LOAD RATING CALCULATIONS
DEVELOPMENTAL DESIGN STANDARDS
FSB SUPERSTRUCTURE PACKAGE
15 FT. CLEAR WIDTH

D30015 - 40 Ft. Span
<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>2.39</td>
<td>6.01</td>
<td>N/A</td>
<td>2.78</td>
<td>7.81</td>
<td>N/A</td>
</tr>
<tr>
<td>Design Inventory</td>
<td>HL-93</td>
<td>36</td>
<td>1.84</td>
<td>4.64</td>
<td>1.40</td>
<td>2.15</td>
<td>6.02</td>
<td>1.54</td>
</tr>
<tr>
<td>Permit</td>
<td>FL-120</td>
<td>60</td>
<td>1.79</td>
<td>4.14</td>
<td>N/A</td>
<td>2.09</td>
<td>5.39</td>
<td>N/A</td>
</tr>
</tbody>
</table>
D30015 - SUPERSTRUCTURE SECTION
Project: "D30015 40 FT LR Ext Bm"

DesignedBy: "GW"

Date: "07/25/2016"

filename = "C:\FDOT Structures\Programs\LRFDPreBamV5.0\FSB Data Files\D30015 40 FT LR Ext Bm.dat"

Comment = "FSB12x52 40 ft span"

Legend

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

Bridge Layout and Dimensions

L_{beam} = 38.83-ft
Span = 37.75-ft
BearingDistance = 6.5-in
PadWidth = 8-in

BeamTypeTog = "FSB12x52"  

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 = 4.47-ft  
t_{\text{slab}} = 6$-in  
h_{\text{buildup}} = 0$-in  
Skew = 0-deg  
t_{\text{integral.ws}} = 0$-in  
NumberofBeams = 4  
t_{\text{slab.delta}} = 0.32$-in  
de = 0.79$-ft

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

$b_{e} = 4.36$-ft  
effective slab width  
LRFD 4.6.2.6

$t_{\text{lab}} := \begin{cases} 
0+0.0001, t_{\text{lab}} \end{cases}$  
Provide a minimum slab thickness to prevent divide by zero errors

Material Properties

Concrete:

Corrosion Classification  
Environment = "extremely"  
density of slab concrete $\gamma_{\text{slab}} = 0.15 \frac{\text{kip}}{\text{ft}^3}$

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

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

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

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

weight of future wearing surface $\text{Weight}_{\text{future.ws}} = 0.015 \frac{\text{kip}}{\text{ft}^2}$

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

$E_{\text{ci}} := \text{AggFactor} \left( \frac{f_{c,\text{beam}}}{\text{ksi}} \right)^{0.33} \cdot \text{ksi}$

initial beam concrete modulus of elasticity  
(LRFD 5.4.2.4)  
$E_{\text{ci}} = 4516$-ksi

$E_{\text{c}} := \text{AggFactor} \left( \frac{f_{c,\text{beam}}}{\text{ksi}} \right)^{0.33} \cdot \text{ksi}$

beam concrete modulus of elasticity  
(LRFD 5.4.2.4)  
$E_{\text{c}} = 5066$-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 $n_{pi} := \frac{E_{p}}{E_{ci}}$

ratio of tendon modulus to beam concrete modulus $n_{p} := \frac{E_{p}}{E_{c}}$
**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** \( n_{m} := \frac{E_s}{E_c} \quad n_{m} = 5.72 \)
- **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** \( A_{s,long} = 0 \text{ in}^2 \)
- **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.** \( d_{long} = 0 \text{ in} \)
- **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** \( q := 0 .. (\text{PermitAxles} - 1) \)
- **PermitAxleLoad** \( \mathbf{T} = (13.33 \quad 53.33 \quad 53.33) \text{kip} \)
- **PermitAxleSpacing** \( \mathbf{T} = (0 \quad 14 \quad 14 \quad 0) \text{ft} \)

**Distribution Factors**

DataMessage = "This is a FSB12x52 Florida Slab Beam design, AASHTO distribution factors used"

- **calculated values:**
  - \( \text{tmp}_g_{mom} = 0.42 \)
  - \( \text{tmp}_g_{shear} = 0.63 \)
  - \( \text{tmp}_g_{mom,fatigue} = 0.28 \)

- **user value overrides (optional):**
  - \( \text{user}_g_{mom} = 0.331 \)
  - \( \text{user}_g_{shear} = 0.615 \)
  - \( \text{user}_g_{mom,fatigue} = 0 \)

- **value check**
  - \( g_{mom} := \text{if}(\text{user}_g_{mom} \neq 0, \text{user}_g_{mom}, \text{tmp}_g_{mom}) \quad g_{mom} = 0.33 \)
  - \( g_{shear} := \text{if}(\text{user}_g_{shear} \neq 0, \text{user}_g_{shear}, \text{tmp}_g_{shear}) \quad g_{shear} = 0.62 \)
  - \( g_{mom,fatigue} := \text{if}(\text{user}_g_{mom,fatigue} \neq 0, \text{user}_g_{mom,fatigue}, \text{tmp}_g_{mom,fatigue}) \quad g_{mom,fatigue} = 0.28 \)
Section Views

Beam Section

Total Slab, Effective Slab, and Beam

feet

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

\[ w_{\text{slab}} = 0.434 \text{ kip/ft} \quad w_{\text{beam}} = 0.543 \text{ kip/ft} \quad w_{\text{forms}} = 0 \text{ kip/ft} \]

\[
\text{Add\_wnoncomp} := 0.0 \text{ kip/ft} \quad \text{additional non composite dead load (positive or negative)}
\]

\[
\text{wnoncomposite} := w_{\text{slab}} + w_{\text{beam}} + w_{\text{forms}} + \text{Add\_wnoncomp}
\]

\[
\text{wnoncomposite} = 0.977 \text{ kip/ft}
\]

\[
\text{wbnoncomposite} := w_{\text{slab}} + w_{\text{forms}} + \text{Add\_wnoncomp}
\]

\[
\text{wbnoncomposite} = 0.434 \text{ kip/ft}
\]

**Diaphragms/Point Load Input**

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

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

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

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

\[
\text{IntDiaphragmB} := 0 \text{ kip} \quad \text{DistB} := 0 \text{ ft}
\]

\[
\text{IntDiaphragmC} := 0 \text{ kip} \quad \text{DistC} := 0 \text{ ft}
\]

\[
\text{IntDiaphragmD} := 0 \text{ kip} \quad \text{DistD} := 0 \text{ ft}
\]

**Composite Dead Load Input:**

\[ w_{\text{future.ws}} = 0.044 \text{ kip/ft} \quad w_{\text{barrier}} = 0.215 \text{ kip/ft} \]

\[
\text{Add\_wcomp} := 0.0 \text{ kip/ft} \quad \text{additional composite dead load (positive or negative)}
\]

\[
\text{wcomposite} := w_{\text{future.ws}} + w_{\text{barrier}} + \text{Add\_wcomp}
\]

\[
\text{wcomposite} = 0.259 \text{ kip/ft}
\]

\[
\text{wcomp.str} := w_{\text{barrier}} + \text{Add\_wcomp}
\]

\[
\text{wcomp.str} = 0.215 \text{ kip/ft}
\]
Release Dead Load Moments and Shear

\[
\begin{align*}
\text{max}(M_{\text{release}}) &= 102.4 \text{ kip-ft} \\
\text{max}(V_{\text{release}}) &= 10.6 \text{ kip}
\end{align*}
\]

Noncomposite Dead Load Moments and Shear

\[
\begin{align*}
\text{max}(M_{\text{dl.non.comp}}) &= 174.2 \text{ kip-ft} \\
\text{max}(V_{\text{dl.non.comp}}) &= 18.4 \text{ kip}
\end{align*}
\]
Composite Dead Load Moments and Shear

\[
\begin{align*}
\text{max}(M_{\text{dl.comp}}) &= 46.1\text{-kip-ft} \\
\text{max}(V_{\text{dl.comp}}) &= 4.9\text{-kip}
\end{align*}
\]

Distributed Live Load Moments and Shear

\[
\begin{align*}
\text{max}(M_{\text{dist.live.pos}}) &= 223.9\text{-kip-ft} \\
\text{min}(M_{\text{dist.live.neg}}) &= -7.7\text{-kip-ft} \\
\text{max}(V_{\text{dist.live.pos}}) &= 51.8\text{-kip} \\
\text{max}(M_{\text{shr.dist.live.pos}}) &= 205.9\text{-kip-ft} \\
\text{Beam End Reactions... with IM factor only}
\end{align*}
\]

\[
\begin{align*}
\text{Reaction}_{\text{LL}} &= 52.82\text{-kip} \\
\text{Reaction}_{\text{DL}} &= 24\text{-kip}
\end{align*}
\]
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:

Strand Template:
- Standard
- Custom

Recalculate Worksheet  Read Strand Data

Collapsed Region for Custom Strand Sizes...

Strand Multiplier

Strand Data and Pattern

Strand Properties

Tendon Layout

Support Location \( r_{\text{release}} = 0 \text{ ft} \) 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")**

- **PartialPSforce = 40-kip**  
  *partial prestress total force*

- **PartialPSforce := if (BeamTypeTog = "II", 20-kip, PartialPSforce)**
  
- **PartialPSlocation = 1.4375in**  
  *centroid location of partial prestress from the top of the beam*

- **PartialPSlocation := 2.4375-in if BeamTypeTog = "II"**
  - 3-in if substr(BeamTypeTog, 0, 5) = "FSB12"
  - 2-in if substr(BeamTypeTog, 0, 5) = "FSB15"
  - 3-in if substr(BeamTypeTog, 0, 5) = "FSB18"
  - PartialPSlocation otherwise

---

**Section Properties & Strand Profile Properties**

**Release Stresses**

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

- **ftop.beam.reln**
  - ksi

- **fbot.beam.reln**
  - ksi

- **fall.tension.reln**
  - ksi

- **fall.comp.reln**
  - ksi

---

**Prestress Force**
Release Checks & Final Checks for Capacity Ratio (CR)

**Stress Checks**

\[
\begin{align*}
\min(CR_{_f\text{tension.rel}}) &= 10 \quad \text{Check } f_{\text{tension.rel}} \text{= "OK"} \\
\min(CR_{_f\text{comp.rel}}) &= 1.28 \quad \text{Check } f_{\text{comp.rel}} \text{= "OK"} \\
\min(CR_{_f\text{tension.stage8}}) &= 10 \quad \text{Check } f_{\text{tension.stage8}} \text{= "OK"} \\
\min(CR_{_f\text{comp.stage8.c1}}) &= 1.91 \quad \text{Check } f_{\text{comp.stage8.c1}} \text{= "OK"} \\
\min(CR_{_f\text{comp.stage8.c2}}) &= 2.13 \quad \text{Check } f_{\text{comp.stage8.c2}} \text{= "OK"} \\
\min(CR_{_f\text{comp.FatigueI}}) &= 2.68 \quad \text{Check } f_{\text{comp.FatigueI}} \text{= "OK"}
\end{align*}
\]

(Release tension)
(Release compression)
(Service III, PS + DL + LL*0.8)
(Service I, PS + DL)
(Service I, PS + DL + LL)
(Fatigue I, (PS + DL)*0.5 + 1.5 Fatigue Truck)
Strand Pattern Checks

CheckPattern0 = "OK"  
**check 0** - no debonded tendon in outside row  

CheckPattern1 = "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)*

CheckPattern2 = "OK"  
**check 2** - less than 40% debonded tendons in any row

CheckPattern3 = "OK"  
**check 3** - less than 40% of debonded tendons terminated at same section  
(LRFD 5.11.4.3)

CheckPattern4 = "OK"  
**check 4** - more than half beam depth debond length  
(SDG 4.3.1)

Section and Strand Properties Summary

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A_beam</td>
<td>521.75 in^2</td>
</tr>
<tr>
<td>y_comp</td>
<td>-3.37 in</td>
</tr>
<tr>
<td>A_deck</td>
<td>337.77 in^2</td>
</tr>
<tr>
<td>d_ps</td>
<td>0.6 in</td>
</tr>
<tr>
<td>f_py</td>
<td>243 ksi</td>
</tr>
<tr>
<td>L_shielding</td>
<td>(0 0 0) ft</td>
</tr>
<tr>
<td>A_ps_row</td>
<td>(3.7 0.4 0.2) in^2</td>
</tr>
<tr>
<td>d_ps_row</td>
<td>in</td>
</tr>
</tbody>
</table>

TotalNumberOfTendons = 19  
StrandSize = "0.6 in low lax"

NumberOfDebondedTendons = 0  
StrandArea = 0.22 in^2

NumberOfDrapedTendons = 0  
JackingForce_per_strand = 43.94 kip
**Prestress Losses Summary**

\[ f_{pj} = 202.5 \text{ ksi} \quad \text{Check } f_{pt} = "OK" \]

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

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

\[ \Delta f_{pT} = -21 \text{ ksi} \]

\[ \frac{\Delta f_{pT}}{f_{pj}} = -10.57\% \]

\[ f_{pe} = 181 \text{ ksi} \]

\[ \frac{f_{pe}}{f_{pj}} = 89.43\% \]

\[ 0.8 \cdot f_{py} = 194 \text{ ksi} \quad \text{Check } f_{pe} = "OK" \]

**Service Limit State Moments**

\[ \max(M_{\text{pos.Ser1}}) = 443.9 \text{ kip-ft} \quad \max(M_{\text{pos.Ser3}}) = 399.2 \text{ kip-ft} \]
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>−1.05</td>
<td>−2.08</td>
</tr>
<tr>
<td>2</td>
<td>−1.07</td>
<td>−1.75</td>
</tr>
<tr>
<td>4</td>
<td>−1</td>
<td>−1.81</td>
</tr>
<tr>
<td>6</td>
<td>−1.93</td>
<td>−1.02</td>
</tr>
<tr>
<td>8</td>
<td>−2.4</td>
<td>−0.04</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>−874.9</td>
<td>−156.9</td>
</tr>
<tr>
<td>Final</td>
<td>−782.4</td>
<td>−134</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>517.43</td>
<td>6327.91</td>
<td>−6.37</td>
</tr>
<tr>
<td>Transformed Beam (initial)</td>
<td>544.7</td>
<td>6497.53</td>
<td>−6.48</td>
</tr>
<tr>
<td>Transformed Beam</td>
<td>541.74</td>
<td>6479.7</td>
<td>−6.47</td>
</tr>
<tr>
<td>Composite</td>
<td>885.89</td>
<td>23557.21</td>
<td>−3.43</td>
</tr>
</tbody>
</table>

ServiceMoments =

<table>
<thead>
<tr>
<th>Type</th>
<th>Value (kip*ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release</td>
<td>102.4</td>
</tr>
<tr>
<td>Non-composite (includes bm wt.)</td>
<td>174.2</td>
</tr>
<tr>
<td>Composite</td>
<td>46.1</td>
</tr>
<tr>
<td>Distributed Live Load</td>
<td>223.4</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, Shrinkage, and Dead Load Deflection Components

![Graph showing camber and deflection over time and location.]

<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></td>
<td>&quot;Release&quot;</td>
<td>−0.0673</td>
<td>−0.2276</td>
<td>0.2794</td>
<td>0.4673</td>
</tr>
<tr>
<td></td>
<td>&quot;30 Days&quot;</td>
<td>−0.1791</td>
<td>−0.439</td>
<td>0.4849</td>
<td>0.6901</td>
</tr>
<tr>
<td></td>
<td>&quot;60 Days&quot;</td>
<td>−0.2203</td>
<td>−0.517</td>
<td>0.5643</td>
<td>0.791</td>
</tr>
<tr>
<td></td>
<td>&quot;90 Days&quot;</td>
<td>−0.2417</td>
<td>−0.5576</td>
<td>0.6056</td>
<td>0.8644</td>
</tr>
<tr>
<td></td>
<td>&quot;120 Days&quot;</td>
<td>−0.2549</td>
<td>−0.5824</td>
<td>0.6309</td>
<td>0.9213</td>
</tr>
<tr>
<td></td>
<td>&quot;240 Days&quot;</td>
<td>−0.2788</td>
<td>−0.6277</td>
<td>0.677</td>
<td>1.0645</td>
</tr>
<tr>
<td></td>
<td>&quot;non-comp DL&quot;</td>
<td>−0.0553</td>
<td>0.0473</td>
<td>−0.2452</td>
<td>−0.6054</td>
</tr>
<tr>
<td></td>
<td>&quot;comp DL&quot;</td>
<td>−0.0048</td>
<td>0.012</td>
<td>−0.0401</td>
<td>−0.099</td>
</tr>
<tr>
<td></td>
<td>&quot;LL&quot;</td>
<td>−0.0205</td>
<td>0.0511</td>
<td>−0.171</td>
<td>−0.4144</td>
</tr>
</tbody>
</table>

7/25/2016

MainProgram.xmcd v5.0

14
**Strength Limit State Moments**

Nominal and Ultimate Moment Strength (kip-ft)

<table>
<thead>
<tr>
<th>Location (ft)</th>
<th>Strength State</th>
<th>Value (kip-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$M_{cr_{mn}}$</td>
<td>0</td>
</tr>
<tr>
<td>9.707</td>
<td>$M_{pos.Str1_{mn}}$</td>
<td>200</td>
</tr>
<tr>
<td>19.415</td>
<td>$M_{pos.Str2_{mn}}$</td>
<td>400</td>
</tr>
<tr>
<td>29.122</td>
<td>$M_{reqd_{mn}}$</td>
<td>600</td>
</tr>
<tr>
<td>38.83</td>
<td></td>
<td>800</td>
</tr>
</tbody>
</table>

CR$_{Str.mom_{n}}$ := 10  
CR$_{Str.mom_{mn}}$ := \( \frac{\phi_{mom_{mn}} \cdot (M_{mn})_{0}}{M_{reqd_{mn}}} \)  \( (LRFD \, 5.7.3.3.2) \)  
min\( (CR_{Str.mom}) = 1.27 \)  
max\( (M_{reqd}) = 783.4 \)-kip ft  
CheckMomentCapacity := if \( \min(CR_{Str.mom}) > 0.99, "OK", "No Good!" \)  
CheckMomentCapacity = "OK"

---

**Strength Shear and Associated Moments**

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

<table>
<thead>
<tr>
<th>Location (ft)</th>
<th>Shear V (kip)</th>
<th>Corresponding Moment (kip-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$V_{u.Str_{n}}$</td>
<td>0</td>
</tr>
<tr>
<td>9.707</td>
<td>$M_{shr.u.Str_{n}}$</td>
<td>200</td>
</tr>
<tr>
<td>19.415</td>
<td></td>
<td>400</td>
</tr>
<tr>
<td>29.122</td>
<td></td>
<td>600</td>
</tr>
<tr>
<td>38.83</td>
<td></td>
<td>800</td>
</tr>
</tbody>
</table>

max\( (V_{u.Str}) = 120.9 \)-kip  
max\( (M_{shr.u.Str}) = 662.9 \)-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>6, 18</td>
<td>8</td>
<td>0.8, 0.8, 0.8, 0.8</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>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.

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

The interface_factor accounts for situations where not all of the shear reinforcing is embedded in the poured in place slab.

EndCover = 6.5 in
**Computation for Checks**

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

**Longitudinal Reinforcement**

Longitudinal Steel Required vs. Provided

\[
\frac{V_{\text{long,reqd}}_{\text{hs}}}{\text{kip}} \quad \frac{V_{\text{long,prov}}_{\text{hs}}}{\text{kip}}
\]

\[\text{Location}_{\text{hs}} \quad \text{ft}\]

\[\text{CRLongSteel}_{\text{hs}} := \begin{cases} 
0.01 \text{kip} & \text{if } V_{\text{long,reqd}}_{\text{hs}} \geq V_{\text{long,prov}}_{\text{hs}} \\
100 & \text{if } V_{\text{long,reqd}}_{\text{hs}} < V_{\text{long,prov}}_{\text{hs}} \\
\end{cases}
\]

\[\text{CheckLongSteel} := \begin{cases} 
\text{"OK"} & \text{if } \min (\text{CRLongSteel}) > 1, \text{"No Good, add steel!"} \\
\end{cases}
\]

\[\text{CheckLongSteel} = "OK"
\]

**Interface Shear Reinforcement**

Interface Steel Required vs Provided

\[\frac{A_{\text{f,rq,reqd}}_{\text{hs}}}{\text{in}^2} \quad \frac{A_{\text{f,rq,prov,interface}}_{\text{hs}}}{\text{in}^2} \quad \text{in}^2\]

\[\text{Location}_{\text{hs}} \quad \text{ft}\]
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.

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

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"

\[
\text{CheckInterfaceSteel} := \begin{cases} \text{TotalInterfaceSteelProvided} & \geq 1, \text{"OK"}, \text{"No Good"} \\
\text{TotalInterfaceSteelRequired} + 0.001 \text{ in}^2 & \end{cases}
\]

CheckInterfaceSteel = "OK"

**Anchorage Reinforcement and Maximum Prestressing Force**

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

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

**Summary of Design Checks**

check0 := AcceptAASHTO  check1 := AcceptSDG  check2 := AcceptOntario  check3 := Check_fpt  check4 := Check_fpe  check5 := Check_frel  check6 := Check_fcomp.rel  check7 := Check_frel.stage8  check8 := Check_fcomp.stage8.c1  check9 := Check_fcomp.stage8.c2  check10 := Check_fcomp.Fatiguel  check11 := CheckMomentCapacity  check12 := CheckMaxCapacity  check13 := CheckStirArea  check14 := CheckShearCapacity  check15 := CheckMinStirArea  check16 := CheckMaxStirSpacing  check17 := CheckLongSteel  check18 := CheckInterfaceSpacing  check19 := CheckSplittingSteel  check20 := CheckMaxPrestressingForce  check21 := CheckPattern0  check22 := CheckPattern1  check23 := CheckPattern2  check24 := CheckPattern3  check25 := CheckPattern4  check26 := CheckInterfaceSteel  check27 := CheckStrandFit  check28 := Check_SDG1.2.Dispaly2

**Table Check**

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&quot;OK&quot;</td>
<td>&quot;N.A.&quot;</td>
<td>&quot;N.A.&quot;</td>
<td>&quot;OK&quot;</td>
<td>...</td>
</tr>
</tbody>
</table>

Click table to reveal scroll bar...  TotalCheck = "OK"
LRFR Load Rating Analysis

*FDOT Maintenance Office Bridge Load Rating Manual*

### Load Rating Computations

<table>
<thead>
<tr>
<th></th>
<th>Moment (Strength) or Stress (Service)</th>
<th>Shear (Strength)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LRFR_loadrating</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;Limit State&quot;</td>
<td>&quot;DF&quot;</td>
</tr>
<tr>
<td>&quot;Strength I(Inv)&quot;</td>
<td>0.33</td>
<td>1.84</td>
</tr>
<tr>
<td>&quot;Strength I(Op)&quot;</td>
<td>0.33</td>
<td>2.39</td>
</tr>
<tr>
<td>&quot;Service III(Inv)&quot;</td>
<td>0.33</td>
<td>1.40</td>
</tr>
<tr>
<td>&quot;Service III(Op)&quot;</td>
<td>0.33</td>
<td>1.93</td>
</tr>
<tr>
<td>&quot;Strength II&quot;</td>
<td>0.33</td>
<td>1.79</td>
</tr>
</tbody>
</table>

HL-93

HL-93

HL-93

HL-93

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

**Longitudinal Steel Check:**

\[ C_{r, LongSteel, HL93} = 1.58 \quad C_{r, LongSteel, Permit} = 1.49 \]

CheckLongSteel\_loadrating = "OK"

**Write Data Out**
**LRFD Prestressed Beam Program**

**Project** = "D30015 40 FT LR Int Bm"
**DesignedBy** = "GW"
**Date** = "07/25/2016"

filename = "C:\FDOT Structures\Programs\LRFDPBeamV5.0\FSB Data Files\D30015 40 FT LR Int Bm.dat"

Comment = "FSB12x52 40 ft span"

**Legend**

<table>
<thead>
<tr>
<th>TanHighlight = DataEntry</th>
<th>YellowHighlight = CheckValues</th>
<th>GreyHighlight = UserComments + Graphs</th>
</tr>
</thead>
<tbody>
<tr>
<td>BlackText = ProgramEquations</td>
<td>Maroon Text = Code Reference</td>
<td>Blue Text = Commentary</td>
</tr>
</tbody>
</table>

**Bridge Layout and Dimensions**

![Beam Layout Diagram]

- $L_{\text{beam}} = 38.83\text{-ft}$
- Span = 37.75-ft
- BearingDistance = 6.5-in
- PadWidth = 8-in

BeamTypeTog = "FSB12x52"  
*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 = 4.47-ft  
$t_{\text{slab}} = 6 \text{-in}$  
$h_{\text{buildup}} = 0 \text{-in}$  
Skew = 0-deg  
t_{\text{integral.ws}} = 0 \text{-in}  
NumberOfBeams = 4  
t_{\text{slab.delta}} = 0.32 \text{-in}$  
de = 0.79 \text{-ft}$

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

$b_c = 4.47 \text{-ft}$  
*effective slab width*  
LRFD 4.6.2.6

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

**Material Properties**

**Concrete:**

*Corrosion Classification*  
Environment = "extremely"  
density of slab concrete $\gamma_{\text{slab}} = 0.15 \frac{\text{kip}}{\text{ft}^3}$

*strength of slab concrete* $f_{c,\text{slab}} = 4.5 \text{-ksi}$  
density of beam concrete $\gamma_{\text{beam}} = 0.15 \frac{\text{kip}}{\text{ft}^3}$

*strength of beam concrete* $f_{c,\text{beam}} = 8.5 \text{-ksi}$  
weight of future wearing surface $\text{Weight}_{\text{future.ws}} = 0.015 \frac{\text{kip}}{\text{ft}^2}$

*release beam strength* $f_{c,\text{beam}} = 6 \text{-ksi}$  
type of course aggregate, "Florida" or "Standard"  
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 := if [AggregateType = "Florida", (1.0-2500), 2500]  
*(SDG 1.4.1)*  
AggFactor = 2500

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

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

**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* $t_j = 0.75$  
ratio of tendon modulus to initial beam concrete modulus $n_{pi} := \frac{E_p}{E_{ci}}$  
$$n_p := \frac{E_p}{E_c}$$

7/25/2016  
MainProgram.xmcd v5.0  
2
**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** \( n_{ni} := \frac{E_s}{E_{ci}}, \quad n_{ni} = 6.42 \)
- **ratio of rebar modulus to beam concrete modulus** \( n_m := \frac{E_s}{E_c}, \quad n_m = 5.72 \)
- **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** \( A_{s, long} = 0 \text{ in}^2 \)
- **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.** \( d_{long} = 0 \text{ in} \)
- **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

\[ q := 0 .. (\text{PermitAxles} - 1) \quad qt_{\text{axl}} := 0 .. \text{PermitAxles} \]

\[ \text{PermitAxleLoad}^T = (13.33 \ 53.33 \ 53.33) \text{ kip} \]

\[ \text{PermitAxleSpacing}^T = (0 \ 14 \ 14 \ 0) \text{ ft} \]

**Distribution Factors**

DataMessage = "This is a FSB12x52 Florida Slab Beam design, AASHTO distribution factors used"

- **calculated values:**
  - \( \text{tmp}_g\text{mom} = 0.4 \)
  - \( \text{tmp}_g\text{shear} = 0.53 \)
  - \( \text{tmp}_g\text{mom.fatigue} = 0.24 \)

- **user value overrides (optional):**
  - \( \text{user}_g\text{mom} := 0.288 \)
  - \( \text{user}_g\text{shear} := 0.477 \)
  - \( \text{user}_g\text{mom.fatigue} := 0 \)

- **value check**
  - \( g_{\text{mom}} := \text{if}(\text{user}_g\text{mom} \neq 0, \text{user}_g\text{mom}, \text{tmp}_g\text{mom}) \)
  - \( g_{\text{shear}} := \text{if}(\text{user}_g\text{shear} \neq 0, \text{user}_g\text{shear}, \text{tmp}_g\text{shear}) \)
  - \( g_{\text{mom.fatigue}} := \text{if}(\text{user}_g\text{mom.fatigue} \neq 0, \text{user}_g\text{mom.fatigue}, \text{tmp}_g\text{mom.fatigue}) \)

\[ g_{\text{mom}} = 0.29 \]
\[ g_{\text{shear}} = 0.48 \]
\[ g_{\text{mom.fatigue}} = 0.24 \]
Section Views

Beam Section

Beam Section

Total Slab, Effective Slab, and Beam

feet

feet

slab

effective slab

beam
Non-Composite Dead Load Input:

\[
\begin{align*}
\text{w}_{\text{slab}} &= 0.453 \text{ kip/ft} \\
\text{w}_{\text{beam}} &= 0.543 \text{ kip/ft} \\
\text{w}_{\text{forms}} &= 0 \text{ kip/ft} \\
\text{Add}_\text{w}_{\text{noncomp}} &= 0.0 \text{ kip/ft}
\end{align*}
\]

\textit{additional non composite dead load (positive or negative)}
\textit{note: not saved to data file, may be saved to Mathcad worksheet.}

\[
\begin{align*}
\text{w}_{\text{noncomposite}} &= \text{w}_{\text{slab}} + \text{w}_{\text{beam}} + \text{w}_{\text{forms}} + \text{Add}_\text{w}_{\text{noncomp}} \\
\text{w}_{\text{noncomposite}} &= 0.997 \text{ kip/ft} \\
\text{wb}_{\text{noncomposite}} &= \text{w}_{\text{slab}} + \text{w}_{\text{forms}} + \text{Add}_\text{w}_{\text{noncomp}} \\
\text{wb}_{\text{noncomposite}} &= 0.453 \text{ kip/ft}
\end{align*}
\]

Diaphragms/Point Load Input

\textit{End Diaphragms or Misc. Point Loads over bearing... included in bearing reaction calculation only}

\[
\begin{align*}
\text{EndDiaphragmA} &= 0 \text{ kip} \\
\text{EndDiaphragmE} &= 0 \text{ kip} \\
\text{begin bridge} \\
\text{end bridge}
\end{align*}
\]

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

\[
\begin{align*}
\text{IntDiaphragmB} &= 0 \text{ kip} \\
\text{IntDiaphragmC} &= 0 \text{ kip} \\
\text{IntDiaphragmD} &= 0 \text{ kip} \\
\text{DistB} &= 0 \text{ ft} \\
\text{DistC} &= 0 \text{ ft} \\
\text{DistD} &= 0 \text{ ft}
\end{align*}
\]

Composite Dead Load Input:

\[
\begin{align*}
\text{w}_{\text{future.ws}} &= 0.067 \text{ kip/ft} \\
\text{w}_{\text{barrier}} &= 0.215 \text{ kip/ft} \\
\text{Add}_\text{w}_{\text{comp}} &= 0.0 \text{ kip/ft}
\end{align*}
\]

\textit{additional composite dead load (positive or negative)}
\textit{note: not saved to data file, may be saved to Mathcad worksheet}

\[
\begin{align*}
\text{w}_{\text{composite}} &= \text{w}_{\text{future.ws}} + \text{w}_{\text{barrier}} + \text{Add}_\text{w}_{\text{comp}} \\
\text{w}_{\text{composite}} &= 0.282 \text{ kip/ft} \\
\text{w}_{\text{comp.str}} &= \text{w}_{\text{barrier}} + \text{Add}_\text{w}_{\text{comp}} \\
\text{w}_{\text{comp.str}} &= 0.215 \text{ kip/ft}
\end{align*}
\]
**Release Dead Load Moments and Shear**

Max($M_{release}$) = 102.4 kip-ft  
Max($V_{release}$) = 10.6 kip

**Noncomposite Dead Load Moments and Shear**

Max($M_{dl.non.comp}$) = 177.8 kip-ft  
Max($V_{dl.non.comp}$) = 18.8 kip
Composite Dead Load Moments and Shear

max\( (M_{dl.comp}) = 50.1\text{-kip-ft} \)
max\( (V_{dl.comp}) = 5.3\text{-kip} \)

Distributed Live Load Moments and Shear

max\( (M_{dist.live.pos}) = 194.8\text{-kip-ft} \)
min\( (M_{dist.live.neg}) = -6.7\text{-kip-ft} \)
max\( (V_{dist.live.pos}) = 40.1\text{-kip} \)
max\( (M_{shr.dist.live.pos}) = 179.1\text{-kip-ft} \)

Beam End Reactions... with IM factor only

max\( (M_{dist.live.pos}) = 194.8\text{-kip-ft} \)
min\( (M_{dist.live.neg}) = -6.7\text{-kip-ft} \)
max\( (V_{dist.live.pos}) = 40.1\text{-kip} \)
max\( (M_{shr.dist.live.pos}) = 179.1\text{-kip-ft} \)

Reaction\(_{LL} = 40.97\text{-kip}\)
Reaction\(_{DL} = 24.82\text{-kip}\)
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.

Collapsed Region for Custom Strand Sizes...

Stranded Multiplier

Strand Data and Pattern

Strand Properties

Tendon Layout

\[ \text{SupportLocation}_{\text{release}} = 0 \text{ ft} \]

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")

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

\[ \text{PartialPSforce} := \begin{cases} \text{BeamTypeTog} = \text{"II"}, 20 \text{-kip}, \text{PartialPSforce} \\ \text{otherwise} \end{cases} \quad \text{PartialPSforce} = 40 \text{-kip} \]

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

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

### Release Stresses

#### Location (ft)

#### Prestress Force

<table>
<thead>
<tr>
<th>Location (ft)</th>
<th>( f_{\text{top beam rel}} ) ksi</th>
<th>( f_{\text{bot beam rel}} ) ksi</th>
<th>( f_{\text{fall tension rel}} ) ksi</th>
<th>( f_{\text{fall comp rel}} ) ksi</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>-3</td>
</tr>
<tr>
<td>9.707</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>-3</td>
</tr>
<tr>
<td>19.415</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>-3</td>
</tr>
<tr>
<td>29.122</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>-3</td>
</tr>
<tr>
<td>38.83</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>-3</td>
</tr>
</tbody>
</table>

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

![Graph showing Final Stresses (ksi) Top, Bot., & Allowable](image)

**Stress Checks**

- $\min(CR_{tension,rel}) = 10$
  - Check $tension_{rel} = "OK"$
    - (Release tension)

- $\min(CR_{comp,rel}) = 1.28$
  - Check $comp_{rel} = "OK"$
    - (Release compression)

- $\min(CR_{tension,stage8}) = 10$
  - Check $tension_{stage8} = "OK"$
    - (Service III, PS + DL + LL*0.8)

- $\min(CR_{comp,stage8,c1}) = 1.86$
  - Check $comp_{stage8,c1} = "OK"$
    - (Service I, PS + DL)

- $\min(CR_{comp,stage8,c2}) = 2.14$
  - Check $comp_{stage8,c2} = "OK"$
    - (Service I, PS + DL + LL)

- $\min(CR_{comp,Fatigue}) = 2.71$
  - Check $comp_{Fatigue} = "OK"$
    - (Fatigue I, (PS + DL)*0.5 + 1.5 Fatigue Truck)
**Strand Pattern Checks**

- **CheckPattern0 = "OK"**
  - check 0 - no debonded tendon in outside row

- **CheckPattern1 = "OK"**
  - check 1 - less than 25% debonded tendons total provided that debonding does not occur within the horizontal limits of the web (See SDG 4.3.1)

- **CheckPattern2 = "OK"**
  - check 2 - less than 40% debonded tendons in any row

- **CheckPattern3 = "OK"**
  - check 3 - less than 40% of debonded tendons terminated at same section (LRFD 5.11.4.3)

- **CheckPattern4 = "OK"**
  - check 4 - more than half beam depth debond length (SDG 4.3.1)

**Section and Strand Properties Summary**

- $A_{beam} = 521.75 \text{ in}^2$ - Concrete area of beam
- $I_{beam} = 6355.6223 \text{ in}^4$ - Gross Moment of Inertia of Beam about CG
- $y_{comp} = -3.32 \text{ in}$ - Dist. from top of beam to CG of gross composite section
- $I_{comp} = 23021.7546 \text{ in}^4$ - Gross Moment of Inertia of Composite Section about CG
- $A_{deck} = 352.89 \text{ in}^2$ - Concrete area of deck slab
- $A_{ps} = 4.1 \text{ in}^2$ - total area of strands
- $d_{ps} = 0.6 \text{ in}$ - diameter of Prestressing strand
- $f_{py} = 243 \text{ ksi}$ - tendon yield strength
- $f_{pj} = 203 \text{ ksi}$ - prestress jacking stress
- $L_{shielding} = (0 \text{ ft})$
- $A_{ps,row} = (3.7 \text{ in}^2)$
- $T = (0 \text{ ft})$

**Strand Size and Draped Tendons**

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>-7</td>
<td>-7</td>
<td>-7</td>
<td>-7</td>
<td>-7</td>
<td>-7</td>
<td>-7</td>
<td>-7</td>
<td>-7</td>
<td>-7</td>
</tr>
<tr>
<td>-3</td>
<td>-3</td>
<td>-3</td>
<td>-3</td>
<td>-3</td>
<td>-3</td>
<td>-3</td>
<td>-3</td>
<td>-3</td>
<td>-3</td>
</tr>
</tbody>
</table>

**Debonded Tendons**

- $d_{ps,row} = \text{ in}$
- TotalNumberOfTendons = 19
- NumberOfDebondedTendons = 0
- NumberOfDrapedTendons = 0
- StrandSize = "0.6 in low lax"
- StrandArea = 0.22 in$^2$
- JackingForce_per_strand = 43.94 kip
Section and Strand Properties Summary

Prestress Losses Summary

\[ f_{pj} = 202.5 \text{ ksi} \]
\[ \Delta f_{pE} = 0 \text{ ksi} \]
Note: Elastic shortening losses are zero in concrete stress calculations when using transformed section properties per LRFD 5.9.5.2.3.

\[ \Delta f_{pT} = -21 \text{ ksi} \]
\[ \frac{\Delta f_{pT}}{f_{pj}} = -10.57\% \]

\[ f_{pt} = 181 \text{ ksi} \]
\[ \frac{f_{pt}}{f_{pj}} = 89.43\% \]

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

Check \( f_{pt} = \text"OK" \)

Check \( f_{pt} = \text"OK" \)

Service Limit State Moments

\[ \max(M_{\text{pos.Ser1}}) = 422.6 \text{ kip-ft} \]
\[ \max(M_{\text{pos.Ser3}}) = 383.6 \text{ kip-ft} \]
### 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>1.05</td>
<td>2.08</td>
</tr>
<tr>
<td>2</td>
<td>1.07</td>
<td>1.75</td>
</tr>
<tr>
<td>4</td>
<td>-1</td>
<td>-1.81</td>
</tr>
<tr>
<td>6</td>
<td>1.97</td>
<td>0.98</td>
</tr>
<tr>
<td>8</td>
<td>2.39</td>
<td>0.09</td>
</tr>
</tbody>
</table>

**Prestress Force**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Axial (kip)</th>
<th>Moment (kip*ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release</td>
<td>-874.9</td>
<td>-156.9</td>
</tr>
<tr>
<td>Final (about composite centroid)</td>
<td>-782.4</td>
<td>-134</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 beam (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Beam</td>
<td>517.43</td>
<td>6327.91</td>
<td>-6.37</td>
</tr>
<tr>
<td>Transformed Beam (initial)</td>
<td>544.7</td>
<td>6497.53</td>
<td>-6.48</td>
</tr>
<tr>
<td>Transformed Beam</td>
<td>541.74</td>
<td>6479.7</td>
<td>-6.47</td>
</tr>
<tr>
<td>Composite</td>
<td>901.17</td>
<td>23899.8</td>
<td>-3.39</td>
</tr>
</tbody>
</table>

**Service Moments**

<table>
<thead>
<tr>
<th>Type</th>
<th>Value (kip*ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release</td>
<td>102.4</td>
</tr>
<tr>
<td>Non-composite (includes bm wt.)</td>
<td>177.8</td>
</tr>
<tr>
<td>Composite</td>
<td>50.1</td>
</tr>
<tr>
<td>Distributed Live Load</td>
<td>194.4</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

<table>
<thead>
<tr>
<th>Location in feet</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></td>
<td>&quot;Release&quot;</td>
<td>−0.0673</td>
<td>−0.2276</td>
<td>0.2794</td>
<td>0.4673</td>
</tr>
<tr>
<td></td>
<td>&quot;30 Days&quot;</td>
<td>−0.1791</td>
<td>−0.439</td>
<td>0.4849</td>
<td>0.6901</td>
</tr>
<tr>
<td></td>
<td>&quot;60 Days&quot;</td>
<td>−0.2203</td>
<td>−0.517</td>
<td>0.5643</td>
<td>0.791</td>
</tr>
<tr>
<td></td>
<td>&quot;90 Days&quot;</td>
<td>−0.2417</td>
<td>−0.5576</td>
<td>0.6056</td>
<td>0.8644</td>
</tr>
<tr>
<td></td>
<td>&quot;120 Days&quot;</td>
<td>−0.2549</td>
<td>−0.5824</td>
<td>0.6309</td>
<td>0.9213</td>
</tr>
<tr>
<td></td>
<td>&quot;240 Days&quot;</td>
<td>−0.2788</td>
<td>−0.6277</td>
<td>0.677</td>
<td>1.0645</td>
</tr>
<tr>
<td></td>
<td>&quot;Non-comp DL&quot;</td>
<td>−0.058</td>
<td>0.0496</td>
<td>−0.2569</td>
<td>−0.6343</td>
</tr>
<tr>
<td></td>
<td>&quot;Comp DL&quot;</td>
<td>−0.0051</td>
<td>0.0129</td>
<td>−0.043</td>
<td>−0.1062</td>
</tr>
<tr>
<td></td>
<td>&quot;LL&quot;</td>
<td>−0.0173</td>
<td>0.0441</td>
<td>−0.1467</td>
<td>−0.3554</td>
</tr>
</tbody>
</table>

SlopeData = 

Ultimate Moment Capacity
**Strength Limit State Moments**

\[
\frac{\phi_{mom}}{kip\cdot ft} \cdot (M_{mn})_0
\]

\[
\frac{M_{cr}}{kip\cdot ft}
\]

\[
\frac{M_{pos.Str1}}{kip\cdot ft}
\]

\[
\frac{M_{pos.Str2}}{kip\cdot ft}
\]

\[
\frac{M_{reqd}}{kip\cdot ft}
\]

CRStr.mom := 10  
\[
CR_{Str.mom} := \frac{\phi_{mom} \cdot (M_{mn})_0}{M_{reqd}}
\]  
\((LRFD 5.7.3.3.2)\)  
\[
\min(CR_{Str.mom}) = 1.32
\]

\[
\max(M_{reqd}) = 770.5\text{-kip ft}
\]

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

CheckMomentCapacity = "OK"

---

**Shear Analysis**

**Strength Shear and Associated Moments**

\[
\frac{V_{u,Str}}{kip}
\]

\[
\frac{M_{shr.u,Str}}{kip\cdot ft}
\]

max\(V_{u,Str}\) = 100.9-kip  
max\(M_{shr.u,Str}\) = 623.0-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>6</td>
<td>8</td>
<td>0.8</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.

<table>
<thead>
<tr>
<th>Location</th>
<th>user_s_nspacings</th>
<th>user_NumberSpaces_nspacings</th>
<th>user_A_stirrup_nspacings</th>
<th>interface_factor_nspacings</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 stirrup</td>
<td>-1 in</td>
<td>-1</td>
<td>-1</td>
<td>0.25</td>
</tr>
<tr>
<td>A2 stirrup</td>
<td>-1 in</td>
<td>-1</td>
<td>-1</td>
<td>0.5</td>
</tr>
<tr>
<td>A3 stirrup</td>
<td>-1 in</td>
<td>-1</td>
<td>-1</td>
<td>1</td>
</tr>
<tr>
<td>S1 stirrup</td>
<td>-1 in</td>
<td>-1</td>
<td>-1</td>
<td>1</td>
</tr>
<tr>
<td>S2 stirrup</td>
<td>-1 in</td>
<td>-1</td>
<td>-1</td>
<td>1</td>
</tr>
<tr>
<td>S3 stirrup</td>
<td>-1 in</td>
<td>-1</td>
<td>-1</td>
<td>1</td>
</tr>
<tr>
<td>S4 stirrup</td>
<td>-1 in</td>
<td>-1</td>
<td>-1</td>
<td>1</td>
</tr>
</tbody>
</table>

**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.

<table>
<thead>
<tr>
<th>Location</th>
<th>s</th>
<th>NumberSpaces</th>
<th>A_stirrup</th>
<th>EndCover</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 stirrup</td>
<td>6</td>
<td>8</td>
<td>0.8</td>
<td>6.5 in</td>
</tr>
<tr>
<td>A2 stirrup</td>
<td>18</td>
<td>1</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>A3 stirrup</td>
<td>18</td>
<td>1</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>S1 stirrup</td>
<td>18</td>
<td>1</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>S2 stirrup</td>
<td>18</td>
<td>1</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>S3 stirrup</td>
<td>18</td>
<td>1</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>S4 stirrup</td>
<td>18</td>
<td>4.92</td>
<td>0.8</td>
<td></td>
</tr>
</tbody>
</table>
Computation for Checks

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

### Longitudinal Reinforcement

<table>
<thead>
<tr>
<th>Location</th>
<th>Vlong.reqd</th>
<th>Vlong.prov</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location 0</td>
<td>Vlong.reqd&lt;0.01kip, 100Vlong.prov/Vlong.reqd</td>
<td>(\min{CR_{LongSteel}} = 1.64)</td>
</tr>
</tbody>
</table>
| Location 1 | CR_{LongSteel} = \(\min\{CR_{LongSteel}\} > 1, "OK", "No Good, add steel!"\) | CheckLongSteel = "OK"

### Interface Shear Reinforcement

<table>
<thead>
<tr>
<th>Location</th>
<th>Avf.reqd</th>
<th>Av.prov.interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location 0</td>
<td>(\frac{A_{v.f,reqd}}{\text{in}^2})</td>
<td>(\frac{A_{v.prov.interface}}{\text{in}^2})</td>
</tr>
<tr>
<td>Location 1</td>
<td>(\frac{A_{v.f,reqd}}{\text{in}^2})</td>
<td>(\frac{A_{v.prov.interface}}{\text{in}^2})</td>
</tr>
</tbody>
</table>
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.

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

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

CheckInterfaceSpacing = "OK"

**Anchorage Reinforcement and Maximum Prestressing Force**

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

\[
\text{StandardSplittingReinforcing} := \begin{array}{l}
\text{yes} \\
\text{no}
\end{array}
\]

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**

<table>
<thead>
<tr>
<th>check0 := AcceptAASHTO</th>
<th>check1 := AcceptSDG</th>
<th>check2 := AcceptOntario</th>
</tr>
</thead>
<tbody>
<tr>
<td>check3 := Check_f_pt</td>
<td>check4 := Check_f_pe</td>
<td>check5 := Check_f_tensionrel</td>
</tr>
<tr>
<td>check6 := Check_f_comprel</td>
<td>check7 := Check_f_tensionstage8</td>
<td>check8 := Check_f_compstage8c1</td>
</tr>
<tr>
<td>check9 := Check_f_compstage8c2</td>
<td>check10 := Check_f_compFatigue</td>
<td>check11 := CheckMomentCapacity</td>
</tr>
<tr>
<td>check12 := CheckMaxCapacity</td>
<td>check13 := CheckStirArea</td>
<td>check14 := CheckShearCapacity</td>
</tr>
<tr>
<td>check15 := CheckMinStirArea</td>
<td>check16 := CheckMaxStirSpacing</td>
<td>check17 := CheckLongSteel</td>
</tr>
<tr>
<td>check18 := CheckInterfaceSpacing</td>
<td>check19 := CheckSplittingSteel</td>
<td>check20 := CheckMaxPrestressingForce</td>
</tr>
<tr>
<td>check21 := Check_Pattern0</td>
<td>check22 := Check_Pattern1</td>
<td>check23 := Check_Pattern2</td>
</tr>
<tr>
<td>check24 := Check_Pattern3</td>
<td>check25 := Check_Pattern4</td>
<td>check26 := CheckInterfaceSteel</td>
</tr>
<tr>
<td>check27 := Check_StrandFit</td>
<td>check28 := Check_SDG_1_2_Display2</td>
<td></td>
</tr>
</tbody>
</table>

**Check**

\[
\begin{array}{|c|c|c|c|c|}
\hline
& 0 & 1 & 2 & 3 & 4 \\
\hline
\text{check} & \text{"OK"} & \text{"N.A."} & \text{"N.A."} & \text{"OK"} & \ldots \\
\hline
\end{array}
\]

Link to Note- Checks, 0, 1 & 2

TotalCheck = "OK"

7/25/2016

MainProgram.xmcd v5.0
LRFR Load Rating Analysis

FDOT Maintenance Office Bridge Load Rating Manual

## Load Rating Computations

<table>
<thead>
<tr>
<th>Load Rating Computations</th>
<th>Moment (Strength) or Stress (Service)</th>
<th>Shear (Strength)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LRFR_loadrating</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;Limit State&quot; &quot;DF&quot; &quot;Rating&quot; &quot;Tons&quot; &quot;Dim(ft)&quot; &quot;DF&quot; &quot;Rating&quot; &quot;Tons&quot; &quot;Dim(ft)&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;Strength I(Inv)&quot;</td>
<td>0.29 2.15 &quot;N/A&quot; 18.50 0.48 6.02 &quot;N/A&quot; 4.15</td>
<td></td>
</tr>
<tr>
<td>&quot;Strength I(Op)&quot;</td>
<td>0.29 2.78 &quot;N/A&quot; 18.50 0.48 7.81 &quot;N/A&quot; 4.15</td>
<td></td>
</tr>
<tr>
<td>&quot;Service III(Inv)&quot;</td>
<td>0.29 1.54 &quot;N/A&quot; 18.50 &quot;N/A&quot; &quot;N/A&quot; &quot;N/A&quot; &quot;N/A&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;Service III(Op)&quot;</td>
<td>0.29 2.16 &quot;N/A&quot; 18.50 &quot;N/A&quot; &quot;N/A&quot; &quot;N/A&quot; &quot;N/A&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;Strength II&quot;</td>
<td>0.29 2.09 125.24 16.99 0.48 5.39 323.14 4.15</td>
<td>HL-93</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

### Longitudinal Steel Check:

\[ \text{CR}_{\text{LongSteel}\_\text{HL93}} = 1.73 \quad \text{CR}_{\text{LongSteel}\_\text{Permit}} = 1.64 \]

CheckLongSteel\_loadrating = "OK"

## Write Data Out