

# LOAD RATING CALCULATIONS

DEVELOPMENTAL DESIGN STANDARDS

FSB SUPERSTRUCTURE PACKAGE

24 FT. CLEAR WIDTH

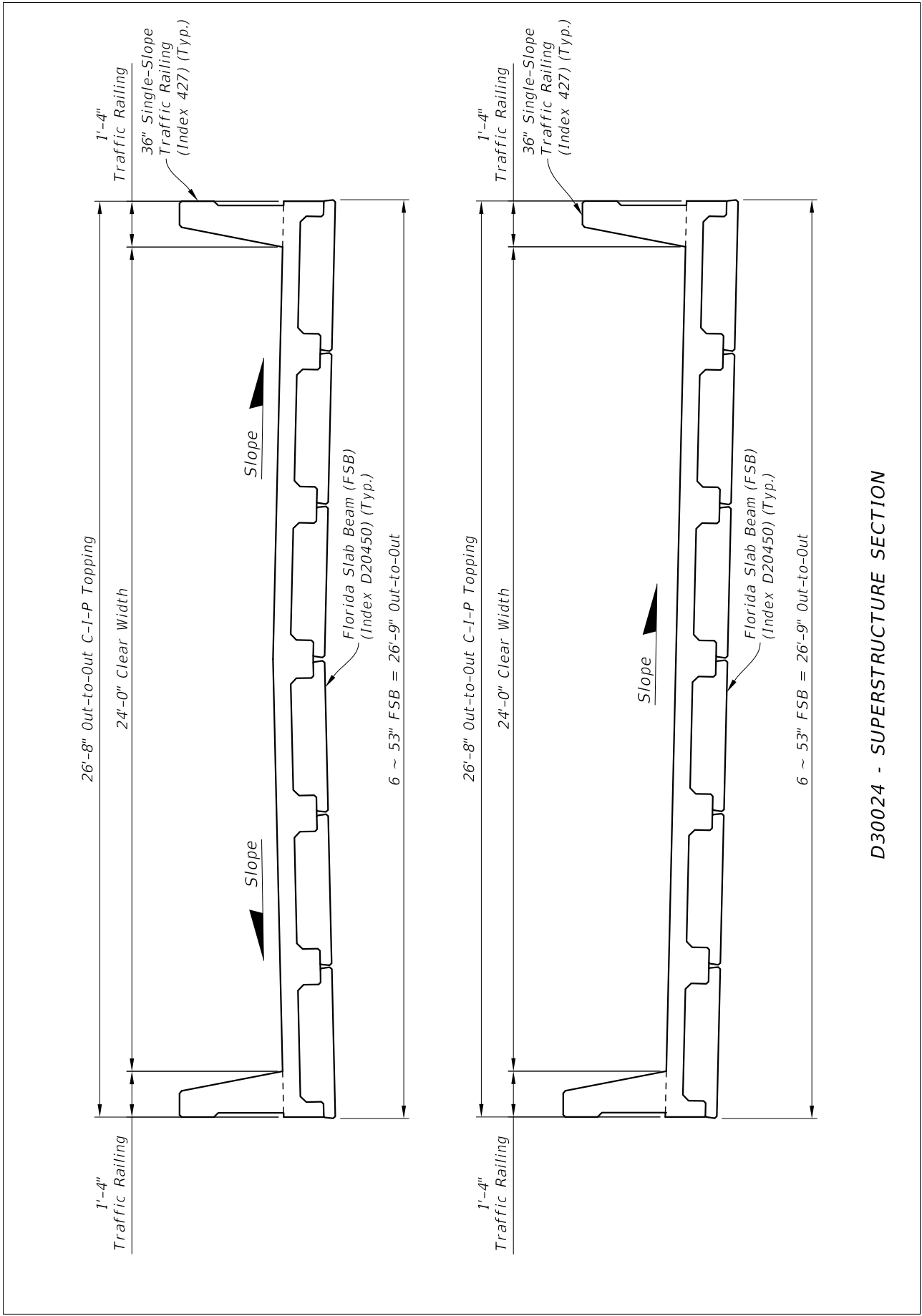
**D30024 - 30 Ft. Span**

Developmental Design Standards - FSB Superstructure Package

<b>D30024</b>	<b>FDOT Bridge Load Rating Summary</b>
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LRFR using Part A		
Int. / Ext. Beam	Ext.	Int.
Span Length (ft)	30	30
<b>Controlling Rating Factor</b>		

Rating Level	Vehicle	Weight (Tons)	Flexure (Strength)	Shear (Strength)	Stress (Service)	Flexure (Strength)	Shear (Strength)	Stress (Service)
Design Operating	HL-93	36	2.31	5.58	N/A	2.47	6.51	N/A
Design Inventory			1.78	4.30	1.68	1.91	5.02	1.78
Permit	FL-120	60	1.96	3.78	N/A	2.10	4.42	N/A



D30024 - SUPERSTRUCTURE SECTION

# LRFD Prestressed Beam Program

Project = "D30024 30 FT, LR Ext. Bm."

DesignedBy = "JRM"

Date = "8-2-2016"

filename = "C:\FDOT Structures\Programs\LRFDBeamV5.0\FSB Data Files\D30024 30 FT LR.dat"

Comment = "FSB12x53 30 ft span"

## Legend

TanHighlight = DataEntry

YellowHighlight = CheckValues

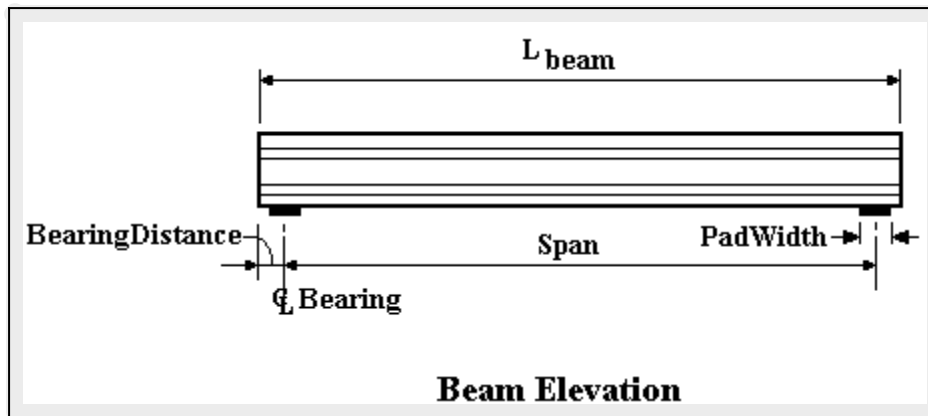
GreyHighlight = UserComments + Graphs

BlackText = ProgramEquations

Maroon Text = Code Reference

Blue Text = Commentary

## Bridge Layout and Dimensions



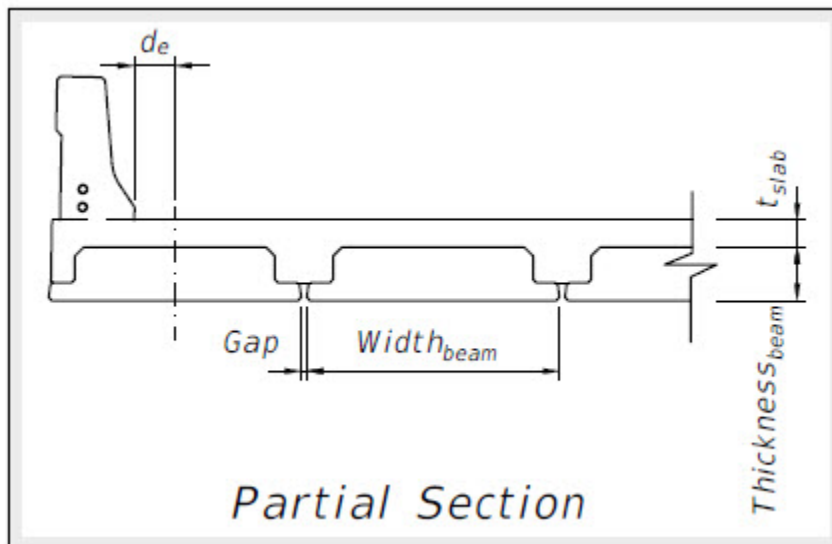
$L_{beam} = 28.83 \cdot ft$

Span = 27.75 · ft

BearingDistance = 6.5 · in

PadWidth = 8 · in

BeamTypeTog = "FSB12x53" [\*These are typically the FDOT designations found in our standards. The user can also create a .ordinate file for a custom shape. In all cases the top of the beam is at the  \$v=0\$  ordinate.\*](#)





## Mild Steel:

mild steel yield strength  $f_y = 60 \cdot \text{ksi}$

mild steel modulus of elasticity  $E_s = 29000 \cdot \text{ksi}$

ratio of rebar modulus to initial beam concrete modulus  $n_{mi} := \frac{E_s}{E_{ci}} \quad n_{mi} = 6.42$

area per unit width of longitudinal slab reinf.  $A_{slab.rebar} = 0.31 \cdot \frac{\text{in}^2}{\text{ft}}$

ratio of rebar modulus to beam concrete modulus  $n_m := \frac{E_s}{E_c} \quad n_m = 5.72$

area of mild reinf lumped at centroid of bar locations  $A_{s,long} = 0 \cdot \text{in}^2$

d distance from top of slab to centroid of slab reinf.  $d_{slab.rebar} = 2.5 \cdot \text{in}$

d distance from top of beam to centroid of mild flexural tension reinf.  $d_{long} = 0 \cdot \text{in}$

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  $q := 0 \dots (\text{PermitAxles} - 1) \quad qt := 0 \dots \text{PermitAxles}$

$\text{PermitAxleLoad}^T = (13.33 \quad 53.33 \quad 53.33) \cdot \text{kip}$

$\text{PermitAxleSpacing}^T = (0 \quad 14 \quad 14 \quad 0) \cdot \text{ft}$

## Distribution Factors

DataMessage = "This is a FSB12x53 Florida Slab Beam design, AASHTO distribution factors used"

calculated values:

$\text{tmp\_g}_{mom} = 0.42 \quad \text{tmp\_g}_{shear} = 0.66 \quad \text{tmp\_g}_{mom.fatigue} = 0.3$

user value overrides (optional):

$\text{user\_g}_{mom} := 0 \quad \text{user\_g}_{shear} := 0 \quad \text{user\_g}_{mom.fatigue} := 0$

value check

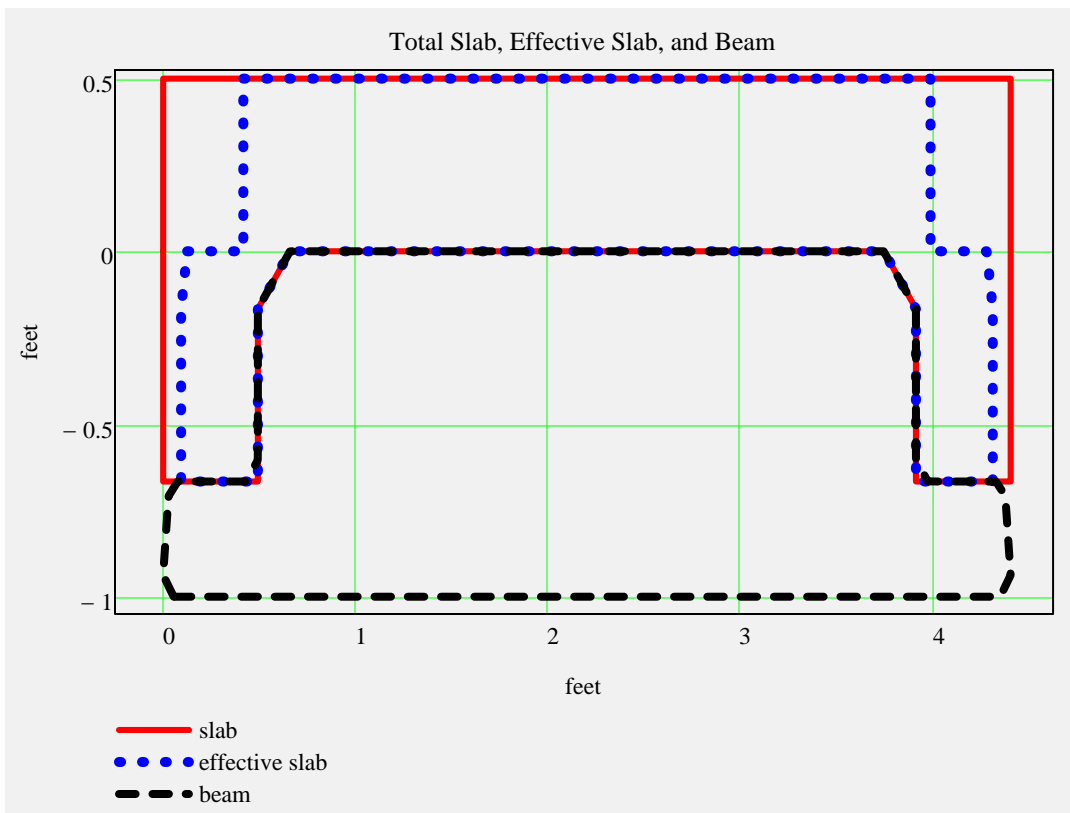
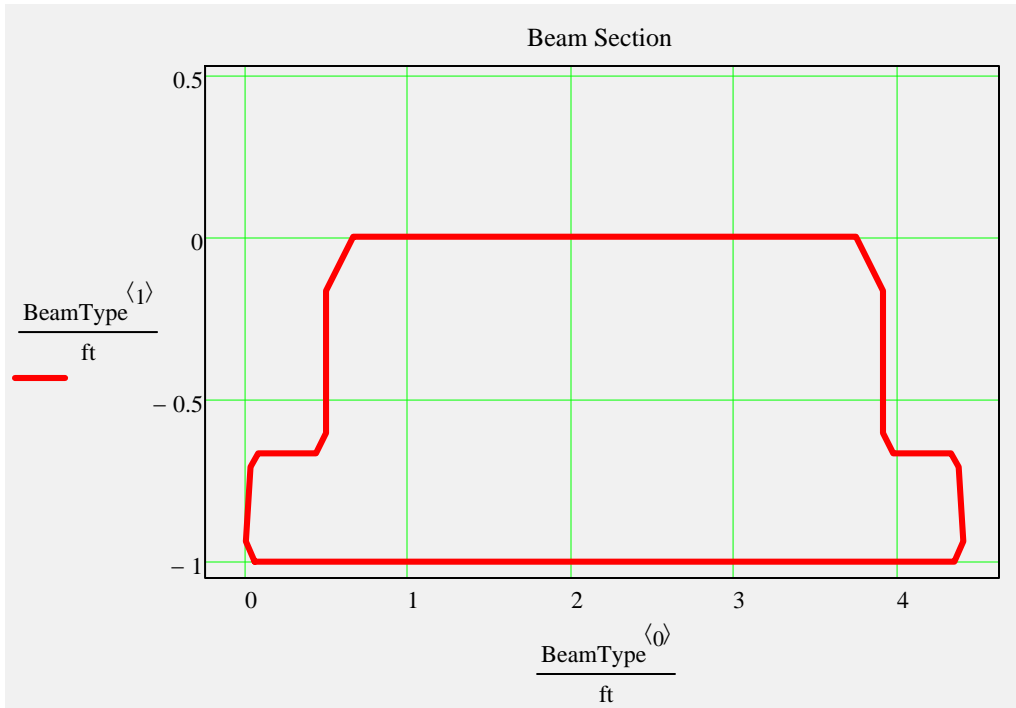
$\text{g}_{mom} := \text{if}(\text{user\_g}_{mom} \neq 0, \text{user\_g}_{mom}, \text{tmp\_g}_{mom}) \quad \text{g}_{mom} = 0.42$

$\text{g}_{shear} := \text{if}(\text{user\_g}_{shear} \neq 0, \text{user\_g}_{shear}, \text{tmp\_g}_{shear}) \quad \text{g}_{shear} = 0.66$

$\text{g}_{mom.fatigue} := \text{if}(\text{user\_g}_{mom.fatigue} \neq 0, \text{user\_g}_{mom.fatigue}, \text{tmp\_g}_{mom.fatigue}) \quad \text{g}_{mom.fatigue} = 0.3$



## Section Views



### Non-Composite Dead Load Input:

$$w_{\text{slab}} = 0.433 \cdot \frac{\text{kip}}{\text{ft}} \quad w_{\text{beam}} = 0.556 \cdot \frac{\text{kip}}{\text{ft}} \quad w_{\text{forms}} = 0 \cdot \frac{\text{kip}}{\text{ft}}$$

$$\text{Add\_}w_{\text{noncomp}} := 0.0 \cdot \frac{\text{kip}}{\text{ft}}$$

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

$$w_{\text{noncomposite}} := w_{\text{slab}} + w_{\text{beam}} + w_{\text{forms}} + \text{Add\_}w_{\text{noncomp}}$$

$$w_{\text{noncomposite}} = 0.989 \cdot \frac{\text{kip}}{\text{ft}}$$

$$w_{\text{bnoncomposite}} := w_{\text{slab}} + w_{\text{forms}} + \text{Add\_}w_{\text{noncomp}}$$

$$w_{\text{bnoncomposite}} = 0.433 \cdot \frac{\text{kip}}{\text{ft}}$$

### 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

$$\text{EndDiaphragmA} := 0 \cdot \text{kip} \quad \text{begin bridge}$$

$$\text{IntDiaphragmB} := 0 \cdot \text{kip}$$

input load is per beam

$$\text{DistB} := 0 \cdot \text{ft}$$

$$\text{EndDiaphragmE} := 0 \cdot \text{kip} \quad \text{end bridge}$$

$$\text{IntDiaphragmC} := 0 \cdot \text{kip}$$

Longitudinal Distance B, C, & D - Measured from CL Bearing at begin bridge

$$\text{DistC} := 0 \cdot \text{ft}$$

$$\text{IntDiaphragmD} := 0 \cdot \text{kip}$$

$$\text{DistD} := 0 \cdot \text{ft}$$



### Composite Dead Load Input:

$$w_{\text{future.ws}} = 0.046 \cdot \frac{\text{kip}}{\text{ft}} \quad w_{\text{barrier}} = 0.143 \cdot \frac{\text{kip}}{\text{ft}}$$

$$\text{Add\_}w_{\text{comp}} := 0.0 \cdot \frac{\text{kip}}{\text{ft}}$$

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

$$w_{\text{composite}} := w_{\text{future.ws}} + w_{\text{barrier}} + \text{Add\_}w_{\text{comp}}$$

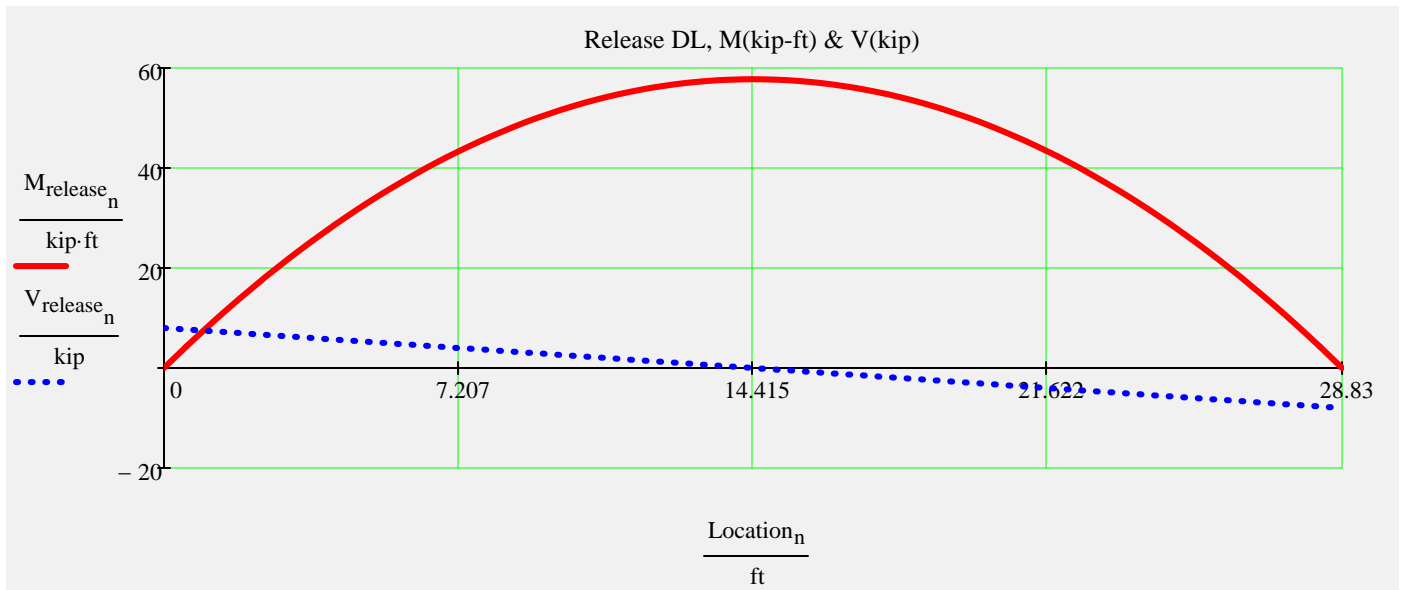
$$w_{\text{composite}} = 0.189 \cdot \frac{\text{kip}}{\text{ft}}$$

$$w_{\text{comp.str}} := w_{\text{barrier}} + \text{Add\_}w_{\text{comp}}$$

$$w_{\text{comp.str}} = 0.143 \cdot \frac{\text{kip}}{\text{ft}}$$



## Release Dead Load Moments and Shear

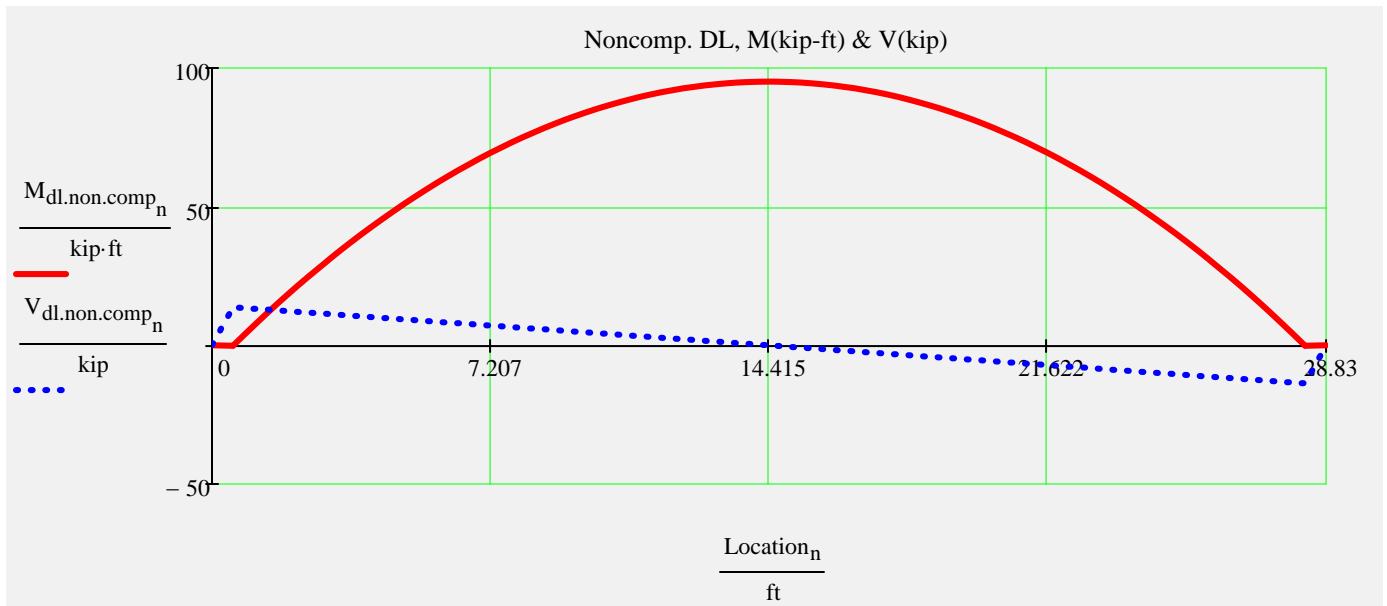


$$\max(M_{\text{release}}) = 57.8 \cdot \text{kip} \cdot \text{ft}$$

$$\max(V_{\text{release}}) = 8 \cdot \text{kip}$$



## Noncomposite Dead Load Moments and Shear

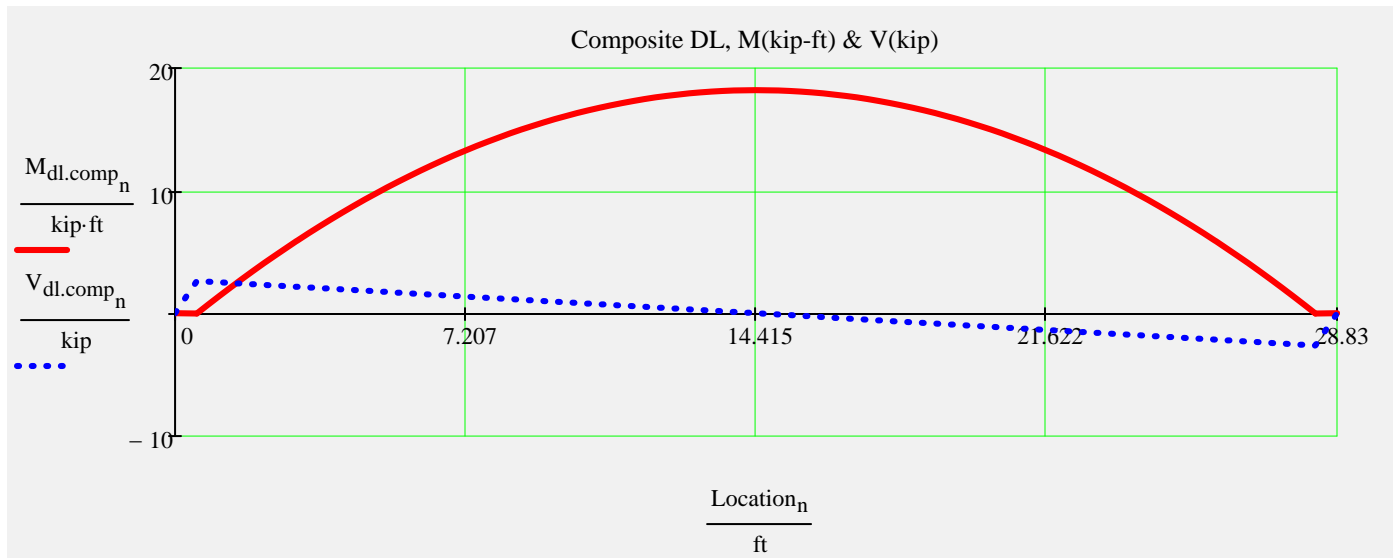


$$\max(M_{\text{dl.non.comp}}) = 95.1 \cdot \text{kip} \cdot \text{ft}$$

$$\max(V_{\text{dl.non.comp}}) = 13.7 \cdot \text{kip}$$



## Composite Dead Load Moments and Shear

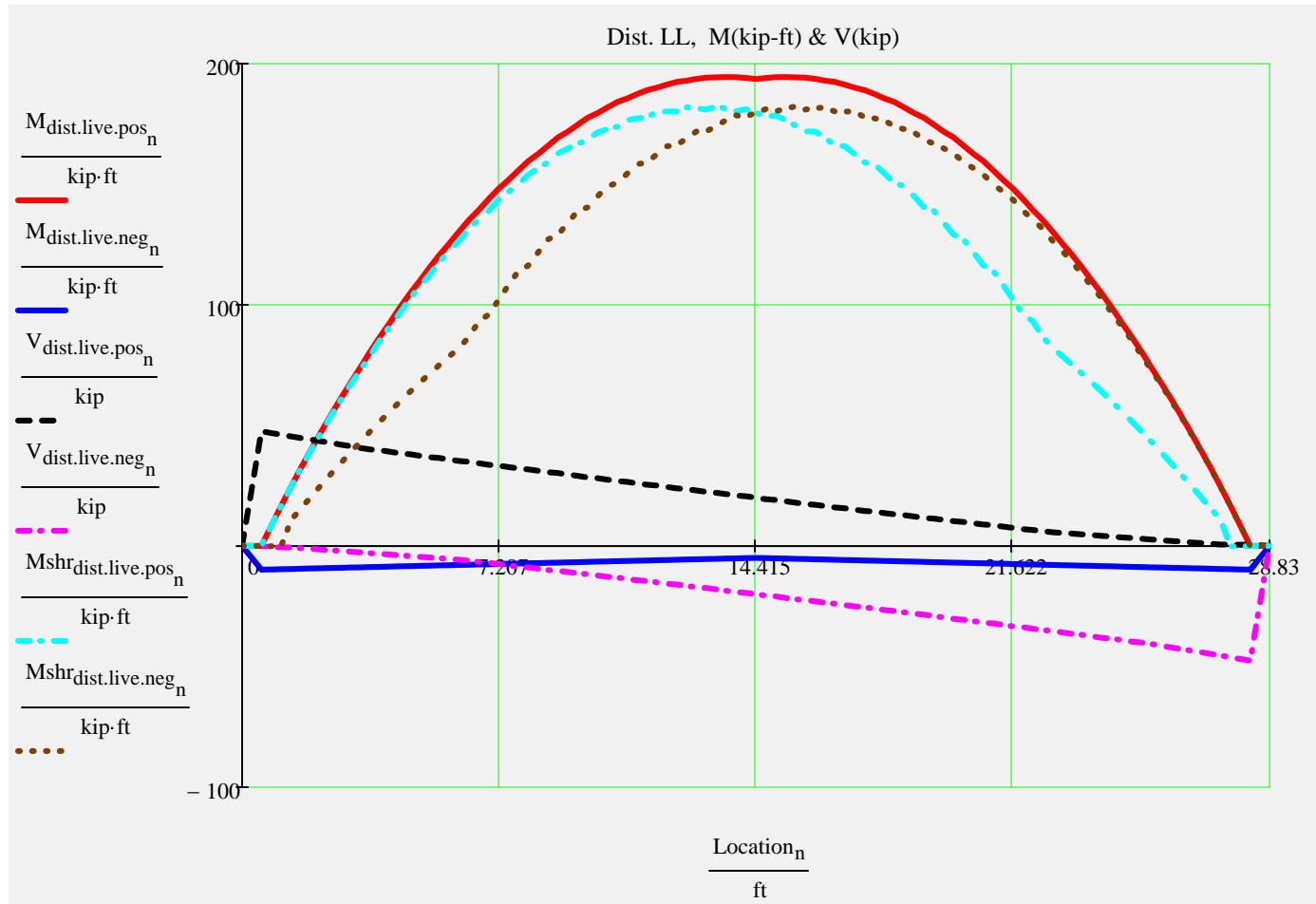


$$\max(M_{dl.comp}) = 18.2 \cdot \text{kip} \cdot \text{ft}$$

$$\max(V_{dl.comp}) = 2.6 \cdot \text{kip}$$



## Distributed Live Load Moments and Shear



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

$$\max(M_{dist.live.pos}) = 194.4 \cdot \text{kip} \cdot \text{ft}$$

$$\min(M_{dist.live.neg}) = -9.8 \cdot \text{kip} \cdot \text{ft}$$

$$\text{Reaction}_{LL} = 48.95 \cdot \text{kip}$$

$$\max(V_{dist.live.pos}) = 47.5 \cdot \text{kip}$$

$$\max(Mshr_{dist.live.pos}) = 182.3 \cdot \text{kip} \cdot \text{ft}$$

$$\text{Reaction}_{DL} = 16.98 \cdot \text{kip}$$

## Prestress Strand Layout Input

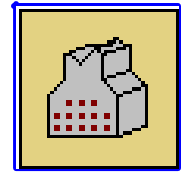
### Instructions:

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 :=

### Strand Pattern Generator:



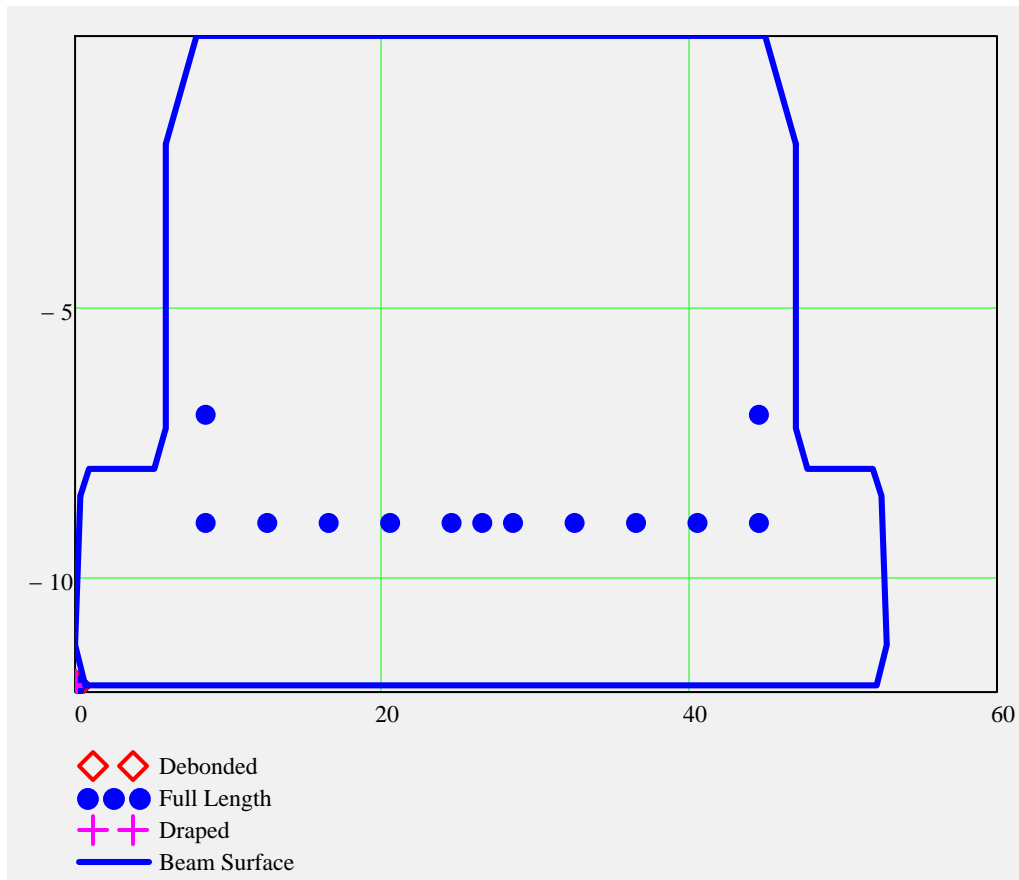
### Collapsed Region for Custom Strand Sizes...

▾ Strand Multiplier

▾ Strand Data and Pattern

▾ Strand Properties

## Tendon Layout



SupportLocation<sub>release</sub> ≡ 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")

PartialPS<sub>force</sub> ≡ 40·kip *partial prestress total force*

PartialPS<sub>force</sub> := if (BeamTypeTog = "II", 20·kip, PartialPS<sub>force</sub>)

PartialPS<sub>force</sub> = 40·kip

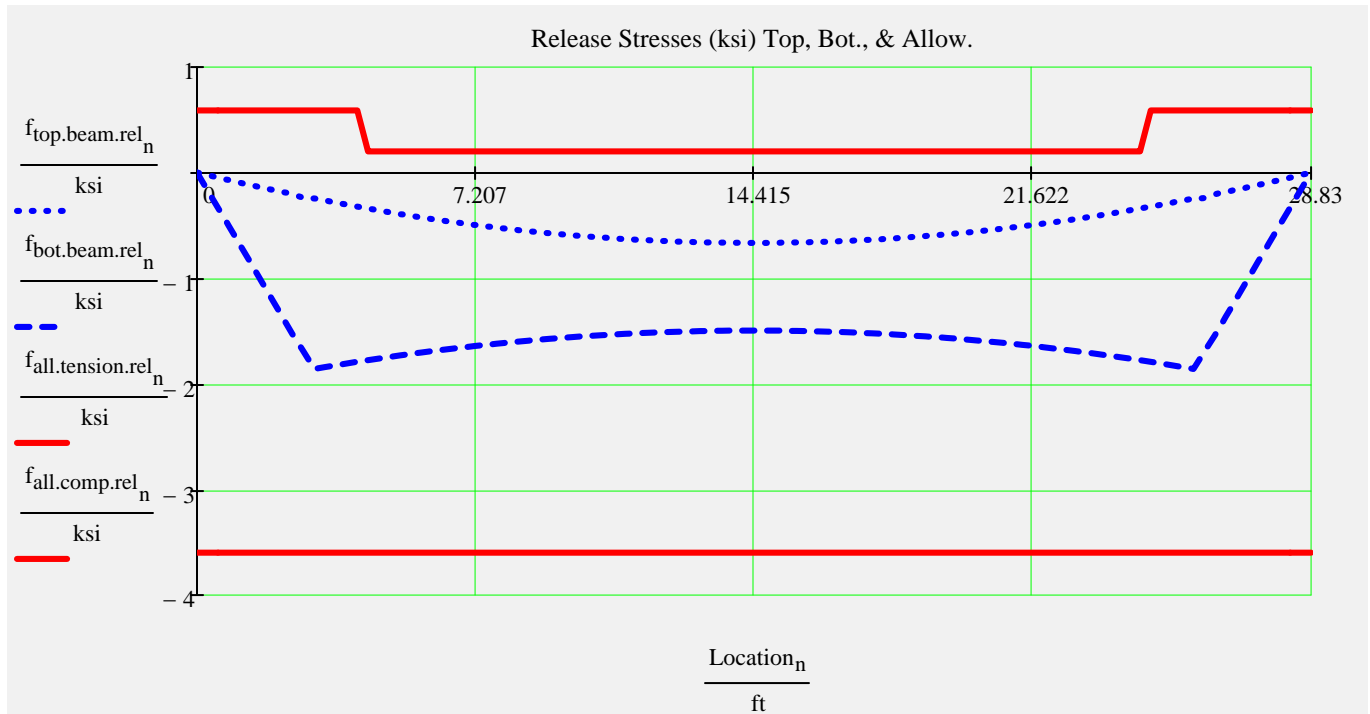
PartialPS<sub>location</sub> ≡ 1.4375in *centroid location of partial prestress from the top of the beam*

PartialPS<sub>location</sub> :=  $\begin{cases} 2.4375\cdot\text{in} & \text{if BeamTypeTog} = \text{"II"} \\ 3\cdot\text{in} & \text{if substr(BeamTypeTog, 0, 5)} = \text{"FSB12"} \\ 2\cdot\text{in} & \text{if substr(BeamTypeTog, 0, 5)} = \text{"FSB15"} \\ 3\cdot\text{in} & \text{if substr(BeamTypeTog, 0, 5)} = \text{"FSB18"} \\ \text{PartialPS}_{\text{location}} & \text{otherwise} \end{cases}$

PartialPS<sub>location</sub> = 3·in

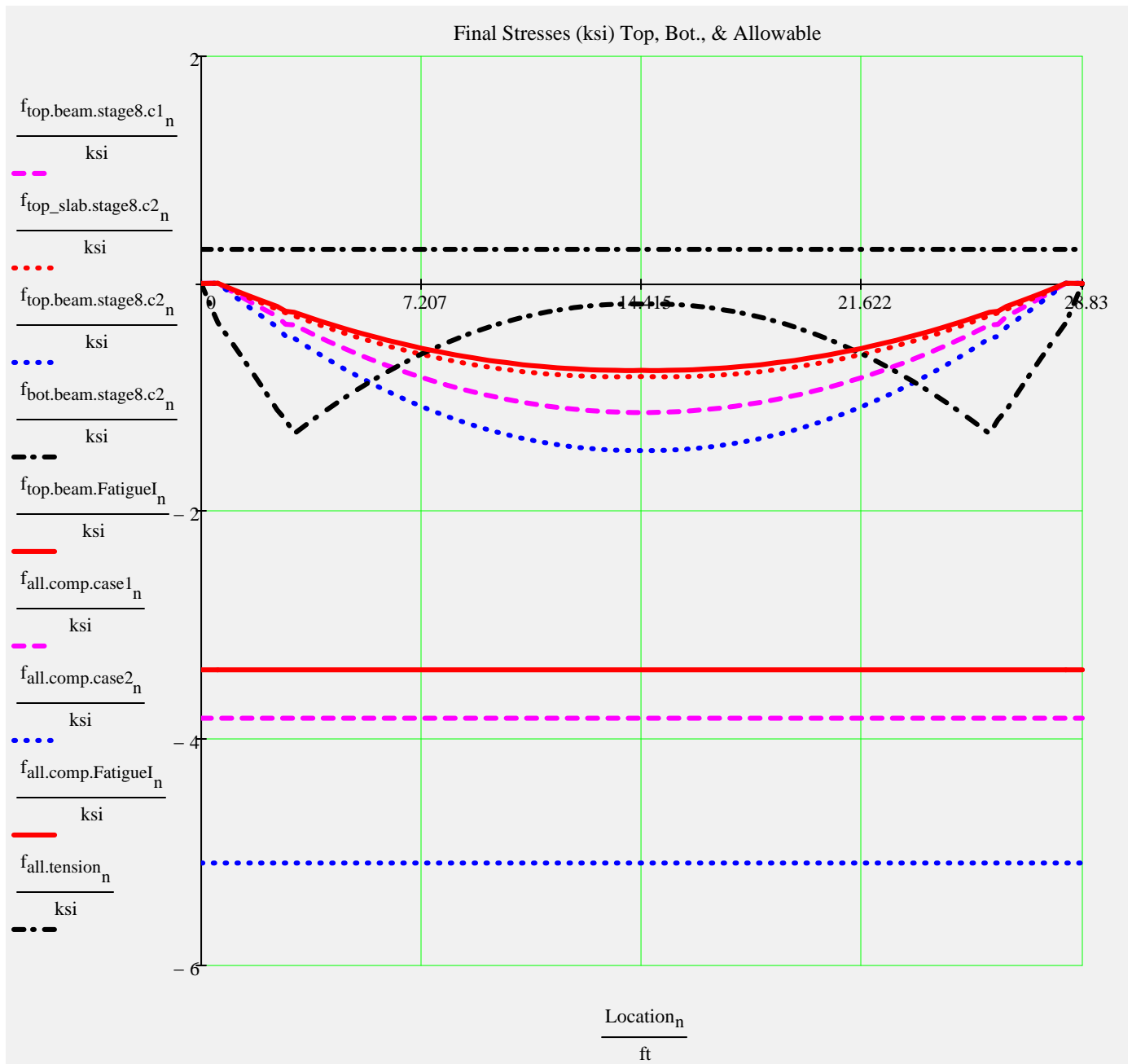
▢ Section Properties & Strand Profile Properties

### Release Stresses



▢ Prestress Force

## Final Stresses



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

#### Stress Checks

$$\min(CR_{f_{tension.rel}}) = 10$$

Check\_  $f_{tension.rel}$  = "OK"

[\(Release tension\)](#)

$$\min(CR_{f_{comp.rel}}) = 1.93$$

Check\_  $f_{comp.rel}$  = "OK"

[\(Release compression\)](#)

$$\min(CR_{f_{tension.stage8}}) = 10$$

Check\_  $f_{tension.stage8}$  = "OK"

[\(Service III, PS + DL + LL\\*0.8\)](#)

$$\min(CR_{f_{comp.stage8.c1}}) = 3.37$$

Check\_  $f_{comp.stage8.c1}$  = "OK"

[\(Service I, PS + DL\)](#)

$$\min(CR_{f_{comp.stage8.c2}}) = 3.47$$

Check\_  $f_{comp.stage8.c2}$  = "OK"

[\(Service I, PS + DL + LL\)](#)

$$\min(CR_{f_{comp.FatigueI}}) = 4.44$$

Check\_  $f_{comp.FatigueI}$  = "OK"

[\(Fatigue I, \(PS + DL\)\\*0.5 + 1.5 Fatigue Truck\)](#)

## Strand Pattern Checks

CheckPattern<sub>0</sub> = "OK"

**check 0** - no debonded tendon in outside row

CheckPattern<sub>1</sub> = "OK"

**check 1** - less than 25% debonded tendons total

*\*Note: Check 1 may be less than 30% provided that debonding does not occur within the horizontal limits of the web (See SDG 4.3.1)*

CheckPattern<sub>2</sub> = "OK"

**check 2** - less than 40% debonded tendons in any row

CheckPattern<sub>3</sub> = "OK"

**check 3** - less than 40% of debonded tendons terminated at same section

*(LRFD 5.11.4.3)*

CheckPattern<sub>4</sub> = "OK"

**check 4** - more than half beam depth debond length

*(SDG 4.3.1)*

### Section and Strand Properties Summary

## Section and Strand Properties Summary

$$A_{\text{beam}} = 533.75 \cdot \text{in}^2$$

Concrete area of beam

$$I_{\text{beam}} = 6501.409 \cdot \text{in}^4$$

Gross Moment of Inertia of Beam about CG

$$y_{\text{comp}} = -3.38 \cdot \text{in}$$

Dist. from top of beam to CG of gross composite section

$$I_{\text{comp}} = 23001.1148 \cdot \text{in}^4$$

Gross Moment of Inertia Composite Section about CG

$$A_{\text{deck}} = 336.74 \cdot \text{in}^2$$

Concrete area of deck slab

$$A_{\text{ps}} = 2.8 \cdot \text{in}^2$$

total area of strands

$$d_{\text{b,ps}} = 0.6 \cdot \text{in}$$

diameter of Prestressing strand

$$\text{min}(\text{PrestressType}) = 0$$

0 - low lax 1 - stress relieved

$$f_{\text{py}} = 243 \cdot \text{ksi}$$

tendon yield strength

$$f_{\text{pj}} = 203 \cdot \text{ksi}$$

prestress jacking stress

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

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

	0	1	2	3	4	5	6	7	8	9		
$d_{\text{ps,row}} =$	0	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	·in
	1	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7	
	2	-3	-3	-3	-3	-3	-3	-3	-3	-3	...	

TotalNumberOfTendons = 13

StrandSize = "0.6 in low lax"

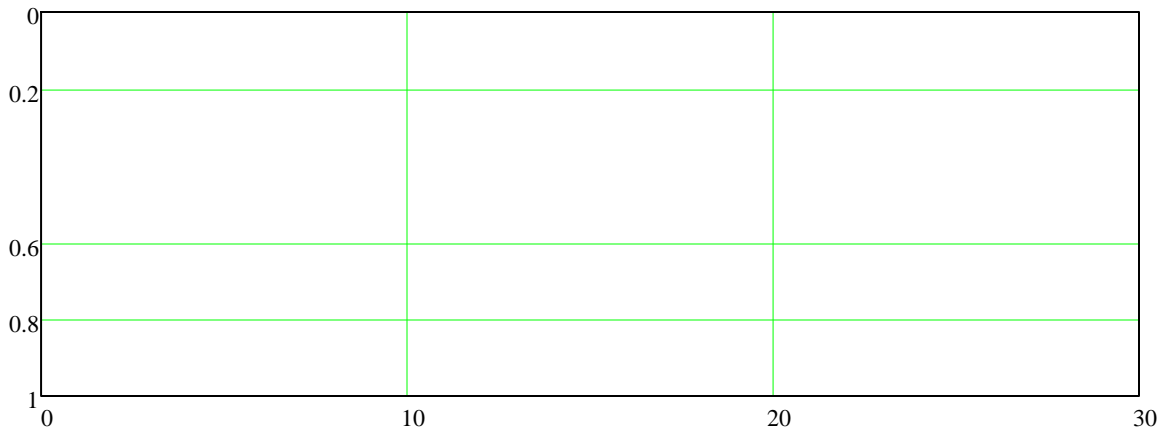
NumberOfDebondedTendons = 0

StrandArea =  $0.22 \cdot \text{in}^2$

NumberOfDrapedTendons = 0

JackingForce<sub>per.strand</sub> =  $43.94 \cdot \text{kip}$

Location of Depressed Strands



Section and Strand Properties Summary

**Prestress Losses Summary**

$f_{pj} = 202.5 \cdot \text{ksi}$

Check\_ $f_{pt}$  = "OK"

$\Delta f_{pES} = 0 \cdot \text{ksi}$

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

$\Delta f_{pT} = -18 \cdot \text{ksi}$

$\frac{\Delta f_{pT}}{f_{pj}} = -8.79 \cdot \%$

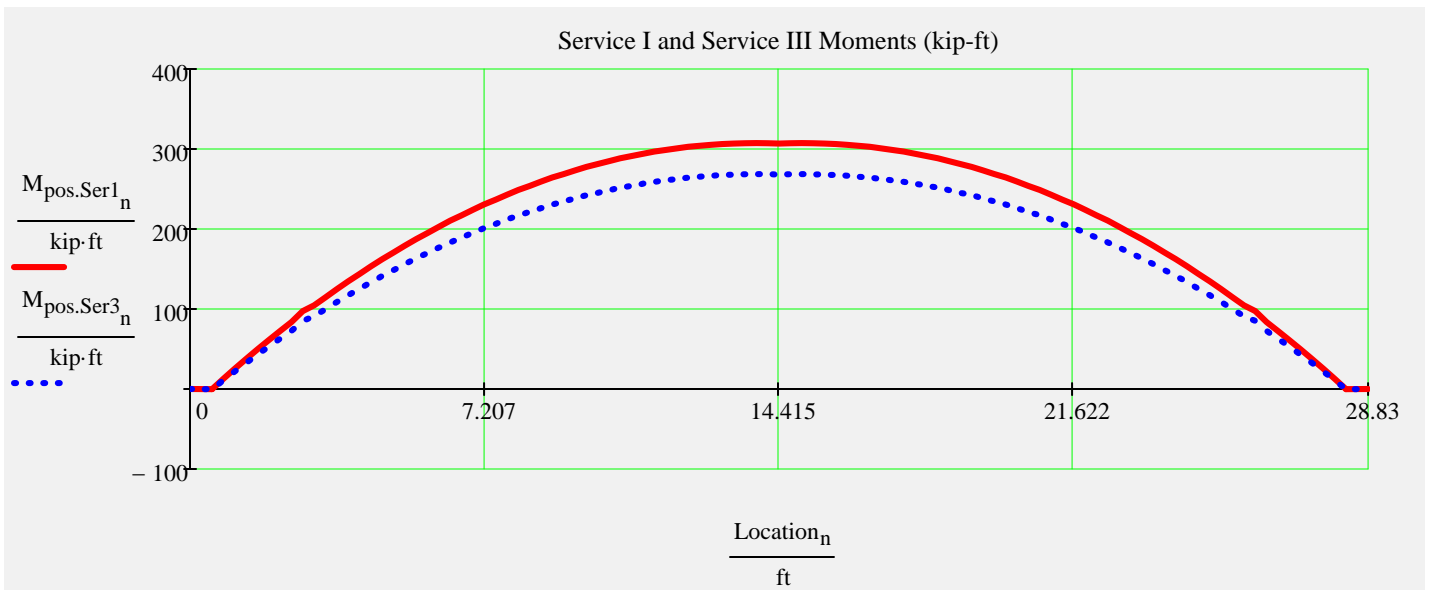
$f_{pe} = 185 \cdot \text{ksi}$

$\frac{f_{pe}}{f_{pj}} = 91.21 \cdot \%$

$0.8 \cdot f_{py} = 194 \cdot \text{ksi}$

Check\_ $f_{pe}$  = "OK"

**Service Limit State Moments**



$\max(M_{\text{pos.Ser1}}) = 307.4 \cdot \text{kip} \cdot \text{ft}$

$\max(M_{\text{pos.Ser3}}) = 268.6 \cdot \text{kip} \cdot \text{ft}$

## Summary of Values at Midspan

$$\text{Stresses} = \begin{pmatrix} \text{"Stage"} & \text{"Top of Beam (ksi)} & \text{"Bott of Beam (ksi)} \\ 1 & -0.67 & -1.5 \\ 2 & -0.67 & -1.31 \\ 4 & -0.62 & -1.36 \\ 6 & -1.1 & -0.94 \\ 8 & -1.47 & -0.18 \end{pmatrix}$$

$$\text{PrestressForce} = \begin{pmatrix} \text{"Condition"} & \text{"Axial (kip)} & \text{"Moment (kip*ft)} \\ \text{"Release"} & -611.3 & -99.3 \\ \text{"Final (about composite centroid)} & -557.5 & -87.7 \end{pmatrix}$$

$$\text{Properties} = \begin{pmatrix} \text{"Section"} & \text{"Area (in^2)} & \text{"Inertia (in^4)} & \text{"distance to centroid from top of bm (in)} \\ \text{"Net Beam"} & 530.73 & 6482.56 & -6.37 \\ \text{"Transformed Beam (initial)"} & 549.78 & 6599.43 & -6.44 \\ \text{"Transformed Beam"} & 547.71 & 6586.97 & -6.43 \\ \text{"Composite"} & 890.9 & 23680.64 & -3.41 \end{pmatrix}$$

$$\text{ServiceMoments} = \begin{pmatrix} \text{"Type"} & \text{"Value (kip*ft)} \\ \text{"Release"} & 57.8 \\ \text{"Non-composite (includes bm wt.)"} & 95.1 \\ \text{"Composite"} & 18.2 \\ \text{"Distributed Live Load"} & 193.6 \end{pmatrix}$$

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

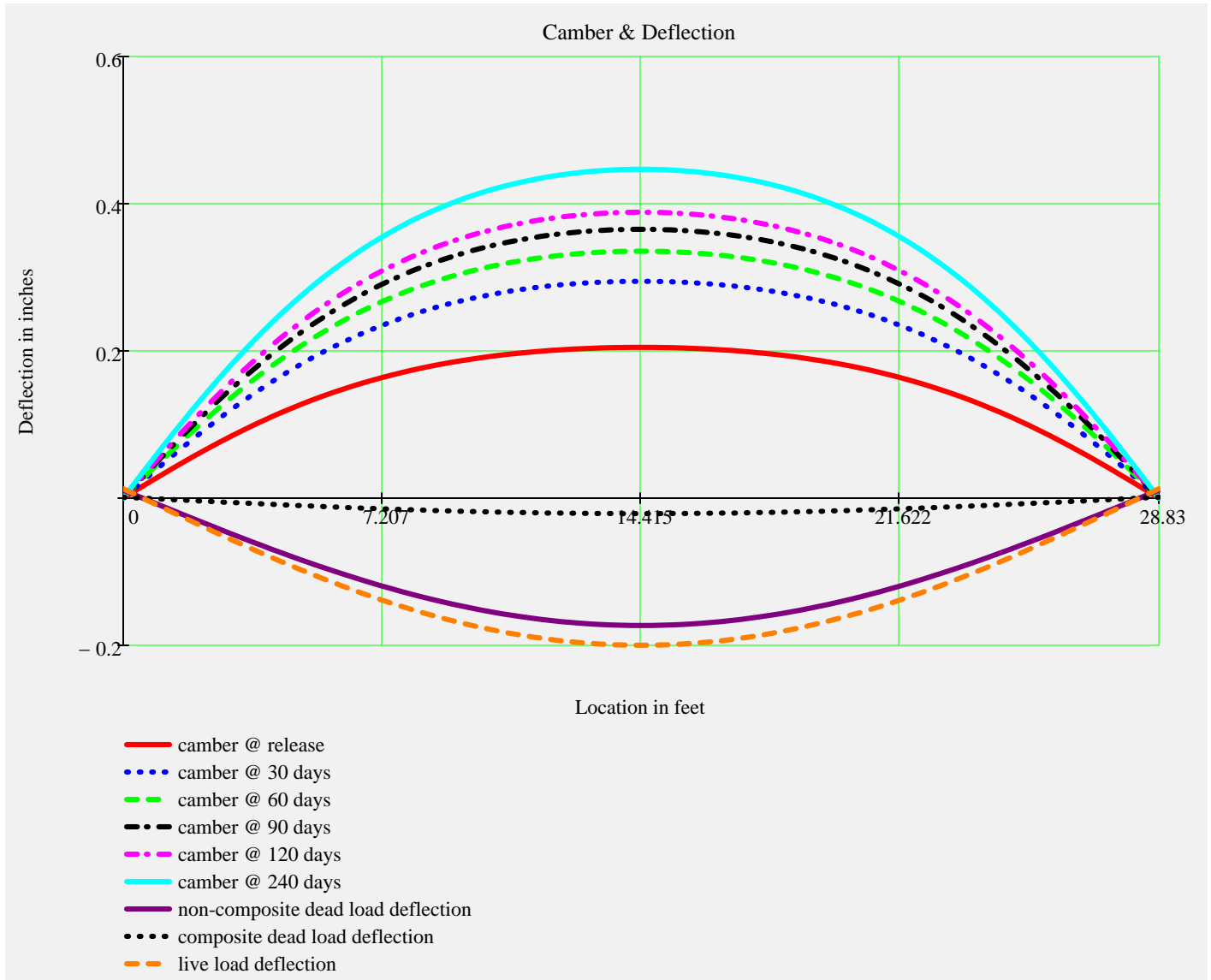
Stage 4 ---> Same as stage 2 with supports changed from the end of the beam to the bearing locations

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



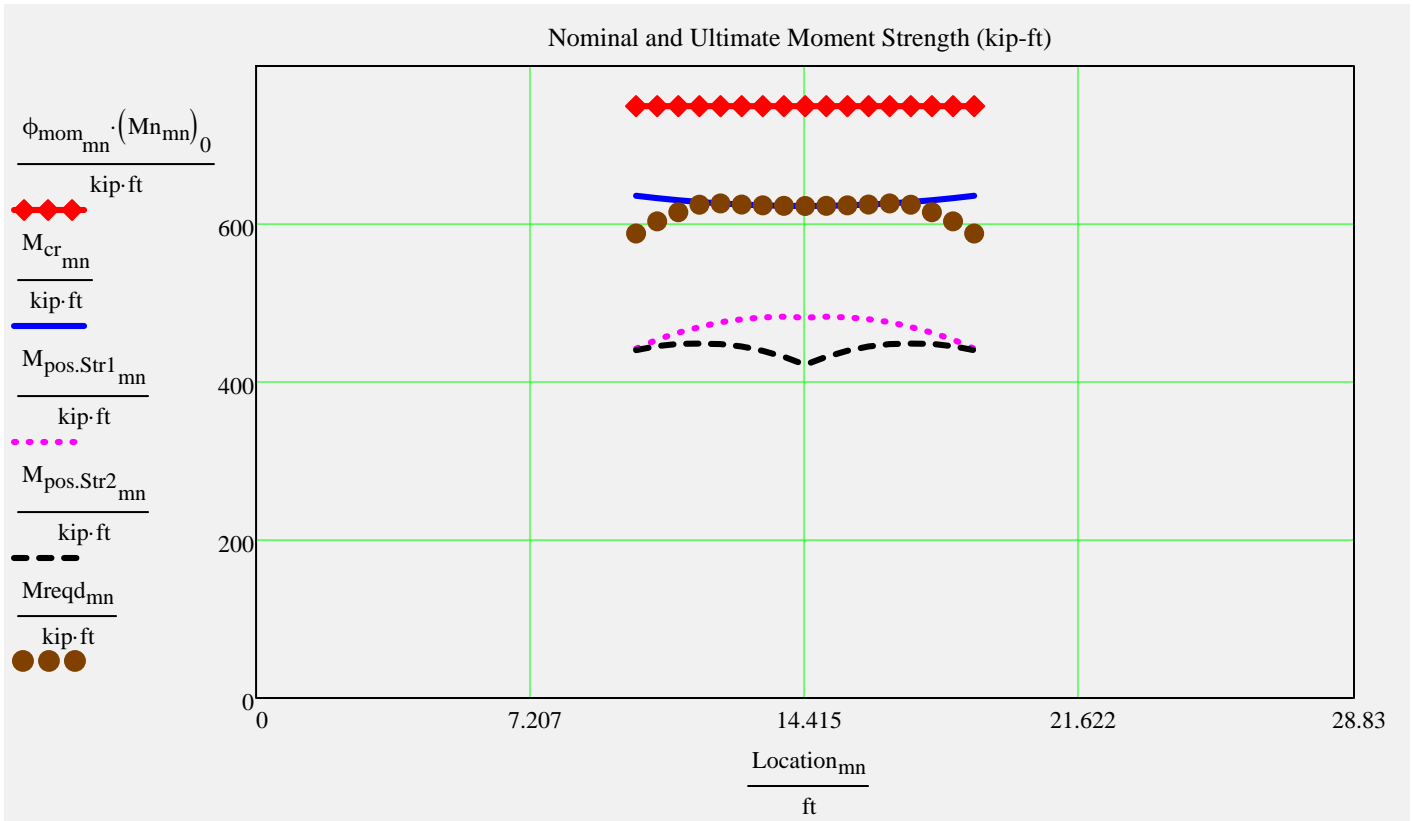
### Camber, Shrinkage, and Dead Load Deflection Components



SlopeData =

"Stage"	"Change in L @ Top (in)"	"Change in L @ Bot. (in)"	"Slope at End (deg)"	"midspan defl (in)"
"Release"	-0.0338	-0.1136	0.148	0.2049
"30 Days"	-0.1068	-0.2362	0.2519	0.2947
"60 Days"	-0.1337	-0.2814	0.2921	0.3355
"90 Days"	-0.1477	-0.3049	0.313	0.3653
"120 Days"	-0.1563	-0.3193	0.3258	0.3884
"240 Days"	-0.1719	-0.3455	0.3492	0.4467
"non-comp DL"	-0.0214	0.0185	-0.0953	-0.1731
"comp DL"	-0.0014	0.0035	-0.0116	-0.021
"LL"	-0.0132	0.0332	-0.1109	-0.1998

## Strength Limit State Moments



$$CR_{Str.mom_n} := 10 \quad CR_{Str.mom_{mn}} := \frac{\phi_{mom_{mn}} \cdot (Mn_{mn})_0}{Mreqd_{mn}} \quad (LRFD 5.7.3.3.2) \quad \min(CR_{Str.mom}) = 1.2$$

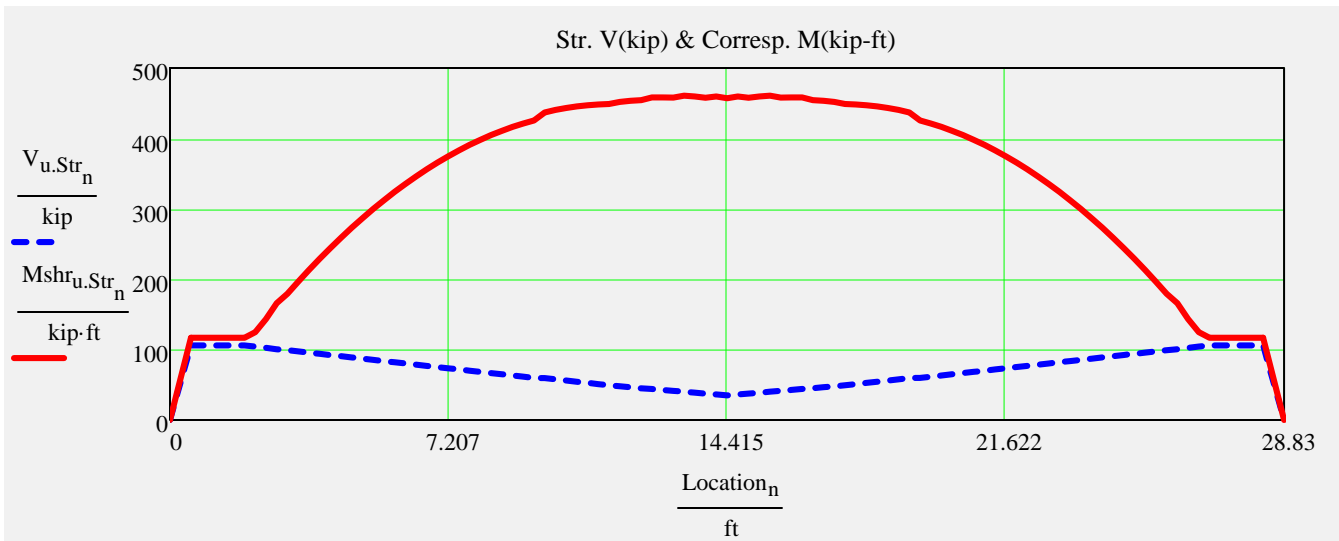
$$\max(Mreqd) = 626.0 \cdot \text{kip} \cdot \text{ft} \quad \text{CheckMomentCapacity} := \text{if}(\min(CR_{Str.mom}) > 0.99, \text{"OK"}, \text{"No Good!"})$$

CheckMomentCapacity = "OK"

FSB only - Design Check of Transverse reinforcing Bars E

Shear Analysis

## Strength Shear and Associated Moments



$$\max(V_{u.Str}) = 105.9 \cdot \text{kip}$$

$$\max(M_{shr_{u.Str}}) = 460.7 \cdot \text{kip} \cdot \text{ft}$$

## Design Shear, Longitudinal, Interface and Anchorage Reinforcement

Stirrup sizes and spacings assigned in input file

<u>Location</u>	<u>spacing</u>	<u>Number of Spaces</u>	<u>area per stirrup</u>
<u>A1 stirrup</u>	$\text{tmp\_s} = \begin{pmatrix} 18 \\ 18 \\ 18 \\ 18 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot \text{in}$	$\text{tmp\_NumberSpaces} = \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 0 \end{pmatrix}$	$\text{tmp\_A\_stirrup} = \begin{pmatrix} 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \end{pmatrix} \cdot \text{in}^2$
<u>A2 stirrup</u>			
<u>A3 stirrup</u>			
<u>S1 stirrup</u>			
<u>S2 stirrup</u>			
<u>S3 stirrup</u>			
<u>S4 stirrup</u>			

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.

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

	<u>user_s_nspacings :=</u>	<u>user_NumberSpaces_nspacings :=</u>	<u>user_A_stirrup_nspacings :=</u>	<u>interface_factor_nspacings :=</u>
<u>A1 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	0.25
<u>A2 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	0.5
<u>A3 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	1
<u>S1 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	1
<u>S2 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	1
<u>S3 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	1
<u>S4 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	1

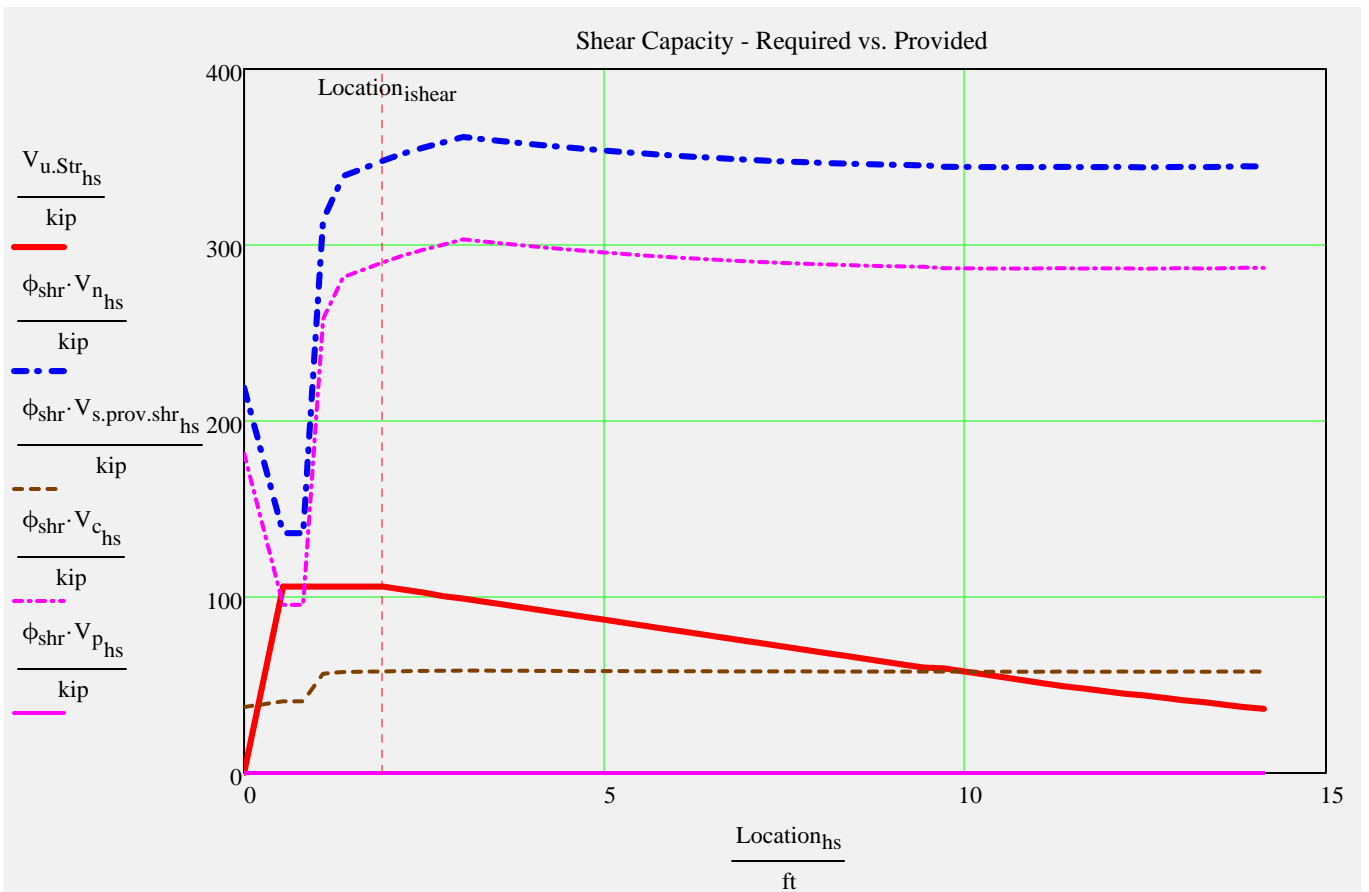
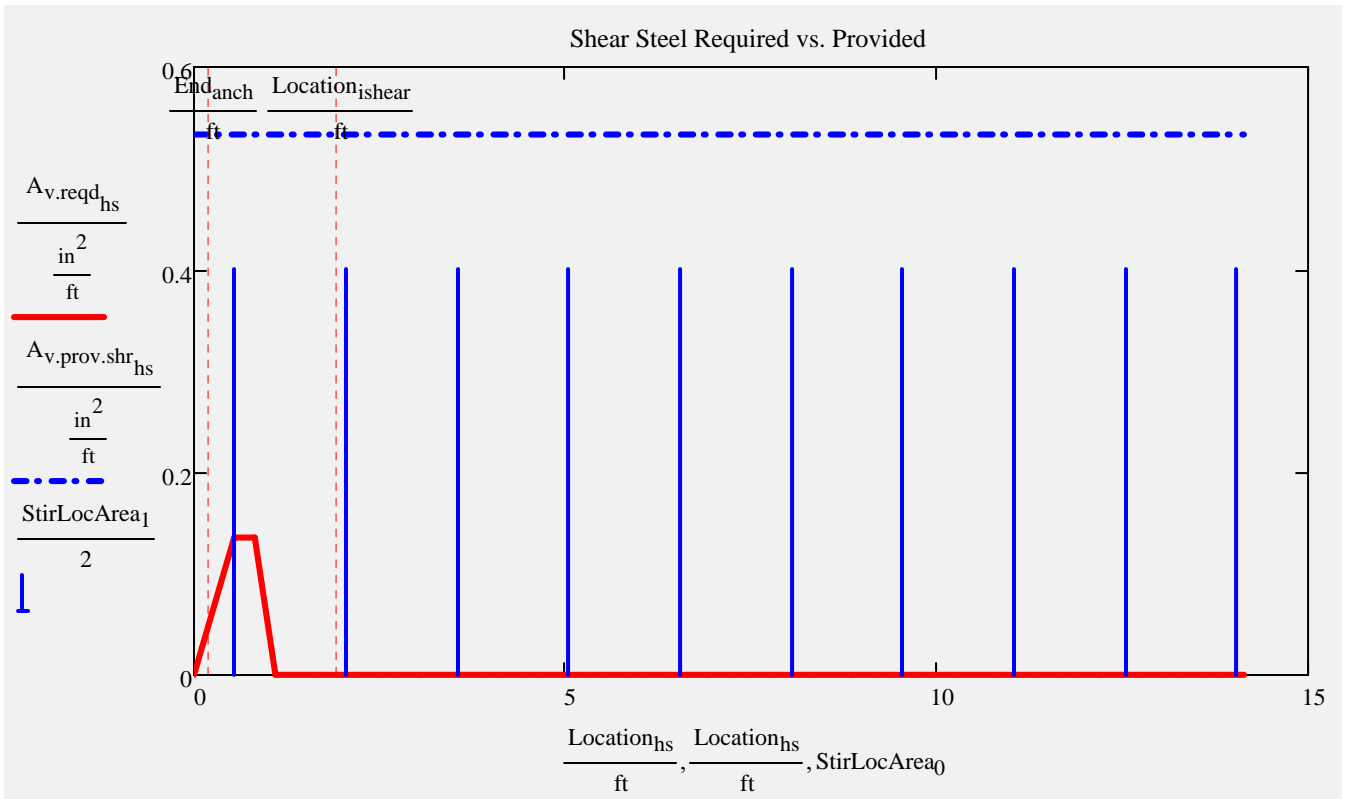
Recalculate Worksheet

### 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.

<u>A1 stirrup</u>	$s = \begin{pmatrix} 18 \\ 18 \\ 18 \\ 18 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot \text{in}$	$\text{NumberSpaces} = \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 3.25 \end{pmatrix}$	$A_{\text{stirrup}} = \begin{pmatrix} 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \end{pmatrix} \cdot \text{in}^2$	EndCover = 6.5 · in
<u>A2 stirrup</u>				
<u>A3 stirrup</u>				
<u>S1 stirrup</u>				
<u>S2 stirrup</u>				
<u>S3 stirrup</u>				
<u>S4 stirrup</u>				



Computation for Checks

CheckShearCapacity = "OK"

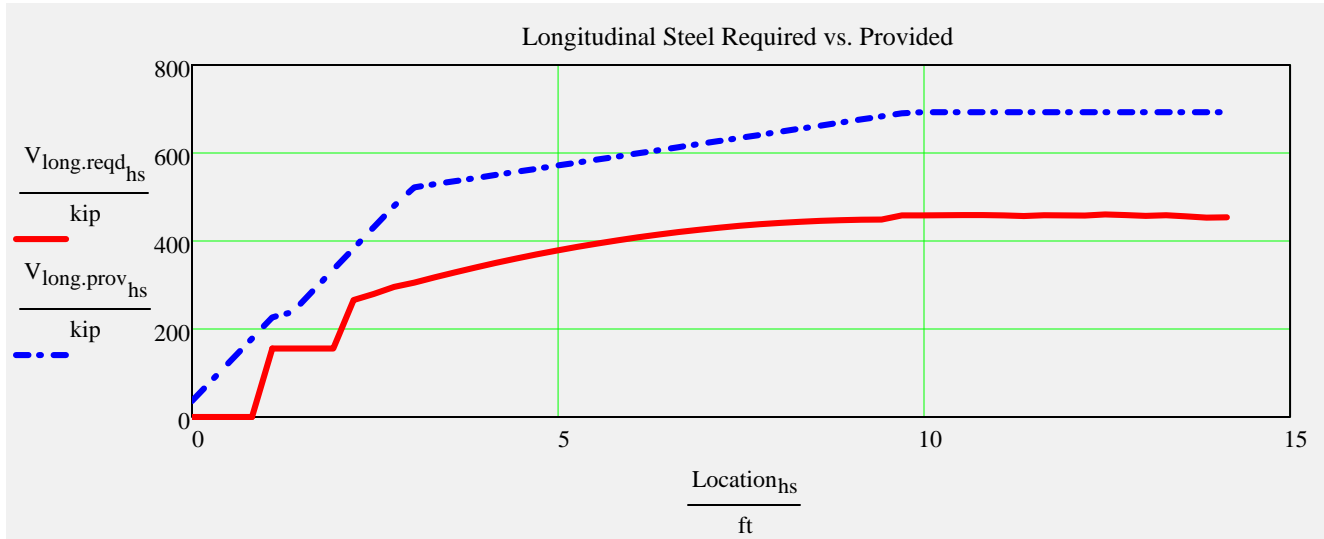
CheckMaxShearStress = "OK"

CheckStirArea = "OK"

CheckMinStirArea = "OK"

CheckMaxStirSpacing = "OK"

Longitudinal Reinforcement

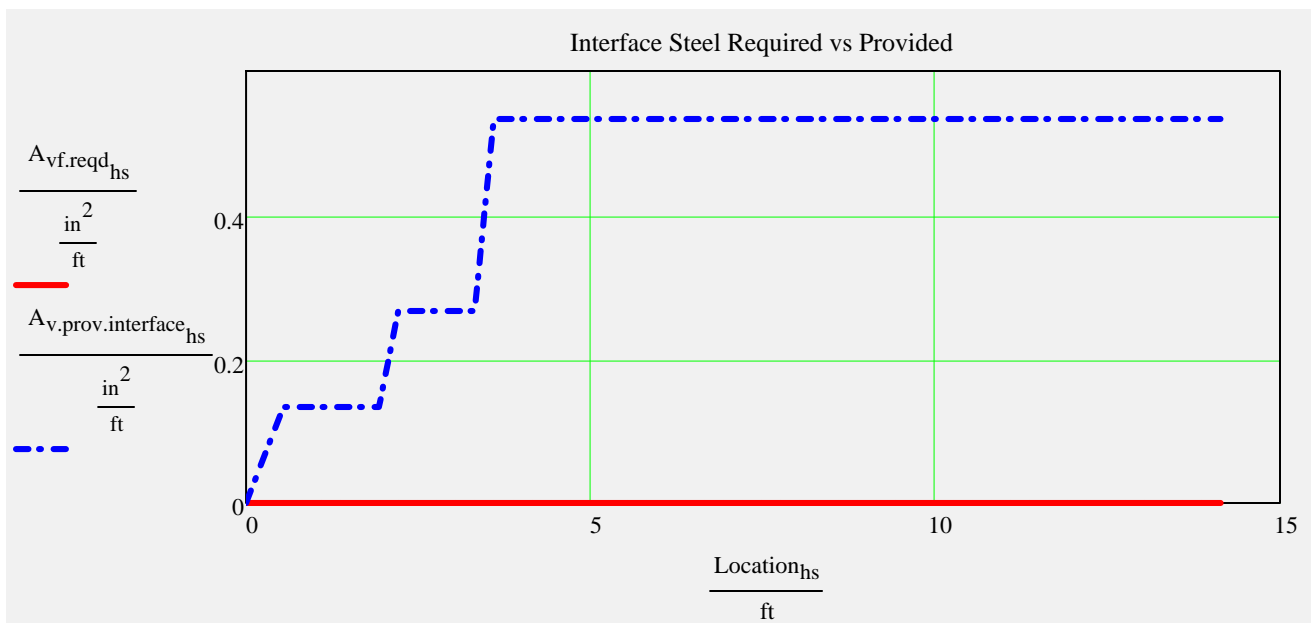


$$CR_{LongSteel}_{hs} := \text{if} \left( V_{long.reqd}_{hs} < .01kip, 100, \frac{V_{long.prov}_{hs}}{V_{long.reqd}_{hs}} \right) \quad \min(CR_{LongSteel}) = 1.44$$

CheckLongSteel := if (min(CR<sub>LongSteel</sub>) > 1, "OK", "No Good, add steel!")

CheckLongSteel = "OK"

Interface Shear Reinforcement



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.

$$\max(A_{vf,min}) = 0 \cdot \frac{\text{in}^2}{\text{ft}}$$

$$\max(A_{vf,des}) = 0 \cdot \frac{\text{in}^2}{\text{ft}}$$

If max(Avf.min) or max(Avf.des) is greater than 0 in<sup>2</sup>/ft, interface steel is required.

CheckInterfaceSpacing = "OK"

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

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 :=

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

CheckSplittingSteel = "N.A."

CheckMaxPrestressingForce = "OK"

## Summary of Design Checks

check<sub>0</sub> := AcceptAASHTO = "OK"

check<sub>2</sub> := AcceptOntario = "N.A."

check<sub>4</sub> := Check\_f<sub>pe</sub> = "OK"

check<sub>6</sub> := Check\_f<sub>comp.rel</sub> = "OK"

check<sub>8</sub> := Check\_f<sub>comp.stage8.c1</sub> = "OK"

check<sub>10</sub> := Check\_f<sub>comp.FatigueI</sub> = "OK"

check<sub>12</sub> := CheckMaxCapacity = "OK"

check<sub>14</sub> := CheckShearCapacity = "OK"

check<sub>16</sub> := CheckMaxStirSpacing = "OK"

check<sub>18</sub> := CheckInterfaceSpacing = "OK"

check<sub>20</sub> := CheckMaxPrestressingForce = "OK"

check<sub>22</sub> := CheckPattern<sub>1</sub> = "OK"

check<sub>24</sub> := CheckPattern<sub>3</sub> = "OK"

check<sub>26</sub> := CheckInterfaceSteel = "OK"

check<sub>1</sub> := AcceptSDG = "N.A."

check<sub>3</sub> := Check\_f<sub>pt</sub> = "OK"

check<sub>5</sub> := Check\_f<sub>tension.rel</sub> = "OK"

check<sub>7</sub> := Check\_f<sub>tension.stage8</sub> = "OK"

check<sub>9</sub> := Check\_f<sub>comp.stage8.c2</sub> = "OK"

check<sub>11</sub> := CheckMomentCapacity = "OK"

check<sub>13</sub> := CheckStirArea = "OK"

check<sub>15</sub> := CheckMinStirArea = "OK"

check<sub>17</sub> := CheckLongSteel = "OK"

check<sub>19</sub> := CheckSplittingSteel = "N.A."

check<sub>21</sub> := CheckPattern<sub>0</sub> = "OK"

check<sub>23</sub> := CheckPattern<sub>2</sub> = "OK"

check<sub>25</sub> := CheckPattern<sub>4</sub> = "OK"

check<sub>27</sub> := CheckStrandFit = "OK"

check<sub>28</sub> := Check\_SDG1.2.Display<sub>2</sub> = "OK"

[Link to Note- Checks, 0, 1 & 2](#)



TotalCheck = "OK"

## LRFR Load Rating Analysis

*FDOT Maintenance Office Bridge Load Rating Manual*



Load Rating Computations

		Moment (Strength) or Stress (Service)				Shear (Strength)				
LRFR <sub>loadrating</sub> =	"Limit State"	"DF"	"Rating"	"Tons"	"Dim(ft)"	"DF"	"Rating"	"Tons"	"Dim(ft)"	
	"Strength I(Inv)"	0.42	1.78	"N/A"	13.32	0.66	4.30	"N/A"	1.39	HL-93
	"Strength I(Op)"	0.42	2.31	"N/A"	13.32	0.66	5.58	"N/A"	1.39	HL-93
	"Service III(Inv)"	0.42	1.68	"N/A"	13.32	"N/A"	"N/A"	"N/A"	"N/A"	HL-93
	"Service III(Op)"	0.42	2.29	"N/A"	13.32	"N/A"	"N/A"	"N/A"	"N/A"	HL-93
	"Strength II"	0.42	1.96	117.54	10.54	0.66	3.78	226.82	1.39	*Permit

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

### Longitudinal Steel Check:

CR<sub>LongSteel.HL93</sub> = 1.51    CR<sub>LongSteel.Permit</sub> = 1.36

CheckLongSteel<sub>loadrating</sub> = "OK"



Write Data Out

# LRFD Prestressed Beam Program

Project = "D30024 30 FT, LR Int. Bm."

DesignedBy = "JRM"

Date = "7-25-2016"

filename = "C:\FDOT Structures\Programs\LRFPBeamV5.0\FSB Data Files\D30024 30 FT LR Int. Bm.dat"

Comment = "FSB12x53 30 ft span"

## Legend

TanHighlight = DataEntry

YellowHighlight = CheckValues

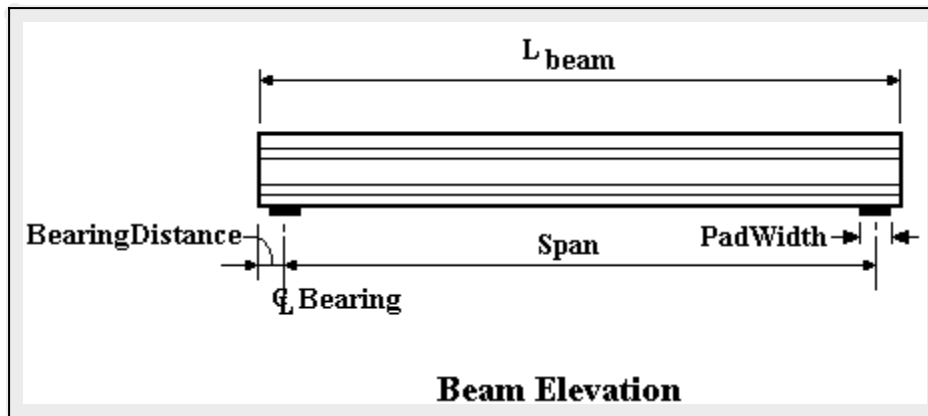
GreyHighlight = UserComments + Graphs

BlackText = ProgramEquations

Maroon Text = Code Reference

Blue Text = Commentary

## Bridge Layout and Dimensions



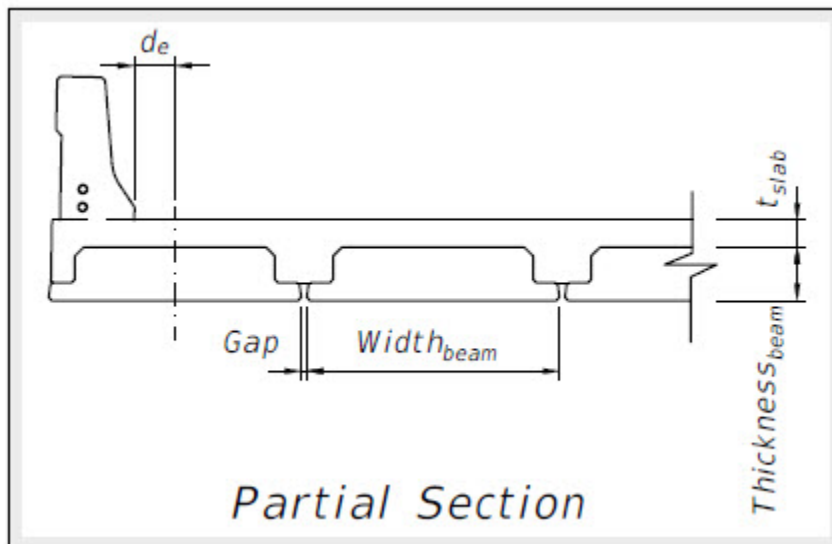
$L_{beam} = 28.83 \cdot ft$

Span = 27.75 · ft

BearingDistance = 6.5 · in

PadWidth = 8 · in

BeamTypeTog = "FSB12x53" [\*These are typically the FDOT designations found in our standards. The user can also create a .ordinate file for a custom shape. In all cases the top of the beam is at the  \$v=0\$  ordinate.\*](#)







## Mild Steel:

mild steel yield strength  $f_y = 60 \cdot \text{ksi}$

mild steel modulus of elasticity  $E_s = 29000 \cdot \text{ksi}$

ratio of rebar modulus to initial beam concrete modulus  $n_{mi} := \frac{E_s}{E_{ci}} \quad n_{mi} = 6.42$

area per unit width of longitudinal slab reinf.  $A_{slab.rebar} = 0.31 \cdot \frac{\text{in}^2}{\text{ft}}$

ratio of rebar modulus to beam concrete modulus  $n_m := \frac{E_s}{E_c} \quad n_m = 5.72$

area of mild reinf lumped at centroid of bar locations  $A_{s,long} = 0 \cdot \text{in}^2$

d distance from top of slab to centroid of slab reinf.  $d_{slab.rebar} = 2.5 \cdot \text{in}$

d distance from top of beam to centroid of mild flexural tension reinf.  $d_{long} = 0 \cdot \text{in}$

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  $q := 0 \dots (\text{PermitAxles} - 1) \quad qt := 0 \dots \text{PermitAxles}$

$\text{PermitAxleLoad}^T = (13.33 \quad 53.33 \quad 53.33) \cdot \text{kip}$

$\text{PermitAxleSpacing}^T = (0 \quad 14 \quad 14 \quad 0) \cdot \text{ft}$

## Distribution Factors

`DataMessage = "This is a FSB12x53 Florida Slab Beam design, AASHTO distribution factors used"`

calculated values:

$\text{tmp\_g}_{mom} = 0.39 \quad \text{tmp\_g}_{shear} = 0.56 \quad \text{tmp\_g}_{mom.fatigue} = 0.26$

user value overrides (optional):

`user_g_mom := 0` `user_g_shear := 0` `user_g_mom.fatigue := 0`

value check

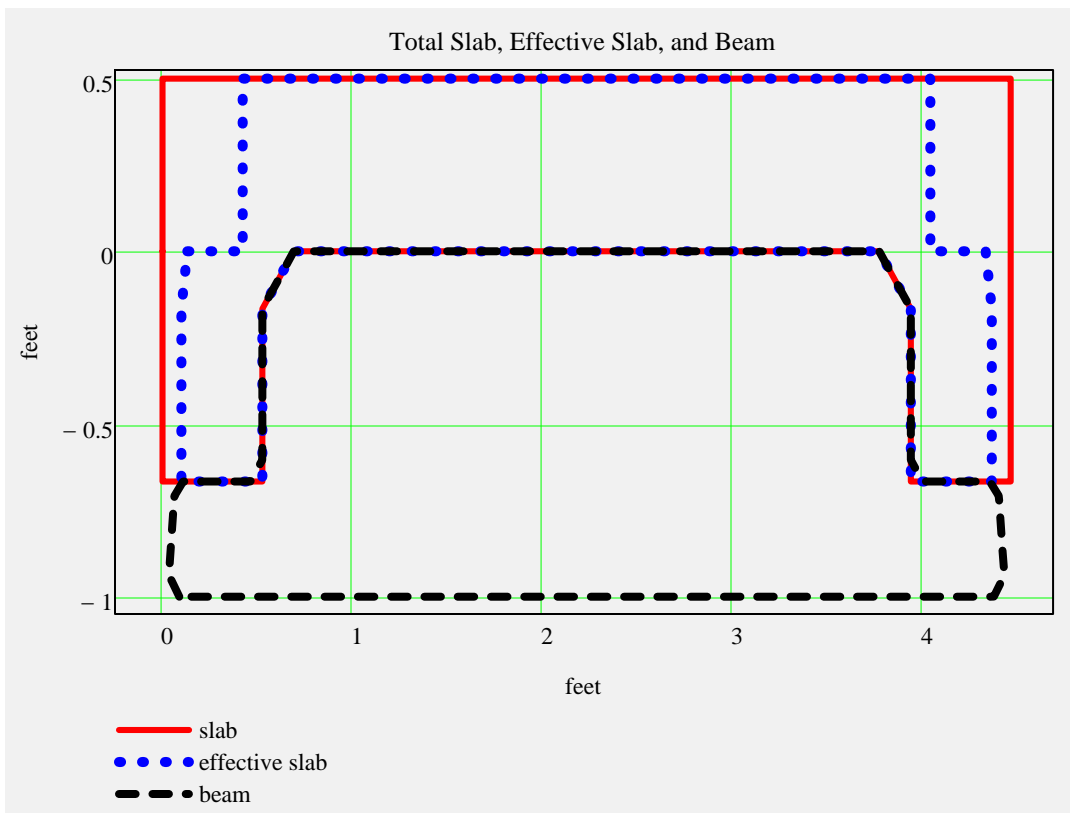
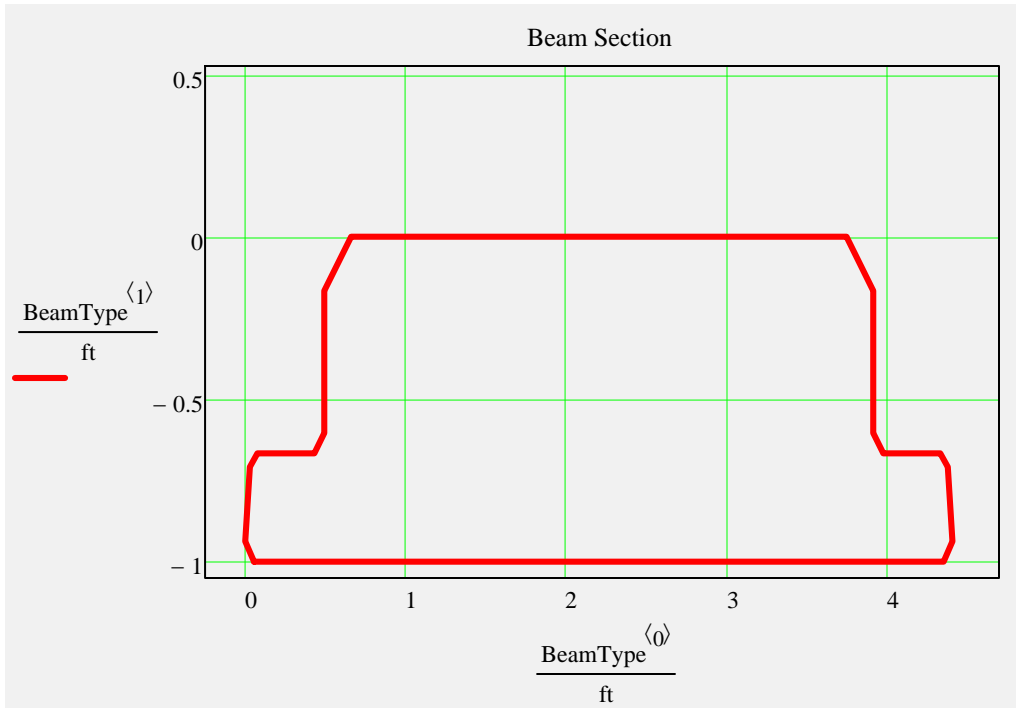
$\text{g}_{mom} := \text{if}(\text{user\_g}_{mom} \neq 0, \text{user\_g}_{mom}, \text{tmp\_g}_{mom}) \quad \text{g}_{mom} = 0.39$

$\text{g}_{shear} := \text{if}(\text{user\_g}_{shear} \neq 0, \text{user\_g}_{shear}, \text{tmp\_g}_{shear}) \quad \text{g}_{shear} = 0.56$

$\text{g}_{mom.fatigue} := \text{if}(\text{user\_g}_{mom.fatigue} \neq 0, \text{user\_g}_{mom.fatigue}, \text{tmp\_g}_{mom.fatigue}) \quad \text{g}_{mom.fatigue} = 0.26$



## Section Views



### Non-Composite Dead Load Input:

$$w_{\text{slab}} = 0.445 \cdot \frac{\text{kip}}{\text{ft}} \quad w_{\text{beam}} = 0.556 \cdot \frac{\text{kip}}{\text{ft}} \quad w_{\text{forms}} = 0 \cdot \frac{\text{kip}}{\text{ft}}$$

$$\text{Add\_w}_{\text{noncomp}} := 0.0 \cdot \frac{\text{kip}}{\text{ft}} \quad \text{additional non composite dead load (positive or negative)}$$

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

$$w_{\text{noncomposite}} := w_{\text{slab}} + w_{\text{beam}} + w_{\text{forms}} + \text{Add\_w}_{\text{noncomp}}$$

$$w_{\text{noncomposite}} = 1.001 \cdot \frac{\text{kip}}{\text{ft}}$$

$$w_{\text{bnoncomposite}} := w_{\text{slab}} + w_{\text{forms}} + \text{Add\_w}_{\text{noncomp}}$$

$$w_{\text{bnoncomposite}} = 0.445 \cdot \frac{\text{kip}}{\text{ft}}$$

### 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

$$\text{EndDiaphragmA} := 0 \cdot \text{kip} \quad \text{begin bridge}$$

$$\text{IntDiaphragmB} := 0 \cdot \text{kip}$$

*input load is per beam*

$$\text{DistB} := 0 \cdot \text{ft}$$

$$\text{EndDiaphragmE} := 0 \cdot \text{kip} \quad \text{end bridge}$$

$$\text{IntDiaphragmC} := 0 \cdot \text{kip}$$

*Longitudinal Distance B, C, & D - Measured from CL Bearing at begin bridge*

$$\text{DistC} := 0 \cdot \text{ft}$$

$$\text{IntDiaphragmD} := 0 \cdot \text{kip}$$

$$\text{DistD} := 0 \cdot \text{ft}$$



### Composite Dead Load Input:

$$w_{\text{future.ws}} = 0.067 \cdot \frac{\text{kip}}{\text{ft}} \quad w_{\text{barrier}} = 0.143 \cdot \frac{\text{kip}}{\text{ft}}$$

$$\text{Add\_w}_{\text{comp}} := 0.0 \cdot \frac{\text{kip}}{\text{ft}} \quad \text{additional composite dead load (positive or negative)}$$

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

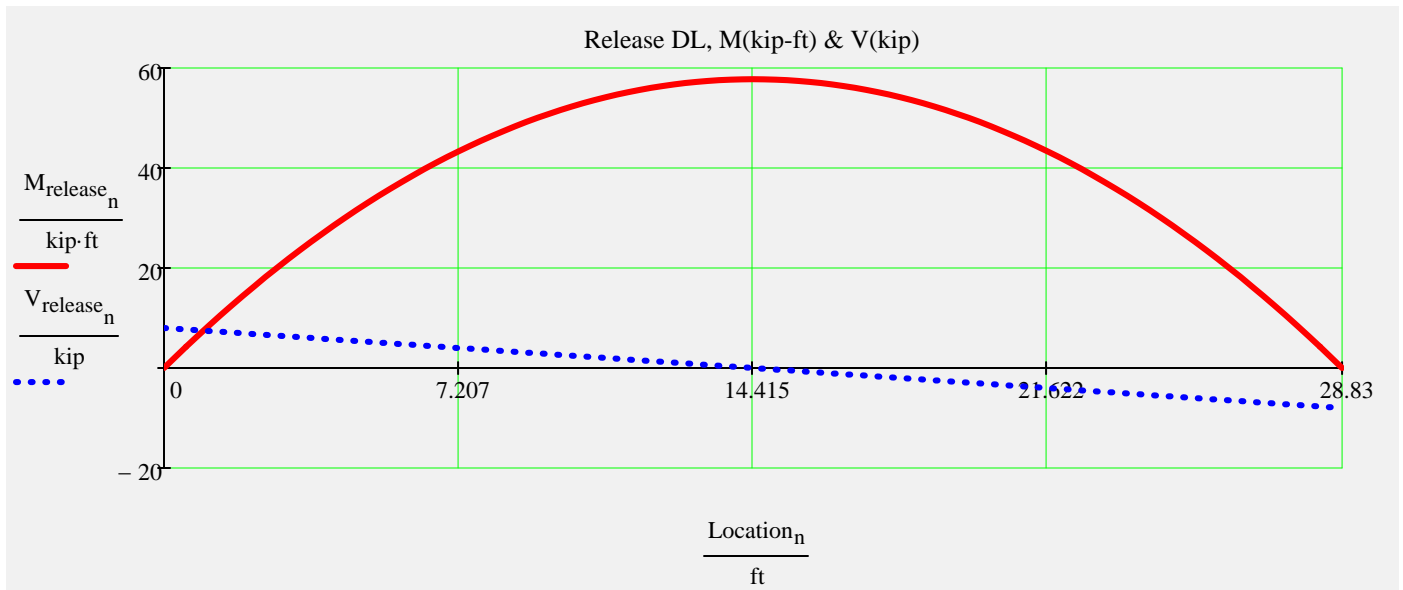
$$w_{\text{composite}} := w_{\text{future.ws}} + w_{\text{barrier}} + \text{Add\_w}_{\text{comp}}$$

$$w_{\text{composite}} = 0.21 \cdot \frac{\text{kip}}{\text{ft}}$$

$$w_{\text{comp.str}} := w_{\text{barrier}} + \text{Add\_w}_{\text{comp}}$$

$$w_{\text{comp.str}} = 0.143 \cdot \frac{\text{kip}}{\text{ft}}$$

## Release Dead Load Moments and Shear

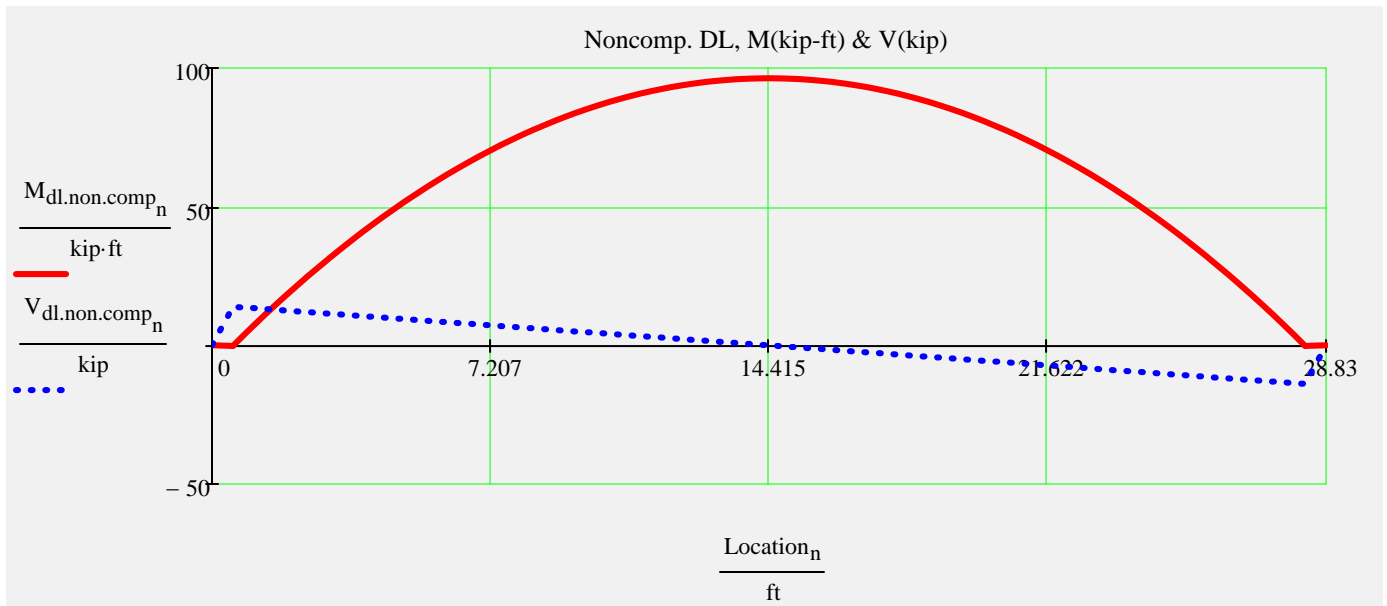


$$\max(M_{release}) = 57.8 \cdot \text{kip} \cdot \text{ft}$$

$$\max(V_{release}) = 8 \cdot \text{kip}$$



## Noncomposite Dead Load Moments and Shear

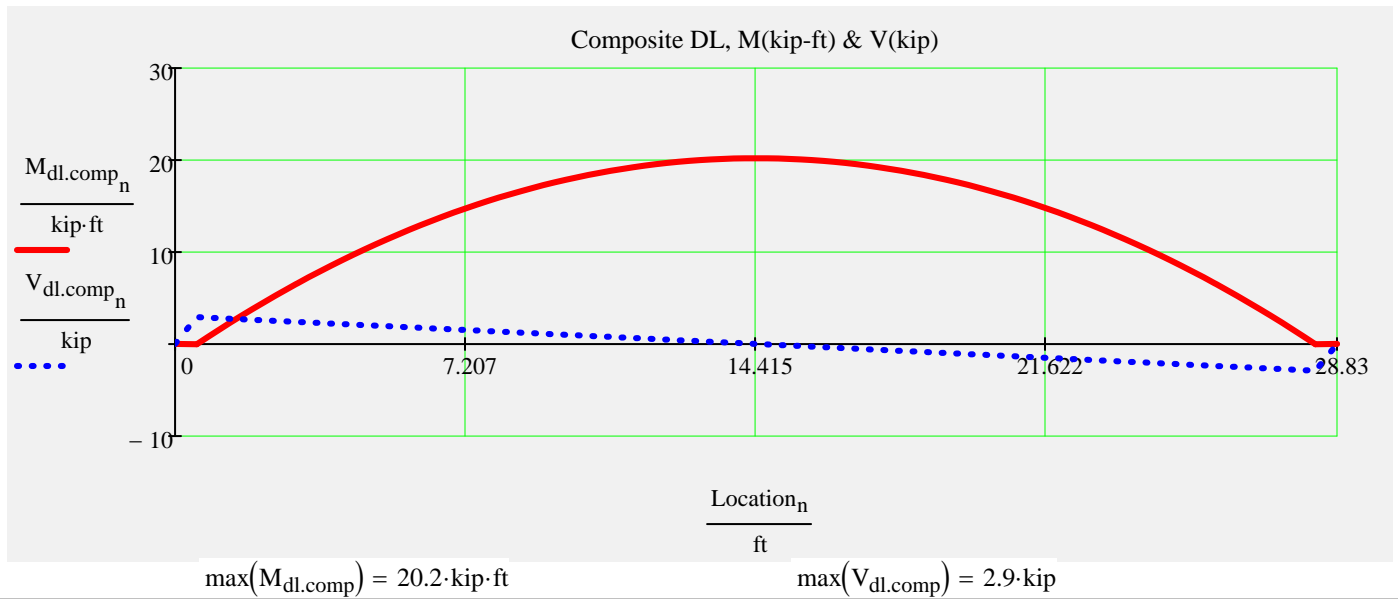


$$\max(M_{dl.non.comp}) = 96.3 \cdot \text{kip} \cdot \text{ft}$$

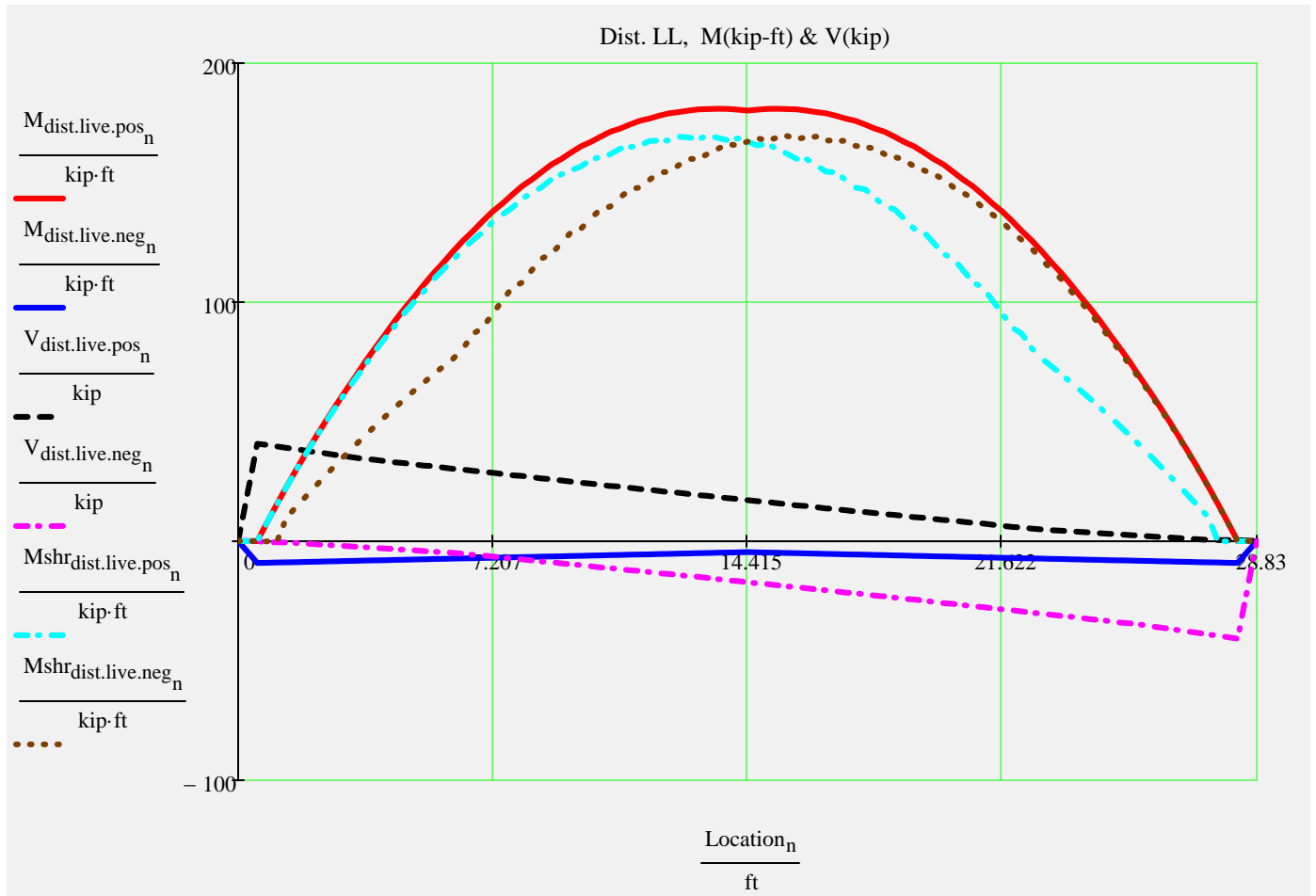
$$\max(V_{dl.non.comp}) = 13.9 \cdot \text{kip}$$



## Composite Dead Load Moments and Shear



## Distributed Live Load Moments and Shear



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

$$\max(M_{dist.live.pos}) = 180.8 \cdot \text{kip} \cdot \text{ft}$$

$$\min(M_{dist.live.neg}) = -9.1 \cdot \text{kip} \cdot \text{ft}$$

$$\text{Reaction}_{LL} = 42 \cdot \text{kip}$$

$$\max(V_{dist.live.pos}) = 40.8 \cdot \text{kip}$$

$$\max(Mshr_{dist.live.pos}) = 169.5 \cdot \text{kip} \cdot \text{ft}$$

$$\text{Reaction}_{DL} = 17.45 \cdot \text{kip}$$

## Prestress Strand Layout Input

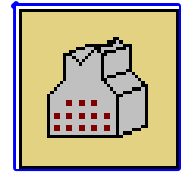
### Instructions:

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 :=

### Strand Pattern Generator:



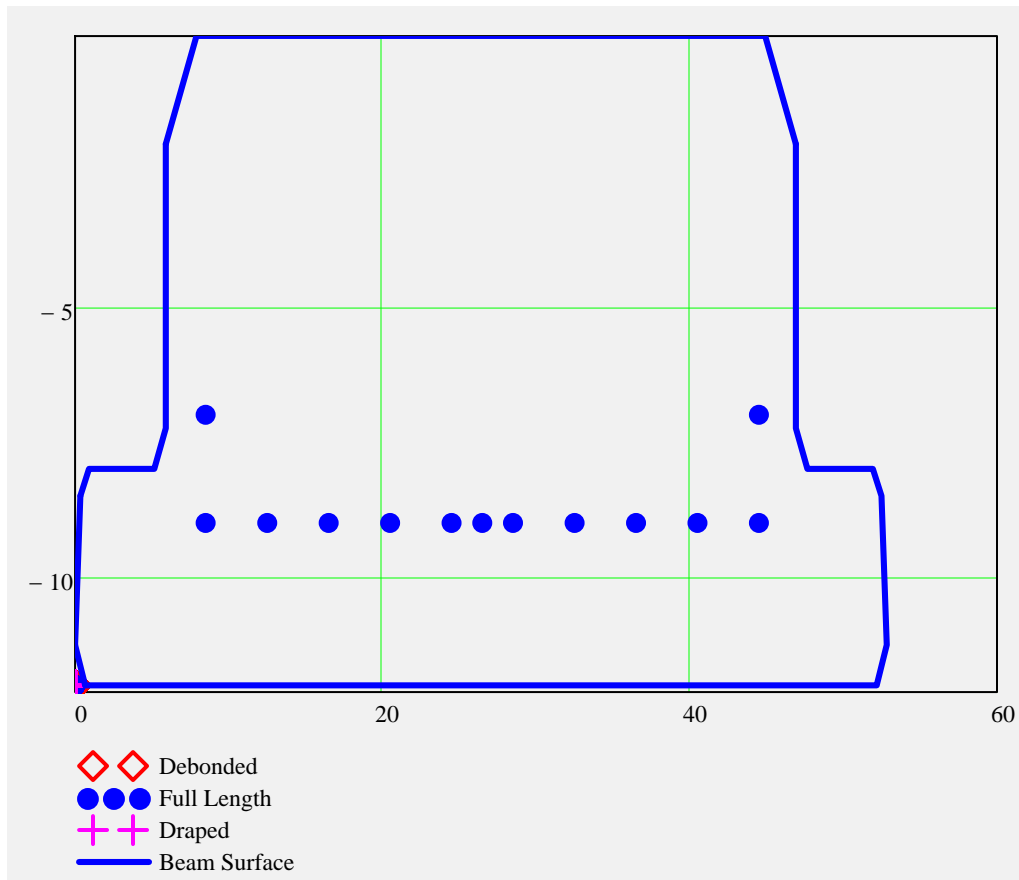
### Collapsed Region for Custom Strand Sizes...

▾ Strand Multiplier

▾ Strand Data and Pattern

▾ Strand Properties

## Tendon Layout



SupportLocation<sub>release</sub> = 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")

PartialPS<sub>force</sub> ≡ 40·kip *partial prestress total force*

PartialPS<sub>force</sub> := if (BeamTypeTog = "II", 20·kip, PartialPS<sub>force</sub>)

PartialPS<sub>force</sub> = 40·kip

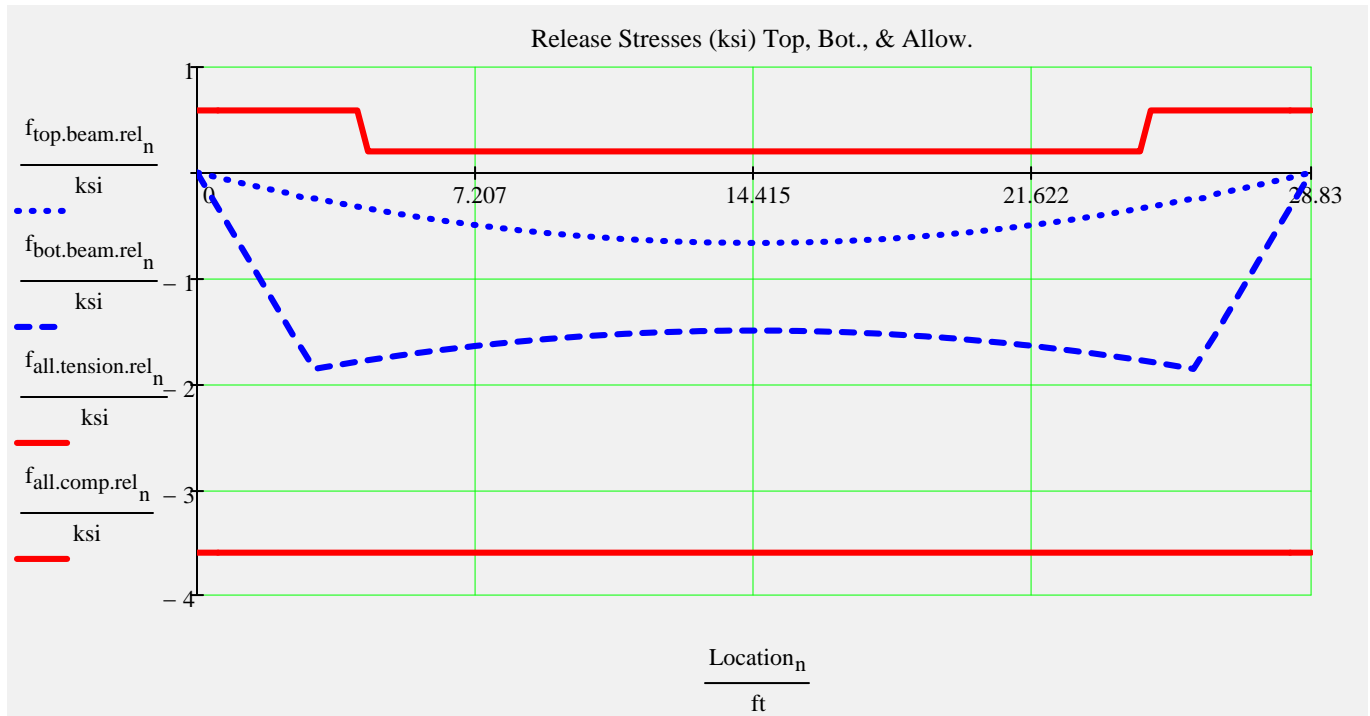
PartialPS<sub>location</sub> ≡ 1.4375in *centroid location of partial prestress from the top of the beam*

PartialPS<sub>location</sub> :=  $\begin{cases} 2.4375\text{·in} & \text{if BeamTypeTog} = \text{"II"} \\ 3\text{·in} & \text{if substr(BeamTypeTog, 0, 5)} = \text{"FSB12"} \\ 2\text{·in} & \text{if substr(BeamTypeTog, 0, 5)} = \text{"FSB15"} \\ 3\text{·in} & \text{if substr(BeamTypeTog, 0, 5)} = \text{"FSB18"} \\ \text{PartialPS}_{\text{location}} & \text{otherwise} \end{cases}$

PartialPS<sub>location</sub> = 3·in

▢ Section Properties & Strand Profile Properties

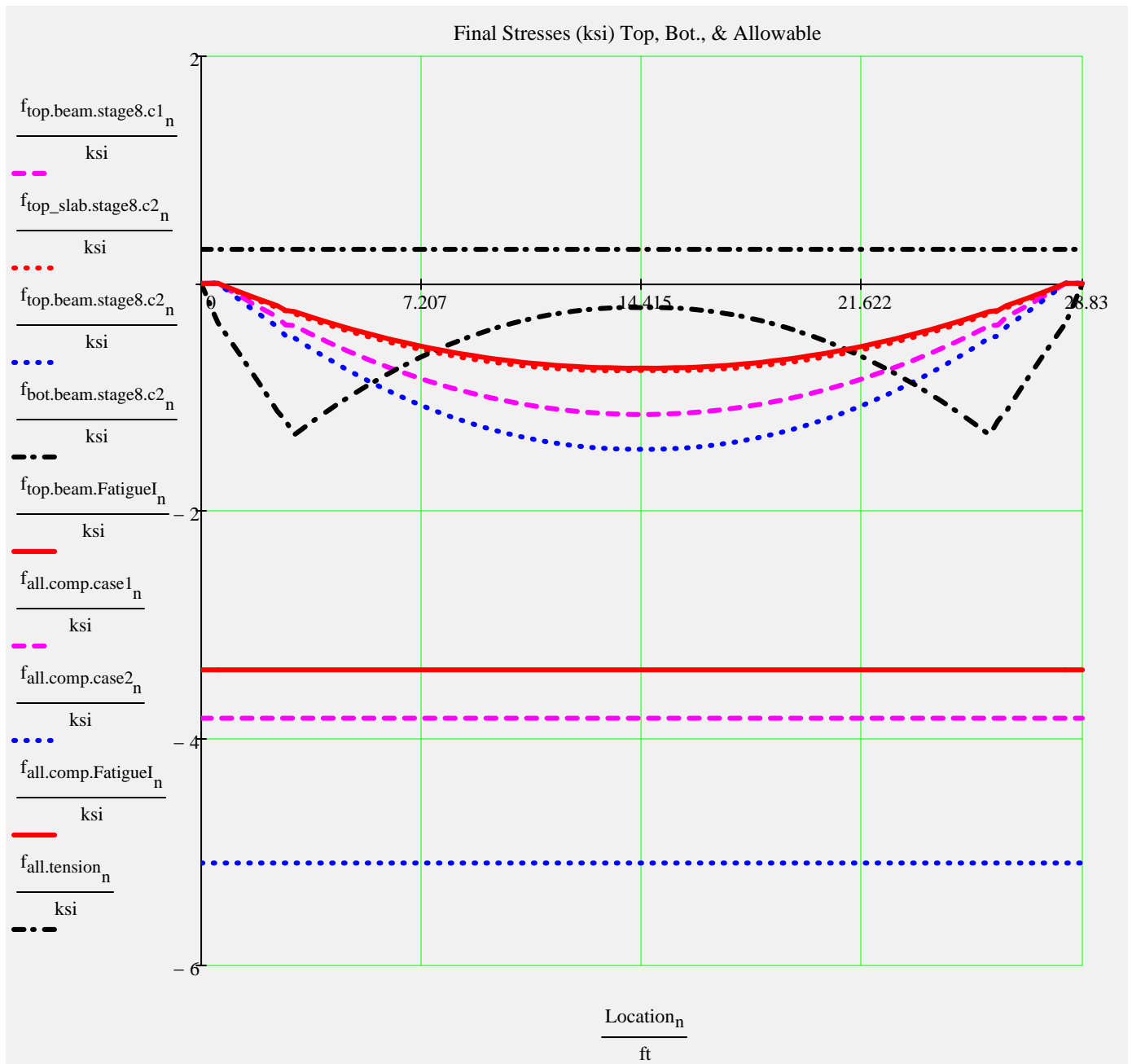
### Release Stresses



▢ Prestress Force



## Final Stresses



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

#### Stress Checks

$$\min(CR_{f_{tension.rel}}) = 10$$

Check\_  $f_{tension.rel}$  = "OK"

[\(Release tension\)](#)

$$\min(CR_{f_{comp.rel}}) = 1.93$$

Check\_  $f_{comp.rel}$  = "OK"

[\(Release compression\)](#)

$$\min(CR_{f_{tension.stage8}}) = 10$$

Check\_  $f_{tension.stage8}$  = "OK"

[\(Service III, PS + DL + LL\\*0.8\)](#)

$$\min(CR_{f_{comp.stage8.c1}}) = 3.32$$

Check\_  $f_{comp.stage8.c1}$  = "OK"

[\(Service I, PS + DL\)](#)

$$\min(CR_{f_{comp.stage8.c2}}) = 3.49$$

Check\_  $f_{comp.stage8.c2}$  = "OK"

[\(Service I, PS + DL + LL\)](#)

$$\min(CR_{f_{comp.FatigueI}}) = 4.56$$

Check\_  $f_{comp.FatigueI}$  = "OK"

[\(Fatigue I, \(PS + DL\)\\*0.5 + 1.5 Fatigue Truck\)](#)

## Strand Pattern Checks

CheckPattern<sub>0</sub> = "OK"

**check 0** - no debonded tendon in outside row

CheckPattern<sub>1</sub> = "OK"

**check 1** - less than 25% debonded tendons total

*\*Note: Check 1 may be less than 30% provided that debonding does not occur within the horizontal limits of the web (See SDG 4.3.1)*

CheckPattern<sub>2</sub> = "OK"

**check 2** - less than 40% debonded tendons in any row

CheckPattern<sub>3</sub> = "OK"

**check 3** - less than 40% of debonded tendons terminated at same section

*(LRFD 5.11.4.3)*

CheckPattern<sub>4</sub> = "OK"

**check 4** - more than half beam depth debond length

*(SDG 4.3.1)*

### Section and Strand Properties Summary

## Section and Strand Properties Summary

$$A_{\text{beam}} = 533.75 \cdot \text{in}^2$$

Concrete area of beam

$$I_{\text{beam}} = 6501.409 \cdot \text{in}^4$$

Gross Moment of Inertia of Beam about CG

$$y_{\text{comp}} = -3.36 \cdot \text{in}$$

Dist. from top of beam to CG of gross composite section

$$I_{\text{comp}} = 23203.5285 \cdot \text{in}^4$$

Gross Moment of Inertia Composite Section about CG

$$A_{\text{deck}} = 345.96 \cdot \text{in}^2$$

Concrete area of deck slab

$$A_{\text{ps}} = 2.8 \cdot \text{in}^2$$

total area of strands

$$d_{\text{b,ps}} = 0.6 \cdot \text{in}$$

diameter of Prestressing strand

$$\text{min}(\text{PrestressType}) = 0$$

0 - low lax 1 - stress relieved

$$f_{\text{py}} = 243 \cdot \text{ksi}$$

tendon yield strength

$$f_{\text{pj}} = 203 \cdot \text{ksi}$$

prestress jacking stress

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

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

$$d_{\text{ps.row}} =$$

	0	1	2	3	4	5	6	7	8	9
0	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9
1	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7
2	-3	-3	-3	-3	-3	-3	-3	-3	-3	...

·in

TotalNumberOfTendons = 13

StrandSize = "0.6 in low lax"

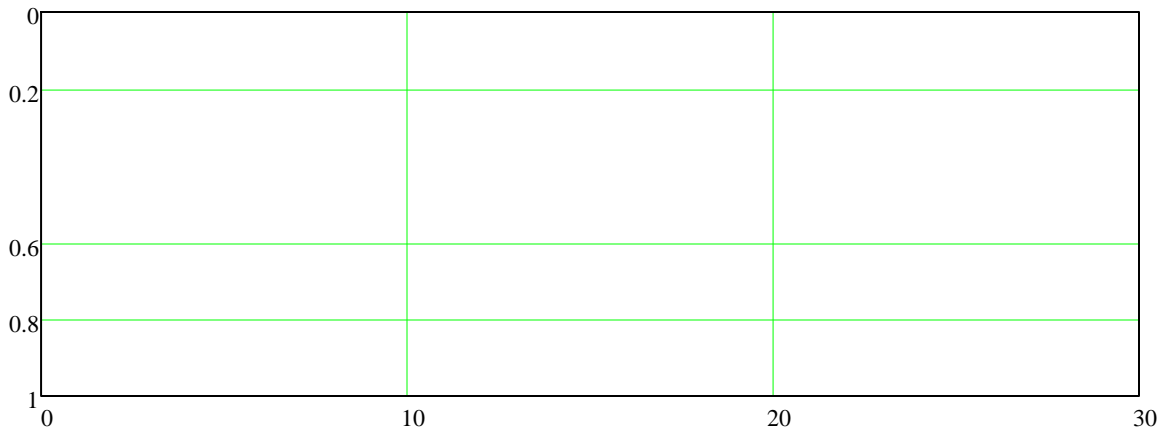
NumberOfDebondedTendons = 0

StrandArea = 0.22·in<sup>2</sup>

NumberOfDrapedTendons = 0

JackingForce<sub>per.strand</sub> = 43.94·kip

Location of Depressed Strands



Section and Strand Properties Summary

**Prestress Losses Summary**

$f_{pj} = 202.5 \cdot \text{ksi}$

Check\_  $f_{pt}$  = "OK"

$\Delta f_{pES} = 0 \cdot \text{ksi}$

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

$\Delta f_{pT} = -18 \cdot \text{ksi}$

$\frac{\Delta f_{pT}}{f_{pj}} = -8.79 \cdot \%$

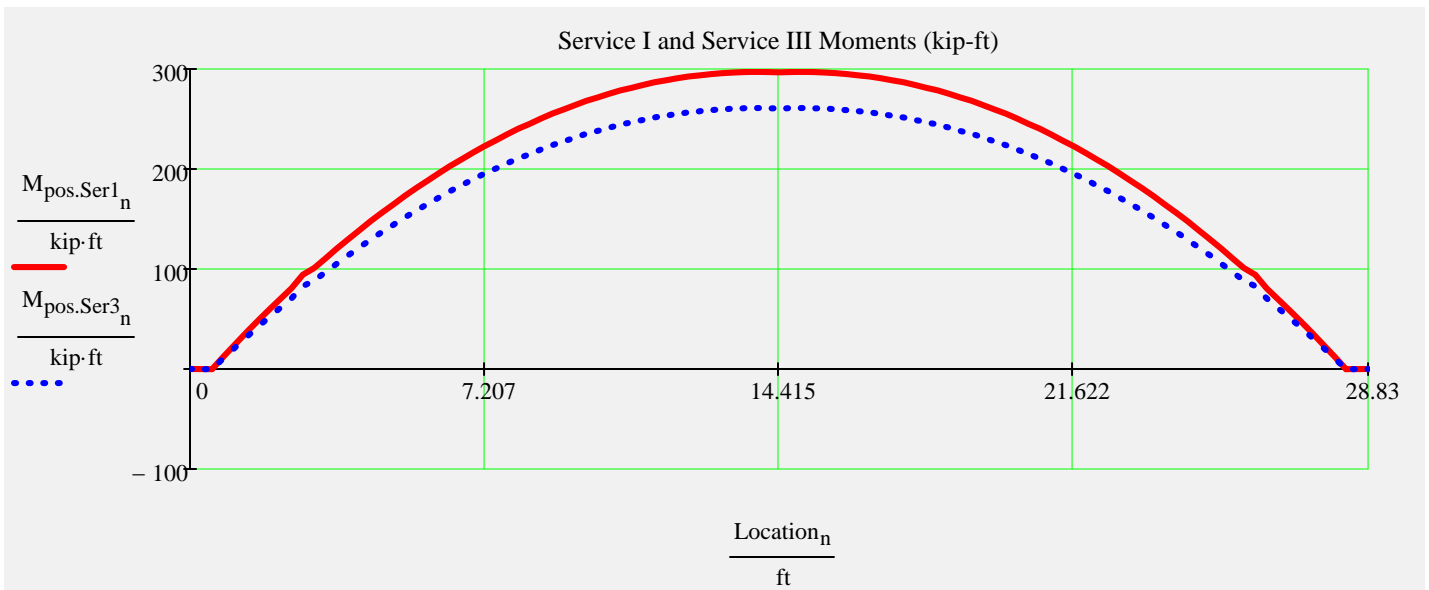
$f_{pe} = 185 \cdot \text{ksi}$

$\frac{f_{pe}}{f_{pj}} = 91.21 \cdot \%$

$0.8 \cdot f_{py} = 194 \cdot \text{ksi}$

Check\_  $f_{pe}$  = "OK"

**Service Limit State Moments**



$\max(M_{\text{pos.Ser1}}) = 297.1 \cdot \text{kip} \cdot \text{ft}$

$\max(M_{\text{pos.Ser3}}) = 260.9 \cdot \text{kip} \cdot \text{ft}$

## Summary of Values at Midspan

$$\text{Stresses} = \begin{pmatrix} \text{"Stage"} & \text{"Top of Beam (ksi)} & \text{"Bott of Beam (ksi)} \\ 1 & -0.67 & -1.5 \\ 2 & -0.67 & -1.31 \\ 4 & -0.62 & -1.36 \\ 6 & -1.12 & -0.92 \\ 8 & -1.46 & -0.21 \end{pmatrix}$$

$$\text{PrestressForce} = \begin{pmatrix} \text{"Condition"} & \text{"Axial (kip)} & \text{"Moment (kip*ft)} \\ \text{"Release"} & -611.3 & -99.3 \\ \text{"Final (about composite centroid)} & -557.5 & -87.7 \end{pmatrix}$$

$$\text{Properties} = \begin{pmatrix} \text{"Section"} & \text{"Area (in^2)} & \text{"Inertia (in^4)} & \text{"distance to centroid from top of bm (in)} \\ \text{"Net Beam"} & 530.73 & 6482.56 & -6.37 \\ \text{"Transformed Beam (initial)} & 549.78 & 6599.43 & -6.44 \\ \text{"Transformed Beam"} & 547.71 & 6586.97 & -6.43 \\ \text{"Composite"} & 900.22 & 23888.97 & -3.38 \end{pmatrix}$$

$$\text{ServiceMoments} = \begin{pmatrix} \text{"Type"} & \text{"Value (kip*ft)} \\ \text{"Release"} & 57.8 \\ \text{"Non-composite (includes bm wt.)"} & 96.3 \\ \text{"Composite"} & 20.2 \\ \text{"Distributed Live Load"} & 180.1 \end{pmatrix}$$

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

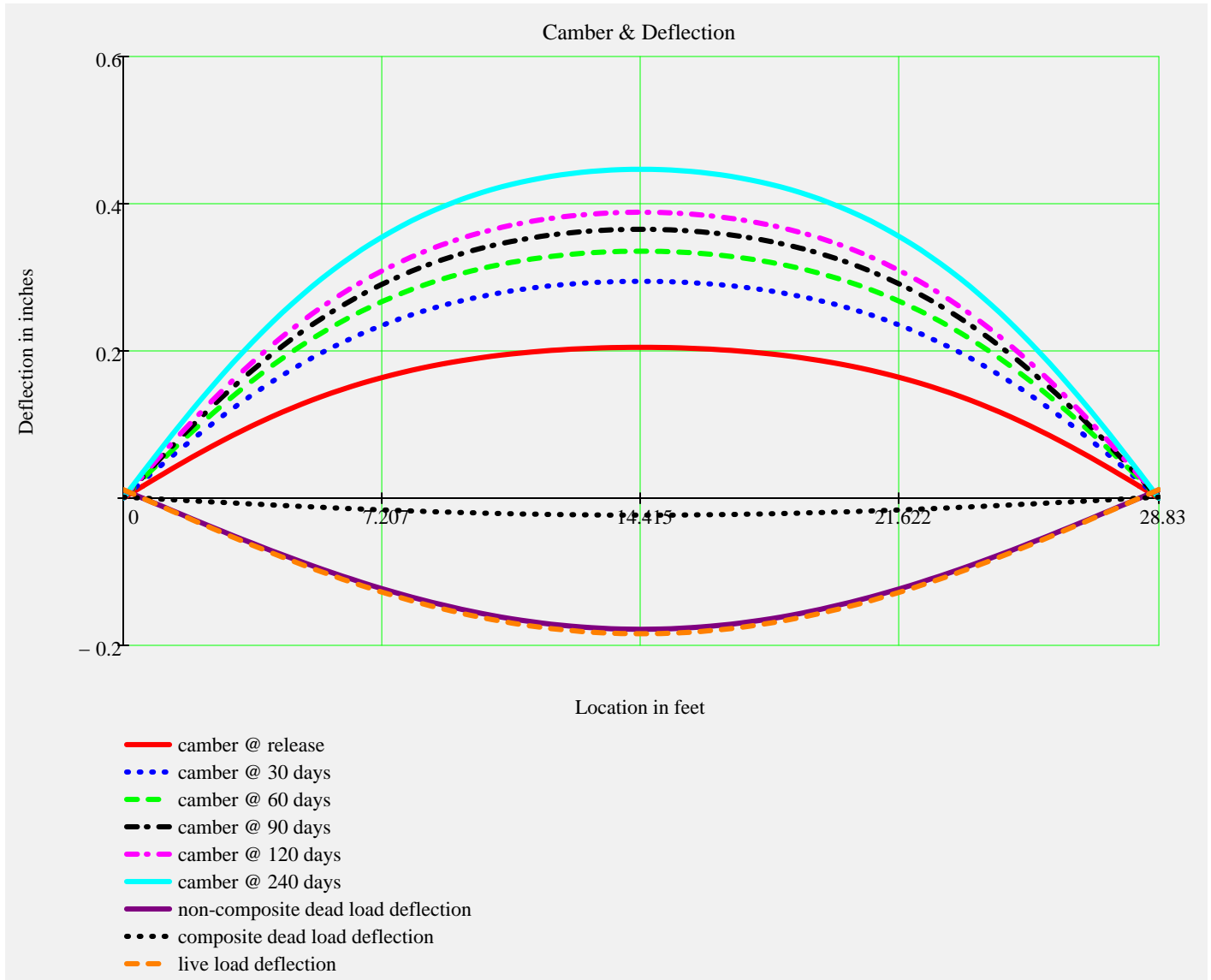
Stage 2 ---> Same as release with the addition of the remaining prestress losses applied to the transformed beam

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

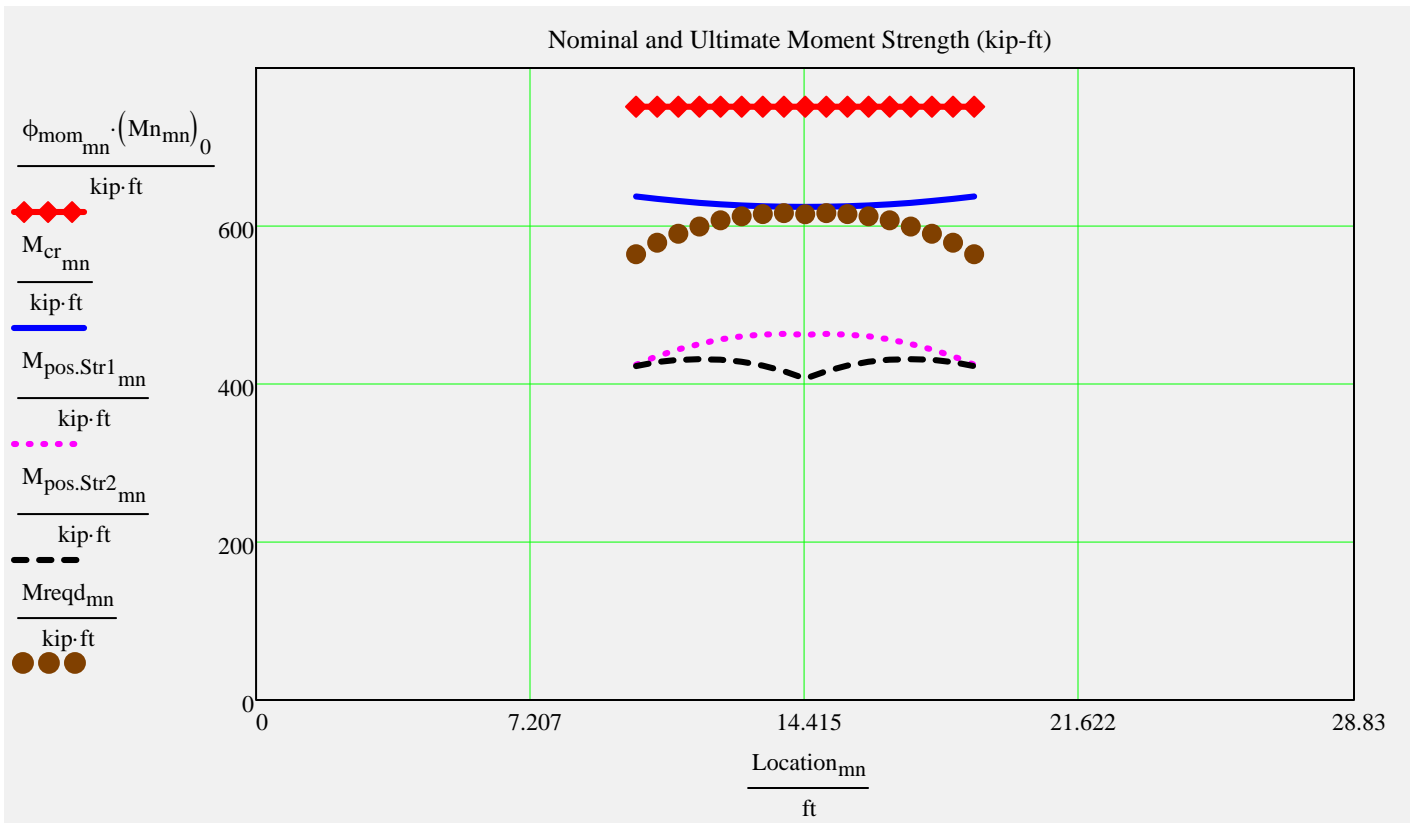
### Camber, Shrinkage, and Dead Load Deflection Components



SlopeData =

"Stage"	"Change in L @ Top (in)"	"Change in L @ Bot. (in)"	"Slope at End (deg)"	"midspan defl (in)"
"Release"	-0.0338	-0.1136	0.148	0.2049
"30 Days"	-0.1068	-0.2362	0.2519	0.2947
"60 Days"	-0.1337	-0.2814	0.2921	0.3355
"90 Days"	-0.1477	-0.3049	0.313	0.3653
"120 Days"	-0.1563	-0.3193	0.3258	0.3884
"240 Days"	-0.1719	-0.3455	0.3492	0.4467
"non-comp DL"	-0.022	0.0191	-0.0982	-0.1782
"comp DL"	-0.0015	0.0038	-0.0127	-0.0231
"LL"	-0.0121	0.0307	-0.1023	-0.1843

## Strength Limit State Moments



$$CR_{Str.mom_n} := 10 \quad CR_{Str.mom_{mn}} := \frac{\phi_{mom_{mn}} \cdot (Mn_{mn})_0}{M_{reqd_{mn}}} \quad (LRFD 5.7.3.3.2) \quad \min(CR_{Str.mom}) = 1.22$$

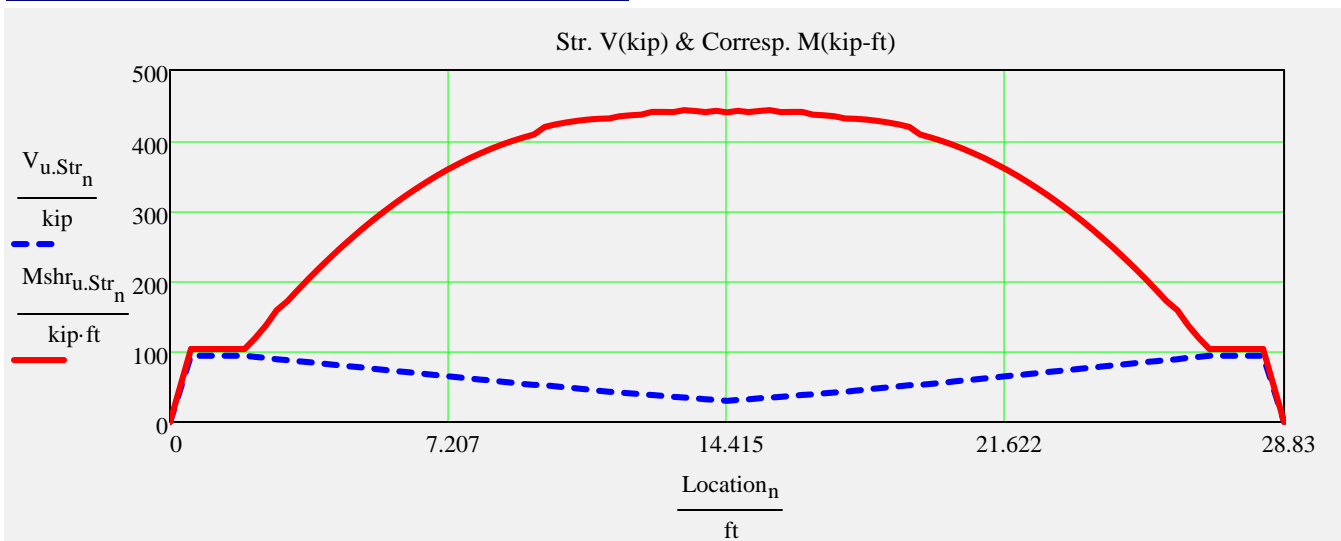
$$\max(M_{reqd}) = 616.2 \cdot \text{kip} \cdot \text{ft} \quad \text{CheckMomentCapacity} := \text{if}(\min(CR_{Str.mom}) > 0.99, \text{"OK"}, \text{"No Good!"})$$

CheckMomentCapacity = "OK"

FSB only - Design Check of Transverse reinforcing Bars E

Shear Analysis

## Strength Shear and Associated Moments



$$\max(V_{u.Str}) = 94.1 \cdot \text{kip}$$

$$\max(M_{shr_u.Str}) = 443.0 \cdot \text{kip} \cdot \text{ft}$$

## Design Shear, Longitudinal, Interface and Anchorage Reinforcement

Stirrup sizes and spacings assigned in input file

<u>Location</u>	<u>spacing</u>	<u>Number of Spaces</u>	<u>area per stirrup</u>
<u>A1 stirrup</u>	$\text{tmp\_s} = \begin{pmatrix} 18 \\ 18 \\ 18 \\ 18 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot \text{in}$	$\text{tmp\_NumberSpaces} = \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 0 \end{pmatrix}$	$\text{tmp\_A\_stirrup} = \begin{pmatrix} 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \end{pmatrix} \cdot \text{in}^2$
<u>A2 stirrup</u>			
<u>A3 stirrup</u>			
<u>S1 stirrup</u>			
<u>S2 stirrup</u>			
<u>S3 stirrup</u>			
<u>S4 stirrup</u>			

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.

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

	<u>user_s_nspacings :=</u>	<u>user_NumberSpaces_nspacings :=</u>	<u>user_A_stirrup_nspacings :=</u>	<u>interface_factor_nspacings :=</u>
<u>A1 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	0.25
<u>A2 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	0.5
<u>A3 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	1
<u>S1 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	1
<u>S2 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	1
<u>S3 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	1
<u>S4 stirrup</u>	-1 · in	-1	-1 · in <sup>2</sup>	1

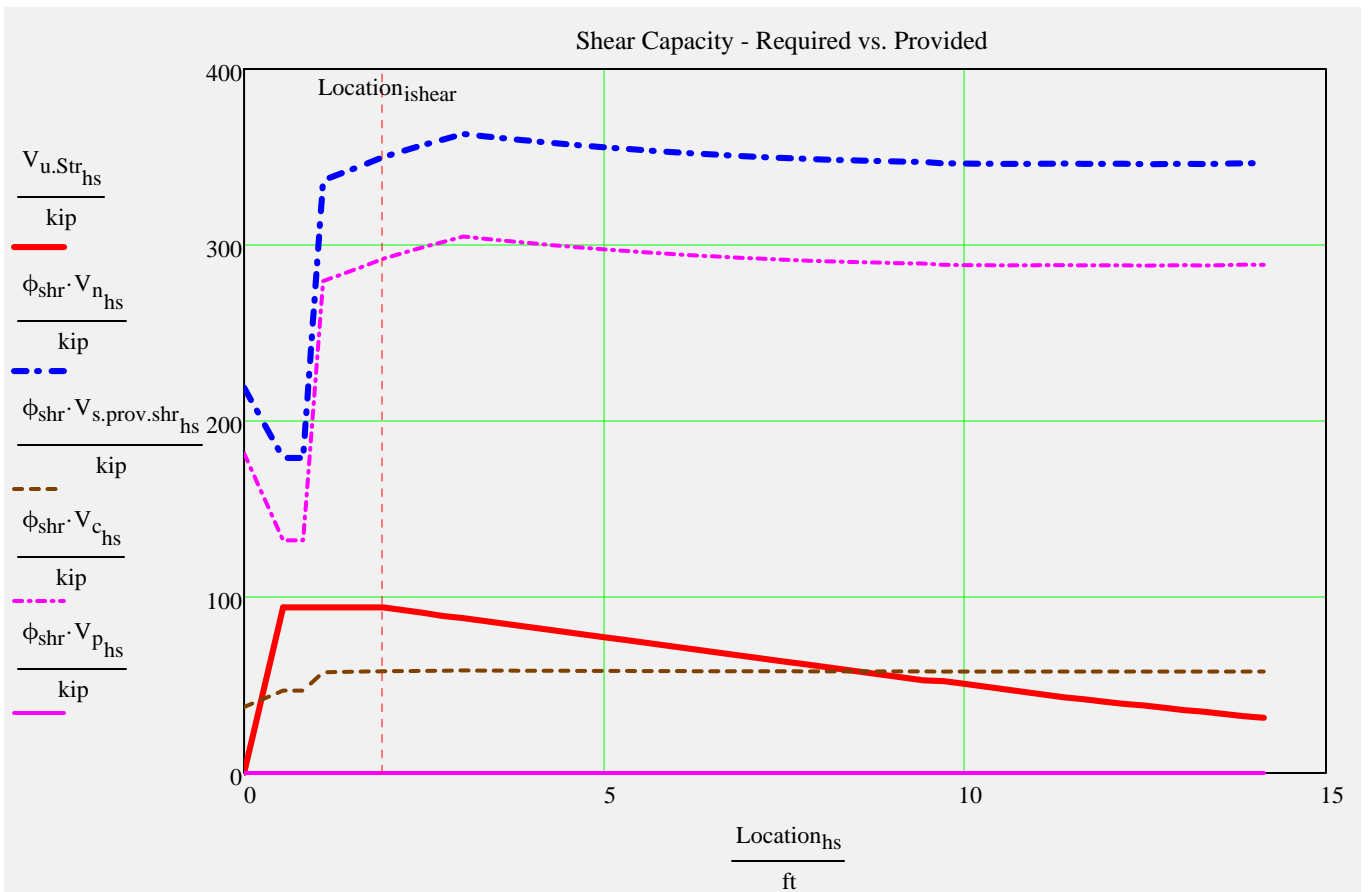
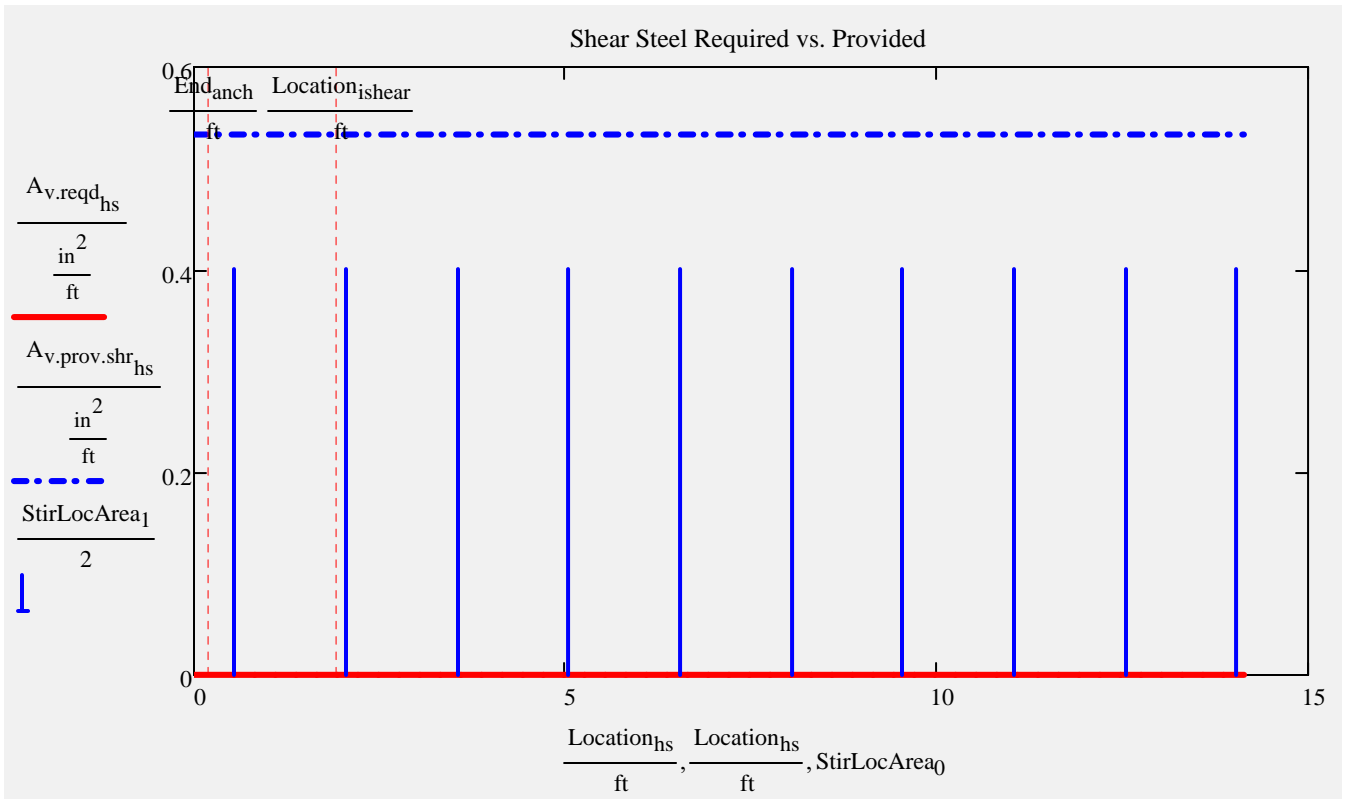
Recalculate Worksheet

### 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.

<u>A1 stirrup</u>	$s = \begin{pmatrix} 18 \\ 18 \\ 18 \\ 18 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot \text{in}$	$\text{NumberSpaces} = \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 3.25 \end{pmatrix}$	$A_{\text{stirrup}} = \begin{pmatrix} 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \\ 0.8 \end{pmatrix} \cdot \text{in}^2$	EndCover = 6.5 · in
<u>A2 stirrup</u>				
<u>A3 stirrup</u>				
<u>S1 stirrup</u>				
<u>S2 stirrup</u>				
<u>S3 stirrup</u>				
<u>S4 stirrup</u>				





Computation for Checks

CheckShearCapacity = "OK"

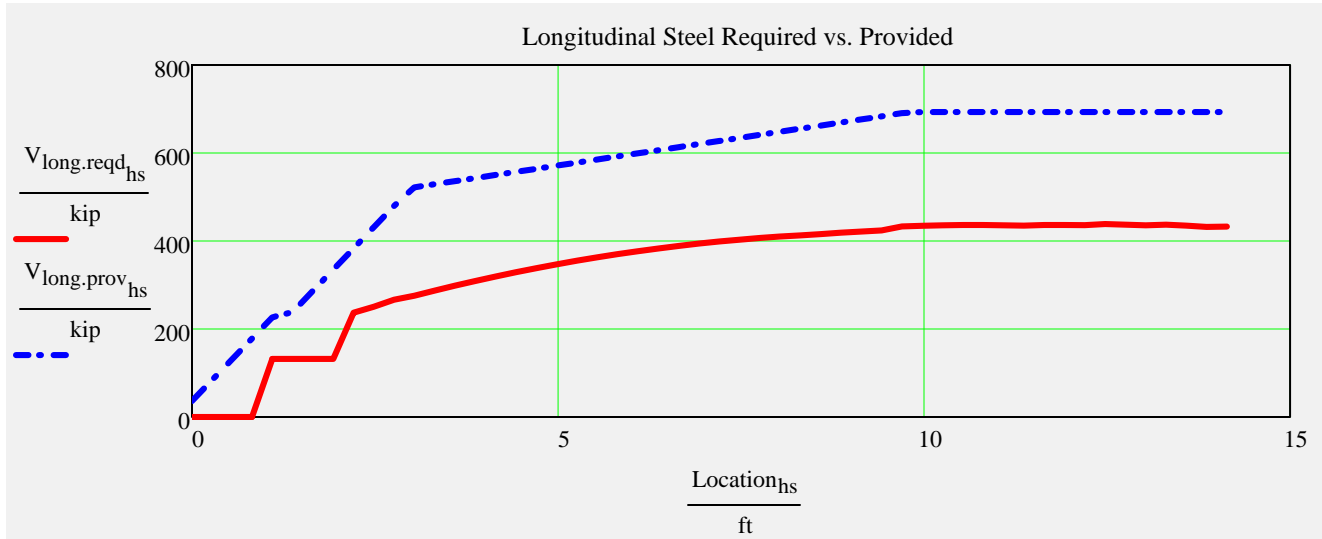
CheckMaxShearStress = "OK"

CheckStirArea = "OK"

CheckMinStirArea = "OK"

CheckMaxStirSpacing = "OK"

Longitudinal Reinforcement

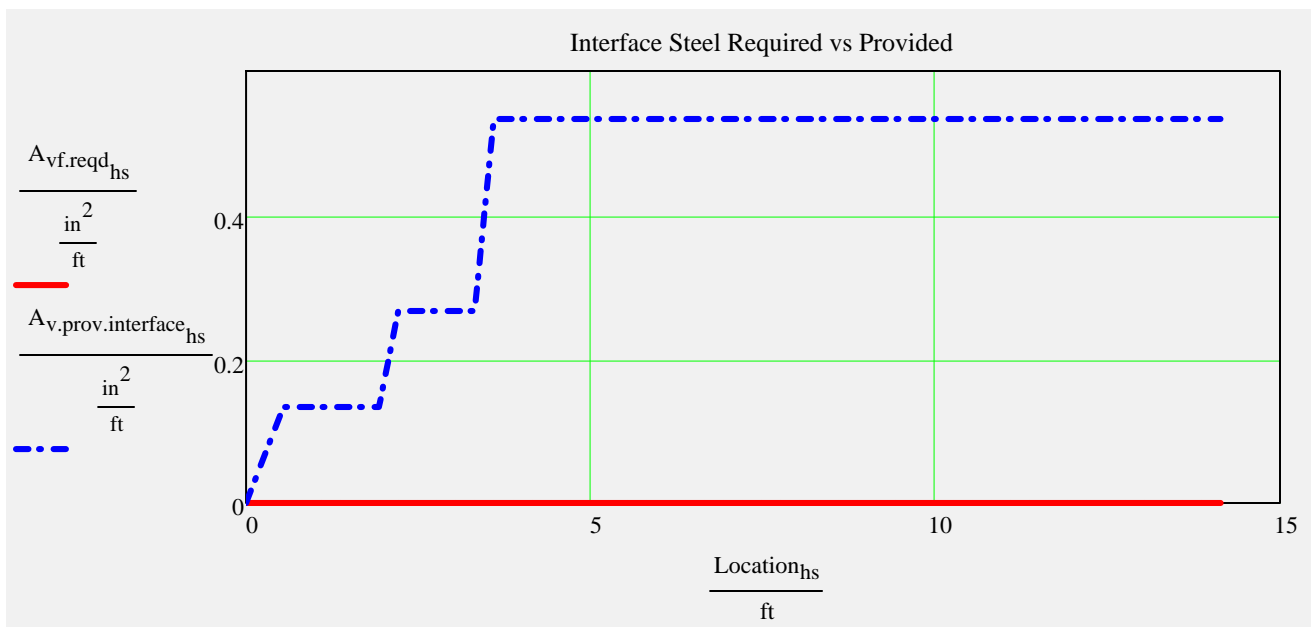


$$CR_{LongSteel}_{hs} := \text{if} \left( V_{long.reqd}_{hs} < .01kip, 100, \frac{V_{long.prov}_{hs}}{V_{long.reqd}_{hs}} \right) \quad \min(CR_{LongSteel}) = 1.57$$

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

CheckLongSteel = "OK"

Interface Shear Reinforcement



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.

$$\max(A_{vf.min}) = 0 \cdot \frac{\text{in}^2}{\text{ft}}$$

$$\max(A_{vf.des}) = 0 \cdot \frac{\text{in}^2}{\text{ft}}$$

If max(Avf.min) or max(Avf.des) is greater than 0 in<sup>2</sup>/ft, interface steel is required.

CheckInterfaceSpacing = "OK"

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

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 :=

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

CheckSplittingSteel = "N.A."

CheckMaxPrestressingForce = "OK"

## Summary of Design Checks

check<sub>0</sub> := AcceptAASHTO = "OK"

check<sub>2</sub> := AcceptOntario = "N.A."

check<sub>4</sub> := Check<sub>f<sub>pe</sub></sub> = "OK"

check<sub>6</sub> := Check<sub>f<sub>comp.rel</sub></sub> = "OK"

check<sub>8</sub> := Check<sub>f<sub>comp.stage8.c1</sub></sub> = "OK"

check<sub>10</sub> := Check<sub>f<sub>comp.FatigueI</sub></sub> = "OK"

check<sub>12</sub> := CheckMaxCapacity = "OK"

check<sub>14</sub> := CheckShearCapacity = "OK"

check<sub>16</sub> := CheckMaxStirSpacing = "OK"

check<sub>18</sub> := CheckInterfaceSpacing = "OK"

check<sub>20</sub> := CheckMaxPrestressingForce = "OK"

check<sub>22</sub> := CheckPattern<sub>1</sub> = "OK"

check<sub>24</sub> := CheckPattern<sub>3</sub> = "OK"

check<sub>26</sub> := CheckInterfaceSteel = "OK"

check<sub>1</sub> := AcceptSDG = "N.A."

check<sub>3</sub> := Check<sub>f<sub>pt</sub></sub> = "OK"

check<sub>5</sub> := Check<sub>f<sub>tension.rel</sub></sub> = "OK"

check<sub>7</sub> := Check<sub>f<sub>tension.stage8</sub></sub> = "OK"

check<sub>9</sub> := Check<sub>f<sub>comp.stage8.c2</sub></sub> = "OK"

check<sub>11</sub> := CheckMomentCapacity = "OK"

check<sub>13</sub> := CheckStirArea = "OK"

check<sub>15</sub> := CheckMinStirArea = "OK"

check<sub>17</sub> := CheckLongSteel = "OK"

check<sub>19</sub> := CheckSplittingSteel = "N.A."

check<sub>21</sub> := CheckPattern<sub>0</sub> = "OK"

check<sub>23</sub> := CheckPattern<sub>2</sub> = "OK"

check<sub>25</sub> := CheckPattern<sub>4</sub> = "OK"

check<sub>27</sub> := CheckStrandFit = "OK"

check<sub>28</sub> := Check\_SDG1.2.Display<sub>2</sub> = "OK"

[Link to Note- Checks, 0, 1 & 2](#)



TotalCheck = "OK"

## LRFR Load Rating Analysis

*FDOT Maintenance Office Bridge Load Rating Manual*

### Load Rating Computations

	Moment (Strength) or Stress (Service)					Shear (Strength)				
LRFR <sub>loadrating</sub> =	"Limit State"	"DF"	"Rating"	"Tons"	"Dim(ft)"	"DF"	"Rating"	"Tons"	"Dim(ft)"	
"Strength I(Inv)"	0.39	1.91	"N/A"	13.32	13.32	0.56	5.02	"N/A"	1.39	HL-93
"Strength I(Op)"	0.39	2.47	"N/A"	13.32	13.32	0.56	6.51	"N/A"	1.39	HL-93
"Service III(Inv)"	0.39	1.78	"N/A"	13.32	13.32	"N/A"	"N/A"	"N/A"	"N/A"	HL-93
"Service III(Op)"	0.39	2.44	"N/A"	13.32	13.32	"N/A"	"N/A"	"N/A"	"N/A"	HL-93
"Strength II"	0.39	2.10	125.86	10.54	10.54	0.56	4.42	264.98	1.39	*Permit

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

### Longitudinal Steel Check:

CR<sub>LongSteel.HL93</sub> = 1.58    CR<sub>LongSteel.Permit</sub> = 1.57    CheckLongSteel<sub>loadrating</sub> = "OK"

### Write Data Out