LOAD RATING CALCULATIONS

DEVELOPMENTAL DESIGN STANDARDS

FSB SUPERSTRUCTURE PACKAGE

28 FT. CLEAR WIDTH

D30028 - 30 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>2.44</td>
<td>5.58</td>
<td>N/A</td>
<td>2.60</td>
<td>6.62</td>
<td>N/A</td>
</tr>
<tr>
<td>Design Inventory</td>
<td>HL-93</td>
<td>36</td>
<td>1.88</td>
<td>4.31</td>
<td>1.79</td>
<td>2.01</td>
<td>5.10</td>
<td>1.89</td>
</tr>
<tr>
<td>Permit</td>
<td>FL-120</td>
<td>60</td>
<td>2.06</td>
<td>3.78</td>
<td>N/A</td>
<td>2.20</td>
<td>4.49</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>
<th>Span Length (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

Controlling Rating Factor
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}

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
Skew = 0-deg
BeamSpacing = 4.41-ft
禀 integral.ws = 0-in
tslab = 6-in
NumberOfBeams = 7
tslab.delta = 0.22-in
de = 0.83-ft

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

b_e = 4.33-ft  
effective slab width  
LRFD 4.6.2.6

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

Material Properties

Concrete:

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

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

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

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

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

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

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  
\( n_{pi} := \frac{E_p}{E_{ci}} \)

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.** \( A_{\text{slab.rebar}} = 0.31\,\text{in}^2/\text{ft} \)
- **area of mild reinf lumped at centroid of bar locations** \( A_{\text{s,long}} = 0\,\text{in}^2 \)
- **d distance from top of slab to centroid of slab reinf.** \( d_{\text{slab.rebar}} = 2.5\,\text{in} \)
- **d distance from top of beam to centroid of mild flexural tension reinf.** \( d_{\text{long}} = 0\,\text{in} \)
- **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** \( \text{PermitAxles} = 3 \)
- **Indexes used to identify values in the P and d vectors** \( q := 0..(\text{PermitAxles} - 1) \quad qt := 0..\text{PermitAxles} \)
- **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:**
    - \( \text{tmp}_g_{\text{mom}} = 0.4 \)
    - \( \text{tmp}_g_{\text{shear}} = 0.65 \)
    - \( \text{tmp}_g_{\text{mom.fatigue}} = 0.29 \)
  - **user value overrides (optional):**
    - \( \text{user}_g_{\text{mom}} := 0 \)
    - \( \text{user}_g_{\text{shear}} := 0 \)
    - \( \text{user}_g_{\text{mom.fatigue}} := 0 \)
  - **value check**
    - \( g_{\text{mom}} := \text{if}(\text{user}_g_{\text{mom}} \neq 0, \text{user}_g_{\text{mom}} \cdot \text{tmp}_g_{\text{mom}}) \quad g_{\text{mom}} = 0.4 \)
    - \( g_{\text{shear}} := \text{if}(\text{user}_g_{\text{shear}} \neq 0, \text{user}_g_{\text{shear}} \cdot \text{tmp}_g_{\text{shear}}) \quad g_{\text{shear}} = 0.65 \)
    - \( g_{\text{mom.fatigue}} := \text{if}(\text{user}_g_{\text{mom.fatigue}} \neq 0, \text{user}_g_{\text{mom.fatigue}} \cdot \text{tmp}_g_{\text{mom.fatigue}}) \quad g_{\text{mom.fatigue}} = 0.29 \)
Section Views

Beam Section

Beam Type 1

Beam Type 0

Total Slab, Effective Slab, and Beam

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

\[
\begin{align*}
\text{w}_{\text{slab}} &= 0.428 \frac{\text{kip}}{\text{ft}} \\
\text{w}_{\text{beam}} &= 0.543 \frac{\text{kip}}{\text{ft}} \\
\text{w}_{\text{forms}} &= 0 \frac{\text{kip}}{\text{ft}} \\
\text{Add}_{\text{w}_{\text{noncomp}}} &:= 0.0 \frac{\text{kip}}{\text{ft}}
\end{align*}
\]

additional non composite dead load (positive or negative)

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

\[
\begin{align*}
\text{w}_{\text{noncomposite}} &:= \text{w}_{\text{slab}} + \text{w}_{\text{beam}} + \text{w}_{\text{forms}} + \text{Add}_{\text{w}_{\text{noncomp}}} \\
\text{w}_{\text{noncomposite}} &:= 0.972 \frac{\text{kip}}{\text{ft}}
\end{align*}
\]

**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

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

**Composite Dead Load Input:**

\[
\begin{align*}
\text{w}_{\text{future.ws}} &= 0.045 \frac{\text{kip}}{\text{ft}} \\
\text{w}_{\text{barrier}} &= 0.123 \frac{\text{kip}}{\text{ft}} \\
\text{Add}_{\text{w}_{\text{comp}}} &:= 0.0 \frac{\text{kip}}{\text{ft}}
\end{align*}
\]

additional composite dead load (positive or negative)

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

\[
\begin{align*}
\text{w}_{\text{composite}} &:= \text{w}_{\text{future.ws}} + \text{w}_{\text{barrier}} + \text{Add}_{\text{w}_{\text{comp}}} \\
\text{w}_{\text{composite}} &:= 0.168 \frac{\text{kip}}{\text{ft}} \\
\text{w}_{\text{comp.str}} &:= \text{w}_{\text{barrier}} + \text{Add}_{\text{w}_{\text{comp}}} \\
\text{w}_{\text{comp.str}} &:= 0.123 \frac{\text{kip}}{\text{ft}}
\end{align*}
\]
Release Dead Load Moments and Shear

\[
\begin{align*}
\max(M_{\text{release}}) &= 56.5 \text{ kip-ft} \\
\max(V_{\text{release}}) &= 7.8 \text{ kip}
\end{align*}
\]

Noncomposite Dead Load Moments and Shear

\[
\begin{align*}
\max(M_{\text{dl.non.comp}}) &= 93.4 \text{ kip-ft} \\
\max(V_{\text{dl.non.comp}}) &= 13.5 \text{ kip}
\end{align*}
\]
Composite Dead Load Moments and Shear

\[ \text{max}(M_{dl,\text{comp}}) = 16.1 \text{-kip} \cdot \text{ft} \quad \text{max}(V_{dl,\text{comp}}) = 2.3 \text{-kip} \]

Distributed Live Load Moments and Shear

\[ \text{max}(M_{\text{dist.live.pos}}) = 185.4 \text{-kip} \cdot \text{ft} \quad \text{min}(M_{\text{dist.live.neg}}) = -9.4 \text{-kip} \cdot \text{ft} \]
\[ \text{max}(V_{\text{dist.live.pos}}) = 46.9 \text{-kip} \quad \text{max}(M_{\text{shr.dist.live.pos}}) = 173.8 \text{-kip} \cdot \text{ft} \]

\[ \text{Reaction}_{LL} = 48.29 \text{-kip} \quad \text{Reaction}_{DL} = 16.42 \text{-kip} \]

Beam End Reactions... with IM factor only
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

Strand Multiplier
Strand Data and Pattern
Strand Properties

Collapsed Region for Custom Strand Sizes...

Tendon Layout

SupportLocation_{release} = 0·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")**

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

\[ \text{PartialPSforce} := \text{if}\ (\text{BeamTypeTog} = "II", 20 \text{-kip}, \text{PartialPSforce}) \quad \text{PartialPSforce} = 40 \text{-kip} \]

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

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

**Release Stresses**

![Graph of Release Stresses (ksi) Top, Bot., & Allow.]

**Prestress Force**

7/25/2016 MainProgram.xmcd v5.0
Final Stresses

**Stress Checks**

- \( \min(\text{CR}_{f_{\text{tension.rel}}}) = 10 \)  
  Check \( f_{\text{tension.rel}} = \text{"OK"} \)  
  (Release tension)

- \( \min(\text{CR}_{f_{\text{comp.rel}}}) = 1.89 \)  
  Check \( f_{\text{comp.rel}} = \text{"OK"} \)  
  (Release compression)

- \( \min(\text{CR}_{f_{\text{tension.stage8}}}) = 10 \)  
  Check \( f_{\text{tension.stage8}} = \text{"OK"} \)  
  (Service III, PS + DL + LL*0.8)

- \( \min(\text{CR}_{f_{\text{comp.stage8.c1}}}) = 3.35 \)  
  Check \( f_{\text{comp.stage8.c1}} = \text{"OK"} \)  
  (Service I, PS + DL)

- \( \min(\text{CR}_{f_{\text{comp.stage8.c2}}}) = 3.47 \)  
  Check \( f_{\text{comp.stage8.c2}} = \text{"OK"} \)  
  (Service I, PS + DL + LL)

- \( \min(\text{CR}_{f_{\text{comp.Fatigue}}} ) = 4.44 \)  
  Check \( f_{\text{comp.Fatigue}} = \text{"OK"} \)  
  (Fatigue I, (PS + DL)*0.5 + 1.5 Fatigue Truck)
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

CheckPattern$_4$ = "OK"
check 4 - more than half beam depth debond length

*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)

Section and Strand Properties Summary

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

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

$I_{comp} = 22593.3921 \text{ in}^4$
Gross Moment of Inertia Composite Section about CG

$A_{deck} = 333.29 \text{ in}^2$
Concrete area of deck slab

$A_{ps} = 2.8 \text{ in}^2$
total area of strands

$d_{b.ps} = 0.6 \text{ in}$
diameter of Prestressing strand

$min(PrestressType) = 0$
0 - low lax 1 - stress relieved

$f_{py} = 243 \text{ ksi}$
tendon yield strength

$f_{pj} = 203 \text{ ksi}$
prestress jacking stress

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

$A_{ps, row} = (2.4 \ 0.4 \ 0.2) \text{ in}^2$

$d_{ps, row}$

TotalNumberOfTendons = 13
StrandSize = "0.6 in low lax"

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

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

Prestress Losses Summary

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

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

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

\[ \frac{\Delta f_{pT}}{f_{pj}} = -8.88\% \]

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

\[ \frac{f_{pc}}{f_{pj}} = 91.12\% \]

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

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

Service Limit State Moments

\[ \max(M_{\text{pos.Ser1}}) = 294.7 \text{ kip-ft} \]

\[ \max(M_{\text{pos.Ser3}}) = 257.6 \text{ kip-ft} \]
Calculation of Summary Values at Midspan & Stress Comparison with Different Methods

Summary of Values at Midspan

<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>-0.67</td>
<td>-1.54</td>
</tr>
<tr>
<td>2</td>
<td>-0.67</td>
<td>-1.35</td>
</tr>
<tr>
<td>4</td>
<td>-0.62</td>
<td>-1.39</td>
</tr>
<tr>
<td>6</td>
<td>-1.11</td>
<td>-0.97</td>
</tr>
<tr>
<td>8</td>
<td>-1.47</td>
<td>-0.24</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>-611.3</td>
<td>-98.8</td>
</tr>
<tr>
<td>Final (about composite centroid)</td>
<td>-557</td>
<td>-87.2</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>518.73</td>
<td>6336.87</td>
<td>-6.38</td>
</tr>
<tr>
<td>Transformed Beam (initial)</td>
<td>537.78</td>
<td>6453.08</td>
<td>-6.45</td>
</tr>
<tr>
<td>Transformed Beam</td>
<td>535.71</td>
<td>6440.7</td>
<td>-6.44</td>
</tr>
<tr>
<td>Composite</td>
<td>875.35</td>
<td>23268.02</td>
<td>-3.41</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>56.5</td>
</tr>
<tr>
<td>Non-composite (includes bm wt.)</td>
<td>93.4</td>
</tr>
<tr>
<td>Composite</td>
<td>16.1</td>
</tr>
<tr>
<td>Distributed Live Load</td>
<td>184.6</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

- Camber @ release
- Camber @ 30 days
- Camber @ 60 days
- Camber @ 90 days
- Camber @ 120 days
- Camber @ 240 days
- Non-composite dead load deflection
- Composite dead load deflection
- Live load deflection

Location in feet

<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>-0.0341</td>
<td>-0.1164</td>
<td>0.1528</td>
<td>0.2126</td>
</tr>
<tr>
<td></td>
<td>&quot;30 Days&quot;</td>
<td>-0.1073</td>
<td>-0.2407</td>
<td>0.26</td>
<td>0.3064</td>
</tr>
<tr>
<td></td>
<td>&quot;60 Days&quot;</td>
<td>-0.1343</td>
<td>-0.2866</td>
<td>0.3014</td>
<td>0.3489</td>
</tr>
<tr>
<td></td>
<td>&quot;90 Days&quot;</td>
<td>-0.1483</td>
<td>-0.3105</td>
<td>0.3229</td>
<td>0.3797</td>
</tr>
<tr>
<td></td>
<td>&quot;120 Days&quot;</td>
<td>-0.1569</td>
<td>-0.3251</td>
<td>0.3361</td>
<td>0.4037</td>
</tr>
<tr>
<td></td>
<td>&quot;240 Days&quot;</td>
<td>-0.1726</td>
<td>-0.3517</td>
<td>0.3602</td>
<td>0.464</td>
</tr>
<tr>
<td></td>
<td>&quot;non-comp DL&quot;</td>
<td>-0.0217</td>
<td>0.0187</td>
<td>-0.0965</td>
<td>-0.1751</td>
</tr>
<tr>
<td></td>
<td>&quot;comp DL&quot;</td>
<td>-0.0012</td>
<td>0.0031</td>
<td>-0.0104</td>
<td>-0.0189</td>
</tr>
<tr>
<td></td>
<td>&quot;LL&quot;</td>
<td>-0.0128</td>
<td>0.0323</td>
<td>-0.1077</td>
<td>-0.194</td>
</tr>
</tbody>
</table>

Ultimate Moment Capacity
**Strength Limit State Moments**

Nominal and Ultimate Moment Strength (kip-ft)

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

\[ M_{crmn} \] kip ft

\[ M_{pos. Str1 mn} \] kip ft

\[ M_{pos. Str2 mn} \] kip ft

\[ M_{reqdmn} \] kip ft

CRStr.mom \( := 10 \)

\[ CR_{Str.mom} := \frac{\phi_{mom} \left( M_{mn} \right)}{M_{reqd}} \] (LRFD 5.7.3.3.2)

\[ \min(CR_{Str.mom}) = 1.22 \]

\[ \max(M_{reqd}) = 614.6 \text{-kip-ft} \]

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

**Shear Analysis**

**Strength Shear and Associated Moments**

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

\[ V_{u.Strn} \] kip

\[ M_{shr.u.Strn} \] kip-ft

\[ \max(V_{u.Str}) = 104.1 \text{-kip} \]

\[ \max(M_{shr.u.Str}) = 441.3 \text{-kip-ft} \]
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</td>
<td>1</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>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.**

<table>
<thead>
<tr>
<th>A1 stirrup</th>
<th>user_s :=</th>
<th>user_NumberSpaces :=</th>
<th>user_Astirrup :=</th>
<th>interface_factor :=</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.8</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0.8</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0.8</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0.8</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0.8</td>
<td>1</td>
<td></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>spacing</th>
<th>Number of Spaces</th>
<th>area per stirrup</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 stirrup</td>
<td>18</td>
<td>1</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>3.25</td>
<td>0.8</td>
</tr>
</tbody>
</table>

EndCover = 6.5-in
Computation for Checks

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

Longitudinal Reinforcement

\[
\frac{V_{\text{long reqd hs}}}{\text{kip}} = \frac{V_{\text{long prov hs}}}{\text{kip}}
\]

Location_{hs} \quad \text{ft}

\[
\text{CR}_{\text{LongSteel hs}} := \text{if} \left( V_{\text{long reqd hs}} < .01 \text{kip}, 100 \frac{V_{\text{long prov hs}}}{V_{\text{long reqd hs}}} \right) \]

\min(\text{CR}_{\text{LongSteel}}) = 1.49

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

CheckLongSteel = "OK"

Interface Shear Reinforcement

\[
\frac{A_{\text{v reqd hs}}}{\text{in}^2/\text{ft}} = \frac{A_{\text{v prov interface hs}}}{\text{in}^2/\text{ft}}
\]

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.

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

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

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

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)

\[
\text{StandardSplittingReinforcing} := \text{yes}
\]

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

**Summary of Design Checks**

- check\(_0\) := AcceptAASHTO = "OK"
- check\(_2\) := AcceptOntario = "N.A."
- check\(_4\) := Check\(_f_{pc}\) = "OK"
- check\(_6\) := Check\(_f_{comp,rel}\) = "OK"
- check\(_8\) := Check\(_f_{comp,stage8,c1}\) = "OK"
- check\(_10\) := Check\(_f_{comp,Fatigue}\) = "OK"
- check\(_12\) := CheckMaxCapacity = "OK"
- check\(_14\) := CheckShearCapacity = "OK"
- check\(_16\) := CheckMaxStirSpacing = "OK"
- check\(_18\) := CheckInterfaceSpacing = "OK"
- check\(_20\) := CheckMaxPrestressingForce = "OK"
- check\(_1\) := AcceptSDG = "N.A."
- check\(_3\) := Check\(_f_{pt}\) = "OK"
- check\(_5\) := Check\(_f_{tension,rel}\) = "OK"
- check\(_7\) := Check\(_f_{tension,stage8}\) = "OK"
- check\(_9\) := Check\(_f_{comp,stage8,c2}\) = "OK"
- check\(_11\) := CheckMomentCapacity = "OK"
- check\(_13\) := CheckStirArea = "OK"
- check\(_15\) := CheckMinStirArea = "OK"
- check\(_17\) := CheckLongSteel = "OK"
- check\(_19\) := CheckSplittingSteel = "N.A."
- check\(_21\) := CheckPattern\(_0\) = "OK"
- check\(_22\) := CheckPattern\(_1\) = "OK"
- check\(_24\) := CheckPattern\(_3\) = "OK"
- check\(_26\) := CheckInterfaceSteel = "OK"
- check\(_23\) := CheckPattern\(_2\) = "OK"
- check\(_25\) := CheckPattern\(_4\) = "OK"
- check\(_27\) := CheckStrandFit = "OK"
LRFR Load Rating Analysis

FDOT Maintenance Office Bridge Load Rating Manual

Load Rating Computations

Moment (Strength) or Stress (Service)  Shear (Strength)

\[
\text{HL-93} = \begin{cases} 
\text{"Limit State"} & 0.40 \\
\text{"Strength I(Inv)"} & 0.40 \\
\text{"Strength I(Op)"} & 0.40 \\
\text{"Service III(Inv)"} & 0.40 \\
\text{"Service III(Op)"} & 0.40 \\
\text{"Strength II"} & 0.40 \\
\end{cases}
\begin{align*}
\text{"DF"} & : 1.88 \\
\text{"Rating"} & : "N/A" \\
\text{"Tons"} & : 13.32 \\
\text{"DF"} & : 0.65 \\
\text{"Rating"} & : 4.31 \\
\text{"Tons"} & : "N/A" \\
\text{"Dim(ft)"} & : 1.39 \\
\end{align*}
\begin{align*}
\text{"DF"} & : 2.44 \\
\text{"Rating"} & : "N/A" \\
\text{"Tons"} & : 13.32 \\
\text{"DF"} & : 0.65 \\
\text{"Rating"} & : 5.58 \\
\text{"Tons"} & : "N/A" \\
\text{"Dim(ft)"} & : 1.39 \\
\end{align*}
\begin{align*}
\text{"DF"} & : 1.79 \\
\text{"Rating"} & : "N/A" \\
\text{"Tons"} & : 13.32 \\
\text{"DF"} & : "N/A" \\
\text{"Rating"} & : "N/A" \\
\text{"Tons"} & : "N/A" \\
\text{"Dim(ft)"} & : "N/A" \\
\end{align*}
\begin{align*}
\text{"DF"} & : 2.42 \\
\text{"Rating"} & : "N/A" \\
\text{"Tons"} & : 13.32 \\
\text{"DF"} & : "N/A" \\
\text{"Rating"} & : "N/A" \\
\text{"Tons"} & : "N/A" \\
\text{"Dim(ft)"} & : "N/A" \\
\end{align*}
\begin{align*}
\text{"DF"} & : 2.06 \\
\text{"Rating"} & : 123.72 \\
\text{"Tons"} & : 10.54 \\
\text{"DF"} & : 0.65 \\
\text{"Rating"} & : 3.78 \\
\text{"Tons"} & : 227.10 \\
\text{"Dim(ft)"} & : 1.39 \\
\end{align*}

*note: default permit load is FL120 per input worksheet

Longitudinal Steel Check:

\[
\text{CR}_{\text{LongSteel.HL93}} = 1.57 \quad \text{CR}_{\text{LongSteel.Permit}} = 1.39
\]

CheckLongSteelloadrating = "OK"

Write Data Out
**Bridge Layout and Dimensions**

- $L_{beam} = 28.83\text{-ft}$
- Span = 27.75\text{-ft}
- BearingDistance = 6.5\text{-in}
- PadWidth = 8\text{-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 = 4.41 ft  tslab = 6 in  hbuildup = 0 in
Skew = 0 deg  t_integral.ws = 0 in  NumberOfBeams = 7  tslab.delta = 0.22 in
de = 0.83 ft

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

b_e = 4.41 ft  effective slab width  LRFD 4.6.2.6

tslab := if(tslab \leq 0 in, 0.00001 in, tslab)  Provide a minimum slab thickness to prevent divide by zero errors

Material Properties

Concrete:

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

strength of slab concrete  \( f_{c,slab} = 4.5 \, \text{ksi} \)
density of beam concrete  \( \gamma_{beam} = 0.15 \, \text{kip/ft}^3 \)

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

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

weight of future wearing surface  Weight_{future.ws} = 0.015 \, \text{kip/ft}^2

Relative humidity  H = 75

AggregateType = "Florida"  used in distribution calculation

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

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

\[ n_d = 1.23 \]

initial beam concrete modulus of elasticity  \( E_{ci} = 4516 \, \text{ksi} \)

beam concrete modulus of elasticity  \( E_c = 5066 \, \text{ksi} \)

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
\[ n_{pi} := \frac{E_p}{E_{ci}} \]

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**

\[ n_{ni} := \frac{E_s}{E_{ci}} \quad n_{ni} = 6.42 \]

**Ratio of Rebar Modulus to Beam Concrete Modulus**

\[ n_{ni} := \frac{E_s}{E_c} \quad n_{n} = 5.72 \]

**Area per Unit Width of Longitudinal Slab Reinforcement**

$$A_{slab.rebar} = 0.31 \text{ in}^2 \text{ per ft}$$

**Area of Mild Reinforcement Lumped at Centroid of Bar Locations**

$$A_{s.long} = 0 \text{ in}^2$$

**d Distance from Top of Slab to Centroid of Slab Reinforcement**

$$d_{slab.rebar} = 2.5 \text{ in}$$

**d Distance from Top of Beam to Centroid of Mild Flexural Tension Reinforcement**

$$d_{long} = 0 \text{ in}$$

**Size of Bar 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**

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

**Permit Axle Load**

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

**Permit Axle Spacing**

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

**Distribution Factors**

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

**Calculated Values:**

- $\text{tmp}_g_{mom} = 0.38$
- $\text{tmp}_g_{shear} = 0.55$
- $\text{tmp}_g_{mom.fatigue} = 0.25$

**User Value Overrides (Optional):**

- $\text{user}_g_{mom} := 0$
- $\text{user}_g_{shear} := 0$
- $\text{user}_g_{mom.fatigue} := 0$

**Value Check:**

- $g_{mom} := \text{if}(\text{user}_g_{mom} \neq 0, \text{user}_g_{mom} \cdot \text{tmp}_g_{mom})$
- $g_{shear} := \text{if}(\text{user}_g_{shear} \neq 0, \text{user}_g_{shear} \cdot \text{tmp}_g_{shear})$
- $g_{mom.fatigue} := \text{if}(\text{user}_g_{mom.fatigue} \neq 0, \text{user}_g_{mom.fatigue} \cdot \text{tmp}_g_{mom.fatigue})$

7/26/2016 MainProgram.xmcd v5.0
Section Views

Beam Section

Beam Type 1

Beam Type 0

Total Slab, Effective Slab, and Beam

feet

feet
Non-Composite Dead Load Input:

\[ w_{\text{slab}} = 0.442 \frac{\text{kip}}{\text{ft}} \quad w_{\text{beam}} = 0.543 \frac{\text{kip}}{\text{ft}} \quad w_{\text{forms}} = 0 \frac{\text{kip}}{\text{ft}} \]

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

\[ \text{note: not saved to data file, may be saved to Mathcad worksheet.} \]

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

\[ w_{\text{noncomposite}} = 0.985 \frac{\text{kip}}{\text{ft}} \]

\[ w_{\text{noncomposite}} = 0.442 \frac{\text{kip}}{\text{ft}} \]

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**

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

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

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

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

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

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

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

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

\[ \text{Bearing at begin bridge} \]

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

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

Composite Dead Load Input:

\[ w_{\text{future.ws}} = 0.066 \frac{\text{kip}}{\text{ft}} \quad w_{\text{barrier}} = 0.123 \frac{\text{kip}}{\text{ft}} \]

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

\[ \text{note: not saved to data file, may be saved to Mathcad worksheet} \]

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

\[ w_{\text{composite}} = 0.189 \frac{\text{kip}}{\text{ft}} \]

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

\[ w_{\text{comp.str}} = 0.123 \frac{\text{kip}}{\text{ft}} \]
Release Dead Load Moments and Shear

max($M_{\text{release}}$) = 56.5 kip-ft

max($V_{\text{release}}$) = 7.8 kip

Noncomposite Dead Load Moments and Shear

max($M_{\text{dl.non.comp}}$) = 94.8 kip-ft

max($V_{\text{dl.non.comp}}$) = 13.7 kip
Composite Dead Load Moments and Shear

\[
\max(M_{dl,\text{comp}}) = 18.1 \text{kip-ft} \quad \quad \max(V_{dl,\text{comp}}) = 2.6 \text{kip}
\]

Distributed Live Load Moments and Shear

\[
\max(M_{\text{dist.live.pos}}) = 172.7 \text{kip-ft} \
\min(M_{\text{dist.live.neg}}) = -8.7 \text{kip-ft} \
\max(V_{\text{dist.live.pos}}) = 39.6 \text{kip} \
\max(M_{\text{shr dist.live.pos}}) = 161.9 \text{kip-ft} \
\text{Reaction}_{\text{LL}} = 40.82 \text{kip} \
\text{Reaction}_{\text{DL}} = 16.92 \text{kip}
\]
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
  - Custom

- **Recalculate Worksheet**
- **Read Strand Data**

**Collapsed Region for Custom Strand Sizes...**

- **Strand Multiplier**
- **Strand Data and Pattern**
- **Strand Properties**

**Tendon Layout**

![Tendon Layout Diagram]

- Debonded
- Full Length
- Draped
- Beam Surface

**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")

PartialPS\textsubscript{force} = 40-kip \hspace{1cm} \textit{partial prestress total force}

PartialPS\textsubscript{force} := \text{if}(\text{BeamTypeTog} = "II", 20-kip, \text{PartialPS}\textsubscript{force})

PartialPS\textsubscript{location} = 1.4375\text{in} \hspace{1cm} \textit{centroid location of partial prestress from the top of the beam}

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

Section Properties & Strand Profile Properties

Release Stresses

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

\begin{figure}
\centering
\includegraphics[width=\textwidth]{Release_Stresses.png}
\end{figure}

Prestress Force
**Final Stresses**

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

- $f_{\text{top beam stage 8 c1}}$ ksi
- $f_{\text{top slab stage 8 c2}}$ ksi
- $f_{\text{bot beam stage 8 c2}}$ ksi
- $f_{\text{top beam Fatigue I}}$ ksi
- $f_{\text{fall comp case 1}}$ ksi
- $f_{\text{fall comp case 2}}$ ksi
- $f_{\text{fall comp Fatigue I}}$ ksi

**Location ft**

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

**Stress Checks**

- $\min(\text{CR } f_{\text{tension rel}}) = 10$
  - $\text{Check } f_{\text{tension rel}} = "OK"$
  - (Release tension)

- $\min(\text{CR } f_{\text{comp rel}}) = 1.89$
  - $\text{Check } f_{\text{comp rel}} = "OK"$
  - (Release compression)

- $\min(\text{CR } f_{\text{tension stage 8}}) = 10$
  - $\text{Check } f_{\text{tension stage 8}} = "OK"$
  - (Service III, PS + DL + LL*0.8)

- $\min(\text{CR } f_{\text{comp stage 8 c1}}) = 3.29$
  - $\text{Check } f_{\text{comp stage 8 c1}} = "OK"$
  - (Service I, PS + DL)

- $\min(\text{CR } f_{\text{comp stage 8 c2}}) = 3.49$
  - $\text{Check } f_{\text{comp stage 8 c2}} = "OK"$
  - (Service I, PS + DL + LL)

- $\min(\text{CR } f_{\text{comp Fatigue I}}) = 4.56$
  - $\text{Check } f_{\text{comp Fatigue I}} = "OK"$
  - (Fatigue I, (PS + DL)*0.5 + 1.5 Fatigue Truck)
**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

- **CheckPattern\_4 = “OK”**
  - check 4 - more than half beam depth debond length

*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)*

**Section and Strand Properties Summary**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A_{\text{beam}}) = 521.75-in^2</td>
<td>Concrete area of beam</td>
</tr>
<tr>
<td>(y_{\text{comp}} = -3.35)-in</td>
<td>Dist. from top of beam to CG of gross composite section</td>
</tr>
<tr>
<td>(A_{\text{deck}} = 343.93)-in^2</td>
<td>Concrete area of deck slab</td>
</tr>
<tr>
<td>(d_{\text{ps}} = 0.6)-in</td>
<td>diameter of Prestressing strand</td>
</tr>
<tr>
<td>(f_{\text{py}} = 243)-ksi</td>
<td>tendon yield strength</td>
</tr>
<tr>
<td>(f_{\text{pj}} = 203)-ksi</td>
<td>prestress jacking stress</td>
</tr>
<tr>
<td>(L_{\text{shielding}}) (T = (0\ 0\ 0))-ft</td>
<td></td>
</tr>
<tr>
<td>(A_{\text{ps, row}}) (T = (2.4\ 0.4\ 0.2))-in^2</td>
<td></td>
</tr>
</tbody>
</table>

**Strand Details**

<table>
<thead>
<tr>
<th>Row</th>
<th>(d_{\text{ps, row}})</th>
<th>Strand Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0 -9 -9 -9 -9 -9 -9 -9 -9</td>
<td>low lax</td>
</tr>
<tr>
<td>1</td>
<td>1 -7 -7 -7 -7 -7 -7 -7 -7</td>
<td>stress relieved</td>
</tr>
<tr>
<td>2</td>
<td>2 -3 -3 -3 -3 -3 -3 -3 -3</td>
<td></td>
</tr>
</tbody>
</table>

**Additional Calculations**

- TotalNumberOfTendons = 13
- NumberOfDebondedTendons = 0
- NumberOfDrapedTendons = 0
- StrandSize = "0.6 in low lax"
- StrandArea = 0.22-in\^2
- JackingForce\_per\_strand = 43.94-kip
Prestress Losses Summary

- **$f_{pj}$** = 202.5 ksi
  - Check $f_{pt}$ = "OK"

- **$\Delta f_{pES}$** = 0 ksi
  - Note: Elastic shortening losses are zero in concrete stress calculations when using transformed section properties per LRFD 5.9.5.2.3

- **$\Delta f_{pT}$** = -18 ksi
  - $\frac{\Delta f_{pT}}{f_{pj}} = -8.88\%$

- **$f_{pe}$** = 185 ksi
  - $\frac{f_{pe}}{f_{pj}} = 91.12\%$

- 0.8 $f_{py}$ = 194 ksi
  - Check $f_{pe}$ = "OK"

Service Limit State Moments

- **Service I and Service III Moments (kip-ft)**

  - $M_{pos.Ser1_{n}}$ = $285.5\text{-kip}\cdot\text{ft}$
  - $M_{pos.Ser3_{n}}$ = $250.9\text{-kip}\cdot\text{ft}$
**Calculation of Summary Values at Midspan & Stress Comparison with Different Methods**

### Summary of Values at Midspan

<table>
<thead>
<tr>
<th>Stage</th>
<th>&quot;Top of Beam (ksi)&quot;</th>
<th>&quot;Bott of Beam (ksi)&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.67</td>
<td>-1.54</td>
</tr>
<tr>
<td>2</td>
<td>-0.67</td>
<td>-1.35</td>
</tr>
<tr>
<td>4</td>
<td>-0.62</td>
<td>-1.39</td>
</tr>
<tr>
<td>6</td>
<td>-1.13</td>
<td>-0.95</td>
</tr>
<tr>
<td>8</td>
<td>-1.46</td>
<td>-0.27</td>
</tr>
</tbody>
</table>

\[
\text{PrestressForce} = \begin{bmatrix}
\text{"Condition "} & \text{"Axial (kip)"} & \text{"Moment (kip*ft)"} \\
\text{"Release"} & -611.3 & -98.8 \\
\text{"Final (about composite centroid)"} & -557 & -87.2 \\
\end{bmatrix}
\]

<table>
<thead>
<tr>
<th>&quot;Section &quot;</th>
<th>&quot;Area (in^2)&quot;</th>
<th>&quot;Inertia (in^4)&quot;</th>
<th>&quot;distance to centroid from top of bm (in)&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Net Beam &quot;</td>
<td>518.73</td>
<td>6336.87</td>
<td>-6.38</td>
</tr>
<tr>
<td>&quot;Transformed Beam (initial)&quot;</td>
<td>537.78</td>
<td>6453.08</td>
<td>-6.45</td>
</tr>
<tr>
<td>&quot;Transformed Beam &quot;</td>
<td>535.71</td>
<td>6440.7</td>
<td>-6.44</td>
</tr>
<tr>
<td>&quot;Composite &quot;</td>
<td>886.1</td>
<td>23508.11</td>
<td>-3.38</td>
</tr>
</tbody>
</table>

\[
\text{ServiceMoments} = \begin{bmatrix}
\text{"Type "} & \text{"Value (kip*ft)"} \\
\text{"Release"} & 56.5 \\
\text{"Non-composite (includes bm wt.)"} & 94.8 \\
\text{"Composite"} & 18.1 \\
\text{"Distributed Live Load"} & 172 \\
\end{bmatrix}
\]

**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 @ Release, Short Term Camber, & Summary of Slope Data

<table>
<thead>
<tr>
<th>Stage</th>
<th>Change in L @ Top (in)</th>
<th>Change in L @ Bot. (in)</th>
<th>Slope at End (deg)</th>
<th>Midspan defl (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Release&quot;</td>
<td>-0.0341</td>
<td>-0.1164</td>
<td>0.1528</td>
<td>0.2126</td>
</tr>
<tr>
<td>&quot;30 Days&quot;</td>
<td>-0.1073</td>
<td>-0.2407</td>
<td>0.26</td>
<td>0.3064</td>
</tr>
<tr>
<td>&quot;60 Days&quot;</td>
<td>-0.1343</td>
<td>-0.2866</td>
<td>0.3014</td>
<td>0.3489</td>
</tr>
<tr>
<td>&quot;90 Days&quot;</td>
<td>-0.1483</td>
<td>-0.3105</td>
<td>0.3229</td>
<td>0.3797</td>
</tr>
<tr>
<td>&quot;120 Days&quot;</td>
<td>-0.1569</td>
<td>-0.3251</td>
<td>0.3361</td>
<td>0.4037</td>
</tr>
<tr>
<td>&quot;240 Days&quot;</td>
<td>-0.1726</td>
<td>-0.3517</td>
<td>0.3602</td>
<td>0.464</td>
</tr>
<tr>
<td>&quot;non-comp DL&quot;</td>
<td>-0.0224</td>
<td>0.0193</td>
<td>-0.0997</td>
<td>-0.181</td>
</tr>
<tr>
<td>&quot;comp DL&quot;</td>
<td>-0.0014</td>
<td>0.0035</td>
<td>-0.0116</td>
<td>-0.0211</td>
</tr>
<tr>
<td>&quot;LL&quot;</td>
<td>-0.0117</td>
<td>0.0299</td>
<td>-0.0993</td>
<td>-0.1789</td>
</tr>
</tbody>
</table>

Ultimate Moment Capacity
**Strength Limit State Moments**

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

Nominal and Ultimate Moment Strength (kip-ft)

- **Nominal Moment** \( M_{nom} \)
- **Ultimate Moment** \( M_{ult} \)
- **Residual Moment** \( M_{res} \)
- **Required Moment** \( M_{req} \)
- **Critical Moment** \( M_{cr} \)

\[ CR_{mom} := 10 \]

\[ CR_{mom} := \frac{M_{cr}}{M_{req}} \]

(LRFD 5.7.3.3.2) \[ \min (CR_{mom}) = 1.27 \]

Max \( M_{req} \) = 591.5 kip-ft

Check Moment Capacity

- \[ \text{CheckMomentCapacity} := \text{if} (\min (CR_{mom}) > 0.99, "OK", "No Good!") \]
- \( \text{CheckMomentCapacity} = "OK" \)

**Strength Shear and Associated Moments**

Max \( V_{u,Str} \) = 91.4 kip

Max \( M_{shr,Str} \) = 425.3 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 in</td>
<td>1</td>
<td>0.8 in²</td>
</tr>
<tr>
<td>A3 stirrup</td>
<td>18 in</td>
<td>1</td>
<td>0.8 in²</td>
</tr>
<tr>
<td>S1 stirrup</td>
<td>18 in</td>
<td>1</td>
<td>0.8 in²</td>
</tr>
<tr>
<td>S2 stirrup</td>
<td>18 in</td>
<td>1</td>
<td>0.8 in²</td>
</tr>
<tr>
<td>S3 stirrup</td>
<td>18 in</td>
<td>1</td>
<td>0.8 in²</td>
</tr>
<tr>
<td>S4 stirrup</td>
<td>18 in</td>
<td>0</td>
<td>0.8 in²</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.

Locally assigned stirrup sizes and spacings

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

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.

Recalculate Worksheet

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.
Shear Steel Required vs. Provided

Shear Capacity - Required vs. Provided

Location_{\text{shear}}

Location_{\text{hs}}

\text{ft}

\text{ft}

StirLocArea_0

\text{ft}

\text{ft}

Av.req\_hs

\text{in}^2

\text{ft}

Av.prov.shr\_hs

\text{in}^2

\text{ft}

\text{kip}

\phi\text{shr} \ V_{\text{hs}}

\text{kip}

\phi\text{shr} \ V_{\text{prov.shr}}\_hs

\text{kip}

\phi\text{shr} \ V_{\text{ch}}

\text{kip}

\phi\text{shr} \ V_{\text{ph}}

\text{kip}

7/26/2016 MainProgram.xmcd v5.0
Computation for Checks

CheckShearCapacity = "OK"  
CheckMaxShearStress = "OK"

CheckStirArea = "OK"  
CheckMinStirArea = "OK"  
CheckMaxStirSpacing = "OK"

Longitudinal Reinforcement

\[
\text{Longitudinal Steel Required vs. Provided}
\]

\[
\begin{align*}
V_{\text{long,reqd}} &\hspace{1ex} \text{kip} \\
V_{\text{long,prov}} &\hspace{1ex} \text{kip}
\end{align*}
\]

\[
\text{Locationhs} \hspace{1ex} \text{ft}
\]

\[
\text{CR}_{\text{LongSteel,hs}} := \begin{cases} 
\frac{V_{\text{long,reqd}}}{V_{\text{long,prov}}} < 0.01 \text{kip}, & \frac{V_{\text{long,prov}}}{V_{\text{long,reqd}}} \\
\min(\text{CR}_{\text{LongSteel}}) & = 1.64
\end{cases}
\]

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

CheckLongSteel = "OK"

Interface Shear Reinforcement

\[
\text{Interface Steel Required vs Provided}
\]

\[
\begin{align*}
A_{\text{v,reqd}} &\hspace{1ex} \text{in}^2 \hspace{1ex} \text{ft} \\
A_{\text{v,prov.interface}} &\hspace{1ex} \text{in}^2 \hspace{1ex} \text{ft}
\end{align*}
\]

\[
\text{Locationhs} \hspace{1ex} \text{ft}
\]
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 in²/ft, interface steel is required.

CheckInterfaceSpacing = "OK"

CheckInterfaceSteel := if \(\frac{\text{TotalInterfaceSteelProvided}}{\text{TotalInterfaceSteelRequired} + 0.001\text{ in}^2} \geq 1\), "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**

check₀ := AcceptAASHTO = "OK"
check₁ := AcceptSDG = "N.A."
check₂ := AcceptOntario = "N.A."
check₃ := Check_fₚt = "OK"
check₄ := Check_fₚₑ = "OK"
check₅ := Check_fₚₑN = "OK"
check₆ := Check_fₚₑS = "OK"
check₇ := Check_fₚₑc₁ = "OK"
check₈ := Check_fₚₑc₂ = "OK"
check₉ := Check_fₚₑc₃ = "OK"
check₁₀ := Check_fₚₑc₄ = "OK"
check₁₁ := Check_fₚₑc₅ = "OK"
check₁₂ := Check_fₚₑc₆ = "OK"
check₁₃ := Check_fₚₑc₇ = "OK"
check₁₄ := Check_fₚₑc₈ = "OK"
check₁₅ := Check_fₚₑc₉ = "OK"
check₁₆ := Check_fₚₑc₁₀ = "OK"
check₁₇ := Check_fₚₑc₁₁ = "OK"
check₁₈ := Check_fₚₑc₁₂ = "OK"
check₁₉ := Check_fₚₑc₁₃ = "OK"
check₂₀ := Check_fₚₑc₁₄ = "OK"
check₂₁ := Check_fₚₑc₁₅ = "OK"
check₂₂ := Check_fₚₑc₁₆ = "OK"
check₂₃ := Check_fₚₑc₁₇ = "OK"
check₂₄ := Check_fₚₑc₁₈ = "OK"
check₂₅ := Check_fₚₑc₁₉ = "OK"
check₂₆ := Check_fₚₑc₂₀ = "OK"
check₂₇ := Check_fₚₑc₂₁ = "OK"
check₂₈ := Check_fₚₑc₂₂ = "OK"
check₂₉ := Check_fₚₑc₂₃ = "OK"
check₃₀ := Check_fₚₑc₂₄ = "OK"
check₃₁ := Check_fₚₑc₂₅ = "OK"
check₃₂ := Check_fₚₑc₂₆ = "OK"
check₃₃ := Check_fₚₑc₂₇ = "OK"
check₃₄ := Check_fₚₑc₂₈ = "OK"
check₃₅ := Check_fₚₑc₂₉ = "OK"
check₃₆ := Check_fₚₑc₃₀ = "OK"
check₃₇ := Check_fₚₑc₃₁ = "OK"
check₃₈ := Check_fₚₑc₃₂ = "OK"
check₃₉ := Check_fₚₑc₃₃ = "OK"
check₄₀ := Check_fₚₑc₃₄ = "OK"
check₄₁ := Check_fₚₑc₃₅ = "OK"
check₄₂ := Check_fₚₑc₃₆ = "OK"
check₄₃ := Check_fₚₑc₃₇ = "OK"
check₄₄ := Check_fₚₑc₃₈ = "OK"
check₄₅ := Check_fₚₑc₃₉ = "OK"
check₄₆ := Check_fₚₑc₄₀ = "OK"
check₄₇ := Check_fₚₑc₄₁ = "OK"
check₄₈ := Check_fₚₑc₄₂ = "OK"
check₄₉ := Check_fₚₑc₄₃ = "OK"
check₅₀ := Check_fₚₑc₄₄ = "OK"
check₅₁ := Check_fₚₑc₄₅ = "OK"
check₅₂ := Check_fₚₑc₄₆ = "OK"
check₅₃ := Check_fₚₑc₄₇ = "OK"
check₅₄ := Check_fₚₑc₄₈ = "OK"
check₅₅ := Check_fₚₑc₄₉ = "OK"
check₅₆ := Check_fₚₑc₅₀ = "OK"
check₅₇ := Check_fₚₑc₅₁ = "OK"
check₅₈ := Check_fₚₑc₅₂ = "OK"
check₅₉ := Check_fₚₑc₅₃ = "OK"
check₆₀ := Check_fₚₑc₅₄ = "OK"
check₆₁ := Check_fₚₑc₅₅ = "OK"
check₆₂ := Check_fₚₑc₅₆ = "OK"
check₆₃ := Check_fₚₑc₅₇ = "OK"
check₆₄ := Check_fₚₑc₅₈ = "OK"
check₆₅ := Check_fₚₑc₅₉ = "OK"
check₆₆ := Check_fₚₑc₆₀ = "OK"
check₆₇ := Check_fₚₑc₆₁ = "OK"
check₆₈ := Check_fₚₑc₆₂ = "OK"
check₆₉ := Check_fₚₑc₆₃ = "OK"
check₇₀ := Check_fₚₑc₆₄ = "OK"
check₇₁ := Check_fₚₑc₆₅ = "OK"
check₇₂ := Check_fₚₑc₆₆ = "OK"
check₇₃ := Check_fₚₑc₆₇ = "OK"
check₇₄ := Check_fₚₑc₆₈ = "OK"
check₇₅ := Check_fₚₑc₆₉ = "OK"
check₇₆ := Check_fₚₑc₇₀ = "OK"
check₇₇ := Check_fₚₑc₇₁ = "OK"
check₇₈ := Check_fₚₑc₇₂ = "OK"
check₇₉ := Check_fₚₑc₇₃ = "OK"
check₈₀ := Check_fₚₑc₇₄ = "OK"
check₈₁ := Check_fₚₑc₇₅ = "OK"
check₈₂ := Check_fₚₑc₇₆ = "OK"
check₈₃ := Check_fₚₑc₇₇ = "OK"
check₈₄ := Check_fₚₑc₇₈ = "OK"
check₈₅ := Check_fₚₑc₇₉ = "OK"
check₈₆ := Check_fₚₑc₈₀ = "OK"
check₈₇ := Check_fₚₑc₈₁ = "OK"
check₈₈ := Check_fₚₑc₈₂ = "OK"
check₈₉ := Check_fₚₑc₈₃ = "OK"
check₉₀ := Check_fₚₑc₈₄ = "OK"
check₉₁ := Check_fₚₑc₈₅ = "OK"
check₉₂ := Check_fₚₑc₈₆ = "OK"
check₉₃ := Check_fₚₑc₈₇ = "OK"
check₉₄ := Check_fₚₑc₈₈ = "OK"
check₉₅ := Check_fₚₑc₈₉ = "OK"
check₉₆ := Check_fₚₑc₉₀ = "OK"
check₉₇ := Check_fₚₑc₉₁ = "OK"
check₉₈ := Check_fₚₑc₉₂ = "OK"
check₉₉ := Check_fₚₑc₉₃ = "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>2.01</td>
<td>&quot;N/A&quot;</td>
<td>13.32</td>
<td>0.55</td>
<td>5.10</td>
<td>&quot;N/A&quot;</td>
<td>1.39</td>
</tr>
<tr>
<td>Strength I(Op)</td>
<td>0.38</td>
<td>2.60</td>
<td>&quot;N/A&quot;</td>
<td>13.32</td>
<td>0.55</td>
<td>6.62</td>
<td>&quot;N/A&quot;</td>
<td>1.39</td>
</tr>
<tr>
<td>Service III(Inv)</td>
<td>0.38</td>
<td>1.89</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>2.57</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>2.20</td>
<td>132.29</td>
<td>10.54</td>
<td>0.55</td>
<td>4.49</td>
<td>269.27</td>
<td>1.39</td>
</tr>
</tbody>
</table>

**Longitudinal Steel Check:**

\[
\text{Check}_{\text{LongSteel.loadrating}} = \text{"OK"}
\]

7/26/2016  MainProgram.xmcd v5.0  20