LOAD RATING CALCULATIONS

DEVELOPMENTAL DESIGN STANDARDS

FSB SUPERSTRUCTURE PACKAGE

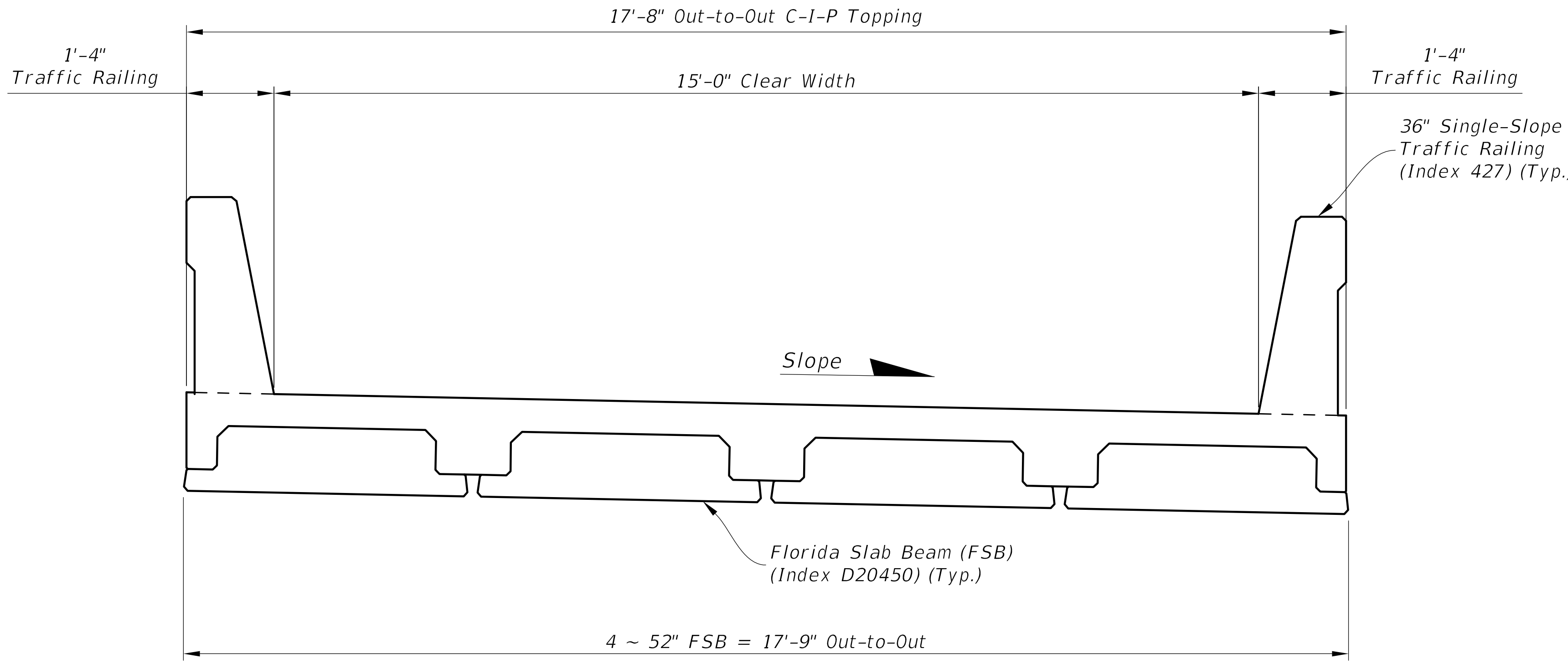
15 FT. CLEAR WIDTH

D30015 - 50 Ft. Span

Developmental Design Standards - FSB Superstructure Package

D30015	FDOT Bridge Load Rating Summary

			LRFR using Part A					
	Int. / Ext. Beam		Ext.			Int.		
	Span Length (ft)		50			50		
			Controlling Rating Factor					
Rating Level	Vehicle	Weight (Tons)	**Flexure (Strength)**	**Shear (Strength)**	**Stress (Service)**	**Flexure (Strength)**	**Shear (Strength)**	**Stress (Service)**
Design Operating	HL-93	36	2.29	6.05	N/A	2.68	7.78	N/A
Design Inventory			1.77	4.67	1.32	2.07	6.00	1.44
Permit	FL-120	60	1.70	4.33	N/A	1.99	5.56	N/A



D30015 - SUPERSTRUCTURE SECTION

LRFD Prestressed Beam Program

Project = "D30015 50 FT LR Ext"
DesignedBy = "FP"
Date = "7-1-2016"

filename = "C:\FDOT Structures\Programs\LRFDPBeamV5.0\FSB Data Files\D30015 50 FT LR Ext.dat"

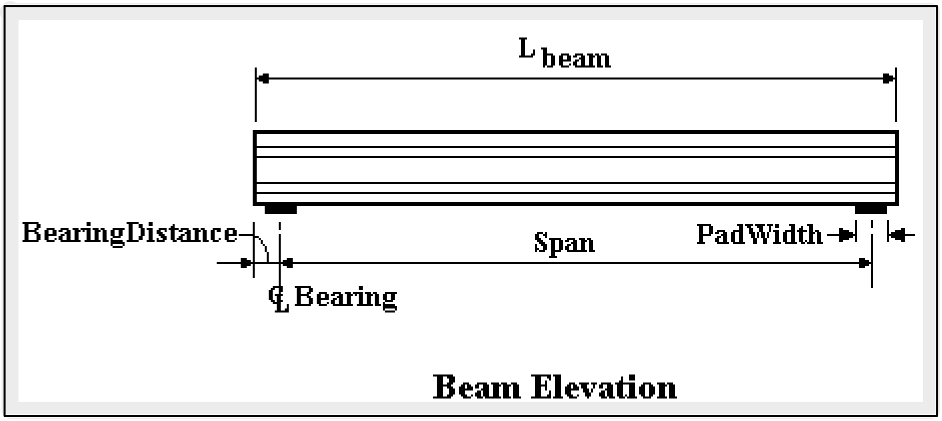
Comment = "FSB 15x52 50 FT"

Legend

TanHighlight = DataEntry | YellowHighlight = CheckValues | GreyHighlight = UserComments + Graphs

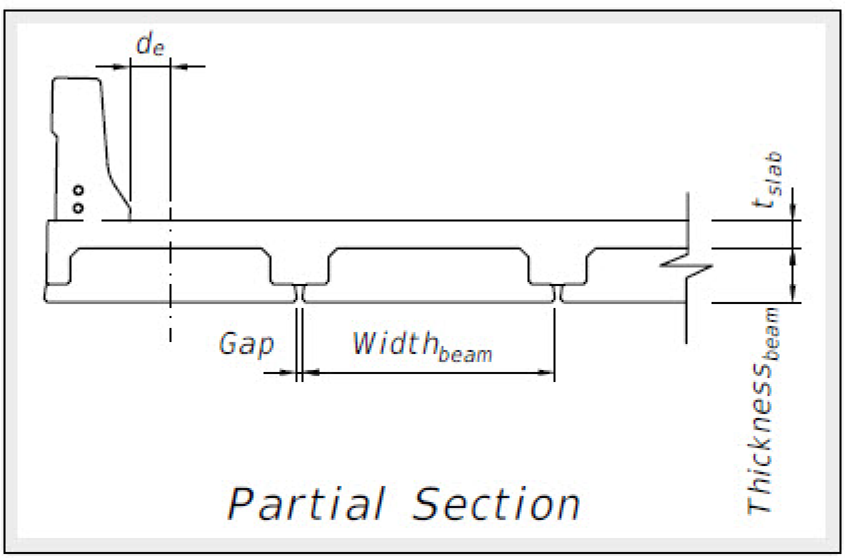
BlackText = ProgramEquations | *Maroon Text = Code Reference* | *Blue Text = Commentary*

Bridge Layout and Dimensions



L_{beam} = 48.83·ft   Span = 47.75·ft   BearingDistance = 6.5·in   PadWidth = 8·in

BeamTypeTog = "FSB15x52"   *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.*



$Overhang = 0 \cdot ft$ $BeamSpacing = 4.47 \cdot ft$ $t_{slab} = 6 \cdot in$ $h_{buildup} = 0 \cdot in$

$Skew = 0 \cdot deg$ $t_{integral.ws} = 0 \cdot in$ $NumberOfBeams = 4$ $t_{slab.delta} = 0.26 \cdot in$

$de = 0.79\,ft$

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

$b_e = 4.36\,ft$ *effective slab width* *LRFD 4.6.2.6*

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

Material Properties

Concrete:

Corrosion Classification Environment = "extremely"

density of slab concrete $\gamma_{slab} = 0.15 \cdot \frac{kip}{ft^3}$

strength of slab concrete $f_{c.slab} = 4.5 \cdot ksi$

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

strength of beam concrete $f_{c.beam} = 8.5 \cdot ksi$

weight of future wearing surface $Weight_{future.ws} = 0.015 \cdot \frac{kip}{ft^2}$

release beam strength $f_{ci.beam} = 6 \cdot ksi$

type of course aggregate, "Florida" *or* "Standard" AggregateType = "Florida"

relative humidity $H = 75$

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

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

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

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

Prestressing Tendons:

tendon ultimate tensile strength $f_{pu} = 270 \cdot ksi$

tendon modulus of elasticity $E_p = 28500 \cdot ksi$

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 $f_y = 60 \cdot ksi$

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

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

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

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

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

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

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

Size of bar used create used to calculate development length BarSize = 5

Permit Loads

This is the number of wheel loads that comprise the truck, max for DLL is 11 PermitAxles = 3

Indexes used to identify values in the P and d vectors $q := 0 .. (PermitAxles - 1)$ $qt := 0 .. PermitAxles$

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

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

Distribution Factors

DataMessage = "This is a FSB15x52 Florida Slab Beam design, AASHTO distribution factors used"

calculated values:

$tmp\_g_{mom} = 0.41$ $tmp\_g_{shear} = 0.61$ $tmp\_g_{mom.fatigue} = 0.25$

user value overrides (optional):

$user\_g_{mom} := 0.30$ $user\_g_{shear} := 0.59$ $user\_g_{mom.fatigue} := 0$

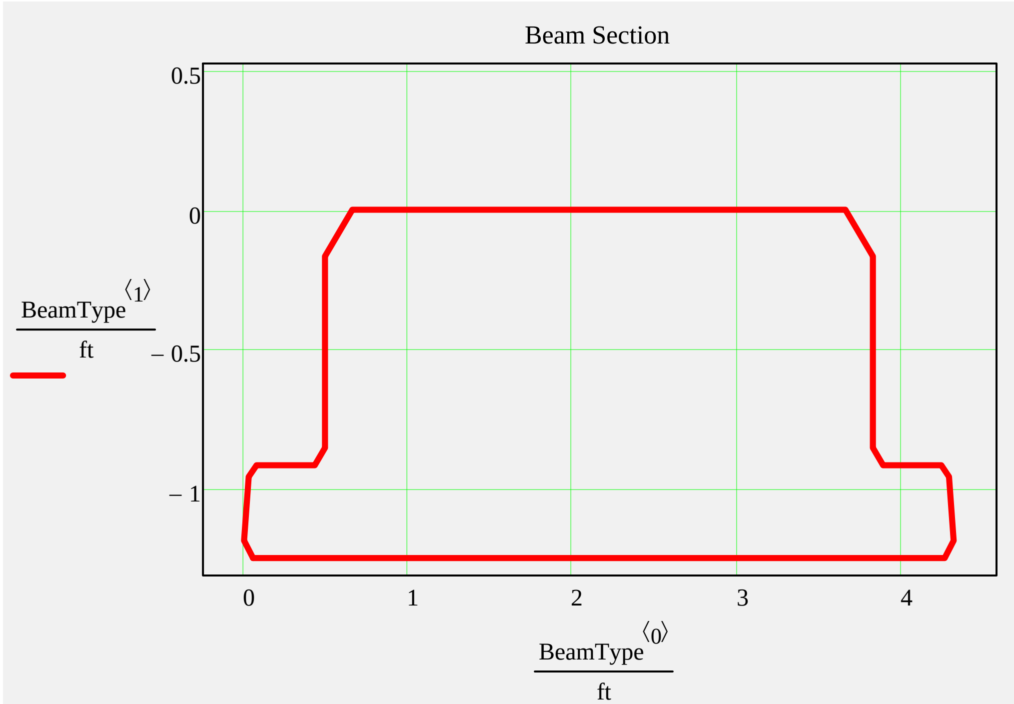
value check

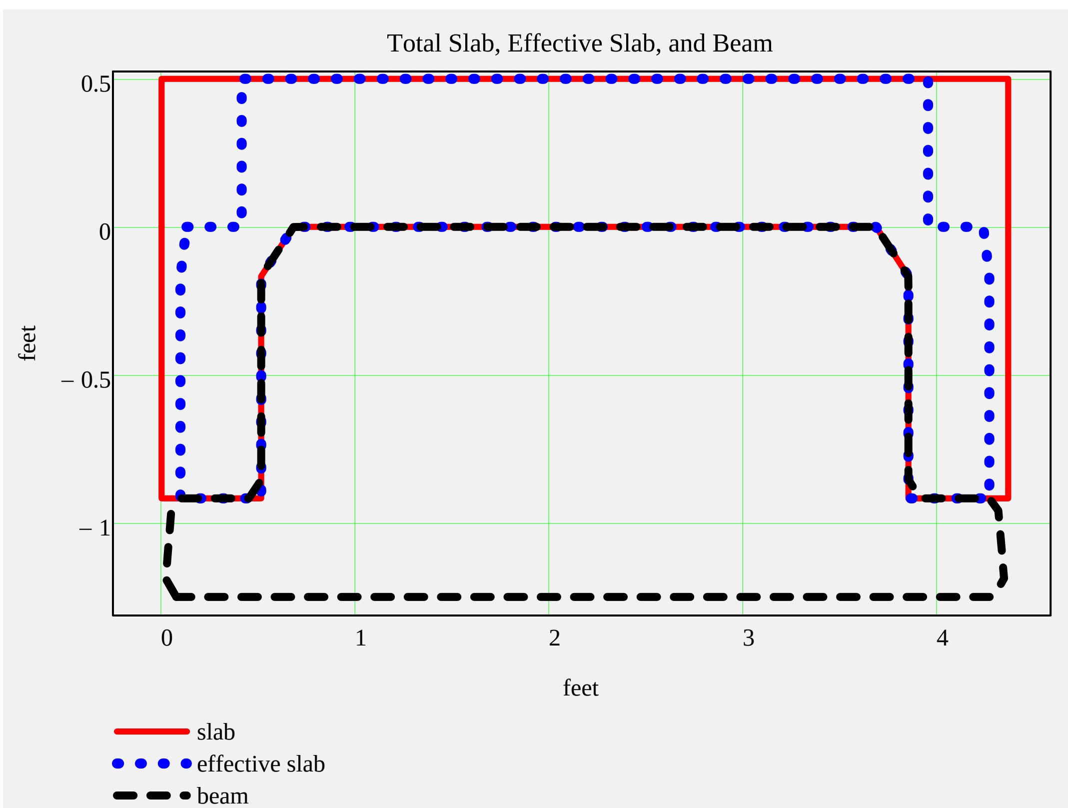
$g_{mom} := if(user\_g_{mom} \neq 0, user\_g_{mom}, tmp\_g_{mom})$ $g_{mom} = 0.3$

$g_{shear} := if(user\_g_{shear} \neq 0, user\_g_{shear}, tmp\_g_{shear})$ $g_{shear} = 0.59$

$g_{mom.fatigue} := if(user\_g_{mom.fatigue} \neq 0, user\_g_{mom.fatigue}, tmp\_g_{mom.fatigue})$ $g_{mom.fatigue} = 0.25$

Section Views





Non-Composite Dead Load Input:

$w_{slab} = 0.473 \cdot \frac{kip}{ft}$ $w_{beam} = 0.668 \cdot \frac{kip}{ft}$ $w_{forms} = 0 \cdot \frac{kip}{ft}$

$Add\_w_{noncomp} := 0.0 \cdot \frac{kip}{ft}$

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

$w_{noncomposite} := w_{slab} + w_{beam} + w_{forms} + Add\_w_{noncomp}$ $w_{noncomposite} = 1.141 \cdot \frac{kip}{ft}$

$wb_{noncomposite} := w_{slab} + w_{forms} + Add\_w_{noncomp}$ $wb_{noncomposite} = 0.473 \cdot \frac{kip}{ft}$

Diaphragms/Point Load Input

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

EndDiaphragmA := 0·kip *begin bridge*

EndDiaphragmE := 0·kip *end bridge*

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

input load is per beam

IntDiaphragmB := 0·kip
DistB := 0·ft

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

IntDiaphragmC := 0·kip
DistC := 0·ft

IntDiaphragmD := 0·kip
DistD := 0·ft

Composite Dead Load Input:

$w_{future.ws} = 0.044 \cdot \frac{kip}{ft}$ $w_{barrier} = 0.215 \cdot \frac{kip}{ft}$

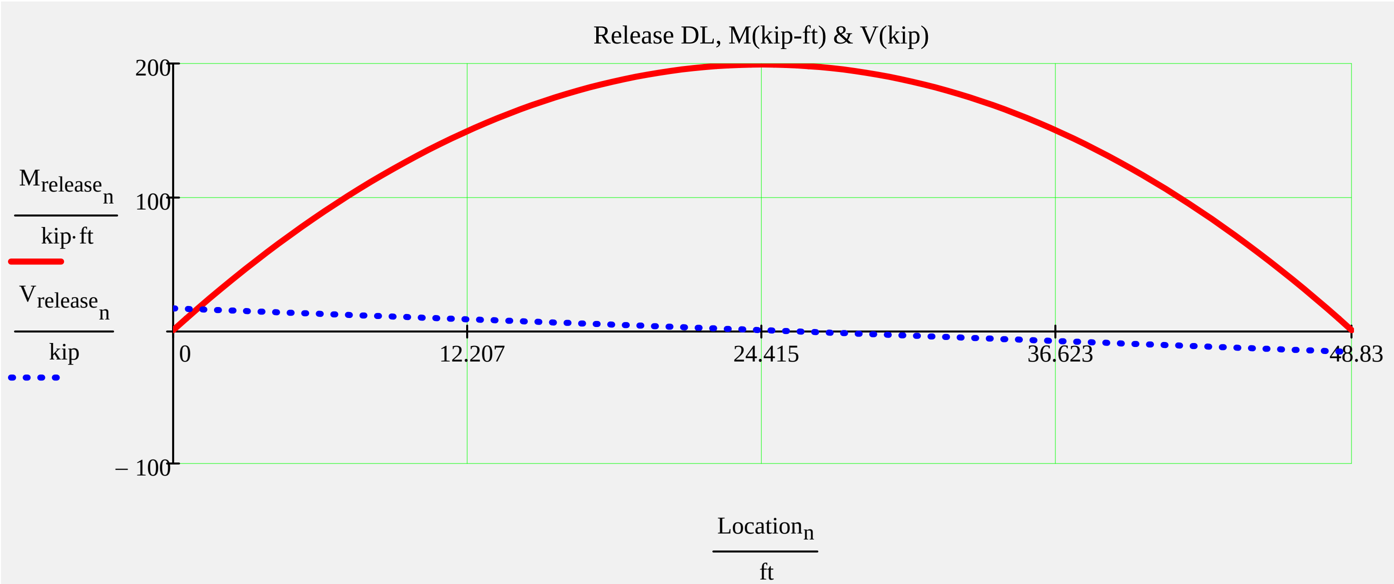
$Add\_w_{comp} := 0.0 \cdot \frac{kip}{ft}$

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

$w_{composite} := w_{future.ws} + w_{barrier} + Add\_w_{comp}$ $w_{composite} = 0.259 \cdot \frac{kip}{ft}$

$w_{comp.str} := w_{barrier} + Add\_w_{comp}$ $w_{comp.str} = 0.215 \cdot \frac{kip}{ft}$

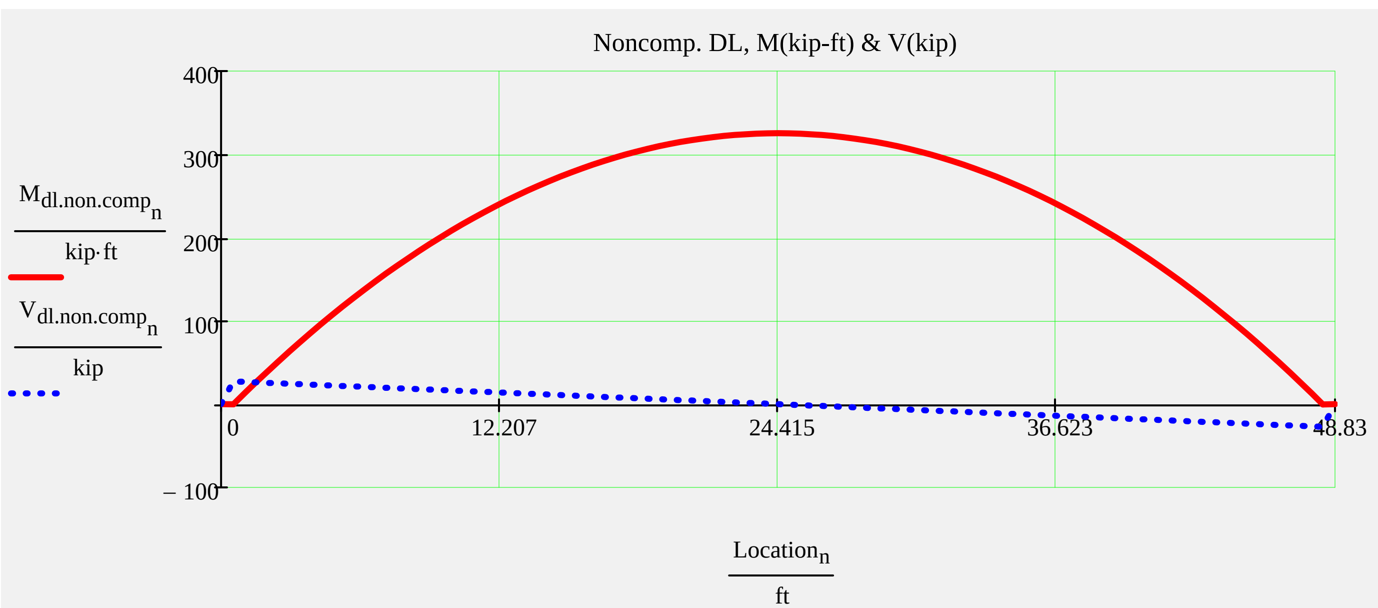
Release Dead Load Moments and Shear



$\max(M_{release}) = 199.2 \cdot kip \cdot ft$

$\max(V_{release}) = 16.3 \cdot kip$

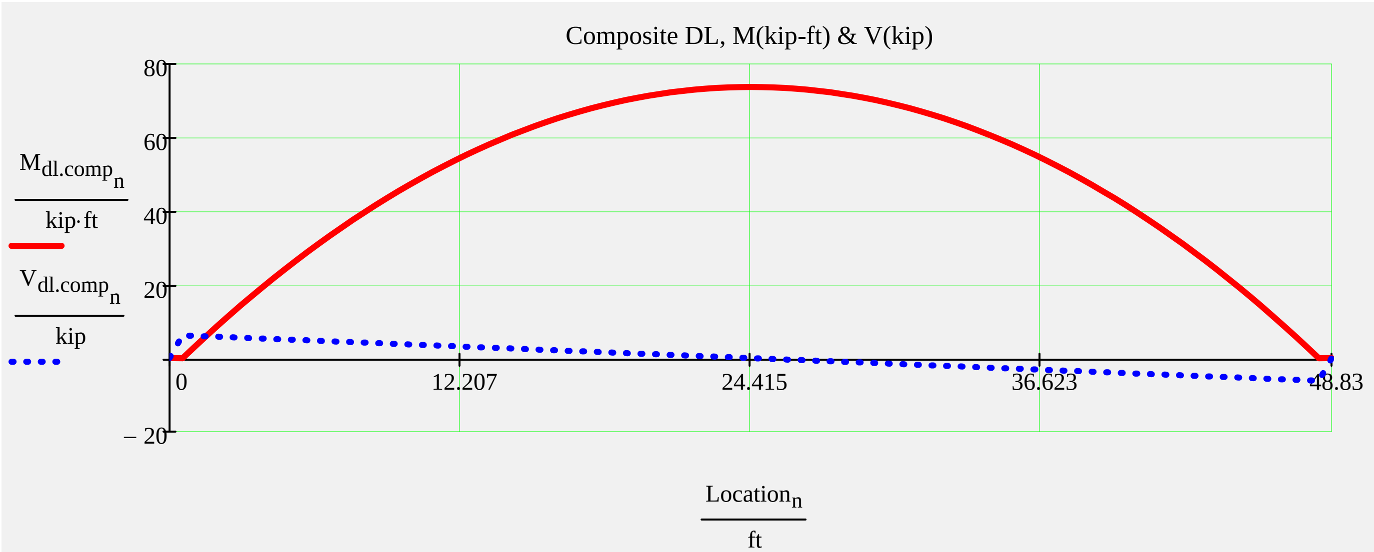
Noncomposite Dead Load Moments and Shear



$\max(M_{dl.non.comp}) = 325.3 \cdot kip \cdot ft$

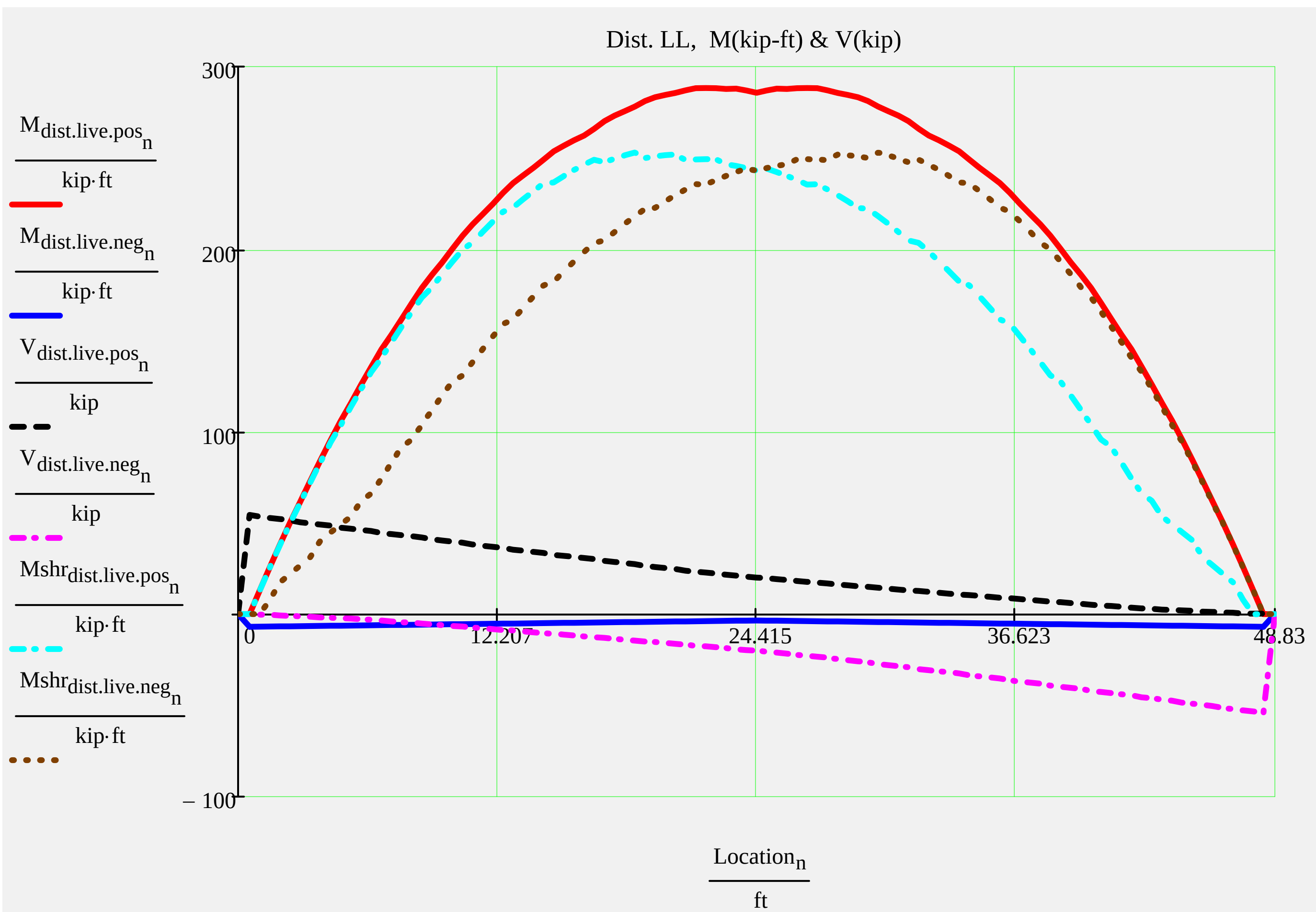
$\max(V_{dl.non.comp}) = 27.2 \cdot kip$

Composite Dead Load Moments and Shear



$max(M_{dl.comp}) = 73.7 \cdot kip \cdot ft$ $max(V_{dl.comp}) = 6.2 \cdot kip$

Distributed Live Load Moments and Shear



Beam End Reactions... with IM factor only

$max(M_{dist.live.pos}) = 288.3 \cdot kip \cdot ft$ $min(M_{dist.live.neg}) = -6.9 \cdot kip \cdot ft$ $Reaction_{LL} = 55.31 \cdot kip$

$max(V_{dist.live.pos}) = 54.4 \cdot kip$ $max(Mshr_{dist.live.pos}) = 252.9 \cdot kip \cdot ft$ $Reaction_{DL} = 34.18 \cdot kip$

Prestress Strand Layout Input

Instructions:

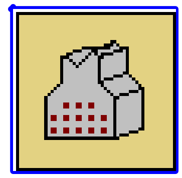
Double click the icon to open the 'Strand Pattern Generator'. Specify the type, location, size, and debonding of strands. When finished, press the 'Continue' button. Then press 'Read Strand Data' button. Then press 'Recalculate Worksheet' button.

Strand Pattern Input Mode:

StrandTemplate :=

Standard
Custom

Strand Pattern Generator:



Recalculate Worksheet

Read Strand Data

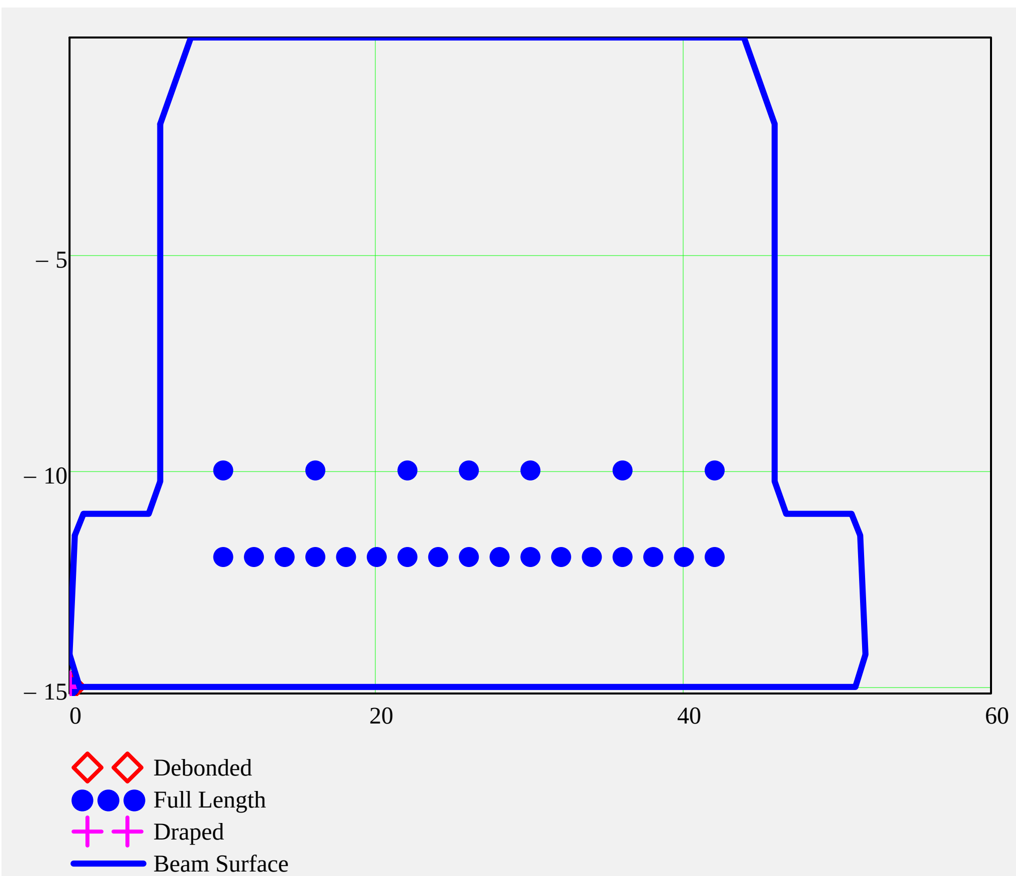
Collapsed Region for Custom Strand Sizes...

Strand Multiplier

Strand Data and Pattern

Strand Properties

Tendon Layout



$\text{SupportLocation}_{\text{release}} \equiv 0 \cdot \text{ft}$ *distance supports are located from the end of the beam after release; may be used to check lifting points immediately after transfer*

Partially Stressed Tendons ("Strand N")

$PartialPS_{force} \equiv 40 \cdot kip$ *partial prestress total force*

$PartialPS_{force} := if(BeamTypeTog = "II", 20 \cdot kip, PartialPS_{force})$ $PartialPS_{force} = 40 \cdot kip$

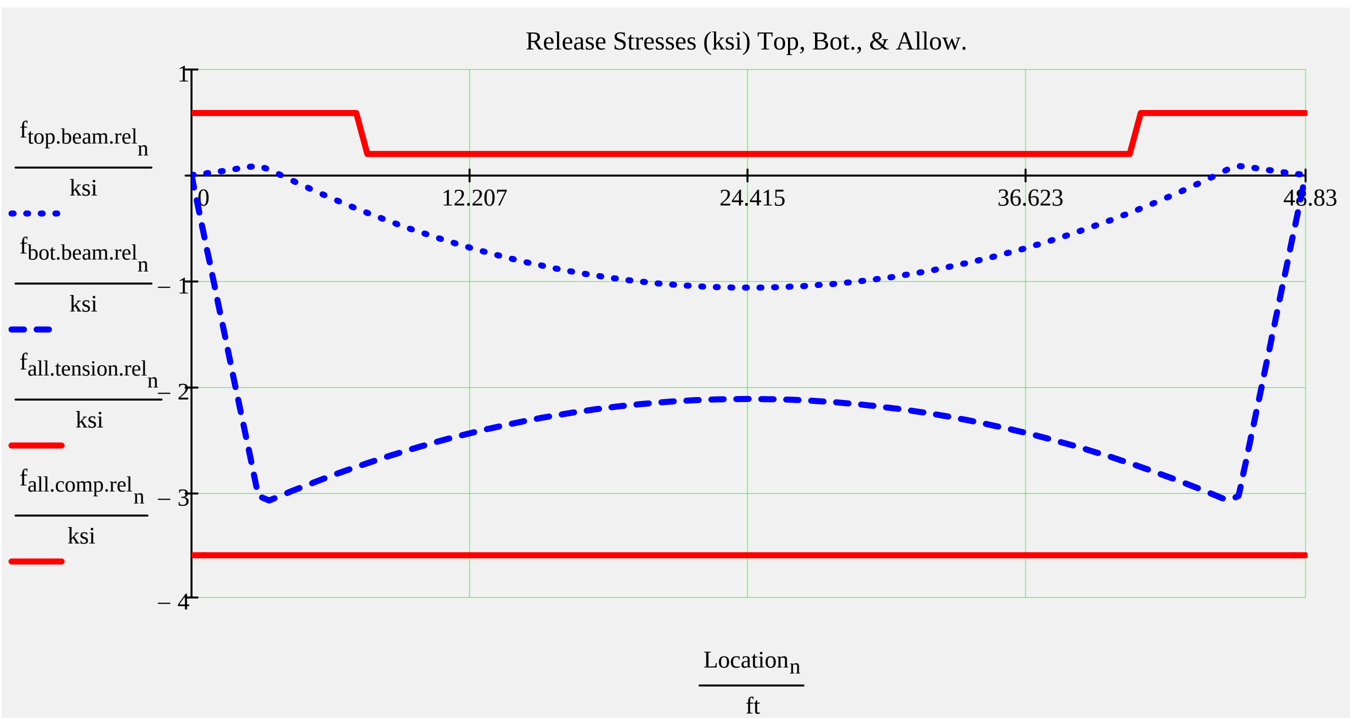
$PartialPS_{location} \equiv 1.4375in$ *centroid location of partial prestress from the top of the beam*

$PartialPS_{location} :=$
| 2.4375·in if BeamTypeTog = "II"
| 3·in if substr(BeamTypeTog, 0, 5) = "FSB12"
| 2·in if substr(BeamTypeTog, 0, 5) = "FSB15"
| 3·in if substr(BeamTypeTog, 0, 5) = "FSB18"
| $PartialPS_{location}$ otherwise

$PartialPS_{location} = 2 \cdot in$

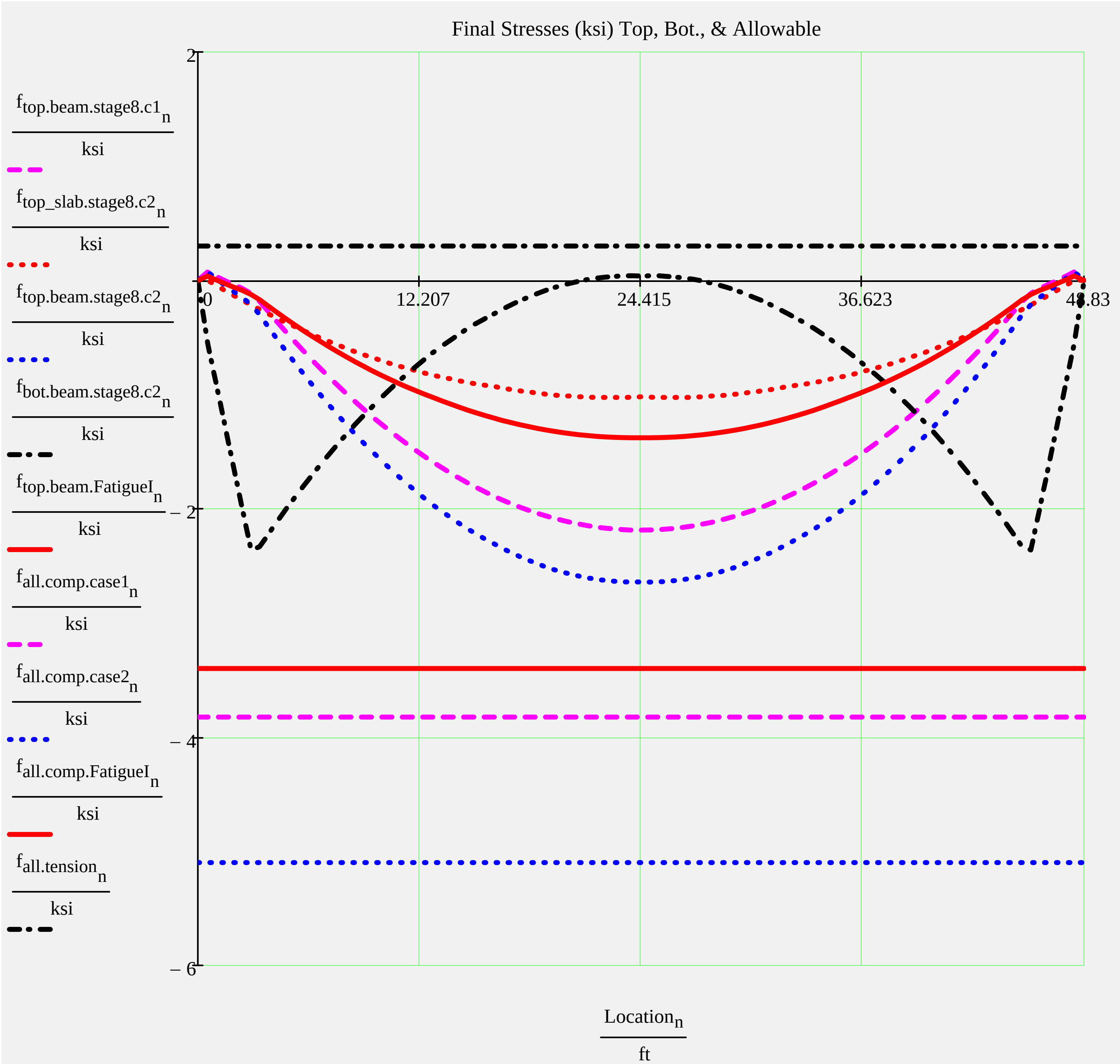
▶ Section Properties & Strand Profile Properties

Release Stresses



▶ Prestress Force

Final Stresses



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

Stress Checks

$\min(CR\_f_{tension.rel}) = 6.78$	$Check\_f_{tension.rel}$ = "OK"	*(Release tension)*
$\min(CR\_f_{comp.rel}) = 1.17$	$Check\_f_{comp.rel}$ = "OK"	*(Release compression)*
$\min(CR\_f_{tension.stage8}) = 7.52$	$Check\_f_{tension.stage8}$ = "OK"	*(Service III , PS + DL +LL*0.8)*
$\min(CR\_f_{comp.stage8.c1}) = 1.75$	$Check\_f_{comp.stage8.c1}$ = "OK"	*(Service I , PS + DL)*
$\min(CR\_f_{comp.stage8.c2}) = 1.93$	$Check\_f_{comp.stage8.c2}$ = "OK"	*(Service I , PS + DL +LL)*
$\min(CR\_f_{comp.FatigueI}) = 2.47$	$Check\_f_{comp.FatigueI}$ = "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*

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

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

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

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

Section and Strand Properties Summary

Section and Strand Properties Summary

$A_{beam} = 641.75 \cdot in^2$ *Concrete area of beam*

$I_{beam} = 12381.9946 \cdot in^4$ *Gross Moment of Inertia of Beam about CG*

$y_{comp} = -4.89 \cdot in$ *Dist. from top of beam to CG of gross composite section*

$I_{comp} = 36146.4645 \cdot in^4$ *Gross Moment of Inertia Composite Section about CG*

$A_{deck} = 367.76 \cdot in^2$ *Concrete area of deck slab*

$A_{ps} = 5.2 \cdot in^2$ *total area of strands*

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

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

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

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

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

$A_{ps.row}{}^T = (3.7 \quad 1.5 \quad 0.2) \cdot in^2$

$d_{ps.row} =$ (·in)

	0	1	2	3	4	5	6	7	8	9
0	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12
1	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
2	-2	-2	-2	-2	-2	-2	-2	-2	-2	...

TotalNumberOfTendons = 24

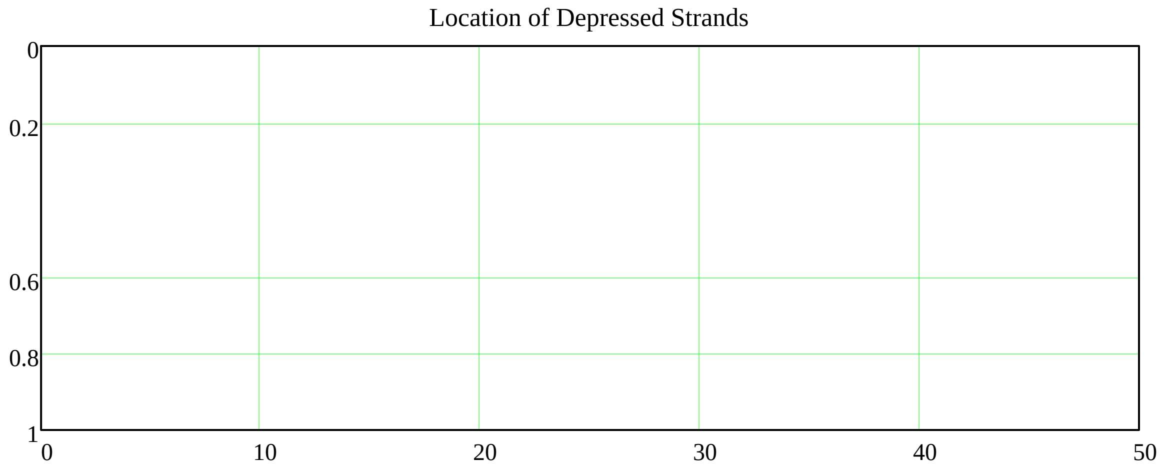
NumberOfDebondedTendons = 0

NumberOfDrapedTendons = 0

StrandSize = "0.6 in low lax"

$StrandArea = 0.22 \cdot in^2$

$JackingForce_{per.strand} = 43.94 \cdot kip$



Section and Strand Properties Summary

Prestress Losses Summary

$f_{pj} = 202.5 \cdot ksi$ | Check_f_{pt} = "OK"

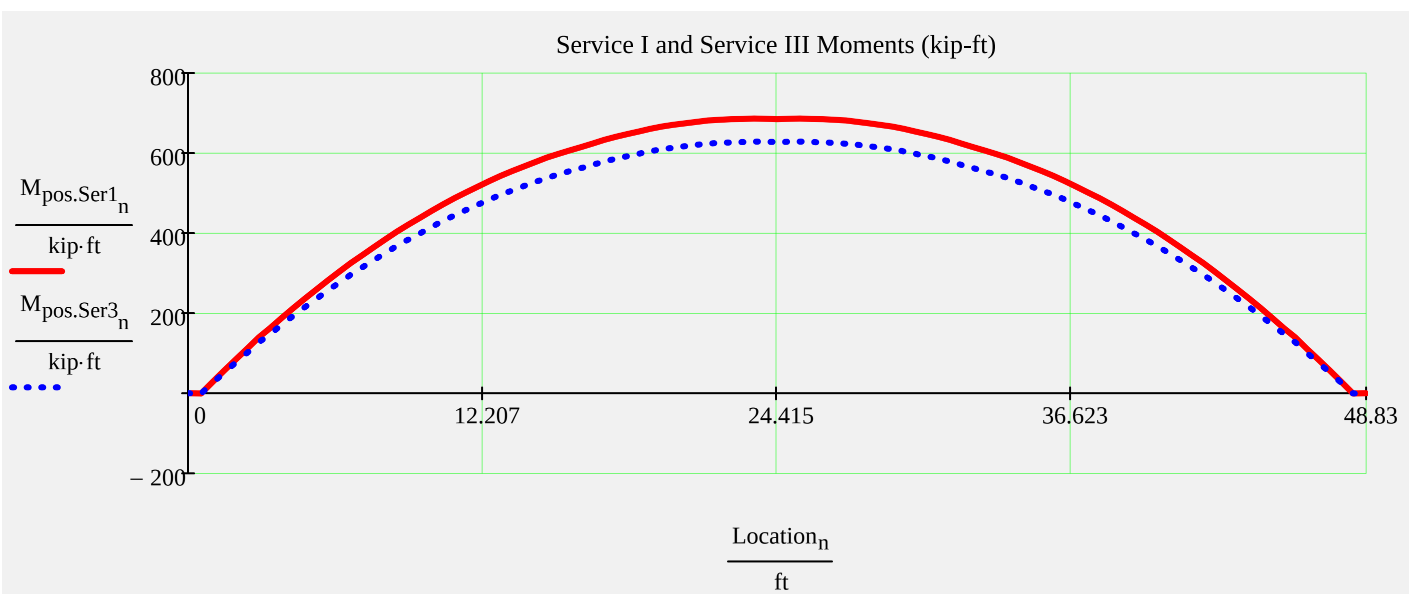
$\Delta f_{pES} = 0 \cdot ksi$ | *Note: Elastic shortening losses are zero in concrete stress calculations when using transformed section properties per LRFD 5.9.5.2.3*

$\Delta f_{pT} = -22 \cdot ksi$ | $\frac{\Delta f_{pT}}{f_{pj}} = -10.71 \cdot \%$

$f_{pe} = 181 \cdot ksi$ | $\frac{f_{pe}}{f_{pj}} = 89.29 \cdot \%$

$0.8 \cdot f_{py} = 194 \cdot ksi$ | Check_f_{pe} = "OK"

Service Limit State Moments



$\max(M_{pos.Ser1}) = 686.3 \cdot kip \cdot ft$ $\quad$ $\max(M_{pos.Ser3}) = 628.7 \cdot kip \cdot ft$

Summary of Values at Midspan

Stresses =

"Stage "	"Top of Beam (ksi) "	"Bott of Beam (ksi)"
1	–1.07	–2.12
2	–1.11	–1.75
4	–1.05	–1.81
6	–2.07	–0.93
8	–2.64	0.04

PrestressForce =

"Condition "	"Axial (kip)"	"Moment (kip*ft)"
"Release"	–1094.6	–288.7
"Final (about composite centroid)"	–977.4	–246

Properties =

"Section "	"Area (in^2) "	"Inertia (in^4) "	"distance to centroid from top of bm (in)"
"Net Beam "	636.35	12307.11	–7.91
"Transformed Beam (initial)"	670.46	12765.19	–8.07
"Transformed Beam "	666.76	12717.06	–8.05
"Composite "	1040.91	37640.37	–4.99

ServiceMoments =

"Type "	"Value (kip*ft)"
"Release"	199.2
"Non-composite (includes bm wt.)"	325.3
"Composite"	73.7
"Distributed Live Load"	285.6

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

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

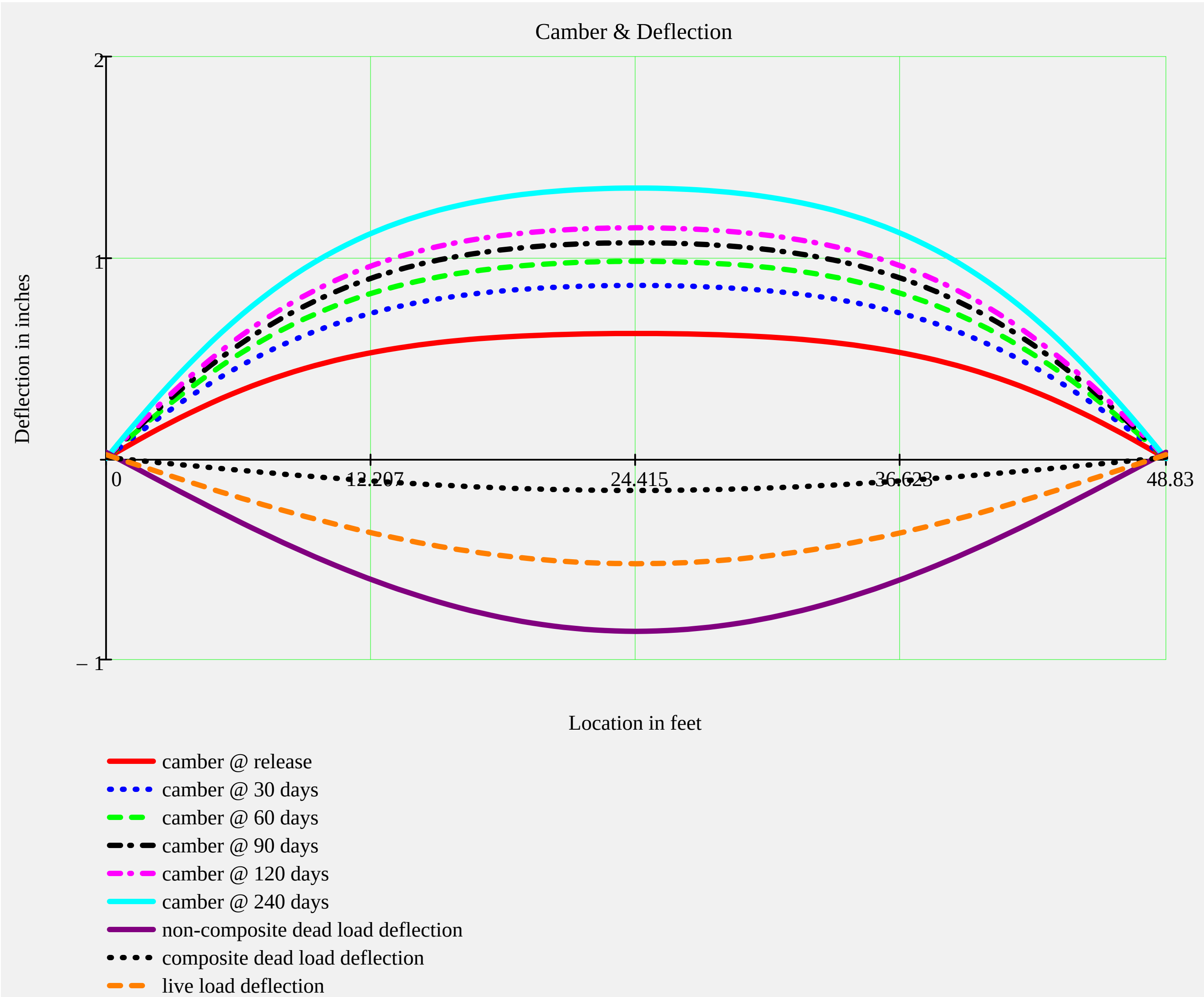
Stage 4 ---> Same as stage 2 with supports changed from the end of the beam to the bearing locations

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

Stage 8 ---> Stage 6 with the addition of composite dead load and live loads applied to the composite section

Camber at Release, Short Term Camber, & Summary of Slope Data

Camber, Shrinkage, and Dead Load Deflection Components

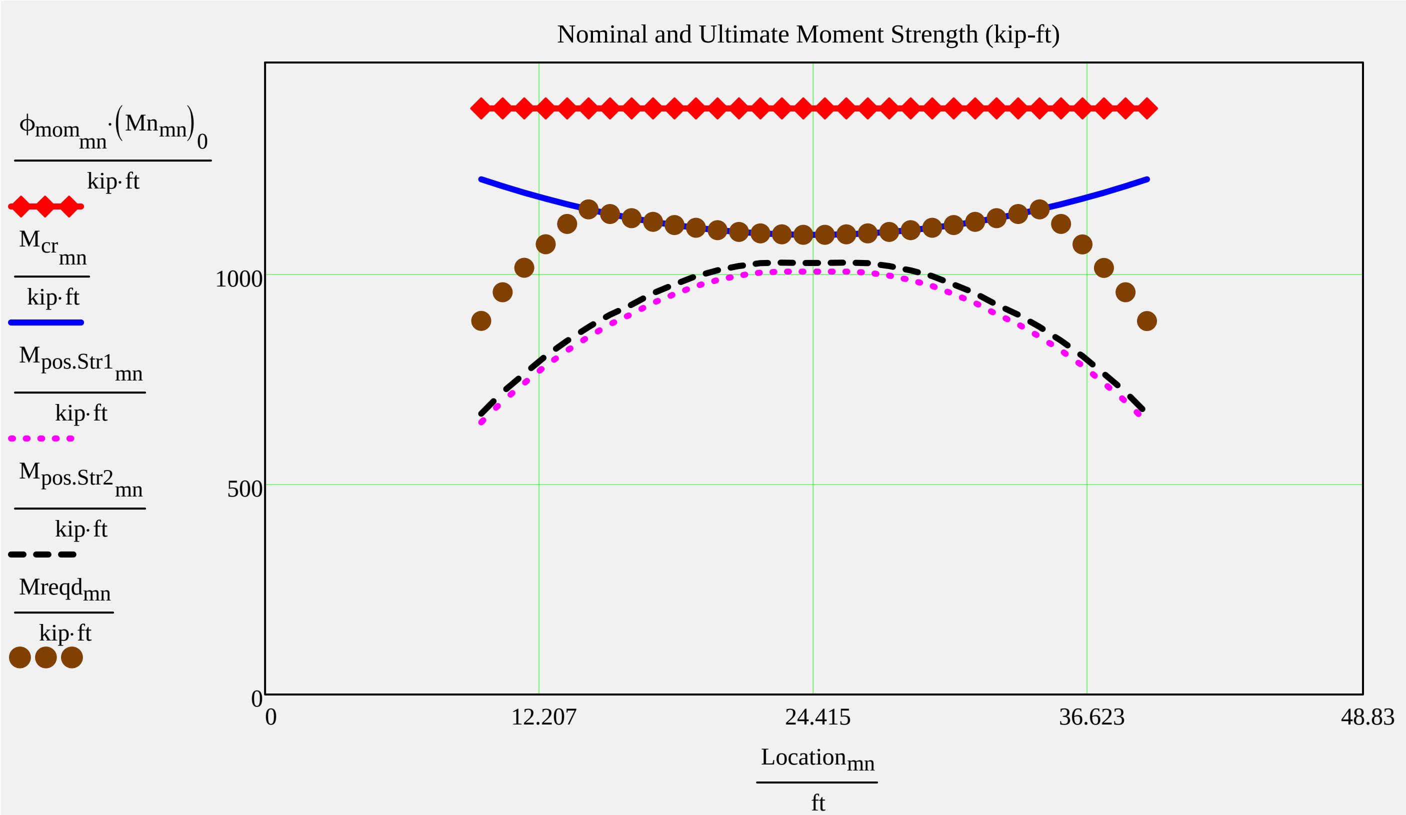


SlopeData =

"Stage"	"Change in L @ Top (in)"	"Change in L @ Bot. (in)"	"Slope at End (deg)"	"midspan defl (in)"
"Release"	−0.0759	−0.3069	0.3162	0.6222
"30 Days"	−0.2111	−0.5855	0.5519	0.8613
"60 Days"	−0.2609	−0.6884	0.643	0.9813
"90 Days"	−0.2869	−0.7418	0.6904	1.0735
"120 Days"	−0.3028	−0.7746	0.7195	1.148
"240 Days"	−0.3317	−0.8343	0.7723	1.3456
"non-comp DL"	−0.0773	0.0667	−0.2752	−0.8595
"comp DL"	−0.0088	0.0177	−0.0508	−0.1587
"LL"	−0.0296	0.0595	−0.1704	−0.5232

Ultimate Moment Capacity

Strength Limit State Moments



$CR_{Str.mom_n} := 10$ $CR_{Str.mom_{mn}} := \frac{\phi_{mom_{mn}} \cdot (Mn_{mn})_0}{Mreqd_{mn}}$ *(LRFD 5.7.3.3.2)* $\min(CR_{Str.mom}) = 1.21$

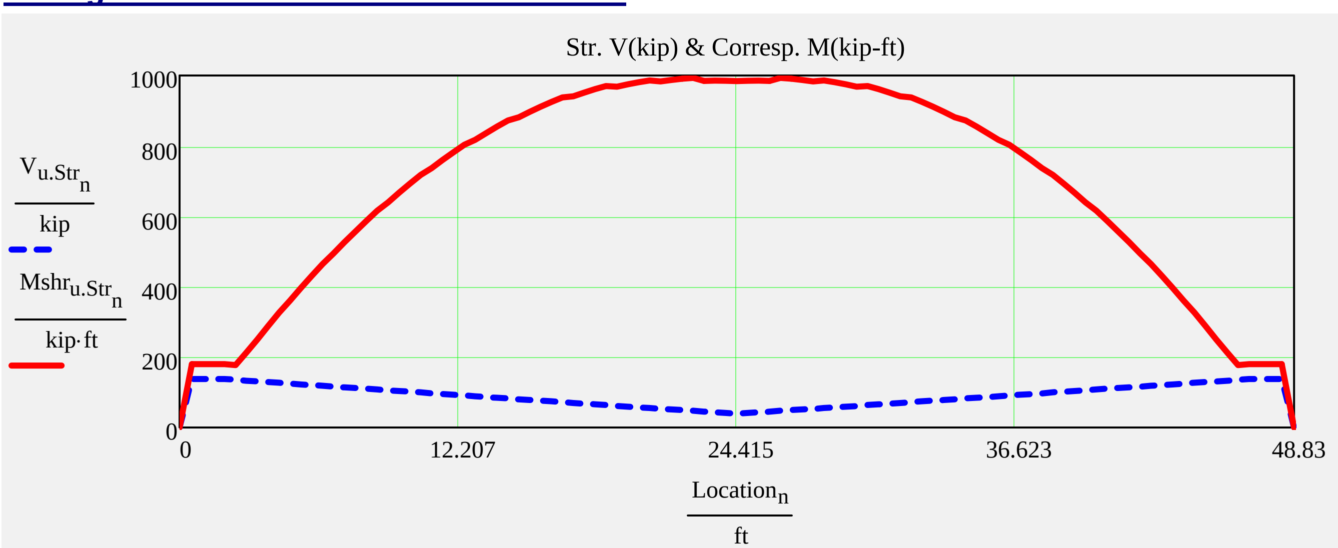
$\max(Mreqd) = 1151.5 \cdot kip \cdot ft$ CheckMomentCapacity := if $(\min(CR_{Str.mom}) > 0.99$, "OK" , "No Good!")

CheckMomentCapacity = "OK"

FSB only - Design Check of Transverse reinforcing Bars E

Shear Analysis

Strength Shear and Associated Moments



$\max(V_{u.Str}) = 137.7 \cdot kip$ $\max(Mshr_{u.Str}) = 993.3 \cdot kip \cdot ft$

Design Shear, Longitudinal, Interface and Anchorage Reinforcement

Stirrup sizes and spacings assigned in input file

Location	spacing	Number of Spaces	area per stirrup
A1 stirrup	12	4	0.8
A2 stirrup	18	1	0.8
A3 stirrup	18	1	0.8
S1 stirrup	18	1	0.8
S2 stirrup	18	1	0.8
S3 stirrup	18	1	0.8
S4 stirrup	18	0	0.8

$tmp\_s = (12, 18, 18, 18, 18, 18, 18)^T \cdot in$

$tmp\_NumberSpaces = (4, 1, 1, 1, 1, 1, 0)^T$

$tmp\_A_{stirrup} = (0.8, 0.8, 0.8, 0.8, 0.8, 0.8, 0.8)^T \cdot in^2$

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.

Location	$user\_s_{nspacings} :=$	$user\_NumberSpaces_{nspacings} :=$	$user\_A_{stirrup_{nspacings}} :=$	$interface\_factor_{nspacings} :=$
A1 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	0.25
A2 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	0.5
A3 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	1
S1 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	1
S2 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	1
S3 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	1
S4 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	1
			$-1 \cdot in^2$	

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.

Location	s (in)	NumberSpaces	$A_{stirrup}$ (in^2)
A1 stirrup	12	4	0.8
A2 stirrup	18	1	0.8
A3 stirrup	18	1	0.8
S1 stirrup	18	1	0.8
S2 stirrup	18	1	0.8
S3 stirrup	18	1	0.8
S4 stirrup	18	8.25	0.8

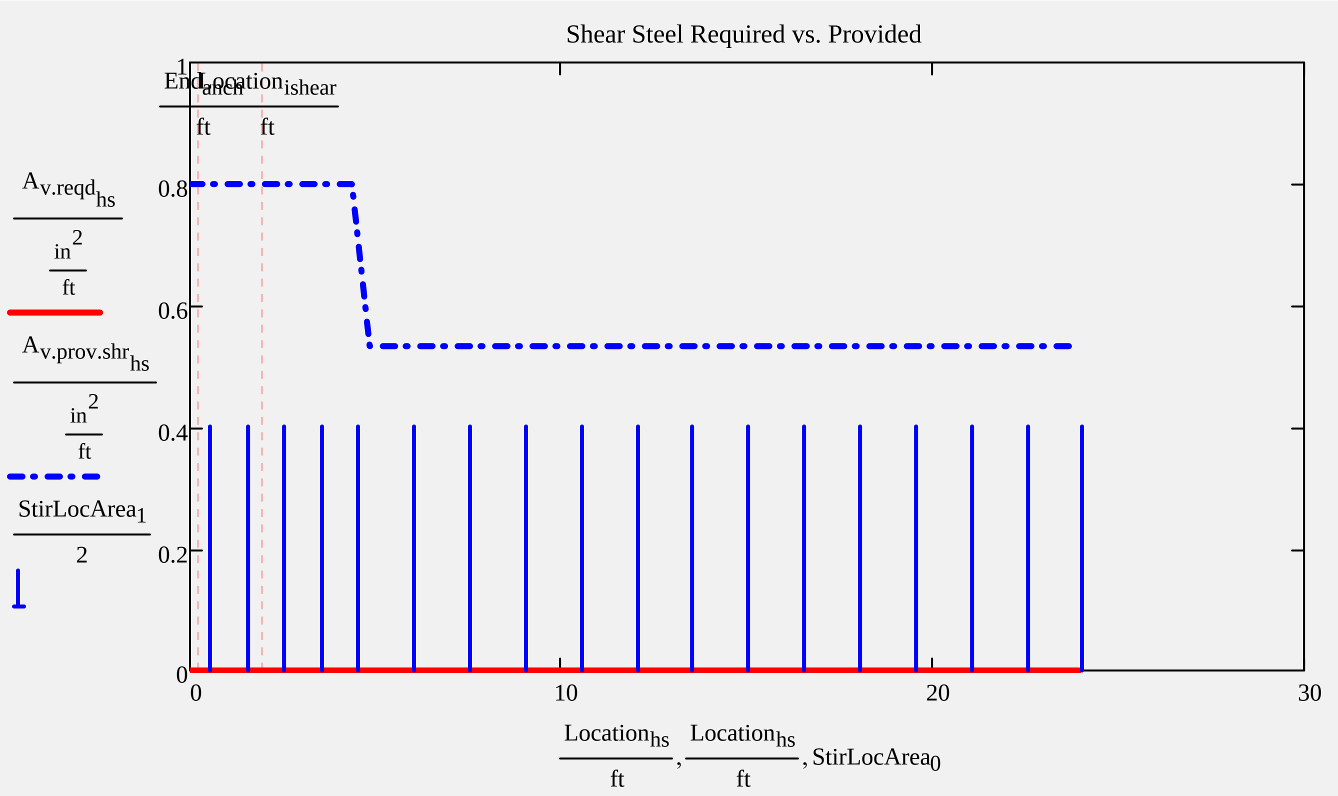
$s = (12, 18, 18, 18, 18, 18, 18)^T \cdot in$

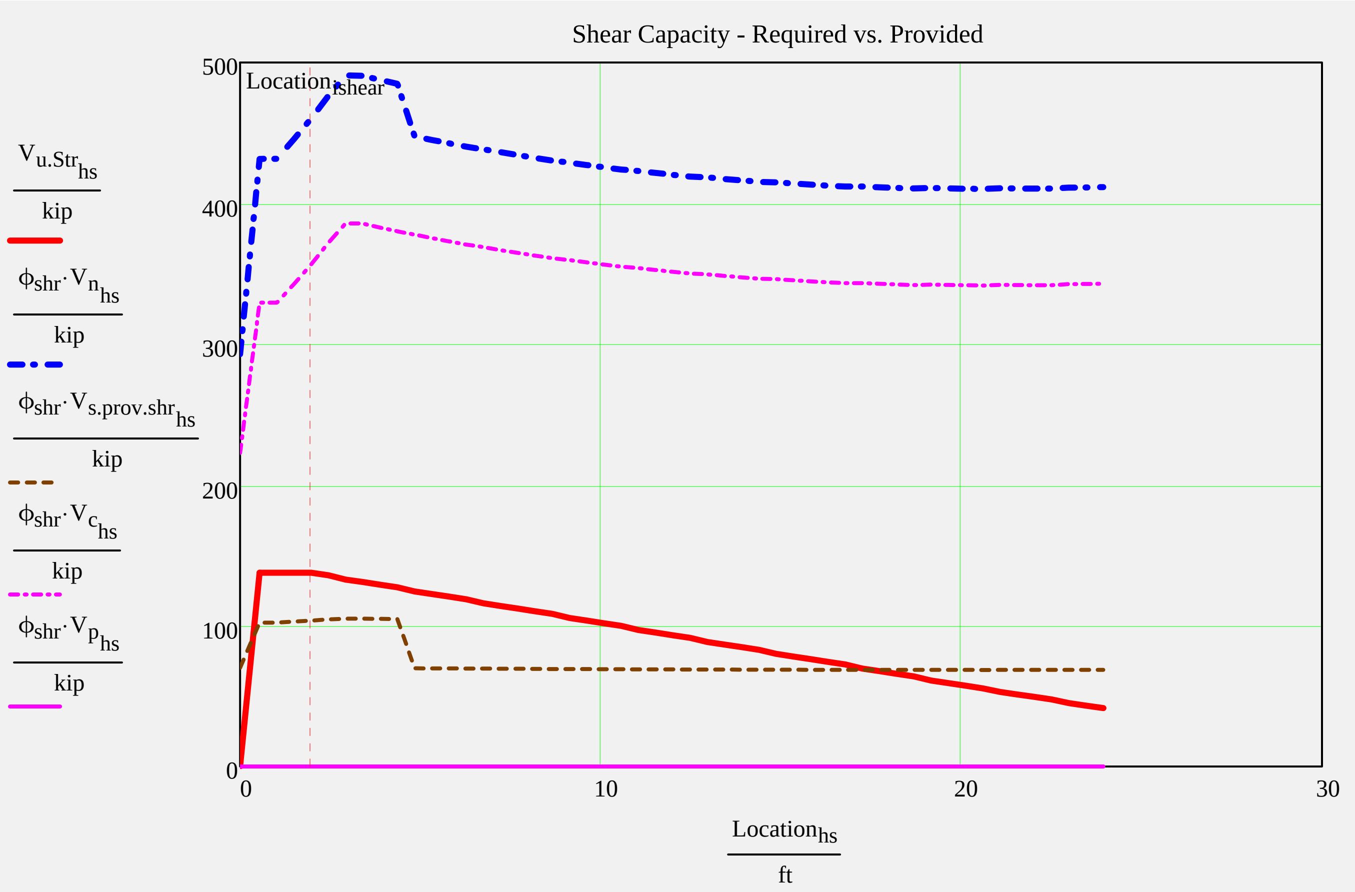
$NumberSpaces = (4, 1, 1, 1, 1, 1, 8.25)^T$

$A_{stirrup} = (0.8, 0.8, 0.8, 0.8, 0.8, 0.8, 0.8)^T \cdot in^2$

$EndCover = 6.5 \cdot in$

Shear Steel Required vs. Provided Computation





Computation for Checks

CheckShearCapacity = "OK"

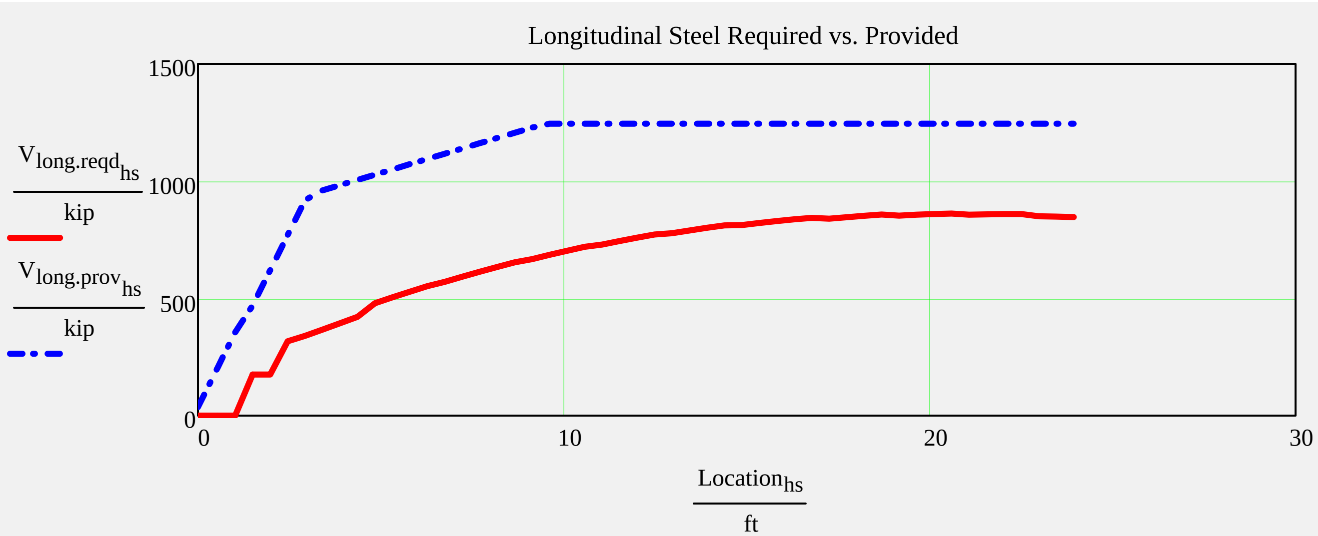
CheckMaxShearStress = "OK"

CheckStirArea = "OK"

CheckMinStirArea = "OK"

CheckMaxStirSpacing = "OK"

Longitudinal Reinforcement



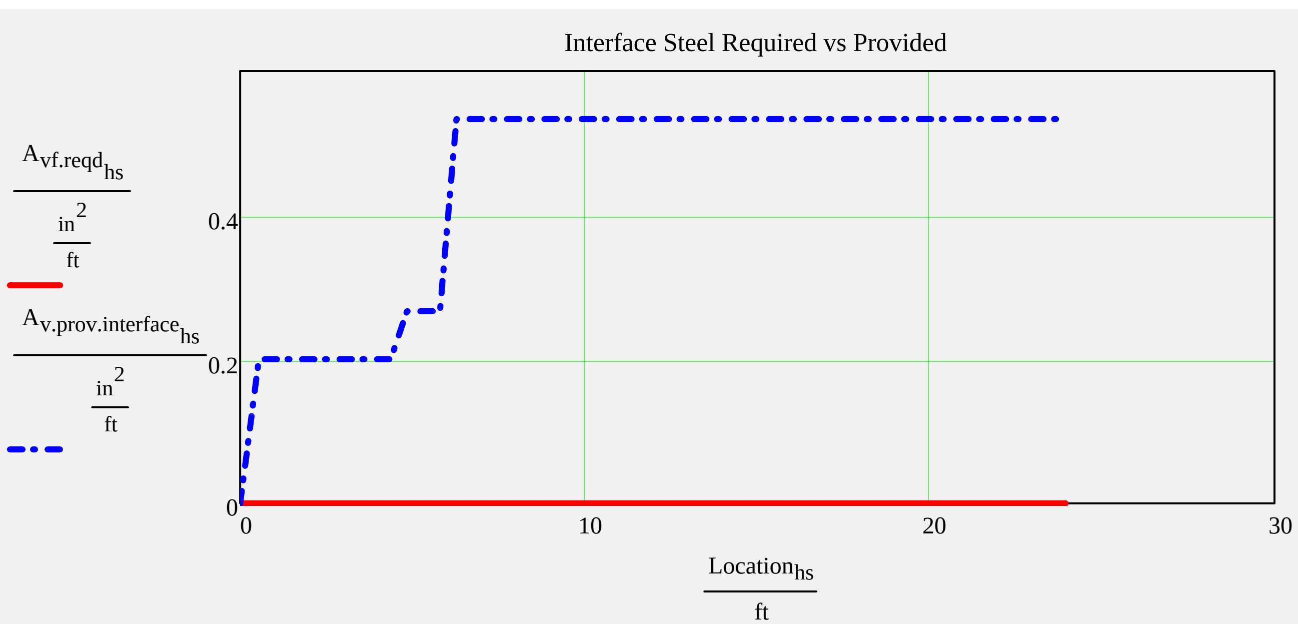
$CR_{LongSteel_{hs}} := \text{if}\left(V_{long.reqd_{hs}} < .01\text{kip}, 100, \frac{V_{long.prov_{hs}}}{V_{long.reqd_{hs}}}\right)$

$\min\left(CR_{LongSteel}\right) = 1.44$

CheckLongSteel := if(min(CR_LongSteel) > 1, "OK", "No Good, add steel!")

CheckLongSteel = "OK"

Interface Shear Reinforcement



Interface Steel

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.*

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

If max(Avf.min) or max(Avf.des) is greater than 0 in²/ft, interface steel is required.

CheckInterfaceSpacing = "OK"

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

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 := yes

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

Splitting (Bursting) Resistance

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

Summary of Design Checks

$check_0$:= AcceptAASHTO	$check_1$:= AcceptSDG	$check_2$:= AcceptOntario
$check_3$:= $Check\_f_{pt}$	$check_4$:= $Check\_f_{pe}$	$check_5$:= $Check\_f_{tension.rel}$
$check_6$:= $Check\_f_{comp.rel}$	$check_7$:= $Check\_f_{tension.stage8}$	$check_8$:= $Check\_f_{comp.stage8.c1}$
$check_9$:= $Check\_f_{comp.stage8.c2}$	$check_{10}$:= $Check\_f_{comp.FatigueI}$	$check_{11}$:= CheckMomentCapacity
$check_{12}$:= CheckMaxCapacity	$check_{13}$:= CheckStirArea	$check_{14}$:= CheckShearCapacity
$check_{15}$:= CheckMinStirArea	$check_{16}$:= CheckMaxStirSpacing	$check_{17}$:= CheckLongSteel
$check_{18}$:= CheckInterfaceSpacing	$check_{19}$:= CheckSplittingSteel	$check_{20}$:= CheckMaxPrestressingForce
$check_{21}$:= $CheckPattern_0$	$check_{22}$:= $CheckPattern_1$	$check_{23}$:= $CheckPattern_2$
$check_{24}$:= $CheckPattern_3$	$check_{25}$:= $CheckPattern_4$	$check_{26}$:= CheckInterfaceSteel
$check_{27}$:= CheckStrandFit	$check_{28}$:= $Check\_SDG_{1.2.Display_2}$	**Link to Note- Checks, 0, 1 & 2**

$check^T$ =

	0	1	2	3	4
0	"OK"	"N.A."	"N.A."	"OK"	...

click table to reveal scroll bar... TotalCheck = "OK"

LRFR Load Rating Analysis

FDOT Maintenance Office Bridge Load Rating Manual

▶ Load Rating Computations

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

$LRFR_{loadrating} =$

"Limit State"	"DF"	"Rating"	"Tons"	"Dim(ft)"	"DF"	"Rating"	"Tons"	"Dim(ft)"	
"Strength I(Inv)"	0.30	1.77	"N/A"	22.44	0.59	4.67	"N/A"	1.43	HL-93
"Strength I(Op)"	0.30	2.29	"N/A"	22.44	0.59	6.05	"N/A"	1.43	HL-93
"Service III(Inv)"	0.30	1.32	"N/A"	22.92	"N/A"	"N/A"	"N/A"	"N/A"	HL-93
"Service III(Op)"	0.30	1.89	"N/A"	22.92	"N/A"	"N/A"	"N/A"	"N/A"	HL-93
"Strength II"	0.30	1.70	101.85	21.49	0.59	4.33	259.60	1.43	*Permit

*note: default permit load is FL120 per input worksheet

Longitudinal Steel Check:

$CR_{LongSteel.HL93} = 1.54$ $CR_{LongSteel.Permit} = 1.44$ $CheckLongSteel_{loadrating} =$ "OK"

▶ Write Data Out

LRFD Prestressed Beam Program

Project = "D30015 50 FT LR Int"
DesignedBy = "FP"
Date = "7-5-2016"

filename = "C:\FDOT Structures\Programs\LRFDPBeamV5.0\FSB Data Files\D30015 50 FT LR Int.dat"

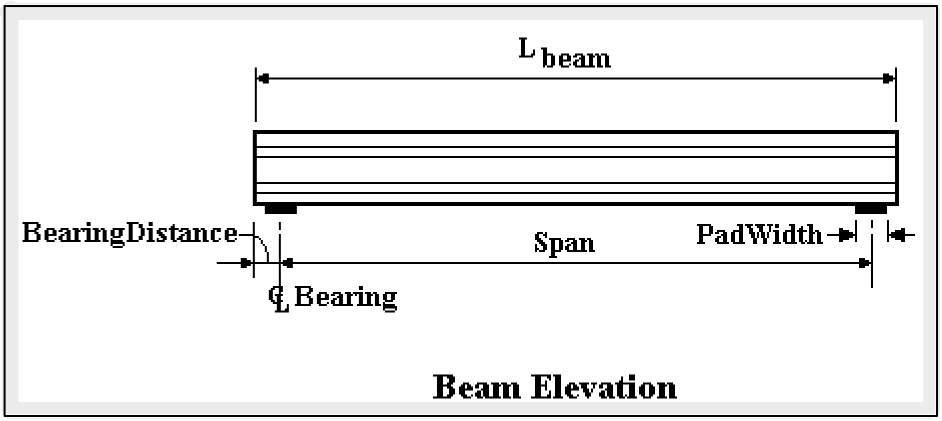
Comment = "FSB 15x52 50 FT"

Legend

TanHighlight = DataEntry | YellowHighlight = CheckValues | GreyHighlight = UserComments + Graphs

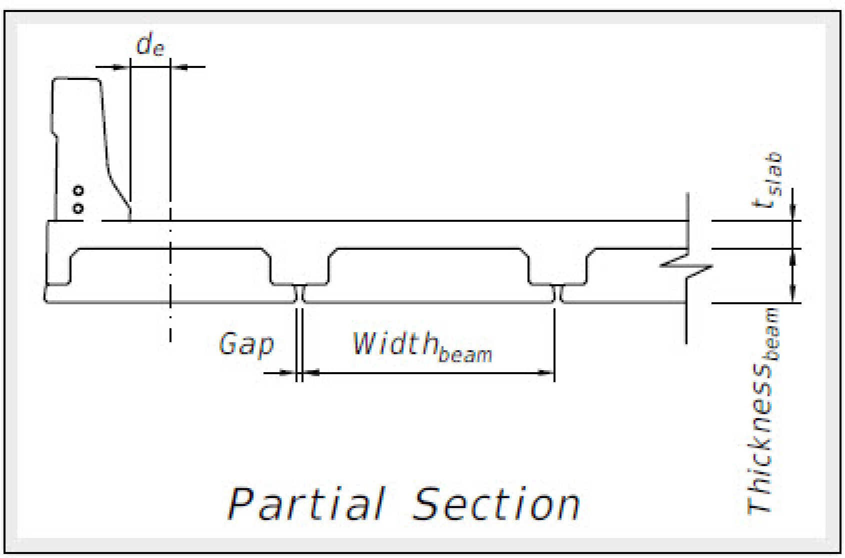
BlackText = ProgramEquations | *Maroon Text = Code Reference* | *Blue Text = Commentary*

Bridge Layout and Dimensions



$L_{beam} = 48.83 \cdot ft$ $Span = 47.75 \cdot ft$ $BearingDistance = 6.5 \cdot in$ $PadWidth = 8 \cdot in$

BeamTypeTog = "FSB15x52"   *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.*



$Overhang = 0 \cdot ft$ $BeamSpacing = 4.47 \cdot ft$ $t_{slab} = 6 \cdot in$ $h_{buildup} = 0 \cdot in$

$Skew = 0 \cdot deg$ $t_{integral.ws} = 0 \cdot in$ $NumberOfBeams = 4$ $t_{slab.delta} = 0.26 \cdot in$

$de = 0.79\,ft$

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

$b_e = 4.47\,ft$ *effective slab width* *LRFD 4.6.2.6*

$t_{slab} := if\left(t_{slab} \le 0 \cdot in, 0.00001 \cdot in, t_{slab}\right)$ *Provide a minimum slab thickness to prevent divide by zero errors*

Material Properties

Concrete:

Corrosion Classification Environment = "extremely"

density of slab concrete $\gamma_{slab} = 0.15 \cdot \frac{kip}{ft^3}$

strength of slab concrete $f_{c.slab} = 4.5 \cdot ksi$

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

strength of beam concrete $f_{c.beam} = 8.5 \cdot ksi$

weight of future wearing surface $Weight_{future.ws} = 0.015 \cdot \frac{kip}{ft^2}$

release beam strength $f_{ci.beam} = 6 \cdot ksi$

type of course aggregate, "Florida" *or* "Standard" AggregateType = "Florida"

relative humidity $H = 75$

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

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

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

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

Prestressing Tendons:

tendon ultimate tensile strength $f_{pu} = 270 \cdot ksi$

tendon modulus of elasticity $E_p = 28500 \cdot ksi$

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 $f_y = 60 \cdot ksi$

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

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

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

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

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

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

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

Size of bar used create used to calculate development length BarSize = 5

Permit Loads

This is the number of wheel loads that comprise the truck, max for DLL is 11 PermitAxles = 3

Indexes used to identify values in the P and d vectors $q := 0 .. (PermitAxles - 1)$ $qt := 0 .. PermitAxles$

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

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

Distribution Factors

DataMessage = "This is a FSB15x52 Florida Slab Beam design, AASHTO distribution factors used"

calculated values:

$tmp\_g_{mom} = 0.38$ $tmp\_g_{shear} = 0.52$ $tmp\_g_{mom.fatigue} = 0.22$

user value overrides (optional):

$user\_g_{mom} := 0.26$ $user\_g_{shear} := 0.46$ $user\_g_{mom.fatigue} := 0$

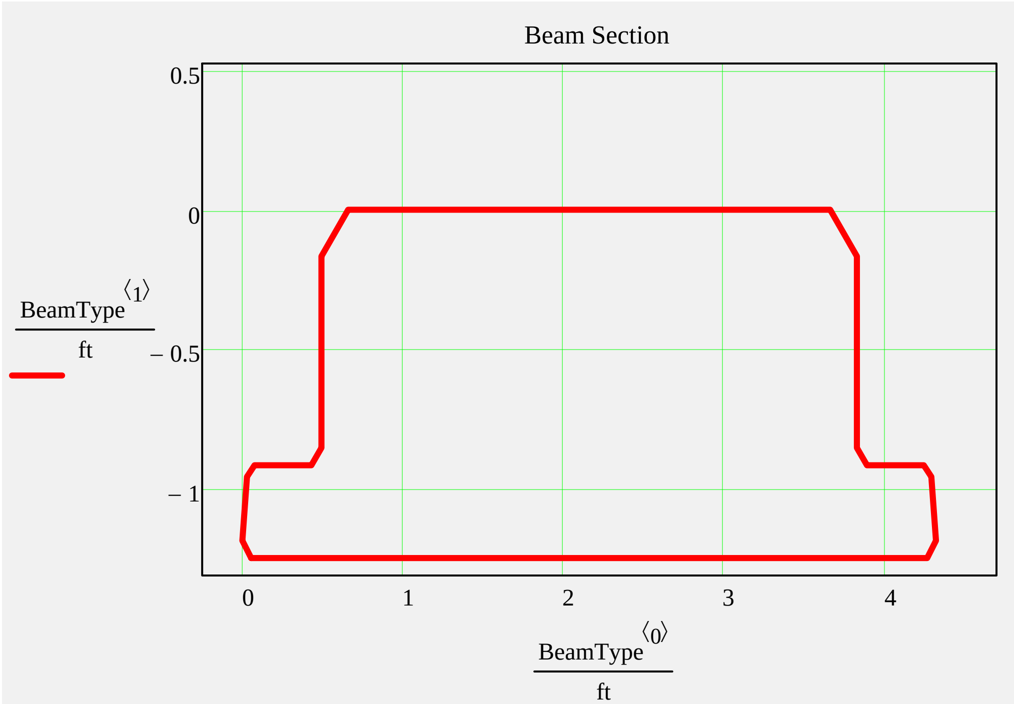
value check

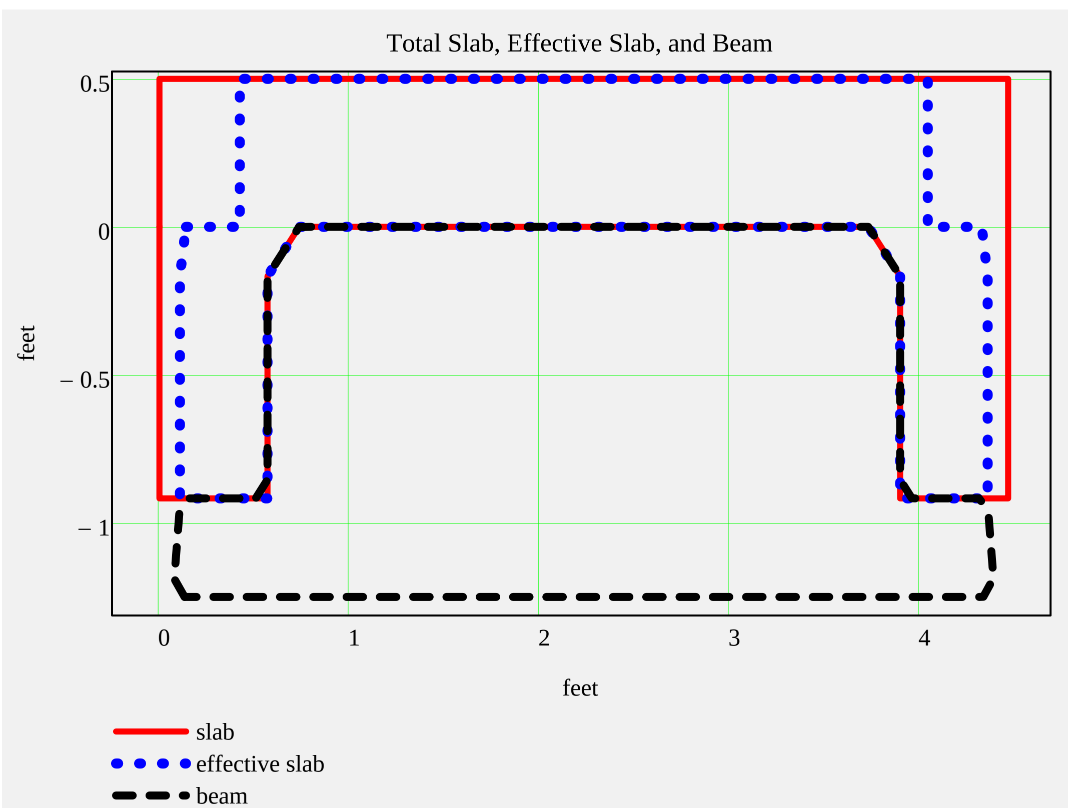
$g_{mom} := if(user\_g_{mom} \neq 0, user\_g_{mom}, tmp\_g_{mom})$ $g_{mom} = 0.26$

$g_{shear} := if(user\_g_{shear} \neq 0, user\_g_{shear}, tmp\_g_{shear})$ $g_{shear} = 0.46$

$g_{mom.fatigue} := if(user\_g_{mom.fatigue} \neq 0, user\_g_{mom.fatigue}, tmp\_g_{mom.fatigue})$ $g_{mom.fatigue} = 0.22$

Section Views





Non-Composite Dead Load Input:

$w_{slab} = 0.496 \cdot \frac{kip}{ft}$ $w_{beam} = 0.668 \cdot \frac{kip}{ft}$ $w_{forms} = 0 \cdot \frac{kip}{ft}$

$Add\_w_{noncomp} := 0.0 \cdot \frac{kip}{ft}$

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

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

$w_{noncomposite} = 1.165 \cdot \frac{kip}{ft}$

$wb_{noncomposite} := w_{slab} + w_{forms} + Add\_w_{noncomp}$

$wb_{noncomposite} = 0.496 \cdot \frac{kip}{ft}$

Diaphragms/Point Load Input

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

EndDiaphragmA := 0·kip *begin bridge*

EndDiaphragmE := 0·kip *end bridge*

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

IntDiaphragmB := 0·kip

DistB := 0·ft

input load is per beam

IntDiaphragmC := 0·kip

DistC := 0·ft

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

IntDiaphragmD := 0·kip

DistD := 0·ft

Composite Dead Load Input:

$w_{future.ws} = 0.067 \cdot \frac{kip}{ft}$ $w_{barrier} = 0.215 \cdot \frac{kip}{ft}$

$Add\_w_{comp} := 0.0 \cdot \frac{kip}{ft}$

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

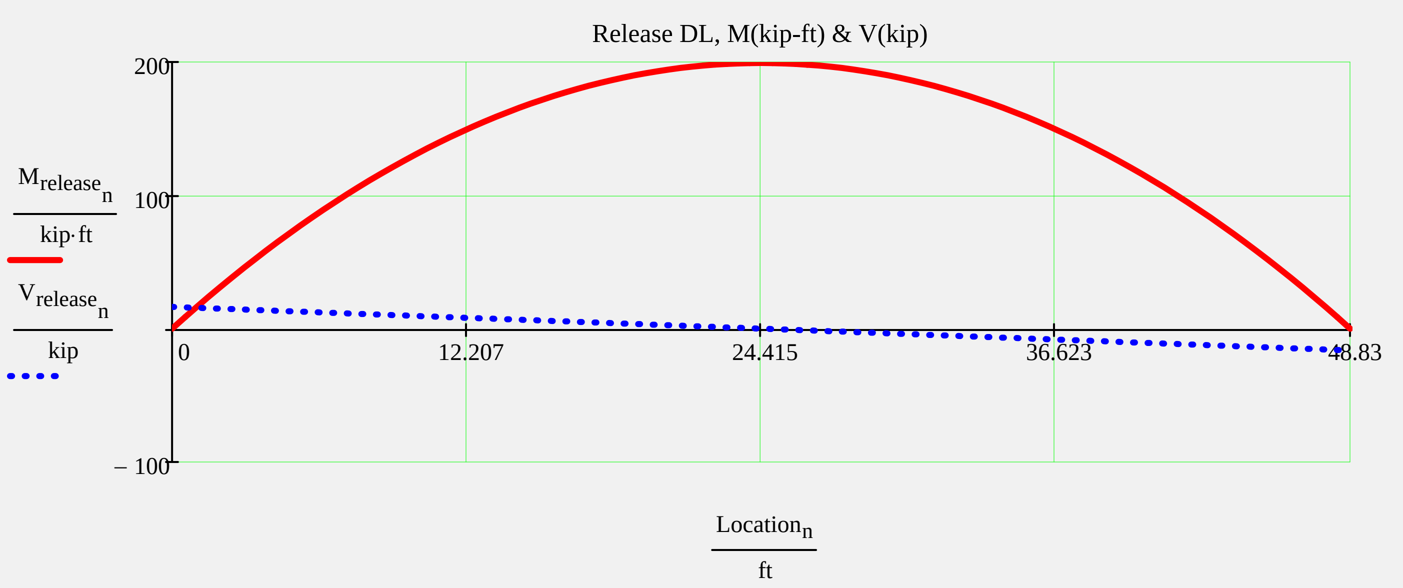
$w_{composite} := w_{future.ws} + w_{barrier} + Add\_w_{comp}$

$w_{composite} = 0.282 \cdot \frac{kip}{ft}$

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

$w_{comp.str} = 0.215 \cdot \frac{kip}{ft}$

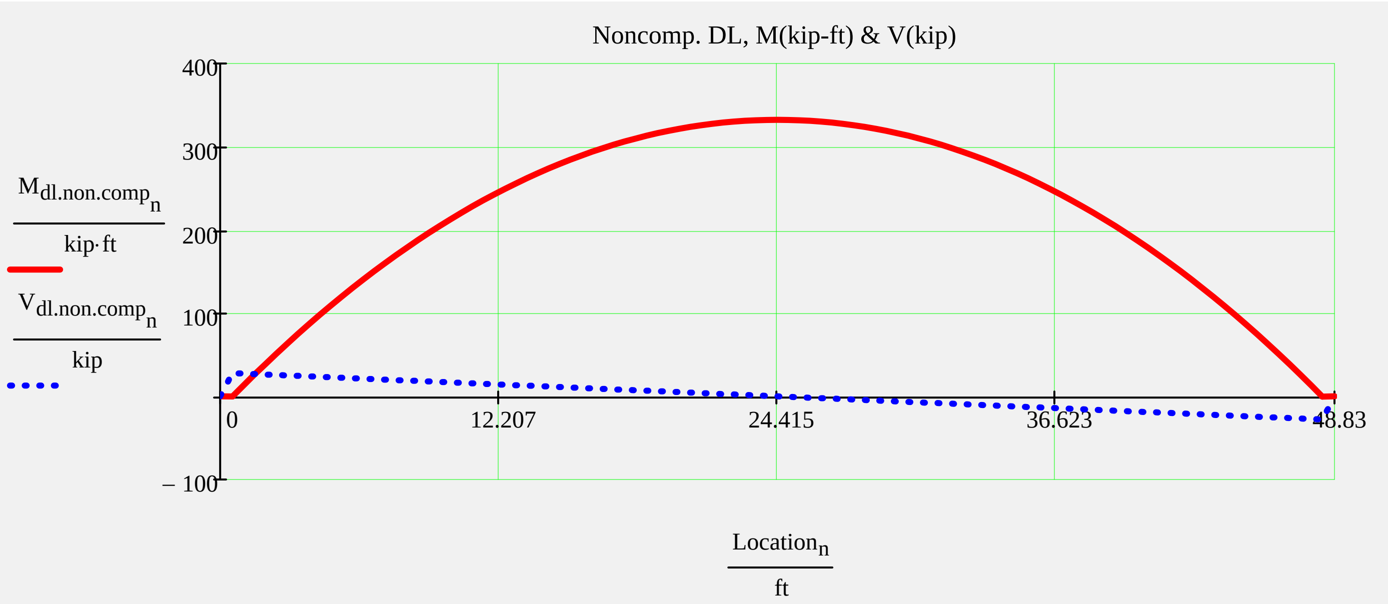
Release Dead Load Moments and Shear



$\max(M_{release}) = 199.2 \cdot kip \cdot ft$

$\max(V_{release}) = 16.3 \cdot kip$

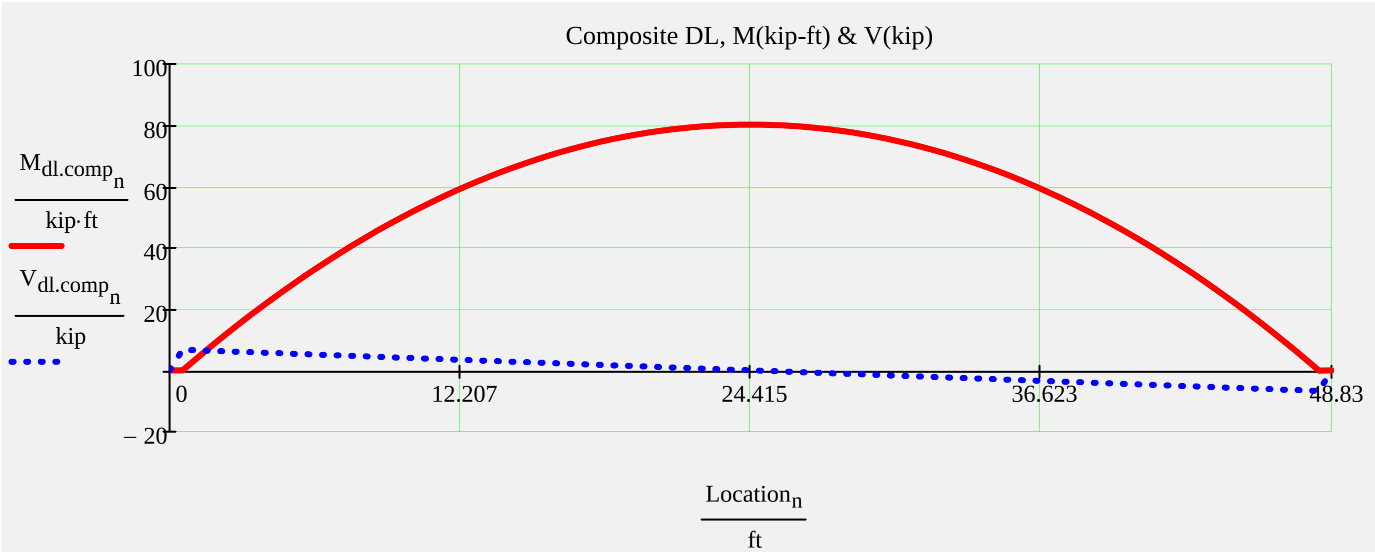
Noncomposite Dead Load Moments and Shear



$\max(M_{dl.non.comp}) = 332.3 \cdot kip \cdot ft$

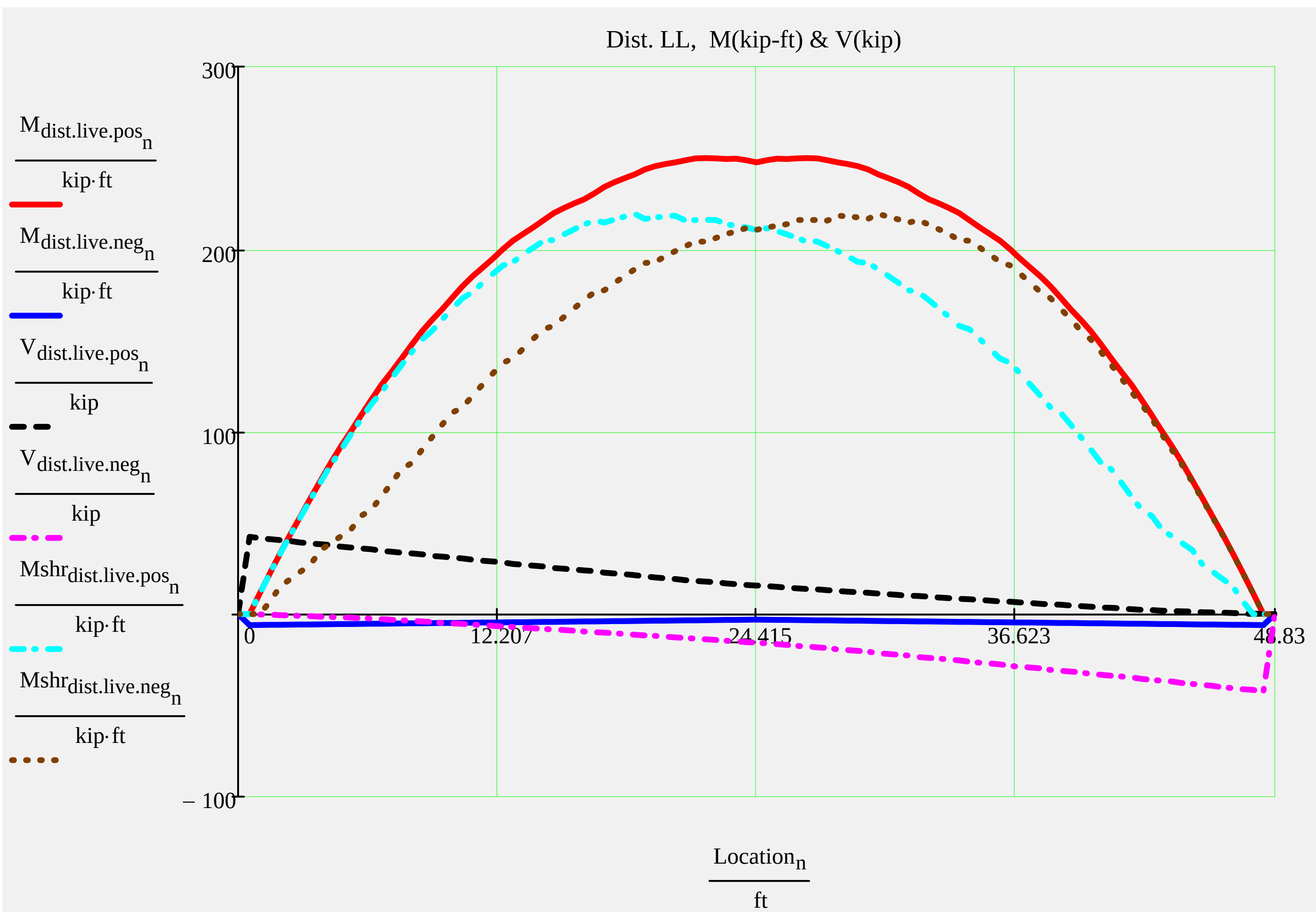
$\max(V_{dl.non.comp}) = 27.8 \cdot kip$

Composite Dead Load Moments and Shear



$max(M_{dl.comp}) = 80.2 \cdot kip \cdot ft$ $max(V_{dl.comp}) = 6.7 \cdot kip$

Distributed Live Load Moments and Shear



Beam End Reactions... with IM factor only

$max(M_{dist.live.pos}) = 249.8 \cdot kip \cdot ft$ $min(M_{dist.live.neg}) = -6 \cdot kip \cdot ft$ $Reaction_{LL} = 43.13 \cdot kip$

$max(V_{dist.live.pos}) = 42.4 \cdot kip$ $max(Mshr_{dist.live.pos}) = 219.2 \cdot kip \cdot ft$ $Reaction_{DL} = 35.31 \cdot kip$

Prestress Strand Layout Input

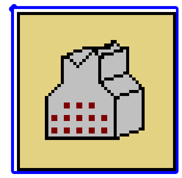
Instructions:

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

Strand Pattern Generator:



Recalculate Worksheet   Read Strand Data

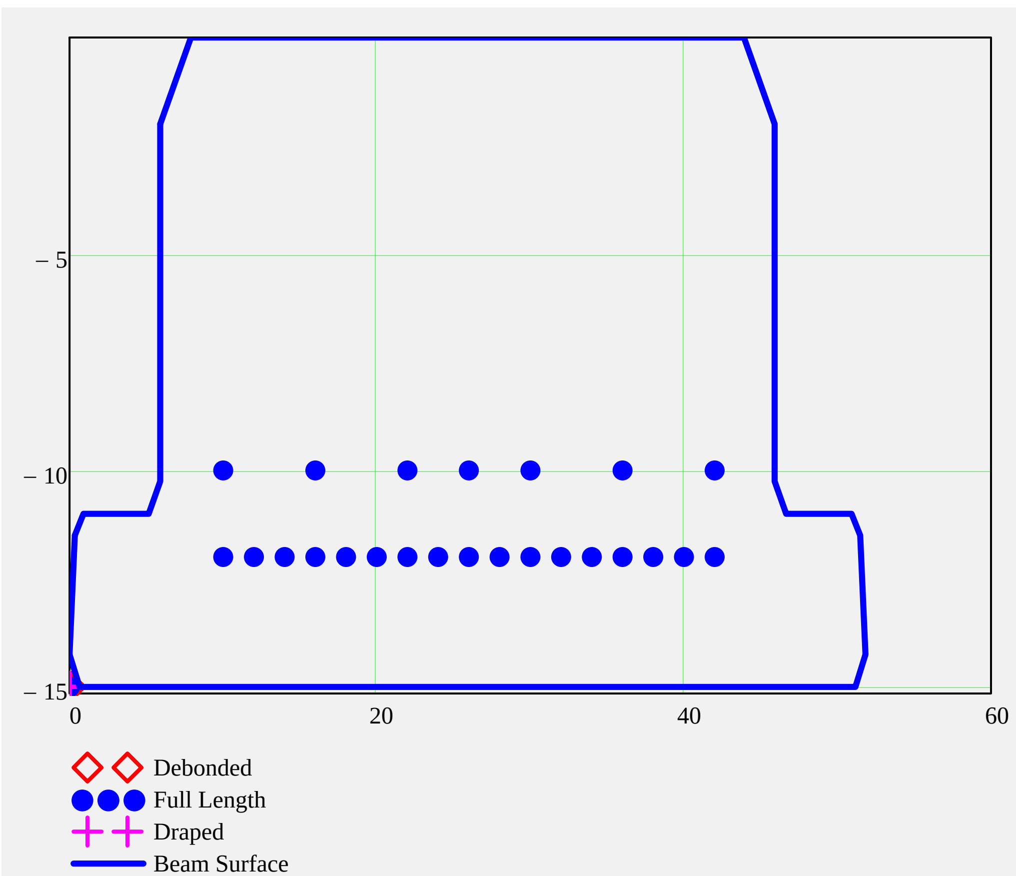
Collapsed Region for Custom Strand Sizes...

Strand Multiplier

Strand Data and Pattern

Strand Properties

Tendon Layout



$SupportLocation_{release} \equiv 0 \cdot ft$ *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")

$PartialPS_{force} \equiv 40 \cdot kip$ *partial prestress total force*

$PartialPS_{force} := if(BeamTypeTog = "II", 20 \cdot kip, PartialPS_{force})$ $PartialPS_{force} = 40 \cdot kip$

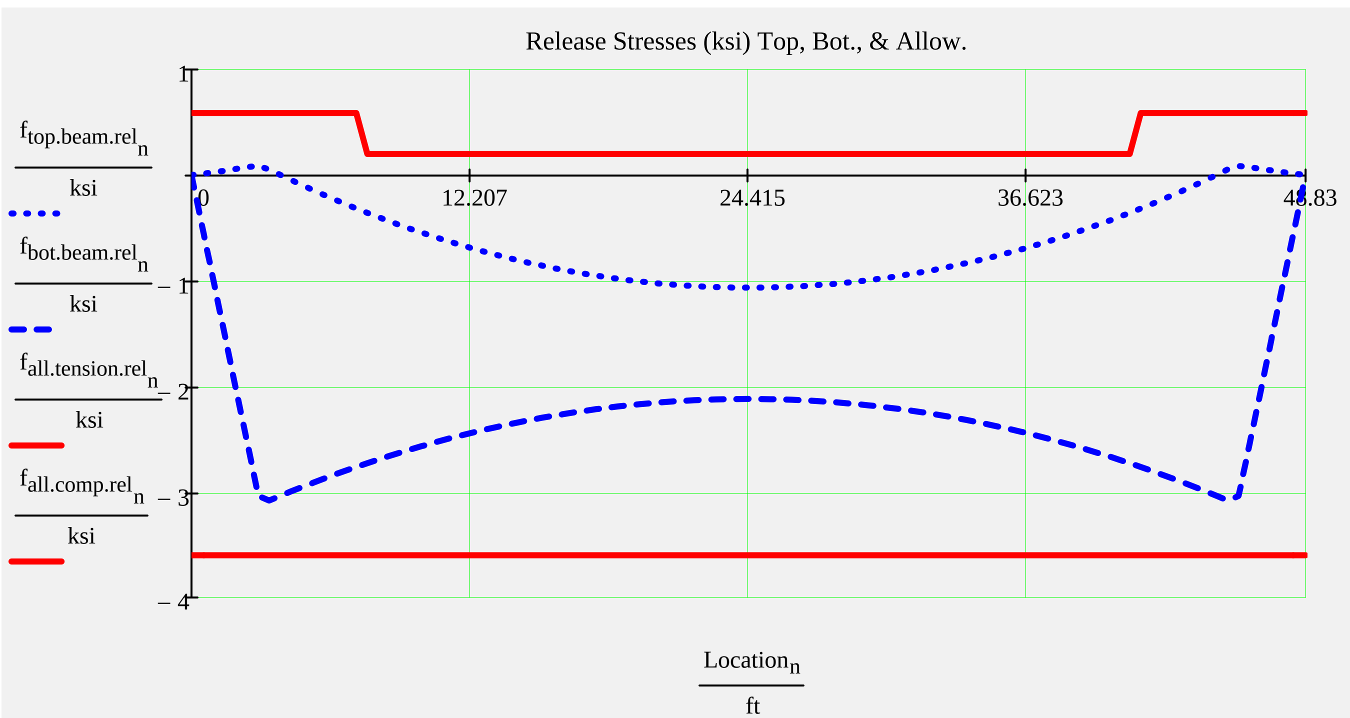
$PartialPS_{location} \equiv 1.4375in$ *centroid location of partial prestress from the top of the beam*

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

$PartialPS_{location} = 2 \cdot in$

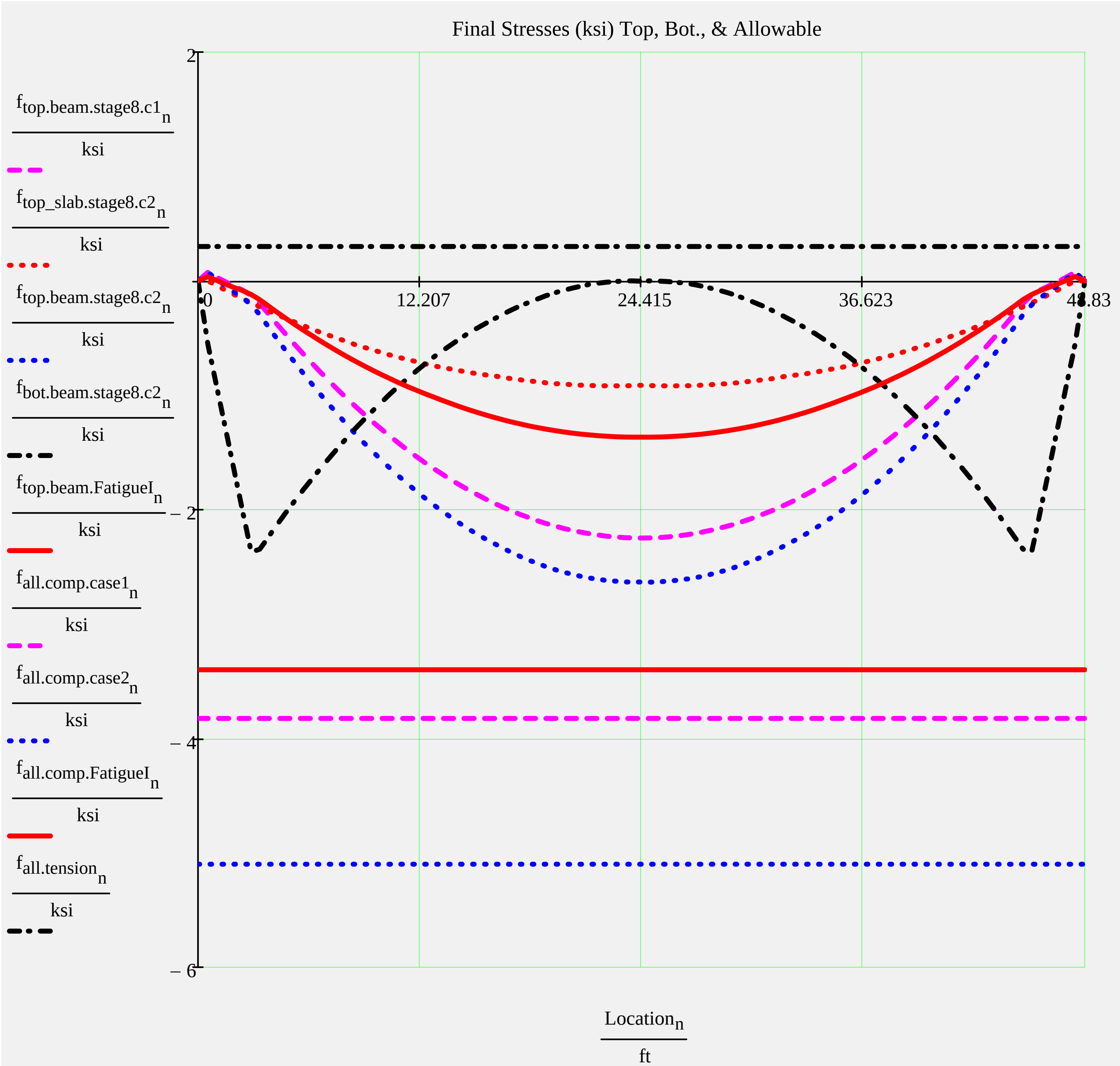
▶ Section Properties & Strand Profile Properties

Release Stresses



▶ Prestress Force

Final Stresses



Release Checks & Final Checks for Capacity Ratio (CR)

Stress Checks

$\min(CR\_f_{tension.rel}) = 6.78$	$Check\_f_{tension.rel} = "OK"$	(Release tension)
$\min(CR\_f_{comp.rel}) = 1.17$	$Check\_f_{comp.rel} = "OK"$	(Release compression)
$\min(CR\_f_{tension.stage8}) = 10$	$Check\_f_{tension.stage8} = "OK"$	(Service III , PS + DL +LL*0.8)
$\min(CR\_f_{comp.stage8.c1}) = 1.7$	$Check\_f_{comp.stage8.c1} = "OK"$	(Service I , PS + DL)
$\min(CR\_f_{comp.stage8.c2}) = 1.94$	$Check\_f_{comp.stage8.c2} = "OK"$	(Service I , PS + DL +LL)
$\min(CR\_f_{comp.FatigueI}) = 2.49$	$Check\_f_{comp.FatigueI} = "OK"$	(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*

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

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

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

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

Section and Strand Properties Summary

Section and Strand Properties Summary

$A_{beam} = 641.75 \cdot in^2$ *Concrete area of beam*

$I_{beam} = 12381.9946 \cdot in^4$ *Gross Moment of Inertia of Beam about CG*

$y_{comp} = -4.85 \cdot in$ *Dist. from top of beam to CG of gross composite section*

$I_{comp} = 36691.4201 \cdot in^4$ *Gross Moment of Inertia Composite Section about CG*

$A_{deck} = 386.12 \cdot in^2$ *Concrete area of deck slab*

$A_{ps} = 5.2 \cdot in^2$ *total area of strands*

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

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

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

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

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

$A_{ps.row}^T = (3.7 \;\; 1.5 \;\; 0.2) \cdot in^2$

$d_{ps.row}$ = (·in)

	0	1	2	3	4	5	6	7	8	9
0	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12
1	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
2	-2	-2	-2	-2	-2	-2	-2	-2	-2	...

TotalNumberOfTendons = 24

NumberOfDebondedTendons = 0

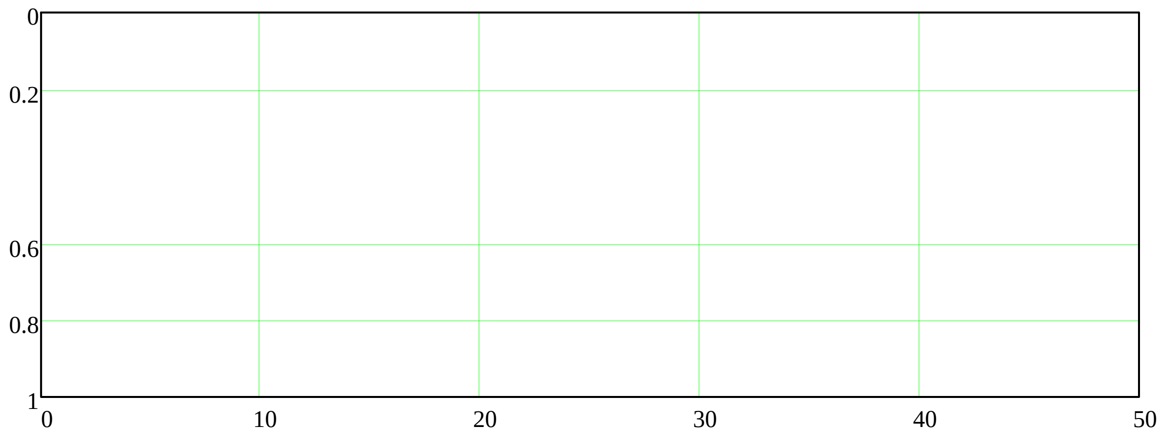
NumberOfDrapedTendons = 0

StrandSize = "0.6 in low lax"

$StrandArea = 0.22 \cdot in^2$

$JackingForce_{per.strand} = 43.94 \cdot kip$

Location of Depressed Strands



Section and Strand Properties Summary

Prestress Losses Summary

$f_{pj} = 202.5 \cdot ksi$

Check_f_{pt} = "OK"

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

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

$\Delta f_{pT} = -22 \cdot ksi$

$\frac{\Delta f_{pT}}{f_{pj}} = -10.71 \cdot \%$

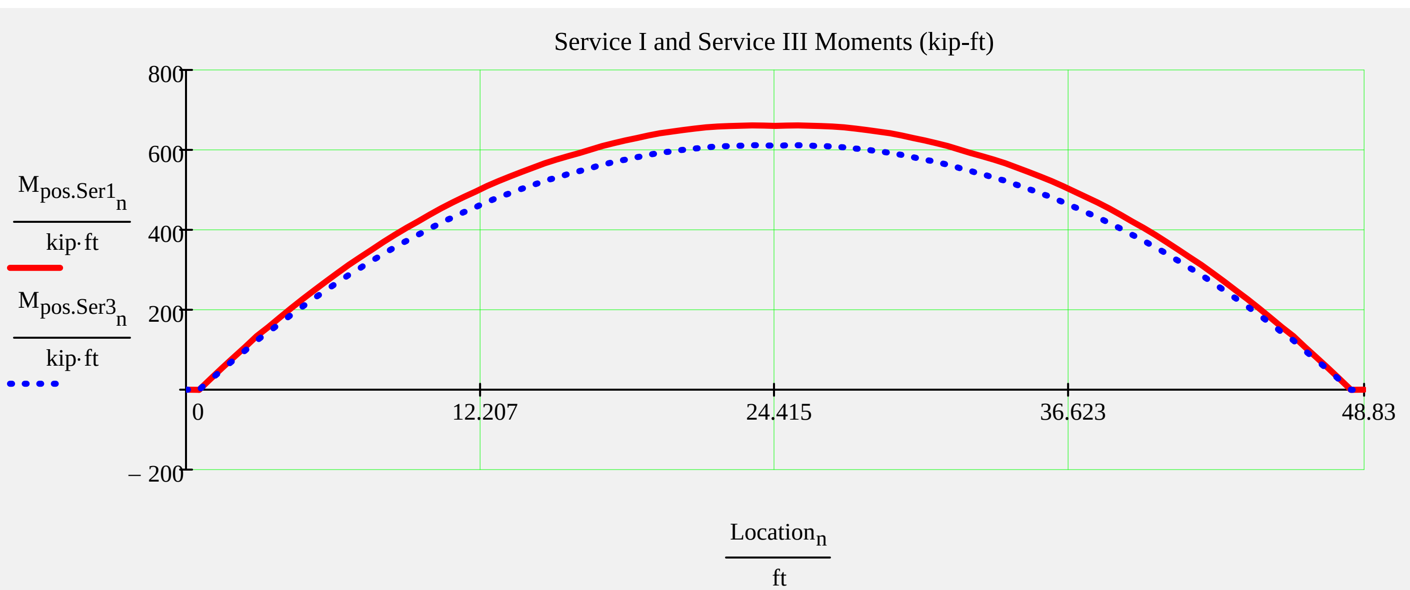
$f_{pe} = 181 \cdot ksi$

$\frac{f_{pe}}{f_{pj}} = 89.29 \cdot \%$

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

Check_f_{pe} = "OK"

Service Limit State Moments



$\max(M_{pos.Ser1}) = 661.4 \cdot kip \cdot ft$ $\max(M_{pos.Ser3}) = 611.5 \cdot kip \cdot ft$

Summary of Values at Midspan

Stresses =

"Stage "	"Top of Beam (ksi) "	"Bott of Beam (ksi)"
1	−1.07	−2.12
2	−1.11	−1.75
4	−1.05	−1.81
6	−2.12	−0.88
8	−2.63	−0

PrestressForce =

"Condition "	"Axial (kip)"	"Moment (kip*ft)"
"Release"	−1094.6	−288.7
"Final (about composite centroid)"	−977.4	−246

Properties =

"Section "	"Area (in^2) "	"Inertia (in^4) "	"distance to centroid from top of bm (in)"
"Net Beam "	636.35	12307.11	−7.91
"Transformed Beam (initial)"	670.46	12765.19	−8.07
"Transformed Beam "	666.76	12717.06	−8.05
"Composite "	1059.43	38205.51	−4.94

ServiceMoments =

"Type "	"Value (kip*ft)"
"Release"	199.2
"Non-composite (includes bm wt.)"	332.3
"Composite"	80.2
"Distributed Live Load"	247.5

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

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

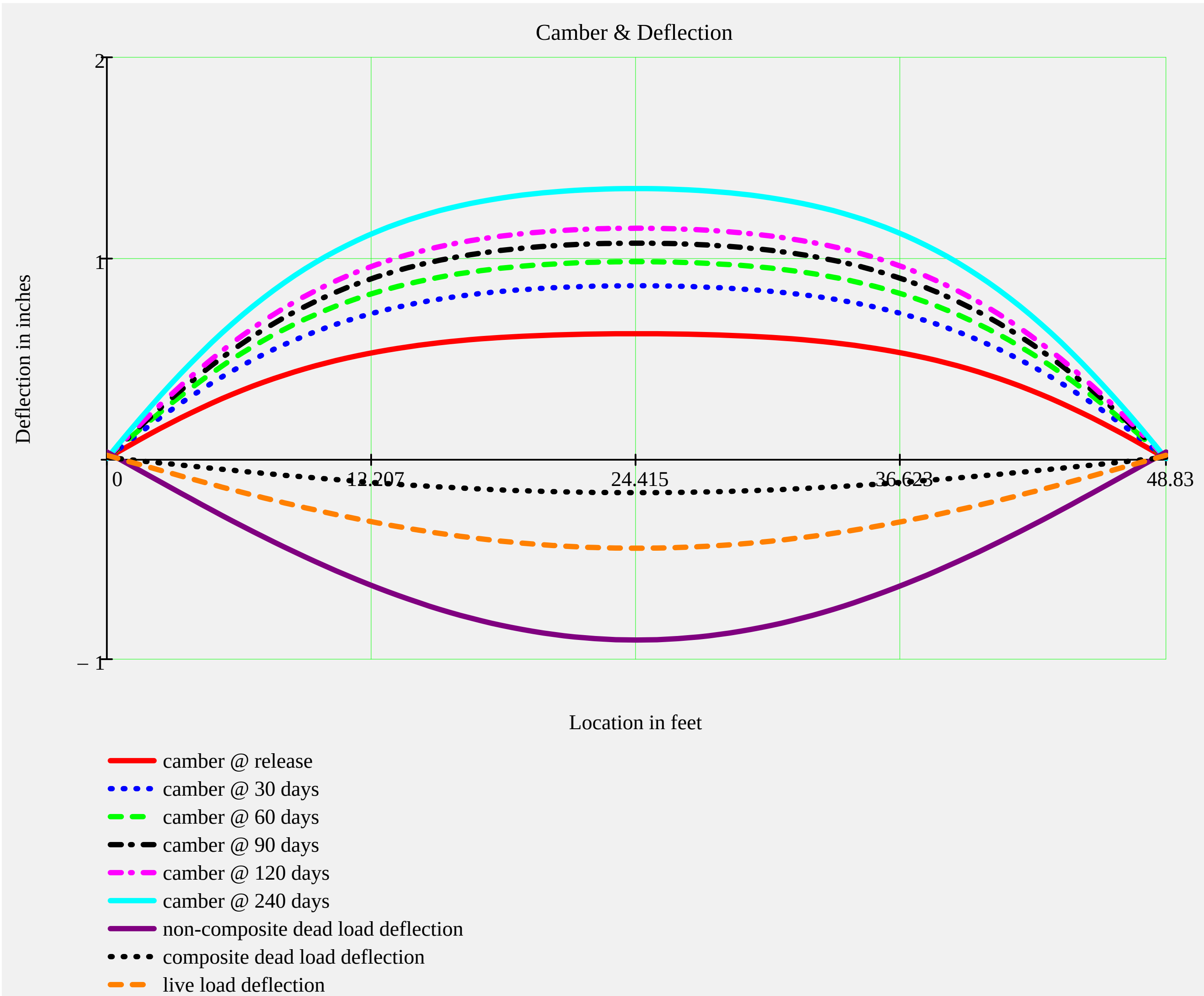
Stage 4 ---> Same as stage 2 with supports changed from the end of the beam to the bearing locations

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

Stage 8 ---> Stage 6 with the addition of composite dead load and live loads applied to the composite section

Camber at Release, Short Term Camber, & Summary of Slope Data

Camber, Shrinkage, and Dead Load Deflection Components

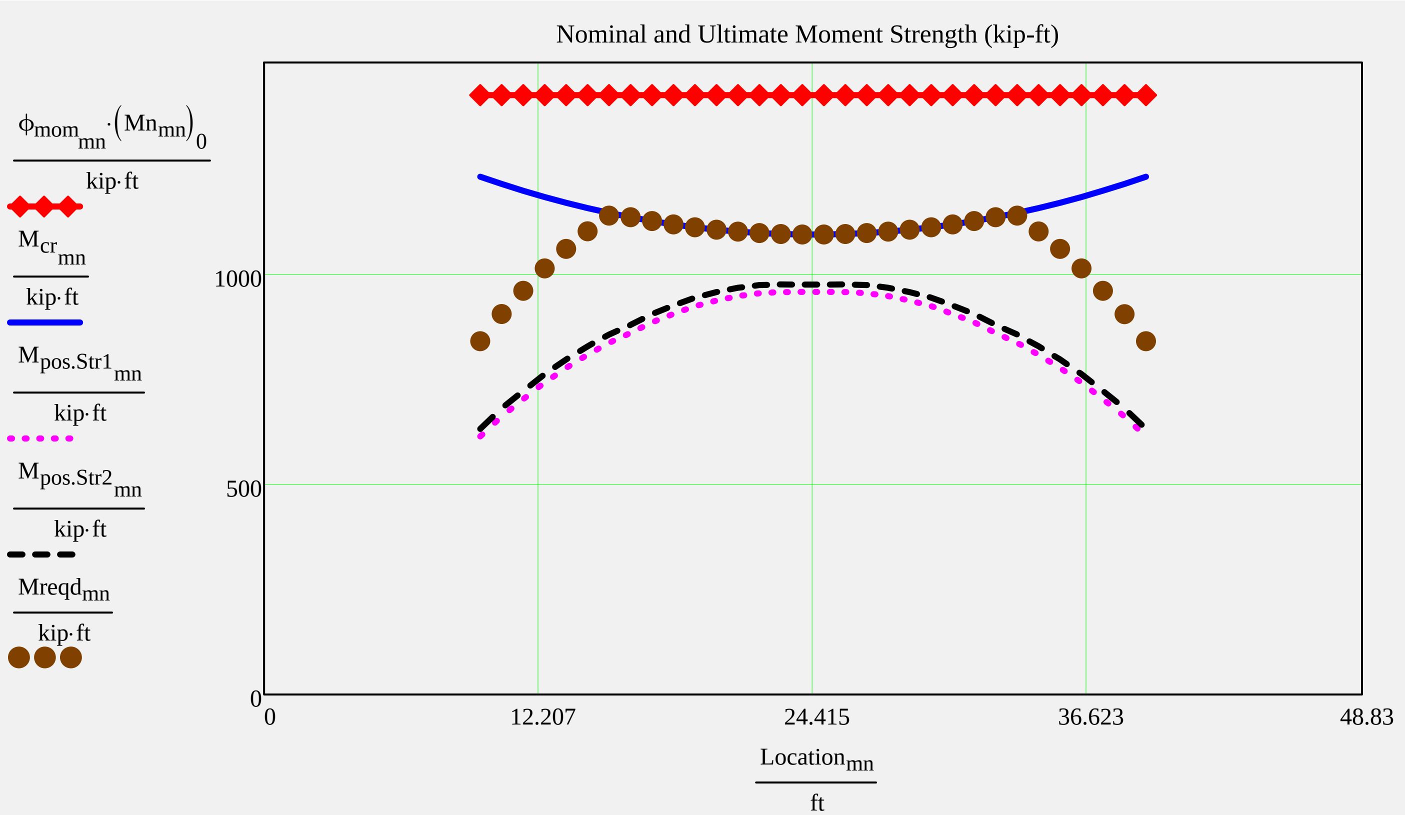


SlopeData =

"Stage"	"Change in L @ Top (in)"	"Change in L @ Bot. (in)"	"Slope at End (deg)"	"midspan defl (in)"
"Release"	–0.0759	–0.3069	0.3162	0.6222
"30 Days"	–0.2111	–0.5855	0.5519	0.8613
"60 Days"	–0.2609	–0.6884	0.643	0.9813
"90 Days"	–0.2869	–0.7418	0.6904	1.0735
"120 Days"	–0.3028	–0.7746	0.7195	1.148
"240 Days"	–0.3317	–0.8343	0.7723	1.3456
"non-comp DL"	–0.0813	0.0702	–0.2896	–0.9044
"comp DL"	–0.0094	0.0191	–0.0544	–0.17
"LL"	–0.0251	0.051	–0.1455	–0.4467

Ultimate Moment Capacity

Strength Limit State Moments



$CR_{Str.mom_n} := 10$ $\qquad CR_{Str.mom_{mn}} := \frac{\phi_{mom_{mn}} \cdot (Mn_{mn})_0}{Mreqd_{mn}}$ *(LRFD 5.7.3.3.2)* $\qquad \min(CR_{Str.mom}) = 1.25$

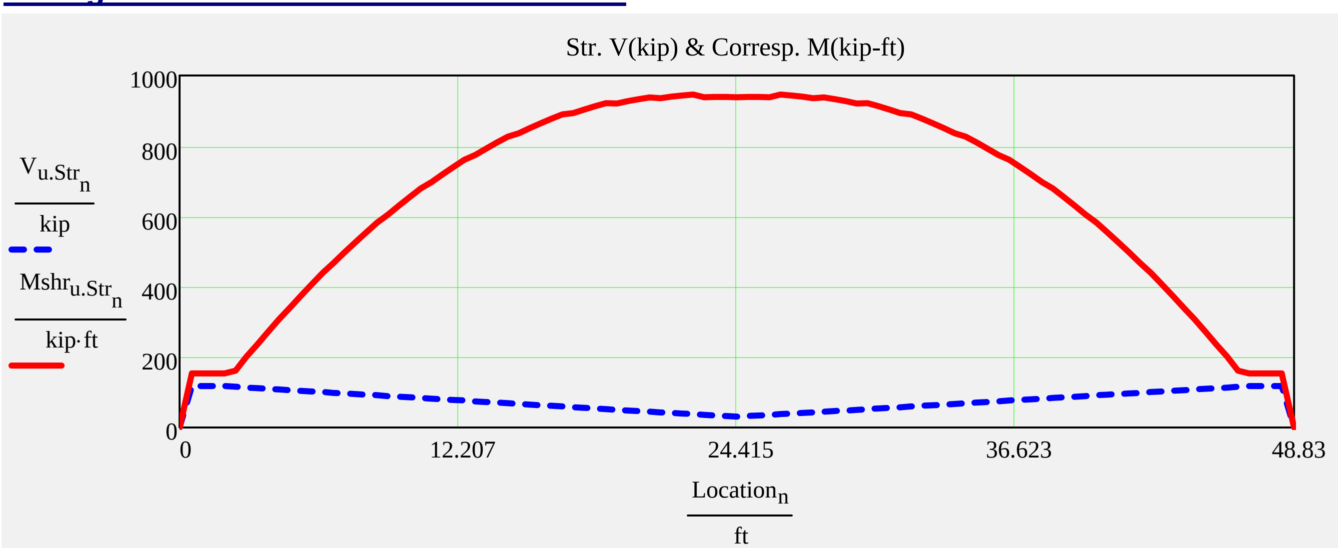
$\max(Mreqd) = 1136.6 \cdot kip \cdot ft$ $\qquad CheckMomentCapacity := \text{if}\left(\min(CR_{Str.mom}) > 0.99, \text{"OK"}, \text{"No Good!"}\right)$

$CheckMomentCapacity = \text{"OK"}$

FSB only - Design Check of Transverse reinforcing Bars E

Shear Analysis

Strength Shear and Associated Moments



$\max(V_{u.Str}) = 117.5 \cdot kip$ $\qquad \max(Mshr_{u.Str}) = 945.7 \cdot kip \cdot ft$

Design Shear, Longitudinal, Interface and Anchorage Reinforcement

Stirrup sizes and spacings assigned in input file

Location	spacing	Number of Spaces	area per stirrup
A1 stirrup	12	4	0.8
A2 stirrup	18	1	0.8
A3 stirrup	18	1	0.8
S1 stirrup	18	1	0.8
S2 stirrup	18	1	0.8
S3 stirrup	18	1	0.8
S4 stirrup	18	0	0.8

$tmp\_s = (12, 18, 18, 18, 18, 18, 18)^T \cdot in$

$tmp\_NumberSpaces = (4, 1, 1, 1, 1, 1, 0)^T$

$tmp\_A_{stirrup} = (0.8, 0.8, 0.8, 0.8, 0.8, 0.8, 0.8)^T \cdot in^2$

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.

Location	$user\_s_{nspacings} :=$	$user\_NumberSpaces_{nspacings} :=$	$user\_A_{stirrup_{nspacings}} :=$	$interface\_factor_{nspacings} :=$
A1 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	0.25
A2 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	0.5
A3 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	1
S1 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	1
S2 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	1
S3 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	1
S4 stirrup	$-1 \cdot in$	-1	$-1 \cdot in^2$	1
			$-1 \cdot in^2$	

Recalculate Worksheet

Spacing Computation

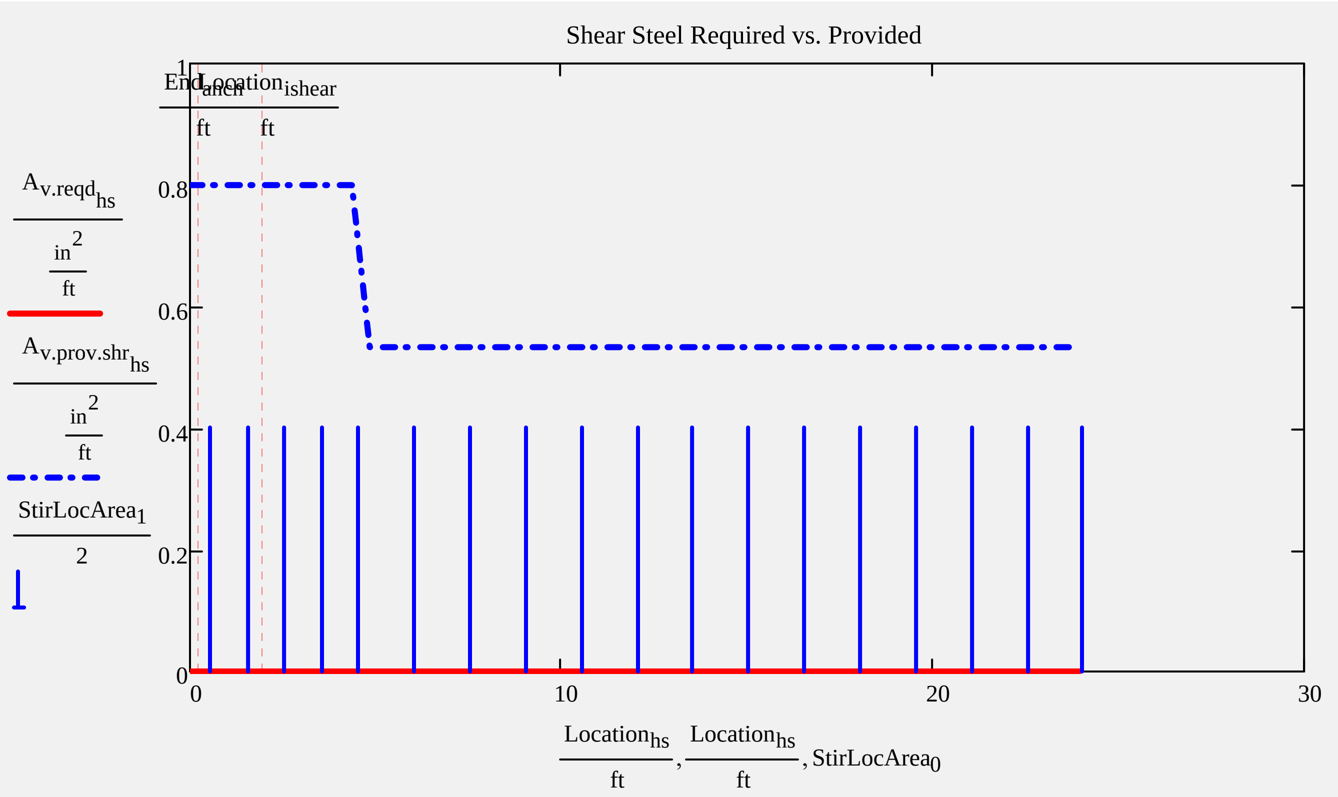
Stirrup sizes and spacings used in analysis

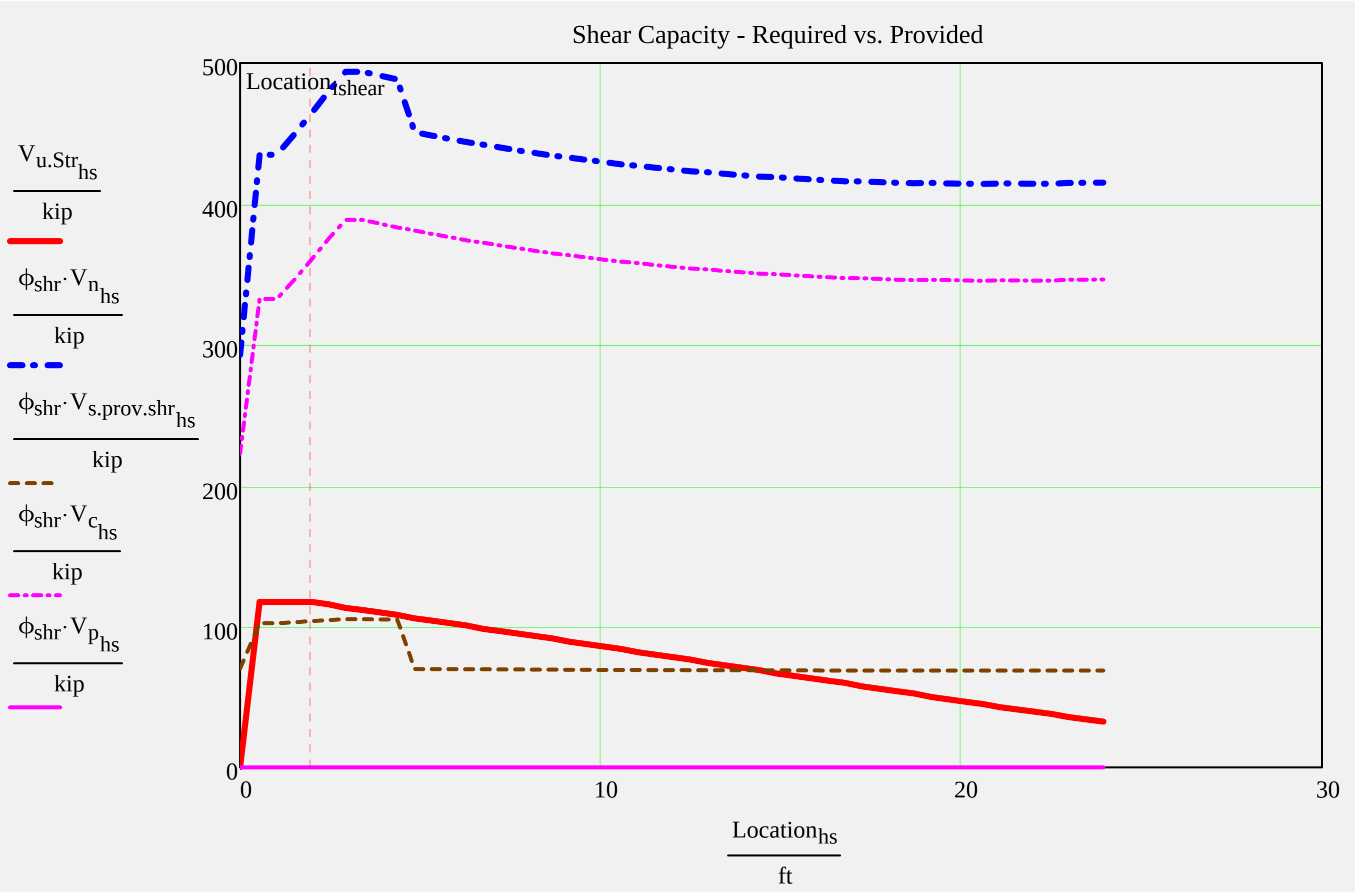
The number of spaces for the S4 stirrup is calculated by the program to complete the half beam length.

Location	s (in)	NumberSpaces	$A_{stirrup}$ (in^2)
A1 stirrup	12	4	0.8
A2 stirrup	18	1	0.8
A3 stirrup	18	1	0.8
S1 stirrup	18	1	0.8
S2 stirrup	18	1	0.8
S3 stirrup	18	1	0.8
S4 stirrup	18	8.25	0.8

$EndCover = 6.5 \cdot in$

Shear Steel Required vs. Provided Computation





Computation for Checks

CheckShearCapacity = "OK"

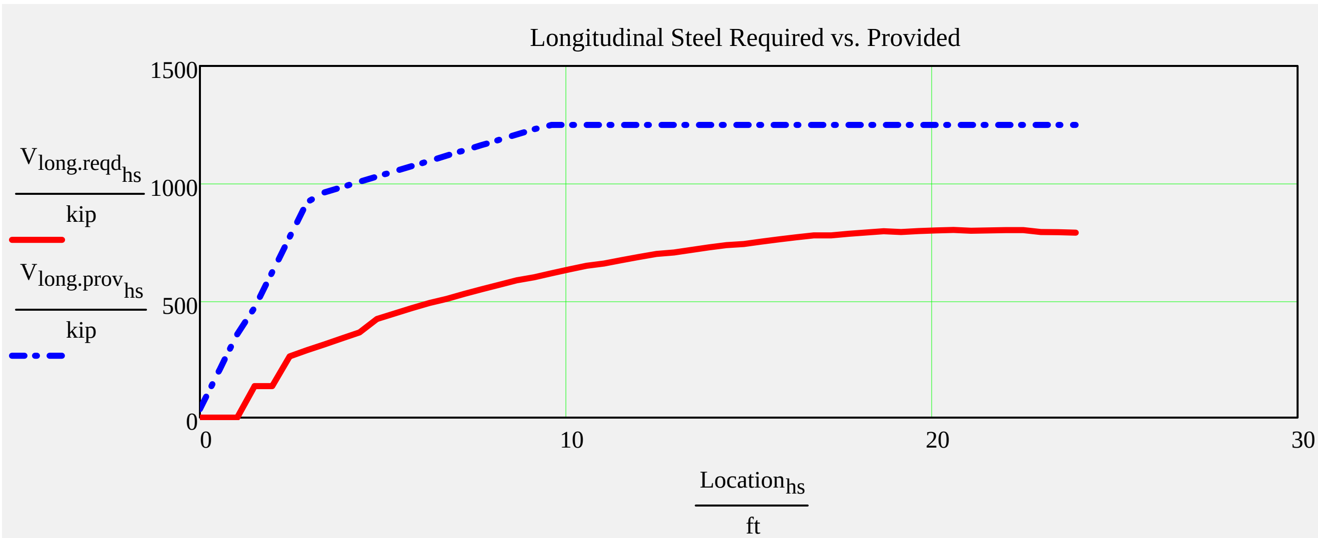
CheckMaxShearStress = "OK"

CheckStirArea = "OK"

CheckMinStirArea = "OK"

CheckMaxStirSpacing = "OK"

Longitudinal Reinforcement



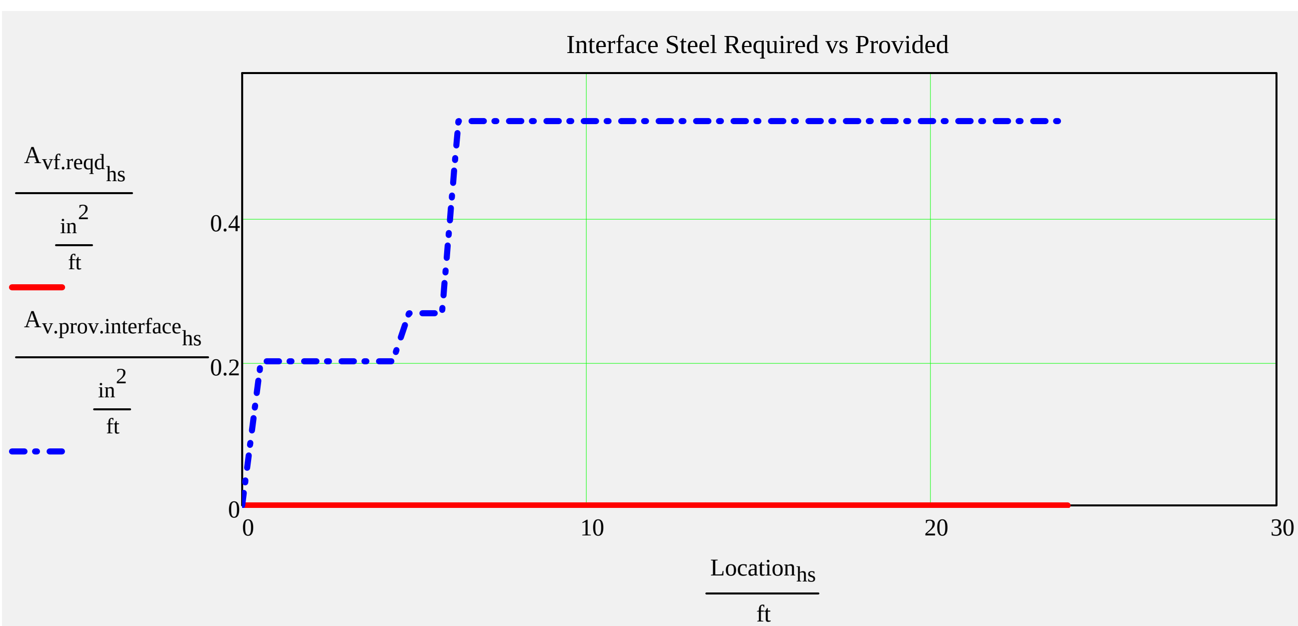
$CR_{LongSteel_{hs}} := \text{if}\left(V_{long.reqd_{hs}} < .01kip, 100, \frac{V_{long.prov_{hs}}}{V_{long.reqd_{hs}}}\right)$

$\min(CR_{LongSteel}) = 1.56$

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

CheckLongSteel = "OK"

Interface Shear Reinforcement



Interface Steel

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.*

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

If max(Avf.min) or max(Avf.des) is greater than 0 in²/ft, interface steel is required.

CheckInterfaceSpacing = "OK"

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

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 := yes

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

Splitting (Bursting) Resistance

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

Summary of Design Checks

$check_0$:= AcceptAASHTO $check_1$:= AcceptSDG $check_2$:= AcceptOntario

$check_3$:= $Check\_f_{pt}$ $check_4$:= $Check\_f_{pe}$ $check_5$:= $Check\_f_{tension.rel}$

$check_6$:= $Check\_f_{comp.rel}$ $check_7$:= $Check\_f_{tension.stage8}$ $check_8$:= $Check\_f_{comp.stage8.c1}$

$check_9$:= $Check\_f_{comp.stage8.c2}$ $check_{10}$:= $Check\_f_{comp.FatigueI}$ $check_{11}$:= CheckMomentCapacity

$check_{12}$:= CheckMaxCapacity $check_{13}$:= CheckStirArea $check_{14}$:= CheckShearCapacity

$check_{15}$:= CheckMinStirArea $check_{16}$:= CheckMaxStirSpacing $check_{17}$:= CheckLongSteel

$check_{18}$:= CheckInterfaceSpacing $check_{19}$:= CheckSplittingSteel $check_{20}$:= CheckMaxPrestressingForce

$check_{21}$:= $CheckPattern_0$ $check_{22}$:= $CheckPattern_1$ $check_{23}$:= $CheckPattern_2$

$check_{24}$:= $CheckPattern_3$ $check_{25}$:= $CheckPattern_4$ $check_{26}$:= CheckInterfaceSteel

$check_{27}$:= CheckStrandFit $check_{28}$:= $Check\_SDG_{1.2.Display_2}$ **Link to Note- Checks, 0, 1 & 2**

$check^T$ =

	0	1	2	3	4
0	"OK"	"N.A."	"N.A."	"OK"	...

click table to reveal scroll bar... TotalCheck = "OK"

LRFR Load Rating Analysis

FDOT Maintenance Office Bridge Load Rating Manual

▶ Load Rating Computations

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

$LRFR_{loadrating}$ =

"Limit State"	"DF"	"Rating"	"Tons"	"Dim(ft)"	"DF"	"Rating"	"Tons"	"Dim(ft)"	
"Strength I(Inv)"	0.26	2.07	"N/A"	22.44	0.46	6.00	"N/A"	1.43	HL-93
"Strength I(Op)"	0.26	2.68	"N/A"	22.44	0.46	7.78	"N/A"	1.43	HL-93
"Service III(Inv)"	0.26	1.44	"N/A"	22.92	"N/A"	"N/A"	"N/A"	"N/A"	HL-93
"Service III(Op)"	0.26	2.10	"N/A"	22.92	"N/A"	"N/A"	"N/A"	"N/A"	HL-93
"Strength II"	0.26	1.99	119.25	21.49	0.46	5.56	333.72	1.43	*Permit

*note: default permit load is FL120 per input worksheet

Longitudinal Steel Check:

$CR_{LongSteel.HL93} = 1.65$ $CR_{LongSteel.Permit} = 1.56$ $CheckLongSteel_{loadrating}$ = "OK"

▶ Write Data Out