

V Slab Bridge Design Software

Loading Verification Study

PURPOSE

The Engineer of Record (EOR) is ultimately responsible for the bridge design. Any tools used to assist in designing the structure should be verified to the EOR's satisfaction. This study is provided to serve the EOR in the verification process for the V Slab Bridge Design Program.

GENERAL STUDY DISCUSSION

This study will focus on verification of bridge live loading. A typical slab bridge will be analyzed using V Slab, for each of the different haunch configurations. V Slab uses standard (constant) stiffness coefficients to create the structure stiffness matrix for the flat (constant depth) slab and the constant depth (drop) haunch, as these are prismatic (constant EI) members.

For the variable depth options (slope-tapered and parabolic haunches), V Slab uses Gauss-Quadrature to numerically integrate the member stiffness matrixes, prior to combining them into the structure stiffness matrix. Numerical integration is also used to calculate the member fixed-end forces for variable depth members. A general overview of the numerical integration procedure is provided in the appendix. This appendix explains the transformation from the physical coordinate system to the natural coordinate system, where integration can be approximated by the summation of weighted Gauss points, as explained in the appendix. V Slab uses 5 Gauss points, which is more than required to obtain an exact solution.

This provides an explanation of the method used by the software to convert the function, to be integrated, into a formula that can be processed into a solution. The actual setup of the functions, to be integrated to obtain the stiffness coefficients and fixed-end forces, is beyond the scope of this study.

V Slab only uses the alternate Gauss analysis procedures for determining the member stiffness matrixes when a variable depth haunch is used. To determine if the procedures are producing accurate results, the haunched solutions will be compared to the constant depth solutions using a haunch depth only 0.01 inches deeper than the slab within the span. This has the effect of modelling a constant depth slab using the haunched, numerical integration stiffness matrix calculation routines.

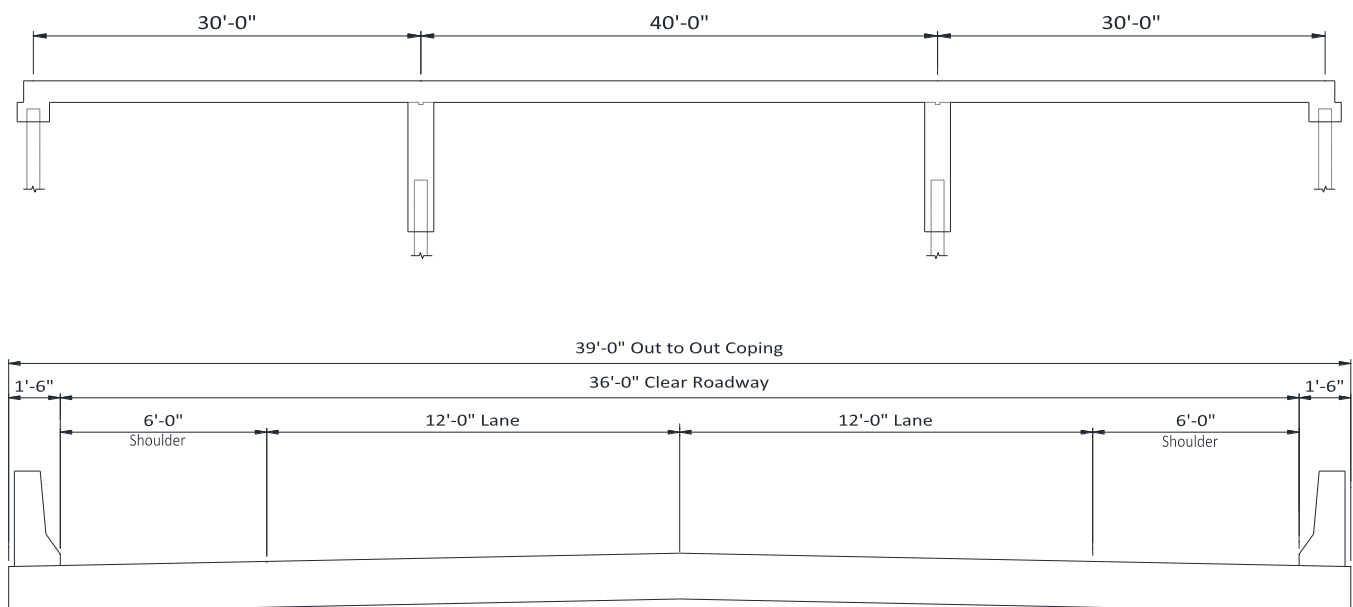
Only standard HL-93 loading (no special vehicles) will be used to make the comparison easier for live loading. V Slab generates the structure stiffness matrix, then calculates all structure influence ordinates. These are stored and used to generate all loading calculations, so multiple the bridge analysis runs are not required. As such, special vehicle calculations use the same process as the standard vehicle loading.

The Washington State Department of Transportation, Bridge and Structures Office, QConBridge Version 1.3 software package was used to compare the live load results. Qcon was programmed using the original metric LRFD code version. The metric version uses metric load values and dimensions and then soft converts the results to the English equivalent units.

For the standard truck, the metric equivalent axle load is 145KN (32.6 kips) which is about 2% higher than the English version, but the lane load is 9.3N/mm (637 plf) instead of 640 plf, which is 0.5% lower. The distance between the first and second axles is 4.3m compared to 14 feet which is about 0.8% higher. The rear axle spacing varies between 4.3m-9m compared to 14-30 feet. The difference between 9m and 30 feet is about 1.6% lower. As such, the comparison of loading values is not likely to result in exact matches.

BRIDGE GEOMETRY

The following bridge was used for the analysis. For this example, a three span (30',40',30') continuous flat slab was selected. The slab depth is 20 inches.



The bridge cross section consists of two 12-foot lanes with 6-foot shoulders and 18-inch barrier railing on each side. Based on the calculation Roadway/12, the code indicates a 3-lane bridge. However, we have overridden this calculation and specified a 2 lanes bridge.

For this example, the railing weighs 400 plf, and a future wearing surface of 35 psf was used. For simplicity of calculations, the bridge is not skewed. The other bridge properties and materials are presented in the report printout. While these properties are not directly applicable to this loading analysis verification study, the same bridge is used for other verification study sections for consistency.

As discussed earlier, the two variable depth haunch runs use a slab depth of 20.01 inches at each pier. To align with the same segment location in the constant depth runs, a haunch length of 7.57 feet with a 1-foot pier offset was used. This aligns with a design point in each span at 8.57 feet from the center of pier in each direction.

ANALYSIS SUMMARY TABLE

The following table was developed to compare the previously discussed analysis options. The HL-93 Envelope and Dead Load values at several typical locations are Included. The analysis output is included in the appendix if other comparison values are desired.

LOAD TYPE AND LOCATION	Qcon	V Slab Constant Depth	Qcon-V Slab Comparison	V Slab Drop Haunch	V Slab Slope Taper	V Slab Parabolic	V Slab Max. Difference
HL-93 Envelope							
Support 1 - R max	71.762	70.860	-1.27 %	70.870	70.870	70.870	0.010
Support 1 - R min	-10.753	-10.650	-0.97 %	-10.650	-10.650	-10.650	0.000
Support 2 - R max	112.974	111.880	-0.98 %	111.760	111.760	111.750	0.130
Support 2 - R min	-8.769	-8.670	-1.14 %	-8.670	-8.670	-8.660	0.010
Span 1 - M+ max	415.485	418.662	0.76 %	418.619	418.628	418.633	0.043
Span 1 - M- max	-370.521	-379.739	2.43 %	-379.913	-379.874	-379.853	0.174
Span 2 - M+ max	449.631	452.921	0.73 %	452.798	452.833	452.849	0.123
Dead Load Only							
Support 1 - R		2.700		2.700	2.700	2.700	0.000
Support 2 - R		9.800		9.810	9.800	9.800	0.010
Span 1 - M+ max		14.544		14.541	14.541	14.542	0.003
Span 1 - M- max		-31.597		-31.612	-31.608	-31.606	0.015
Span 2 - M+ max		18.403		18.392	18.394	18.396	0.011

SUMMARY

Since the metric Qcon and English V Slab versions use different load values and dimensions, the results are not expected to match exactly. However, most of the V Slab calculated values are generally within about 1% of the Qcon values. The negative moment at the pier is about 2% different. Considering the differences in metric loading discussed in an earlier section, these values appear to correspond to the soft conversion differences.

The differences between the four V Slab analysis runs are negligible. As discussed, the Slope Taper and Parabolic runs use numerical integration to calculate the member stiffness matrix and fixed end forces. Given the results so closely align with the standard stiffness matrix values used for the Constant Depth and Drop Haunch runs, this verifies the accuracy of the numerical integration procedures.

V Slab

Numerical Integration Process

GAUSSIAN QUADRATURE

FOR THE CASES OF VARIABLE MOMENTS OF INERTIA AND AREA, THE COMPUTER MUST PERFORM THE INTEGRAL CALCULUS. THIS IS ACCOMPLISHED THROUGH GAUSSIAN QUADRATURE.

IF A FUNCTION $f(x)$ IS TO BE INTEGRATED BETWEEN THE LIMITS a & b ,

$$\int_a^b f(x) dx$$

THEN THE FUNCTION CAN BE TRANSFORMED TO NATURAL COORDINATES (s) AND INTEGRATED FROM -1 TO 1 . x & s ARE LINEARLY RELATED SUCH THAT:

$$x = A(s) + B$$

$$\text{At } x = a, s = -1$$

$$x = b, s = 1$$

$$\therefore a = A(-1) + B \rightarrow B = a + A$$

$$b = A(1) + B$$

$$b = A + (a + A) = a + 2A$$

$$\text{OR } A = \frac{b-a}{2} \quad \& \quad B = a + \frac{b-a}{2} = \frac{b+a}{2}$$

$$x = \left(\frac{b-a}{2}\right)s + \left(\frac{b+a}{2}\right)$$

TAKING THE DERIVATIVE:

$$\frac{dx}{ds} = \left(\frac{b-a}{2}\right) \therefore dx = \left(\frac{b-a}{2}\right) ds$$

THEN $\int_a^b f(x) dx = \int_{-1}^1 f(s) |J| ds$ JACOBIAN $|J|$

WHERE $f(s) = f\left(x = \left(\frac{b-a}{2}\right)s + \left(\frac{b+a}{2}\right)\right)$

$$x = \frac{b}{2}(s) - \frac{a}{2}(s) + \frac{b}{2} + \frac{a}{2}$$

$$x = [b(1+s) + a(1-s)]/2$$

$$\int_{-1}^1 f(z) dz = \sum_{i=0}^n w_i f(z) \quad \text{FOR OUR CASE } z = s$$

THE # OF POINTS USED IS DETERMINED FROM THE DEGREE OF THE POLYNOMIAL. AN EXACT SOLUTION EXISTS WHEN THE DEGREE IS LESS THAN OR EQUAL TO THE # OF POINTS $(n+1)$, SINCE WE LOOP FROM 0 TO n , TIMES 2 MINUS 1. $\therefore (n+1) - 1 = 2n + 1$. USING FIVE POINT $n=4$ (SEE NEXT PAGE) THE SOLUTION IS GOOD UP TO x^9 .

$$\int_a^b f(x) dx = \left[\frac{b-a}{2}\right] \sum_{i=0}^4 (w_i) f\left[\frac{b(1+s_i) + a(1-s_i)}{2}\right]$$

WHERE $f[]$ IS THE ORIGINAL EQUATION WITH THE SUBSTITUTION OF $\frac{b(1+s_i) + a(1-s_i)}{2}$ FOR EACH x TERM.

For example, for $n = 3$, the coefficient of the high-order (z^4) term of $P_{n+1}(z) = P_4(z)$ is $35/8$ [see (2.65)]. Since the n th-order coefficient of $\prod_{i=0}^n (z - z_i)$ is 1, $h_{n+1} = 8/35$. The important feature of (2.93) is that the polynomial $\prod_{i=0}^n (z - z_i)$ is already in factored form, that is, it has the $n + 1$ roots z_i , $i = 0, 1, \dots, n$. Since $h_{n+1}P_{n+1}(z)$ is the same polynomial, the z_i must be the roots of $h_{n+1}P_{n+1}(z)$ as well, or equivalently, of $P_{n+1}(z)$. Thus the $n + 1$

base points to be used in the integration formula of (2.84) are the $n + 1$ roots of the appropriate $[(n + 1)\text{th-degree}]$ Legendre polynomial. The relative weight assigned each functional value $F(z_i)$ is given by (2.85). Values of the appropriate base points (roots) and weight factors for $n = 1, 2, 3, 4, 5, 9$, and 14 (corresponding to the 2, 3, 4, 5, 6, 10, and 15-point formulas respectively) are shown in Table 2.2. The integration formulas of (2.84) with base

Table 2.2. Roots of the Legendre Polynomials $P_{n+1}(z)$ and the Weight Factors for the Gauss-Legendre Quadrature[4]

$\int_{-1}^1 F(z) dz \approx \sum_{i=0}^n w_i F(z_i)$	
Roots (z_i)	Weight Factors (w_i)
<i>Two-Point Formula</i> $n = 1$	
$\pm 0.57735 \ 02691 \ 89626$	1.00000 00000 00000
<i>Three-Point Formula</i> $n = 2$	
0.00000 00000 00000	0.88888 88888 88889
$\pm 0.77459 \ 66692 \ 41483$	0.55555 55555 55556
<i>Four-Point Formula</i> $n = 3$	
$\pm 0.33998 \ 10435 \ 84856$	0.65214 51548 62546
$\pm 0.86113 \ 63115 \ 94053$	0.34785 48451 37454
<i>Five-point Formula</i> $n = 4$	
0.00000 00000 00000	0.56888 88888 88889
$\pm 0.53846 \ 93101 \ 05683$	0.47862 86704 99366
$\pm 0.90617 \ 98459 \ 38664$	0.23692 68850 56189
<i>Six-Point Formula</i> $n = 5$	
$\pm 0.23861 \ 91860 \ 83197$	0.46791 39345 72691
$\pm 0.66120 \ 93864 \ 66265$	0.36076 15730 48139
$\pm 0.93246 \ 95142 \ 03152$	0.17132 44923 79170
<i>Ten-Point Formula</i> $n = 9$	
$\pm 0.14887 \ 43389 \ 81631$	0.29552 42247 14753
$\pm 0.43339 \ 53941 \ 29247$	0.26926 67193 09996
$\pm 0.67940 \ 95682 \ 99024$	0.21908 63625 15982
$\pm 0.86506 \ 33666 \ 88985$	0.14945 13491 50581
$\pm 0.97390 \ 65285 \ 17172$	0.06667 13443 08688
<i>Fifteen-Point Formula</i> $n = 14$	
0.00000 00000 00000	0.20257 82419 25561
$\pm 0.20119 \ 40939 \ 97435$	0.19843 14853 27111
$\pm 0.39415 \ 13470 \ 77563$	0.18616 10001 15562
$\pm 0.57097 \ 21726 \ 08539$	0.16626 92058 16994
$\pm 0.72441 \ 77313 \ 60170$	0.13957 06779 26154
$\pm 0.84820 \ 65834 \ 10427$	0.10715 92204 67172
$\pm 0.93727 \ 33924 \ 00706$	0.07036 60474 88108
$\pm 0.98799 \ 25180 \ 20485$	0.03075 32419 96117

Qcon OUTPUT
REPORT

Washington State Department of Transportation
Bridge and Structures Office
QConBridge Version 1.0

Code: LRFD First Edition 1994

Span Data

Span 1 Length: 30.000 ft

Section Properties

Location	Ax	Iz	Mod. E	Unit Wgt
(ft)	(in ²)	(in ⁴)	(psi)	(pcf)
0.000	2.400e+03	8.000e+03	3.000e+03	1.000e+00

Live Load Distribution Factors

Location	Str/Serv	Limit States	Fatigue	Limit State
(ft)	gM	gV	gM	gV
0.000	1.000	1.000	1.000	1.000

Strength	Limit State	Factors:	Ductility 1.00	Redundancy 1.00	Importance 1.00
Service	Limit State	Factors:	Ductility 1.00	Redundancy 1.00	Importance 1.00

Span 2 Length: 40.000 ft

Section Properties

Location	Ax	Iz	Mod. E	Unit Wgt
(ft)	(in ²)	(in ⁴)	(psi)	(pcf)
0.000	2.400e+03	8.000e+03	3.000e+03	1.000e+00

Live Load Distribution Factors

Location	Str/Serv	Limit States	Fatigue	Limit State
(ft)	gM	gV	gM	gV
0.000	1.000	1.000	1.000	1.000

Strength	Limit State	Factors:	Ductility 1.00	Redundancy 1.00	Importance 1.00
Service	Limit State	Factors:	Ductility 1.00	Redundancy 1.00	Importance 1.00

Span 3 Length: 30.000 ft

Section Properties

Location	Ax	Iz	Mod. E	Unit Wgt
(ft)	(in ²)	(in ⁴)	(psi)	(pcf)
0.000	2.400e+03	8.000e+03	3.000e+03	1.000e+00

Live Load Distribution Factors

Location	Str/Serv	Limit States	Fatigue	Limit State
(ft)	gM	gV	gM	gV
0.000	1.000	1.000	1.000	1.000

Strength	Limit State	Factors:	Ductility 1.00	Redundancy 1.00	Importance 1.00
Service	Limit State	Factors:	Ductility 1.00	Redundancy 1.00	Importance 1.00

Support Data

 Support 1 Pinned
 Support 2 Roller
 Support 3 Roller
 Support 4 Roller

Loading Data

 DC Loads
 Self Weight Generation Disabled
 Traffic Barrier Load Disabled

DW Loads
 Utility Load Disabled
 Wearing Surface Load Disabled

Live Load Data

 Live Load Generation Parameters
 Design Tandem : Enabled
 Design Truck : 1 rear axle spacing increments
 Dual Truck Train : Headway Spacing varies from 49.213 ft to 49.213 ft using 1 increments
 Dual Tandem Train: Disabled
 Fatigue Truck : Enabled

Live Load Impact
 Truck Loads 33.000%
 Lane Loads 0.000%
 Fatigue Truck 15.000%

Pedestrian Live Load 0.000e+00 plf

Live Load Envelopes (Per Lane)

Span	Point	Min Shear (lbs)	Max Shear (lbs)	Min Moment (ft-lbs)	Max Moment (ft-lbs)
1	0	-10.753e+03	71.762e+03	0.000e+00	0.000e+00
1	1	-10.813e+03	63.018e+03	-23.042e+03	136.372e+03
1	2	-10.993e+03	55.325e+03	-46.085e+03	241.934e+03
1	3	-14.460e+03	48.676e+03	-69.127e+03	322.627e+03
1	4	-20.479e+03	42.276e+03	-92.170e+03	377.599e+03
1	5	-20.569e+03	36.398e+03	-115.212e+03	408.054e+03
1	6	-32.640e+03	30.345e+03	-138.255e+03	415.485e+03
1	7	-38.645e+03	24.874e+03	-161.297e+03	408.649e+03
1	8	-44.549e+03	19.773e+03	-184.340e+03	387.228e+03
1	9	-44.870e+03	15.120e+03	-207.383e+03	345.815e+03
1	10	-50.703e+03	10.819e+03	-230.425e+03	286.658e+03
1	11	-56.706e+03	6.975e+03	-253.468e+03	212.291e+03
1	12	-70.596e+03	4.328e+03	-278.810e+03	127.721e+03
1	13	-77.481e+03	2.148e+03	-313.409e+03	61.017e+03
1	14	-83.951e+03	2.004e+03	-370.521e+03	60.133e+03
2	0	-6.765e+03	88.722e+03	-370.521e+03	60.133e+03
2	1	-6.809e+03	80.826e+03	-220.692e+03	68.988e+03
2	2	-6.951e+03	72.162e+03	-178.023e+03	151.993e+03
2	3	-10.108e+03	63.370e+03	-152.514e+03	251.152e+03
2	4	-15.068e+03	54.781e+03	-135.871e+03	338.970e+03

2	5	-20.630e+03	46.272e+03	-119.599e+03	403.027e+03
2	6	-26.632e+03	39.568e+03	-103.327e+03	440.346e+03
2	7	-26.803e+03	33.232e+03	-87.056e+03	449.631e+03
2	8	-39.568e+03	26.632e+03	-103.327e+03	440.346e+03
2	9	-39.909e+03	20.739e+03	-119.599e+03	403.027e+03
2	10	-54.781e+03	15.068e+03	-135.871e+03	338.970e+03
2	11	-63.370e+03	10.108e+03	-152.514e+03	251.152e+03
2	12	-72.162e+03	6.951e+03	-178.023e+03	151.993e+03
2	13	-80.826e+03	6.809e+03	-220.692e+03	68.988e+03
2	14	-81.692e+03	6.765e+03	-370.521e+03	60.133e+03
3	0	-2.004e+03	81.851e+03	-370.521e+03	60.133e+03
3	1	-2.148e+03	77.481e+03	-313.409e+03	61.017e+03
3	2	-4.328e+03	70.596e+03	-278.810e+03	127.721e+03
3	3	-6.960e+03	63.357e+03	-253.468e+03	212.291e+03
3	4	-10.788e+03	55.898e+03	-230.425e+03	286.658e+03
3	5	-15.067e+03	50.313e+03	-207.383e+03	345.815e+03
3	6	-19.773e+03	44.549e+03	-184.340e+03	387.228e+03
3	7	-24.874e+03	38.645e+03	-161.297e+03	408.649e+03
3	8	-30.345e+03	32.640e+03	-138.255e+03	415.485e+03
3	9	-36.156e+03	26.572e+03	-115.212e+03	408.054e+03
3	10	-42.276e+03	20.479e+03	-92.170e+03	377.599e+03
3	11	-48.676e+03	14.460e+03	-69.127e+03	322.627e+03
3	12	-55.325e+03	10.993e+03	-46.085e+03	241.934e+03
3	13	-63.018e+03	10.813e+03	-23.042e+03	136.372e+03
3	14	-71.762e+03	10.753e+03	0.000e+00	0.000e+00

Live Load Envelopes (Per Lane)

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	-10.753e+03	71.762e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-8.769e+03	112.974e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-8.769e+03	112.974e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	-10.753e+03	71.762e+03	0.000e+00	0.000e+00

V SLAB OUTPUT
(CONSTANT DEPTH) REPORT

V SLAB (v5) - VARIABLE DEPTH REINFORCED CONCRETE SLAB BRIDGE DESIGN PROGRAM

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Engineering Resources, Inc. (Corp)

Variable Depth Slab Loading Verification (Constant Depth)

GENERAL BRIDGE DATA

Code Check is based on the AASHTO LRFD Bridge Design Specification, 9th Edition

THE BRIDGE IS A 3 SPAN CONTINUOUS
FLAT SLAB BRIDGE

SPAN # 1 LENGTH OF SPAN = 30.00 Ft., SLAB DEPTH = 20.00 In.
SPAN # 2 LENGTH OF SPAN = 40.00 Ft., SLAB DEPTH = 20.00 In.
SPAN # 3 LENGTH OF SPAN = 30.00 Ft., SLAB DEPTH = 20.00 In.

GEOMETRICS

ROADWAY WIDTH = 36.00 ft.
OUT TO OUT BRIDGE WIDTH = 39.00 ft.
NUMBER OF TRAFFIC LANES = 2
UPPER CLEAR COVER = 2.50 In.
LOWER CLEAR COVER = 1.00 In.
TIRE WEAR DEPTH = 0.50 In.
BRIDGE SKEW = 0.00 Degrees
TOP EXPOSURE FACTOR = 0.750
BOTTOM EXPOSURE FACTOR = 0.750

MATERIAL PROPERTIES

Fy = 60.00 ksi
TOP REINFORCING IS EPOXY COATED
BOTTOM REINFORCING IS EPOXY COATED

F'c = 4.00 ksi
REINF. CONCRETE UNIT WEIGHT = 0.15 kcf
THE CALCULATED LIVE LOAD CONCRETE MODULUS WAS USED
A USER DEFINED DEAD LOAD CONCRETE MODULUS WAS ENTERED

LOADING SPECIFICATION

RAILING LOAD / SIDE = 400.00 plf
50% RAILING LOAD TO BRIDGE & 50% TO EDGE BEAM

FUTURE WEARING SURFACE = 35.00 psf
INTERIOR STRIP SPECIAL DISTRIBUTED LOAD = 0.00 Plf
EXTERIOR STRIP SPECIAL DISTRIBUTED LOAD = 0.00 Plf
ADDITIONAL EXTERIOR STRIP DEAD LOAD = 0.00 Plf

V SLAB (v5) - VARIABLE DEPTH REINFORCED CONCRETE SLAB BRIDGE DESIGN PROGRAM

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Engineering Resources, Inc. (Corp)

Variable Depth Slab Loading Verification (Constant Depth)

REINFORCING DEVELOPMENT AND SPLICE VALUES

CALCULATED DEVELOPMENT AND SPLICE TABLE VALUES

TOP REINFORCING FACTORS

$\lambda_{rl} = 1.3$, $\lambda_{cf} = 1.5$, $\lambda_{rl} * \lambda_{cf} = 1.70$, $\lambda = \lambda_{er} = 1.0$, $K_{tr} = 0.0$
 λ_{rc} (Cover Only) = 0.40(#4), 0.40(#5), 0.40(#6), 0.40(#7), 0.40(#8), 0.40(#9), 0.41(#10), 0.45(#11)

CLASS B SPLICE SELECTED

BOTTOM REINFORCING FACTORS

$\lambda_{rl} = 1.0$, $\lambda_{cf} = 1.5$, $\lambda_{rl} * \lambda_{cf} = 1.5$, $\lambda = \lambda_{er} = 1.0$, $K_{tr} = 0.0$
 λ_{rc} (Cover Only) = 0.40(#4), 0.48(#5), 0.55(#6), 0.61(#7), 0.67(#8), 0.72(#9), 0.78(#10), 0.84(#11)

CLASS B SPLICE SELECTED

BAR SIZE	TOP Ld LENGTH (FT)	TOP SPLICE LENGTH (FT)	BOTTOM Ld LENGTH (FT)	BOTTOM SPLICE LENGTH (FT)
#4	2.040	2.652	1.800	2.340
#5	2.550	3.315	2.679	3.482
#6	3.060	3.978	3.682	4.786
#7	3.570	4.641	4.793	6.232
#8	4.080	5.304	6.000	7.800
#9	4.602	5.983	7.322	9.518
#10	5.248	6.822	8.878	11.542
#11	6.569	8.539	10.850	14.105

V SLAB (v5) - VARIABLE DEPTH REINFORCED CONCRETE SLAB BRIDGE DESIGN PROGRAM

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Engineering Resources, Inc. (Corp)

Variable Depth Slab Loading Verification (Constant Depth)

LOADING APPLICATION DETAILS

DISTRIBUTION WIDTH DEFINITION

FATIGUE WIDTH = $1.2 \times \text{SINGLE LANE DISTR.}$ = 16.00 ft./Lane

CALCULATED INTERIOR DISTRIBUTION WIDTH = 11.10 ft./Lane

CALCULATED EXTERIOR DISTRIBUTION WIDTH = 5.28 ft./Lane

DESIGN ENVELOPE LOADING DEFINITION

HL93 LOADING WAS INCLUDED
SPECIAL VEHICLE LOADING WAS INCLUDED
FATIGUE I LOADING COMBINATION WAS INCLUDED

SPECIAL INTERIOR STRIP LINE LOAD WAS INCLUDED
SPECIAL EXTERIOR STRIP LINE LOAD WAS INCLUDED
ADDITIONAL EXTERIOR STRIP DEAD LOAD WAS INCLUDED

MOMENTS WERE NOT REDUCED FOR SKEW CORRECTION

LOAD RATING DEFINITION

CONDITION RATING FACTOR x SYSTEM RATING FACTOR
COMBINED RATING FACTOR: $\Phi(c) \times \Phi(s) = 1.00$

SPECIAL INTERIOR STRIP LINE LOAD WAS INCLUDED
SPECIAL EXTERIOR STRIP LINE LOAD WAS INCLUDED
ADDITIONAL EXTERIOR STRIP DEAD LOAD WAS INCLUDED
FUTURE WEARING SURFACE WAS INCLUDED AS DEAD LOAD (DC)

MOMENTS WERE NOT REDUCED FOR SKEW CORRECTION

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Variable Depth Slab Loading Verification (Constant Depth)

FATIGUE TRUCK ONLY
Values Include 1.15 Dynamic Load Allowance

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
Support # 1					40.93	-4.01
0.00	0.000	0.000	40.927	-4.012		
2.14	79.274	-8.597	36.994	-5.562		
4.29	141.927	-17.195	33.116	-9.772		
6.43	188.458	-25.792	29.316	-13.718		
8.57	219.566	-34.389	25.616	-17.391		
10.71	236.154	-42.986	22.041	-20.716		
12.86	239.323	-51.584	18.614	-23.788		
15.00	230.378	-60.181	15.359	-26.601		
17.14	213.719	-68.778	12.467	-29.867		
19.29	191.007	-77.375	9.904	-33.036		
21.43	160.933	-85.973	7.510	-35.940		
23.57	125.025	-94.570	5.304	-38.568		
25.71	84.973	-139.791	3.304	-40.906		
27.86	42.627	-190.391	1.530	-42.933		
30.00	28.967	-246.033	0.966	-44.666		
Support # 2					56.16	-4.22
0.00	28.967	-246.033	45.434	-3.259		
2.86	28.746	-168.197	41.250	-3.259		
5.71	95.557	-105.843	39.024	-3.259		
8.57	149.067	-73.451	36.396	-6.368		
11.43	185.499	-64.140	33.380	-10.699		
14.29	210.383	-54.830	30.039	-14.742		
17.14	224.255	-45.519	26.416	-18.438		
20.00	223.487	-36.208	22.503	-22.503		
22.86	224.255	-45.519	18.438	-26.416		
25.71	210.383	-54.830	14.742	-30.039		
28.57	185.499	-64.140	10.699	-33.380		
31.43	149.067	-73.451	6.368	-36.396		
34.29	95.557	-105.843	3.259	-39.024		
37.14	28.746	-168.197	3.259	-41.250		
40.00	28.967	-246.033	3.259	-45.434		
Support # 3					56.16	-4.22

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Variable Depth Slab Loading Verification (Constant Depth)

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
0.00	28.967	-246.033	44.666	-0.966		
2.14	42.627	-190.391	42.933	-1.530		
4.29	84.973	-139.791	40.906	-3.304		
6.43	125.025	-94.570	38.568	-5.304		
8.57	160.933	-85.973	35.940	-7.510		
10.71	191.007	-77.375	33.036	-9.904		
12.86	213.719	-68.778	29.867	-12.467		
15.00	230.378	-60.181	26.601	-15.359		
17.14	239.323	-51.584	23.788	-18.614		
19.29	236.154	-42.986	20.716	-22.041		
21.43	219.566	-34.389	17.391	-25.616		
23.57	188.458	-25.792	13.718	-29.316		
25.71	141.927	-17.195	9.772	-33.116		
27.86	79.274	-8.597	5.562	-36.994		
30.00	0.000	0.000	4.012	-40.927		
Support # 4					40.93	-4.01

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Variable Depth Slab Loading Verification (Constant Depth)

HL-93 LIVE LOAD ENVELOPE SUMMARY
Values are Unfactored but Include Dynamic Load Allowance

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
Support # 1					70.86	-10.65
0.00	0.000	0.000	70.864	-10.646		
2.14	135.772	-22.812	62.735	-10.706		
4.29	244.002	-45.624	55.803	-13.439		
6.43	325.330	-68.437	49.091	-18.302		
8.57	380.686	-91.249	42.630	-22.969		
10.71	411.293	-114.061	36.451	-27.347		
12.86	418.662	-136.873	30.585	-32.901		
15.00	411.754	-159.686	25.063	-38.969		
17.14	390.228	-182.498	19.914	-44.936		
19.29	348.487	-205.310	15.166	-50.761		
21.43	288.802	-228.122	10.847	-56.404		
23.57	213.732	-250.935	6.986	-62.601		
25.71	128.439	-276.061	4.259	-69.746		
27.86	60.047	-310.491	2.117	-76.534		
30.00	59.708	-379.739	1.990	-82.911		
Support # 2					111.88	-8.67
0.00	59.708	-379.739	88.096	-6.717		
2.86	50.531	-250.590	79.884	-6.760		
5.71	152.681	-176.821	71.312	-6.902		
8.57	252.818	-151.436	62.567	-10.168		
11.43	341.429	-134.953	54.080	-15.190		
14.29	406.034	-124.980	46.677	-20.786		
17.14	443.630	-120.944	39.907	-26.845		
20.00	452.921	-117.928	33.257	-33.257		
22.86	443.630	-120.944	26.845	-39.907		
25.71	406.034	-124.980	20.786	-46.677		
28.57	341.429	-134.953	15.190	-54.080		
31.43	252.818	-151.436	10.168	-62.567		
34.29	152.681	-176.821	6.902	-71.312		
37.14	50.531	-250.590	6.760	-79.884		
40.00	59.708	-379.739	6.717	-88.096		
Support # 3					111.88	-8.67

V SLAB (v5) - VARIABLE DEPTH REINFORCED CONCRETE SLAB BRIDGE DESIGN PROGRAM

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Variable Depth Slab Loading Verification (Constant Depth)

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
0.00	59.708	-379.739	82.911	-1.990		
2.14	60.047	-310.491	76.534	-2.117		
4.29	128.439	-276.061	69.746	-4.259		
6.43	213.732	-250.935	62.601	-6.986		
8.57	288.802	-228.122	56.404	-10.847		
10.71	348.487	-205.310	50.761	-15.166		
12.86	390.228	-182.498	44.936	-19.914		
15.00	411.754	-159.686	38.969	-25.063		
17.14	418.661	-136.873	32.901	-30.585		
19.29	411.293	-114.061	27.347	-36.451		
21.43	380.686	-91.249	22.969	-42.630		
23.57	325.330	-68.437	18.302	-49.091		
25.71	244.002	-45.624	13.439	-55.803		
27.86	135.772	-22.812	10.706	-62.735		
30.00	0.000	0.000	10.646	-70.864		
Support # 4					70.86	-10.65

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Variable Depth Slab Loading Verification (Constant Depth)

DEAD LOAD & DEFLECTION SUMMARY
MODULUS OF ELASTICITY, E(dead)= 1,200 Ksi, E(live)= 3,640 Ksi

LOCATION (FT)	SLAB * MOMENT (FT-K/FT)	SLAB DEFLECTION (IN.)	LIVE LOAD DEFLECTION (IN.)	LIVE LOAD DEFLECTION L over
Support # 1, R(Slab)* = 2.70 K/Ft.				
0.00	0.000	0.000	0.000	0
2.14	5.205	-0.047	-0.019	19271
4.29	9.262	-0.089	-0.036	9966
6.43	12.170	-0.124	-0.051	7047
8.57	13.931	-0.149	-0.063	5729
10.71	14.544	-0.163	-0.071	5081
12.86	14.009	-0.165	-0.075	4804
15.00	12.326	-0.155	-0.075	4773
17.14	9.495	-0.135	-0.072	4976
19.29	5.517	-0.107	-0.066	5466
21.43	0.390	-0.075	-0.056	6420
23.57	-5.885	-0.042	-0.043	8311
25.71	-13.308	-0.015	-0.029	12455
27.86	-21.879	0.002	-0.014	25749
30.00	-31.597	0.000	0.000	0
Support # 2, R(Slab)* = 9.80 K/Ft.				
0.00	-31.597	0.000	0.000	0
2.86	-18.332	-0.038	-0.025	18863
5.71	-7.107	-0.103	-0.054	8954
8.57	2.076	-0.178	-0.081	5942
11.43	9.219	-0.251	-0.105	4573
14.29	14.321	-0.310	-0.123	3906
17.14	17.382	-0.349	-0.134	3589
20.00	18.403	-0.363	-0.137	3496
22.86	17.382	-0.349	-0.134	3589
25.71	14.321	-0.310	-0.123	3906
28.57	9.219	-0.251	-0.105	4573
31.43	2.076	-0.178	-0.081	5942
34.29	-7.107	-0.103	-0.054	8954
37.14	-18.332	-0.038	-0.025	18863
40.00	-31.597	0.000	0.000	0
Support # 3, R(Slab)* = 9.80 K/Ft.				
0.00	-31.597	0.000	0.000	0
2.14	-21.879	0.002	-0.014	25749

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Variable Depth Slab Loading Verification (Constant Depth)

LOCATION (FT)	SLAB * MOMENT (FT-K/FT)	SLAB DEFLECTION (IN.)	LIVE LOAD DEFLECTION (IN.)	LIVE LOAD DEFLECTION L over
4.29	-13.308	-0.015	-0.029	12455
6.43	-5.885	-0.042	-0.043	8311
8.57	0.390	-0.075	-0.056	6420
10.71	5.517	-0.107	-0.066	5466
12.86	9.495	-0.135	-0.072	4976
15.00	12.326	-0.155	-0.075	4773
17.14	14.009	-0.165	-0.075	4804
19.29	14.544	-0.163	-0.071	5081
21.43	13.931	-0.149	-0.063	5729
23.57	12.170	-0.124	-0.051	7047
25.71	9.262	-0.089	-0.036	9966
27.86	5.205	-0.047	-0.019	19271
30.00	0.000	0.000	0.000	0
Support # 4, R(Slab)* = 2.70 K/Ft.				

* VALUES FOR UNFACTORED SLAB DEAD LOAD

V SLAB OUTPUT
(DROP HAUNCH) REPORT

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Variable Depth Slab Loading Verification (Drop Haunch)

GENERAL BRIDGE DATA

Code Check is based on the AASHTO LRFD Bridge Design Specification, 9th Edition

THE BRIDGE IS A 3 SPAN CONTINUOUS
VARIABLE DEPTH BRIDGE - CONSTANT DEPTH HAUNCH

SPAN # 1 LENGTH OF SPAN = 30.00 Ft., SLAB DEPTH = 20.00 In.
SPAN # 2 LENGTH OF SPAN = 40.00 Ft., SLAB DEPTH = 20.00 In.
SPAN # 3 LENGTH OF SPAN = 30.00 Ft., SLAB DEPTH = 20.00 In.

HAUNCH @ SUPPORT # 2, SLAB DEPTH = 20.01 In.
OFFSET LENGTH LEFT = 1.00 Ft., OFFSET LENGTH RIGHT = 1.00 Ft.
TRANSITION LENGTH LEFT = 7.57 Ft., TRANSITION LENGTH RIGHT = 7.57 Ft.
HAUNCH @ SUPPORT # 3, SLAB DEPTH = 20.01 In.
OFFSET LENGTH LEFT = 1.00 Ft., OFFSET LENGTH RIGHT = 1.00 Ft.
TRANSITION LENGTH LEFT = 7.57 Ft., TRANSITION LENGTH RIGHT = 7.57 Ft.

GEOMETRICS

ROADWAY WIDTH = 36.00 ft.
OUT TO OUT BRIDGE WIDTH = 39.00 ft.
NUMBER OF TRAFFIC LANES = 2
UPPER CLEAR COVER = 2.50 In.
LOWER CLEAR COVER = 1.00 In.
TIRE WEAR DEPTH = 0.50 In.
BRIDGE SKEW = 0.00 Degrees
TOP EXPOSURE FACTOR = 0.750
BOTTOM EXPOSURE FACTOR = 0.750

MATERIAL PROPERTIES

Fy = 60.00 ksi
TOP REINFORCING IS EPOXY COATED
BOTTOM REINFORCING IS EPOXY COATED

F'c = 4.00 ksi
REINF. CONCRETE UNIT WEIGHT = 0.15 kcf
THE CALCULATED LIVE LOAD CONCRETE MODULUS WAS USED
A USER DEFINED DEAD LOAD CONCRETE MODULUS WAS ENTERED

LOADING SPECIFICATION

RAILING LOAD / SIDE = 400.00 plf
50% RAILING LOAD TO BRIDGE & 50% TO EDGE BEAM

FUTURE WEARING SURFACE = 35.00 psf
INTERIOR STRIP SPECIAL DISTRIBUTED LOAD = 0.00 Plf
EXTERIOR STRIP SPECIAL DISTRIBUTED LOAD = 0.00 Plf
ADDITIONAL EXTERIOR STRIP DEAD LOAD = 0.00 Plf

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Variable Depth Slab Loading Verification (Drop Haunch)

REINFORCING DEVELOPMENT AND SPLICE VALUES

CALCULATED DEVELOPMENT AND SPLICE TABLE VALUES

TOP REINFORCING FACTORS

$\lambda_{rl} = 1.3$, $\lambda_{cf} = 1.5$, $\lambda_{rl} * \lambda_{cf} = 1.70$, $\lambda = \lambda_{er} = 1.0$, $K_{tr} = 0.0$
 λ_{rc} (Cover Only) = 0.40(#4), 0.40(#5), 0.40(#6), 0.40(#7), 0.40(#8), 0.40(#9), 0.41(#10), 0.45(#11)

CLASS B SPLICE SELECTED

BOTTOM REINFORCING FACTORS

$\lambda_{rl} = 1.0$, $\lambda_{cf} = 1.5$, $\lambda_{rl} * \lambda_{cf} = 1.5$, $\lambda = \lambda_{er} = 1.0$, $K_{tr} = 0.0$
 λ_{rc} (Cover Only) = 0.40(#4), 0.48(#5), 0.55(#6), 0.61(#7), 0.67(#8), 0.72(#9), 0.78(#10), 0.84(#11)

CLASS B SPLICE SELECTED

BAR SIZE	TOP Ld LENGTH (FT)	TOP SPLICE LENGTH (FT)	BOTTOM Ld LENGTH (FT)	BOTTOM SPLICE LENGTH (FT)
#4	2.040	2.652	1.800	2.340
#5	2.550	3.315	2.679	3.482
#6	3.060	3.978	3.682	4.786
#7	3.570	4.641	4.793	6.232
#8	4.080	5.304	6.000	7.800
#9	4.602	5.983	7.322	9.518
#10	5.248	6.822	8.878	11.542
#11	6.569	8.539	10.850	14.105

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Variable Depth Slab Loading Verification (Drop Haunch)

LOADING APPLICATION DETAILS

DISTRIBUTION WIDTH DEFINITION

FATIGUE WIDTH = $1.2 \times \text{SINGLE LANE DISTR.}$ = 16.00 ft./Lane

CALCULATED INTERIOR DISTRIBUTION WIDTH = 11.10 ft./Lane

CALCULATED EXTERIOR DISTRIBUTION WIDTH = 5.28 ft./Lane

DESIGN ENVELOPE LOADING DEFINITION

HL93 LOADING WAS INCLUDED
SPECIAL VEHICLE LOADING WAS INCLUDED
FATIGUE I LOADING COMBINATION WAS INCLUDED

SPECIAL INTERIOR STRIP LINE LOAD WAS INCLUDED
SPECIAL EXTERIOR STRIP LINE LOAD WAS INCLUDED
ADDITIONAL EXTERIOR STRIP DEAD LOAD WAS INCLUDED

MOMENTS WERE NOT REDUCED FOR SKEW CORRECTION

LOAD RATING DEFINITION

CONDITION RATING FACTOR x SYSTEM RATING FACTOR
COMBINED RATING FACTOR: $\Phi(c) \times \Phi(s) = 1.00$

SPECIAL INTERIOR STRIP LINE LOAD WAS INCLUDED
SPECIAL EXTERIOR STRIP LINE LOAD WAS INCLUDED
ADDITIONAL EXTERIOR STRIP DEAD LOAD WAS INCLUDED
FUTURE WEARING SURFACE WAS INCLUDED AS DEAD LOAD (DC)

MOMENTS WERE NOT REDUCED FOR SKEW CORRECTION

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Variable Depth Slab Loading Verification (Drop Haunch)

FATIGUE TRUCK ONLY
Values Include 1.15 Dynamic Load Allowance

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
Support # 1					40.93	-4.00
0.00	0.000	0.000	40.926	-3.999		
2.14	79.272	-8.569	36.994	-5.526		
4.29	141.922	-17.138	33.115	-9.782		
6.43	188.448	-25.706	29.314	-13.675		
8.57	219.573	-34.275	25.617	-17.394		
10.71	236.149	-42.844	22.041	-20.720		
12.86	239.275	-51.413	18.610	-23.792		
15.00	230.233	-59.981	15.349	-26.605		
17.14	213.686	-68.552	12.465	-29.872		
19.29	190.968	-77.123	9.902	-33.041		
21.43	160.889	-85.693	7.508	-35.945		
23.95	118.127	-102.016	4.932	-39.005		
26.48	70.064	-156.778	2.646	-41.661		
29.00	28.037	-219.885	0.967	-43.903		
30.00	29.004	-246.152	0.967	-44.667		
Support # 2					56.15	-4.23
0.00	29.004	-246.152	45.434	-3.262		
1.00	25.742	-217.370	43.899	-3.262		
4.79	74.503	-125.390	39.795	-3.262		
8.57	149.027	-73.510	36.399	-6.383		
11.43	185.437	-64.190	33.384	-10.701		
14.29	210.438	-54.870	30.042	-14.710		
17.14	224.552	-45.550	26.419	-18.428		
20.00	223.601	-36.230	22.515	-22.515		
22.86	224.552	-45.550	18.428	-26.419		
25.72	210.438	-54.870	14.710	-30.042		
28.57	185.437	-64.190	10.701	-33.384		
31.43	149.027	-73.510	6.383	-36.399		
35.22	74.503	-125.390	3.262	-39.795		
39.00	25.742	-217.370	3.262	-43.899		
40.00	29.004	-246.152	3.262	-45.434		
Support # 3					56.15	-4.23

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Variable Depth Slab Loading Verification (Drop Haunch)

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
0.00	29.004	-246.152	44.667	-0.967		
1.00	28.037	-219.885	43.903	-0.967		
3.52	70.064	-156.778	41.661	-2.646		
6.05	118.127	-102.016	39.005	-4.932		
8.57	160.889	-85.693	35.945	-7.508		
10.71	190.968	-77.123	33.041	-9.902		
12.86	213.686	-68.552	29.872	-12.465		
15.00	230.233	-59.981	26.605	-15.349		
17.14	239.275	-51.413	23.792	-18.610		
19.29	236.149	-42.844	20.720	-22.041		
21.43	219.573	-34.275	17.394	-25.617		
23.57	188.448	-25.706	13.675	-29.314		
25.71	141.922	-17.138	9.782	-33.115		
27.86	79.272	-8.569	5.526	-36.994		
30.00	0.000	0.000	3.999	-40.926		
Support # 4					40.93	-4.00

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Variable Depth Slab Loading Verification (Drop Haunch)

HL-93 LIVE LOAD ENVELOPE SUMMARY
Values are Unfactored but Include Dynamic Load Allowance

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
Support # 1					70.87	-10.65
0.00	0.000	0.000	70.871	-10.653		
2.14	135.769	-22.828	62.733	-10.714		
4.29	243.993	-45.656	55.801	-13.451		
6.43	325.313	-68.484	49.088	-18.253		
8.57	380.660	-91.313	42.627	-22.973		
10.71	411.258	-114.141	36.448	-27.352		
12.86	418.619	-136.969	30.582	-32.905		
15.00	411.705	-159.797	25.060	-38.973		
17.14	390.164	-182.630	19.910	-44.941		
19.29	348.405	-205.464	15.176	-50.767		
21.43	288.702	-228.297	10.866	-56.412		
23.95	199.092	-255.178	6.372	-63.903		
26.48	98.487	-287.538	3.458	-72.215		
29.00	57.989	-337.282	1.998	-80.006		
30.00	59.767	-379.913	1.992	-82.914		
Support # 2					111.76	-8.67
0.00	59.767	-379.913	88.097	-6.721		
1.00	53.195	-331.514	85.271	-6.726		
4.79	118.708	-188.053	74.138	-6.848		
8.57	252.673	-151.507	62.586	-10.143		
11.43	341.287	-135.012	54.078	-15.206		
14.29	405.899	-125.023	46.679	-20.784		
17.14	443.502	-121.044	39.908	-26.844		
20.00	452.798	-118.071	33.257	-33.257		
22.86	443.502	-121.044	26.844	-39.908		
25.72	405.899	-125.023	20.784	-46.679		
28.57	341.287	-135.012	15.206	-54.078		
31.43	252.673	-151.507	10.143	-62.586		
35.22	118.708	-188.053	6.848	-74.138		
39.00	53.195	-331.513	6.726	-85.271		
40.00	59.767	-379.913	6.721	-88.097		
Support # 3					111.76	-8.67

V SLAB (v5) - VARIABLE DEPTH REINFORCED CONCRETE SLAB BRIDGE DESIGN PROGRAM

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Variable Depth Slab Loading Verification (Drop Haunch)

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
0.00	59.767	-379.913	82.914	-1.992		
1.00	57.989	-337.282	80.006	-1.998		
3.52	98.488	-287.538	72.215	-3.458		
6.05	199.092	-255.178	63.903	-6.372		
8.57	288.702	-228.297	56.412	-10.866		
10.71	348.405	-205.464	50.767	-15.176		
12.86	390.164	-182.630	44.941	-19.910		
15.00	411.705	-159.797	38.973	-25.060		
17.14	418.619	-136.969	32.905	-30.582		
19.29	411.258	-114.141	27.352	-36.448		
21.43	380.660	-91.313	22.973	-42.627		
23.57	325.313	-68.484	18.253	-49.088		
25.71	243.993	-45.656	13.451	-55.801		
27.86	135.769	-22.828	10.714	-62.733		
30.00	0.000	0.000	10.653	-70.871		
Support # 4					70.87	-10.65

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Variable Depth Slab Loading Verification (Drop Haunch)

DEAD LOAD & DEFLECTION SUMMARY
MODULUS OF ELASTICITY, E(dead)= 1,200 Ksi, E(live)= 3,640 Ksi

LOCATION (FT)	SLAB * MOMENT (FT-K/FT)	SLAB DEFLECTION (IN.)	LIVE LOAD DEFLECTION (IN.)	LIVE LOAD DEFLECTION L over
Support # 1, R(Slab)* = 2.70 K/Ft.				
0.00	0.000	0.000	0.000	0
2.14	5.204	-0.047	-0.019	19275
4.29	9.260	-0.089	-0.036	9968
6.43	12.168	-0.124	-0.051	7049
8.57	13.928	-0.149	-0.063	5730
10.71	14.541	-0.163	-0.071	5084
12.86	14.005	-0.164	-0.075	4805
15.00	12.321	-0.155	-0.075	4775
17.14	9.489	-0.135	-0.072	4977
19.29	5.508	-0.107	-0.066	5468
21.43	0.379	-0.075	-0.056	6424
23.95	-7.133	-0.037	-0.041	8824
26.48	-16.236	-0.007	-0.024	15305
29.00	-26.933	0.004	-0.006	57173
30.00	-31.612	0.000	0.000	0
Support # 2, R(Slab)* = 9.81 K/Ft.				
0.00	-31.612	0.000	0.000	0
1.00	-26.736	-0.009	-0.008	57430
4.79	-10.545	-0.079	-0.044	10818
8.57	2.062	-0.178	-0.081	5943
11.43	9.206	-0.251	-0.105	4577
14.29	14.310	-0.310	-0.123	3909
17.14	17.372	-0.349	-0.134	3591
20.00	18.392	-0.362	-0.137	3498
22.86	17.372	-0.349	-0.134	3591
25.72	14.310	-0.310	-0.123	3909
28.57	9.206	-0.251	-0.105	4577
31.43	2.062	-0.178	-0.081	5943
35.22	-10.545	-0.079	-0.044	10818
39.00	-26.736	-0.009	-0.008	57430
40.00	-31.612	0.000	0.000	0
Support # 3, R(Slab)* = 9.81 K/Ft.				
0.00	-31.612	0.000	0.000	0
1.00	-26.933	0.004	-0.006	57173

V SLAB (v5) - VARIABLE DEPTH REINFORCED CONCRETE SLAB BRIDGE DESIGN PROGRAM

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Variable Depth Slab Loading Verification (Drop Haunch)

LOCATION (FT)	SLAB * MOMENT (FT-K/FT)	SLAB DEFLECTION (IN.)	LIVE LOAD DEFLECTION (IN.)	LIVE LOAD DEFLECTION L over
3.52	-16.236	-0.007	-0.024	15305
6.05	-7.133	-0.037	-0.041	8824
8.57	0.379	-0.075	-0.056	6424
10.71	5.508	-0.107	-0.066	5468
12.86	9.489	-0.135	-0.072	4977
15.00	12.321	-0.155	-0.075	4775
17.14	14.005	-0.164	-0.075	4805
19.29	14.541	-0.163	-0.071	5084
21.43	13.928	-0.149	-0.063	5730
23.57	12.168	-0.124	-0.051	7049
25.71	9.260	-0.089	-0.036	9968
27.86	5.204	-0.047	-0.019	19275
30.00	0.000	0.000	0.000	0
Support # 4, R(Slab)* = 2.70 K/Ft.				

* VALUES FOR UNFACTORED SLAB DEAD LOAD

V SLAB OUTPUT
(SLOPE TAPER) REPORT

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Variable Depth Slab Loading Verification (Slope Taper)

GENERAL BRIDGE DATA

Code Check is based on the AASHTO LRFD Bridge Design Specification, 9th Edition

THE BRIDGE IS A 3 SPAN CONTINUOUS
VARIABLE DEPTH BRIDGE - SLOPE TAPERED HAUNCH

SPAN # 1 LENGTH OF SPAN = 30.00 Ft., SLAB DEPTH = 20.00 In.
SPAN # 2 LENGTH OF SPAN = 40.00 Ft., SLAB DEPTH = 20.00 In.
SPAN # 3 LENGTH OF SPAN = 30.00 Ft., SLAB DEPTH = 20.00 In.

HAUNCH @ SUPPORT # 2, SLAB DEPTH = 20.01 In.
OFFSET LENGTH LEFT = 1.00 Ft., OFFSET LENGTH RIGHT = 1.00 Ft.
TRANSITION LENGTH LEFT = 7.57 Ft., TRANSITION LENGTH RIGHT = 7.57 Ft.
HAUNCH @ SUPPORT # 3, SLAB DEPTH = 20.01 In.
OFFSET LENGTH LEFT = 1.00 Ft., OFFSET LENGTH RIGHT = 1.00 Ft.
TRANSITION LENGTH LEFT = 7.57 Ft., TRANSITION LENGTH RIGHT = 7.57 Ft.

GEOMETRICS

ROADWAY WIDTH = 36.00 ft.
OUT TO OUT BRIDGE WIDTH = 39.00 ft.
NUMBER OF TRAFFIC LANES = 2
UPPER CLEAR COVER = 2.50 In.
LOWER CLEAR COVER = 1.00 In.
TIRE WEAR DEPTH = 0.50 In.
BRIDGE SKEW = 0.00 Degrees
TOP EXPOSURE FACTOR = 0.750
BOTTOM EXPOSURE FACTOR = 0.750

MATERIAL PROPERTIES

Fy = 60.00 ksi
TOP REINFORCING IS EPOXY COATED
BOTTOM REINFORCING IS EPOXY COATED

F'c = 4.00 ksi
REINF. CONCRETE UNIT WEIGHT = 0.15 kcf
THE CALCULATED LIVE LOAD CONCRETE MODULUS WAS USED
A USER DEFINED DEAD LOAD CONCRETE MODULUS WAS ENTERED

LOADING SPECIFICATION

RAILING LOAD / SIDE = 400.00 plf
50% RAILING LOAD TO BRIDGE & 50% TO EDGE BEAM

FUTURE WEARING SURFACE = 35.00 psf
INTERIOR STRIP SPECIAL DISTRIBUTED LOAD = 0.00 Plf
EXTERIOR STRIP SPECIAL DISTRIBUTED LOAD = 0.00 Plf
ADDITIONAL EXTERIOR STRIP DEAD LOAD = 0.00 Plf

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Variable Depth Slab Loading Verification (Slope Taper)

REINFORCING DEVELOPMENT AND SPLICE VALUES

CALCULATED DEVELOPMENT AND SPLICE TABLE VALUES

TOP REINFORCING FACTORS

$\lambda_{rl} = 1.3$, $\lambda_{cf} = 1.5$, $\lambda_{rl} * \lambda_{cf} = 1.70$, $\lambda = \lambda_{er} = 1.0$, $K_{tr} = 0.0$
 λ_{rc} (Cover Only) = 0.40(#4), 0.40(#5), 0.40(#6), 0.40(#7), 0.40(#8), 0.40(#9), 0.41(#10), 0.45(#11)

CLASS B SPLICE SELECTED

BOTTOM REINFORCING FACTORS

$\lambda_{rl} = 1.0$, $\lambda_{cf} = 1.5$, $\lambda_{rl} * \lambda_{cf} = 1.5$, $\lambda = \lambda_{er} = 1.0$, $K_{tr} = 0.0$
 λ_{rc} (Cover Only) = 0.40(#4), 0.48(#5), 0.55(#6), 0.61(#7), 0.67(#8), 0.72(#9), 0.78(#10), 0.84(#11)

CLASS B SPLICE SELECTED

BAR SIZE	TOP Ld LENGTH (FT)	TOP SPLICE LENGTH (FT)	BOTTOM Ld LENGTH (FT)	BOTTOM SPLICE LENGTH (FT)
#4	2.040	2.652	1.800	2.340
#5	2.550	3.315	2.679	3.482
#6	3.060	3.978	3.682	4.786
#7	3.570	4.641	4.793	6.232
#8	4.080	5.304	6.000	7.800
#9	4.602	5.983	7.322	9.518
#10	5.248	6.822	8.878	11.542
#11	6.569	8.539	10.850	14.105

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Variable Depth Slab Loading Verification (Slope Taper)

LOADING APPLICATION DETAILS

DISTRIBUTION WIDTH DEFINITION

FATIGUE WIDTH = $1.2 \times \text{SINGLE LANE DISTR.}$ = 16.00 ft./Lane

CALCULATED INTERIOR DISTRIBUTION WIDTH = 11.10 ft./Lane

CALCULATED EXTERIOR DISTRIBUTION WIDTH = 5.28 ft./Lane

DESIGN ENVELOPE LOADING DEFINITION

HL93 LOADING WAS INCLUDED
SPECIAL VEHICLE LOADING WAS INCLUDED
FATIGUE I LOADING COMBINATION WAS INCLUDED

SPECIAL INTERIOR STRIP LINE LOAD WAS INCLUDED
SPECIAL EXTERIOR STRIP LINE LOAD WAS INCLUDED
ADDITIONAL EXTERIOR STRIP DEAD LOAD WAS INCLUDED

MOMENTS WERE NOT REDUCED FOR SKEW CORRECTION

LOAD RATING DEFINITION

CONDITION RATING FACTOR x SYSTEM RATING FACTOR
COMBINED RATING FACTOR: $\Phi(c) \times \Phi(s) = 1.00$

SPECIAL INTERIOR STRIP LINE LOAD WAS INCLUDED
SPECIAL EXTERIOR STRIP LINE LOAD WAS INCLUDED
ADDITIONAL EXTERIOR STRIP DEAD LOAD WAS INCLUDED
FUTURE WEARING SURFACE WAS INCLUDED AS DEAD LOAD (DC)

MOMENTS WERE NOT REDUCED FOR SKEW CORRECTION

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Variable Depth Slab Loading Verification (Slope Taper)

FATIGUE TRUCK ONLY
Values Include 1.15 Dynamic Load Allowance

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
Support # 1					40.93	-4.00
0.00	0.000	0.000	40.927	-3.998		
2.14	79.273	-8.568	36.994	-5.526		
4.29	141.923	-17.136	33.115	-9.782		
6.43	188.451	-25.703	29.315	-13.674		
8.57	219.576	-34.271	25.617	-17.394		
10.71	236.153	-42.839	22.041	-20.719		
12.86	239.280	-51.407	18.611	-23.791		
15.00	230.239	-59.974	15.349	-26.604		
17.14	213.692	-68.544	12.465	-29.871		
19.29	190.971	-77.114	9.902	-33.040		
21.43	160.889	-85.683	7.508	-35.945		
23.95	118.123	-101.998	4.931	-39.005		
26.48	70.062	-156.754	2.646	-41.660		
29.00	28.031	-219.857	0.967	-43.903		
30.00	28.997	-246.123	0.967	-44.667		
Support # 2					56.15	-4.23
0.00	28.997	-246.123	45.434	-3.261		
1.00	25.736	-217.343	43.899	-3.261		
4.79	74.503	-125.368	39.795	-3.261		
8.57	149.030	-73.503	36.399	-6.383		
11.43	185.445	-64.184	33.383	-10.701		
14.29	210.450	-54.865	30.042	-14.710		
17.14	224.566	-45.546	26.418	-18.428		
20.00	223.618	-36.227	22.515	-22.515		
22.86	224.566	-45.546	18.428	-26.418		
25.72	210.450	-54.865	14.710	-30.042		
28.57	185.445	-64.184	10.701	-33.383		
31.43	149.030	-73.503	6.383	-36.399		
35.22	74.503	-125.368	3.261	-39.795		
39.00	25.736	-217.343	3.261	-43.899		
40.00	28.997	-246.123	3.261	-45.434		
Support # 3					56.15	-4.23

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Variable Depth Slab Loading Verification (Slope Taper)

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
0.00	28.997	-246.123	44.667	-0.967		
1.00	28.031	-219.857	43.903	-0.967		
3.52	70.062	-156.754	41.660	-2.646		
6.05	118.123	-101.998	39.005	-4.931		
8.57	160.889	-85.683	35.945	-7.508		
10.71	190.971	-77.114	33.040	-9.902		
12.86	213.692	-68.544	29.871	-12.465		
15.00	230.239	-59.974	26.604	-15.349		
17.14	239.280	-51.407	23.791	-18.611		
19.29	236.153	-42.839	20.719	-22.041		
21.43	219.576	-34.271	17.394	-25.617		
23.57	188.451	-25.703	13.674	-29.315		
25.71	141.923	-17.136	9.782	-33.115		
27.86	79.273	-8.568	5.526	-36.994		
30.00	0.000	0.000	3.998	-40.927		
Support # 4					40.93	-4.00

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Variable Depth Slab Loading Verification (Slope Taper)

HL-93 LIVE LOAD ENVELOPE SUMMARY

Values are Unfactored but Include Dynamic Load Allowance

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
Support # 1					70.87	-10.65
0.00	0.000	0.000	70.872	-10.652		
2.14	135.769	-22.826	62.734	-10.713		
4.29	243.995	-45.653	55.802	-13.451		
6.43	325.317	-68.479	49.089	-18.253		
8.57	380.666	-91.305	42.627	-22.972		
10.71	411.266	-114.132	36.448	-27.351		
12.86	418.628	-136.958	30.583	-32.904		
15.00	411.716	-159.784	25.061	-38.972		
17.14	390.176	-182.616	19.910	-44.940		
19.29	348.416	-205.447	15.176	-50.766		
21.43	288.707	-228.278	10.866	-56.411		
23.95	199.092	-255.158	6.371	-63.903		
26.48	98.481	-287.512	3.458	-72.214		
29.00	57.977	-337.256	1.998	-80.005		
30.00	59.754	-379.874	1.992	-82.914		
Support # 2					111.76	-8.67
0.00	59.754	-379.874	88.097	-6.720		
1.00	53.183	-331.476	85.271	-6.725		
4.79	118.707	-188.034	74.138	-6.847		
8.57	252.690	-151.496	62.586	-10.143		
11.43	341.315	-135.003	54.078	-15.206		
14.29	405.932	-125.019	46.679	-20.784		
17.14	443.538	-121.040	39.908	-26.844		
20.00	452.833	-118.065	33.257	-33.257		
22.86	443.538	-121.040	26.844	-39.908		
25.72	405.932	-125.019	20.784	-46.679		
28.57	341.315	-135.003	15.206	-54.078		
31.43	252.690	-151.496	10.143	-62.586		
35.22	118.707	-188.034	6.847	-74.138		
39.00	53.183	-331.476	6.725	-85.271		
40.00	59.754	-379.874	6.720	-88.097		
Support # 3					111.76	-8.67

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Variable Depth Slab Loading Verification (Slope Taper)

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
0.00	59.754	-379.874	82.914	-1.992		
1.00	57.977	-337.256	80.005	-1.998		
3.52	98.481	-287.512	72.214	-3.458		
6.05	199.092	-255.158	63.903	-6.371		
8.57	288.707	-228.278	56.411	-10.866		
10.71	348.416	-205.447	50.766	-15.176		
12.86	390.176	-182.616	44.940	-19.910		
15.00	411.716	-159.784	38.972	-25.061		
17.14	418.628	-136.958	32.904	-30.583		
19.29	411.266	-114.132	27.351	-36.448		
21.43	380.666	-91.305	22.972	-42.627		
23.57	325.317	-68.479	18.253	-49.089		
25.71	243.995	-45.653	13.451	-55.802		
27.86	135.769	-22.826	10.713	-62.734		
30.00	0.000	0.000	10.652	-70.872		
Support # 4					70.87	-10.65

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Variable Depth Slab Loading Verification (Slope Taper)

DEAD LOAD & DEFLECTION SUMMARY
MODULUS OF ELASTICITY, E(dead)= 1,200 Ksi, E(live)= 3,640 Ksi

LOCATION (FT)	SLAB * MOMENT (FT-K/FT)	SLAB DEFLECTION (IN.)	LIVE LOAD DEFLECTION (IN.)	LIVE LOAD DEFLECTION L over
Support # 1, R(Slab)* = 2.70 K/Ft.				
0.00	0.000	0.000	0.000	0
2.14	5.204	-0.047	-0.019	19274
4.29	9.260	-0.089	-0.036	9968
6.43	12.169	-0.124	-0.051	7048
8.57	13.929	-0.149	-0.063	5730
10.71	14.541	-0.163	-0.071	5084
12.86	14.006	-0.164	-0.075	4805
15.00	12.322	-0.155	-0.075	4774
17.14	9.490	-0.135	-0.072	4977
19.29	5.509	-0.107	-0.066	5467
21.43	0.380	-0.075	-0.056	6423
23.95	-7.131	-0.037	-0.041	8822
26.48	-16.233	-0.007	-0.024	15301
29.00	-26.929	0.004	-0.006	57157
30.00	-31.608	0.000	0.000	0
Support # 2, R(Slab)* = 9.80 K/Ft.				
0.00	-31.608	0.000	0.000	0
1.00	-26.732	-0.009	-0.008	57415
4.79	-10.543	-0.079	-0.044	10816
8.57	2.064	-0.178	-0.081	5942
11.43	9.208	-0.251	-0.105	4577
14.29	14.312	-0.310	-0.123	3908
17.14	17.374	-0.349	-0.134	3591
20.00	18.394	-0.362	-0.137	3497
22.86	17.374	-0.349	-0.134	3591
25.72	14.312	-0.310	-0.123	3908
28.57	9.208	-0.251	-0.105	4577
31.43	2.064	-0.178	-0.081	5942
35.22	-10.543	-0.079	-0.044	10816
39.00	-26.732	-0.009	-0.008	57415
40.00	-31.608	0.000	0.000	0
Support # 3, R(Slab)* = 9.80 K/Ft.				
0.00	-31.608	0.000	0.000	0
1.00	-26.929	0.004	-0.006	57157

V SLAB (v5) - VARIABLE DEPTH REINFORCED CONCRETE SLAB BRIDGE DESIGN PROGRAM

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Variable Depth Slab Loading Verification (Slope Taper)

LOCATION (FT)	SLAB * MOMENT (FT-K/FT)	SLAB DEFLECTION (IN.)	LIVE LOAD DEFLECTION (IN.)	LIVE LOAD DEFLECTION L over
3.52	-16.233	-0.007	-0.024	15301
6.05	-7.131	-0.037	-0.041	8822
8.57	0.380	-0.075	-0.056	6423
10.71	5.509	-0.107	-0.066	5467
12.86	9.490	-0.135	-0.072	4977
15.00	12.322	-0.155	-0.075	4774
17.14	14.006	-0.164	-0.075	4805
19.29	14.541	-0.163	-0.071	5084
21.43	13.929	-0.149	-0.063	5730
23.57	12.169	-0.124	-0.051	7048
25.71	9.260	-0.089	-0.036	9968
27.86	5.204	-0.047	-0.019	19274
30.00	0.000	0.000	0.000	0
Support # 4, R(Slab)* = 2.70 K/Ft.				

* VALUES FOR UNFACTORED SLAB DEAD LOAD

V SLAB OUTPUT
(PARAPOLIC) REPORT

V SLAB (v5) - VARIABLE DEPTH REINFORCED CONCRETE SLAB BRIDGE DESIGN PROGRAM

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Variable Depth Slab Loading Verification (Parabolic)

GENERAL BRIDGE DATA

Code Check is based on the AASHTO LRFD Bridge Design Specification, 9th Edition

THE BRIDGE IS A 3 SPAN CONTINUOUS
VARIABLE DEPTH BRIDGE - PARABOLIC HAUNCH

SPAN # 1 LENGTH OF SPAN = 30.00 Ft., SLAB DEPTH = 20.00 In.

SPAN # 2 LENGTH OF SPAN = 40.00 Ft., SLAB DEPTH = 20.00 In.

SPAN # 3 LENGTH OF SPAN = 30.00 Ft., SLAB DEPTH = 20.00 In.

HAUNCH @ SUPPORT # 2, SLAB DEPTH = 20.01 In.

OFFSET LENGTH LEFT = 1.00 Ft., OFFSET LENGTH RIGHT = 1.00 Ft.

TRANSITION LENGTH LEFT = 7.57 Ft., TRANSITION LENGTH RIGHT = 7.57 Ft.

HAUNCH @ SUPPORT # 3, SLAB DEPTH = 20.01 In.

OFFSET LENGTH LEFT = 1.00 Ft., OFFSET LENGTH RIGHT = 1.00 Ft.

TRANSITION LENGTH LEFT = 7.57 Ft., TRANSITION LENGTH RIGHT = 7.57 Ft.

GEOMETRICS

ROADWAY WIDTH = 36.00 ft.

OUT TO OUT BRIDGE WIDTH = 39.00 ft.

NUMBER OF TRAFFIC LANES = 2

UPPER CLEAR COVER = 2.50 In.

LOWER CLEAR COVER = 1.00 In.

TIRE WEAR DEPTH = 0.50 In.

BRIDGE SKEW = 0.00 Degrees

TOP EXPOSURE FACTOR = 0.750

BOTTOM EXPOSURE FACTOR = 0.750

MATERIAL PROPERTIES

Fy = 60.00 ksi

TOP REINFORCING IS EPOXY COATED

BOTTOM REINFORCING IS EPOXY COATED

F'c = 4.00 ksi

REINF. CONCRETE UNIT WEIGHT = 0.15 kcf

THE CALCULATED LIVE LOAD CONCRETE MODULUS WAS USED

A USER DEFINED DEAD LOAD CONCRETE MODULUS WAS ENTERED

LOADING SPECIFICATION

RAILING LOAD / SIDE = 400.00 plf

50% RAILING LOAD TO BRIDGE & 50% TO EDGE BEAM

FUTURE WEARING SURFACE = 35.00 psf

INTERIOR STRIP SPECIAL DISTRIBUTED LOAD = 0.00 Plf

EXTERIOR STRIP SPECIAL DISTRIBUTED LOAD = 0.00 Plf

ADDITIONAL EXTERIOR STRIP DEAD LOAD = 0.00 Plf

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Variable Depth Slab Loading Verification (Parabolic)

REINFORCING DEVELOPMENT AND SPLICE VALUES

CALCULATED DEVELOPMENT AND SPLICE TABLE VALUES

TOP REINFORCING FACTORS

$\lambda_{rl} = 1.3$, $\lambda_{cf} = 1.5$, $\lambda_{rl} * \lambda_{cf} = 1.70$, $\lambda = \lambda_{er} = 1.0$, $K_{tr} = 0.0$
 λ_{rc} (Cover Only) = 0.40(#4), 0.40(#5), 0.40(#6), 0.40(#7), 0.40(#8), 0.40(#9), 0.41(#10), 0.45(#11)

CLASS B SPLICE SELECTED

BOTTOM REINFORCING FACTORS

$\lambda_{rl} = 1.0$, $\lambda_{cf} = 1.5$, $\lambda_{rl} * \lambda_{cf} = 1.5$, $\lambda = \lambda_{er} = 1.0$, $K_{tr} = 0.0$
 λ_{rc} (Cover Only) = 0.40(#4), 0.48(#5), 0.55(#6), 0.61(#7), 0.67(#8), 0.72(#9), 0.78(#10), 0.84(#11)

CLASS B SPLICE SELECTED

BAR SIZE	TOP Ld LENGTH (FT)	TOP SPLICE LENGTH (FT)	BOTTOM Ld LENGTH (FT)	BOTTOM SPLICE LENGTH (FT)
#4	2.040	2.652	1.800	2.340
#5	2.550	3.315	2.679	3.482
#6	3.060	3.978	3.682	4.786
#7	3.570	4.641	4.793	6.232
#8	4.080	5.304	6.000	7.800
#9	4.602	5.983	7.322	9.518
#10	5.248	6.822	8.878	11.542
#11	6.569	8.539	10.850	14.105

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Variable Depth Slab Loading Verification (Parabolic)

LOADING APPLICATION DETAILS

DISTRIBUTION WIDTH DEFINITION

FATIGUE WIDTH = $1.2 \times \text{SINGLE LANE DISTR.}$ = 16.00 ft./Lane

CALCULATED INTERIOR DISTRIBUTION WIDTH = 11.10 ft./Lane

CALCULATED EXTERIOR DISTRIBUTION WIDTH = 5.28 ft./Lane

DESIGN ENVELOPE LOADING DEFINITION

HL93 LOADING WAS INCLUDED
SPECIAL VEHICLE LOADING WAS INCLUDED
FATIGUE I LOADING COMBINATION WAS INCLUDED

SPECIAL INTERIOR STRIP LINE LOAD WAS INCLUDED
SPECIAL EXTERIOR STRIP LINE LOAD WAS INCLUDED
ADDITIONAL EXTERIOR STRIP DEAD LOAD WAS INCLUDED

MOMENTS WERE NOT REDUCED FOR SKEW CORRECTION

LOAD RATING DEFINITION

CONDITION RATING FACTOR x SYSTEM RATING FACTOR
COMBINED RATING FACTOR: $\Phi(c) \times \Phi(s) = 1.00$

SPECIAL INTERIOR STRIP LINE LOAD WAS INCLUDED
SPECIAL EXTERIOR STRIP LINE LOAD WAS INCLUDED
ADDITIONAL EXTERIOR STRIP DEAD LOAD WAS INCLUDED
FUTURE WEARING SURFACE WAS INCLUDED AS DEAD LOAD (DC)

MOMENTS WERE NOT REDUCED FOR SKEW CORRECTION

V SLAB (v5) - VARIABLE DEPTH REINFORCED CONCRETE SLAB BRIDGE DESIGN PROGRAM

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Variable Depth Slab Loading Verification (Parabolic)

PARABOLIC HAUNCH - DETAILED SLAB DEPTH SUMMARY

All Distances are Measured from the Left End of the Span

LOCATION (FT)	HAUNCH DEPTH (IN)
Span # 1	
21.43	20.000
22.94	20.000
24.46	20.002
25.97	20.004
27.49	20.006
29.00	20.010
Support # 2	
1.00	20.010
2.51	20.006
4.03	20.004
5.54	20.002
7.06	20.000
8.57	20.000
Span # 2	
31.43	20.000
32.94	20.000
34.46	20.002
35.97	20.004
37.49	20.006
39.00	20.010
Support # 3	
1.00	20.010
2.51	20.006
4.03	20.004
5.54	20.002
7.06	20.000
8.57	20.000
Span # 3	

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Variable Depth Slab Loading Verification (Parabolic)

FATIGUE TRUCK ONLY
Values Include 1.15 Dynamic Load Allowance

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
Support # 1					40.93	-4.00
0.00	0.000	0.000	40.927	-3.998		
2.14	79.273	-8.567	36.994	-5.525		
4.29	141.924	-17.135	33.116	-9.782		
6.43	188.452	-25.702	29.315	-13.674		
8.57	219.578	-34.269	25.617	-17.393		
10.71	236.156	-42.837	22.041	-20.718		
12.86	239.283	-51.404	18.611	-23.790		
15.00	230.242	-59.971	15.349	-26.604		
17.14	213.695	-68.541	12.465	-29.870		
19.29	190.974	-77.110	9.902	-33.039		
21.43	160.891	-85.679	7.508	-35.944		
23.95	118.123	-101.988	4.931	-39.004		
26.48	70.061	-156.741	2.646	-41.660		
29.00	28.027	-219.843	0.966	-43.902		
30.00	28.993	-246.108	0.966	-44.667		
Support # 2					56.15	-4.23
0.00	28.993	-246.108	45.434	-3.261		
1.00	25.732	-217.328	43.899	-3.261		
4.79	74.505	-125.357	39.795	-3.261		
8.57	149.033	-73.498	36.399	-6.383		
11.43	185.451	-64.180	33.383	-10.701		
14.29	210.456	-54.862	30.041	-14.710		
17.14	224.573	-45.544	26.418	-18.427		
20.00	223.627	-36.226	22.515	-22.515		
22.86	224.573	-45.544	18.427	-26.418		
25.72	210.456	-54.862	14.710	-30.041		
28.57	185.451	-64.180	10.701	-33.383		
31.43	149.033	-73.498	6.383	-36.399		
35.22	74.505	-125.357	3.261	-39.795		
39.00	25.732	-217.328	3.261	-43.899		
40.00	28.993	-246.108	3.261	-45.434		
Support # 3					56.15	-4.23

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Variable Depth Slab Loading Verification (Parabolic)

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
0.00	28.993	-246.108	44.667	-0.966		
1.00	28.027	-219.843	43.902	-0.966		
3.52	70.061	-156.741	41.660	-2.646		
6.05	118.123	-101.988	39.004	-4.931		
8.57	160.891	-85.679	35.944	-7.508		
10.71	190.974	-77.110	33.039	-9.902		
12.86	213.695	-68.541	29.870	-12.465		
15.00	230.242	-59.971	26.604	-15.349		
17.14	239.283	-51.404	23.790	-18.611		
19.29	236.156	-42.837	20.718	-22.041		
21.43	219.578	-34.269	17.393	-25.617		
23.57	188.452	-25.702	13.674	-29.315		
25.71	141.924	-17.135	9.782	-33.116		
27.86	79.273	-8.567	5.525	-36.994		
30.00	0.000	0.000	3.998	-40.927		
Support # 4					40.93	-4.00

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Variable Depth Slab Loading Verification (Parabolic)

HL-93 LIVE LOAD ENVELOPE SUMMARY
Values are Unfactored but Include Dynamic Load Allowance

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
Support # 1					70.87	-10.65
0.00	0.000	0.000	70.872	-10.652		
2.14	135.770	-22.825	62.734	-10.712		
4.29	243.996	-45.650	55.802	-13.450		
6.43	325.319	-68.476	49.089	-18.252		
8.57	380.670	-91.301	42.628	-22.972		
10.71	411.270	-114.126	36.449	-27.350		
12.86	418.633	-136.951	30.583	-32.903		
15.00	411.722	-159.777	25.061	-38.972		
17.14	390.182	-182.607	19.911	-44.940		
19.29	348.423	-205.437	15.176	-50.766		
21.43	288.713	-228.267	10.866	-56.411		
23.95	199.095	-255.145	6.371	-63.903		
26.48	98.481	-287.498	3.458	-72.213		
29.00	57.970	-337.240	1.997	-80.005		
30.00	59.747	-379.853	1.992	-82.913		
Support # 2					111.75	-8.66
0.00	59.747	-379.853	88.097	-6.720		
1.00	53.177	-331.455	85.270	-6.725		
4.79	118.710	-188.022	74.138	-6.846		
8.57	252.701	-151.488	62.586	-10.143		
11.43	341.329	-134.997	54.078	-15.206		
14.29	405.948	-125.015	46.679	-20.784		
17.14	443.554	-121.036	39.908	-26.844		
20.00	452.849	-118.061	33.257	-33.257		
22.86	443.554	-121.036	26.844	-39.908		
25.72	405.948	-125.015	20.784	-46.679		
28.57	341.329	-134.997	15.206	-54.078		
31.43	252.701	-151.488	10.143	-62.586		
35.22	118.710	-188.022	6.846	-74.138		
39.00	53.177	-331.455	6.725	-85.270		
40.00	59.747	-379.853	6.720	-88.097		
Support # 3					111.75	-8.66

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Variable Depth Slab Loading Verification (Parabolic)

LOCATION (FT)	POSITIVE MOMENT (FT-K/LANE)	NEGATIVE MOMENT (FT-K/LANE)	POSITIVE SHEAR (K/LANE)	NEGATIVE SHEAR (K/LANE)	MAXIMUM REACTION (K/LANE)	MINIMUM REACTION (K/LANE)
0.00	59.747	-379.853	82.913	-1.992		
1.00	57.970	-337.240	80.005	-1.997		
3.52	98.481	-287.498	72.213	-3.458		
6.05	199.095	-255.145	63.903	-6.371		
8.57	288.713	-228.267	56.411	-10.866		
10.71	348.423	-205.437	50.766	-15.176		
12.86	390.182	-182.607	44.940	-19.911		
15.00	411.722	-159.777	38.972	-25.061		
17.14	418.633	-136.951	32.903	-30.583		
19.29	411.270	-114.126	27.350	-36.449		
21.43	380.670	-91.301	22.972	-42.628		
23.57	325.319	-68.476	18.252	-49.089		
25.71	243.996	-45.650	13.450	-55.802		
27.86	135.770	-22.825	10.712	-62.734		
30.00	0.000	0.000	10.652	-70.872		
Support # 4					70.87	-10.65

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Variable Depth Slab Loading Verification (Parabolic)

DEAD LOAD & DEFLECTION SUMMARY
MODULUS OF ELASTICITY, E(dead)= 1,200 Ksi, E(live)= 3,640 Ksi

LOCATION (FT)	SLAB * MOMENT (FT-K/FT)	SLAB DEFLECTION (IN.)	LIVE LOAD DEFLECTION (IN.)	LIVE LOAD DEFLECTION L over
Support # 1, R(Slab)* = 2.70 K/Ft.				
0.00	0.000	0.000	0.000	0
2.14	5.204	-0.047	-0.019	19273
4.29	9.261	-0.089	-0.036	9967
6.43	12.169	-0.124	-0.051	7048
8.57	13.929	-0.149	-0.063	5730
10.71	14.542	-0.163	-0.071	5084
12.86	14.006	-0.165	-0.075	4804
15.00	12.323	-0.155	-0.075	4774
17.14	9.490	-0.135	-0.072	4976
19.29	5.510	-0.107	-0.066	5467
21.43	0.381	-0.075	-0.056	6422
23.95	-7.130	-0.037	-0.041	8821
26.48	-16.232	-0.007	-0.024	15300
29.00	-26.927	0.004	-0.006	57152
30.00	-31.606	0.000	0.000	0
Support # 2, R(Slab)* = 9.80 K/Ft.				
0.00	-31.606	0.000	0.000	0
1.00	-26.730	-0.009	-0.008	57410
4.79	-10.542	-0.079	-0.044	10815
8.57	2.065	-0.178	-0.081	5942
11.43	9.210	-0.251	-0.105	4576
14.29	14.313	-0.310	-0.123	3908
17.14	17.375	-0.349	-0.134	3591
20.00	18.396	-0.362	-0.137	3497
22.86	17.375	-0.349	-0.134	3591
25.72	14.313	-0.310	-0.123	3908
28.57	9.210	-0.251	-0.105	4576
31.43	2.065	-0.178	-0.081	5942
35.22	-10.542	-0.079	-0.044	10815
39.00	-26.730	-0.009	-0.008	57410
40.00	-31.606	0.000	0.000	0
Support # 3, R(Slab)* = 9.80 K/Ft.				
0.00	-31.606	0.000	0.000	0
1.00	-26.927	0.004	-0.006	57152

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Variable Depth Slab Loading Verification (Parabolic)

LOCATION (FT)	SLAB * MOMENT (FT-K/FT)	SLAB DEFLECTION (IN.)	LIVE LOAD DEFLECTION (IN.)	LIVE LOAD DEFLECTION L over
3.52	-16.232	-0.007	-0.024	15300
6.05	-7.130	-0.037	-0.041	8821
8.57	0.381	-0.075	-0.056	6422
10.71	5.510	-0.107	-0.066	5467
12.86	9.490	-0.135	-0.072	4976
15.00	12.323	-0.155	-0.075	4774
17.14	14.006	-0.165	-0.075	4804
19.29	14.542	-0.163	-0.071	5084
21.43	13.929	-0.149	-0.063	5730
23.57	12.169	-0.124	-0.051	7048
25.71	9.261	-0.089	-0.036	9967
27.86	5.204	-0.047	-0.019	19273
30.00	0.000	0.000	0.000	0
Support # 4, R(Slab)* = 2.70 K/Ft.				

* VALUES FOR UNFACTORED SLAB DEAD LOAD