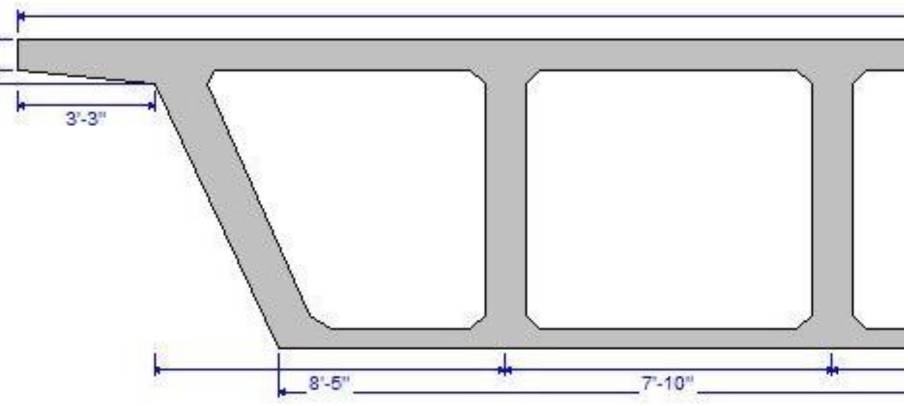
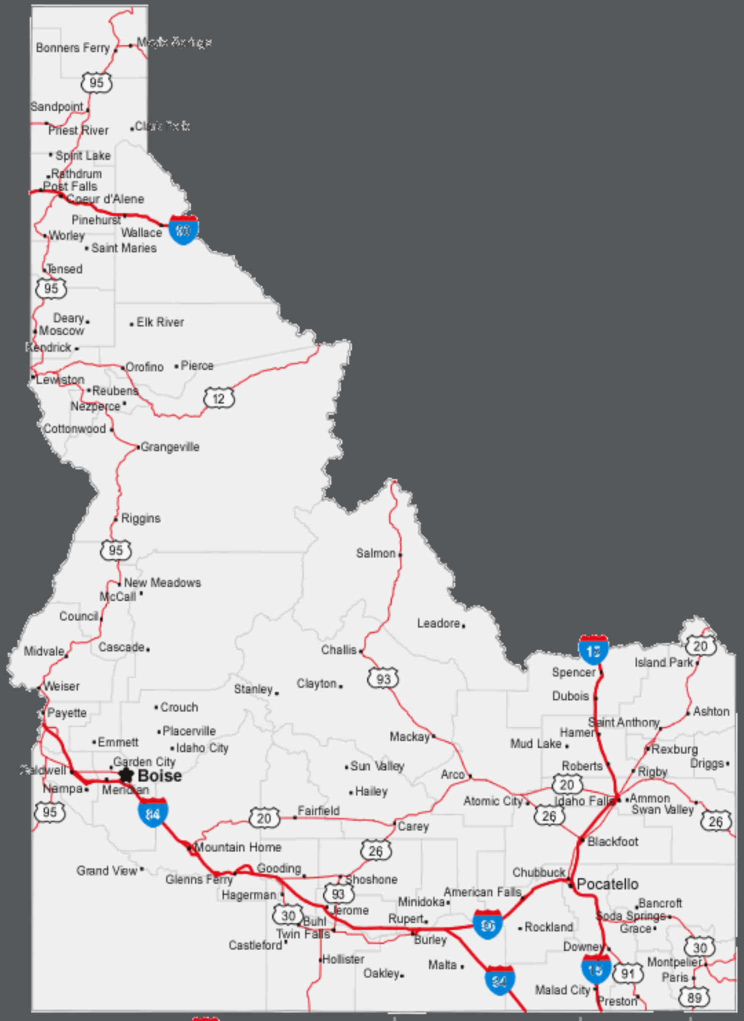



# IDAHO & UTAH CONCRETE BOX GIRDER BRIDGES LOAD RATED IN AASHTOWARE BRIDGE RATING

# IDAHO CONC. BOX RATINGS

- BrR v6.7.0
- 15 P/T and RC Concrete Boxes in BrR
- Load rating effort was 45 to 186 hours per bridge
  - Included rating, checking, QC, and some verification
- LRFR Rating (HL-93)
- AASHTO Refined Losses
- Most bridges had integral pier supports



# RATING VERIFICATION

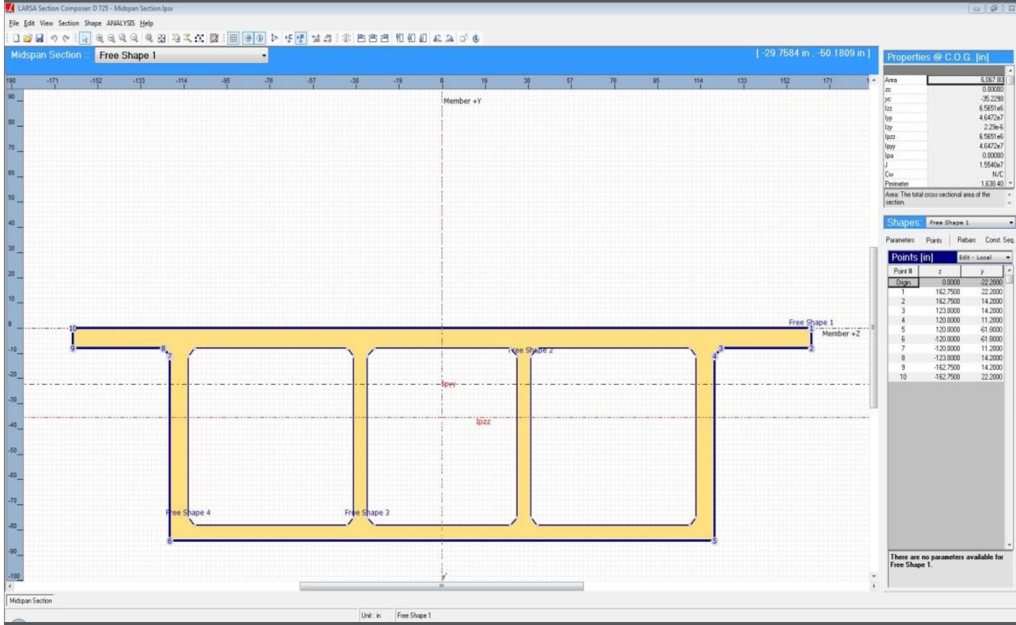
- Section Properties
- Losses
- LLDF
- Substructure Stiffness
- DL & LL Moments
- Bentley LEAP CONBOX

# RATING VERIFICATION
## SECTION PROPERTIES

- LARSA Section Composer

Spec Check Detail for PS_Basic_Properties Calculation

```
Mechanics of Materials
Basic PS Beam Property Calculations
(AASHTO LRFD Bridge Design Specifications, Seventh Edition - 2014, with 2015 Interims)

PT MultiCellBox - At Location = 24.7156 (ft) - Right     Stage 1


                    Cross Section Properties
-----------------------------------------------------------------
Input Method : Simple
Section Entry Method : Width

Number of Cells : 6
Top Slab f'c =     4.00(ksi)
Other Parts f'c =     4.00(ksi)

D   =     1.33(ft)          CJ  =     0.33(ft)
W1  =    76.00(ft)          W2  =    76.00(ft)
LT1 =     0.33(ft)          LT2 =     0.33(ft)
LW1 =     0.00(ft)          LV  =     0.00(ft)
LW2 =     0.00(ft)

Top Slab Thick. =     3.50(in)
Bot Slab Thick. =    12.50(in)
Top Left Web Thick. =    84.00(in)

Cell      S         Top Right
                    Web Thick.
         (ft)         (in)
1       14.00        156.00
2       12.00        144.00
3       12.00        144.00
4       12.00        144.00
5       12.00        156.00
6       14.00         84.00
```



# RATING VERIFICATION

## LOSSES

Spec Check Detail for 5.9.5.2.2 Friction

```
5 Concrete Structures
5.9 Prestressing and Partial Prestressing
5.9.5 Loss of Prestress
5.9.5.2 Instantaneous Losses
5.9.5.2.2 Friction
(AASHTO LRFD Bridge Design Specifications, Seventh Edition - 2014, with 2015 Interims)

PT MultiCellBox - At Location = 16.6250 (ft) - Left     Stage 1

fpF = fpj * (1 - e^-(K*x + u*alpha))        (5.9.5.2.2b-1)


INPUT:

K (Wobble coefficient) = 2.0000E-4 (per foot of tendon)
u (Coeff. of friction) = 2.5000E-1
fpj                    =  202.5000 (ksi)
alpha                  =    0.1368 (Radians)
Curve tendon dist.     =   16.6379 (ft)

SUMMARY:

fpF =    7.4609 (ksi)
```

HDR

| | | | | |
|---|---|---|---|---|
| | Page | | of | |
| Project No. | Sheet | 1 | of | |
| Computed By SMW | Date | 7/26/2016 | | |
| Checked By | Date | | | |

Reference

| | | | | |
|---|---|---|---|---|
| Span Length = | 179 | ft | | |
| $P_{jack}$ = | 2604.231 | kips | 0.75 | 270 |
| $A_{strands}$ = | 12.8604 | $in^2$ | | |
| $E_{strands}$ = | 28500 | ksi | | |
| μ = | 0.25 | | | |
| k = | 0.0002 | | | |
| Anchor Set = | 0.625 | in | | |
| Initial Losses (ksi) = | 10 | ksi | | |
| Final Losses (ksi) = | 45 | ksi | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Location (ft): | 0 | 89.5 | 161.1 | 179 | 196.9 | 268.5 | 358 |
| C.G. Strands (in): | 48.125 | 10 | 63.125 | 76.5 | 63.125 | 10 | 48.125 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Segment Length (in): | 1074 | 859.2 | 214.8 | 214.8 | 859.2 | 1074 |
| Strand height (in): | 38.125 | 53.125 | 13.375 | 13.375 | 53.125 | 38.125 |
| Radius (in): | 3801.0 | 1763.6 | 437.9 | 437.9 | 1763.6 | 3801.0 |
| Sweep Angle: | 0.2835094 | 0.49214766 | 0.49558633 | 0.49558633 | 0.49214766 | 0.2835094 |
| Length (in): | 1077.61 | 867.93 | 217.01 | 217.01 | 867.93 | 1077.61 |

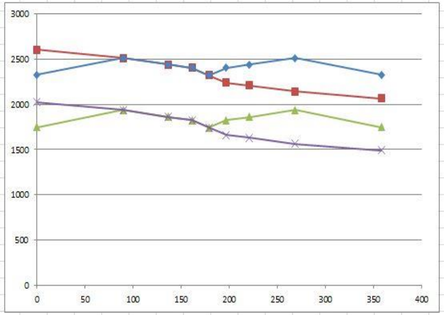
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $\alpha_i$: | | 0.0710 | 0.1235 | 0.1244 | 0.1244 | 0.1235 | 0.0710 |
| $\mu\alpha_i + kx_i$: | | 0.0356 | 0.0452 | 0.0347 | 0.0347 | 0.0452 | 0.0356 |
| $\Sigma(\mu\alpha_i + kx_i)$ | | 0.0356 | 0.0808 | 0.1155 | 0.1502 | 0.1954 | 0.2310 |
| $e^{\Sigma(\mu\alpha_i + kx_i)}$ | | 1.0363 | 1.0842 | 1.1224 | 1.1620 | 1.2158 | 1.2599 |
| $e^{-\Sigma(\mu\alpha_i + kx_i)}$ | | 0.9650 | 0.9223 | 0.8909 | 0.8605 | 0.8225 | 0.7937 |
| Jack one end: | 2604.231 | 2513.04662 | 2401.99521 | 2320.13706 | 2241.06857 | 2142.03586 | 2067.03476 |
| Jack both ends: | 2604.231 | 2513.04662 | 2401.99521 | 2320.13706 | 2401.99521 | 2513.04662 | 2604.231 |

| | | | |
|---|---|---|---|
| $p_{set}$ = | 0.0849 | k/in | |
| $L_{set}$ = | 1642.60 | in | 137 |
| ΔP = | 278.9 | kips | |
| $P_{average}$ = | 2498.2289 | kips | |
| Elongation = | 29.48 | in | |
| 90% Elongation = | 26.53 | in | |

HDR

| | | | | |
|---|---|---|---|---|
| | Page | | of | |
| 0 Project No. | Sheet | 2 | of | |
| 0 Computed By SMW | Date | 7/26/2016 | | |
| 0 Checked By | Date | | | |

Reference



# RATING VERIFICATION

## LIVE LOAD DISTRIBUTION FACTORS

| | | |
|---|---|---|
| HDR | Project: ITD Statewide Bridge Load Rating<br>Subject: Bridge 13095<br>Task: Live Load Distribution Calculations | BY: SMW Date: 12/15/2015<br>CHKD:MJH Date: 12/15/2015<br>SHEET NO. 1 OF 6<br>PAGE ______ of ______ |

OBJECTIVE: Determine the live load distribution factors for a cast-in-place concrete multi-cell box bridge.

REFERENCE: AASHTO LRFD Bridge Design Specifications, 7th Edition, 2014, w/ 2015 Interims

| Cast-in-Place Concrete Multicell Box | Monolithic concrete | |
|---|---|---|

(d)

Span Length: $L := 179ft$

Support Skew: $Skew := 45deg$

Depth of Member: $d := 7ft + 4in + 1in - 0.5in = 88.500 \cdot in$

Interior Web Spacing: $S_{int} := 7ft + 10in$

Exterior Web Spacing: $S_{ext} := S_{int}$ assume exterior bay spacing same as interior bay at deck

Avg. Web Spacing: $S := \frac{(S_{int} + S_{ext})}{2}$ $S = 7.833ft$

Number of Cells: $N_c := 7$

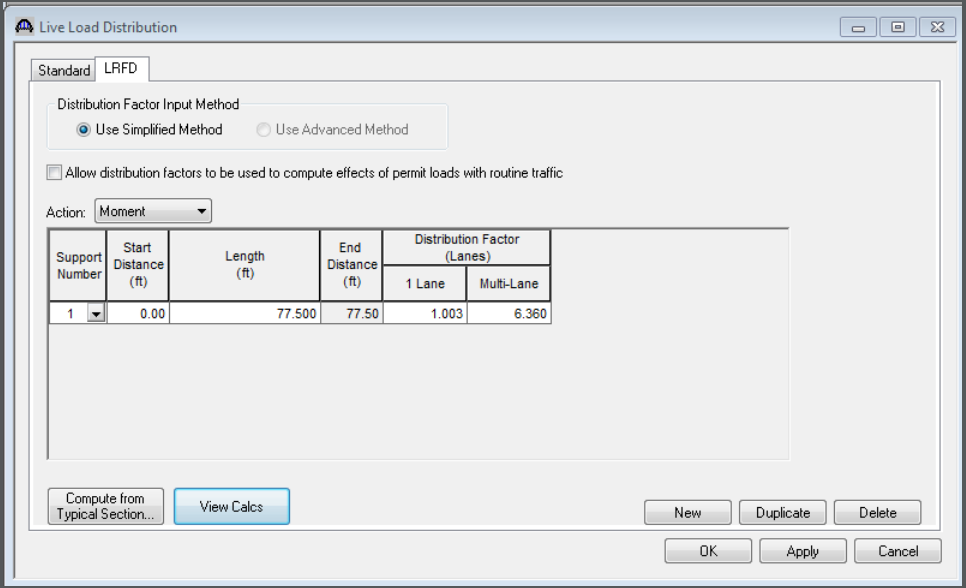
Width of overhang: $W_{OH} := 3ft + 10in$

Width of barrier: $W_{barrier} := 15in$

Width out-out: $W_{out} := 2 \cdot W_{OH} + 2 \cdot S_{ext} + (N_c - 2) \cdot S_{int} = 62.500ft$

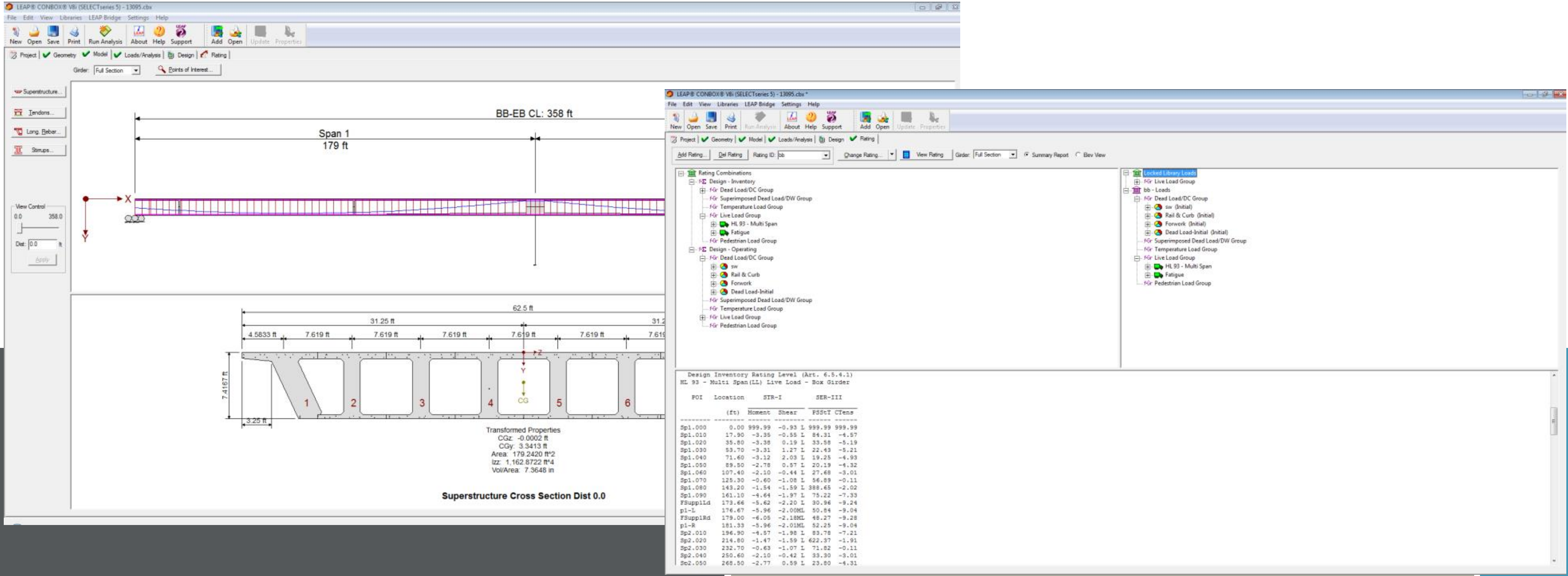
Half the web spacing, plus the total overhang: $W_e := 0.5S_{ext} + W_{OH} = 7.750ft$

c:\pw working\sea\d1638958\13095_LLDF Type (d).xmcd    Printed: 7/26/2016 2:13 PM



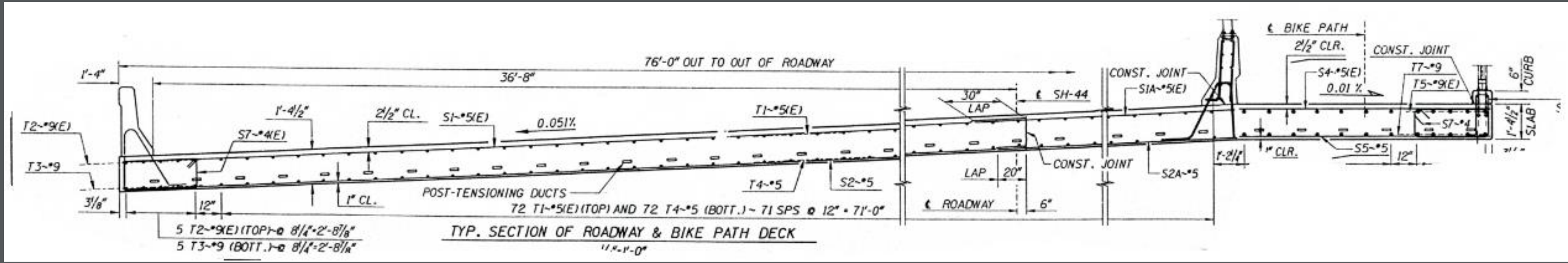
# RATING VERIFICATION

Bentley LEAP CONBOX



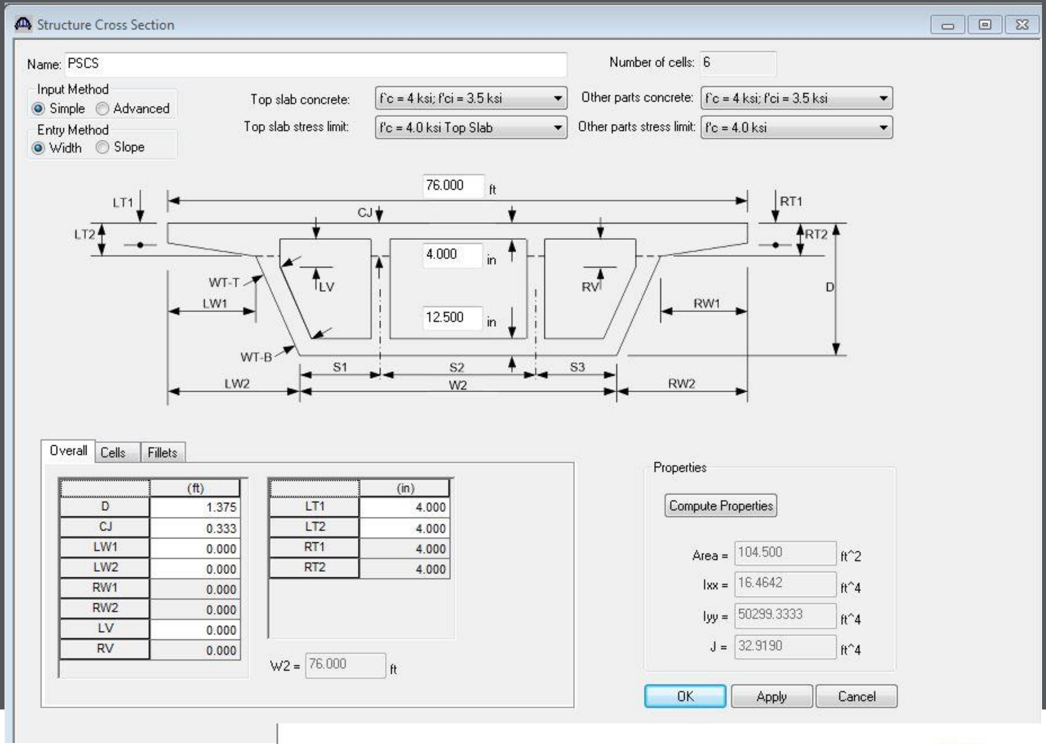
# P/T SLAB

- 3-span
- Integral Substructure
- No voids



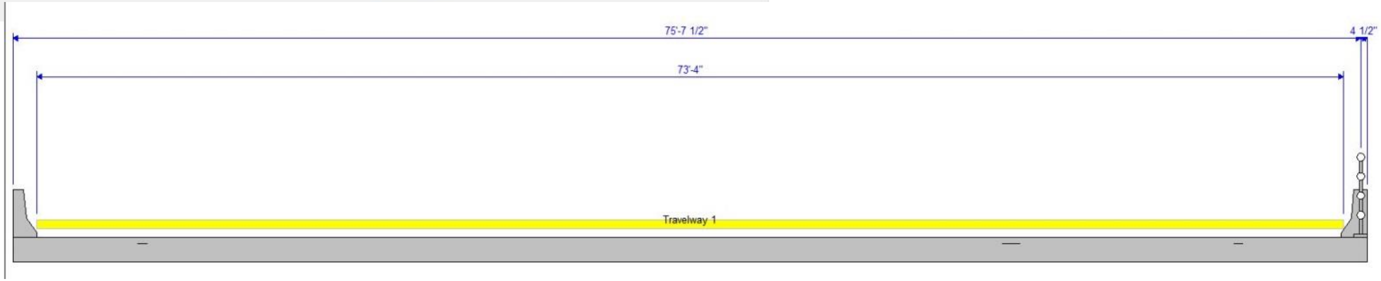

# P/T SLAB

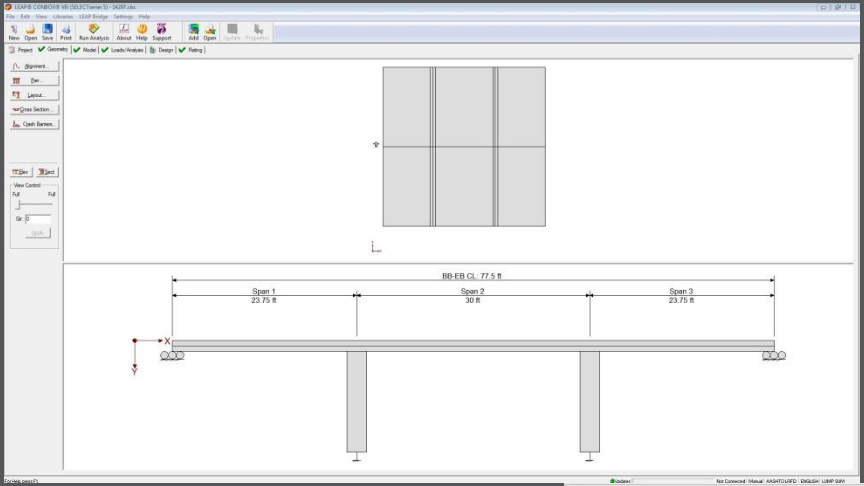
## Cross Section

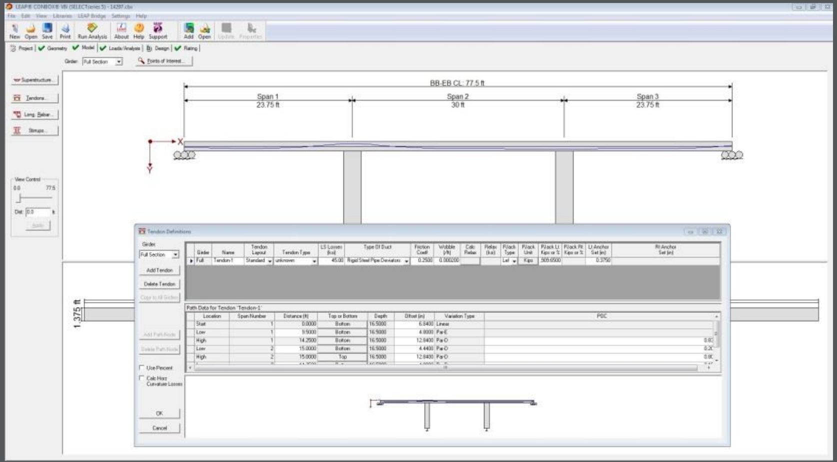


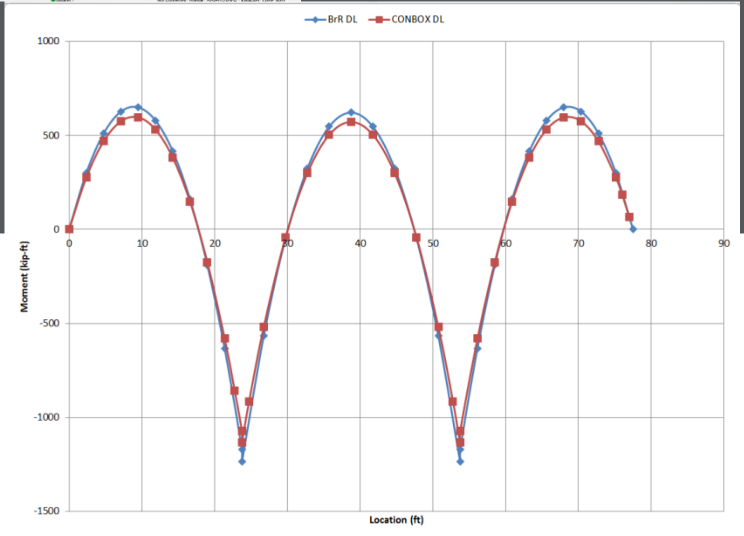

# P/T SLAB

## Cross Section






# P/T SLAB

## Verification

# 4D 725

## UDOT Rating Method

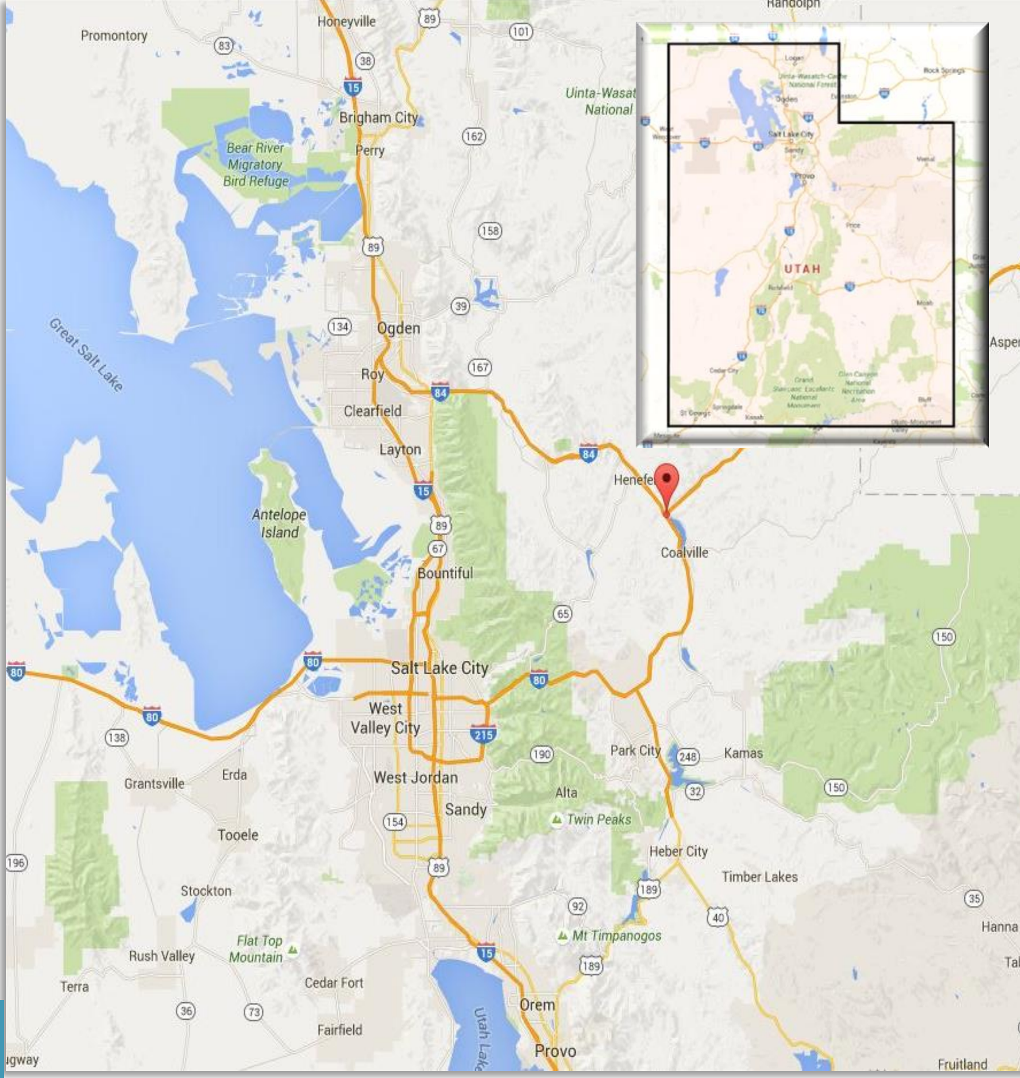
- UTAH Standard Programs
  - AASHTOWare BrR
  - CSi Bridge – If Outside BrR Limitation
- Csi Bridge Can Be Cumbersome
- BrR Does Not Rate Curved Boxes
- Rated Bridge w/ BrR
  - LARSA 4D to Analyze for Torsion Affects
  - MathCad to Calculate Shear Flow
  - Excel to Calculate Load Increase Due to Torsion

# 4D 725

- 5-span
- Single Column Piers w/ Integral Cap Beam
- Constructed in 1970
- Alignment on a 265’ Radius

# 4D 725
## Location

- In the Mountains East of Salt Lake City
- 50 Mile Drive along I-80
- Near Echo Reservoir (Recreation)

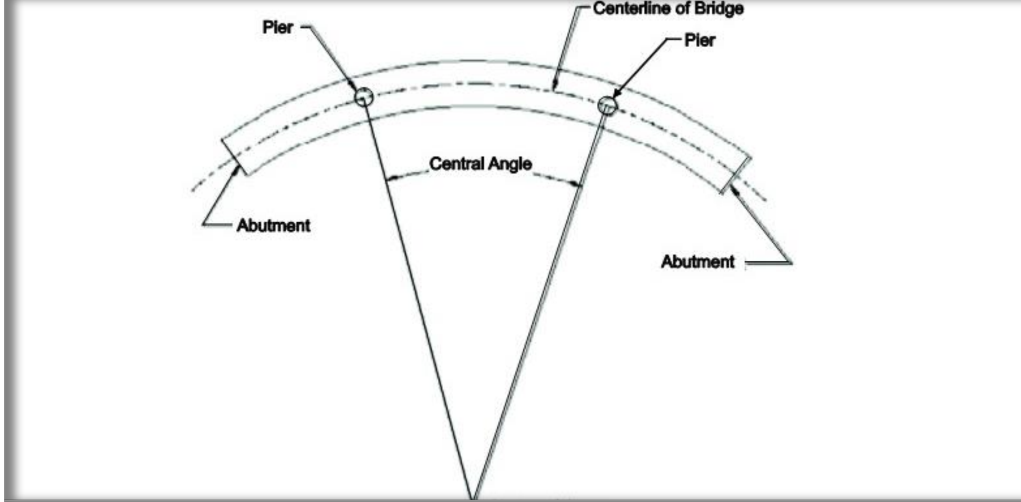


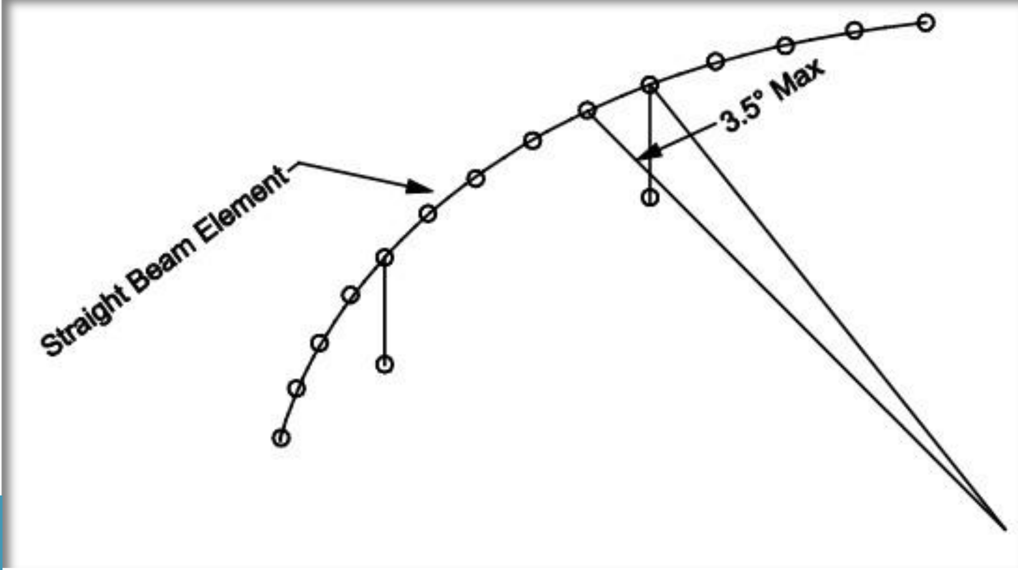
# 4D 725

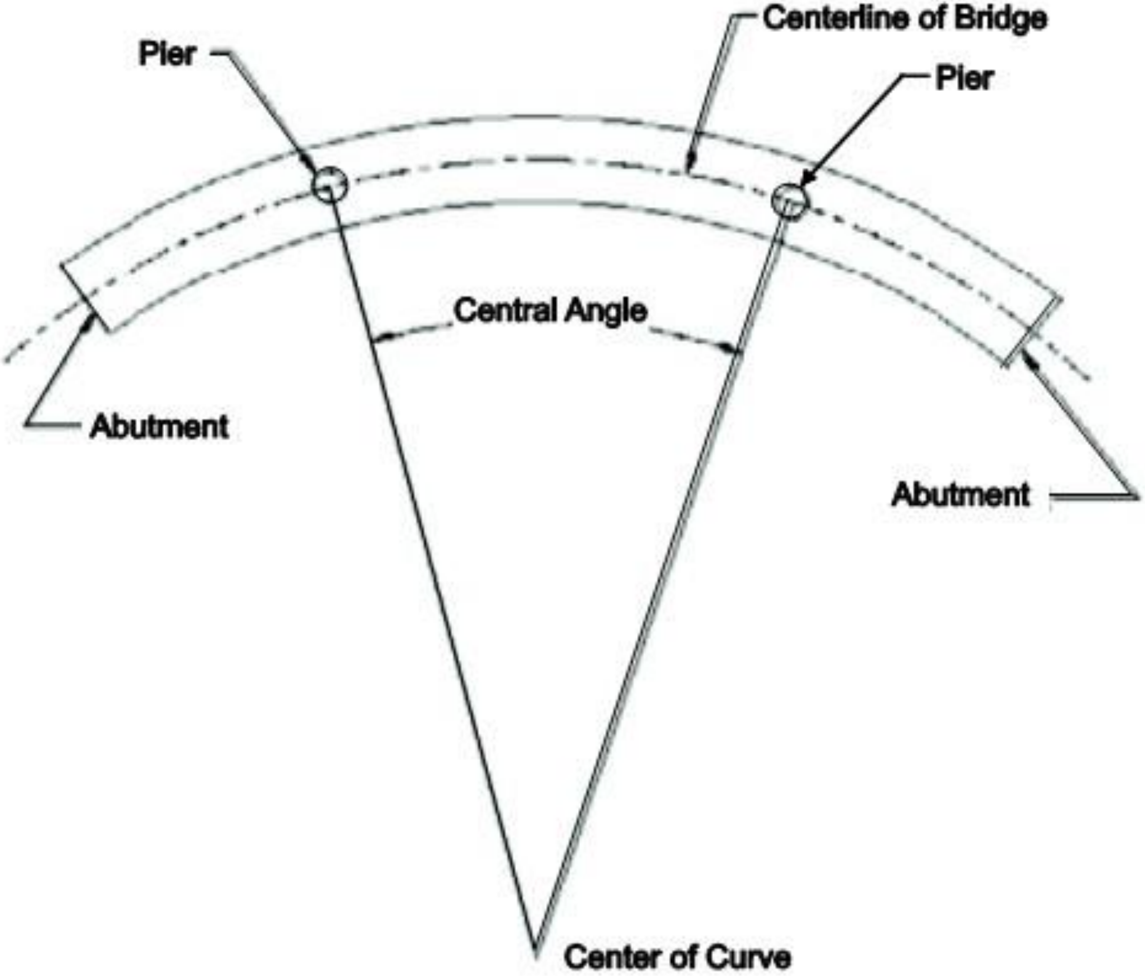
## Curved Box Beam Analysis Type

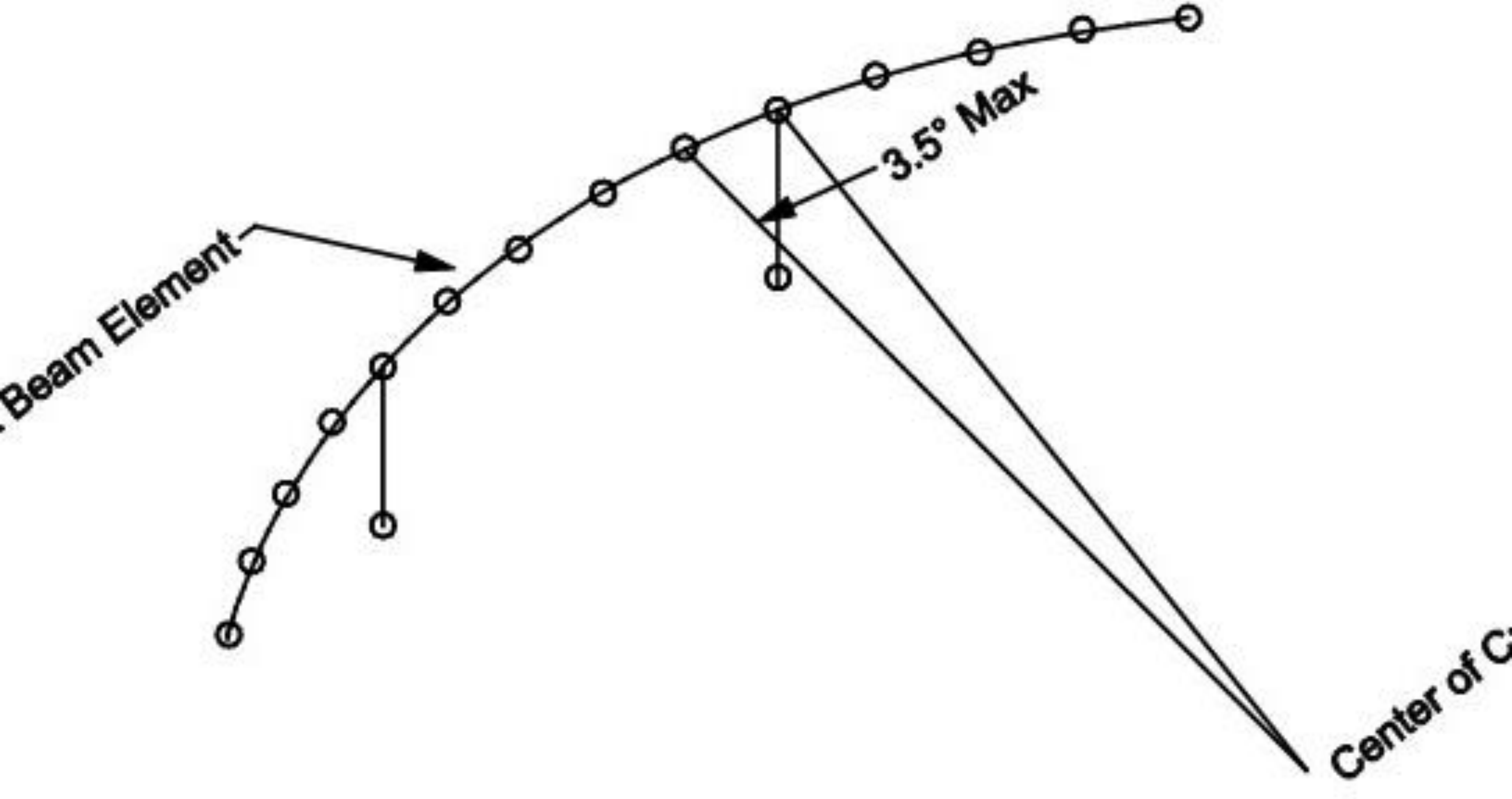
- AASHTO 4.6.1.2.3
  - C.A. <12º - Straight Segments
  - 12º < C.A. < 34º - 3D Single-Spine
  - C.A. > 34º - 3D F.E.A.

- Unusual Plan Geometry - 3D F.E.A.
  - Variable Width
  - Unconventional Orientation of Skewed Supports

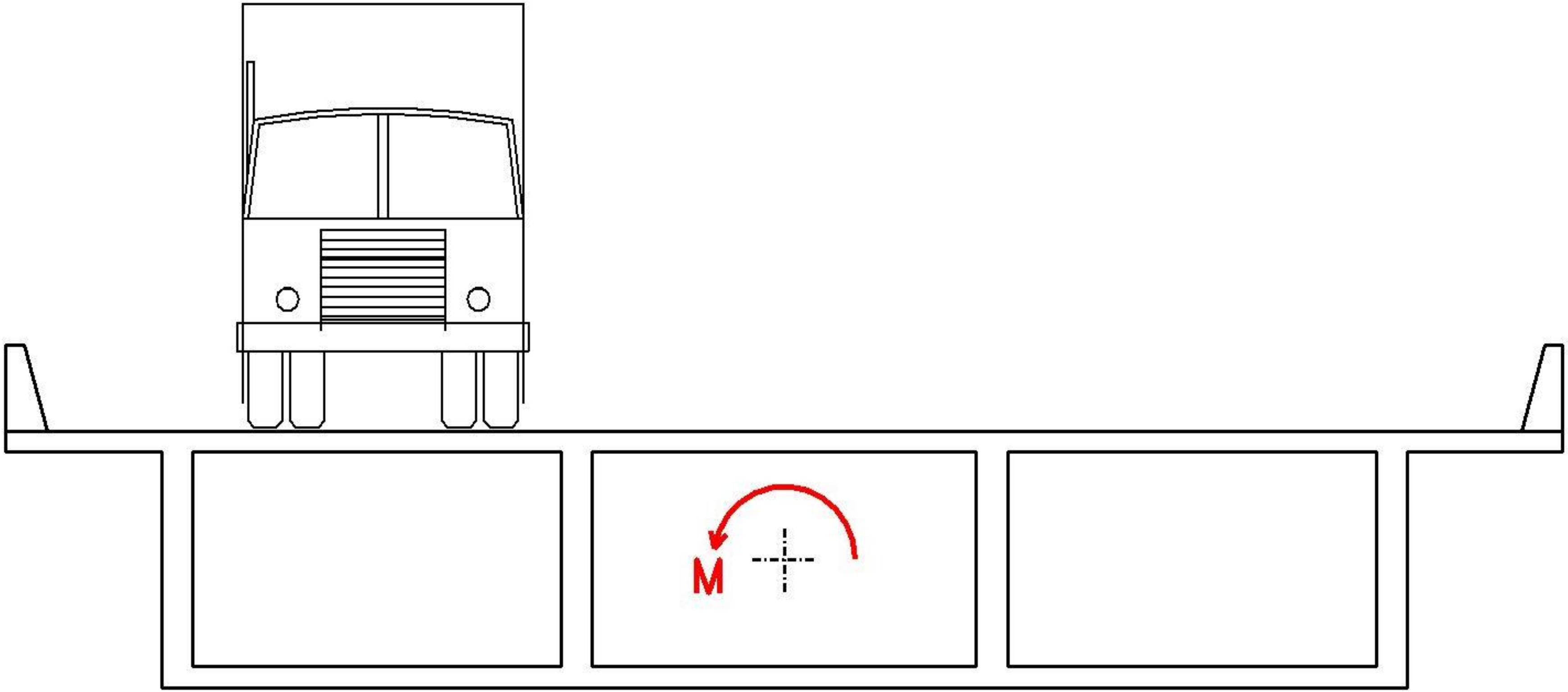


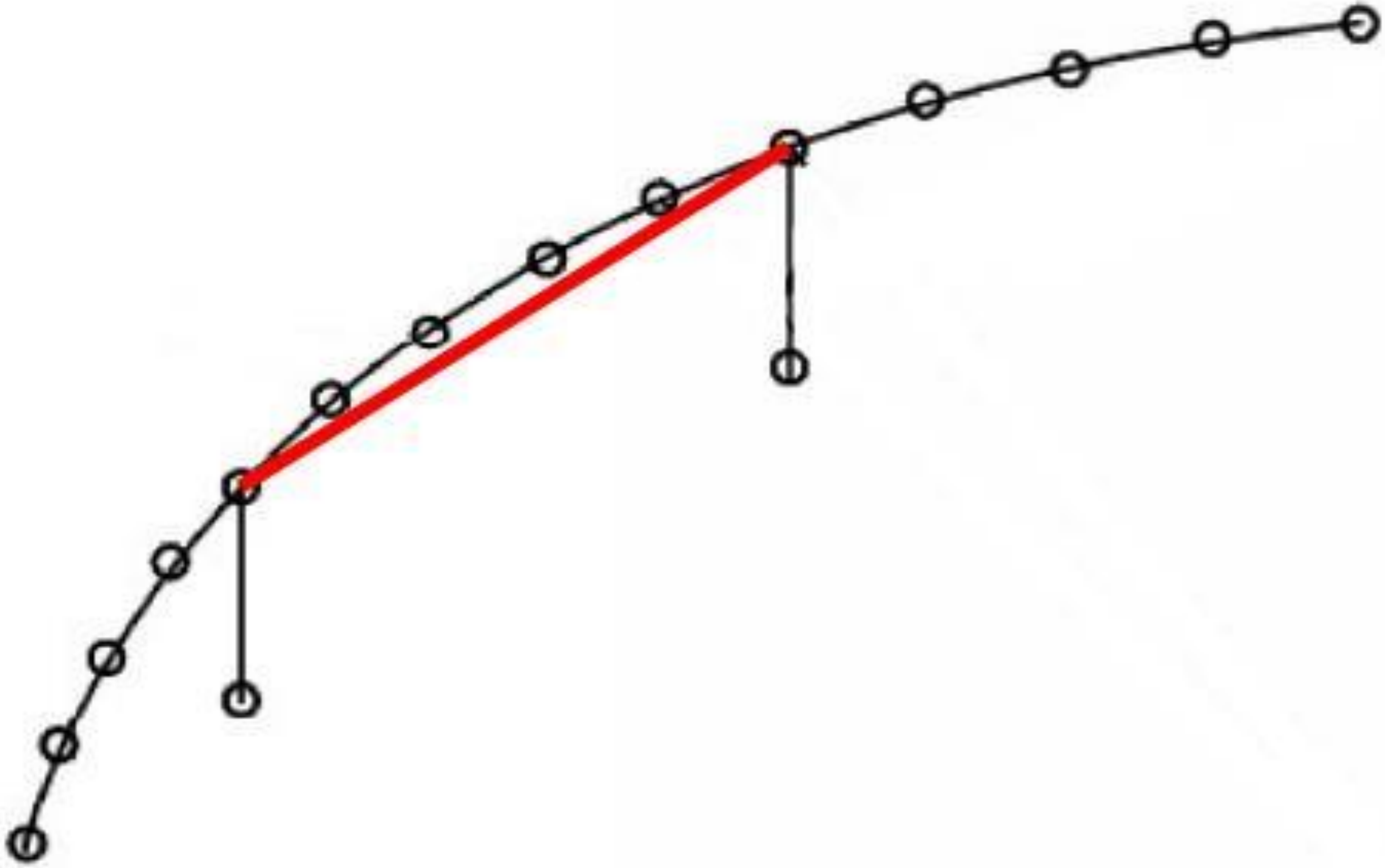




Centerline of Bridge
Pier
Pier
Central Angle
Abutment
Abutment
Center of Curve



Beam Element
3.5° Max
Center of C


M



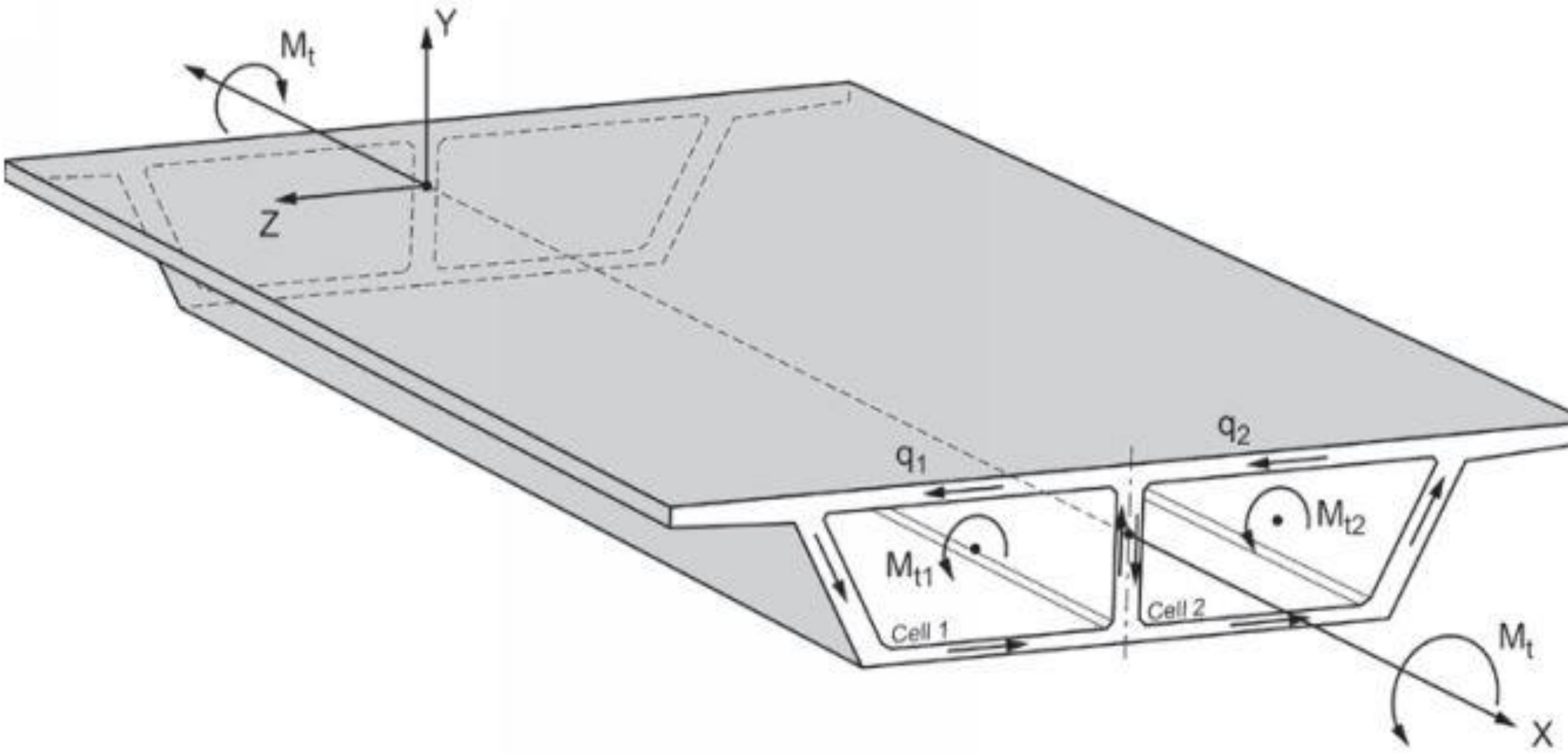
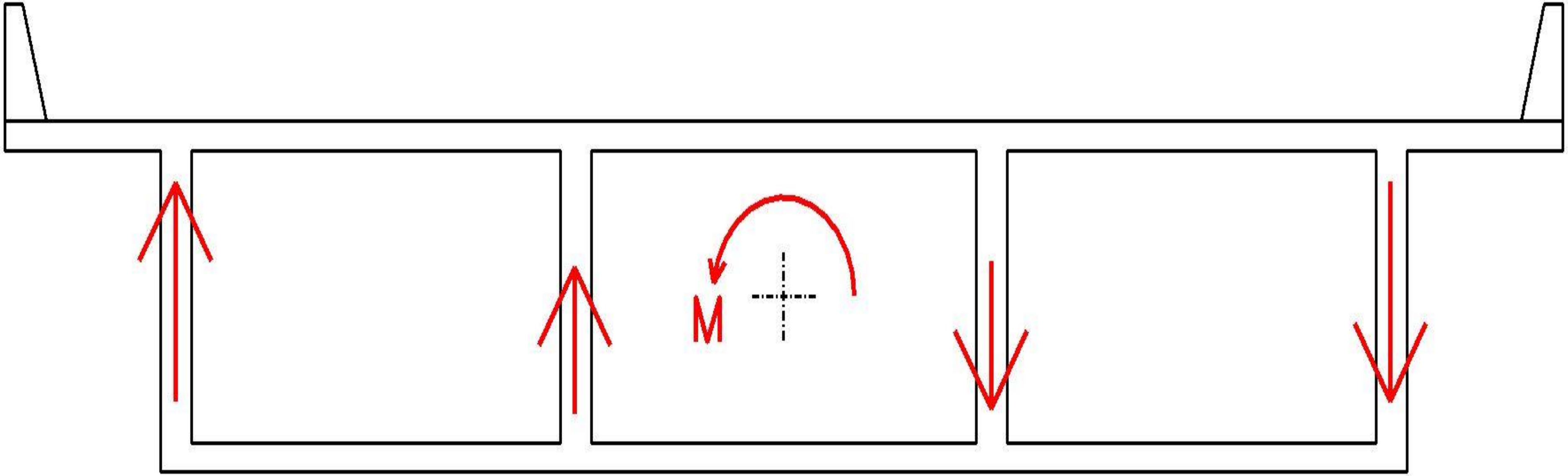
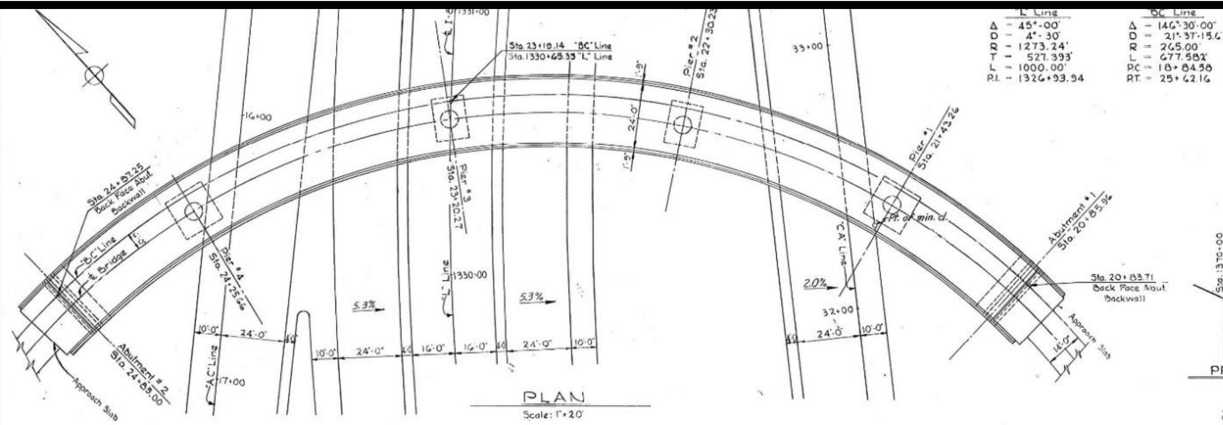
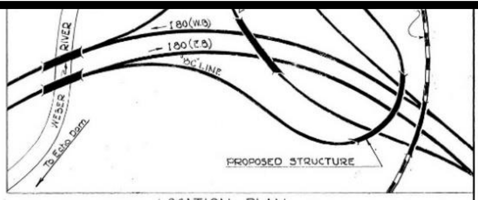



*Figure 7.15 –Torsion in a Two-Cell Box Girder*

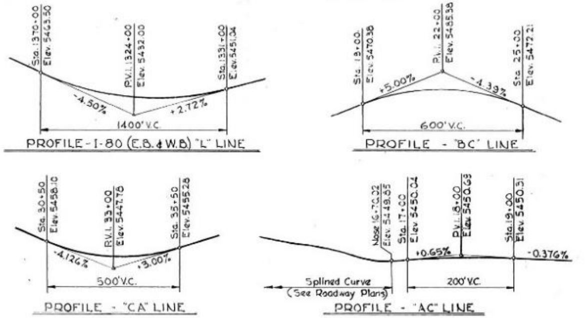

M

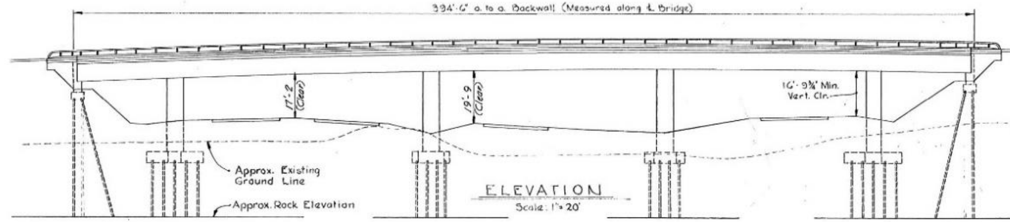



## PLAN
Scale: 1" = 20'

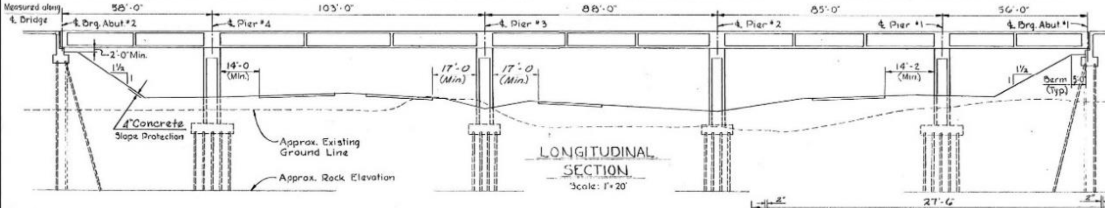



## LOCATION PLAN
Scale: 1" = 200'




## ELEVATION
Scale: 1" = 20'




## LONGITUDINAL SECTION
Scale: 1" = 20'

## GENERAL NOTES

**SPECIFICATIONS**

(1) AASHO Standard Specifications for Highways Bridges, 1965 Edition and State of Utah Standard Specifications, 1960 Edition and Supplements thereto.

**DESIGN LOADING**

(1) The roadway live load shall be H.S. 20-44 or Alternate Load for Interstate Bridge Design.
(2) Wearing Surface: 1" Concrete, 15 lb/sq. ft. Future Surface.

**DESIGN UNIT STRESSES**

(1) f'c = 3000 psi - fc = 1200 psi
(2) fs = 20,000 psi
(3) Shear and Bond Stresses in accordance with AASHO Standard Specifications.

**REINFORCEMENT**

(1) All dimensions to reinforcing steel on detail drawings are to centerline of bar except where the clear distance is noted from the face of concrete.
(2) All reinforcing steel shall be intermediate grade AASHO Designation M-31 and deformed to AASHO M-137.
(3) All reinforcing shall have 2" cover except where otherwise shown.
(4) All reinforcing shall be spliced a minimum of 20 diameters.

**CONCRETE**

(1) All concrete to be Class A(AE) or Class AA(AE)
(2) All exposed edges of concrete shall be chamfered ¾" × 45° unless otherwise noted or shown.
(3) Construction joints shall be placed as shown on the plans. Additional construction joints or alterations to construction joints shall require the approval of the Engineer.
(4) Raised bearing areas shall be bush hammered and ground to 1/16" ± of the given elevations. Grouting will not be permitted.

**STRUCTURAL STEEL**

(1) Structural Steel shall be Structural Carbon Steel conforming to AASHO M183 (ASTM A36)

**METAL RAILING**

(1) Railing shall be placed on the structure to the alignment and grades indicated on the plans or may be directed by the Engineers.

**FOUNDATIONS**

(1) Abutment footings to be supported by 10BP42 H-piles driven to a 35 Ton bearing capacity. Pier footings to be supported by 12BP53 H-piles driven to a 45 Ton bearing capacity.

**SYMBOLS**

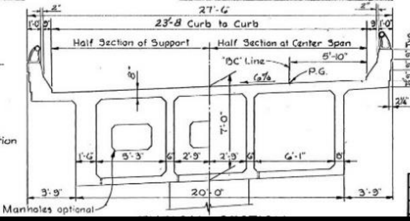
(1) N.F. = Near Face
(2) F.F. = Far Face
(3) E.F. = Each Face
(4) E.W. = Each Way
(5) Cutting Plane = Sheet No. / Sheet Designation / Sheet on which section is to be detailed.

## QUANTITIES

| ITEM | UNIT | QUANTITY ESTIMATED | QUANTITY AS CONSTR. |
|---|---|---|---|
| Excavation for Structures, Unclassified | C.Y. | 560 | 365.70 |
| Class "A" Concrete (AE) | C.Y. | 806 | Lump |
| Reinforcing Steel | Lb. | 268,593 | 267,219.84 |
| Structural Steel | Lb. | 5,650 | Lump |
| Metal Railing (Single Rail) | L.F. | 837 | Lump |
| Pile ( 12 BP 53 ) | L.F. | 3,170 | 2,613.70 |
| Class "AA" Concrete (AE) | C.Y. | 385 | Lump |
| Furnishing Pile Driving Equipment | L.S. | L.S. | Lump |
| ⚠ Concrete Slope Protection | S.Y. | 914 | 578.49 |
| Mechanical Tamping | Hr. | 10 | 70.00 |
| Electrical Work, Bridges | 1 | Lump | 1.00 |

## INDEX OF DRAWINGS






| | | |
|---|---|---|
| ⚠ | Quantities | 2/26/68 T.J.T. |

DESIGN AND DRAWING BY
**KNOERLE, GRAEF, BENDER AND SHUPE**
*CONSULTING ENGINEERS*
SALT LAKE CITY, UTAH

**UTAH STATE DEPARTMENT OF HIGHWAYS**
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

**WEST COALVILLE TO ECHO JUNCTION**
RAMP "BC" OVER I-80 & I-80 N
**GENERAL PLAN & ELEVATION**

| | | |
|---|---|---|
| DESIGNED BY G.G. | CHECKED BY | I-80-4(9)160 2ND CONT. PROJECT NUMBER |
| DRAWN BY W.O.D. | CHECKED BY R.E.S. | |
| QUANTITIES BY H.L. | CHECKED BY V.F.H. | 23+19.14 BC LINE STATION |
| APPROVAL RECOMMENDED BY | GROUP LEADER | |
| APPROVED 1/11/68 DATE | A. E. Mansey CHIEF STRUCTURAL ENG'R | SUMMIT COUNTY |

D-725

# 4D 725

## Bridge General Information

- Conventionally Reinforced Concrete Box
- Largest Central Angle (Span 4) = 22º
- Segment Central Angle = 1º
- No Unusual Geometry
  - Was Not Symmetrical
  - Span Lengths Were Not Significantly Different
- Include the Substructure

# 4D 725

- BrR Had 2 Separate Models
- Moment Model
- Shear Model

# 4D 725

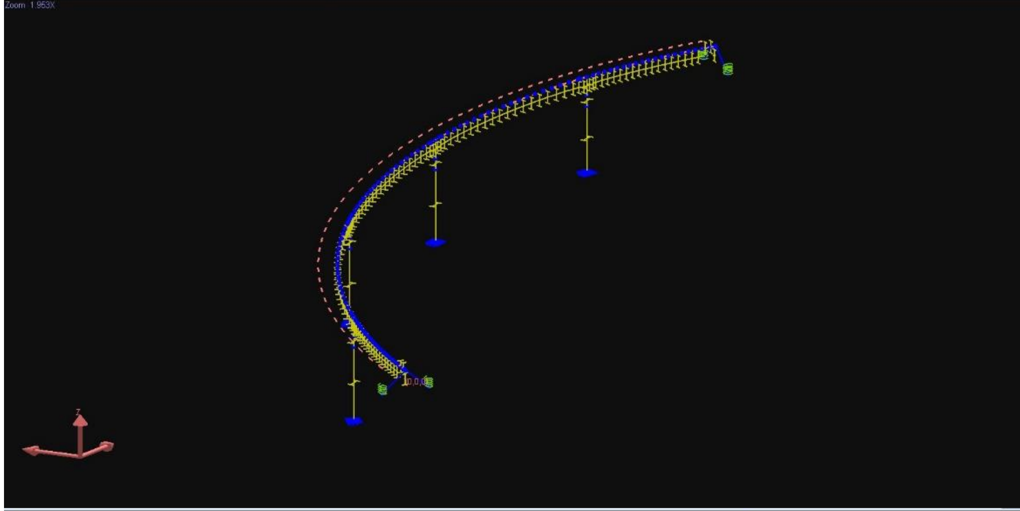
## Moment Model

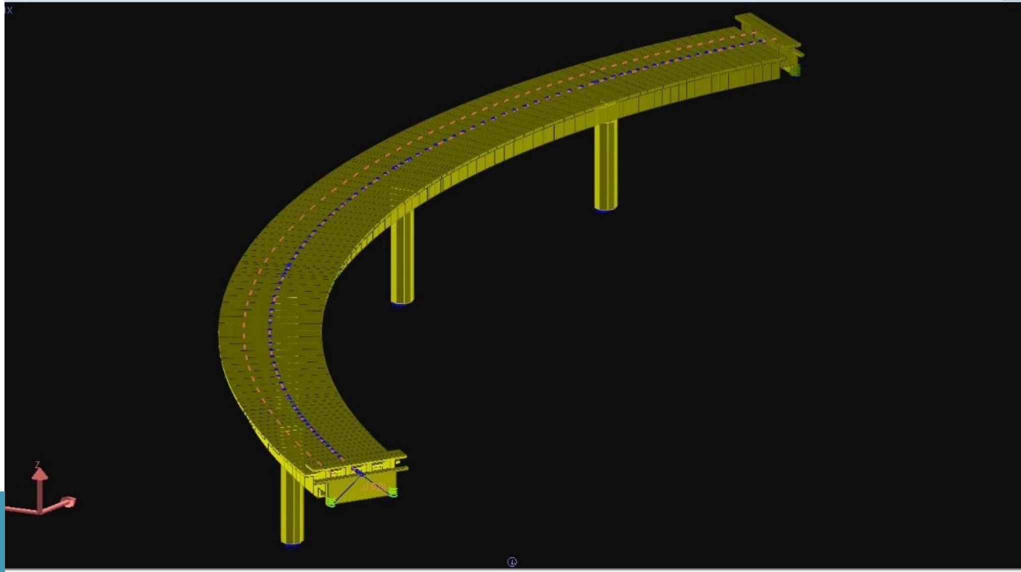
- Analyzes Moment as a Full Structure
- Input the Bridge as a Straight Bridge
- Ignored Shear in the Moment Model

# 4D 725

## Shear Model

- Modeled As A Spine w/ Straight Segments
  - 20 Segments Each Span (1% Segment C.A.)
  - Included Varying Web Width at Bents
- Included the Substructure
  - Single Column Bents
  - Bearings at Abutments
- Dead Load
  - Box Beam and Deck - Self Weight
  - Barriers (Lights Included in Barrier) – Line Load
- Live Load
  - 2 Lanes Offset to Match Travel Way



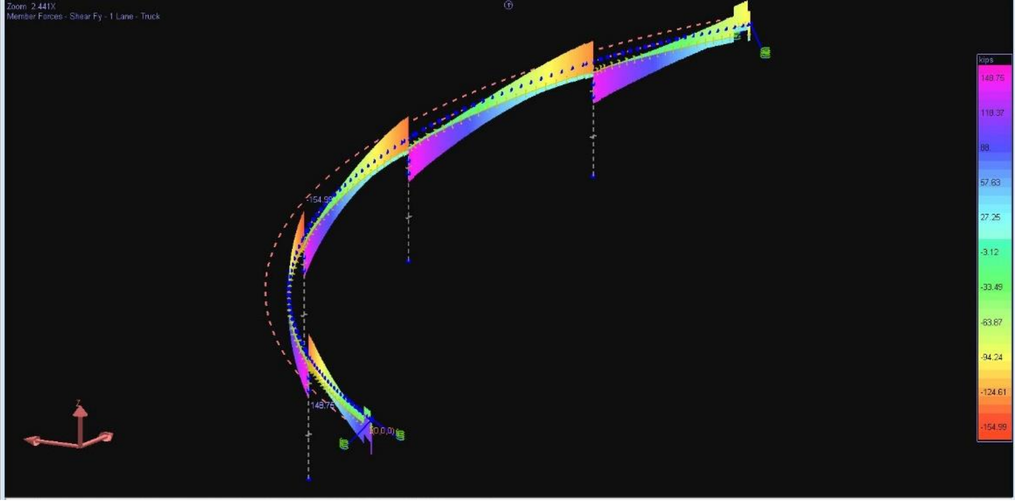


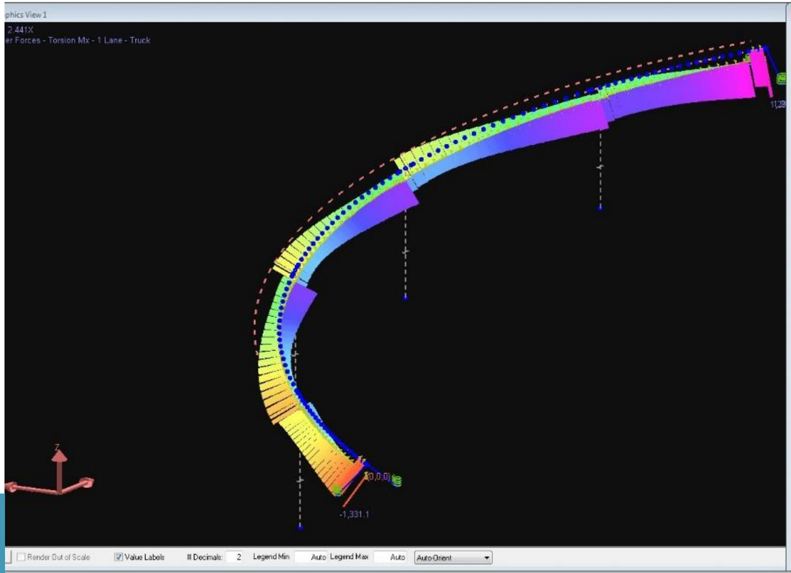
# 4D 725

## LARSA Results

- Went Through the Full QC Process
  - Rater
  - Independent Check
  - S.I.R. – Expert in Modelling and Box Beam Bridges

- Completed a Sensitivity Analysis
  - Pier Properties
  - Bearings Assumptions




Member End Forces (Local) [Envelope]

Min/Max for Moment -- X -- (kips-ft) Max Only

| | Force Z (kips) | Moment X (kips-ft) | Moment Y (kips-ft) | Moment Z (kips-ft) |
|---|---|---|---|---|
| 1 | 0.0000 | 1,331.1025 | 0.0000 | -2.5697 |
| 2 | 0.0000 | 9.9496 | 0.0000 | -0.3330 |
| 3 | 0.0000 | 1,322.3616 | 0.0000 | -106.0158 |
| 4 | 0.0000 | 9.9476 | 0.0000 | -1.0041 |
| 5 | 0.0000 | 1,301.9494 | 0.0000 | -282.9503 |
| 6 | 0.0000 | 10.0008 | 0.0000 | 7.3962 |
| 7 | 0.0000 | 1,267.8909 | 0.0000 | -503.4482 |
| 8 | 0.0000 | 10.6411 | 0.0000 | 352.9141 |
| 9 | 0.0000 | 1,229.9198 | 0.0000 | -671.3703 |
| 10 | 0.0000 | 20.0987 | 0.0000 | 457.7248 |
| 11 | 0.0000 | 1,189.8105 | 0.0000 | -790.6690 |
| 12 | 0.0000 | 32.1676 | 0.0000 | 545.4016 |
| 13 | 0.0000 | 1,148.6779 | 0.0000 | -863.5682 |
| 14 | 0.0000 | 51.6827 | 0.0000 | 707.7066 |
| 15 | 0.0000 | 1,108.4240 | 0.0000 | -900.5349 |
| 16 | 0.0000 | 76.4370 | 0.0000 | 834.4152 |
| 17 | 0.0000 | 1,068.2520 | 0.0000 | -891.3222 |
| 18 | 0.0000 | 104.6168 | 0.0000 | 923.2498 |
| 19 | 0.0000 | 1,029.8565 | 0.0000 | -845.9086 |
| 20 | 0.0000 | 134.7297 | 0.0000 | 974.5586 |
| 21 | 0.0000 | 994.0959 | 0.0000 | -768.2350 |
| 22 | 0.0000 | 166.5057 | 0.0000 | 993.3457 |
| 23 | 0.0000 | 962.0685 | 0.0000 | -662.3801 |
| 24 | 0.0000 | 200.8729 | 0.0000 | 982.1934 |
| 25 | 0.0000 | 934.1175 | 0.0000 | -532.0452 |
| 26 | 0.0000 | 235.0132 | 0.0000 | 931.3273 |
| 27 | 0.0000 | 909.8585 | 0.0000 | -381.4364 |
| 28 | 0.0000 | 268.1171 | 0.0000 | 842.1593 |
| 29 | 0.0000 | 891.1792 | 0.0000 | -10.4169 |
| 30 | 0.0000 | 299.2821 | 0.0000 | 716.8532 |
| 31 | 0.0000 | 879.7883 | 0.0000 | 135.4871 |
| 32 | 0.0000 | 328.2218 | 0.0000 | 560.6809 |
| 33 | 0.0000 | 872.7822 | 0.0000 | 736.8951 |
| 34 | 0.0000 | 352.9829 | 0.0000 | 367.7775 |
| 35 | 0.0000 | 873.3371 | 0.0000 | 998.8760 |
| 36 | 0.0000 | 374.3228 | 0.0000 | 150.0924 |
| 37 | 0.0000 | 876.6270 | 0.0000 | 1,128.4549 |
| 38 | 0.0000 | 391.3523 | 0.0000 | -91.9946 |
| 39 | 0.0000 | 881.0986 | 0.0000 | 1,280.3548 |

# 4D 725

## Torsion Induced Shear

- Shear Flow Theory - MathCad
  - Weighted Average of Member Thickness
  - Calculate Shear Stress in Each Flow Path
  - Determine Shear per Unit Torsion in Each Web

TORSION INDUCED SHEAR IN WEBS

The shear induced by torsion in the section is applied to the model in BrR as a uniform load. The uniform shear load is adjusted so that the maximum shear in each span in the BrR model match the magnitude of the calculated shear induced by the max torsion per span from the 3D spine model.

shear per unit torsion (exterior web) $a_{ext} := \frac{\tau 1 \cdot L_4 \cdot 12in}{Torsion} = (0.041) \cdot \frac{kip}{kip \cdot ft}$ $\frac{1}{a_{ext}} = (24.686)\,ft$

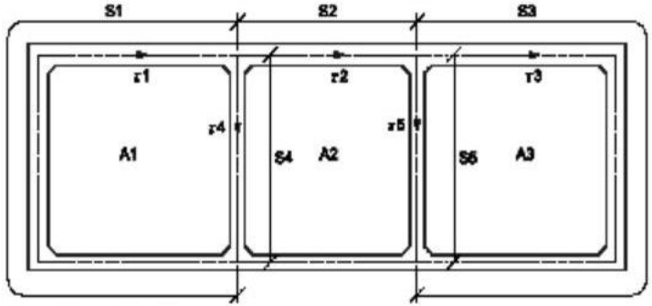
shear per unit torsion (web 3 and 3) $a_{int} := \frac{\tau 5 \cdot L_4 \cdot 12in}{Torsion} = (0.007) \cdot \frac{kip}{kip \cdot ft}$ $\frac{1}{a_{int}} = (136.695)\,ft$

4D 725
ECHO INTCHG. RAMP

Notes and Input Calculations

Made By: RRK
Date: 11/17/2015
Checked By: SMW
Date: 1/22/2016

GEOMETRY




formula for average thickness
(t = member thickness around shear flow path)
(L = length of elements around shear flow path)
(s = perimeter of shear flow path)

$t_{avg}(t, L, s) := \frac{(t \cdot L)}{s}$

Shear flow path 1

length of elements around shear flow path $L_1 := \begin{pmatrix} w_{c_1} + \frac{t_{w_1} + t_{w_2}}{2} \\ h_c + \frac{t_s + ws_1 + t_b}{2} \\ w_{c_1} + \frac{t_{w_1} + t_{w_2}}{2} \end{pmatrix} = \begin{pmatrix} 80 \\ 77 \\ 80 \end{pmatrix} \cdot in$

perimeter of shear flow path $s_1 := \sum L_1 = 237 \cdot in$

member thickness around shear flow path $t_{s1} := \begin{pmatrix} t_s + ws_1 \\ t_{w_1} \\ t_b \end{pmatrix} = \begin{pmatrix} 8 \\ 8 \\ 6 \end{pmatrix} \cdot in$

average thickness around shear flow path $t_1 := t_{avg}(t_{s1}, L_1, s_1) = 7.325 \cdot in$

area enclosed by median line $A_1 := L_{1_1} \cdot L_{1_2} = 6160 \cdot in^2$

# 4D 725

## Dead Load Torsion Induced Shear

- Use Excel to Calculate Increase to Put Into BrR
- Dead Load Increase Input as a Line Load
  - Exterior
  - Interior

Additional Shear to account for Torsional Dead Load (kips)

| Span | Length | Ext. | |
|---|---|---|---|
| | | DC | DW |
| 1 | 56 | 4.508 | 0.606 |
| 2 | 85 | 7.163 | 0.854 |
| 3 | 88 | 5.174 | 0.622 |
| 4 | 103 | 12.732 | 1.538 |
| 5 | 58 | 7.692 | 0.930 |

Additional Load to be applied in BrR to compesate for Additional Torsional Dead Load (kip/ft)

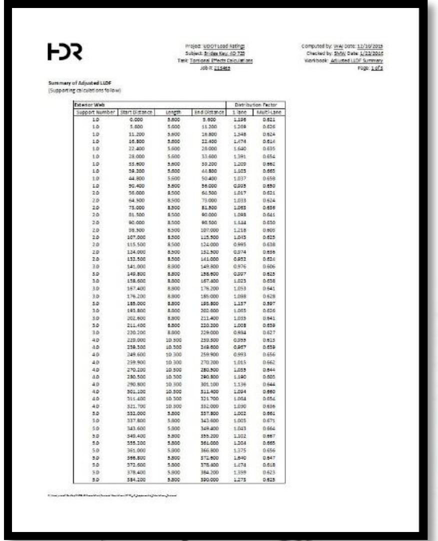
| Span | Constant* | Ext. | | Total | |
|---|---|---|---|---|---|
| | | DC | DW | DC | DW |
| 1 | 0.7 | -0.115 | -0.015 | -0.460 | -0.062 |
| 2 | 0.5 | -0.169 | -0.020 | -0.674 | -0.080 |
| 3 | 0.5 | -0.118 | -0.014 | -0.470 | -0.057 |
| 4 | 0.5 | -0.247 | -0.030 | -0.989 | -0.119 |
| 5 | 0.7 | -0.189 | -0.023 | -0.758 | -0.092 |

*Constant was found by creating a simple Larsa model to approximate the span/dead load/shear ratio

# 4D 725

## Live Load Torsion Induced Shear

- Live Load Increased by Adjusting LLDF
  - Exterior
  - Interior
- Modified at 10th Points
- Use HL-93, Applied to All Trucks
- Check Shear Full Section
  - Uses Interior LLDF x # Webs



| Exterior Web | | | | Distribution Factor | |
|---|---|---|---|---|---|
| Support Number | Start Distance | Length | End Distance | 1 lane | Multi-Lane |
| 1.0 | 0.000 | 5.600 | 5.600 | 1.196 | 0.621 |
| 1.0 | 5.600 | 5.600 | 11.200 | 1.269 | 0.626 |
| 1.0 | 11.200 | 5.600 | 16.800 | 1.348 | 0.624 |
| 1.0 | 16.800 | 5.600 | 22.400 | 1.474 | 0.614 |
| 1.0 | 22.400 | 5.600 | 28.000 | 1.640 | 0.635 |
| 1.0 | 28.000 | 5.600 | 33.600 | 1.391 | 0.654 |
| 1.0 | 33.600 | 5.600 | 39.200 | 1.209 | 0.662 |
| 1.0 | 39.200 | 5.600 | 44.800 | 1.103 | 0.663 |
| [illegible] | 44.800 | 5.600 | 50.400 | 1.037 | 0.658 |
| [illegible] | 50.400 | 5.600 | 56.000 | 0.995 | 0.650 |
| [illegible] | 56.000 | 8.500 | 64.500 | 1.017 | 0.621 |
| [illegible] | 64.500 | 8.500 | 73.000 | 1.033 | 0.624 |
| [illegible] | 73.000 | 8.500 | 81.500 | 1.063 | 0.636 |
| [illegible] | 81.500 | 8.500 | 90.000 | 1.098 | 0.641 |
| [illegible] | 90.000 | 8.500 | 98.500 | 1.144 | 0.630 |
| [illegible] | 98.500 | 8.500 | 107.000 | 1.218 | 0.603 |
| [illegible] | 107.000 | 8.500 | 115.500 | 1.043 | 0.625 |
| [illegible] | 115.500 | 8.500 | 124.000 | 0.995 | 0.638 |
| [illegible] | 124.000 | 8.500 | 132.500 | 0.974 | 0.636 |
| [illegible] | 132.500 | 8.500 | 141.000 | 0.952 | 0.624 |
| [illegible] | 141.000 | 8.800 | 149.800 | 0.976 | 0.606 |
| [illegible] | 149.800 | 8.800 | 158.600 | 0.997 | 0.625 |
| [illegible] | 158.600 | 8.800 | 167.400 | 1.023 | 0.638 |
| 3.0 | 167.400 | 8.800 | 176.200 | 1.053 | 0.641 |
| 3.0 | 176.200 | 8.800 | 185.000 | 1.088 | 0.628 |
| 3.0 | 185.000 | 8.800 | 193.800 | 1.137 | 0.597 |
| 3.0 | 193.800 | 8.800 | 202.600 | 1.065 | 0.626 |

# 4D 725

## Results

- Input Bridge As a Box Girder
  - Copy/Past Distribution Factors From Excel
  - Only Analyzes LRFR

- Modifying the File Simple
  - Used BrR File to Re-rate the Bridge After a Rehabilitation Project

- Used a Similar Method on Other Bridge Types

| | | LRFR RESULTS | | | | | LFR RESULTS | | |
|---|---|---|---|---|---|---|---|---|---|
| Vehicle | Tons | Rating Factor | Limit State | Mode | Member | Span | Rating Factor | Mode | Member |
| HL-93 (INV) | 36 | 0.56 | Strength_I | Shear | Web 4 | 4 | NA | NA | NA |
| HL-93 (OPR) | 36 | 0.82 | Strength_I | Shear | Web 4 | 4 | NA | NA | NA |
| HS-20 (INV) | 36 | NA | NA | NA | NA | NA | NA | NA | NA |
| HS-20 (OPR) | 36 | NA | NA | NA | NA | NA | NA | NA | NA |
| Type 3 | 25 | 1.68 | Strength_I | Flexure | Full Box | 1 | NA | NA | NA |
| Type 3S2 | 36 | 1.55 | Strength_I | Shear | Web 4 | 4 | NA | NA | NA |
| Type 3-3 | 40 | 1.56 | Strength_I | Shear | Web 4 | 4 | NA | NA | NA |
| Span | 40 | NA | NA | NA | NA | NA | NA | NA | NA |
| Neg Mom | 40 | 1.98 | Strength_I | Flexure | Full Box | 4 | NA | NA | NA |
| SU4 | 27 | 1.47 | Strength_I | Flexure | Full Box | 1 | NA | NA | NA |
| SU5 | 31 | 1.35 | Strength_I | Flexure | Full Box | 1 | NA | NA | NA |
| SU6 | 35 | 1.22 | Strength_I | Flexure | Full Box | 1 | NA | NA | NA |
| SU7 | 39 | 1.14 | Strength_I | Flexure | Full Box | 1 | NA | NA | NA |
| UT-P6 | 48 | 1.26 | Strength_II | Shear | Web 4 | 4 | NA | NA | NA |
| UT-P7 | 54 | 1.13 | Strength_II | Shear | Web 4 | 4 | NA | NA | NA |
| UT-P8 | 52.5 | 1.10 | Strength_II | Shear | Web 4 | 4 | NA | NA | NA |
| UT-P9a | 53 | 1.28 | Strength_II | Shear | Web 4 | 4 | NA | NA | NA |
| UT-P9b | 66 | 1.25 | Strength_II | Shear | Web 4 | 4 | NA | NA | NA |