LOAD RATING CALCULATIONS

DEVELOPMENTAL DESIGN STANDARDS

FSB SUPERSTRUCTURE PACKAGE

40 FT. CLEAR WIDTH

D30040 - 30 Ft. Span
### FDOT Bridge Load Rating Summary

<table>
<thead>
<tr>
<th>Rating Level</th>
<th>Vehicle</th>
<th>Weight (Tons)</th>
<th>Flexure (Strength)</th>
<th>Shear (Strength)</th>
<th>Stress (Service)</th>
<th>Flexure (Strength)</th>
<th>Shear (Strength)</th>
<th>Stress (Service)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Operating</td>
<td>HL-93</td>
<td>36</td>
<td>2.61</td>
<td>5.65</td>
<td>N/A</td>
<td>2.80</td>
<td>6.32</td>
<td>N/A</td>
</tr>
<tr>
<td>Design Inventory</td>
<td>HL-93</td>
<td>36</td>
<td>2.01</td>
<td>4.36</td>
<td>1.94</td>
<td>2.16</td>
<td>4.88</td>
<td>2.07</td>
</tr>
<tr>
<td>Permit</td>
<td>FL-120</td>
<td>60</td>
<td>2.21</td>
<td>3.83</td>
<td>N/A</td>
<td>2.38</td>
<td>4.29</td>
<td>N/A</td>
</tr>
</tbody>
</table>

LRFR using Part A

<table>
<thead>
<tr>
<th>Int. / Ext. Beam</th>
<th>Ext.</th>
<th>Int.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span Length (ft)</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>
LRFD Prestressed Beam Program

Project = "D30040 30 FT, LR Ext. Bm."
DesignedBy = "VAY"
Date = "7-26-2016"

filename = "C:\FDOT Structures\Programs\LRFDPBeamV5.0\FSB Data Files\D30040 30 FT LR.dat"
Comment = "FSB12x56 30 ft span"

Legend

BrownText = DataEntry  YellowHighlight = CheckValues  GreyHighlight = UserComments + Graphs
BlackText = ProgramEquations  Maroon Text = Code Reference  Blue Text = Commentary

Bridge Layout and Dimensions

L_{beam} = 28.83\text{-ft}  \quad \text{Span} = 27.75\text{-ft}  \quad \text{BearingDistance} = 6.5\text{-in}  \quad \text{PadWidth} = 8\text{-in}

BeamTypeTog = "FSB12x56"

These are typically the FDOT designations found in our standards. The user can also create a coordinate file for a custom shape. In all cases the top of the beam is at the y=0 ordinate.
Overhang = 0 ft
BeamSpacing = 4.76 ft
Skew = 0 deg
t_{\text{integral.ws}} = 0 in
Number of Beams = 9
t_{\text{slab}} = 6 in
t_{\text{slab.delta}} = 0.24 in
de = 1 ft

BeamPosition = "exterior"  
*For calculating distribution factors must be either interior or exterior*

b_e = 4.67 ft  
*effective slab width*  
*LRFD 4.6.2.6*

t_{\text{slab}} := \text{if}(t_{\text{slab}} \leq 0 in, 0.00001 \text{ in}, t_{\text{slab}})  
*Provide a minimum slab thickness to prevent divide by zero errors*

**Material Properties**

**Concrete:**

*Corrosion Classification*  
Environment = "extremely"

density of slab concrete  
\( \gamma_{\text{slab}} = 0.15 \frac{\text{kip}}{\text{ft}^3} \)

density of beam concrete  
\( \gamma_{\text{beam}} = 0.15 \frac{\text{kip}}{\text{ft}^3} \)

*strength of slab concrete*  
f_{c,\text{slab}} = 4.5 ksi

*strength of beam concrete*  
f_{c,\text{beam}} = 8.5 ksi

*release beam strength*  
f_{c,\text{beam}} = 6 ksi

*type of course aggregate*  
AggregateType = "Florida"  
*relative humidity*  
H = 75

\( n_d := \left( \frac{f_{c,\text{beam}}}{f_{c,\text{slab}}} \right)^{0.33} \)  
*used in distribution calculation*  
\( n_d = 1.23 \)

AggFactor := \text{if}[\text{AggregateType} = "\text{Florida}" , (1.0-2500), 2500]  
*(SDG 1.4.1)*  
AggFactor = 2500

E_{c_i} := \text{AggFactor} \left( \frac{f_{c,\text{beam}}}{\text{ksi}} \right)^{0.33} \text{ ksi}  
*initial beam concrete modulus of elasticity*  
*(LRFD 5.4.2.4)*  
E_{c_i} = 4516 ksi

E_{c} := \text{AggFactor} \left( \frac{f_{c,\text{beam}}}{\text{ksi}} \right)^{0.33} \text{ ksi}  
*beam concrete modulus of elasticity*  
*(LRFD 5.4.2.4)*  
E_{c} = 5066 ksi

**Prestressing Tendons:**

*tendon ultimate tensile strength*  
f_{pu} = 270 ksi

*tendon modulus of elasticity*  
E_p = 28500 ksi

*time in days between jacking and transfer*  
t_j = 0.75

*ratio of tendon modulus to initial beam concrete modulus*  
n_{pi} := \frac{E_p}{E_{c_i}}

*ratio of tendon modulus to beam concrete modulus*  
n_{pi} := \frac{E_p}{E_{c}}
**Mild Steel:**

- **Mild steel yield strength:** \( f_y = 60 \text{ ksi} \)
- **Mild steel modulus of elasticity:** \( E_s = 29000 \text{ ksi} \)
- **Ratio of rebar modulus to initial beam concrete modulus:** \( n_{mi} := \frac{E_s}{E_{ci}} \quad n_{mi} = 6.42 \)
- **Ratio of rebar modulus to beam concrete modulus:** \( n_{m} := \frac{E_s}{E_c} \quad n_{m} = 5.72 \)
- **Distance from top of slab to centroid of slab reinf.:** \( d_{slab.rebar} = 2.5 \text{ in} \)
- **Distance from top of beam to centroid of mild flexural tension reinf.:** \( d_{long} = 0 \text{ in} \)
- **Area per unit width of longitudinal slab reinf.:** \( A_{slab.rebar} = 0.31 \text{ in}^2 \text{ ft} \)
- **Area of mild reinf lumped at centroid of bar locations:** \( A_{s.long} = 0 \text{ in}^2 \)
- **Size of bar used create used to calculate development length:** \( \text{BarSize} = 5 \)

**Permit Loads**

- This is the number of wheel loads that comprise the truck, max for DLL is 11
  - **PermitAxles:** \( 3 \)

Indexes used to identify values in the P and d vectors
- \( q := 0 \ldots (\text{PermitAxles} - 1) \)
- \( q_t := 0 \ldots \text{PermitAxles} \)

- **PermitAxleLoad** \( ^T = (13.33 \ 53.33 \ 53.33) \text{ kip} \)
- **PermitAxleSpacing** \( ^T = (0 \ 14 \ 14 \ 0) \text{ ft} \)

**Distribution Factors**

- DataMessage = "This is a FSB12x56 Florida Slab Beam design, AASHTO distribution factors used"

Calculated values:
- \( \text{tmp}_g_{mom} = 0.41 \)
- \( \text{tmp}_g_{shear} = 0.68 \)
- \( \text{tmp}_g_{mom.fatigue} = 0.28 \)

User value overrides (optional):
- \( \text{user}_g_{mom} := 0 \)
- \( \text{user}_g_{shear} := 0 \)
- \( \text{user}_g_{mom.fatigue} := 0 \)

Value check:
- \( g_{mom} := \text{if}(\text{user}_g_{mom} \neq 0, \text{user}_g_{mom} \cdot \text{tmp}_g_{mom}) \quad g_{mom} = 0.41 \)
- \( g_{shear} := \text{if}(\text{user}_g_{shear} \neq 0, \text{user}_g_{shear} \cdot \text{tmp}_g_{shear}) \quad g_{shear} = 0.68 \)
- \( g_{mom.fatigue} := \text{if}(\text{user}_g_{mom.fatigue} \neq 0, \text{user}_g_{mom.fatigue} \cdot \text{tmp}_g_{mom.fatigue}) \quad g_{mom.fatigue} = 0.28 \)
Beam Section

BeamType $^{(1)}_{\text{ft}}$

BeamType $^{(0)}_{\text{ft}}$

Total Slab, Effective Slab, and Beam

- slab
- effective slab
- beam
Non-Composite Dead Load Input:

\[ w_{\text{slab}} = 0.455 \frac{\text{kip}}{\text{ft}} \quad w_{\text{beam}} = 0.593 \frac{\text{kip}}{\text{ft}} \quad w_{\text{forms}} = 0 \frac{\text{kip}}{\text{ft}} \]

\[ \text{Add}_w_{\text{noncomp}} := 0 \frac{\text{kip}}{\text{ft}} \]

Additional non composite dead load (positive or negative)

Note: not saved to data file, may be saved to Mathcad worksheet.

\[ w_{\text{noncomposite}} := w_{\text{slab}} + w_{\text{beam}} + w_{\text{forms}} + \text{Add}_w_{\text{noncomp}} \]

\[ w_{\text{noncomposite}} = 1.049 \frac{\text{kip}}{\text{ft}} \]

\[ w_{\text{noncomposite}} := \text{Add}_w_{\text{noncomp}} \]

\[ w_{\text{noncomposite}} = 0.455 \frac{\text{kip}}{\text{ft}} \]

Diaphragms/Point Load Input

End Diaphragms or Misc. Point Loads over bearing... included in bearing reaction calculation only

\[ \text{EndDiaphragm}A := 0 \text{kip} \quad \text{begin bridge} \]

\[ \text{EndDiaphragm}E := 0 \text{kip} \quad \text{end bridge} \]

Intermediate Diaphragms or Misc. Point Loads... included in shear, moment, and bearing reaction calculations

\[ \text{IntDiaphragm}B := 0 \text{kip} \]

\[ \text{Dist}B := 0 \text{ft} \]

\[ \text{IntDiaphragm}C := 0 \text{kip} \]

\[ \text{Dist}C := 0 \text{ft} \]

\[ \text{IntDiaphragm}D := 0 \text{kip} \]

\[ \text{Dist}D := 0 \text{ft} \]

Composite Dead Load Input:

\[ w_{\text{future.ws}} = 0.05 \frac{\text{kip}}{\text{ft}} \quad w_{\text{barrier}} = 0.095 \frac{\text{kip}}{\text{ft}} \]

\[ \text{Add}_w_{\text{comp}} := 0 \frac{\text{kip}}{\text{ft}} \]

Additional composite dead load (positive or negative)

Note: not saved to data file, may be saved to Mathcad worksheet.

\[ w_{\text{composite}} := w_{\text{future.ws}} + w_{\text{barrier}} + \text{Add}_w_{\text{comp}} \]

\[ w_{\text{composite}} = 0.145 \frac{\text{kip}}{\text{ft}} \]

\[ w_{\text{comp.str}} := w_{\text{barrier}} + \text{Add}_w_{\text{comp}} \]

\[ w_{\text{comp.str}} = 0.095 \frac{\text{kip}}{\text{ft}} \]
Release Dead Load Moments and Shear

\[ M_{\text{release}} \]  
\[ V_{\text{release}} \]  
\[ \text{max}(M_{\text{release}}) = 61.7 \text{-kip-ft} \]  
\[ \text{max}(V_{\text{release}}) = 8.6 \text{-kip} \]

Noncomposite Dead Load Moments and Shear

\[ M_{\text{dl,non.comp}} \]  
\[ V_{\text{dl,non.comp}} \]  
\[ \text{max}(M_{\text{dl,non.comp}}) = 100.8 \text{-kip-ft} \]  
\[ \text{max}(V_{\text{dl,non.comp}}) = 14.5 \text{-kip} \]
**Composite Dead Load Moments and Shear**

Composite DL, M(kip-ft) & V(kip)

- $\max(M_{\text{dl.comp}}) = 14\text{-kip ft}$
- $\max(V_{\text{dl.comp}}) = 2\text{-kip}$

**Distributed Live Load Moments and Shear**

Dist. LL, M(kip-ft) & V(kip)

- $\max(M_{\text{dist.live.pos}}) = 188.1\text{-kip ft}$
- $\min(M_{\text{dist.live.neg}}) = -9.5\text{-kip ft}$
- $\max(V_{\text{dist.live.pos}}) = 49.4\text{-kip}$
- $\max(M_{\text{shr.dist.live.pos}}) = 176.3\text{-kip ft}$
- $\min(M_{\text{shr.dist.live.neg}}) = -10.2\text{-kip ft}$

**Beam End Reactions... with IM factor only**

- $\max(V_{\text{dist.live.pos}}) = 49.4\text{-kip}$
- $\max(M_{\text{shr.dist.live.pos}}) = 176.3\text{-kip ft}$
- $\max(M_{\text{shr.dist.live.neg}}) = -10.2\text{-kip ft}$
Prestress Strand Layout Input

Instructions:

Double click the icon to open the 'Strand Pattern Generator'. Specify the type, location, size, and debonding of strands. When finished, press the 'Continue' button. Then press 'Read Strand Data' button. Then press 'Recalculate Worksheet' button.

Strand Pattern Input Mode:

StrandTemplate :=

Standard
Custom

Recalculate Worksheet
Read Strand Data

Collapsed Region for Custom Strand Sizes...

- Strand Multiplier
- Strand Data and Pattern
- Strand Properties

Tendon Layout

SupportLocation\textsubscript{release} = 0 \cdot \text{ft}

distance supports are located from the end of the beam after release; may be used to check lifting points immediately after transfer
**Partially Stressed Tendons ("Strand N")**

\[ \text{PartialPS}_{\text{force}} = 40 \text{-kip} \quad \text{partial prestress total force} \]

\[ \text{PartialPS}_{\text{force}} := \text{if} \left( \text{BeamTypeTog} = "\text{II}" \right) \left( 20 \text{-kip}, \text{PartialPS}_{\text{force}} \right) \quad \text{PartialPS}_{\text{force}} = 40 \text{-kip} \]

\[ \text{PartialPS}_{\text{location}} = 1.4375 \text{in} \quad \text{centroid location of partial prestress from the top of the beam} \]

\[ \text{PartialPS}_{\text{location}} := \begin{cases} 
2.4375 \text{-in} & \text{if} \text{ BeamTypeTog} = "\text{II}" \\
3 \text{-in} & \text{if} \text{ substring(BeamTypeTog,0,5)} = "\text{FSB12}" \\
2 \text{-in} & \text{if} \text{ substring(BeamTypeTog,0,5)} = "\text{FSB15}" \\
3 \text{-in} & \text{if} \text{ substring(BeamTypeTog,0,5)} = "\text{FSB18}" \\
\text{PartialPS}_{\text{location}} & \text{otherwise} 
\end{cases} \quad \text{PartialPS}_{\text{location}} = 3 \text{-in} \]

---

**Release Stresses**

<table>
<thead>
<tr>
<th>Location (ft)</th>
<th>Release Stresses (ksi) Top, Bot., &amp; Allow.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>f</em><em>{top.beam.rel}</em>{n}</td>
</tr>
<tr>
<td></td>
<td><em>f</em><em>{bot.beam.rel}</em>{n}</td>
</tr>
<tr>
<td></td>
<td><em>f</em><em>{all.tension.rel}</em>{n}</td>
</tr>
<tr>
<td></td>
<td><em>f</em><em>{all.comp.rel}</em>{n}</td>
</tr>
</tbody>
</table>

---

**Prestress Force**
**Final Stresses**

![Graph showing stress variations](image)

**Stress Checks**

- \( \min(CR_{f\text{tension}.rel}) = 10 \)  
  \( \text{Check}_{f\text{tension}.rel} = "OK" \)  
  
- \( \min(CR_{f\text{comp}.rel}) = 1.89 \)  
  \( \text{Check}_{f\text{comp}.rel} = "OK" \)  
  
- \( \min(CR_{f\text{tension}.stage8}) = 10 \)  
  \( \text{Check}_{f\text{tension}.stage8} = "OK" \)  
  
- \( \min(CR_{f\text{comp}.stage8.c1}) = 3.53 \)  
  \( \text{Check}_{f\text{comp}.stage8.c1} = "OK" \)  
  
- \( \min(CR_{f\text{comp}.stage8.c2}) = 3.68 \)  
  \( \text{Check}_{f\text{comp}.stage8.c2} = "OK" \)  
  
- \( \min(CR_{f\text{comp}.FatigueI}) = 4.73 \)  
  \( \text{Check}_{f\text{comp}.FatigueI} = "OK" \)
**Strand Pattern Checks**

CheckPattern\(_0\) = "OK"  
**check 0** - no debonded tendon in outside row

CheckPattern\(_1\) = "OK"  
**check 1** - less than 25\% debonded tendons total

CheckPattern\(_2\) = "OK"  
**check 2** - less than 40\% debonded tendons in any row

CheckPattern\(_3\) = "OK"  
**check 3** - less than 40\% of debonded tendons terminated at same section  
*(LRFD 5.11.4.3)*

CheckPattern\(_4\) = "OK"  
**check 4** - more than half beam depth debond length  
*(SDG 4.3.1)*

---

**Section and Strand Properties Summary**

\(A_{\text{beam}} = 569.75\text{-in}^2\)  
Concrete area of beam

\(I_{\text{beam}} = 6938.3338\text{-in}^4\)  
Gross Moment of Inertia of Beam about CG

\(y_{\text{comp}} = -3.38\text{-in}\)  
Dist. from top of beam to CG of gross composite section

\(I_{\text{comp}} = 24380.7726\text{-in}^4\)  
Gross Moment of Inertia Composite Section about CG

\(A_{\text{deck}} = 354.18\text{-in}^2\)  
Concrete area of deck slab

\(A_{\text{ps}} = 3\text{-in}^2\)  
total area of strands

\(d_{b,ps} = 0.6\text{-in}\)  
diameter of Prestressing strand

\(f_{\text{py}} = 243\text{-ksi}\)  
tendon yield strength

\(f_{\text{pj}} = 203\text{-ksi}\)  
prestress jacking stress

\(L_{\text{shielding}} = (0 \ 0 \ 0)\text{-ft}\)

\(A_{\text{ps,row}} = (2.6 \ 0.4 \ 0.2)\text{-in}^2\)

\(d_{\text{ps,row}} = \begin{array}{cccccccccc}
0 & -9 & -9 & -9 & -9 & -9 & -9 & -9 & -9 & -9 \\
1 & -7 & -7 & -7 & -7 & -7 & -7 & -7 & -7 & -7 \\
2 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 \\
\end{array}\text{-in}\)

TotalNumberOfTendons = 14  
StrandSize = "0.6 in low lax"

NumberOfDebondedTendons = 0  
StrandArea = 0.22\text{-in}^2

NumberOfDrapedTendons = 0  
JackingForce\_{\text{per, strand}} = 43.94\text{-kip}
Section and Strand Properties Summary

**Prestress Losses Summary**

- \( f_{pj} = 202.5 \text{ ksi} \)  
  \[ \text{Check } f_{pt} = "OK" \]
- \( \Delta f_{pES} = 0 \text{ ksi} \)
  \[ \text{Note: Elastic shortening losses are zero in concrete stress calculations when using transformed section properties per LRFD 5.9.5.2.3} \]
- \( \Delta f_{pT} = -18 \text{ ksi} \)  
  \[ \frac{\Delta f_{pT}}{f_{pj}} = -8.82\% \]
- \( f_{pc} = 185 \text{ ksi} \)  
  \[ \frac{f_{pc}}{f_{pj}} = 91.18\% \]
- \( 0.8 \cdot f_{py} = 194 \text{ ksi} \)  
  \[ \text{Check } f_{pc} = "OK" \]

**Service Limit State Moments**

Service I and Service III Moments (kip-ft)

- \( \max (M_{pos.Ser1}) = 302.6 \text{-kip-ft} \)
- \( \max (M_{pos.Ser3}) = 265 \text{-kip-ft} \)

7/26/2016  MainProgram.xmcd v5.0
Summary of Values at Midspan

Stresses =

<table>
<thead>
<tr>
<th>Stage</th>
<th>Top of Beam (ksi)</th>
<th>Bott of Beam (ksi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.63</td>
<td>-1.54</td>
</tr>
<tr>
<td>2</td>
<td>-0.63</td>
<td>-1.35</td>
</tr>
<tr>
<td>4</td>
<td>-0.58</td>
<td>-1.4</td>
</tr>
<tr>
<td>6</td>
<td>-1.06</td>
<td>-0.98</td>
</tr>
<tr>
<td>8</td>
<td>-1.39</td>
<td>-0.31</td>
</tr>
</tbody>
</table>

PrestressForce =

<table>
<thead>
<tr>
<th>Condition</th>
<th>Axial (kip)</th>
<th>Moment (kip*ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release</td>
<td>-655.2</td>
<td>-110.2</td>
</tr>
<tr>
<td>Final (about composite centroid)</td>
<td>-597.4</td>
<td>-97.4</td>
</tr>
</tbody>
</table>

Properties =

<table>
<thead>
<tr>
<th>Section</th>
<th>Area (in^2)</th>
<th>Inertia (in^4)</th>
<th>distance to centroid from top of bm (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Beam</td>
<td>566.51</td>
<td>6917.67</td>
<td>-6.35</td>
</tr>
<tr>
<td>Transformed Beam (initial)</td>
<td>586.94</td>
<td>7045.64</td>
<td>-6.42</td>
</tr>
<tr>
<td>Transformed Beam</td>
<td>584.72</td>
<td>7032.01</td>
<td>-6.41</td>
</tr>
<tr>
<td>Composite</td>
<td>945.75</td>
<td>25110.98</td>
<td>-3.41</td>
</tr>
</tbody>
</table>

ServiceMoments =

<table>
<thead>
<tr>
<th>Type</th>
<th>Value (kip*ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release</td>
<td>61.7</td>
</tr>
<tr>
<td>Non-composite (includes bm wt.)</td>
<td>100.8</td>
</tr>
<tr>
<td>Composite</td>
<td>14</td>
</tr>
<tr>
<td>Distributed Live Load</td>
<td>187.3</td>
</tr>
</tbody>
</table>

Stage 1 ——> At release with span length equal to length of the beam. Prestress losses are elastic shortening and overnight relax

Stage 2 ——> Same as release with the addition of the remaining prestress losses applied to the transformed beam

Stage 4 ——> Same as stage 2 with supports changed from the end of the beam to the bearing locations

Stage 6 ——> Stage 4 with the addition of non-composite dead load excluding beam weight which has been included since Stage 1

Stage 8 ——> Stage 6 with the addition of composite dead load and live loads applied to the composite section
Camber, Shrinkage, and Dead Load Deflection Components

![Camber, Deflection, and Location in feet graph]

<table>
<thead>
<tr>
<th>SlopeData</th>
<th>&quot;Stage&quot;</th>
<th>&quot;Change in L @ Top (in)&quot;</th>
<th>&quot;Change in L @ Bot. (in)&quot;</th>
<th>&quot;Slope at End (deg)&quot;</th>
<th>&quot;midspan defl (in)&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Release&quot;</td>
<td>-0.0312</td>
<td>-0.1168</td>
<td></td>
<td>0.1595</td>
<td>0.2233</td>
</tr>
<tr>
<td>&quot;30 Days&quot;</td>
<td>-0.1025</td>
<td>-0.2413</td>
<td></td>
<td>0.2708</td>
<td>0.3178</td>
</tr>
<tr>
<td>&quot;60 Days&quot;</td>
<td>-0.1288</td>
<td>-0.2872</td>
<td></td>
<td>0.3139</td>
<td>0.3613</td>
</tr>
<tr>
<td>&quot;90 Days&quot;</td>
<td>-0.1425</td>
<td>-0.3111</td>
<td></td>
<td>0.3363</td>
<td>0.3932</td>
</tr>
<tr>
<td>&quot;120 Days&quot;</td>
<td>-0.1509</td>
<td>-0.3258</td>
<td></td>
<td>0.35</td>
<td>0.4181</td>
</tr>
<tr>
<td>&quot;240 Days&quot;</td>
<td>-0.1662</td>
<td>-0.3524</td>
<td></td>
<td>0.375</td>
<td>0.4812</td>
</tr>
<tr>
<td>&quot;non-comp DL&quot;</td>
<td>-0.021</td>
<td>0.0183</td>
<td>-0.0939</td>
<td></td>
<td>-0.1705</td>
</tr>
<tr>
<td>&quot;comp DL&quot;</td>
<td>-9.9561 × 10^{-4}</td>
<td>0.0025</td>
<td>-0.0084</td>
<td></td>
<td>-0.0152</td>
</tr>
<tr>
<td>&quot;LL&quot;</td>
<td>-0.012</td>
<td>0.0304</td>
<td>-0.1012</td>
<td></td>
<td>-0.1823</td>
</tr>
</tbody>
</table>

Ultimate Moment Capacity
**Strength Limit State Moments**

\[ \phi_{mom_{mn}} \left( M_{mn} \right) \]

- \( M_{cr_{mn}} \)
- \( M_{pos.Str1_{mn}} \)
- \( M_{pos.Str2_{mn}} \)
- \( M_{req_{mn}} \)

CRStr.mom := 10 \[ CRStr.mom_{mn} := \frac{\phi_{mom_{mn}} \left( M_{mn} \right)}{M_{req_{mn}}} \]

\( LRFD 5.7.3.3.2 \)

\[ \min(\text{CRStr.mom}) = 1.28 \]

\[ \max(M_{req}) = 629.8 \text{-kip-ft} \]

CheckMomentCapacity := if(\( \min(\text{CRStr.mom}) > 0.99 \), "OK", "No Good!"

CheckMomentCapacity = "OK"

FSB only - Design Check of Transverse reinforcing Bars E

**Shear Analysis**

**Strength Shear and Associated Moments**

\[ V_{u,Str_{n}} \]

- \( V_{u,Str} \)
- \( M_{shr,Str_{n}} \)

\[ \max(V_{u,Str}) = 109.7 \text{-kip} \]

\[ \max(M_{shr,Str}) = 452.4 \text{-kip-ft} \]
**Design Shear, Longitudinal, Interface and Anchorage Reinforcement**

**Stirrup sizes and spacings assigned in input file**

<table>
<thead>
<tr>
<th>Location</th>
<th>spacing</th>
<th>Number of Spaces</th>
<th>area per stirrup</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 stirrup</td>
<td>18-in</td>
<td>1</td>
<td>(0.8)</td>
</tr>
<tr>
<td>A2 stirrup</td>
<td>18-in</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>A3 stirrup</td>
<td>18-in</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>S1 stirrup</td>
<td>18-in</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>S2 stirrup</td>
<td>18-in</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>S3 stirrup</td>
<td>18-in</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>S4 stirrup</td>
<td>18-in</td>
<td>1</td>
<td>0.8</td>
</tr>
</tbody>
</table>

**Locally assigned stirrup sizes and spacings**

To change the values from the input file enter the new values into the vectors below. Input only those that you wish to change. Values less than 0 are ignored.

**Spacing Computation**

**Stirrup sizes and spacings used in analysis**

The number of spaces for the S4 stirrup is calculated by the program to complete the half beam length.

**EndCover = 6.5-in**
Computation for Checks

CheckShearCapacity = "OK"  CheckMaxShearStress = "OK"
CheckStirArea = "OK"  CheckMinStirArea = "OK"  CheckMaxStirSpacing = "OK"

Longitudinal Reinforcement

Longitudinal Steel Required vs. Provided

\[
CR_{LongSteel} := \begin{cases} 
V_{long,reqd_{hs}} < 0.01 \text{kip}, & \frac{V_{long,prov_{hs}}}{V_{long,reqd_{hs}}} \\
\frac{V_{long,prov_{hs}}}{V_{long,reqd_{hs}}} & \text{min}(CR_{LongSteel}) = 1.48 
\end{cases}
\]

CheckLongSteel := if \(\text{min}(CR_{LongSteel}) > 1\), "OK", "No Good, add steel!"

CheckLongSteel = "OK"

Interface Shear Reinforcement

Interface Steel Required vs Provided

\[
A_{v,reqd_{hs}} := \frac{V_{long,reqd_{hs}}}{0.01 \text{kip}}, \quad A_{v,prov.interface_{hs}} := \frac{V_{long,prov_{hs}}}{V_{long,reqd_{hs}}} 
\]

7/26/2016 MainProgram.xmcd v5.0
Typically shear steel is extended up into the deck slab. These calculations are based on shear steel functioning as interface reinforcing. The interface_factor can be used to adjust this assumption.

\[
\max(A_{vf,\text{min}}) = 0 \text{ in}^2/\text{ft} \quad \max(A_{vf,\text{des}}) = 0 \text{ in}^2/\text{ft}
\]

If \(\max(A_{vf,\text{min}})\) or \(\max(A_{vf,\text{des}})\) is greater than 0 in\(^2/\text{ft}\), interface steel is required.

CheckInterfaceSpacing = "OK"

CheckInterfaceSteel := if \left(\frac{\text{TotalInterfaceSteelProvided}}{\text{TotalInterfaceSteelRequired} + 0.001\text{ in}^2} \geq 1\right), "OK", "No Good"

CheckInterfaceSteel := if (substr(BeamTypeTog, 0, 3) = "FLT", "N.A.", CheckInterfaceSteel)  

CheckInterfaceSteel = "OK"

### Anchorage Reinforcement and Maximum Prestressing Force

Was FDOT Design Standard splitting reinforcing used? (bars Y, K, & Z)

\[\text{StandardSplittingReinforcing} := \text{yes} \quad \text{if yes-> checks max allowable standard prestress force} \]

\[\text{if no-> checks stirrup area given input prestress force} \]

CheckSplittingSteel = "N.A."  

CheckMaxPrestressingForce = "OK"

### Summary of Design Checks

\[\text{check}_0 := \text{AcceptAASHTO} = "OK"\]
\[\text{check}_1 := \text{AcceptSDG} = "N.A."\]
\[\text{check}_2 := \text{AcceptOntario} = "N.A."\]
\[\text{check}_3 := \text{Check}_f_{\text{pt}} = "OK"\]
\[\text{check}_4 := \text{Check}_f_{\text{comp},\text{rel}} = "OK"\]
\[\text{check}_5 := \text{Check}_f_{\text{tension},\text{rel}} = "OK"\]
\[\text{check}_6 := \text{Check}_f_{\text{comp},\text{stage8},\text{c1}} = "OK"\]
\[\text{check}_7 := \text{Check}_f_{\text{tension},\text{stage8}} = "OK"\]
\[\text{check}_8 := \text{Check}_f_{\text{comp},\text{stage8},\text{c2}} = "OK"\]
\[\text{check}_9 := \text{Check}_f_{\text{comp},\text{stage8},\text{c1}} = "OK"\]
\[\text{check}_{10} := \text{Check}_f_{\text{tension},\text{stage8}} = "OK"\]
\[\text{check}_{11} := \text{CheckMomentCapacity} = "OK"\]
\[\text{check}_{12} := \text{CheckMaxCapacity} = "OK"\]
\[\text{check}_{13} := \text{CheckStirArea} = "OK"\]
\[\text{check}_{14} := \text{CheckShearCapacity} = "OK"\]
\[\text{check}_{15} := \text{CheckMinStirArea} = "OK"\]
\[\text{check}_{16} := \text{CheckMaxStirSpacing} = "OK"\]
\[\text{check}_{17} := \text{CheckLongSteel} = "OK"\]
\[\text{check}_{18} := \text{CheckInterfaceSpacing} = "OK"\]
\[\text{check}_{19} := \text{CheckSplittingSteel} = "N.A."\]
\[\text{check}_{20} := \text{CheckMaxPrestressingForce} = "OK"\]
\[\text{check}_{21} := \text{CheckPattern}_0 = "OK"\]
\[\text{check}_{22} := \text{CheckPattern}_1 = "OK"\]
\[\text{check}_{23} := \text{CheckPattern}_2 = "OK"\]
\[\text{check}_{24} := \text{CheckPattern}_3 = "OK"\]
\[\text{check}_{25} := \text{CheckPattern}_4 = "OK"\]
\[\text{check}_{26} := \text{CheckInterfaceSteel} = "OK"\]
\[\text{check}_{27} := \text{CheckStrandFit} = "OK"\]
**LRFR Load Rating Analysis**

*FDOT Maintenance Office Bridge Load Rating Manual*

### Load Rating Computations

<table>
<thead>
<tr>
<th>Limit State</th>
<th>DF</th>
<th>Rating</th>
<th>Tons</th>
<th>Dim(ft)</th>
<th>DF</th>
<th>Rating</th>
<th>Tons</th>
<th>Dim(ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Strength I(Inv)&quot;</td>
<td>0.41</td>
<td>2.01</td>
<td>&quot;N/A&quot;</td>
<td>13.32</td>
<td>0.68</td>
<td>4.36</td>
<td>&quot;N/A&quot;</td>
<td>1.39</td>
</tr>
<tr>
<td>&quot;Strength I(Op)&quot;</td>
<td>0.41</td>
<td>2.61</td>
<td>&quot;N/A&quot;</td>
<td>13.32</td>
<td>0.68</td>
<td>5.65</td>
<td>&quot;N/A&quot;</td>
<td>1.39</td>
</tr>
<tr>
<td>&quot;Service III(Inv)&quot;</td>
<td>0.41</td>
<td>1.94</td>
<td>&quot;N/A&quot;</td>
<td>13.32</td>
<td>&quot;N/A&quot;</td>
<td>&quot;N/A&quot;</td>
<td>&quot;N/A&quot;</td>
<td>&quot;N/A&quot;</td>
</tr>
<tr>
<td>&quot;Service III(Op)&quot;</td>
<td>0.41</td>
<td>2.62</td>
<td>&quot;N/A&quot;</td>
<td>13.32</td>
<td>&quot;N/A&quot;</td>
<td>&quot;N/A&quot;</td>
<td>&quot;N/A&quot;</td>
<td>&quot;N/A&quot;</td>
</tr>
<tr>
<td>&quot;Strength II&quot;</td>
<td>0.41</td>
<td>2.21</td>
<td>132.40</td>
<td>10.54</td>
<td>0.68</td>
<td>3.83</td>
<td>230.07</td>
<td>1.39</td>
</tr>
</tbody>
</table>

**Longitudinal Steel Check:**

\[
\begin{align*}
CR_{\text{Long Steel, HL93}} &= 1.58 \quad CR_{\text{Long Steel, Permit}} = 1.38 \\
\text{CheckLongSteelLoadrating} &= "OK"
\end{align*}
\]

*note: default permit load is FL120 per input worksheet*
**LRFD Prestressed Beam Program**

**Project** = "D30040 30 FT, LR Int. Bm."

**DesignedBy** = "VAY"

**Date** = "7-26-2016"

filename = "C:\FDOT Structures\Programs\LRFDPBeamV5.0\FSB Data Files\D30040 30 FT LR Int. Bm..dat"

Comment = "FSB12x56 30 ft span"

**Legend**

- **TanHighlight = DataEntry**
- **YellowHighlight = CheckValues**
- **GreyHighlight = UserComments + Graphs**
- **BlackText = ProgramEquations**
- **Maroon Text = Code Reference**
- **Blue Text = Commentary**

**Bridge Layout and Dimensions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{beam}$</td>
<td>28.83 ft</td>
</tr>
<tr>
<td>Span</td>
<td>27.75 ft</td>
</tr>
<tr>
<td>BearingDistance</td>
<td>6.5 in</td>
</tr>
<tr>
<td>PadWidth</td>
<td>8 in</td>
</tr>
</tbody>
</table>

These are typically the FDOT designations found in our standards. The user can also create a coordinate file for a custom shape. In all cases the top of the beam is at the $y=0$ ordinate.
Overhang = 0-ft  BeamSpacing = 4.76-ft  t_{slab} = 6-in  h_{buildup} = 0-in
Skew = 0-deg  t_{integral.ws} = 0-in  NumberOfBeams = 9  t_{slab.delta} = 0.24-in
de = 1 ft

BeamPosition = "interior"  

For calculating distribution factors must be either interior or exterior

b_c = 4.76 ft  
effective slab width  
LRFD 4.6.2.6

\[ t_{slab} := \text{if}(t_{slab} \leq 0\text{-in}, 0.00001\text{-in}, t_{slab}) \]  
Provide a minimum slab thickness to prevent divide by zero errors

\[ \text{Material Properties} \]

\[ \text{Concrete:} \]

\[ \text{Corrosion Classification} \]

Environment = "extremely"  
density of slab concrete \( \gamma_{slab} = 0.15 \frac{\text{kip}}{\text{ft}^3} \)

strength of slab concrete \( f_{c,slab} = 4.5 \text{-ksi} \)

strength of beam concrete \( f_{c,beam} = 8.5 \text{-ksi} \)

release beam strength \( f_{ci,beam} = 6 \text{-ksi} \)

AggregateType = "Florida"  
aggregate  
"Florida" or "Standard"

\[ n_d := \left( \frac{f_{c,beam}}{f_{c,slab}} \right)^{0.33} \]  
used in distribution calculation  
\( n_d = 1.23 \)

AggFactor := if[AggregateType = "Florida", (1.0-2500), 2500]  
\( (SDG 1.4.1) \)  
AggFactor = 2500

\[ E_{ci} := \text{AggFactor} \left( \frac{f_{ci,beam}}{\text{ksi}} \right)^{0.33} \text{-ksi} \]  
initial beam concrete modulus of elasticity  
\( (LRFD 5.4.2.4) \)  
\( E_{ci} = 4516 \text{-ksi} \)

\[ E_c := \text{AggFactor} \left( \frac{f_{c,beam}}{\text{ksi}} \right)^{0.33} \text{-ksi} \]  
beam concrete modulus of elasticity  
\( (LRFD 5.4.2.4) \)  
\( E_c = 5066 \text{-ksi} \)

\[ \text{Prestressing Tendons:} \]

tendon ultimate tensile strength \( f_{pu} = 270 \text{-ksi} \)

tendon modulus of elasticity \( E_p = 28500 \text{-ksi} \)

time in days between jacking and transfer \( t_j = 0.75 \)

time in days ratio of tendon modulus to initial beam concrete modulus \( n_{pi} := \frac{E_p}{E_{ci}} \)

time in days ratio of tendon modulus to beam concrete modulus \( n_p := \frac{E_p}{E_c} \)
Mild Steel:

- **mild steel yield strength** $f_y = 60$ ksi
- **mild steel modulus of elasticity** $E_s = 29000$ ksi
- **ratio of rebar modulus to initial beam concrete modulus** $n_{mi} := \frac{E_s}{E_{ci}}$, $n_{mi} = 6.42$
- **area per unit width of longitudinal slab reinf.** $A_{slab, rebar} = 0.31$ in$^2$/ft
- **area of mild reinf lumped at centroid of bar locations** $A_{sl, long} = 0$ in$^2$
- **area of rebar modulus to beam concrete modulus** $n_{m} := \frac{E_s}{E_c}$, $n_{m} = 5.72$
- **ratio of rebar modulus to initial beam concrete modulus** $n_{mi} := \frac{E_s}{E_{ci}}$
- **area per unit width of longitudinal slab reinf.** $A_{slab, rebar} = 0.31$ in$^2$/ft
- **d distance from top of slab to centroid of slab reinf.** $d_{slab, rebar} = 2.5$ in
- **d distance from top of beam to centroid of mild flexural tension reinf.** $d_{long} = 0$ in
- **Size of bar used create used to calculate development length** BarSize = 5

Permit Loads

- **This is the number of wheel loads that comprise the truck, max for DLL is 11**
- **Indexes used to identify values in the P and d vectors** $q := 0..(\text{PermitAxles} - 1)$, $qt := 0..\text{PermitAxles}$
- **PermitAxleLoad** $^T = (13.33 \ 53.33 \ 53.33)$ kip
- **PermitAxleSpacing** $^T = (0 \ 14 \ 14 \ 0)$ ft

Distribution Factors

- **DataMessage** = "This is a FSB12x56 Florida Slab Beam design, AASHTO distribution factors used"

- **calculated values**: $\text{tmp}_\text{g, mom} = 0.38$, $\text{tmp}_\text{g, shear} = 0.61$, $\text{tmp}_\text{g, mom, fatigue} = 0.25$

- **user value overrides (optional)**: $\text{user}_\text{g, mom} := 0$, $\text{user}_\text{g, shear} := 0$, $\text{user}_\text{g, mom, fatigue} := 0$

- **value check**: $g_{mom} := \text{if}(\text{user}_\text{g, mom} \neq 0, \text{user}_\text{g, mom} \cdot \text{tmp}_\text{g, mom})$, $g_{mom} = 0.38$
- $g_{shear} := \text{if}(\text{user}_\text{g, shear} \neq 0, \text{user}_\text{g, shear} \cdot \text{tmp}_\text{g, shear})$, $g_{shear} = 0.61$
- $g_{mom, fatigue} := \text{if}(\text{user}_\text{g, mom, fatigue} \neq 0, \text{user}_\text{g, mom, fatigue} \cdot \text{tmp}_\text{g, mom, fatigue})$, $g_{mom, fatigue} = 0.25$
Section Views

Beam Section

Total Slab, Effective Slab, and Beam

Feed

slab

effective slab

beam
**Non-Composite Dead Load Input:**

\[ w_{slab} = 0.471 \text{ kip/ft} \quad w_{beam} = 0.593 \text{ kip/ft} \quad w_{forms} = 0 \text{ kip/ft} \]

\[ \text{Add}_w_{noncomp} := 0.0 \text{ kip/ft} \]

*additional non composite dead load (positive or negative)*

*note: not saved to data file, may be saved to Mathcad worksheet.*

\[ w_{noncomposite} := w_{slab} + w_{beam} + w_{forms} + \text{Add}_w_{noncomp} \]

\[ w_{noncomposite} = 1.064 \text{ kip/ft} \]

\[ w_{bbnoncomposite} := w_{slab} + w_{forms} + \text{Add}_w_{noncomp} \]

\[ w_{bbnoncomposite} = 0.471 \text{ kip/ft} \]

**Diaphragms/Point Load Input**

*End Diaphragms or Misc. Point Loads over bearing... included in bearing reaction calculation only*

*Intermediate Diaphragms or Misc. Point Loads... included in shear, moment, and bearing reaction calculations*

\[ \text{EndDiaphragmA} := 0 \text{ kip} \quad \text{begin bridge} \]

\[ \text{DistB} := 0 \text{ ft} \]

\[ \text{IntDiaphragmB} := 0 \text{ kip} \]

\[ \text{input load is per beam} \]

\[ \text{EndDiaphragmE} := 0 \text{ kip} \quad \text{end bridge} \]

\[ \text{DistC} := 0 \text{ ft} \]

\[ \text{IntDiaphragmC} := 0 \text{ kip} \]

\[ \text{Longitudinal Distance B, C, & D - Measured from CL Bearing at begin bridge} \]

\[ \text{DistD} := 0 \text{ ft} \]

\[ \text{IntDiaphragmD} := 0 \text{ kip} \]

**Composite Dead Load Input:**

\[ w_{future.ws} = 0.071 \text{ kip/ft} \quad w_{barrier} = 0.095 \text{ kip/ft} \]

\[ \text{Add}_w_{comp} := 0.0 \text{ kip/ft} \]

*additional composite dead load (positive or negative)*

*note: not saved to data file, may be saved to Mathcad worksheet*

\[ w_{composite} := w_{future.ws} + w_{barrier} + \text{Add}_w_{comp} \]

\[ w_{composite} = 0.167 \text{ kip/ft} \]

\[ w_{comp.str} := w_{barrier} + \text{Add}_w_{comp} \]

\[ w_{comp.str} = 0.095 \text{ kip/ft} \]
Release Dead Load Moments and Shear

\[
\max(M_{\text{release}}) = 61.7 \text{-kip}\cdot\text{ft} \\
\max(V_{\text{release}}) = 8.6 \text{-kip}
\]

Noncomposite Dead Load Moments and Shear

\[
\max(M_{\text{dl.non.comp}}) = 102.4 \text{-kip}\cdot\text{ft} \\
\max(V_{\text{dl.non.comp}}) = 14.8 \text{-kip}
\]
Composite Dead Load Moments and Shear

\[ \text{max}(M_{\text{dl.comp}}) = 16\text{-kip ft} \quad \text{max}(V_{\text{dl.comp}}) = 2.3\text{-kip} \]

Distributed Live Load Moments and Shear

\[ \text{max}(M_{\text{dist.live.pos}}) = 174.1\text{-kip ft} \]
\[ \text{min}(M_{\text{dist.live.neg}}) = -8.8\text{-kip ft} \]
\[ \text{max}(V_{\text{dist.live.pos}}) = 44.3\text{-kip} \]
\[ \text{max}(M_{\text{shr.dist.live.pos}}) = 163.3\text{-kip ft} \]
\[ \text{Reaction}_{\text{LL}} = 45.59\text{-kip} \]
\[ \text{Reaction}_{\text{DL}} = 17.74\text{-kip} \]
Prestress Strand Layout Input

Instructions:

Double click the icon to open the 'Strand Pattern Generator'. Specify the type, location, size, and debonding of strands. When finished, press the 'Continue' button. Then press 'Read Strand Data' button. Then press 'Recalculate Worksheet' button.

Strand Pattern Input Mode:

StrandTemplate := Standard

Strand Multiplier

Strand Data and Pattern

Strand Properties

Collapsed Region for Custom Strand Sizes...

Tendon Layout

SupportLocation_{release} = 0 \cdot \text{ft} \quad \text{distance supports are located from the end of the beam after release; may be used to check lifting points immediately after transfer}
Partially Stressed Tendons ("Strand N")

PartialPS\text{force} = 40 \text{-kip} \quad \text{partial prestress total force}

PartialPS\text{force} := \begin{cases} 20 \text{-kip} & \text{if BeamTypeTog = "II"} \\ & \text{otherwise} \end{cases}

PartialPS\text{force} = 40 \text{-kip}

PartialPS\text{location} = 1.4375 \text{in} \quad \text{centroid location of partial prestress from the top of the beam}

PartialPS\text{location} := \begin{cases} 2.4375 \text{-in} & \text{if BeamTypeTog = "II"} \\ 3 \text{-in} & \text{if substr(BeamTypeTog, 0, 5) = "FSB12"} \\ 2 \text{-in} & \text{if substr(BeamTypeTog, 0, 5) = "FSB15"} \\ 3 \text{-in} & \text{if substr(BeamTypeTog, 0, 5) = "FSB18"} \\ \text{otherwise} \end{cases}

PartialPS\text{location} = 3 \text{-in}

Section Properties & Strand Profile Properties

Release Stresses

Release Stresses (ksi) Top, Bot., & Allow.

Location_n \quad \text{ft}

Prestress Force
Final Stresses

Final Stresses (ksi) Top, Bot., & Allowable

Location

Release Checks & Final Checks for Capacity Ratio (CR)

Stress Checks

\[
\begin{align*}
\min(CR_{f_{\text{tension,rel}}}) &= 10 & \text{Check}_{f_{\text{tension,rel}}} &= \text{"OK"} \\
\min(CR_{f_{\text{comp,rel}}}) &= 1.89 & \text{Check}_{f_{\text{comp,rel}}} &= \text{"OK"} \\
\min(CR_{f_{\text{tension,stage8}}}) &= 10 & \text{Check}_{f_{\text{tension,stage8}}} &= \text{"OK"} \\
\min(CR_{f_{\text{comp,stage8,c1}}}) &= 3.47 & \text{Check}_{f_{\text{comp,stage8,c1}}} &= \text{"OK"} \\
\min(CR_{f_{\text{comp,stage8,c2}}}) &= 3.7 & \text{Check}_{f_{\text{comp,stage8,c2}}} &= \text{"OK"} \\
\min(CR_{f_{\text{comp,FatigueI}}}) &= 4.85 & \text{Check}_{f_{\text{comp,FatigueI}}} &= \text{"OK"} \\
\end{align*}
\]
Strand Pattern Checks

CheckPattern_0 = "OK"
check 0 - no debonded tendon in outside row

CheckPattern_1 = "OK"
check 1 - less than 25% debonded tendons total
*Note: Check 1 may be less than 30% provided that debonding does not occur within the horizontal limits of the web (See SDG 4.3.1)

CheckPattern_2 = "OK"
check 2 - less than 40% debonded tendons in any row

CheckPattern_3 = "OK"
check 3 - less than 40% of debonded tendons terminated at same section (LRFD 5.11.4.3)

CheckPattern_4 = "OK"
check 4 - more than half beam depth debond length (SDG 4.3.1)

Section and Strand Properties Summary

A_{beam} = 569.75\text{ in}^2 \quad \text{Concrete area of beam}
I_{beam} = 6938.3338\text{ in}^4 \quad \text{Gross Moment of Inertia of Beam about CG}
y_{comp} = -3.35\text{ in} \quad \text{Dist. from top of beam to CG of gross composite section}
I_{comp} = 24644.5853\text{ in}^4 \quad \text{Gross Moment of Inertia Composite Section about CG}
A_{deck} = 366.23\text{ in}^2 \quad \text{Concrete area of deck slab}
A_{ps} = 3\text{ in}^2 \quad \text{total area of strands}
d_{b,\text{ps}} = 0.6\text{ in} \quad \text{diameter of Prestressing strand}
\min(\text{PrestressType}) = 0 \quad 0 - low lax \ 1 - stress relieved
f_{py} = 243\text{ ksi} \quad \text{tendon yield strength}
f_{pj} = 203\text{ ksi} \quad \text{prestress jacking stress}
L_{\text{shielding}}^{T} = (0 \ 0 \ 0)\text{ ft}
A_{ps,row}^{T} = (2.6 \ 0.4 \ 0.2)\text{ in}^2

d_{ps,row} =
\begin{array}{ccccccccccc}
0 & -9 & -9 & -9 & -9 & -9 & -9 & -9 & -9 & -9 \\
1 & -7 & -7 & -7 & -7 & -7 & -7 & -7 & -7 & -7 \\
2 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & ...
\end{array}

TotalNumberOfTendons = 14 \quad \text{StrandSize = "0.6 in low lax"}
NumberOfDebondedTendons = 0 \quad \text{StrandArea = 0.22 in}^2
NumberOfDrapedTendons = 0 \quad \text{JackingForce}_{\text{per, strand}} = 43.94\text{ kip}
**Section and Strand Properties Summary**

### Prestress Losses Summary

\[ f_{pj} = 202.5 \text{ ksi} \]

**Note:** Elastic shortening losses are zero in concrete stress calculations when using transformed section properties per LRFD 5.9.5.2.3

\[ \Delta f_{pES} = 0 \text{ ksi} \]

\[ \Delta f_{pT} = -18 \text{ ksi} \]

\[ \Delta f_{pT} = -8.82\% \]

\[ f_{pc} = 185 \text{ ksi} \]

\[ f_{pc} = 91.18\% \]

\[ 0.8 \cdot f_{py} = 194 \text{ ksi} \]

**Check \( f_{pT} \) = "OK"**

**Check \( f_{pc} \) = "OK"**

### Service Limit State Moments

\[ \max(M_{\text{pos.Ser}1}) = 292.3 \text{ kip-ft} \]

\[ \max(M_{\text{pos.Ser}3}) = 257.5 \text{ kip-ft} \]
Summary of Values at Midspan

Stresses =

<table>
<thead>
<tr>
<th>Stage</th>
<th>Top of Beam (ksi)</th>
<th>Bott of Beam (ksi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.63</td>
<td>-1.54</td>
</tr>
<tr>
<td>2</td>
<td>-0.63</td>
<td>-1.35</td>
</tr>
<tr>
<td>4</td>
<td>-0.58</td>
<td>-1.4</td>
</tr>
<tr>
<td>6</td>
<td>-1.08</td>
<td>-0.97</td>
</tr>
<tr>
<td>8</td>
<td>-1.38</td>
<td>-0.33</td>
</tr>
</tbody>
</table>

PrestressForce =

<table>
<thead>
<tr>
<th>Condition</th>
<th>Axial (kip)</th>
<th>Moment (kip*ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release</td>
<td>-655.2</td>
<td>-110.2</td>
</tr>
<tr>
<td>Final (about composite centroid)</td>
<td>-597.4</td>
<td>-97.4</td>
</tr>
</tbody>
</table>

Properties =

<table>
<thead>
<tr>
<th>Section</th>
<th>Area (in^2)</th>
<th>Inertia (in^4)</th>
<th>distance to centroid from top of bm (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Beam</td>
<td>566.51</td>
<td>6917.67</td>
<td>-6.35</td>
</tr>
<tr>
<td>Transformed Beam (initial)</td>
<td>586.94</td>
<td>7045.64</td>
<td>-6.42</td>
</tr>
<tr>
<td>Transformed Beam</td>
<td>584.72</td>
<td>7032.01</td>
<td>-6.41</td>
</tr>
<tr>
<td>Composite</td>
<td>957.92</td>
<td>25382.6</td>
<td>-3.37</td>
</tr>
</tbody>
</table>

ServiceMoments =

<table>
<thead>
<tr>
<th>Type</th>
<th>Value (kip*ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release</td>
<td>61.7</td>
</tr>
<tr>
<td>Non-composite (includes bm wt.)</td>
<td>102.4</td>
</tr>
<tr>
<td>Composite</td>
<td>16</td>
</tr>
<tr>
<td>Distributed Live Load</td>
<td>173.4</td>
</tr>
</tbody>
</table>

Stage 1 ---> At release with span length equal to length of the beam. Prestress losses are elastic shortening and overnight relax.

Stage 2 ---> Same as release with the addition of the remaining prestress losses applied to the transformed beam.

Stage 4 ---> Same as stage 2 with supports changed from the end of the beam to the bearing locations.

Stage 6 ---> Stage 4 with the addition of non-composite dead load excluding beam weight which has been included since Stage 1.

Stage 8 ---> Stage 6 with the addition of composite dead load and live loads applied to the composite section.
Camber at Release, Short Term Camber, & Summary of Slope Data

Camber, Shrinkage, and Dead Load Deflection Components

Camber & Deflection

<table>
<thead>
<tr>
<th>Location in feet</th>
<th>Deflection in inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>7.207</td>
<td>0.2</td>
</tr>
<tr>
<td>14.415</td>
<td>0.4</td>
</tr>
<tr>
<td>21.622</td>
<td>0.6</td>
</tr>
<tr>
<td>28.83</td>
<td>0.8</td>
</tr>
</tbody>
</table>

SlopeData = \[
\begin{array}{cccc}
"Stage" & "Change in L @ Top (in)" & "Change in L @ Bot. (in)" & "Slope at End (deg)" & "Midspan defl (in)"\\
"Release" & -0.0312 & -0.1168 & 0.1595 & 0.2233 \\
"30 Days" & -0.1025 & -0.2413 & 0.2709 & 0.3178 \\
"60 Days" & -0.1288 & -0.2872 & 0.3139 & 0.3613 \\
"90 Days" & -0.1425 & -0.3111 & 0.3363 & 0.3931 \\
"120 Days" & -0.1509 & -0.3258 & 0.35 & 0.418 \\
"240 Days" & -0.1662 & -0.3524 & 0.375 & 0.4811 \\
"Non-comp DL" & -0.0218 & 0.019 & -0.0973 & -0.1767 \\
"Comp DL" & -0.0011 & 0.0029 & -0.0095 & -0.0173 \\
"LL" & -0.0109 & 0.0279 & -0.0927 & -0.167 \\
\end{array}
\]

Ultimate Moment Capacity

7/26/2016 MainProgram.xmcd v5.0 14
**Strength Limit State Moments**

Nominal and Ultimate Moment Strength (kip-ft)

\[ \phi_{mommn} \left( M_{mn} \right)_0 \]

- \( M_{cr_{mn}} \) kip-ft
- \( M_{pos.Str1_{mn}} \) kip-ft
- \( M_{pos.Str2_{mn}} \) kip-ft
- \( M_{reqdmn} \) kip-ft

\[ \text{CR}_{Str.momn} := 10 \]

\[ \text{CR}_{Str.momn} := \frac{\phi_{mommn} \left( M_{mn} \right)_0}{M_{reqdmn}} \quad (LRFD 5.7.3.3.2) \]

\[ \min \left( \text{CR}_{Str.momn} \right) = 1.34 \]

\[ \max (M_{reqd}) = 604.1 \text{-kip-ft} \]

CheckMomentCapacity := if \( \min (\text{CR}_{Str.mom}) > 0.99 \), "OK", "No Good!"

CheckMomentCapacity = "OK"

**Strength Shear and Associated Moments**

Str. V(kip) & Corresp. M(kip-ft)

- \( V_{u.Str_n} \) kip
- \( M_{shr.u. Str_n} \) kip-ft

\[ \max (V_{u.Str}) = 100.9 \text{-kip} \]

\[ \max (M_{shr.u.Str}) = 434.5 \text{-kip-ft} \]
### Design Shear, Longitudinal, Interface and Anchorage Reinforcement

Stirrup sizes and spacings assigned in input file

<table>
<thead>
<tr>
<th>Location</th>
<th>spacing</th>
<th>Number of Spaces</th>
<th>area per stirrup</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 stirrup</td>
<td>18 in</td>
<td>1</td>
<td>0.8 in²</td>
</tr>
<tr>
<td>A2 stirrup</td>
<td>18</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>A3 stirrup</td>
<td>18</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>S1 stirrup</td>
<td>18</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>S2 stirrup</td>
<td>18</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>S3 stirrup</td>
<td>18</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>S4 stirrup</td>
<td>18</td>
<td>0</td>
<td>0.8</td>
</tr>
</tbody>
</table>

**Locally assigned stirrup sizes and spacings**

To change the values from the input file enter the new values into the vectors below. Input only those that you wish to change. Values less than 0 are ignored.

- **user_snspacings**
- **user_NumberSpaces**
- **user_Astirrup**
- **interface_factor**

### Spacing Computation

Stirrup sizes and spacings used in analysis

The number of spaces for the S4 stirrup is calculated by the program to complete the half beam length.

- **A1 stirrup**
- **A2 stirrup**
- **A3 stirrup**
- **S1 stirrup**
- **S2 stirrup**
- **S3 stirrup**
- **S4 stirrup**

```plaintext
A1 stirrup
A2 stirrup
A3 stirrup
S1 stirrup
S2 stirrup
S3 stirrup
S4 stirrup
```
Computation for Checks

- CheckShearCapacity = "OK"
- CheckMaxShearStress = "OK"
- CheckStirArea = "OK"
- CheckMinStirArea = "OK"
- CheckMaxStirSpacing = "OK"

Longitudinal Reinforcement

Longitudinal Steel Required vs. Provided

\[ \text{V}_{\text{long,reqd}_{hs}} \quad \text{kip} \]

\[ \text{V}_{\text{long,prov}_{hs}} \quad \text{kip} \]

Location_{hs} \quad \text{ft}

\[ \text{CR}_{\text{LongSteel}_{hs}} := \begin{cases} \text{V}_{\text{long,reqd}_{hs}} < 0.01 \text{kip}, & \text{V}_{\text{long,prov}_{hs}} \ \\ \text{min} \left( \text{CR}_{\text{LongSteel}} \right) = 1.66 \end{cases} \]

CheckLongSteel := if \( \text{min} \left( \text{CR}_{\text{LongSteel}} \right) > 1 \), "OK", "No Good, add steel!"

Interface Shear Reinforcement

Interface Steel Required vs Provided

\[ \text{A}_{\text{v,reqd}_{hs}} \quad \text{in}^2/\text{ft} \]

\[ \text{A}_{\text{v,prov.interface}_{hs}} \quad \text{in}^2/\text{ft} \]

Location_{hs} \quad \text{ft}
Typically shear steel is extended up into the deck slab. These calculations are based on shear steel functioning as interface reinforcing. The interface factor can be used to adjust this assumption.

\[
\text{max}(A_{vf,\text{min}}) = 0 \text{ in}^2/\text{ft} \quad \text{max}(A_{vf,\text{des}}) = 0 \text{ in}^2/\text{ft}
\]

If max(A_{vf,\text{min}}) or max(A_{vf,\text{des}}) is greater than 0 in²/ft, interface steel is required.

CheckInterfaceSpacing = "OK"

CheckInterfaceSteel := if \left( \frac{\text{TotalInterfaceSteelProvided}}{\text{TotalInterfaceSteelRequired} + 0.001 \text{ in}^2} \geq 1 \right), "OK", "No Good"

CheckInterfaceSteel := if (substr(BeamTypeTog, 0, 3) = "FLT", "N.A.", CheckInterfaceSteel)

CheckInterfaceSteel = "OK"

Anchorage Reinforcement and Maximum Prestressing Force

Was FDOT Design Standard splitting reinforcing used? (bars Y, K, & Z)

StandardSplittingReinforcing := yes
if yes -> checks max allowable standard prestress force if no -> checks stirrup area given input prestress force

CheckSplittingSteel = "N.A.", CheckMaxPrestressingForce = "OK"

Summary of Design Checks

check\_0 := AcceptAASHTO = "OK"
check\_1 := AcceptSDG = "N.A."
check\_2 := AcceptOntario = "N.A."
check\_3 := Check\_\text{f}_{\text{pt}} = "OK"
check\_4 := Check\_f_{\text{pc}} = "OK"
check\_5 := Check\_\text{f}_{\text{tension.rel}} = "OK"
check\_6 := Check\_\text{f}_{\text{comp.rel}} = "OK"
check\_7 := Check\_\text{f}_{\text{tension.stage8}} = "OK"
check\_8 := Check\_\text{f}_{\text{comp.stage8,c1}} = "OK"
check\_9 := Check\_\text{f}_{\text{comp.stage8,c2}} = "OK"
check\_{10} := Check\_\text{f}_{\text{fatigue}} = "OK"
check\_{11} := Check\_\text{f}_{\text{comp.FatigueI}} = "OK"
check\_{12} := Check\_\text{MaxCapacity} = "OK"
check\_{13} := Check\_\text{StirArea} = "OK"
check\_{14} := Check\_\text{ShearCapacity} = "OK"
check\_{15} := Check\_\text{MinStirArea} = "OK"
check\_{16} := Check\_\text{MaxStirSpacing} = "OK"
check\_{17} := Check\_\text{LongSteel} = "OK"
check\_{18} := Check\_\text{InterfaceSpacing} = "OK"
check\_{19} := Check\_\text{SplittingSteel} = "N.A."
check\_{20} := Check\_\text{MaxPrestressingForce} = "OK"
check\_{21} := Check\_\text{Pattern0} = "OK"
check\_{22} := Check\_\text{Pattern1} = "OK"
check\_{23} := Check\_\text{Pattern2} = "OK"
check\_{24} := Check\_\text{Pattern3} = "OK"
check\_{25} := Check\_\text{Pattern4} = "OK"
check\_{26} := Check\_\text{InterfaceSteel} = "OK"
check\_{27} := Check\_\text{StrandFit} = "OK"
**LRFR Load Rating Analysis**

*FDOT Maintenance Office Bridge Load Rating Manual*

**Load Rating Computations**

<table>
<thead>
<tr>
<th>Limit State</th>
<th>DF</th>
<th>Rating</th>
<th>Tons</th>
<th>Dim(ft)</th>
<th>DF</th>
<th>Rating</th>
<th>Tons</th>
<th>Dim(ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength I(Inv)</td>
<td>0.38</td>
<td>2.16</td>
<td>&quot;N/A&quot;</td>
<td>13.32</td>
<td>0.61</td>
<td>4.88</td>
<td>&quot;N/A&quot;</td>
<td>1.93</td>
</tr>
<tr>
<td>Strength I(Op)</td>
<td>0.38</td>
<td>2.80</td>
<td>&quot;N/A&quot;</td>
<td>13.32</td>
<td>0.61</td>
<td>6.32</td>
<td>&quot;N/A&quot;</td>
<td>1.93</td>
</tr>
<tr>
<td>Service III(Inv)</td>
<td>0.38</td>
<td>2.07</td>
<td>&quot;N/A&quot;</td>
<td>13.32</td>
<td>&quot;N/A&quot;</td>
<td>&quot;N/A&quot;</td>
<td>&quot;N/A&quot;</td>
<td>&quot;N/A&quot;</td>
</tr>
<tr>
<td>Service III(Op)</td>
<td>0.38</td>
<td>2.80</td>
<td>&quot;N/A&quot;</td>
<td>13.32</td>
<td>&quot;N/A&quot;</td>
<td>&quot;N/A&quot;</td>
<td>&quot;N/A&quot;</td>
<td>&quot;N/A&quot;</td>
</tr>
<tr>
<td>Strength II</td>
<td>0.38</td>
<td>2.38</td>
<td>142.51</td>
<td>10.54</td>
<td>0.61</td>
<td>4.29</td>
<td>257.23</td>
<td>1.39</td>
</tr>
</tbody>
</table>

**Longitudinal Steel Check:**

\[ CR_{\text{LongSteel,HL93}} = 1.72 \quad \text{CR}_{\text{LongSteel,Permit}} = 1.55 \]

CheckLongSteelloadrating = "OK"

---

*note: default permit load is FL120 per input worksheet*