 * 0.093}{2.17 * 6.978} \) * 36 * \(\frac{2000}{2204.6}\) = 32.3 metric tons

Operating = \(\frac{15.075 - 1.3 * 0.093}{1.3 * 6.978} \) * 36 * \(\frac{2000}{2204.6}\) = 53.8 metric tons
Plank Rating

Structure F-11-Q

Information from the field:

Plank:

- Thickness is 5/32 of an inch
- Distance between corrugations is 12"
- Height of corrugations is 4"

Girder:

- Spacing (feet): \( S_p := 4.5 \)
- Type: W30x99

Average Asphalt Thickness (inches): \( T := 7.0 \)

Information derived from field information:

From AISC 8th Edition:
- Girder Flange Width (inches): \( b_f := 10.45 \)

From AISI 4th Edition:
- Type A - 4¼x12x9ga. Plank
  - Steel Yield Stress (ksi): \( F_y := 45 \)
  - Moment of Inertia (in\(^4\)/ft): \( I := 8.83 \)
  - Weight of Plank (lbs/ft\(^2\)): \( W_p := 10.5 \)
  - Section Modulus (in\(^3\)/ft): \( S := 4.02 \)

Calculations:

- Effective Span (inches):
  \[
  L = S_p \cdot 12 - b_f = 43.55
  \]

- Distributed Deadload (lbs/in/in):
  \[
  W = \left( \frac{T}{12} \cdot 144 + W_p \right) \cdot \frac{1}{144} = W = 0.656
  \]

- Continuity Factor (AASHTO 3.24.3.1): \( C_f := 0.8 \)

- Deadload Moment (in-kips/in):
  \[
  M_{dl} = \frac{W \cdot L^2}{8 \cdot 1000} \cdot C_f = M_{dl} = 0.124
  \]

- Distributed Live Load (kips/in/in):
  \[
  W_{ll} = \frac{16}{20 \cdot 20} = W_{ll} = 0.04
  \]

- Live Load Reaction (kips/in):
  \[
  R = \frac{W_{ll} \cdot 20}{2} = R = 0.4
  \]

- Live Load Moment (in-kips/in):
  \[
  M_{max} := R \cdot \frac{L - 20}{2} + R \cdot \frac{10}{2} = M_{max} = 6.71
  \]

- Impact Factor = \( I_f := 1.3 \)

- Live Load Moment (in-kips/in):
  \[
  M_{ll} := C_f \cdot I_f \cdot M_{max} = M_{ll} = 6.978
  \]

3.16
3 - 3 Plank Rating Example (continued)

Calculations (continued):

Member Capacity (in-kips/inch):

\[ M_{\text{cap}} = \frac{F_y S}{12} \quad M_{\text{cap}} = 15.075 \]

CDOT Assumes the plank to be braced Noncompact which eliminates the need to do a Servicability Rating because plastic properties are not used.

Moment Rating (metric tons):

Inventory

\[ \text{Inv}_{\text{mom}} = \frac{M_{\text{cap}} - 1.3 \cdot M_{\text{dl}}}{2.17 \cdot M_{\text{llI}}} \times \frac{2000}{2204.6} \]

\[ \text{Inv}_{\text{mom}} = 32.163 \]

Operating

\[ \text{Opr}_{\text{mom}} = \frac{M_{\text{cap}} - 1.3 \cdot M_{\text{dl}}}{1.3 \cdot M_{\text{llI}}} \times \frac{2000}{2204.6} \]

\[ \text{Opr}_{\text{mom}} = 53.688 \]