RC-Pier

LRFD

T-Pier Example

1203 Jefferson

223’ x 40’ PPCB Bridge
(Three Spans: 70.75’ – 91.5’ – 60.75’)
32 deg LA Skew
T-Piers on Pile Footings
Integral Abutments

Office Example
10-10-2010

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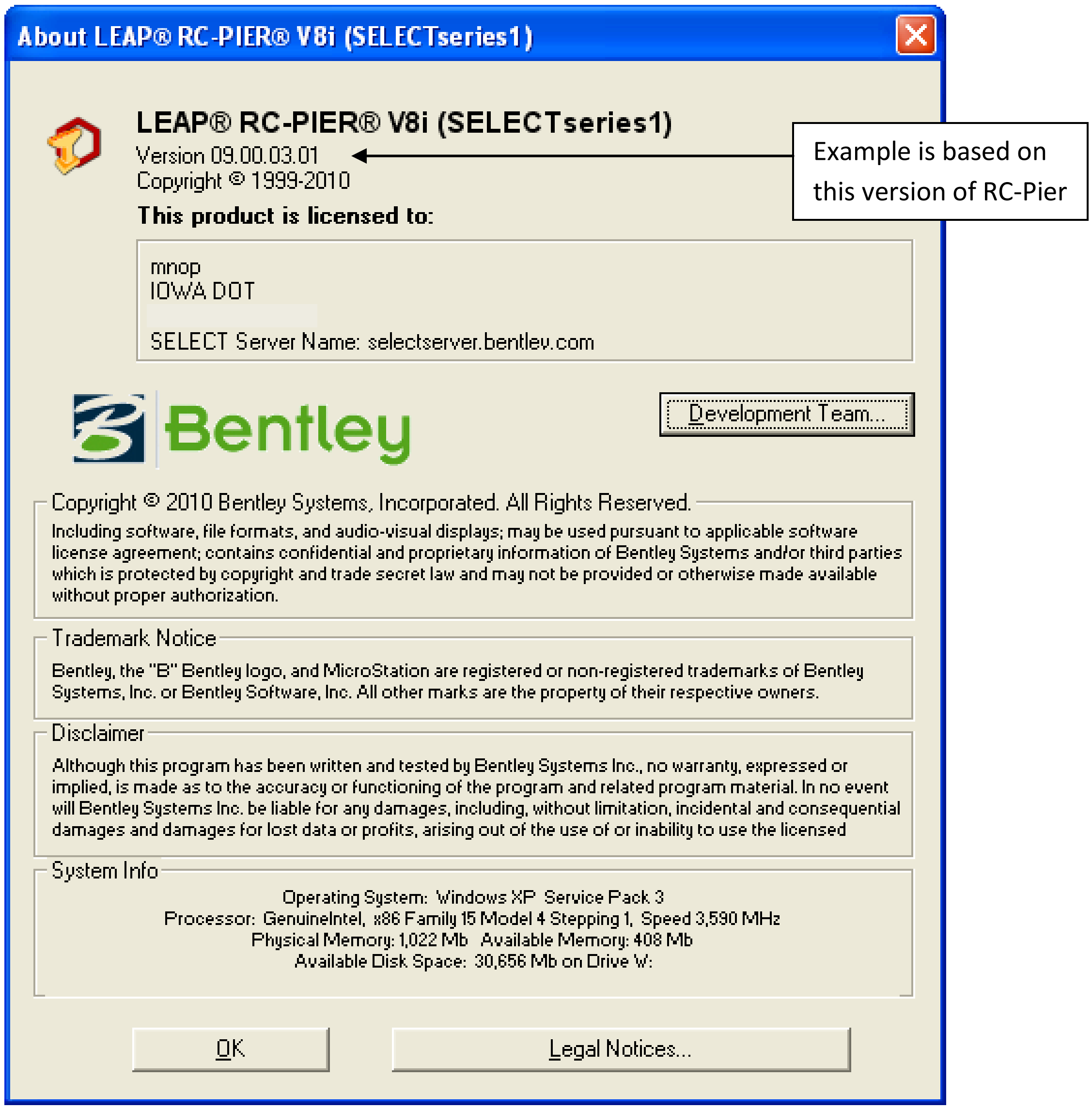
About LEAP® RC-PIER® V8i (SELECTseries1)
LEAP® RC-PIER® V8i (SELECTseries1)
Version 09.00.03.01
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This product is licensed to:
mnop
IOWA DOT
SELECT Server Name: selectserver.bentley.com
Example is based on this version of RC-Pier
Bentley
Development Team...
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System Info
Operating System: Windows XP Service Pack 3
Processor: GenuineIntel, x86 Family 15 Model 4 Stepping 1, Speed 3,590 MHz
Physical Memory: 1,022 Mb Available Memory: 408 Mb
Available Disk Space: 30,656 Mb on Drive W:
OK
Legal Notices...

Notes and Issues

1.) The primary intent of this example is to illustrate the use of RC-Pier, not to show every aspect of a pier design.
2.) Pier No. 1 of the west bound bridge from 1203 Jefferson forms the basis of this example. In general pier dimensions and reinforcement will not deviate from the existing plans (which are not based on an LRFD design) unless necessary to better illustrate some aspect of RC-Pier or LRFD.
3.) Bridge Office preference is to establish column fixity at the base of the column for the cap and column design and then establish fixity at the base of the footing for the footing and pile design. This policy has a few implications as stated below:
    - Foundation springs due to pile flexibility may be incorporated into both models.
    - For the footing/pile analysis designers may extend the column in RC-Pier to the bottom of the footing, but designers will not be required to increase the column inertia over the depth of the footing in order to model the footing's properties.
    - In general, the idea is that the applied loads will not have to be adjusted in RC-Pier due to the column height change between the two models. The loads that would typically be affected for a T-pier by the change in model geometry are column self-weight, column buoyancy, stream flow loading, ice loading, and wind on substructure. Because a number of loads are affected for T-piers it is usually a good idea to adjust the loads.
    - The designer should determine superstructure temperature loads based on pier fixity at the bottom of the column (with foundations springs if desired).
4.) The Bridge Office typically bases wind loading forces on the requirements for "usual girder and slab bridges" from AASHTO LRFD Articles 3.8.1.2.2 and 3.8.1.3 when BDM requirements are met. Iowa allows the use of these provisions for span lengths up to 155' (this is meant to include bridges using Iowa's longest prestressed beam, BTE155) and for top of railing elevations not exceeding 100'. Substructure wind loading is then assumed to be 40 psf in the longitudinal and transverse directions simultaneously. In RC-Pier it is recommended the designer both apply and exclude the wind uplift force from all load combinations since it is conservative and requires less bookkeeping.
5.) There are various issues with RC-Pier version V8i (09.00.03.01). These issues are addressed as they come up in this example.
6.) The Iowa DOT Bridge Design Manual shall be consulted for the most up-to-date DOT policies.

General RC-Pier Layout Geometry

(Figures on this page and the next are taken from the RC-Pier User Manual)

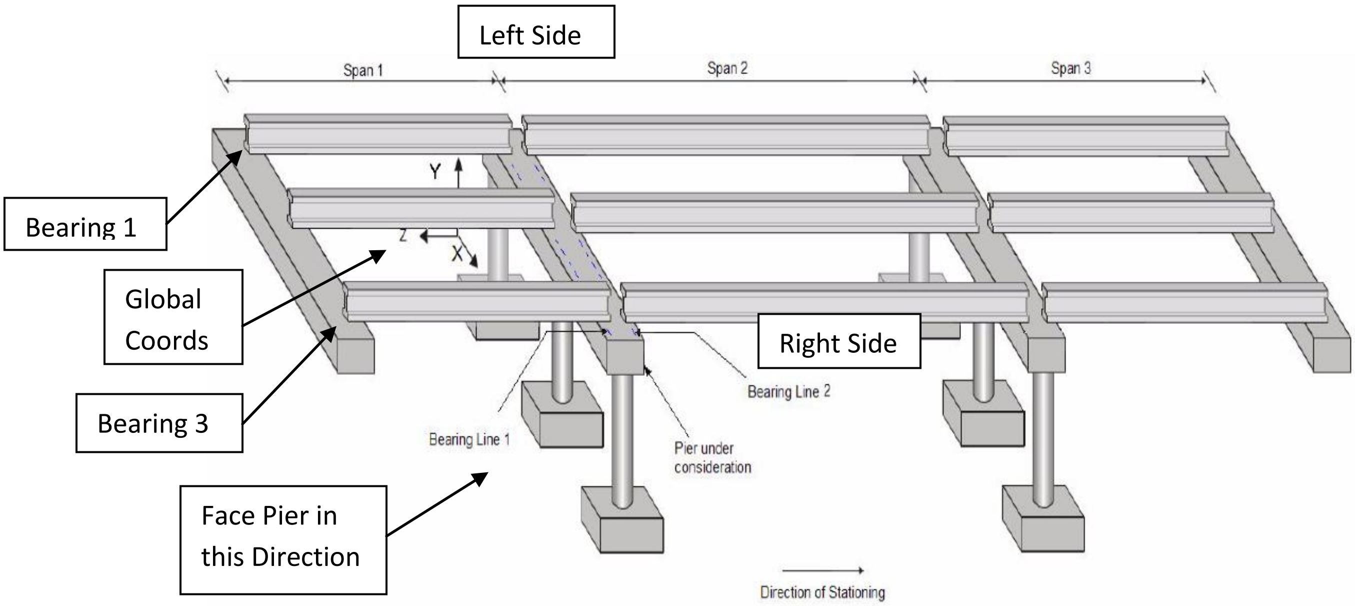


Figure TH-4 Bridge Pier Looking Upstation

Notes

1.) Recommend Upstation View over Downstation View.

2.) Generally Iowa uses only one bearing line in RC-Pier for typical steel and prestressed beam bridges.

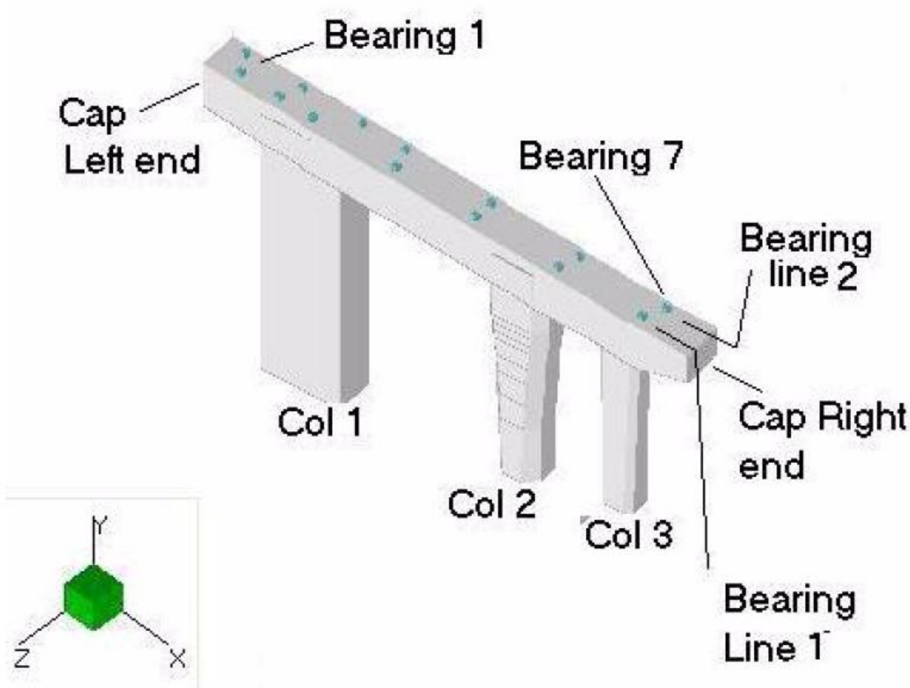


Figure TH-5 Bridge Pier Details in Upstation View

Skew Angle (in degrees)

The skew angle is defined as the angle between the normal to the centerline of the bridge and the centerline of the pier cap (in positive X-direction). It is positive if measured in counterclockwise direction, as shown in Figure TH-9. Note that the skew angle is used only for auto load generation.

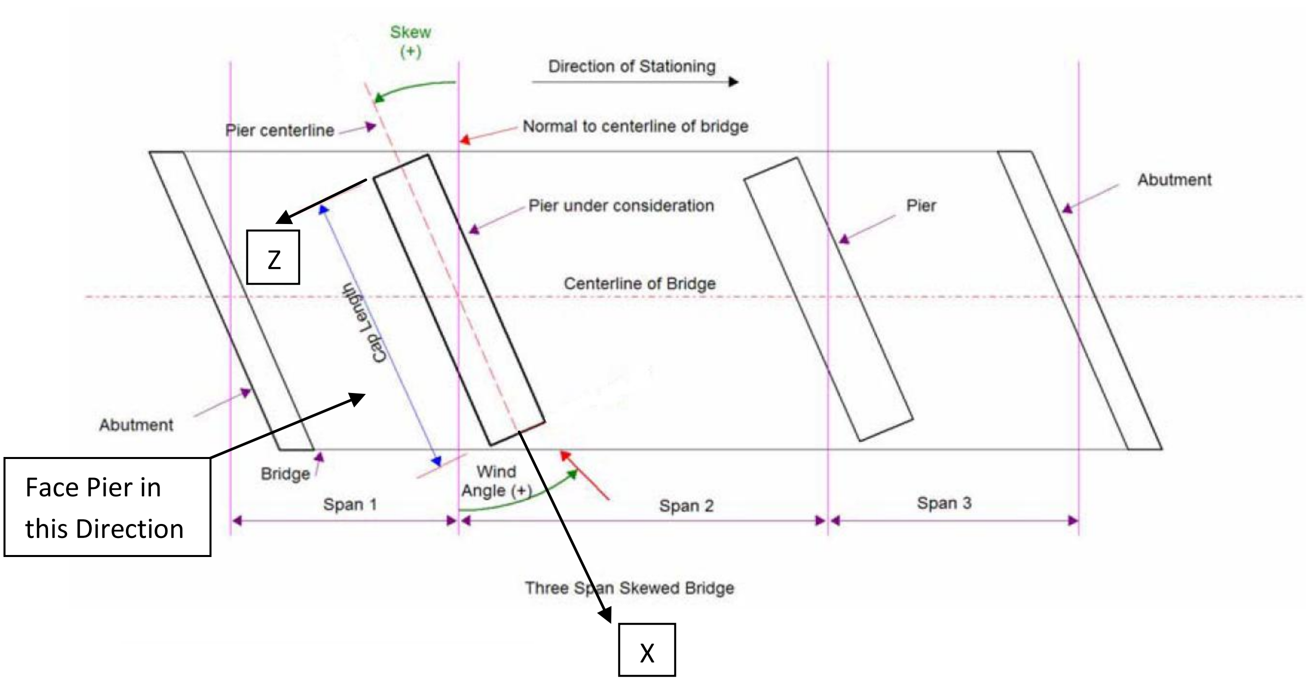


Figure TH-9 Bridge with Piers at Skew
(Modified Coordinate System)

<u>Notes</u>

1.) Redrew coordinate system to make it consistent with Upstation View.
2.) In RC-Pier the global coordinate system rotates with the skew.
3.) Right ahead skews are positive. Left ahead skews are negative.
4.) Face the pier looking in the negative Z-axis direction.

Dead Load: DC1, DC2, and DW

1.) RC-Pier can auto-generate these loads, but there are some drawbacks with doing it this way. Typically the DC1 loads are underestimated because the haunch, intermediate diaphragm, pier diaphragm, and the slab thickening on the overhang are not included. The distribution to the various beams is also based on tributary deck width which doesn't always correlate with Bridge Design Manual policy. So, in general, it is typically better to calculate these apart from RC-Pier and input them manually.
2.) The spreadsheet on the following pages can be used to generate loads for typical prestressed beam bridges. Hand calculations have also been provided as a check.

Pier Dead Load Beam Reactions for Interior and Exterior P/S Beams

Pier beam reactions consider only unfactored superstructure DC and DW loads.

Number of Spans	3	Can be 2 to 6 spans.

Beam Type	D	Beam type must be the same for each span.
Span 1 Beam Size	D70	
Span 2 Beam Size	D90	
Span 3 Beam Size	D60	
~~Span 4 Beam Size~~	----	
~~Span 5 Beam Size~~	----	
~~Span 6 Beam Size~~	----	

The bridge being checked has the "old" LXD beams which are quite similar to the current D beams.

Pier Number of Interest	1	Can be 1, 2, 3, 4, or 5 depending on number of spans.

Default Override	Description	Units	Default	Input/Override	Value Used
☐ Default Override	Span 1 Beam Length, end to end	ft	71.000		71.000
☐ Default Override	Span 2 Beam Length, end to end	ft	91.000		91.000
☐ Default Override	Span 3 Beam Length, end to end	ft	61.000		61.000
☐ Default Override	~~Span 4 Beam Length, end to end~~	~~ft~~	~~0.000~~		~~0.000~~
☐ Default Override	~~Span 5 Beam Length, end to end~~	~~ft~~	~~0.000~~		~~0.000~~
☐ Default Override	~~Span 6 Beam Length, end to end~~	~~ft~~	~~0.000~~		~~0.000~~
☐ Default Override	Span 1 Beam Length, c.l. to c.l. bearing	ft	70.000		70.000
☐ Default Override	Span 2 Beam Length, c.l. to c.l. bearing	ft	90.000		90.000
☐ Default Override	Span 3 Beam Length, c.l. to c.l. bearing	ft	60.000		60.000
☐ Default Override	~~Span 4 Beam Length, c.l. to c.l. bearing~~	~~ft~~	~~0.000~~		~~0.000~~
☐ Default Override	~~Span 5 Beam Length, c.l. to c.l. bearing~~	~~ft~~	~~0.000~~		~~0.000~~
☐ Default Override	~~Span 6 Beam Length, c.l. to c.l. bearing~~	~~ft~~	~~0.000~~		~~0.000~~
☐ Default Override	Distance bt. Beam Ends on Pier 1	in	6.000		6.000
☐ Default Override	Distance bt. Beam Ends on Pier 2	in	6.000		6.000
☐ Default Override	~~Distance bt. Beam Ends on Pier 3~~	~~in~~	~~0.000~~		~~0.000~~
☐ Default Override	~~Distance bt. Beam Ends on Pier 4~~	~~in~~	~~0.000~~		~~0.000~~
☐ Default Override	~~Distance bt. Beam Ends on Pier 5~~	~~in~~	~~0.000~~		~~0.000~~

	Distance bt. Centerline Bearings on Pier 1	ft	1.500		1.500

	Roadway Width (Gutter to Gutter)	ft		40.000	40.000
	Number of Beams in Cross-Section			6.000	6.000

	FWS Load	ksf		0.020	0.020
	SBC Load - Includes Both Rails	klf		0.852	0.852

☐ Default Override	FWS Distribution Factor for Exterior Beam (*)		0.167		0.167
☐ Default Override	FWS Distribution Factor for Interior Beam (*)		0.167		0.167
☐ Default Override	SBC Distribution Factor for Exterior Beam (*)		0.167		0.167
☐ Default Override	SBC Distribution Factor for Interior Beam (*)		0.167		0.167

* Default is an equal distribution of the FWS and SBC loads among all the beams in the cross-section.

☐ Default Override	Pier 1 Reaction Due to 1.00 klf Distributed Load (**)	kips	91.868		91.868

** The pier rxn is used as a ratio to distribute FWS and SBC loads to the pier. It is based on span continuity and a 1.00 klf distr. load.

☐ Default Override	Exterior Beam Reaction for FWS	kips	12.249		12.249
☐ Default Override	Interior Beam Reaction for FWS	kips	12.249		12.249
☐ Default Override	Exterior Beam Reaction for SBC	kips	13.045		13.045
☐ Default Override	Interior Beam Reaction for SBC	kips	13.045		13.045

	Bearing Pad Height at Pier 1 (+)	in		4.000	4.000
	Beam Height at Pier 1	ft	4.500		4.500
	Average Haunch Thickness for Spans 1 and 2	in		1.000	1.000
	Max Haunch Thickness at Pier 1	in		2.000	2.000
	Slab Thickness	in		8.000	8.000
	Slab Cantilever Min. Thickness at Slab Edge	in		8.750	8.750
	Slab Cantilever Max. Thickness at Flange Edge	in		10.250	10.250

+ Bearing pad height is only used in the calculation of pier diaphragm weight for fixed piers.

Top Flange Width	in	20.000		20.000
Beam Area	in^2	638.750		638.750

Beam Spacing Perpendicular to Roadway (++)	ft		7.401	7.401
Slab Cantilever Length (++)	ft		3.083	3.083

++ Beam spacing, slab cantilever length, number of beams, and roadway width should all be consistent.

	Skew, Always Positive	deg		32.000	32.000
☐ Default Override	No. of Intermediate Diaphragms in Span 1		1		1.000
	Enter: 1 = Steel Diaphragm, 2 = Concrete Diaphragm			1	1.000
☐ Default Override	Weight of One Intermediate Diaphragm in Span 1	kips	0.281		0.281
☐ Default Override	No. of Intermediate Diaphragms in Span 2		1		1.000
	Enter: 1 = Steel Diaphragm, 2 = Concrete Diaphragm			1	1.000
☐ Default Override	Weight of One Intermediate Diaphragm in Span 2	kips	0.281		0.281

Perpendicular Thickness of Pier Diaphragm	ft		2.667	2.667
Perp. Extension of Pier Diaph. Past C.L. Ext. Beam (#)	ft		1.583	1.583
Enter: 1 = Fixed Pier, 2 = Expansion Pier			2	2.000

If the pier diaphragm is flush with the exterior side of the exterior beam then enter 0.

Pier 1		Unfactored Beam Reactions (includes both spans)	
Component	Load Type	Interior Beam kips	Exterior Beam kips
Beam	DC1	53.895	53.895
Slab	DC1	60.318	58.723
Haunch	DC1	1.688	1.688
Intermediate Diaphragms	DC1	0.281	0.141
Pier Diaphragm	DC1	14.423	9.213
SBC	DC2	13.045	13.045
Total (##)	DC Total	143.649	136.704
FWS	DW	12.249	12.249

See hand calculations on following sheets for more information.

Pier cap step weight is not included here.

Some designers include pier cap step weight in the beam reactions. That weight is not included here.

	Interior	Exterior
DC1 Pier Cap Step Weight	2.615 k	0.000 k
	143.649 k	136.704 k
Total DC	146.264 k	136.704 k
Total DW	12.249 k	12.249 k

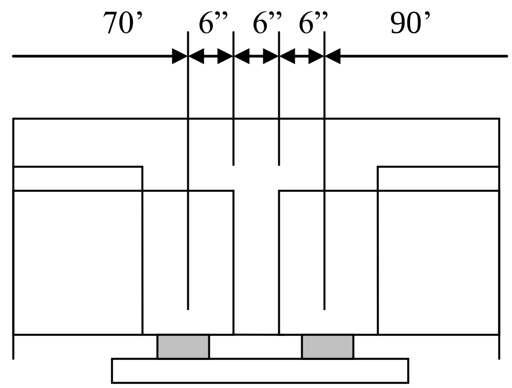
These loads will be used in RC-Pier for the general T-Pier design. The loads for the pier cap overhang will be different.

Hand Calculations for Superstructure Beam Dead Load Reactions

1.) Beam - DC1

Interior & Exterior Beams

(0.5)*(71 ft + 91 ft)*[(638.75 in^2)/(144 in^2/ft^2)]*(0.150 kcf) = 53.895 k



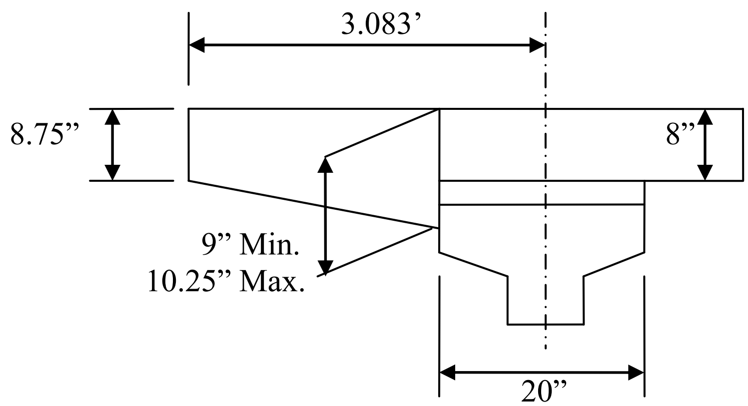
2.) Slab - DC1

Interior Beam

(7.401')*[(8")/(12 in^2/ft^2)]*[(0.5)*(70' + 90') + 1.5']*(0.150 kcf) = 60.318 k

Exterior Beam

{[(0.5)*(7.401') + 3.083']*[(8")/(12 in/ft)] +
[3.083' – (0.5)*(20")/(12 in/ft)]*[0.75" + (0.5)*(1.5")]/(12 in/ft)}*
[(0.5)*(70') + (0.5)*(90') + 1.5']*(0.150 kcf) = 58.723 k



3.) Haunch – DC1

Interior & Exterior Beams

[(1")*(20")/(144 in^2/ft^2)][(0.5)*(70') + (0.5)*(90') + 1']*(0.150 kcf) = 1.688 k

4.) Intermediate Steel Diaphragm – DC1

(One steel diaphragm per span; based on LXD beam data in plan set the diaphragm weighs 0.285 k for 7.5’ beam spacing)

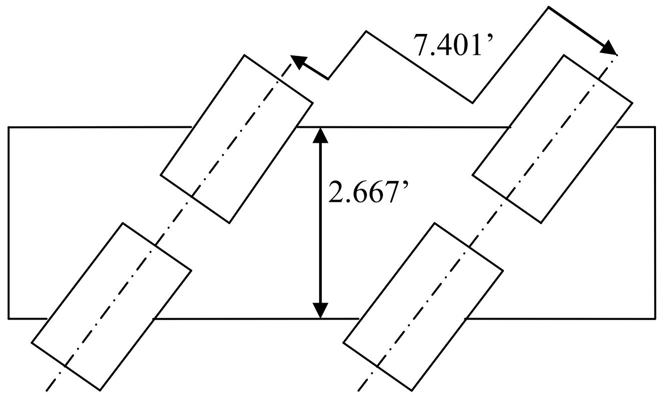
Interior Beam

{(0.285 k)*(7.401’/7.5’) = <u>0.281 k</u>

Exterior Beam

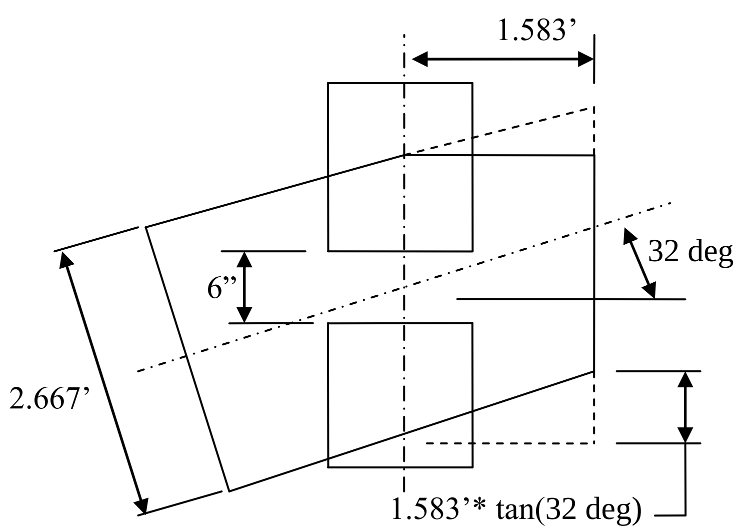
(0.5)*(0.281 k) = <u>0.141 k</u>

5.) Pier Diaphragm – DC1



Interior Beam

{(7.401’)*[(2.667’)/(cos(32 deg))]*[4.5’ + (2”)/(12 in/ft)] –
[(638.75 in^2 + (2”)*(20”))/(144 in^2/ft^2)]*[(2.667’)/(cos(32 deg)) – 0.5’]}*
(0.150 kcf) = <u>14.423 k</u>



Exterior Beam

(0.5)*(14.423 k) + [4.5’ + (2”)/(12 in/ft)]*(1.583’)*[(2.667’)/(cos(32 deg)) –
(0.5)*(1.583’)*(tan(32 deg))] – (0.5)*[(638.75 in^2 + (2”)*(20”))/(144 in^2/ft^2)]*
[(2.667’)/(cos(32 deg)) – 0.5’]}*(0.150 kcf) = <u>9.213 k</u>

5.) Pier Diaphragm – DC1

For simplicity we generally assume the pier step load acts through the interior beams.

Interior Only

Average Step Height = 4.88” average of all six beam seat elevations
Pier Cap Width = 3.5’
Average Total Step Length Along Pier Cap = 49’ approximately

[(4.88”)/(12 in/ft)]*(3.5’)*(49’)*(0.150 kcf)/(4 Int. Beams) = <u>2.615 k</u>

6.) SBC – DC2

Interior & Exterior Beams

Area of One SBC = 2.84 ft^2
Reaction from QConBridge Due to 1.00 k/ft Uniform Dead Load = 91.868 k

(2 SBC)*(2.84 ft^2)*(0.150 kcf)*[(91.868 k)/(1.00 k/ft)]/(6 Beams) = <u>13.045 k</u>

7.) FWS – DW

Interior & Exterior Beams

(0.020 ksf)*(40’)*[(91.868 k)/(1.00 k/ft)]/(6 Beams) = <u>12.249 k</u>

<u>Total Dead Load</u>

DC Load

		Interior	Exterior
DC1	Beam	53.895 k	53.895 k
DC1	Slab	60.318 k	58.723 k
DC1	Haunch	1.688 k	1.688 k
DC1	Interm. Diaph.	0.281 k	0.141 k
DC1	Pier Diaph.	14.423 k	9.213 k
DC1	Pier Steps	2.615 k	0.000 k
DC2 →	SBC	13.045 k	13.045 k
	Total DC	146.264 k	136.704 k

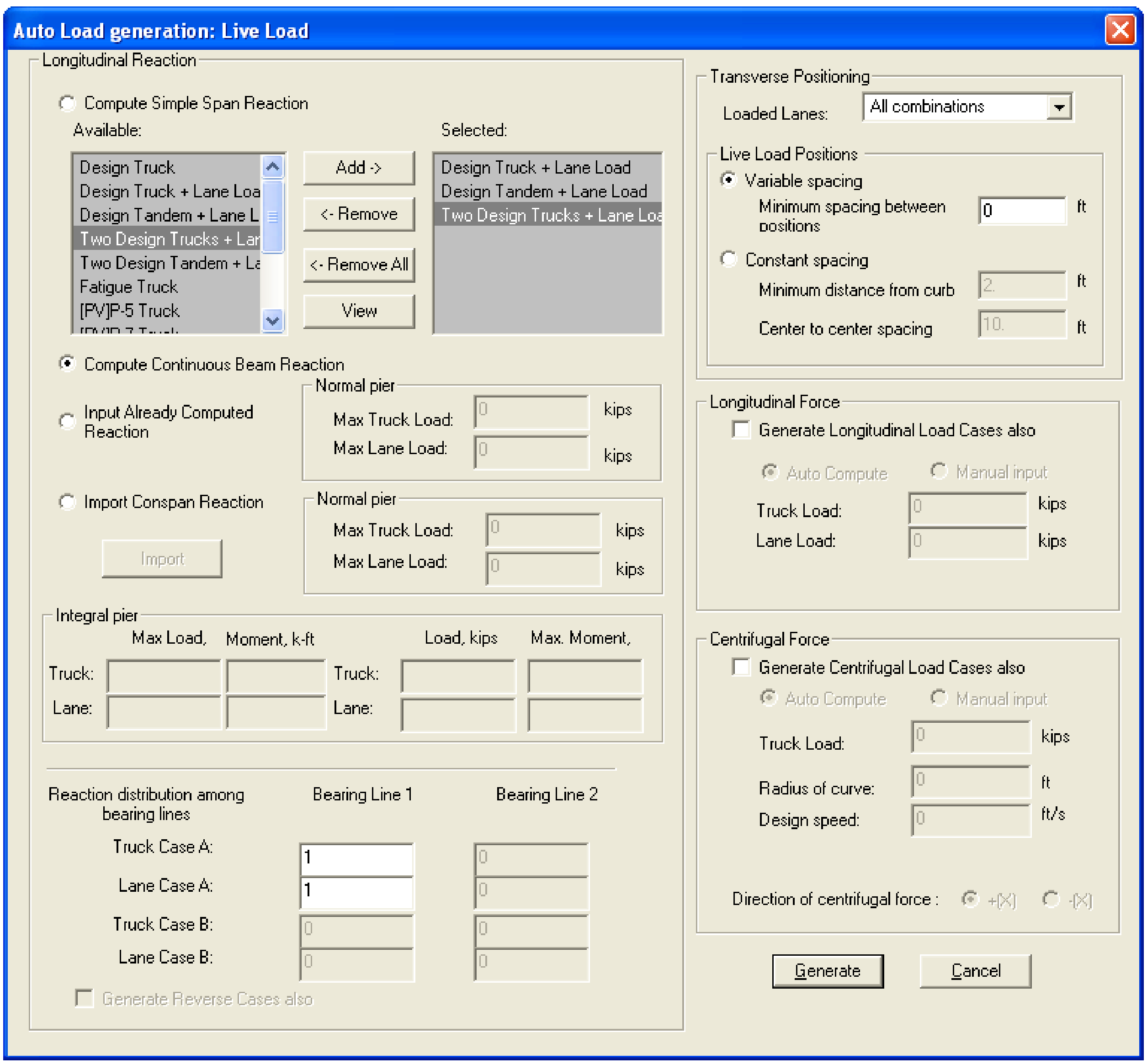
DW Load

	Interior	Exterior
FWS	12.249 k	12.249 k

Live Load: LL

There are a number of ways live load can be done in RC-Pier.

1.) Use QConBridge to get the live load pier reaction. Move the live load(s) transversely back and forth across the deck width and determine the beam reactions for those arrangements that maximize force effects in the pier. Typically placement of live load for maximum force effects can be done intuitively. The spreadsheet on the following pages facilitates this method and consequently is used for this example.
2.) Another method is to use RC-Pier's auto-generation feature for determination of live loads. The program is capable of determining the pier live load reaction for a continuous bridge with a constant moment of inertia. (For this example I checked the live load reaction QConBridge came up with against RC-Pier's value and the two compared quite well.) The user can use RC-Pier's live load reaction, import it from Conspan, or enter their own. Once RC-Pier has this determined there are basically two ways to obtain the actual live load cases.
    a.) Variable spacing
    b.) Constant spacing



RC-Pier's manual explains how the two methods work. Essentially each method follows an algorithm for determining how many different live load positions are possible. The program then seeks to maximize forces for each member and keeps only the live load arrangements that do this. In general the variable spacing method is going to check more possibilities and thus produce more live load cases (especially with 0' as the "Minimum spacing between positions"). This in turn will increase the number of load combinations and computing time. However, for the settings shown above the variable spacing method and constant spacing method both come up with 5 different live load cases.

Note:
When live loads are auto-generated in RC-Pier the user can review some of the processes RC-Pier went through in order to determine the live load cases. There is a "LL details" button on the Loads tab screen that brings this information up. One shortcoming of RC-Pier is that the information for the truck positions in these details is based on a downstation view of the pier even when the user is working in the upstation view mode. I've contacted the developers and they are already aware of the inconsistency and it is on their list of things to fix.

Live Load QConBridge Runs are on the following pages.

Run 1:

This was done to determine what live load controls for the pier reaction. The dual truck train with lane controlled.

Max. LL + I = 168.615 k Dual Truck Train + Lane
Impact
Axle Load
Unfactored

Run 2:

This was done to determine the truck portion of the controlling live load since RC-Pier entry requires the truck and lane to be separated in order to track impact application for the various pier components.

Dual Truck Rxn = 85.662 k No Lane
No Impact
Axle Load
Unfactored

Run 3:

This was done to determine the lane portion of the controlling live load since RC-Pier entry requires the truck and lane to be separated in order to track application for the various pier components.

Dual Lane Rxn = 54.683 k No Truck
No Impact
Axle Load
Unfactored

Check: (85.662 k)*(1.33) + 54.683 k = 168.613 k

Note: The dual truck train + lane often controls the pier reaction. It needs to be remembered that the truck and lane weights are reduced to 90% and that this reduction is already included in the reactions above.

The next page details how the reactions for the truck and lane can be obtained separately in QConBridge.

QConBridge Version 1.3

Getting Truck Load and Lane Load Separately for HL-93 Loading.

This description is taken directly from the Washington DOT website:
http://www.wsdot.wa.gov/eesc/bridge/software/

Q2 How can I get the truck load and lane load results separately?

A2 The HL93 Live Load model consists of the truck and lane applied simultaneously, along with appropriate dynamic load allowance (impact) factors. This is how QConBridge approaches the problem, so there is no direct way to separate the truck and lane response.

However, there is a "trick" that you can use to "turn off" either the truck or lane load. The trick is to use a dynamic load allowance of -100% for the load component you want to turn off. Truck and lane responses are scaled by (1.0 + IM/100) where IM is the applicable dynamic load allowance factor. Using a factor of -100% the response is scaled by (1.0 + -100/100) = 0.0, which, in effect, "turns off" the response.

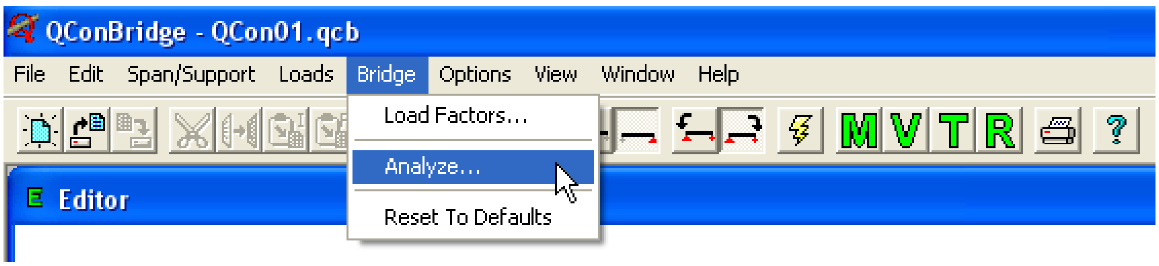
To modify the dynamic load allowance, select Loads | Dynamic Load Allowance... Enter a value of -100% for **either** Truck or Lane. Press the OK button and run the analysis.

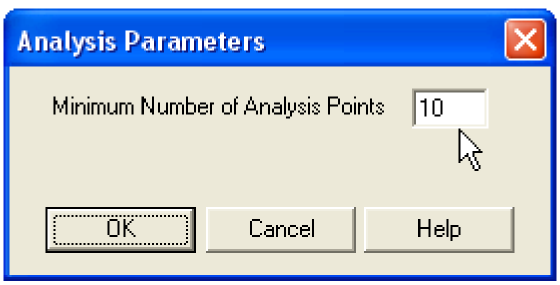
Thanks to Dr. Harry Cole from the Mississippi State University for sharing this tip. (Go Bulldogs)

QConBridge Version 1.3

Minimum Number of Analysis Points

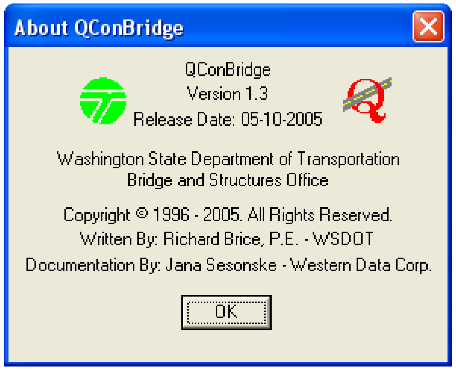
Use a minimum of 10 analysis points for any QConBridge run. QConBridge uses a finer influence line as more analysis points are used. Every axle on every truck is placed at every analysis point. If you decrease the number of points from 10 your results will likely be off by a significant percentage. In order to get reasonable results the minimum default value of 10 analysis points should be used. You can also use more than 10 analysis points, but this isn't typically necessary and as you increase the number of analysis points you increase the time of execution which can be substantial for bridges with a large number of spans.

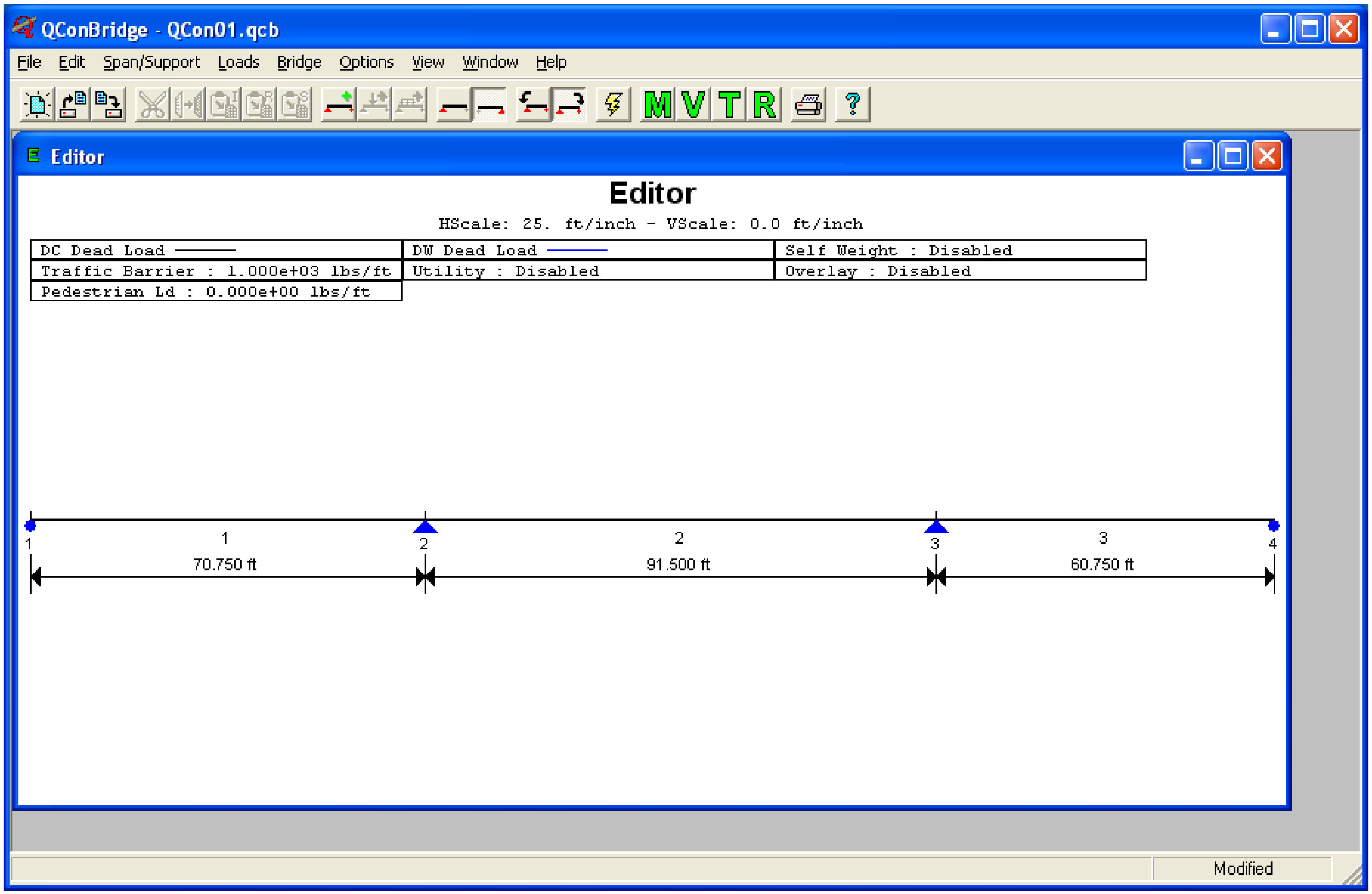


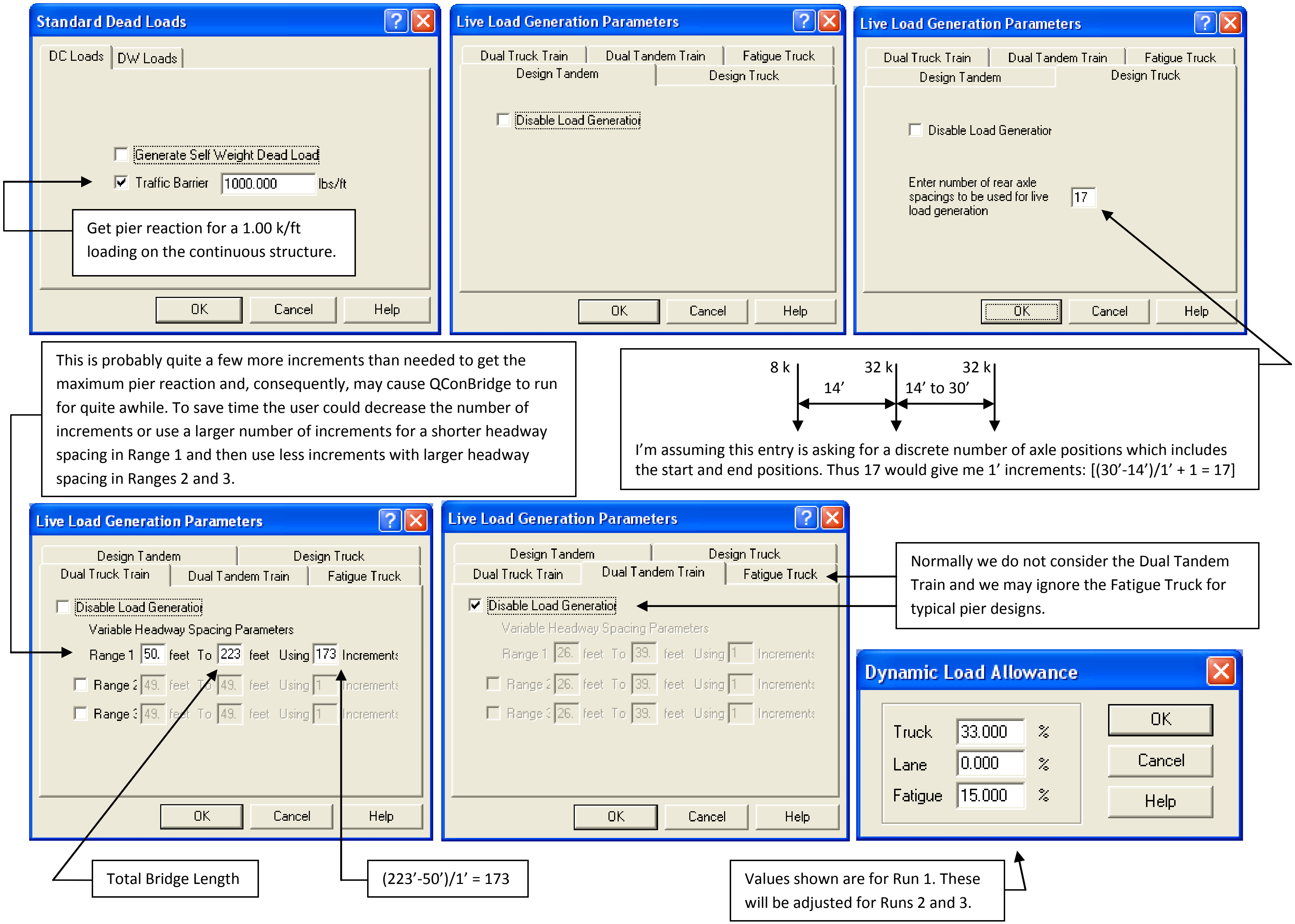


Load Factors

Typically we are only interested in unfactored LL pier reactions from QConBridge. However, it is worth noting that changing the load factors in QConBridge Version 1.3 does show the change in the load factors in the output's echo of the input, but the results for the limit states are not affected. The default load factors always seem to be used in the factored results.


About QConBridge
QConBridge
Version 1.3
Release Date: 05-10-2005
Washington State Department of Transportation
Bridge and Structures Office
Copyright © 1996 - 2005. All Rights Reserved.
Written By: Richard Brice, P.E. - WSDOT
Documentation By: Jana Sesonske - Western Data Corp.
OK


QConBridge - QCon01.qcb
File Edit Span/Support Loads Bridge Options View Window Help
Editor
Editor
HScale: 25. ft/inch - VScale: 0.0 ft/inch
DC Dead Load
DW Dead Load
Self Weight : Disabled
Traffic Barrier : 1.000e+03 lbs/ft
Utility : Disabled
Overlay : Disabled
Pedestrian Ld : 0.000e+00 lbs/ft
1
2
3
70.750 ft
91.500 ft
60.750 ft
1
2
3
4
Modified


Standard Dead Loads
DC Loads
DW Loads
Generate Self Weight Dead Load
Traffic Barrier 1000.000 lbs/ft
OK Cancel Help
Get pier reaction for a 1.00 k/ft loading on the continuous structure.
Live Load Generation Parameters
Dual Truck Train
Dual Tandem Train
Fatigue Truck
Design Tandem
Design Truck
Disable Load Generatioi
OK Cancel Help
Live Load Generation Parameters
Dual Truck Train
Dual Tandem Train
Fatigue Truck
Design Tandem
Design Truck
Disable Load Generatior
Enter number of rear axle spacings to be used for live load generation 17
OK Cancel Help
This is probably quite a few more increments than needed to get the maximum pier reaction and, consequently, may cause QConBridge to run for quite awhile. To save time the user could decrease the number of increments or use a larger number of increments for a shorter headway spacing in Range 1 and then use less increments with larger headway spacing in Ranges 2 and 3.
8 k
32 k
32 k
14'
14' to 30'
I'm assuming this entry is asking for a discrete number of axle positions which includes the start and end positions. Thus 17 would give me 1' increments: [(30'-14')/1' + 1 = 17]
Live Load Generation Parameters
Design Tandem
Design Truck
Dual Truck Train
Dual Tandem Train
Fatigue Truck
Disable Load Generatioi
Variable Headway Spacing Parameters
Range 1 50. feet To 223 feet Using 173 Increments
Range 2 49. feet To 49. feet Using 1 Increments
Range 3 49. feet To 49. feet Using 1 Increments
OK Cancel Help
Live Load Generation Parameters
Design Tandem
Design Truck
Dual Truck Train
Dual Tandem Train
Fatigue Truck
Disable Load Generatioi
Variable Headway Spacing Parameters
Range 1 26. feet To 39. feet Using 1 Increments
Range 2 26. feet To 39. feet Using 1 Increments
Range 3 26. feet To 39. feet Using 1 Increments
OK Cancel Help
Normally we do not consider the Dual Tandem Train and we may ignore the Fatigue Truck for typical pier designs.
Dynamic Load Allowance
Truck 33.000 %
Lane 0.000 %
Fatigue 15.000 %
OK Cancel Help
Total Bridge Length
(223'-50')/1' = 173
Values shown are for Run 1. These will be adjusted for Runs 2 and 3.

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


Code: LRFD First Edition 1994

Span Data
---------

Span  1  Length:     70.750 ft

Section Properties
Location      Ax           Iz         Mod. E      Unit Wgt
  (ft)      (in^2)       (in^4)        (psi)       (pcf)
   0.000  1.000e+00    999.999e-03  1.000e+03    999.997e-03

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:     91.500 ft

Section Properties
Location      Ax           Iz         Mod. E      Unit Wgt
  (ft)      (in^2)       (in^4)        (psi)       (pcf)
   0.000  1.000e+00    999.999e-03  1.000e+03    999.997e-03

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:     60.750 ft

Section Properties
Location      Ax           Iz         Mod. E      Unit Wgt
  (ft)      (in^2)       (in^4)        (psi)       (pcf)
   0.000  1.000e+00    999.999e-03  1.000e+03    999.997e-03

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  Roller
```

QConBridge
Run 1 Output
Max LL+I Rxn = 168.615 k — Dual Truck Train + Lane Controls

Rxn Due to 1.00 k/ft Uniform Load = 91.868 k

```
Support  2  Pinned


Support  3  Pinned


Support  4  Roller


Loading Data
------------
DC Loads
   Self Weight Generation Disabled
   Traffic Barrier Load   1.000e+03 plf

DW Loads
   Utility Load Disabled
   Wearing Surface Load Disabled

Live Load Data
--------------
Live Load Generation Parameters
   Design Tandem    : Enabled
   Design Truck     : 17 rear axle spacing increments
   Dual Truck Train : Headway Spacing varies from 50.000 ft to 223.000 ft using 173
increments
   Dual Tandem Train: Disabled
   Fatigue Truck    : Disabled

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

   Pedestrian Live Load    0.000e+00 plf
```

Impact

```
Load Factors
------------
   Strength I   DC min 0.900 DC max 1.250 DW min 0.650 DW max 1.500 LL     1.750
   Service I    DC     1.000 DW     1.000 LL     1.000
   Service II   DC     1.000 DW     1.000 LL     1.300
   Service III  DC     1.000 DW     1.000 LL     0.800
   Fatigue      DC     0.000 DW     0.000 LL     0.750

Analysis Results
----------------
DC Dead Load
```

Span	Point	Shear(lbs)	Moment(ft-lbs)
1	0	25.587e+03	0.000e+00
1	1	18.512e+03	156.005e+03
1	2	11.437e+03	261.956e+03
1	3	4.362e+03	317.850e+03
1	4	-2.712e+03	323.689e+03
1	5	-9.787e+03	279.473e+03
1	6	-16.862e+03	185.200e+03
1	7	-23.937e+03	40.872e+03
1	8	-31.012e+03	-153.510e+03
1	9	-38.087e+03	-397.949e+03
1	10	-45.162e+03	-692.444e+03
2	0	46.706e+03	-692.444e+03
2	1	37.556e+03	-306.943e+03
2	2	28.406e+03	-5.165e+03

2	3	19.256e+03	212.890e+03
2	4	10.106e+03	347.223e+03
2	5	956.236e+00	397.834e+03
2	6	-8.193e+03	364.722e+03
2	7	-17.343e+03	247.888e+03
2	8	-26.493e+03	47.331e+03
2	9	-35.643e+03	-236.947e+03
2	10	-44.793e+03	-604.948e+03
3	0	40.333e+03	-604.948e+03
3	1	34.258e+03	-378.378e+03
3	2	28.183e+03	-188.714e+03
3	3	22.108e+03	-35.955e+03
3	4	16.033e+03	79.898e+03
3	5	9.958e+03	158.845e+03
3	6	3.883e+03	200.887e+03
3	7	-2.191e+03	206.024e+03
3	8	-8.266e+03	174.255e+03
3	9	-14.341e+03	105.580e+03
3	10	-20.416e+03	0.000e+00

DC Dead Load

Pier	Fx(lbs)	Fy(lbs)	Mz(ft-lbs)
1	0.000e+00	25.587e+03	0.000e+00
2	0.000e+00	91.868e+03	0.000e+00
3	0.000e+00	85.126e+03	0.000e+00
4	0.000e+00	20.416e+03	0.000e+00

DW Dead Load

Span	Point	Shear(lbs)	Moment(ft-lbs)
1	0	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00
1	2	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00
1	9	0.000e+00	0.000e+00
1	10	0.000e+00	0.000e+00
2	0	0.000e+00	0.000e+00
2	1	0.000e+00	0.000e+00
2	2	0.000e+00	0.000e+00
2	3	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00
2	10	0.000e+00	0.000e+00
3	0	0.000e+00	0.000e+00
3	1	0.000e+00	0.000e+00
3	2	0.000e+00	0.000e+00
3	3	0.000e+00	0.000e+00
3	4	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00

DW Dead Load

Pier	Fx(lbs)	Fy(lbs)	Mz(ft-lbs)
1	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00

Live Load Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	-14.367e+03	101.931e+03	0.000e+00	0.000e+00
1	1	-14.646e+03	86.026e+03	-101.651e+03	622.614e+03
1	2	-19.062e+03	70.997e+03	-203.303e+03	1.052e+06
1	3	-28.338e+03	56.973e+03	-304.954e+03	1.300e+06
1	4	-39.927e+03	44.078e+03	-406.606e+03	1.414e+06
1	5	-53.540e+03	32.427e+03	-508.258e+03	1.393e+06
1	6	-67.118e+03	22.129e+03	-609.909e+03	1.261e+06
1	7	-80.487e+03	14.442e+03	-711.561e+03	991.720e+03
1	8	-93.469e+03	8.392e+03	-813.213e+03	611.706e+03
1	9	-105.873e+03	3.453e+03	-1.032e+06	257.017e+03
1	10	-117.504e+03	2.274e+03	-1.573e+06	160.896e+03
2	0	-7.994e+03	117.918e+03	-1.573e+06	160.896e+03
2	1	-8.207e+03	106.088e+03	-901.750e+03	299.239e+03
2	2	-12.263e+03	90.862e+03	-571.975e+03	726.934e+03
2	3	-20.753e+03	75.328e+03	-483.464e+03	1.170e+06
2	4	-32.672e+03	60.032e+03	-399.425e+03	1.435e+06
2	5	-46.236e+03	45.485e+03	-315.385e+03	1.504e+06
2	6	-60.924e+03	32.197e+03	-319.357e+03	1.415e+06
2	7	-76.243e+03	20.618e+03	-368.032e+03	1.130e+06
2	8	-91.667e+03	12.489e+03	-428.013e+03	682.182e+03
2	9	-106.646e+03	11.161e+03	-805.037e+03	286.061e+03
2	10	-120.622e+03	10.963e+03	-1.452e+06	231.796e+03
3	0	-3.815e+03	110.822e+03	-1.452e+06	231.796e+03
3	1	-3.936e+03	101.262e+03	-1.025e+06	252.624e+03
3	2	-8.877e+03	89.149e+03	-887.211e+03	554.894e+03
3	3	-14.939e+03	76.561e+03	-776.310e+03	854.724e+03
3	4	-21.946e+03	63.624e+03	-665.408e+03	1.061e+06
3	5	-31.409e+03	50.501e+03	-554.507e+03	1.153e+06
3	6	-42.577e+03	38.165e+03	-443.605e+03	1.164e+06
3	7	-54.915e+03	28.371e+03	-332.704e+03	1.068e+06
3	8	-68.250e+03	19.412e+03	-221.803e+03	864.870e+03
3	9	-82.513e+03	18.490e+03	-110.901e+03	511.596e+03
3	10	-97.557e+03	18.255e+03	0.000e+00	0.000e+00

Unfactored Max LL+I Rxn based on all live loads: Dual Truck Train + Lane Controls

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	-14.367e+03	101.931e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-10.268e+03	168.615e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-14.779e+03	161.430e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	-18.255e+03	97.557e+03	0.000e+00	0.000e+00

Design Tandem + Lane Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	-11.394e+03	83.906e+03	0.000e+00	0.000e+00
1	1	-11.673e+03	71.573e+03	-80.616e+03	520.357e+03
1	2	-19.062e+03	59.914e+03	-161.233e+03	895.860e+03
1	3	-28.338e+03	49.013e+03	-241.850e+03	1.131e+06
1	4	-37.886e+03	38.949e+03	-322.466e+03	1.233e+06
1	5	-47.591e+03	29.793e+03	-403.083e+03	1.219e+06
1	6	-57.328e+03	21.610e+03	-483.700e+03	1.102e+06
1	7	-66.968e+03	14.442e+03	-564.317e+03	883.849e+03

1	8	-76.398e+03	8.392e+03	-644.933e+03	578.388e+03
1	9	-85.410e+03	3.453e+03	-773.378e+03	257.017e+03
1	10	-93.919e+03	1.829e+03	-994.370e+03	129.405e+03
2	0	-6.429e+03	93.536e+03	-994.370e+03	129.405e+03
2	1	-6.643e+03	85.577e+03	-610.091e+03	299.239e+03
2	2	-12.263e+03	74.175e+03	-453.401e+03	673.313e+03
2	3	-20.337e+03	62.483e+03	-385.731e+03	1.024e+06
2	4	-29.741e+03	50.903e+03	-322.533e+03	1.240e+06
2	5	-40.185e+03	39.795e+03	-259.335e+03	1.304e+06
2	6	-51.356e+03	29.496e+03	-264.945e+03	1.224e+06
2	7	-62.913e+03	20.310e+03	-299.303e+03	992.989e+03
2	8	-74.485e+03	12.489e+03	-344.966e+03	639.750e+03
2	9	-85.696e+03	8.883e+03	-495.957e+03	286.061e+03
2	10	-96.049e+03	8.686e+03	-1.006e+06	183.640e+03
3	0	-3.022e+03	89.565e+03	-1.006e+06	183.640e+03
3	1	-3.841e+03	82.890e+03	-818.560e+03	252.624e+03
3	2	-8.877e+03	74.283e+03	-703.382e+03	529.003e+03
3	3	-14.939e+03	65.339e+03	-615.459e+03	774.302e+03
3	4	-21.946e+03	56.135e+03	-527.537e+03	948.056e+03
3	5	-29.936e+03	46.839e+03	-439.614e+03	1.035e+06
3	6	-38.763e+03	37.548e+03	-351.691e+03	1.039e+06
3	7	-48.392e+03	28.371e+03	-263.768e+03	949.468e+03
3	8	-58.755e+03	19.412e+03	-175.845e+03	749.513e+03
3	9	-69.779e+03	14.708e+03	-87.922e+03	434.238e+03
3	10	-81.384e+03	14.472e+03	0.000e+00	0.000e+00

Design Tandem + Lane 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	-11.394e+03	83.906e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-8.258e+03	126.299e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-11.708e+03	123.741e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	-14.472e+03	81.384e+03	0.000e+00	0.000e+00

Design Truck + Lane Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	-14.367e+03	101.931e+03	0.000e+00	0.000e+00
1	1	-14.646e+03	86.026e+03	-101.651e+03	622.614e+03
1	2	-15.819e+03	70.997e+03	-203.303e+03	1.052e+06
1	3	-27.725e+03	56.973e+03	-304.954e+03	1.300e+06
1	4	-39.927e+03	44.078e+03	-406.606e+03	1.414e+06
1	5	-53.540e+03	32.427e+03	-508.258e+03	1.393e+06
1	6	-67.118e+03	22.129e+03	-609.909e+03	1.261e+06
1	7	-80.487e+03	13.755e+03	-711.561e+03	991.720e+03
1	8	-93.469e+03	6.781e+03	-813.213e+03	611.706e+03
1	9	-105.873e+03	3.209e+03	-962.692e+03	217.821e+03
1	10	-117.504e+03	2.274e+03	-1.204e+06	160.896e+03
2	0	-7.994e+03	117.918e+03	-1.204e+06	160.896e+03
2	1	-8.207e+03	106.088e+03	-749.507e+03	245.825e+03
2	2	-11.313e+03	90.862e+03	-571.975e+03	726.934e+03
2	3	-20.753e+03	75.328e+03	-483.464e+03	1.170e+06
2	4	-32.672e+03	60.032e+03	-399.425e+03	1.435e+06
2	5	-46.236e+03	45.485e+03	-315.385e+03	1.504e+06
2	6	-60.924e+03	32.197e+03	-319.357e+03	1.415e+06
2	7	-76.243e+03	20.618e+03	-368.032e+03	1.130e+06
2	8	-91.667e+03	11.808e+03	-428.013e+03	682.182e+03
2	9	-106.646e+03	11.161e+03	-593.322e+03	242.639e+03
2	10	-120.622e+03	10.963e+03	-1.236e+06	231.796e+03
3	0	-3.815e+03	110.822e+03	-1.236e+06	231.796e+03
3	1	-3.936e+03	101.262e+03	-1.025e+06	227.420e+03
3	2	-7.388e+03	89.149e+03	-887.211e+03	554.894e+03
3	3	-13.610e+03	76.561e+03	-776.310e+03	854.724e+03
3	4	-21.796e+03	63.624e+03	-665.408e+03	1.061e+06

3	5	-31.409e+03	50.501e+03	-554.507e+03	1.153e+06
3	6	-42.577e+03	38.165e+03	-443.605e+03	1.164e+06
3	7	-54.915e+03	26.390e+03	-332.704e+03	1.068e+06
3	8	-68.250e+03	19.194e+03	-221.803e+03	864.870e+03
3	9	-82.513e+03	18.490e+03	-110.901e+03	511.596e+03
3	10	-97.557e+03	18.255e+03	0.000e+00	0.000e+00

Design Truck + Lane 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	-14.367e+03	101.931e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-10.268e+03	155.520e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-14.779e+03	153.137e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	-18.255e+03	97.557e+03	0.000e+00	0.000e+00

Dual Truck Train + Lane Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00	-731.891e+03	0.000e+00
1	9	0.000e+00	0.000e+00	-1.032e+06	0.000e+00
1	10	0.000e+00	0.000e+00	-1.573e+06	0.000e+00
2	0	0.000e+00	0.000e+00	-1.573e+06	0.000e+00
2	1	0.000e+00	0.000e+00	-901.750e+03	0.000e+00
2	2	0.000e+00	0.000e+00	-521.373e+03	0.000e+00
2	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00	-805.037e+03	0.000e+00
2	10	0.000e+00	0.000e+00	-1.452e+06	0.000e+00
3	0	0.000e+00	0.000e+00	-1.452e+06	0.000e+00
3	1	0.000e+00	0.000e+00	-1.025e+06	0.000e+00
3	2	0.000e+00	0.000e+00	-798.490e+03	0.000e+00
3	3	0.000e+00	0.000e+00	-698.679e+03	0.000e+00
3	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Dual Truck Train + Lane Controls

Dual Truck Train + Lane 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	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-9.241e+03	168.615e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-13.301e+03	161.430e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Dual Tandem Train + Lane Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00

1	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Dual Tandem Train + Lane 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	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Fatigue Truck Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00

2	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Fatigue Truck 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	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Strength I Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	-2.114e+03	210.364e+03	0.000e+00	0.000e+00
1	1	-8.969e+03	173.687e+03	-37.485e+03	1.284e+06
1	2	-23.064e+03	138.542e+03	-120.020e+03	2.169e+06
1	3	-45.665e+03	105.157e+03	-247.605e+03	2.672e+06
1	4	-73.263e+03	74.695e+03	-420.240e+03	2.880e+06
1	5	-105.929e+03	47.938e+03	-637.926e+03	2.787e+06
1	6	-138.534e+03	23.551e+03	-900.661e+03	2.439e+06
1	7	-170.774e+03	3.730e+03	-1.208e+06	1.786e+06
1	8	-202.336e+03	-13.224e+03	-1.615e+06	932.325e+03
1	9	-232.886e+03	-28.234e+03	-2.304e+06	91.626e+03
1	10	-262.084e+03	-36.666e+03	-3.619e+06	-341.630e+03
2	0	28.045e+03	264.739e+03	-3.619e+06	-341.630e+03
2	1	19.436e+03	232.600e+03	-1.961e+06	247.420e+03
2	2	4.104e+03	194.516e+03	-1.007e+06	1.267e+06
2	3	-18.988e+03	155.895e+03	-654.460e+03	2.313e+06
2	4	-48.080e+03	117.689e+03	-386.492e+03	2.946e+06
2	5	-80.053e+03	80.795e+03	-193.874e+03	3.130e+06
2	6	-116.860e+03	48.971e+03	-230.625e+03	2.933e+06
2	7	-155.106e+03	20.472e+03	-420.957e+03	2.288e+06
2	8	-193.536e+03	-1.986e+03	-706.425e+03	1.252e+06
2	9	-231.185e+03	-12.547e+03	-1.704e+06	287.354e+03
2	10	-267.081e+03	-21.127e+03	-3.297e+06	-138.810e+03
3	0	29.622e+03	244.355e+03	-3.297e+06	-138.810e+03
3	1	23.942e+03	220.032e+03	-2.267e+06	101.552e+03
3	2	9.828e+03	191.239e+03	-1.788e+06	801.222e+03
3	3	-6.246e+03	161.617e+03	-1.403e+06	1.463e+06
3	4	-23.977e+03	131.384e+03	-1.092e+06	1.957e+06
3	5	-46.004e+03	100.825e+03	-827.426e+03	2.216e+06
3	6	-71.015e+03	71.643e+03	-595.511e+03	2.289e+06
3	7	-98.841e+03	47.678e+03	-396.810e+03	2.127e+06
3	8	-129.771e+03	26.532e+03	-231.325e+03	1.731e+06
3	9	-162.325e+03	19.450e+03	-99.055e+03	1.027e+06
3	10	-196.247e+03	13.571e+03	0.000e+00	0.000e+00

Strength I Limit State Envelopes

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	-2.114e+03	210.364e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	64.711e+03	409.911e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	50.750e+03	388.912e+03	0.000e+00	0.000e+00

4	0.000e+00	0.000e+00	-13.571e+03	196.247e+03	0.000e+00	0.000e+00

Service I Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	11.220e+03	127.519e+03	0.000e+00	0.000e+00
1	1	3.866e+03	104.539e+03	54.354e+03	778.620e+03
1	2	-7.624e+03	82.435e+03	58.652e+03	1.314e+06
1	3	-23.975e+03	61.336e+03	12.895e+03	1.617e+06
1	4	-42.639e+03	41.365e+03	-82.916e+03	1.738e+06
1	5	-63.327e+03	22.639e+03	-228.785e+03	1.672e+06
1	6	-83.980e+03	5.267e+03	-424.709e+03	1.447e+06
1	7	-104.424e+03	-9.494e+03	-670.688e+03	1.032e+06
1	8	-124.481e+03	-22.619e+03	-966.723e+03	458.195e+03
1	9	-143.960e+03	-34.633e+03	-1.430e+06	-140.931e+03
1	10	-162.666e+03	-42.888e+03	-2.266e+06	-531.547e+03
2	0	38.711e+03	164.624e+03	-2.266e+06	-531.547e+03
2	1	29.348e+03	143.644e+03	-1.208e+06	-7.703e+03
2	2	16.142e+03	119.268e+03	-577.141e+03	721.769e+03
2	3	-1.497e+03	94.584e+03	-270.573e+03	1.382e+06
2	4	-22.565e+03	70.138e+03	-52.201e+03	1.783e+06
2	5	-45.280e+03	46.442e+03	82.448e+03	1.902e+06
2	6	-69.118e+03	24.003e+03	45.365e+03	1.780e+06
2	7	-93.587e+03	3.274e+03	-120.144e+03	1.378e+06
2	8	-118.161e+03	-14.003e+03	-380.681e+03	729.514e+03
2	9	-142.289e+03	-24.482e+03	-1.041e+06	49.114e+03
2	10	-165.416e+03	-33.830e+03	-2.057e+06	-373.152e+03
3	0	36.517e+03	151.155e+03	-2.057e+06	-373.152e+03
3	1	30.321e+03	135.520e+03	-1.403e+06	-125.754e+03
3	2	19.305e+03	117.332e+03	-1.075e+06	366.180e+03
3	3	7.168e+03	98.669e+03	-812.265e+03	818.769e+03
3	4	-5.913e+03	79.657e+03	-585.510e+03	1.141e+06
3	5	-21.451e+03	60.459e+03	-395.661e+03	1.312e+06
3	6	-38.694e+03	42.048e+03	-242.718e+03	1.365e+06
3	7	-57.107e+03	26.179e+03	-126.680e+03	1.274e+06
3	8	-76.517e+03	11.145e+03	-47.547e+03	1.039e+06
3	9	-96.855e+03	4.148e+03	-5.321e+03	617.177e+03
3	10	-117.974e+03	-2.161e+03	0.000e+00	0.000e+00

Service I Limit State Envelopes

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	11.220e+03	127.519e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	81.599e+03	260.483e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	70.347e+03	246.557e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	2.161e+03	117.974e+03	0.000e+00	0.000e+00

Service II Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	6.909e+03	158.098e+03	0.000e+00	0.000e+00
1	1	-527.412e+00	130.347e+03	23.858e+03	965.404e+03
1	2	-13.342e+03	103.734e+03	-2.338e+03	1.630e+06
1	3	-32.477e+03	78.428e+03	-78.590e+03	2.007e+06
1	4	-54.617e+03	54.589e+03	-204.898e+03	2.162e+06
1	5	-79.389e+03	32.367e+03	-381.262e+03	2.090e+06
1	6	-104.116e+03	11.906e+03	-607.682e+03	1.825e+06
1	7	-128.571e+03	-5.161e+03	-884.157e+03	1.330e+06
1	8	-152.522e+03	-20.102e+03	-1.210e+06	641.707e+03
1	9	-175.722e+03	-33.597e+03	-1.740e+06	-63.826e+03
1	10	-197.917e+03	-42.205e+03	-2.738e+06	-483.278e+03
2	0	36.313e+03	199.999e+03	-2.738e+06	-483.278e+03
2	1	26.885e+03	175.471e+03	-1.479e+06	82.067e+03
2	2	12.463e+03	146.527e+03	-748.733e+03	939.849e+03
2	3	-7.723e+03	117.183e+03	-415.613e+03	1.733e+06

2	4	-32.367e+03	88.148e+03	-172.028e+03	2.213e+06
2	5	-59.151e+03	60.088e+03	-12.167e+03	2.353e+06
2	6	-87.395e+03	33.663e+03	-50.442e+03	2.205e+06
2	7	-116.460e+03	9.459e+03	-230.554e+03	1.717e+06
2	8	-145.662e+03	-10.256e+03	-509.086e+03	934.169e+03
2	9	-174.283e+03	-21.134e+03	-1.283e+06	134.932e+03
2	10	-201.602e+03	-30.540e+03	-2.493e+06	-303.613e+03
3	0	35.372e+03	184.402e+03	-2.493e+06	-303.613e+03
3	1	29.139e+03	165.899e+03	-1.711e+06	-49.966e+03
3	2	16.641e+03	144.076e+03	-1.342e+06	532.648e+03
3	3	2.687e+03	121.638e+03	-1.045e+06	1.075e+06
3	4	-12.497e+03	98.744e+03	-785.133e+03	1.460e+06
3	5	-30.874e+03	75.609e+03	-562.013e+03	1.658e+06
3	6	-51.467e+03	53.498e+03	-375.799e+03	1.715e+06
3	7	-73.581e+03	34.691e+03	-226.491e+03	1.594e+06
3	8	-96.992e+03	16.969e+03	-114.088e+03	1.298e+06
3	9	-121.609e+03	9.695e+03	-38.591e+03	770.656e+03
3	10	-147.241e+03	3.315e+03	0.000e+00	0.000e+00

Service II Limit State Envelopes

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	6.909e+03	158.098e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	78.519e+03	311.067e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	65.913e+03	294.986e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	-3.315e+03	147.241e+03	0.000e+00	0.000e+00

Service III Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	14.093e+03	107.132e+03	0.000e+00	0.000e+00
1	1	6.795e+03	87.333e+03	74.684e+03	654.097e+03
1	2	-3.811e+03	68.235e+03	99.313e+03	1.104e+06
1	3	-18.307e+03	49.941e+03	73.886e+03	1.357e+06
1	4	-34.654e+03	32.550e+03	-1.595e+03	1.455e+06
1	5	-52.619e+03	16.154e+03	-127.133e+03	1.394e+06
1	6	-70.556e+03	841.625e+00	-302.727e+03	1.194e+06
1	7	-88.327e+03	-12.383e+03	-528.376e+03	834.249e+03
1	8	-105.787e+03	-24.298e+03	-804.081e+03	335.854e+03
1	9	-122.785e+03	-35.324e+03	-1.224e+06	-192.335e+03
1	10	-139.165e+03	-43.342e+03	-1.951e+06	-563.727e+03
2	0	40.310e+03	141.040e+03	-1.951e+06	-563.727e+03
2	1	30.989e+03	122.426e+03	-1.028e+06	-67.551e+03
2	2	18.595e+03	101.096e+03	-462.745e+03	576.382e+03
2	3	2.653e+03	79.519e+03	-173.880e+03	1.148e+06
2	4	-16.031e+03	58.132e+03	27.683e+03	1.495e+06
2	5	-36.032e+03	37.345e+03	145.525e+03	1.601e+06
2	6	-56.933e+03	17.564e+03	109.236e+03	1.497e+06
2	7	-78.338e+03	-849.258e+00	-46.537e+03	1.152e+06
2	8	-99.828e+03	-16.501e+03	-295.079e+03	593.077e+03
2	9	-120.960e+03	-26.714e+03	-880.976e+03	-8.098e+03
2	10	-141.291e+03	-36.022e+03	-1.766e+06	-419.511e+03
3	0	37.280e+03	128.991e+03	-1.766e+06	-419.511e+03
3	1	31.108e+03	115.268e+03	-1.198e+06	-176.279e+03
3	2	21.080e+03	99.502e+03	-898.483e+03	255.201e+03
3	3	10.156e+03	83.357e+03	-657.003e+03	647.824e+03
3	4	-1.524e+03	66.932e+03	-452.429e+03	929.248e+03
3	5	-15.169e+03	50.359e+03	-284.760e+03	1.081e+06
3	6	-30.178e+03	34.415e+03	-153.996e+03	1.132e+06
3	7	-46.124e+03	20.505e+03	-60.139e+03	1.060e+06
3	8	-62.867e+03	7.263e+03	-3.187e+03	866.151e+03
3	9	-80.352e+03	450.586e+00	16.859e+03	514.858e+03
3	10	-98.463e+03	-5.812e+03	0.000e+00	0.000e+00

Service III Limit State Envelopes

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	14.093e+03	107.132e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	83.653e+03	226.760e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	73.303e+03	214.271e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	5.812e+03	98.463e+03	0.000e+00	0.000e+00

Fatigue Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Fatigue Limit State Envelopes

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

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

QConBridge
Run 2 Output

Dual Truck Axle Rxn = 85.662 No Impact
No Lane

Code: LRFD First Edition 1994

Span Data

Span 1 Length: 70.750 ft

Section Properties

Location (ft)	Ax (in^2)	Iz (in^4)	Mod. E (psi)	Unit Wgt (pcf)
0.000	1.000e+00	999.999e-03	1.000e+03	999.997e-03

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: 91.500 ft

Section Properties

Location (ft)	Ax (in^2)	Iz (in^4)	Mod. E (psi)	Unit Wgt (pcf)
0.000	1.000e+00	999.999e-03	1.000e+03	999.997e-03

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: 60.750 ft

Section Properties

Location (ft)	Ax (in^2)	Iz (in^4)	Mod. E (psi)	Unit Wgt (pcf)
0.000	1.000e+00	999.999e-03	1.000e+03	999.997e-03

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 Roller

Support 2 Pinned

Support 3 Pinned

Support 4 Roller

Loading Data

DC Loads
   Self Weight Generation Disabled
   Traffic Barrier Load 1.000e+03 plf

DW Loads
   Utility Load Disabled
   Wearing Surface Load Disabled

Live Load Data

Live Load Generation Parameters
   Design Tandem : Enabled
   Design Truck : 17 rear axle spacing increments
   Dual Truck Train : Headway Spacing varies from 50.000 ft to 223.000 ft using 173 increments
   Dual Tandem Train: Disabled
   Fatigue Truck : Disabled

Live Load Impact
   Truck Loads 0.000%
   Lane Loads -100.000% ← Impact
   Fatigue Truck 15.000%

   Pedestrian Live Load 0.000e+00 plf

Load Factors

Strength I	DC min	0.900	DC max	1.250	DW min	0.650	DW max	1.500	LL	1.750
Service I	DC	1.000	DW	1.000	LL	1.000				
Service II	DC	1.000	DW	1.000	LL	1.300				
Service III	DC	1.000	DW	1.000	LL	0.800				
Fatigue	DC	0.000	DW	0.000	LL	0.750				

Analysis Results

DC Dead Load

Span	Point	Shear(lbs)	Moment(ft-lbs)
1	0	25.587e+03	0.000e+00
1	1	18.512e+03	156.005e+03
1	2	11.437e+03	261.956e+03
1	3	4.362e+03	317.850e+03
1	4	-2.712e+03	323.689e+03
1	5	-9.787e+03	279.473e+03
1	6	-16.862e+03	185.200e+03
1	7	-23.937e+03	40.872e+03
1	8	-31.012e+03	-153.510e+03
1	9	-38.087e+03	-397.949e+03
1	10	-45.162e+03	-692.444e+03
2	0	46.706e+03	-692.444e+03
2	1	37.556e+03	-306.943e+03
2	2	28.406e+03	-5.165e+03

2	3	19.256e+03	212.890e+03
2	4	10.106e+03	347.223e+03
2	5	956.236e+00	397.834e+03
2	6	-8.193e+03	364.722e+03
2	7	-17.343e+03	247.888e+03
2	8	-26.493e+03	47.331e+03
2	9	-35.643e+03	-236.947e+03
2	10	-44.793e+03	-604.948e+03
3	0	40.333e+03	-604.948e+03
3	1	34.258e+03	-378.378e+03
3	2	28.183e+03	-188.714e+03
3	3	22.108e+03	-35.955e+03
3	4	16.033e+03	79.898e+03
3	5	9.958e+03	158.845e+03
3	6	3.883e+03	200.887e+03
3	7	-2.191e+03	206.024e+03
3	8	-8.266e+03	174.255e+03
3	9	-14.341e+03	105.580e+03
3	10	-20.416e+03	0.000e+00

DC Dead Load

Pier	Fx(lbs)	Fy(lbs)	Mz(ft-lbs)
1	0.000e+00	25.587e+03	0.000e+00
2	0.000e+00	91.868e+03	0.000e+00
3	0.000e+00	85.126e+03	0.000e+00
4	0.000e+00	20.416e+03	0.000e+00

DW Dead Load

Span	Point	Shear(lbs)	Moment(ft-lbs)
1	0	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00
1	2	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00
1	9	0.000e+00	0.000e+00
1	10	0.000e+00	0.000e+00
2	0	0.000e+00	0.000e+00
2	1	0.000e+00	0.000e+00
2	2	0.000e+00	0.000e+00
2	3	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00
2	10	0.000e+00	0.000e+00
3	0	0.000e+00	0.000e+00
3	1	0.000e+00	0.000e+00
3	2	0.000e+00	0.000e+00
3	3	0.000e+00	0.000e+00
3	4	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00

DW Dead Load

Pier	Fx(lbs)	Fy(lbs)	Mz(ft-lbs)
1	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00

Live Load Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	-7.778e+03	61.310e+03	0.000e+00	0.000e+00
1	1	-7.778e+03	52.531e+03	-55.033e+03	371.663e+03
1	2	-10.472e+03	43.995e+03	-110.066e+03	622.542e+03
1	3	-16.412e+03	35.806e+03	-165.100e+03	759.993e+03
1	4	-23.693e+03	28.068e+03	-220.133e+03	821.639e+03
1	5	-32.115e+03	20.885e+03	-275.167e+03	805.080e+03
1	6	-40.154e+03	14.361e+03	-330.200e+03	729.700e+03
1	7	-47.703e+03	9.469e+03	-385.234e+03	574.036e+03
1	8	-54.660e+03	5.505e+03	-440.267e+03	359.727e+03
1	9	-60.919e+03	2.115e+03	-570.770e+03	152.485e+03
1	10	-66.375e+03	1.329e+03	-863.315e+03	94.052e+03
2	0	-4.673e+03	64.950e+03	-863.315e+03	94.052e+03
2	1	-4.673e+03	60.279e+03	-514.137e+03	186.812e+03
2	2	-7.199e+03	52.692e+03	-324.435e+03	440.312e+03
2	3	-12.624e+03	44.438e+03	-267.411e+03	678.592e+03
2	4	-20.140e+03	35.876e+03	-210.386e+03	820.243e+03
2	5	-28.377e+03	27.361e+03	-153.361e+03	853.929e+03
2	6	-36.933e+03	19.267e+03	-162.510e+03	809.383e+03
2	7	-45.453e+03	11.946e+03	-205.271e+03	656.943e+03
2	8	-53.575e+03	6.744e+03	-248.031e+03	413.707e+03
2	9	-60.940e+03	6.232e+03	-465.507e+03	170.608e+03
2	10	-67.213e+03	6.232e+03	-795.284e+03	131.761e+03
3	0	-2.168e+03	63.343e+03	-795.284e+03	131.761e+03
3	1	-2.168e+03	58.975e+03	-562.807e+03	137.535e+03
3	2	-5.592e+03	52.486e+03	-479.664e+03	318.116e+03
3	3	-9.627e+03	45.410e+03	-419.706e+03	494.050e+03
3	4	-14.113e+03	37.811e+03	-359.748e+03	617.842e+03
3	5	-20.159e+03	29.786e+03	-299.790e+03	672.543e+03
3	6	-27.180e+03	22.046e+03	-239.832e+03	684.799e+03
3	7	-34.758e+03	15.894e+03	-179.874e+03	633.478e+03
3	8	-42.749e+03	10.034e+03	-119.916e+03	519.406e+03
3	9	-51.091e+03	9.869e+03	-59.958e+03	310.382e+03
3	10	-59.669e+03	9.869e+03	0.000e+00	0.000e+00

Not interested in the overall envelope.

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	-7.778e+03	61.310e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-6.002e+03	85.662e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-8.401e+03	82.260e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	-9.869e+03	59.669e+03	0.000e+00	0.000e+00

Design Tandem + Lane Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	-5.543e+03	47.757e+03	0.000e+00	0.000e+00
1	1	-5.543e+03	41.664e+03	-39.217e+03	294.778e+03
1	2	-10.472e+03	35.662e+03	-78.435e+03	504.627e+03
1	3	-16.412e+03	29.821e+03	-117.653e+03	632.964e+03
1	4	-22.159e+03	24.212e+03	-156.870e+03	685.207e+03
1	5	-27.643e+03	18.905e+03	-196.088e+03	674.342e+03
1	6	-32.793e+03	13.971e+03	-235.306e+03	610.058e+03
1	7	-37.538e+03	9.469e+03	-274.524e+03	492.929e+03

1	8	-41.824e+03	5.505e+03	-313.741e+03	334.677e+03
1	9	-45.534e+03	2.115e+03	-352.959e+03	152.485e+03
1	10	-48.642e+03	994.701e+00	-392.177e+03	70.375e+03
2	0	-3.496e+03	46.618e+03	-392.177e+03	70.375e+03
2	1	-3.496e+03	44.858e+03	-276.636e+03	186.812e+03
2	2	-7.199e+03	40.145e+03	-235.282e+03	399.995e+03
2	3	-12.311e+03	34.780e+03	-193.927e+03	568.964e+03
2	4	-17.937e+03	29.012e+03	-152.573e+03	673.478e+03
2	5	-23.827e+03	23.083e+03	-111.218e+03	703.322e+03
2	6	-29.739e+03	17.236e+03	-121.599e+03	665.101e+03
2	7	-35.430e+03	11.715e+03	-153.594e+03	553.581e+03
2	8	-40.656e+03	6.744e+03	-185.590e+03	381.803e+03
2	9	-45.188e+03	4.519e+03	-217.586e+03	170.608e+03
2	10	-48.737e+03	4.519e+03	-426.808e+03	95.554e+03
3	0	-1.572e+03	47.360e+03	-426.808e+03	95.554e+03
3	1	-2.097e+03	45.161e+03	-384.127e+03	137.535e+03
3	2	-5.592e+03	41.309e+03	-341.446e+03	298.650e+03
3	3	-9.627e+03	36.972e+03	-298.765e+03	433.582e+03
3	4	-14.113e+03	32.180e+03	-256.085e+03	532.404e+03
3	5	-19.052e+03	27.032e+03	-213.404e+03	583.803e+03
3	6	-24.313e+03	21.582e+03	-170.723e+03	590.821e+03
3	7	-29.854e+03	15.894e+03	-128.042e+03	544.103e+03
3	8	-35.610e+03	10.034e+03	-85.361e+03	432.672e+03
3	9	-41.517e+03	7.025e+03	-42.680e+03	252.218e+03
3	10	-47.509e+03	7.025e+03	0.000e+00	0.000e+00

Design Tandem + Lane 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	-5.543e+03	47.757e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-4.491e+03	49.278e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-6.092e+03	49.576e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	-7.025e+03	47.509e+03	0.000e+00	0.000e+00

Design Truck + Lane Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	-7.778e+03	61.310e+03	0.000e+00	0.000e+00
1	1	-7.778e+03	52.531e+03	-55.033e+03	371.663e+03
1	2	-8.034e+03	43.995e+03	-110.066e+03	622.542e+03
1	3	-15.951e+03	35.806e+03	-165.100e+03	759.993e+03
1	4	-23.693e+03	28.068e+03	-220.133e+03	821.639e+03
1	5	-32.115e+03	20.885e+03	-275.167e+03	805.080e+03
1	6	-40.154e+03	14.361e+03	-330.200e+03	729.700e+03
1	7	-47.703e+03	8.953e+03	-385.234e+03	574.036e+03
1	8	-54.660e+03	4.294e+03	-440.267e+03	359.727e+03
1	9	-60.919e+03	1.931e+03	-495.301e+03	123.014e+03
1	10	-66.375e+03	1.329e+03	-550.334e+03	94.052e+03
2	0	-4.673e+03	64.950e+03	-550.334e+03	94.052e+03
2	1	-4.673e+03	60.279e+03	-381.460e+03	146.651e+03
2	2	-6.484e+03	52.692e+03	-324.435e+03	440.312e+03
2	3	-12.624e+03	44.438e+03	-267.411e+03	678.592e+03
2	4	-20.140e+03	35.876e+03	-210.386e+03	820.243e+03
2	5	-28.377e+03	27.361e+03	-153.361e+03	853.929e+03
2	6	-36.933e+03	19.267e+03	-162.510e+03	809.383e+03
2	7	-45.453e+03	11.946e+03	-205.271e+03	656.943e+03
2	8	-53.575e+03	6.232e+03	-248.031e+03	413.707e+03
2	9	-60.940e+03	6.232e+03	-290.792e+03	137.961e+03
2	10	-67.213e+03	6.232e+03	-599.580e+03	131.761e+03
3	0	-2.168e+03	63.343e+03	-599.580e+03	131.761e+03
3	1	-2.168e+03	58.975e+03	-539.622e+03	118.585e+03
3	2	-4.473e+03	52.486e+03	-479.664e+03	318.116e+03
3	3	-8.628e+03	45.410e+03	-419.706e+03	494.050e+03
3	4	-14.000e+03	37.811e+03	-359.748e+03	617.842e+03

3	5	-20.159e+03	29.786e+03	-299.790e+03	672.543e+03
3	6	-27.180e+03	22.046e+03	-239.832e+03	684.799e+03
3	7	-34.758e+03	14.405e+03	-179.874e+03	633.478e+03
3	8	-42.749e+03	9.869e+03	-119.916e+03	519.406e+03
3	9	-51.091e+03	9.869e+03	-59.958e+03	310.382e+03
3	10	-59.669e+03	9.869e+03	0.000e+00	0.000e+00

Design Truck + Lane 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	-7.778e+03	61.310e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-6.002e+03	71.249e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-8.401e+03	71.679e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	-9.869e+03	59.669e+03	0.000e+00	0.000e+00

Dual Truck Train + Lane Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00	-396.240e+03	0.000e+00
1	9	0.000e+00	0.000e+00	-570.770e+03	0.000e+00
1	10	0.000e+00	0.000e+00	-863.315e+03	0.000e+00
2	0	0.000e+00	0.000e+00	-863.315e+03	0.000e+00
2	1	0.000e+00	0.000e+00	-514.137e+03	0.000e+00
2	2	0.000e+00	0.000e+00	-296.951e+03	0.000e+00
2	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00	-465.507e+03	0.000e+00
2	10	0.000e+00	0.000e+00	-795.284e+03	0.000e+00
3	0	0.000e+00	0.000e+00	-795.284e+03	0.000e+00
3	1	0.000e+00	0.000e+00	-562.807e+03	0.000e+00
3	2	0.000e+00	0.000e+00	-431.697e+03	0.000e+00
3	3	0.000e+00	0.000e+00	-377.735e+03	0.000e+00
3	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Dual Truck Axle Rxn – No Impact and No Lane

Dual Truck Train + Lane 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	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-5.402e+03	85.662e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-7.561e+03	82.260e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Dual Tandem Train + Lane Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00

1	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Dual Tandem Train + Lane 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	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Fatigue Truck Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00

2	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Fatigue Truck 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	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Strength I Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	9.416e+03	139.277e+03	0.000e+00	0.000e+00
1	1	3.049e+03	115.071e+03	44.096e+03	845.418e+03
1	2	-8.033e+03	91.290e+03	43.143e+03	1.416e+06
1	3	-24.794e+03	68.114e+03	-2.859e+03	1.727e+06
1	4	-44.853e+03	46.678e+03	-93.913e+03	1.842e+06
1	5	-68.436e+03	27.740e+03	-230.016e+03	1.758e+06
1	6	-91.347e+03	9.957e+03	-411.170e+03	1.508e+06
1	7	-113.403e+03	-4.972e+03	-637.374e+03	1.055e+06
1	8	-134.420e+03	-18.275e+03	-962.356e+03	491.364e+03
1	9	-154.218e+03	-30.576e+03	-1.496e+06	-91.305e+03
1	10	-172.609e+03	-38.319e+03	-2.376e+06	-458.608e+03
2	0	33.857e+03	172.045e+03	-2.376e+06	-458.608e+03
2	1	25.622e+03	152.434e+03	-1.283e+06	50.673e+03
2	2	12.966e+03	127.719e+03	-574.219e+03	765.897e+03
2	3	-4.763e+03	101.838e+03	-276.368e+03	1.453e+06
2	4	-26.150e+03	75.417e+03	-55.675e+03	1.869e+06
2	5	-48.799e+03	49.077e+03	89.667e+03	1.991e+06
2	6	-74.876e+03	26.342e+03	43.856e+03	1.872e+06
2	7	-101.223e+03	5.296e+03	-136.125e+03	1.459e+06
2	8	-126.874e+03	-12.041e+03	-391.457e+03	783.152e+03
2	9	-151.200e+03	-21.173e+03	-1.110e+06	85.313e+03
2	10	-173.615e+03	-29.408e+03	-2.147e+06	-313.871e+03
3	0	32.504e+03	161.267e+03	-2.147e+06	-313.871e+03
3	1	27.036e+03	146.029e+03	-1.457e+06	-99.853e+03
3	2	15.577e+03	127.080e+03	-1.075e+06	386.861e+03
3	3	3.049e+03	107.103e+03	-779.429e+03	832.228e+03
3	4	-10.269e+03	86.211e+03	-557.650e+03	1.181e+06
3	5	-26.317e+03	64.573e+03	-381.671e+03	1.375e+06
3	6	-44.071e+03	43.435e+03	-238.907e+03	1.449e+06
3	7	-63.567e+03	25.843e+03	-129.357e+03	1.366e+06
3	8	-85.145e+03	10.119e+03	-53.023e+03	1.126e+06
3	9	-107.338e+03	4.364e+03	-9.904e+03	675.144e+03
3	10	-129.942e+03	-1.103e+03	0.000e+00	0.000e+00

Strength I Limit State Envelopes

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	9.416e+03	139.277e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	72.176e+03	264.745e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	61.912e+03	250.364e+03	0.000e+00	0.000e+00

4	0.000e+00	0.000e+00	1.103e+03	129.942e+03	0.000e+00	0.000e+00

Service I Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	17.809e+03	86.897e+03	0.000e+00	0.000e+00
1	1	10.734e+03	71.044e+03	100.972e+03	527.669e+03
1	2	965.105e+00	55.433e+03	151.889e+03	884.498e+03
1	3	-12.049e+03	40.169e+03	152.750e+03	1.077e+06
1	4	-26.405e+03	25.355e+03	103.555e+03	1.145e+06
1	5	-41.903e+03	11.098e+03	4.305e+03	1.084e+06
1	6	-57.016e+03	-2.500e+03	-144.999e+03	914.901e+03
1	7	-71.640e+03	-14.467e+03	-344.361e+03	614.908e+03
1	8	-85.672e+03	-25.506e+03	-593.778e+03	206.217e+03
1	9	-99.006e+03	-35.971e+03	-968.720e+03	-245.464e+03
1	10	-111.537e+03	-43.832e+03	-1.555e+06	-598.391e+03
2	0	42.032e+03	111.656e+03	-1.555e+06	-598.391e+03
2	1	32.882e+03	97.835e+03	-821.080e+03	-120.131e+03
2	2	21.206e+03	81.098e+03	-329.601e+03	435.146e+03
2	3	6.631e+03	63.695e+03	-54.520e+03	891.482e+03
2	4	-10.034e+03	45.982e+03	136.837e+03	1.167e+06
2	5	-27.420e+03	28.317e+03	244.472e+03	1.251e+06
2	6	-45.127e+03	11.073e+03	202.212e+03	1.174e+06
2	7	-62.797e+03	-5.397e+03	42.617e+03	904.832e+03
2	8	-80.069e+03	-19.749e+03	-200.699e+03	461.039e+03
2	9	-96.584e+03	-29.411e+03	-702.455e+03	-66.338e+03
2	10	-112.007e+03	-38.561e+03	-1.400e+06	-473.187e+03
3	0	38.164e+03	103.676e+03	-1.400e+06	-473.187e+03
3	1	32.089e+03	93.233e+03	-941.186e+03	-240.842e+03
3	2	22.590e+03	80.669e+03	-668.378e+03	129.402e+03
3	3	12.480e+03	67.518e+03	-455.661e+03	458.094e+03
3	4	1.919e+03	53.844e+03	-279.850e+03	697.740e+03
3	5	-10.201e+03	39.744e+03	-140.944e+03	831.388e+03
3	6	-23.297e+03	25.929e+03	-38.944e+03	885.687e+03
3	7	-36.950e+03	13.702e+03	26.150e+03	839.503e+03
3	8	-51.016e+03	1.767e+03	54.339e+03	693.662e+03
3	9	-65.433e+03	-4.472e+03	45.622e+03	415.962e+03
3	10	-80.086e+03	-10.547e+03	0.000e+00	0.000e+00

Service I Limit State Envelopes

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	17.809e+03	86.897e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	85.865e+03	177.531e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	76.725e+03	167.387e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	10.547e+03	80.086e+03	0.000e+00	0.000e+00

Service II Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	15.475e+03	105.291e+03	0.000e+00	0.000e+00
1	1	8.400e+03	86.804e+03	84.462e+03	639.168e+03
1	2	-2.176e+03	68.632e+03	118.869e+03	1.071e+06
1	3	-16.972e+03	50.911e+03	103.220e+03	1.305e+06
1	4	-33.513e+03	33.776e+03	37.515e+03	1.391e+06
1	5	-51.537e+03	17.363e+03	-78.244e+03	1.326e+06
1	6	-69.062e+03	1.808e+03	-244.060e+03	1.133e+06
1	7	-85.952e+03	-11.627e+03	-459.931e+03	787.119e+03
1	8	-102.070e+03	-23.854e+03	-725.858e+03	314.135e+03
1	9	-117.282e+03	-35.336e+03	-1.139e+06	-199.719e+03
1	10	-131.449e+03	-43.434e+03	-1.814e+06	-570.176e+03
2	0	40.630e+03	131.141e+03	-1.814e+06	-570.176e+03
2	1	31.480e+03	115.919e+03	-975.322e+03	-64.087e+03
2	2	19.046e+03	96.906e+03	-426.932e+03	567.240e+03
2	3	2.843e+03	77.026e+03	-134.744e+03	1.095e+06

2	4	-16.076e+03	56.745e+03	73.721e+03	1.413e+06
2	5	-35.934e+03	36.525e+03	198.464e+03	1.507e+06
2	6	-56.207e+03	16.853e+03	153.458e+03	1.416e+06
2	7	-76.433e+03	-1.813e+03	-18.964e+03	1.101e+06
2	8	-96.142e+03	-17.726e+03	-275.109e+03	585.151e+03
2	9	-114.866e+03	-27.541e+03	-842.107e+03	-15.155e+03
2	10	-132.171e+03	-36.691e+03	-1.638e+06	-433.658e+03
3	0	37.513e+03	122.679e+03	-1.638e+06	-433.658e+03
3	1	31.438e+03	110.925e+03	-1.110e+06	-199.582e+03
3	2	20.912e+03	96.416e+03	-812.277e+03	224.837e+03
3	3	9.592e+03	81.141e+03	-581.573e+03	606.309e+03
3	4	-2.314e+03	65.188e+03	-387.774e+03	883.093e+03
3	5	-16.249e+03	48.680e+03	-230.881e+03	1.033e+06
3	6	-31.451e+03	32.543e+03	-110.893e+03	1.091e+06
3	7	-47.378e+03	18.471e+03	-27.811e+03	1.029e+06
3	8	-63.841e+03	4.777e+03	18.364e+03	849.484e+03
3	9	-80.761e+03	-1.511e+03	27.634e+03	509.077e+03
3	10	-97.987e+03	-7.586e+03	0.000e+00	0.000e+00

Service II Limit State Envelopes

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	15.475e+03	105.291e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	84.064e+03	203.230e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	74.205e+03	192.065e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	7.586e+03	97.987e+03	0.000e+00	0.000e+00

Service III Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	19.364e+03	74.635e+03	0.000e+00	0.000e+00
1	1	12.289e+03	60.538e+03	111.979e+03	453.336e+03
1	2	3.059e+03	46.634e+03	173.902e+03	759.990e+03
1	3	-8.766e+03	33.008e+03	185.770e+03	925.845e+03
1	4	-21.666e+03	19.742e+03	147.582e+03	981.001e+03
1	5	-35.479e+03	6.920e+03	59.339e+03	923.537e+03
1	6	-48.985e+03	-5.372e+03	-78.959e+03	768.961e+03
1	7	-62.100e+03	-16.361e+03	-267.314e+03	500.101e+03
1	8	-74.740e+03	-26.607e+03	-505.724e+03	134.271e+03
1	9	-86.822e+03	-36.394e+03	-854.566e+03	-275.961e+03
1	10	-98.262e+03	-44.098e+03	-1.383e+06	-617.202e+03
2	0	42.967e+03	98.666e+03	-1.383e+06	-617.202e+03
2	1	33.817e+03	85.779e+03	-718.253e+03	-157.493e+03
2	2	22.646e+03	70.560e+03	-264.714e+03	347.084e+03
2	3	9.156e+03	54.807e+03	-1.038e+03	755.764e+03
2	4	-6.006e+03	38.807e+03	178.914e+03	1.003e+06
2	5	-21.745e+03	22.845e+03	275.145e+03	1.080e+06
2	6	-37.740e+03	7.219e+03	234.714e+03	1.012e+06
2	7	-53.706e+03	-7.786e+03	83.671e+03	773.443e+03
2	8	-69.354e+03	-21.098e+03	-151.093e+03	378.297e+03
2	9	-84.396e+03	-30.658e+03	-609.353e+03	-100.460e+03
2	10	-98.564e+03	-39.808e+03	-1.241e+06	-499.539e+03
3	0	38.597e+03	91.007e+03	-1.241e+06	-499.539e+03
3	1	32.522e+03	81.438e+03	-828.624e+03	-268.350e+03
3	2	23.708e+03	70.172e+03	-572.445e+03	65.779e+03
3	3	14.406e+03	58.436e+03	-371.720e+03	359.284e+03
3	4	4.741e+03	46.282e+03	-207.900e+03	574.171e+03
3	5	-6.169e+03	33.787e+03	-80.986e+03	696.880e+03
3	6	-17.861e+03	21.520e+03	9.022e+03	748.727e+03
3	7	-29.999e+03	10.523e+03	62.125e+03	712.807e+03
3	8	-42.466e+03	-239.789e+00	78.322e+03	589.780e+03
3	9	-55.215e+03	-6.446e+03	57.614e+03	353.886e+03
3	10	-68.152e+03	-12.521e+03	0.000e+00	0.000e+00

Service III Limit State Envelopes

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	19.364e+03	74.635e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	87.066e+03	160.398e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	78.405e+03	150.935e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	12.521e+03	68.152e+03	0.000e+00	0.000e+00

Fatigue Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Fatigue Limit State Envelopes

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

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

QConBridge
Run 3 Output

Dual Lane Axle Rxn = 54.683 k   No Impact
No Truck

Code: LRFD First Edition 1994

Span Data

Span 1 Length: 70.750 ft

Section Properties

Location (ft)	Ax (in^2)	Iz (in^4)	Mod. E (psi)	Unit Wgt (pcf)
0.000	1.000e+00	999.999e-03	1.000e+03	999.997e-03

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: 91.500 ft

Section Properties

Location (ft)	Ax (in^2)	Iz (in^4)	Mod. E (psi)	Unit Wgt (pcf)
0.000	1.000e+00	999.999e-03	1.000e+03	999.997e-03

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: 60.750 ft

Section Properties

Location (ft)	Ax (in^2)	Iz (in^4)	Mod. E (psi)	Unit Wgt (pcf)
0.000	1.000e+00	999.999e-03	1.000e+03	999.997e-03

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 Roller

Support 2 Pinned

Support 3 Pinned

Support 4 Roller

Loading Data

DC Loads
   Self Weight Generation Disabled
   Traffic Barrier Load 1.000e+03 plf

DW Loads
   Utility Load Disabled
   Wearing Surface Load Disabled

Live Load Data

Live Load Generation Parameters
   Design Tandem : Enabled
   Design Truck : 17 rear axle spacing increments
   Dual Truck Train : Headway Spacing varies from 50.000 ft to 223.000 ft using 173 increments
   Dual Tandem Train: Disabled
   Fatigue Truck : Disabled

Live Load Impact
   Truck Loads -100.000%
   Lane Loads 0.000%
   Fatigue Truck 15.000%

Impact

   Pedestrian Live Load 0.000e+00 plf

Load Factors

Strength I	DC min	0.900	DC max	1.250	DW min	0.650	DW max	1.500	LL 1.750
Service I	DC	1.000	DW	1.000	LL	1.000			
Service II	DC	1.000	DW	1.000	LL	1.300			
Service III	DC	1.000	DW	1.000	LL	0.800			
Fatigue	DC	0.000	DW	0.000	LL	0.750			

Analysis Results

DC Dead Load

Span	Point	Shear(lbs)	Moment(ft-lbs)
1	0	25.587e+03	0.000e+00
1	1	18.512e+03	156.005e+03
1	2	11.437e+03	261.956e+03
1	3	4.362e+03	317.850e+03
1	4	-2.712e+03	323.689e+03
1	5	-9.787e+03	279.473e+03
1	6	-16.862e+03	185.200e+03
1	7	-23.937e+03	40.872e+03
1	8	-31.012e+03	-153.510e+03
1	9	-38.087e+03	-397.949e+03
1	10	-45.162e+03	-692.444e+03
2	0	46.706e+03	-692.444e+03
2	1	37.556e+03	-306.943e+03
2	2	28.406e+03	-5.165e+03

2	3	19.256e+03	212.890e+03
2	4	10.106e+03	347.223e+03
2	5	956.236e+00	397.834e+03
2	6	-8.193e+03	364.722e+03
2	7	-17.343e+03	247.888e+03
2	8	-26.493e+03	47.331e+03
2	9	-35.643e+03	-236.947e+03
2	10	-44.793e+03	-604.948e+03
3	0	40.333e+03	-604.948e+03
3	1	34.258e+03	-378.378e+03
3	2	28.183e+03	-188.714e+03
3	3	22.108e+03	-35.955e+03
3	4	16.033e+03	79.898e+03
3	5	9.958e+03	158.845e+03
3	6	3.883e+03	200.887e+03
3	7	-2.191e+03	206.024e+03
3	8	-8.266e+03	174.255e+03
3	9	-14.341e+03	105.580e+03
3	10	-20.416e+03	0.000e+00

DC Dead Load

Pier	Fx(lbs)	Fy(lbs)	Mz(ft-lbs)
1	0.000e+00	25.587e+03	0.000e+00
2	0.000e+00	91.868e+03	0.000e+00
3	0.000e+00	85.126e+03	0.000e+00
4	0.000e+00	20.416e+03	0.000e+00

DW Dead Load

Span	Point	Shear(lbs)	Moment(ft-lbs)
1	0	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00
1	2	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00
1	9	0.000e+00	0.000e+00
1	10	0.000e+00	0.000e+00
2	0	0.000e+00	0.000e+00
2	1	0.000e+00	0.000e+00
2	2	0.000e+00	0.000e+00
2	3	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00
2	10	0.000e+00	0.000e+00
3	0	0.000e+00	0.000e+00
3	1	0.000e+00	0.000e+00
3	2	0.000e+00	0.000e+00
3	3	0.000e+00	0.000e+00
3	4	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00

DW Dead Load

Pier	Fx(lbs)	Fy(lbs)	Mz(ft-lbs)
1	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00

Live Load Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	-4.022e+03	20.388e+03	0.000e+00	0.000e+00
1	1	-4.300e+03	16.158e+03	-28.457e+03	128.301e+03
1	2	-5.133e+03	12.482e+03	-56.914e+03	224.705e+03
1	3	-6.510e+03	9.351e+03	-85.371e+03	289.210e+03
1	4	-8.415e+03	6.747e+03	-113.828e+03	321.818e+03
1	5	-10.825e+03	4.649e+03	-142.285e+03	322.527e+03
1	6	-13.713e+03	3.028e+03	-170.743e+03	291.339e+03
1	7	-17.041e+03	1.848e+03	-199.200e+03	228.252e+03
1	8	-20.771e+03	1.069e+03	-227.657e+03	133.267e+03
1	9	-24.850e+03	639.704e+00	-303.942e+03	54.212e+03
1	10	-29.225e+03	506.102e+00	-472.774e+03	35.806e+03
2	0	-1.779e+03	31.534e+03	-472.774e+03	35.806e+03
2	1	-1.992e+03	25.916e+03	-242.164e+03	50.778e+03
2	2	-2.688e+03	20.781e+03	-140.475e+03	141.319e+03
2	3	-3.962e+03	16.224e+03	-127.807e+03	267.527e+03
2	4	-5.885e+03	12.316e+03	-119.610e+03	344.856e+03
2	5	-8.494e+03	9.095e+03	-111.414e+03	368.832e+03
2	6	-11.802e+03	6.572e+03	-103.218e+03	339.455e+03
2	7	-15.790e+03	4.729e+03	-95.022e+03	256.727e+03
2	8	-20.412e+03	3.520e+03	-98.131e+03	131.951e+03
2	9	-25.595e+03	2.872e+03	-206.568e+03	59.151e+03
2	10	-31.228e+03	2.674e+03	-438.560e+03	56.553e+03
3	0	-930.922e+00	26.575e+03	-438.560e+03	56.553e+03
3	1	-1.052e+03	22.825e+03	-307.670e+03	69.701e+03
3	2	-1.439e+03	19.341e+03	-249.258e+03	131.798e+03
3	3	-2.135e+03	16.165e+03	-218.101e+03	197.637e+03
3	4	-3.175e+03	13.335e+03	-186.943e+03	239.958e+03
3	5	-4.597e+03	10.885e+03	-155.786e+03	258.760e+03
3	6	-6.426e+03	8.843e+03	-124.629e+03	254.045e+03
3	7	-8.686e+03	7.231e+03	-93.471e+03	225.811e+03
3	8	-11.393e+03	6.067e+03	-62.314e+03	174.058e+03
3	9	-14.561e+03	5.364e+03	-31.157e+03	98.788e+03
3	10	-18.197e+03	5.128e+03	0.000e+00	0.000e+00

Not interested in the overall envelope.

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	-4.022e+03	20.388e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-2.285e+03	60.759e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-3.605e+03	57.804e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	-5.128e+03	18.197e+03	0.000e+00	0.000e+00

Design Tandem + Lane Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	-4.022e+03	20.388e+03	0.000e+00	0.000e+00
1	1	-4.300e+03	16.158e+03	-28.457e+03	128.301e+03
1	2	-5.133e+03	12.482e+03	-56.914e+03	224.705e+03
1	3	-6.510e+03	9.351e+03	-85.371e+03	289.210e+03
1	4	-8.415e+03	6.747e+03	-113.828e+03	321.818e+03
1	5	-10.825e+03	4.649e+03	-142.285e+03	322.527e+03
1	6	-13.713e+03	3.028e+03	-170.743e+03	291.339e+03
1	7	-17.041e+03	1.848e+03	-199.200e+03	228.252e+03

1	8	-20.771e+03	1.069e+03	-227.657e+03	133.267e+03
1	9	-24.850e+03	639.704e+00	-303.942e+03	54.212e+03
1	10	-29.225e+03	506.102e+00	-472.774e+03	35.806e+03
2	0	-1.779e+03	31.534e+03	-472.774e+03	35.806e+03
2	1	-1.992e+03	25.916e+03	-242.164e+03	50.778e+03
2	2	-2.688e+03	20.781e+03	-140.475e+03	141.319e+03
2	3	-3.962e+03	16.224e+03	-127.807e+03	267.527e+03
2	4	-5.885e+03	12.316e+03	-119.610e+03	344.856e+03
2	5	-8.494e+03	9.095e+03	-111.414e+03	368.832e+03
2	6	-11.802e+03	6.572e+03	-103.218e+03	339.455e+03
2	7	-15.790e+03	4.729e+03	-95.022e+03	256.727e+03
2	8	-20.412e+03	3.520e+03	-98.131e+03	131.951e+03
2	9	-25.595e+03	2.872e+03	-206.568e+03	59.151e+03
2	10	-31.228e+03	2.674e+03	-438.560e+03	56.553e+03
3	0	-930.922e+00	26.575e+03	-438.560e+03	56.553e+03
3	1	-1.052e+03	22.825e+03	-307.670e+03	69.701e+03
3	2	-1.439e+03	19.341e+03	-249.258e+03	131.798e+03
3	3	-2.135e+03	16.165e+03	-218.101e+03	197.637e+03
3	4	-3.175e+03	13.335e+03	-186.943e+03	239.958e+03
3	5	-4.597e+03	10.885e+03	-155.786e+03	258.760e+03
3	6	-6.426e+03	8.843e+03	-124.629e+03	254.045e+03
3	7	-8.686e+03	7.231e+03	-93.471e+03	225.811e+03
3	8	-11.393e+03	6.067e+03	-62.314e+03	174.058e+03
3	9	-14.561e+03	5.364e+03	-31.157e+03	98.788e+03
3	10	-18.197e+03	5.128e+03	0.000e+00	0.000e+00

Design Tandem + Lane 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	-4.022e+03	20.388e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-2.285e+03	60.759e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-3.605e+03	57.804e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	-5.128e+03	18.197e+03	0.000e+00	0.000e+00

Design Truck + Lane Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	-4.022e+03	20.388e+03	0.000e+00	0.000e+00
1	1	-4.300e+03	16.158e+03	-28.457e+03	128.301e+03
1	2	-5.133e+03	12.482e+03	-56.914e+03	224.705e+03
1	3	-6.510e+03	9.351e+03	-85.371e+03	289.210e+03
1	4	-8.415e+03	6.747e+03	-113.828e+03	321.818e+03
1	5	-10.825e+03	4.649e+03	-142.285e+03	322.527e+03
1	6	-13.713e+03	3.028e+03	-170.743e+03	291.339e+03
1	7	-17.041e+03	1.848e+03	-199.200e+03	228.252e+03
1	8	-20.771e+03	1.069e+03	-227.657e+03	133.267e+03
1	9	-24.850e+03	639.704e+00	-303.942e+03	54.212e+03
1	10	-29.225e+03	506.102e+00	-472.774e+03	35.806e+03
2	0	-1.779e+03	31.534e+03	-472.774e+03	35.806e+03
2	1	-1.992e+03	25.916e+03	-242.164e+03	50.778e+03
2	2	-2.688e+03	20.781e+03	-140.475e+03	141.319e+03
2	3	-3.962e+03	16.224e+03	-127.807e+03	267.527e+03
2	4	-5.885e+03	12.316e+03	-119.610e+03	344.856e+03
2	5	-8.494e+03	9.095e+03	-111.414e+03	368.832e+03
2	6	-11.802e+03	6.572e+03	-103.218e+03	339.455e+03
2	7	-15.790e+03	4.729e+03	-95.022e+03	256.727e+03
2	8	-20.412e+03	3.520e+03	-98.131e+03	131.951e+03
2	9	-25.595e+03	2.872e+03	-206.568e+03	59.151e+03
2	10	-31.228e+03	2.674e+03	-438.560e+03	56.553e+03
3	0	-930.922e+00	26.575e+03	-438.560e+03	56.553e+03
3	1	-1.052e+03	22.825e+03	-307.670e+03	69.701e+03
3	2	-1.439e+03	19.341e+03	-249.258e+03	131.798e+03
3	3	-2.135e+03	16.165e+03	-218.101e+03	197.637e+03
3	4	-3.175e+03	13.335e+03	-186.943e+03	239.958e+03

3	5	-4.597e+03	10.885e+03	-155.786e+03	258.760e+03
3	6	-6.426e+03	8.843e+03	-124.629e+03	254.045e+03
3	7	-8.686e+03	7.231e+03	-93.471e+03	225.811e+03
3	8	-11.393e+03	6.067e+03	-62.314e+03	174.058e+03
3	9	-14.561e+03	5.364e+03	-31.157e+03	98.788e+03
3	10	-18.197e+03	5.128e+03	0.000e+00	0.000e+00

Design Truck + Lane 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	-4.022e+03	20.388e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-2.285e+03	60.759e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-3.605e+03	57.804e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	-5.128e+03	18.197e+03	0.000e+00	0.000e+00

Dual Truck Train + Lane Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00	-204.891e+03	0.000e+00
1	9	0.000e+00	0.000e+00	-273.547e+03	0.000e+00
1	10	0.000e+00	0.000e+00	-425.496e+03	0.000e+00
2	0	0.000e+00	0.000e+00	-425.496e+03	0.000e+00
2	1	0.000e+00	0.000e+00	-217.948e+03	0.000e+00
2	2	0.000e+00	0.000e+00	-126.428e+03	0.000e+00
2	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00	-185.911e+03	0.000e+00
2	10	0.000e+00	0.000e+00	-394.704e+03	0.000e+00
3	0	0.000e+00	0.000e+00	-394.704e+03	0.000e+00
3	1	0.000e+00	0.000e+00	-276.903e+03	0.000e+00
3	2	0.000e+00	0.000e+00	-224.332e+03	0.000e+00
3	3	0.000e+00	0.000e+00	-196.291e+03	0.000e+00
3	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Dual Lane Axle Rxn – No Impact and No Truck

Dual Truck Train + Lane 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	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-2.056e+03	54.683e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-3.245e+03	52.023e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Dual Tandem Train + Lane Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00

1	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Dual Tandem Train + Lane 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	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Fatigue Truck Envelopes (Per Lane)

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00

2	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Fatigue Truck 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	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Strength I Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	15.990e+03	67.665e+03	0.000e+00	0.000e+00
1	1	9.135e+03	51.418e+03	90.605e+03	419.535e+03
1	2	1.310e+03	36.142e+03	136.160e+03	720.679e+03
1	3	-7.466e+03	21.817e+03	136.665e+03	903.432e+03
1	4	-18.116e+03	9.367e+03	92.120e+03	967.794e+03
1	5	-31.179e+03	-671.576e+00	2.525e+03	913.765e+03
1	6	-45.075e+03	-9.876e+03	-132.119e+03	741.344e+03
1	7	-59.744e+03	-18.308e+03	-311.814e+03	450.533e+03
1	8	-75.115e+03	-26.039e+03	-590.288e+03	95.059e+03
1	9	-91.096e+03	-33.159e+03	-1.029e+06	-263.282e+03
1	10	-107.596e+03	-39.760e+03	-1.692e+06	-560.538e+03
2	0	38.922e+03	113.567e+03	-1.692e+06	-560.538e+03
2	1	30.313e+03	92.299e+03	-807.467e+03	-187.386e+03
2	2	20.861e+03	71.874e+03	-252.289e+03	242.660e+03
2	3	10.396e+03	52.463e+03	-32.061e+03	734.286e+03
2	4	-1.203e+03	34.186e+03	103.182e+03	1.037e+06
2	5	-14.005e+03	17.112e+03	163.075e+03	1.142e+06
2	6	-30.896e+03	4.127e+03	147.618e+03	1.049e+06
2	7	-49.313e+03	-7.332e+03	56.811e+03	759.133e+03
2	8	-68.838e+03	-17.684e+03	-129.131e+03	290.080e+03
2	9	-89.346e+03	-27.052e+03	-657.678e+03	-109.737e+03
2	10	-110.642e+03	-35.633e+03	-1.523e+06	-445.485e+03
3	0	34.670e+03	96.923e+03	-1.523e+06	-445.485e+03
3	1	28.990e+03	82.767e+03	-1.011e+06	-218.562e+03
3	2	22.845e+03	69.076e+03	-672.095e+03	60.805e+03
3	3	16.160e+03	55.925e+03	-426.621e+03	313.506e+03
3	4	8.872e+03	43.377e+03	-255.243e+03	519.799e+03
3	5	916.702e+00	31.497e+03	-129.665e+03	651.388e+03
3	6	-7.751e+03	20.329e+03	-37.302e+03	695.688e+03
3	7	-17.940e+03	10.682e+03	21.846e+03	652.699e+03
3	8	-30.272e+03	3.177e+03	47.779e+03	522.422e+03
3	9	-43.409e+03	-3.520e+03	40.497e+03	304.855e+03
3	10	-57.366e+03	-9.399e+03	0.000e+00	0.000e+00

Strength I Limit State Envelopes

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	15.990e+03	67.665e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	78.682e+03	221.164e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	70.303e+03	207.565e+03	0.000e+00	0.000e+00

4	0.000e+00	0.000e+00	9.399e+03	57.366e+03	0.000e+00	0.000e+00

Service I Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	21.565e+03	45.976e+03	0.000e+00	0.000e+00
1	1	14.211e+03	34.671e+03	127.548e+03	284.307e+03
1	2	6.304e+03	23.920e+03	205.041e+03	486.661e+03
1	3	-2.147e+03	13.713e+03	232.479e+03	607.061e+03
1	4	-11.127e+03	4.035e+03	209.861e+03	645.508e+03
1	5	-20.613e+03	-5.137e+03	137.187e+03	602.000e+03
1	6	-30.575e+03	-13.833e+03	14.457e+03	476.540e+03
1	7	-40.978e+03	-22.088e+03	-158.327e+03	269.125e+03
1	8	-51.783e+03	-29.942e+03	-381.168e+03	-20.242e+03
1	9	-62.937e+03	-37.447e+03	-701.891e+03	-343.737e+03
1	10	-74.387e+03	-44.656e+03	-1.165e+06	-656.637e+03
2	0	44.927e+03	78.240e+03	-1.165e+06	-656.637e+03
2	1	35.563e+03	63.472e+03	-549.108e+03	-256.165e+03
2	2	25.718e+03	49.187e+03	-145.641e+03	136.153e+03
2	3	15.293e+03	35.481e+03	85.083e+03	480.418e+03
2	4	4.221e+03	22.422e+03	227.612e+03	692.079e+03
2	5	-7.538e+03	10.051e+03	286.419e+03	766.666e+03
2	6	-19.996e+03	-1.621e+03	261.504e+03	704.178e+03
2	7	-33.134e+03	-12.614e+03	152.866e+03	504.615e+03
2	8	-46.905e+03	-22.973e+03	-50.799e+03	179.283e+03
2	9	-61.238e+03	-32.771e+03	-443.515e+03	-177.795e+03
2	10	-76.022e+03	-42.118e+03	-1.043e+06	-548.395e+03
3	0	39.402e+03	66.908e+03	-1.043e+06	-548.395e+03
3	1	33.205e+03	57.083e+03	-686.049e+03	-308.676e+03
3	2	26.743e+03	47.524e+03	-437.972e+03	-56.915e+03
3	3	19.972e+03	38.273e+03	-254.056e+03	161.682e+03
3	4	12.857e+03	29.368e+03	-107.045e+03	319.856e+03
3	5	5.360e+03	20.843e+03	3.059e+03	417.606e+03
3	6	-2.543e+03	12.726e+03	76.258e+03	454.933e+03
3	7	-10.878e+03	5.039e+03	112.552e+03	431.835e+03
3	8	-19.660e+03	-2.199e+03	111.940e+03	348.314e+03
3	9	-28.903e+03	-8.977e+03	74.423e+03	204.369e+03
3	10	-38.614e+03	-15.288e+03	0.000e+00	0.000e+00

Service I Limit State Envelopes

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	21.565e+03	45.976e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	89.583e+03	152.627e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	81.520e+03	142.931e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	15.288e+03	38.614e+03	0.000e+00	0.000e+00

Service II Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	20.358e+03	52.093e+03	0.000e+00	0.000e+00
1	1	12.921e+03	39.519e+03	119.011e+03	322.798e+03
1	2	4.764e+03	27.665e+03	187.967e+03	554.073e+03
1	3	-4.100e+03	16.519e+03	206.867e+03	693.824e+03
1	4	-13.652e+03	6.059e+03	175.712e+03	742.053e+03
1	5	-23.860e+03	-3.742e+03	94.501e+03	698.759e+03
1	6	-34.689e+03	-12.925e+03	-36.765e+03	563.941e+03
1	7	-46.091e+03	-21.534e+03	-218.087e+03	337.601e+03
1	8	-58.015e+03	-29.621e+03	-449.465e+03	19.737e+03
1	9	-70.392e+03	-37.255e+03	-793.074e+03	-327.473e+03
1	10	-83.154e+03	-44.504e+03	-1.307e+06	-645.895e+03
2	0	44.393e+03	87.700e+03	-1.307e+06	-645.895e+03
2	1	34.966e+03	71.247e+03	-621.757e+03	-240.931e+03
2	2	24.911e+03	55.421e+03	-187.784e+03	178.549e+03
2	3	14.105e+03	40.348e+03	46.741e+03	560.676e+03

2	4	2.455e+03	26.117e+03	191.729e+03	795.536e+03
2	5	-10.086e+03	12.780e+03	252.995e+03	877.316e+03
2	6	-23.537e+03	350.374e+00	230.538e+03	806.015e+03
2	7	-37.871e+03	-11.195e+03	124.359e+03	581.633e+03
2	8	-53.029e+03	-21.917e+03	-80.238e+03	218.869e+03
2	9	-68.917e+03	-31.909e+03	-505.486e+03	-160.050e+03
2	10	-85.390e+03	-41.316e+03	-1.175e+06	-531.429e+03
3	0	39.122e+03	74.881e+03	-1.175e+06	-531.429e+03
3	1	32.889e+03	63.931e+03	-778.350e+03	-287.766e+03
3	2	26.311e+03	53.326e+03	-512.750e+03	-17.375e+03
3	3	19.332e+03	43.123e+03	-319.486e+03	220.973e+03
3	4	11.904e+03	33.368e+03	-163.128e+03	391.844e+03
3	5	3.981e+03	24.109e+03	-43.676e+03	495.234e+03
3	6	-4.471e+03	15.379e+03	38.869e+03	531.146e+03
3	7	-13.483e+03	7.209e+03	84.510e+03	499.578e+03
3	8	-23.078e+03	-379.127e+00	93.246e+03	400.531e+03
3	9	-33.271e+03	-7.368e+03	65.075e+03	234.005e+03
3	10	-44.073e+03	-13.749e+03	0.000e+00	0.000e+00

Service II Limit State Envelopes

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	20.358e+03	52.093e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	88.897e+03	170.855e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	80.439e+03	160.272e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	13.749e+03	44.073e+03	0.000e+00	0.000e+00

Service III Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	22.370e+03	41.898e+03	0.000e+00	0.000e+00
1	1	15.072e+03	31.439e+03	133.240e+03	258.647e+03
1	2	7.331e+03	21.424e+03	216.424e+03	441.720e+03
1	3	-845.361e+00	11.843e+03	249.553e+03	549.219e+03
1	4	-9.444e+03	2.685e+03	232.626e+03	581.144e+03
1	5	-18.447e+03	-6.067e+03	165.644e+03	537.495e+03
1	6	-27.832e+03	-14.439e+03	48.606e+03	418.272e+03
1	7	-37.570e+03	-22.458e+03	-118.487e+03	223.474e+03
1	8	-47.629e+03	-30.156e+03	-335.636e+03	-46.896e+03
1	9	-57.967e+03	-37.575e+03	-641.103e+03	-354.579e+03
1	10	-68.542e+03	-44.757e+03	-1.070e+06	-663.799e+03
2	0	45.282e+03	71.933e+03	-1.070e+06	-663.799e+03
2	1	35.962e+03	58.289e+03	-500.675e+03	-266.320e+03
2	2	26.255e+03	45.031e+03	-117.546e+03	107.890e+03
2	3	16.086e+03	32.236e+03	110.644e+03	426.912e+03
2	4	5.398e+03	19.959e+03	251.534e+03	623.108e+03
2	5	-5.839e+03	8.232e+03	308.702e+03	692.900e+03
2	6	-17.635e+03	-2.935e+03	282.148e+03	636.287e+03
2	7	-29.976e+03	-13.560e+03	171.870e+03	453.270e+03
2	8	-42.823e+03	-23.677e+03	-31.173e+03	152.893e+03
2	9	-56.119e+03	-33.345e+03	-402.202e+03	-189.626e+03
2	10	-69.776e+03	-42.653e+03	-955.796e+03	-559.706e+03
3	0	39.588e+03	61.593e+03	-955.796e+03	-559.706e+03
3	1	33.416e+03	52.518e+03	-624.514e+03	-322.617e+03
3	2	27.031e+03	43.656e+03	-388.120e+03	-83.275e+03
3	3	20.399e+03	35.040e+03	-210.436e+03	122.155e+03
3	4	13.492e+03	26.701e+03	-69.656e+03	271.864e+03
3	5	6.280e+03	18.666e+03	34.216e+03	365.854e+03
3	6	-1.258e+03	10.957e+03	101.184e+03	404.124e+03
3	7	-9.140e+03	3.593e+03	131.246e+03	386.673e+03
3	8	-17.381e+03	-3.412e+03	124.403e+03	313.502e+03
3	9	-25.990e+03	-10.050e+03	80.654e+03	184.611e+03
3	10	-34.974e+03	-16.313e+03	0.000e+00	0.000e+00

Service III Limit State Envelopes

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	22.370e+03	41.898e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	90.040e+03	140.475e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	82.242e+03	131.370e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	16.313e+03	34.974e+03	0.000e+00	0.000e+00

Fatigue Limit State Envelopes

Span	Point	Min Shear(lbs)	Max Shear(lbs)	Min Moment(ft-lbs)	Max Moment(ft-lbs)
1	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
1	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	2	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	3	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	4	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	6	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	7	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	8	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	9	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	10	0.000e+00	0.000e+00	0.000e+00	0.000e+00

Fatigue Limit State Envelopes

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

LRFD Pier Live Load Distribution

Developed on 12/09/2006
Last Modified on 8/26/2010

DOT refers to the Iowa Department of Transportation.
OBS refers to the Iowa DOT Office of Bridges and Structures

Please report any spreadsheet errors to the Iowa DOT OBS.

This spreadsheet was developed to aid the design of typical Iowa DOT piers. The Iowa DOT Bridge Design Manual (BDM) should be consulted for the most up-to-date policies.

Description:
This spreadsheet allows the user to determine live load beam reactions to a pier cap for varying transverse live load positions and varying numbers of lanes loaded. The distribution of live load through the slab to the beams is based on the assumption that the slab between beams is simply supported. Office practice is to distribute the live load to the exterior beam with the assumption that all of the live load on the slab overhang is transferred to the exterior beam. [However, provision is made in the spreadsheet to distribute live load on the slab overhang to the exterior and first interior beam based on slab continuity over the simple exterior beam support.] This spreadsheet is designed to facilitate input into the LEAP® RC-PIER® (RC-Pier) program.

RC-Pier Import Feature:
The loads generated by this spreadsheet can be exported to a text file that can be imported directly into RC-Pier.

Steps:
1.) The user must determine the HL-93 live load axle pier reaction from a software such as QConBridge™. The truck and lane axle reactions must be determined separately. Impact should be removed from the live load truck reation. Multiple Presence Factors should be excluded as well.
2.) The user should fill in the cell input entries on the **Geometry** tab. Cell input entries are typically shown in bold blue text as: **Input**
Cells with calculated output are typically shown in bold red text as: **Output**
3.) The **Placement** tab allows the user to place lanes of live load in different positions along the slab. The resulting beam reactions are based on unit load influence values of 1.000 kip for the lane and truck axle live loads (see the **Geometry** tab). Each load case can be stored, recalled, and/or deleted using the buttons on the **Placement** tab. (The calculated beam reactions include the Multiple Presence Factors.)
4.) The **PierResults** tab allows the user to scale the unit load influence beam reactions by the actual truck and lane axle reactions for up to four piers (i.e. four different live load pier reactions). These live load reactions can be exported to a text file which can be imported directly into RC-Pier.
5.) The **LoadGraphs** tab allows the user to print a copy of the graphs showing the live load arrangements for each load case.

Limitations:
1.) Up to 10 beam lines can be entered.
2.) Up to 8 lanes of live load can be present in a load case.
3.) Up to 20 load cases can be stored.
4.) Beam reactions, based on the same unit load influence values, can be stored for up to 4 piers.

Notes:
1.) The user must manually place the live loads in order to create a suitable envelope of loads for a pier design. On the **Geometry** tab the user has the option to enter some of the pier geometry. Entering this geometry allows the pier to be graphed on the **Placement** tab. The intent is to help the user to visualize how the live loads should be placed in order to generate the live load envelopes needed for pier design.
2.) On the **Placement** tab, you must enter both the traffic location and the distributed lane location in order for the graph to plot the new load and for the beam reactions to be recalculated for the new load.
3.) A truck axle load is placed on the slab as two concentrated wheel loads spaced 6' apart. The lane axle load is placed as a 10' wide uniformly distributed load. The truck load is always centered about the lane load.
4.) If you change something on the **Geometry** tab you should recall each saved load case and resave to overwrite the previous one. The spreadsheet does not automatically update the beam reactions for changes.
5.) The **unitLoadResults**, **calcGraph**, and **calcBeamRxn** tabs contain most of the calculations needed for the spreadsheet to work.

Specify Bridge Geometry and Live Load

Note:	Roadway dimensions and beam spacing should be taken as perpendicular to roadway.

Note:	Blue text is for user input Red text is typ. calculated

Out to Out Slab Width (vOOS)	43.160	ft
Roadway Width (vRW)	40.000	ft
Left Curb Width (vLCW): Slab Edge to Gutterline	1.580	ft

Beam Height (vBH)	4.500	ft
Number of Beams (vNB)	6	
Left Slab Edge to Beam 1 (vBM01)	3.080	ft
Beam 1 to Beam 2 (vBM12)	7.400	ft
Beam 2 to Beam 3 (vBM23)	7.400	ft
Beam 3 to Beam 4 (vBM34)	7.400	ft
Beam 4 to Beam 5 (vBM45)	7.400	ft
Beam 5 to Beam 6 (vBM56)	7.400	ft
Beam 6 to Beam 7 (vBM67)		ft
Beam 7 to Beam 8 (vBM78)		ft
Beam 8 to Beam 9 (vBM89)		ft
Beam 9 to Beam 10 (vBM910)		ft

Overhang: 1 = Continuous, 0 = Hinged (vOHG)	0	

<-- Office practice is to use Hinged. RC-Pier uses Continuous for auto-generation of LL.

Traffic Lane Width for Placement (vTLWP)	12.000	ft

<-- Office practice is to use 12'. RC-Pier uses 10'.

*

Unit Truck Axle Reaction (vTAR)	1.000	k
Unit Lane Axle Reaction (vLAR)	1.000	k

<-- Unit loads for truck and lane.

Traffic Lane Width for Max # of Lanes	12.000	ft
Max. Number of Possible Lanes (vNPL)	3	
Transv. Wheel Spacing (vWS)	6.000	ft
Transv. Lane Distribution Width (vLDW)	10.000	ft

\#

Graph Pier: 1 = Yes, 0 = No (vGP)	1	

Note: Fill out information below if you want to graph the pier.

Skew, always positive (vSKW)	32.000	deg

Pier dimensions should be based on distances along the skewed cap.		
Cap Length (vCL)	49.000	ft
Left Cap Edge to Beam 1 (vLCEB1)	2.688	ft
Cap Height (vCH)	7.000	ft
Round Column: 1 = Yes, 0 = No (vRCOL)	0	
Column Diameter or Width (vCW)	20.000	ft
Number of Columns (vNC)	1	
Left Cap Edge to Column 1 (vCOL01)	24.500	ft
Column 1 to Column 2 (vCOL12)		ft
Column 2 to Column 3 (vCOL23)		ft
Column 3 to Column 4 (vCOL34)		ft
Column 4 to Column 5 (vCOL45)		ft

Number of Lanes	MPF
1 Lane (vMPF1)	1.20
2 Lanes (vMPF2)	1.00
3 Lanes (vMPF3)	0.85
> 3 Lanes (vMPF4)	0.65

* The truck and lane axle reactions will be treated as influence values first. Thus piers with similar geometry, but different live load reactions may be scaled from the same set of influence values for different live load positions.

\# Graphing the pier allows the user to better visualize the column locations with respect to the beam locations.

Place Traffic Lane Loads

Roadway Width	40.00000	ft

Lane #	Traffic Lane Location - ft (based on left gutterline) Min	Max	Actual
Lane 1	0.00000	28.00000	2.00000
Lane 2	14.00000	28.00000	14.00000
Lane 3	26.00000	28.00000	26.00000
Lane 4	Can't fit	Can't fit	
Lane 5			
Lane 6			
Lane 7			
Lane 8			
Number of Lanes Occupied			3

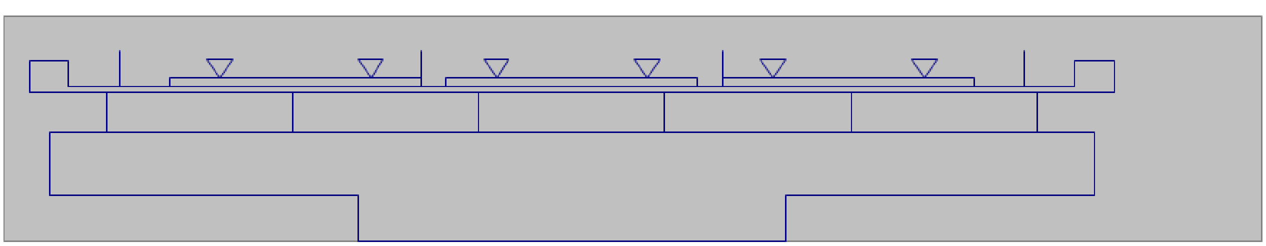
Number of Load Cases Stored (20 Max.) =	7

Store As Case # | Recall Case # | 7 | Delete Case #

Uniform Lane Load	0.100	k/ft
Conc Truck Load One wheel Line	0.500	k

Lane #	Distributed Lane Location - ft (based on left lane edge) Min	Max	Actual
Lane 1	0.00000	2.00000	2.00000
Lane 2	0.00000	2.00000	1.00000
Lane 3	0.00000	2.00000	0.00000
Lane 4	0.00000	2.00000	
Lane 5			
Lane 6			
Lane 7			
Lane 8			

Beam Reactions	MPF =		0.85
Beam #	Truck Rxn (k)	Lane Rxn (k)	Total Rxn (k)
1	0.167	0.138	0.304
2	0.505	0.572	1.078
3	0.603	0.565	1.168
4	0.603	0.565	1.168
5	0.505	0.572	1.078
6	0.167	0.138	0.304
7			
8			
9			
10			
Total	2.550	2.550	5.100



Looking Perpendicular to Roadway

Live Load Placement Screen showing the 7th live load case.

These are influence values.

Unit Load Results

For RC-Pier live load input:

1.) Impact should be excluded from the (truck) reactions.
2.) Multiple Presence Factors (MPF) are included in the reactions.
3.) Beam reactions for truck and lane loads should be entered separately.
4.) Truck load results should be entered first, followed by lane load results.
5.) Auto-generation of live load in RC-Pier assumes the overhang is continuous over the exterior beam.
6.) Auto-generation of live load in RC-Pier assumes 10' traffic lanes.

These are the pier 1 LL reactions from QConBridge (no impact).

Export Pier 1 Loads to Text Files

This button allows the user to export these loads to a text file that may be imported into RC-Pier.

Pier 1

Enter Truck Axle Rxn at Pier	85.662	k
Enter Lane Axle Rxn at Pier	54.683	k
Truck Axle Rxn Used	85.662	k
Lane Axle Rxn Used	54.683	k

Unit Truck Axle Rxn Influence Value	1.000
Unit Lane Axle Rxn Influence Value	1.000

Beam Reactions (kips)

Case Number		Beam 1	Beam 2	Beam 3	Beam 4	Beam 5	Beam 6	Beam 7	Beam 8	Beam 9	Beam 10
1	Truck	54.175	48.619	0.000	0.000	0.000	0.000				
	Lane	34.122	30.961	0.536	0.000	0.000	0.000				
2	Truck	0.000	0.000	0.000	0.000	48.619	54.175				
	Lane	0.000	0.000	0.000	0.536	30.961	34.122				
3	Truck	45.146	53.828	50.934	21.416	0.000	0.000				
	Lane	28.435	32.632	36.294	12.004	0.000	0.000				
4	Truck	0.000	0.000	21.416	50.934	53.828	45.146				
	Lane	0.000	0.000	12.004	36.294	32.632	28.435				
5	Truck	38.374	45.754	43.294	43.294	43.294	4.428				
	Lane	24.170	27.738	30.850	26.035	28.008	2.641				
6	Truck	4.428	43.294	43.294	43.294	45.754	38.374				
	Lane	2.641	28.008	26.035	30.850	27.738	24.170				
7	Truck	14.267	43.294	51.658	51.658	43.294	14.267				
	Lane	7.541	31.302	30.878	30.878	31.302	7.541				
8	Truck										
	Lane										
9	Truck										
	Lane										
10	Truck										
	Lane										

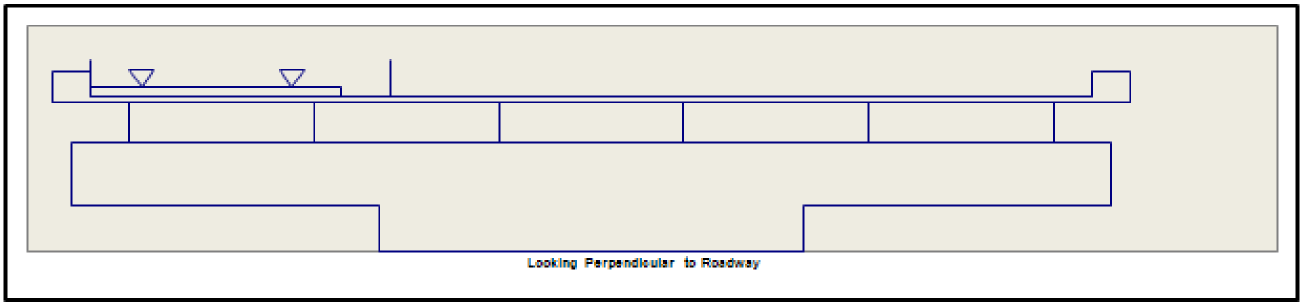
These loads may be entered or imported directly into RC-Pier. As required by RC-Pier: impact is not included, but multiple presence factors (MPFs) are included.

Location of Live Loads (ft)										
Case Number		Lane 1	Lane 2	Lane 3	Lane 4	Lane 5	Lane 6	Lane 7	Lane 8
1	Traffic Lane Location	0.000							
	Distributed Lane Location	0.000							
2	Traffic Lane Location	28.000							
	Distributed Lane Location	2.000							
3	Traffic Lane Location	0.000	12.000						
	Distributed Lane Location	0.000	0.000						
4	Traffic Lane Location	16.000	28.000						
	Distributed Lane Location	2.000	2.000						
5	Traffic Lane Location	0.000	12.000	24.000					
	Distributed Lane Location	0.000	0.000	0.000					
6	Traffic Lane Location	4.000	16.000	28.000					
	Distributed Lane Location	2.000	2.000	2.000					
7	Traffic Lane Location	2.000	14.000	26.000					
	Distributed Lane Location	2.000	1.000	0.000					
8	Traffic Lane Location								
	Distributed Lane Location								
9	Traffic Lane Location								
	Distributed Lane Location								
10	Traffic Lane Location								
	Distributed Lane Location								

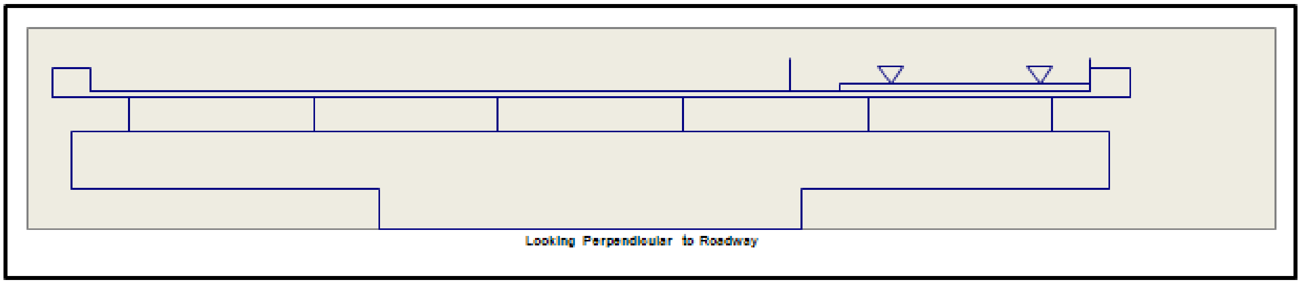
Describes the location of each live load for each load case with respect to the left gutterline.

Graphs depict live load locations for each load case.

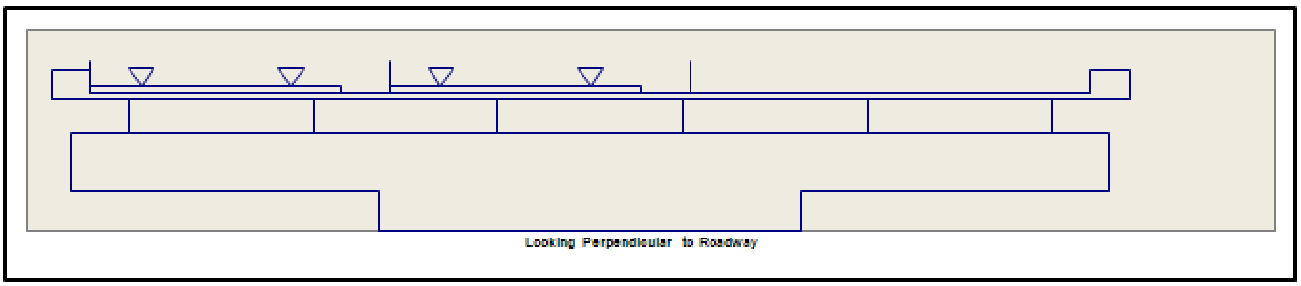
Load Case 1



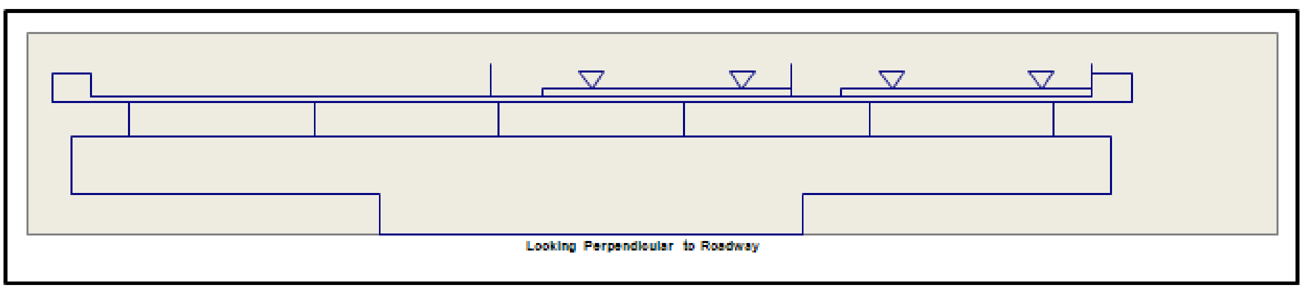
Load Case 2



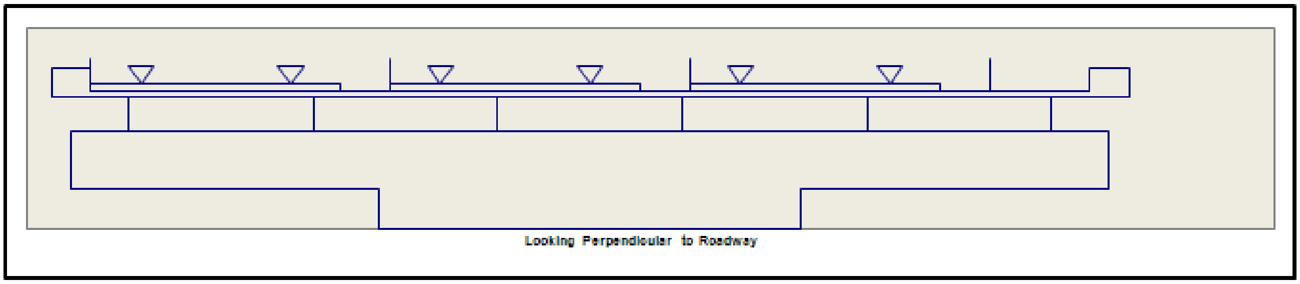
Load Case 3



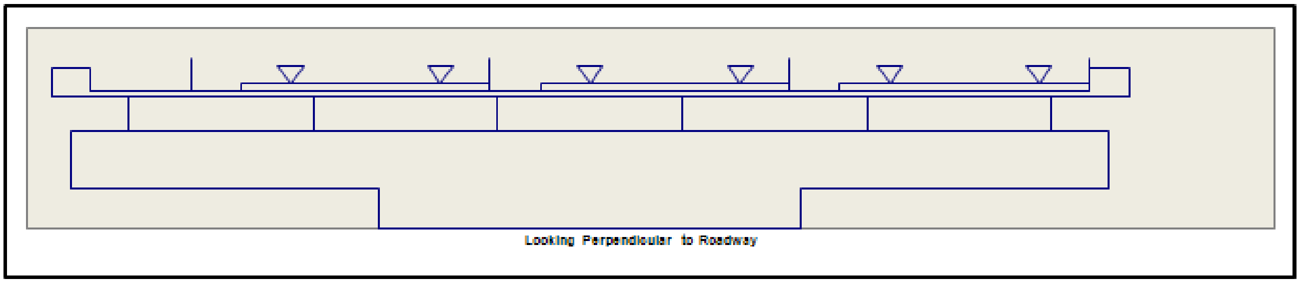
Load Case 4



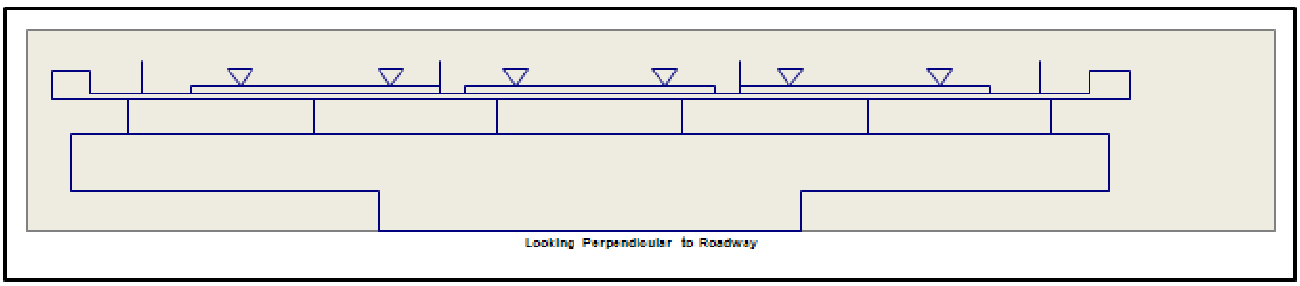
Load Case 5



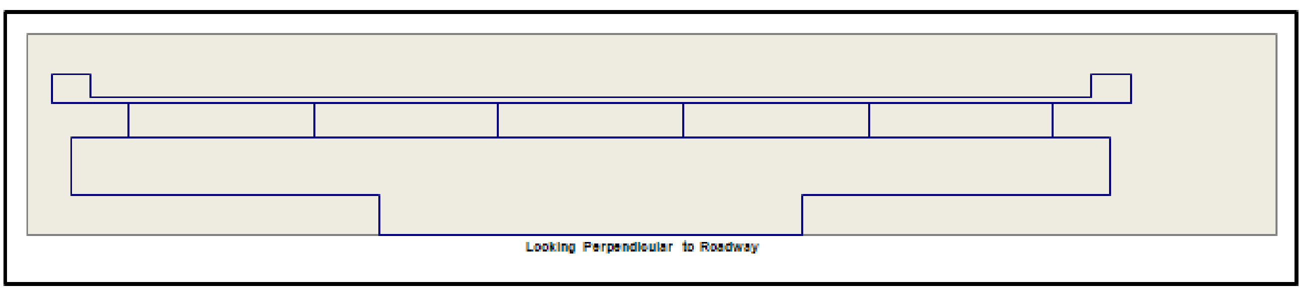
Load Case 6



Load Case 7



Load Case 8



Geometrical Considerations for Various Loadings

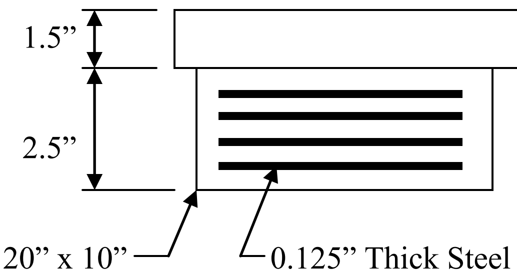
Average span length is used for superstructure wind loading and braking forces.

Avg Span Length = (0.5)*(70.75’ + 91.5’) = 81.125’

Typically average step height, bearing pad height, and average haunch are used for determining exposed wind areas and distances from lateral superstructure loads to the top of the pier cap. RC-Pier is not really able to accommodate this in its load auto-generation procedure. Since these additional depths are relatively small for this bridge they will be ignored.

Avg Step Hgt = [(693.71 + 693.94 + 694.18 + 694.35 + 694.29 + 694.23)/(6 Beams)] – 693.71
= 0.407’ -- Ignored

Bearing Pad Hgt + Pintle Plate Thk = 2.5” + 1.5” = 0.333’ -- Ignored



Length x Width = 20” x 10” 0.125” Thick Steel Plates
Pad Area = 200 in^2
Neoprene Thk = 2.5” – (4 plates)*(0.125”) = 2”
Shear Modulus, Gmax = 0.130 ksi -- 50 Durometer

Avg Haunch = 1” = 0.083’ -- Ignored

Superstructure Wind Area = (2.833’ SBC Hgt) + (8” Slab Thk)/(12 in/ft) + (4.5’ Beam Hgt)
= 8.00’

Center of Gravity of Superstructure Wind Area to Top of Pier Cap = (0.5)*(8.00’) = 4.00’

Dist from Slab Top to Top of Pier Cap = (8” Slab Thk)/(12 in/ft) + (4.5’ Beam Hgt) = 5.17’

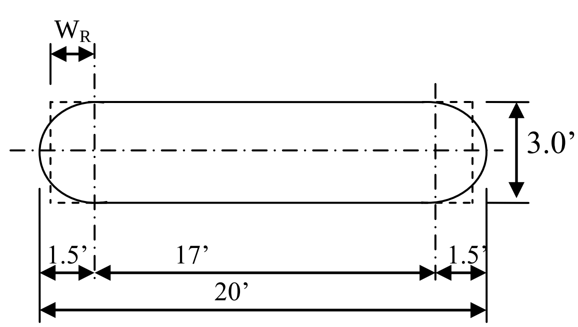
Earth cover on top of footing is used not only for the fill weight on the footing. It can also figure into the exposed wind area of the substructure, stream flow forces, and ice forces.

Depth of Earth Cover over Top of Footing = 10’ approximate

Equivalent Column Dimensions

$W_R = [(0.5)*(\pi*R^2)]/(2*R)$
$W_R = [(0.5)*(\pi)*(1.5')^2]/(2*1.5') = 1.178'$

Equiv Column Length = 17’ + $2*W_R$
Equiv Column Length = 17’ + 2*1.178’
Equiv Column Length = 19.356’



Use 19.5’ for equivalent column length and 3.0’ for column width.

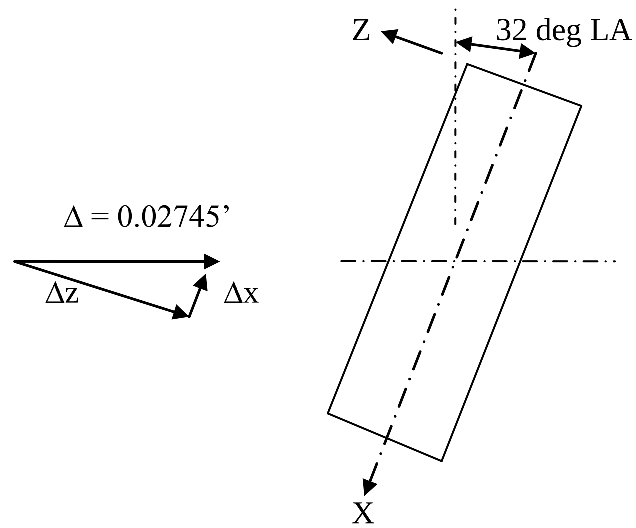
Temperature Considerations

1.) Superstructure Temperature Movement

Pier 1 has laminated neoprene expansion bearings. Pier 2 has fixed bearings. The abutments are integral. The temperature change is 50 degrees each way from 50 degrees F. The coefficient of thermal expansion is $\mu = 6x10^{-6}$ per degree F.

Δ = (91.5')*($6x10^{-6}$ per degree F)*(50 degrees F) = 0.02745' = 0.3294"

$\Delta z = \Delta*\cos\theta$ = (0.02745')*(cos(32 deg)) = 0.02328'
$\Delta x = \Delta*\sin\theta$ = (0.02745')*(sin(32 deg)) = 0.01455'



Load Factors for Temperature Loads

Aashto Lrfd 3.4.1, 5th Edition, Top of Page 3-12

For substructure design Iowa typically uses gross inertia for the pier components. This means we will use the smaller load factors in Aashto Lrfd Load Tables 3.4.1-1 and 3.4.1-3 for TU when calculating force effects.

PIER TEMPERATURE FORCES

DOT refers to the Iowa Department of Transportation.
OBS refers to the Iowa DOT Office of Bridges and Structures

Developed on 6/27/2006
Last Modified on 8/26/2010

This spreadsheet was developed to aid the design of typical Iowa DOT piers. The Iowa DOT Bridge Design Manual (BDM) should be consulted for the most up-to-date policies.

Description:
This spreadsheet will determine the lateral forces that must be applied to the top of a pier in order to produce the corresponding lateral deflections that are typically induced by the superstructure temperature movements. The spreadsheet can also generate a STAAD input file for verification. There are a number of simplifying assumptions made in the spreadsheet. The user is responsible for understanding those assumptions and for determining their appropriateness for their design.

The "Description", "Input", and "Output" worksheets are the only worksheets the user needs to consider. Some intermediate calculations are performed on the "Input" worksheet. The worksheet area where these are done is clearly marked.

Assumptions & Limitations
1.) Bearing pad flexibility can be considered.
2.) The pier cap stiffness is not considered for single column piers. The cantilevers if present use the average cross-sectional dimension of the cap height at end and cap height at center. The cap can be considered "infinitely" stiff (the cap area and inertia are set to 10,000 ft^2 and 100,000 ft^2 respectively if this option is used).
3.) One to five columns can be input. Each column can be of a different height and cross-sectional dimension. Columns can be round or rectangular, and if rectangular they can also be tapered in one or both directions. Columns are split into five segments and the average cross-sectional dimensions of the individual segments are used for member properties. Column height input by the user is used in both directions. The column height is not adjusted by the spreadsheet (ie. column height is not adjusted by one-half of the cap height.)
4.) The rotational flexibilty of the pile footings due to axial pile shortening can be input. Up to 50 piles per footing can be entered. Each footing can have a different pile arrangement and pile type. Pile arrangements must be symmetrical about the centerline of the column.
5.) The Direct Stiffness Method is used to solve the problem.
6.) The pier is assumed to move as a unit in the weak-axis direction (all columns deflect the same amount). The cap does not contribute to the model in the weak-axis direction. In the strong-axis direction, the average deflection of the pier at the top of the columns due to a unit lateral force is used to establish the pier stiffness. This stiffness combined with the actual superstructure deflection due to temperature is then used to determine the actual temperature force.
7.) The action and response of the pier in the X and Z axes directions are treated independently of one another.

Pier Stiffness and Temperature Forces

This spreadsheet is designed to determine the forces induced in the pier by temperature movements from the superstructure. The temperature movement along the c.l. of the bridge roadway should be broken down into components transverse and parallel to the pier (always use positive displacements). Once these have been input and the geometry of the pier including any pads and piling have been defined then the program will determine the forces needed to produce those movements. These forces can be entered into RC-Pier as a temperature load. The user must ensure that the sign of the forces enterd into RC-Pier are correct.

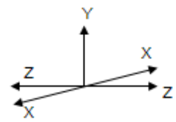
See previous page for calculation of temperature movements.

Expansion Pier

Input

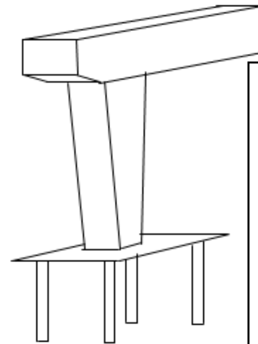
	X-Dir'n, ft	Z-Dir'n, ft
Temperature Movement	0.01455	0.02328

Number of Elastomeric Pads	12	0 if no pads
Pad Shear Modulus, G	130.000	psi
Thickness of Neoprene Only	2.000	in
Area of One Pad	200.000	in^2
f'c	3500.000	psi
Cap Height at Center (Y)	7.000	ft
Cap Height at End (Y)	4.000	ft
Cap Depth (Z)	3.500	ft
Treat Cap as Infinitely Rigid?	N	(Y)es or (N)o
Left Overhang Length (X)	24.500	ft
Right Overhang Length (X)	24.500	ft
Number of Columns	1	Max of 5



Treat Pier Cap Axial Stiffness as Infinitely Rigid?	
Y	(Y)es or (N)o

Just axial stiffness not bending.



Piling flexibility will be ignored. Even though we have T-Piers on a large skew we have fairly flexible expansion bearings so the temperature forces won't be that significant. Additionally the piling doesn't add much flexibility to the pier since the piling is short and the pile inertia of the group is large.

	Column 1-2	Column 2-3	Column 3-4	Column 4-5	
Distance Between Columns (X)					ft

All Columns the Same?	Y	(Y)es or (N)o	If yes then only enter information for column 1.			
Column Dimensions	Column 1, ft	Column 2, ft	Column 3, ft	Column 4, ft	Column 5, ft	
Column Width at Top (X)	19.500					Enter column diameter for round columns.
Column Width at Bottom (X)	19.500					Enter 0 if column is round.
Column Depth at Top (Z)	3.000					Enter 0 if column is round.
Column Depth at Bottom (Z)	3.000					Enter 0 if column is round.
Column Height (Y)	32.000					Column Height: Frame Pier: Top of ftg to ctr of cap. T-Pier: Top of ftg to top of cap.

Include Piling?	N	(Y)es or (N)o	
All Piling the Same?	Y	(Y)es or (N)o	If yes then only enter information for footing 1.

HP 10x57 End Bearing Pile = (0.75)*(20' pile length)

Pile arrangement based on existing plans.

Piling Information	Footing 1, ft		Footing 2, ft		Footing 3, ft		Footing 4, ft		Footing 5, ft	
Pile: 1=Steel,2=Wood,3=Conc	1									
If Concrete Pile, Enter f'c in psi										
Effective Pile Length, ft	15.000									
Area of One Pile, ft^2	0.117									
Pile Location	X, ft	Z, ft	X, ft	Z, ft	X, ft	Z, ft	X, ft	Z, ft	X, ft	Z, ft
1	12.500	6.000								
2	12.500	2.000								
3	12.500	-2.000								
4	12.500	-6.000								
5	7.500	6.000								
6	7.500	2.000								
7	7.500	-2.000								
8	7.500	-6.000								
9	2.500	6.000								
10	2.500	2.000								
11	2.500	-2.000								
12	2.500	-6.000								
13	-2.500	6.000								
14	-2.500	2.000								
15	-2.500	-2.000								
16	-2.500	-6.000								
17	-7.500	6.000								
18	-7.500	2.000								
19	-7.500	-2.000								
20	-7.500	-6.000								
21	-12.500	6.000								
22	-12.500	2.000								
23	-12.500	-2.000								
24	-12.500	-6.000								
25										
26										
27										

Typically the designer does not take pile flexibility into account since the pile arrangement is unknown and it is conservative to neglect it.

Results

Number of Columns	1

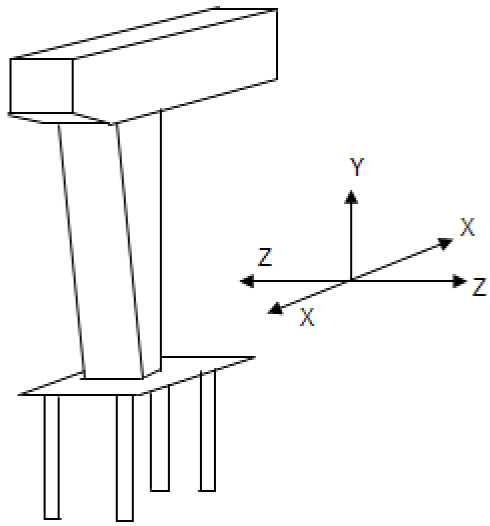
Are Pads Present?	Y
Is Cap Infinitely Rigid?	N
Is Piling Considered?	N

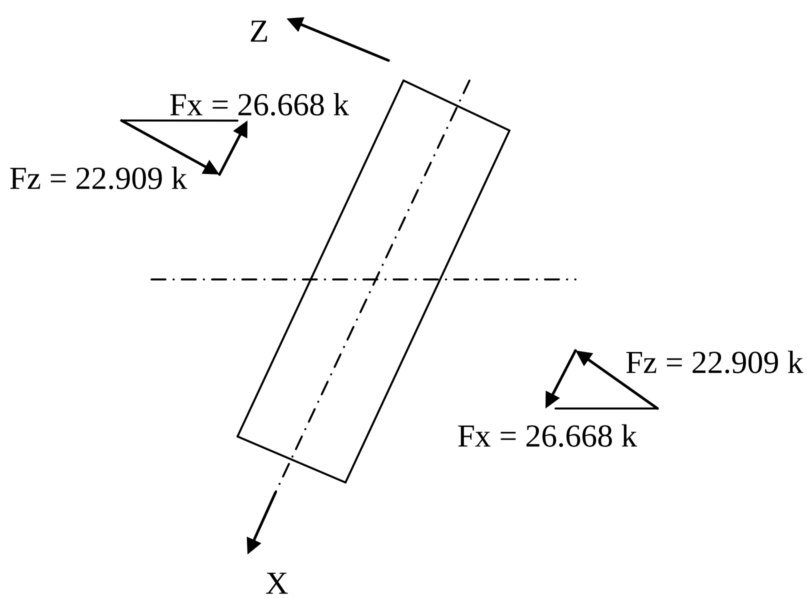
	X-Dir'n, ft	Z-Dir'n, ft
Temperature Movement	0.01455	0.02328

	X-Dir'n, k/ft	Z-Dir'n, k/ft
Pier Stiffness	1832.855	984.051

	X-Dir'n, k	Z-Dir'n, k
Temperature Force	26.668	22.909

These forces are typically divided among the beams and applied to the top of the pier cap in RC-Pier.

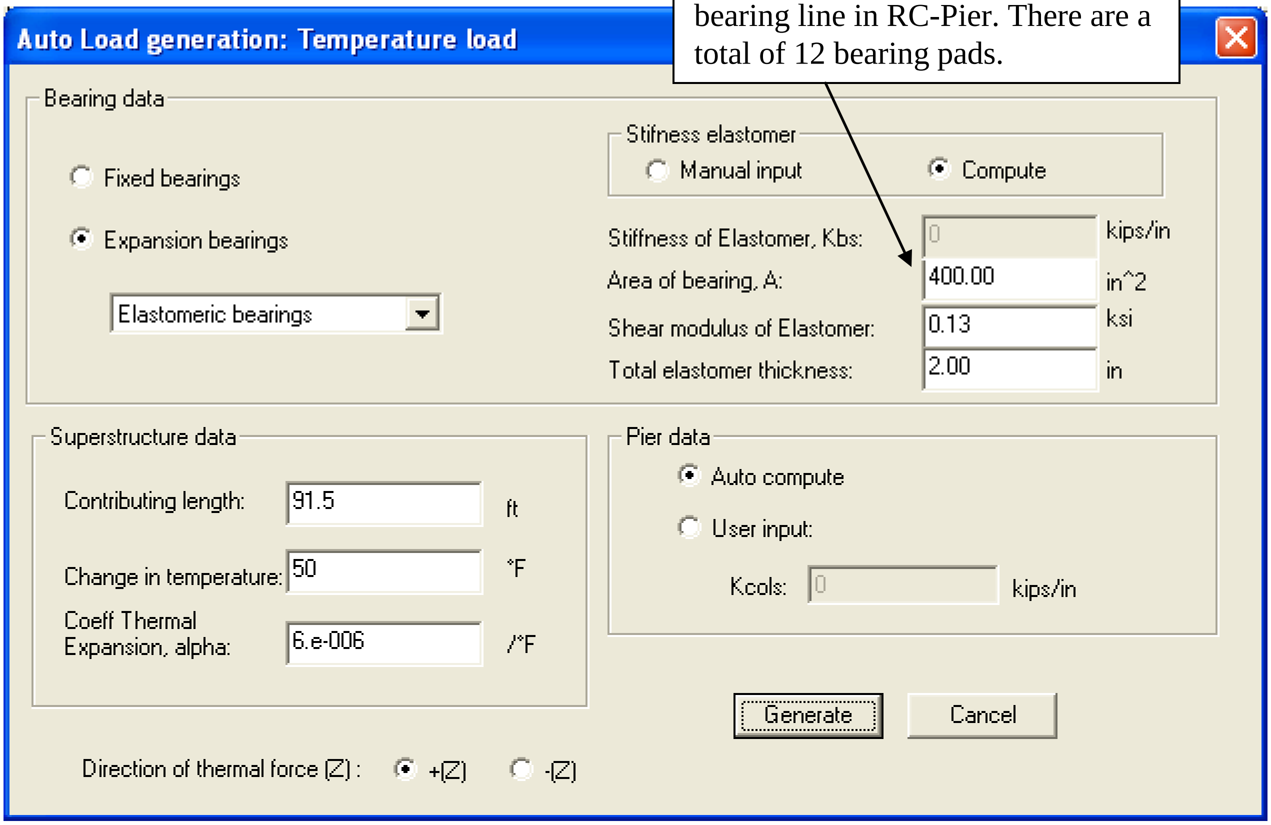




<u>Per Beam</u>
Z: (22.909 k) / (6 beams) = 3.82 k
X: (26.668 k) / (6 beams) = 4.44 k

Auto-generated Temperature Loads in RC-Pier

The area of the bearing pad must be doubled since we only input one bearing line in RC-Pier. There are a total of 12 bearing pads.



RC-Pier does not auto-generate temperature loads for skewed piers according to Iowa DOT policy. First, the program calculates a thermal movement based on user input in the figure above. This thermal movement is assumed to act along the Z-axis of the pier. RC-Pier then calculates a thermal force based on the pier's stiffness about the weak axis (i.e. stiffness about the X-axis). The calculated thermal force is then inconsistently assumed to act along the C.L. of the roadway. Based on that inconsistent assumption, RC-Pier breaks the thermal force into component forces (and subsequently component beam forces) along the X- and Z-axes.

The Iowa DOT assumes the original thermal movement acts along the C.L. of the roadway. This movement is broken down into components along the X- and Z- axes. These component movements are used with the pier's stiffness about the strong and weak axes, respectively, in order to determine the thermal forces in each direction. RC-Pier will only determine the correct thermal forces for piers that are not skewed or for piers that have the same stiffness about both axes.

One additional note is that RC-Pier bases pier stiffness on column heights measured from the bottom of the column to the top of the pier cap. This is a good practice for T-Piers, but not for frame piers.

The temperature loads per beam that RC-Pier would auto-generate for this example based on the input in the figure above are:

$F_z = -3.8179$ k $\qquad$ $F_x = -2.3857$ k

These may be compared to the values calculated per beam on the previous page. The values are not too far off since the bearing pad flexibility is the same along both axes and because it dominates the flexibility.

BR & CE Pier Forces

Developed on 12/15/2005
Last Modified on 8/26/2010

DOT refers to the Iowa Department of Transportation.
OBS refers to the Iowa DOT Office of Bridges and Structures

Please report any spreadsheet errors to the Iowa DOT OBS.

This spreadsheet was developed to aid the design of typical Iowa DOT piers. The Iowa DOT Bridge Design Manual (BDM) should be consulted for the most up-to-date policies.

General Input Tab:

1.) The axes and direction of skew angle match the sign convention used in RC-Pier.
2.) The spreadsheet can handle up to 10 beam lines. The beam spacings can be constant or variable.
3.) Slab and beam dimensions should be entered perpendicular to the centerline of the roadway. Do not enter them along the skew of the pier.
4.) RC-Pier does not have an option to enter haunch thickness, bearing device thickness, or average step height on its Superstructure Parameters screen. This means the auto-generated loads for BR and CE will not be based on these additional dimensions.

RC-Pier Import Feature:

The loads generated by this spreadsheet can be exported to a text file that can be imported directly into RC-Pier.

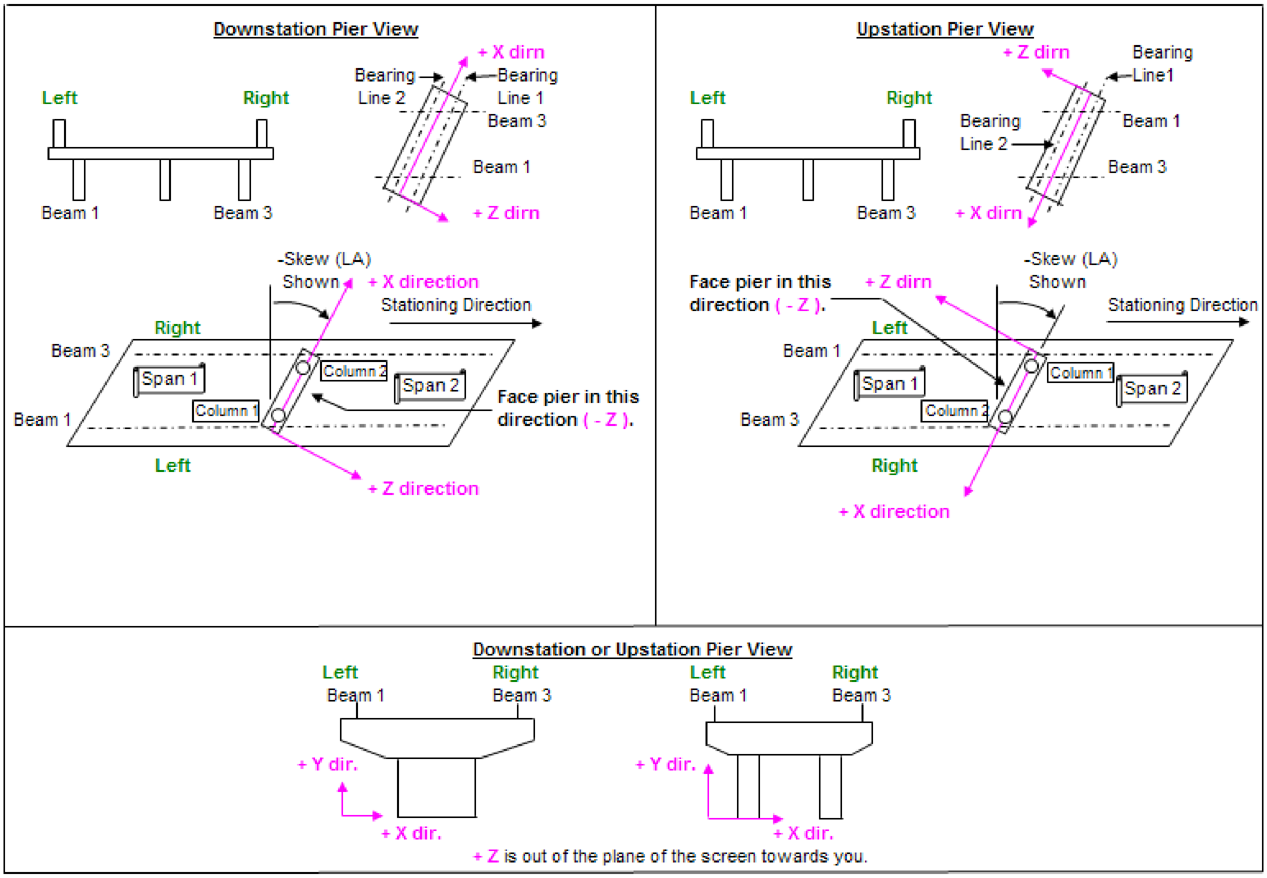
BR Force Tab:

1.) If you auto-generate the BR loads in RC-Pier, then the entire truck portion of the BR load is applied to the pier. In RC-Pier, the truck portion of the BR load is not distributed proportionally to the pier of interest based on total number of bents, average span length, or bearing types. This contradicts office practice.
2.) If you auto-generate the BR loads in RC-Pier, then a torsional moment (Mx) will be generated about the pier cap. Office practice is to exclude such a moment about the pier's weak axis because we assume there is not a sufficient mechansim to transmit a moment from the superstructure to the substructure about this axis.
3.) Do not use the "Two Design Trucks + Lane Load" or "Two Design Tandem + Lane Load" options for auto-generating BR loads. These options use 90% of the axle weight for two trucks/tandems. This would contradict office practice.
4.) Office practice is to base the BR forces on the maximum number of lanes for all load combinations regardless of the number of lanes used for vertical live load. That is, we treat the BR load case (singular) independantly from the vertical live load cases.

CE Force Tab:

1.) The total calculated CE force should, in its entirety, be applied to the pier of interest. The CE force is not distributed among the bents.
2.) If you auto-generate the CE loads in RC-Pier for a skewed bridge, then a torsional moment (Mx) will be generated about the pier cap. Office practice is to exclude such a moment about the pier's weak axis because we assume there is not a sufficient mechansim to transmit a moment from the superstructure to the substructure about this axis.
3.) Do not use the "Two Design Trucks + Lane Load" or "Two Design Tandem + Lane Load" options for auto-generating CE loads. These options use 90% of the axle weight for two trucks/tandems. This would contradict office practice.
4.) Office practice is to base the number of lanes for the CE force on the number of loaded lanes for vertical live load. That is, the CE load cases (plural) and the vertical live load cases are dependant on each other.
5.) The sign of the CE load depends upon the Pier View Direction. A +CE load in the downstation view is a -CE load in the Upstation View.

Definitions



Distribution of BR and CE through Beams

Aashto Lrfd 3.6.4 & 3.6.3

BR = Braking Force **CE = Centrifugal Force**

Important Note:	**Roadway dimensions and beam spacing should be taken as perpendicular to roadway.**

Note:	Blue text is for user input
	Red text is typ. calculated

Pier View Direction (vVIEW), D or U	U	D is downstation, U is upstation	
Skew (vSKW), RA is "+" LA is "-"	-32.000	deg	

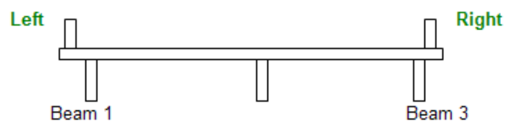
Slab Thickness (vST)	8.000	in	
Haunch Thickness (vHT)	0.000	in	*
Beam Height (vBH)	54.000	in	
Bearing Device Thickness (vBDT)	0.000	in	*
Average Step Height (vASH)	0.000	in	*

Out to Out Slab Width (vOOS)	43.160	ft
Roadway Width (vRW)	40.000	ft
Left Curb Width (vLCW)	1.580	ft

Number of Beams (vNB)	6	
Left Slab Edge to Beam 1 (vBM01)	3.080	ft
Beam 1 to Beam 2 (vBM12)	7.400	ft
Beam 2 to Beam 3 (vBM23)	7.400	ft
Beam 3 to Beam 4 (vBM34)	7.400	ft
Beam 4 to Beam 5 (vBM45)	7.400	ft
Beam 5 to Beam 6 (vBM56)	7.400	ft
Beam 6 to Beam 7 (vBM67)		ft
Beam 7 to Beam 8 (vBM78)		ft
Beam 8 to Beam 9 (vBM89)		ft
Beam 9 to Beam 10 (vBM910)		ft
Last Beam to Right Slab Edge	3.080	ft
Tot. Distance bet. Ext. Beams (vTBD)	37.000	ft

Number of Lanes	MPF
1 Lane (vMPF1)	1.20
2 Lanes (vMPF2)	1.00
3 Lanes (vMPF3)	0.85
> 3 Lanes (vMPF4)	0.65

* RC-Pier does not provide the option to enter these dimensions for its auto-generate features on the Superstructure Parameters screen, so you may want to set them to 0.



Distribution of BR through Beams

Aashto Lrfd 3.6.4

Total Truck Axle Weight (72 kips) or Total Tandem Axle Weight (50 kips) (Do not include impact.)	72.000	k	*
Uniformly Distr. Lane Load (0.640 klf)	0.640	klf	
Average Span Length	81.125	ft	#
Total Bridge Length	223.000	ft	%
Number of Traffic Lanes Loaded	2		

++	BR: 25% of Truck/Tandem	13.096	k	+
	BR: 5% of Design Truck/Tandem + Lane	7.811	k	
	Enter BR Force to be Used (vBRF)	13.096	k	!

Height of BR above Top of Slab (vHTS)	6.000	ft	**

How is Mz Transferred to the Pier? Enter 1 if by Exterior Beams Only Enter 2 if All Beams Participate	1	##

Export Loads to Text Files

* Enter the tandem weight if the tandem controls the live load pier reaction. Enter the truck weight if the truck or double truck controls the live load pier reaction.

\# For some piers it may be necessary to use a different length than the average length (ex. bridges with friction-acting bearings require special consideration).

% This could also be the distance between superstructure expansion joints.

\+ Loads include the number of lanes loaded and the appropriate MPF.

! Allows the user to override the calculated values. Enter positive value.

** BR is typically assumed to act 6' above top of slab.

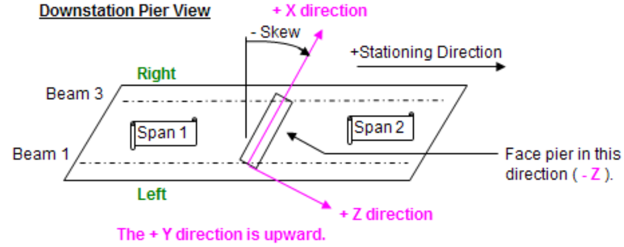
\## The overturning moment, Mz, is transferred to the pier by equal and opposite Fy forces acting through the beams. RC-Pier assumes that only the exterior beams are involved.

Beam #	BR Loads to the Pier (kips)					
	BR acts in +Stationing Dir'n			BR acts in -Stationing Dir'n		
	Fx	Fy	Fz	Fx	Fy	Fz
1	-1.157	-1.776	-1.851	1.157	1.776	1.851
2	-1.157	0.000	-1.851	1.157	0.000	1.851
3	-1.157	0.000	-1.851	1.157	0.000	1.851
4	-1.157	0.000	-1.851	1.157	0.000	1.851
5	-1.157	0.000	-1.851	1.157	0.000	1.851
6	-1.157	1.776	-1.851	1.157	-1.776	1.851
7						
8						
9						
10						
		Mx (k*ft)	-124.021 %%		Mx (k*ft)	124.021 %%

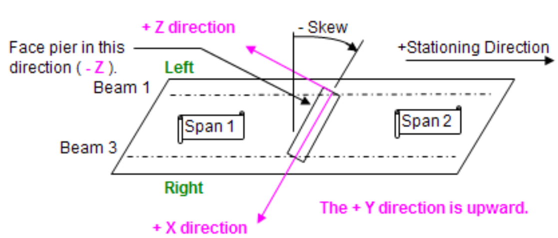
%% Bridge office practice is to set the overturning moment Mx to 0.00 even though RC-Pier does not. Mx is provided here for information only.

++ Typically 25% of the truck will control for short to medium bridge lengths.

Downstation Pier View



Upstation Pier View



<u>Braking Example</u>   Sample Calculations

Use 2 lanes for all vertical LL cases, MPF = 1.0.
Total Truck Axle Weight = 8 k + 32 k + 32 k = 72 k
Average Span Length = (0.5)*(70.75' + 91.5') = 81.125'
Total Bridge Length = 70.75' + 91.5' + 60.75' = 223'

BR Load = (0.25)*(72 k)*(2 lanes)*[(81.125')/(223')]*(1.0) = 13.096 k   ← Controls
OR
= (0.05)*[72 k + (0.640 k/ft)*(223')]*(2 lanes)*[(81.125')/(223')]*(1.0) = 7.811 k

F_{z_total} = (13.096 k)*(cos(32 deg)) = 11.106 k
F_{x_total} = (13.096 k)*(sin(32 deg)) = 6.940 k

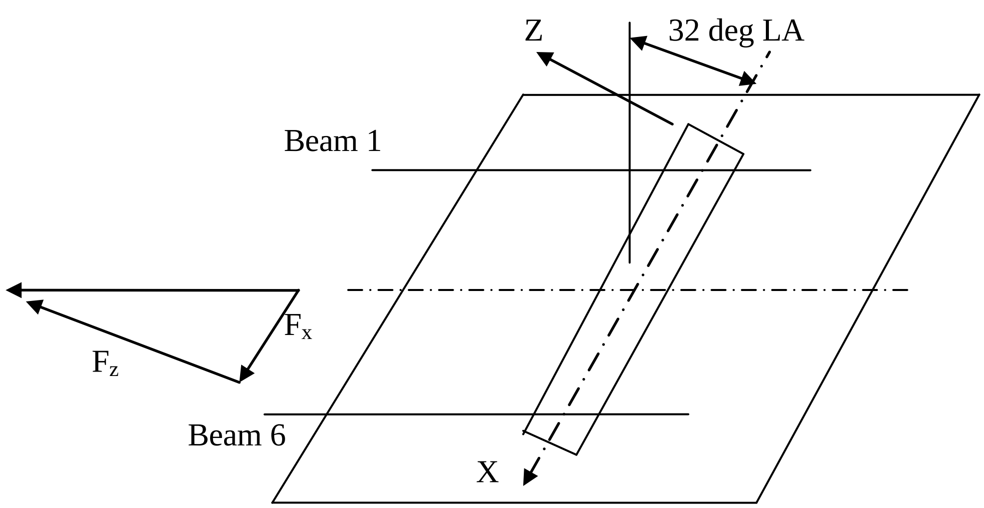
F_z per beam = (11.106 k)/(6 Beams) = 1.851 k
F_x per beam = (6.940 k)/(6 Beams) = 1.157 k

M_z = (6.940 k)*[6' + (8")/(12 in/ft) + (54")/(12 in/ft)] = -77.497 k*ft

F_y = (-77.497 k*ft)/[(5 Beam Spa)*(7.4')/(cos(32 deg))] = -1.776 k

Beam 1, F_y = 1.776 k
Beam 6, F_y = -1.776 k

M_x = (11.106 k)*[6' + (8" + 54")/(12 in/ft)] = 124.021 k*ft   ← Office Policy is to ignore



<u>General Notes for Water Elevations</u> See BDM 6.6.2.7, 6.6.2.9, and 6.6.4.1.3.1

For typical T-piers over water there are 5 water elevations of interest:

1.) Average Low Water Elevation
If the average low water elevation is not listed on the Situation (or TS&L = Type, Size, and Location) Plan prepared by Preliminary Bridge then average low water may be set as 1' above the average stream bed elevation. This water elevation is used in the design for the Strength and Service Limit State combinations.

2.) Design High Water (50 year flood) Elevation
Iowa typically uses this water elevation as the Design Flood for Waterway Opening from Aashto Lrfd 2.2. This water elevation should always be given on the Situation Plan. This water elevation is used in the design for the Strength and Service Limit State combinations.

3.) Ice Elevation
If this elevation is not listed on the Situation Plan then it may be assumed to be midway between Design High Water and Average Low Water. This elevation is used with ice loads in the Extreme Event Limit State.

4.) Design Flood (100 year flood) Elevation
This elevation shall be considered for checking pile scour for the Strength and Service Limit States. See BDM 6.6.4.1.3.1 and Aashto Lrfd 2.2, 2.6.4.4.2, 3.7.5, 10.5.5.3.2, and 11.7.2.3.

5.) Check Flood (500 year flood or Super Flood) Elevation
This elevation shall be considered for checking pile scour for the Strength and Service Limit States. See BDM 6.6.4.1.3.1 and Aashto Lrfd 2.2, 2.6.4.4.2, 3.7.5, 10.5.5.3.2, and 11.7.2.3.

Additional Notes:

- A sixth water elevation is included when a seal coat design is required for coffer dams. This water elevation is based on 25 year flood. See BDM 6.6.4.1.4.
- The 100 year flood is used to determine the need for venting of the superstructure. If venting of the superstructure is required then the designer shall also investigate a special extreme event design condition for the 500 year check flood (BDM 6.6.2.7). The load case will include both vertical and lateral loads on the pile.
- In some instances it may make sense to assume "No Water" rather than "Average Low Water" as a load case. Typically this may make sense when a stream bed is dry for part of the year. Using a "No Water" condition would remove buoyancy loading from the footing and the fill and thus produce a maximum axial load condition for the footing design.

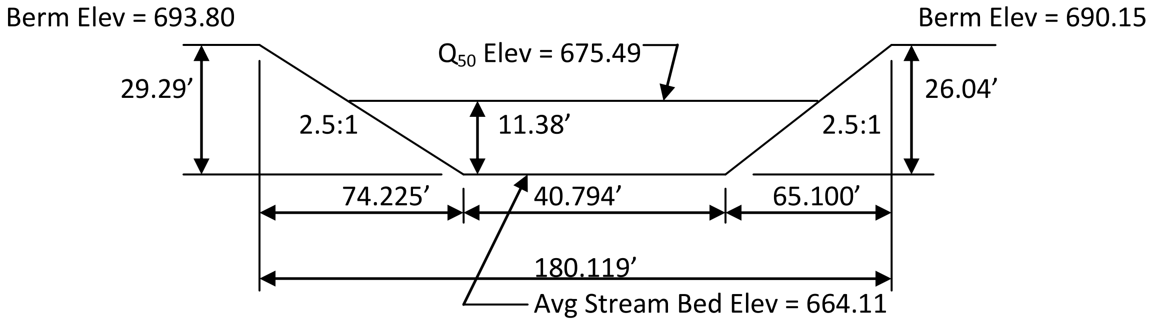
Water Elevations for 1203 Jefferson

1.) Average Low Water Elevation

Average low water elevation is not listed on the Situation plan. The average stream bed elevation is listed as 664.11. So, 1' above that elevation is 665.11 which is the elevation of the Excavation Classification Line.

2.) Design High Water (50 year flood) Elevation

The design high water elevation is listed as 675.49. The Situation plan should typically list the average stream velocity for Q_{50}; however, this plan does not so we will calculate it.



Channel width = (226.542' bridge length)*(cos(32 deg)) – (2)*(3' abut. Width) – (2)*(3' berm width)
= 180.119'

Q_{50} discharge = 4308.4 cfs

Stream area = (11.38')*(40.794') + (2.5 slope)*(11.38')*(11.38') = 788 ft^2

Avg velocity = (4308.4 cfs)/(788 ft^2) = 5.47 ft/s

Note: The pier cross-sectional area may be ignored when determining average stream velocity.

Since the average stream velocity is greater than 5.0 ft/s, the pier will be designed for stream flow forces. The forces will be small since the average velocity is quite low and because the pier is aligned with the channel.

3.) Ice Elevation

The ice elevation is not listed on the Situation plan. This elevation may be assumed to be midway between Design High Water and Average Low Water which is (0.5)*(675.49 + 665.11) = 670.30. The drainage area for this bridge is only 3.75 square miles so ice loads may not be a concern according to BDM 6.6.1.1.2 and 6.6.2.9. However, this design will still consider ice load.

4.) Design Flood (100 year flood) Elevation

This elevation is given as 676.12 on the Situation plan. The calculated scour is 6.23'. This example will not consider the scour checks.

5.) Check Flood (500 year flood or Super Flood) Elevation

This elevation is not listed on the Situation plan. The policy for including this data was not yet in-place when this bridge was designed. This example will not consider the scour checks.

Notes: There is no indication that coffer dams are needed for this structure. The 100 year design flood elevation is well below the bottom of the prestressed beams. Stream and wind forces are assumed not to act below the top of the (exposed) footing.

Water Elevation Load Combinations

The load cases below are assumed to cover the force envelope needed for this particular design with respect to the loads considered below. Other pier designs may require additional load cases.

Strength/Service Load Combinations

Case 1 -- Maximum Axial Load

- Average low water
- Full soil cover / No scour
- No stream forces needed for average low water
- Bouyancy for average low water
- Wind on substructure above pier's soil cover (the soil cover at the pier is higher than the average low water elevation)

Case 2 -- Minimum Axial Load

- Design high water
- No soil cover / Full scour
- Stream forces based on design high water
- Bouyancy for design high water
- Wind on substructure above design high water

Extreme Event 2 Combination

Case 3 -- Must assume the soil is scoured away if ice forces are to be present on the pier

- Ice elevation
- No soil cover / Full scour
- Stream forces ignored since they will be minimal
- Bouyancy based on ice elevation
- Wind forces are not a part of Extreme Event 2

Summary of Elevations

Footing thickness = 4'
Top of footing elevation = 661.71'
Bottom of footing elevation = 657.71'

Average low water elevation = 665.11'
Design high water elevation = 675.49'
Ice elevation = 670.30'

Soil elevation = 671.71' (assumed 10' of cover on top of footing)

WA & IC Pier Forces

DOT refers to the Iowa Department of Transportation.
OBS refers to the Iowa DOT Office of Bridges and Structures

Developed on 12/20/2006
Last Modified on 8/26/2010

The OBS will only support those persons using this software in connection with Iowa DOT related business.

Please report any spreadsheet errors to the Iowa DOT OBS.

This spreadsheet was developed to aid the design of typical Iowa DOT piers. The Iowa DOT Bridge Design Manual (BDM) should be consulted for the most up-to-date policies.

Forces calculated include stream flow, buoyancy and ice. These loads are for the cap and column design since the point of fixity is assumed to be at base of column.

General Input Tab:
1.) The axes and direction of skew angle match the sign convention used in RC-Pier.

WA Force Tab:
1.) Stream flow pressure and bouyancy are considered.
2.) The TS&L should report the design high water and check flood events. The average low water may also be given on the TS&L.
3.) For piers nominally parallel with stream flow in streams with low average velocities, 0 to 5 ft/s, stream flow pressures may be neglected. However, if there is any skew between the pier and the stream flow, the designer shall determine the longitudinal and lateral pressures even if the average velocity is below 5 ft/s. Also, if the average velocity exceeds 5 ft/s then the designer shall determine the stream flow pressures.
4.) Normally the design highwater and average low water will be used for Strength and Service Limit States. The check flood events are limited to the Extreme Event Limit States. Foundation scour should be considered as appropriate.
5.) Stream flow forces on the superstructure are not considered in this spreadsheet, but they should be addressed if the possibility exists.
6.) A longitudinal drag coefficient, C_D, of 1.4 based on debris being present is assumed when computing stream pressures. However, the dimensions of the pier should be used in determining stream flow forces unless there is specific information about debris raft dimensions.
7.) Bouyancy forces should always be applied to the footing, soil, column, cap, and superstructure as is appropriate to the water level under consideration.

IC Force Tab:
1.) Only dynamic ice force effects are considered in this spreadsheet -- Aashto Lrfd 3.9.2.
2.) The effective ice crushing strength should be taken as 24.0 ksf per BDM 6.6.2.9. The design ice thickness is also given in the same section of the BDM.
3.) It is permissible to use the small stream reduction factor for stream widths less than 300' at mean water level. As a simplification, Iowa assumes stream width is equal to bridge length.
4.) Iowa does not typically slope the nose of T-Piers; thus the ice force is usually controlled by crushing rather than flexure.
5.) Normally the pier is aligned with the stream; however, provision is made in this spreadsheet to account for piers skewed to flow -- see Aashto Lrfd 3.9.2.4.2.

Loads WA and IC

WA = Water Loads **IC = Ice Load**

Pier View Direction (vVIEW), D or U	U	D is downstation, U is upstation	
Skew (vSKW), RA is "+" LA is "-"	-32.000	deg	

Note:	Blue text is for user input
	Red text is typ. calculated

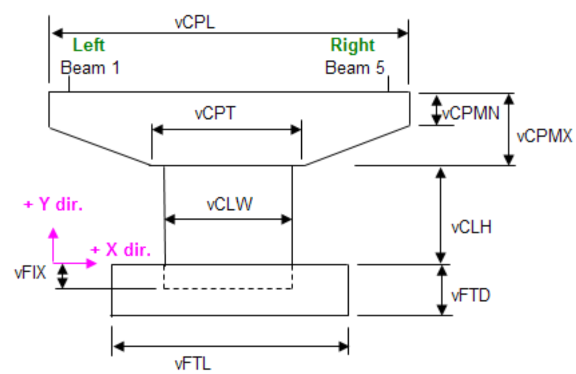
Important Note:	**Cap length, column width, and footing length should be taken along the skew (X axis).**

Cap Length, X (vCPL)	49.000	ft
Lgth of Non-Tapered Segment, X (vCPT)	20.500	ft
Cap Depth, Z (vCPD)	3.500	ft
Cap Min. Height, Y (vCPMN)	4.000	ft
Cap Max. Height, Y (vCPMX)	7.000	ft

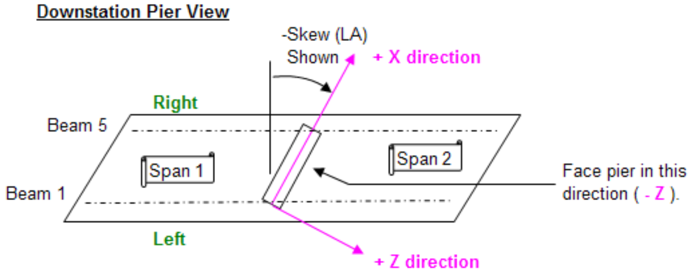
Column Width, X (vCLW)	19.500	ft
Column Depth, Z (vCLD)	3.000	ft
Column Height, Y (vCLH)	25.000	ft

Footing Length, X (vFTL)	28.000	ft
Footing Width, Z (vFTW)	15.000	ft
Footing Depth, Y (vFTD)	4.000	ft

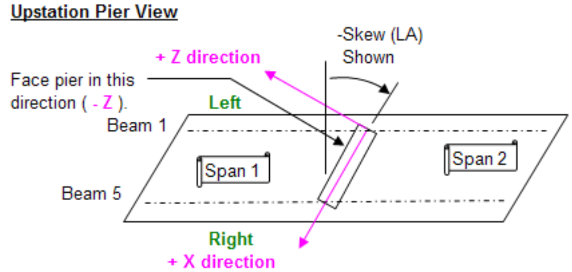
Column Extension to Fixity, Y (vFIX)	0.000	ft	Typically 0'. This is only used to adjust start and end fractions (y1 / L and y2 / L) for loads.



Downstation Pier View



Upstation Pier View



WA Force (Stream Flow & Bouyancy)

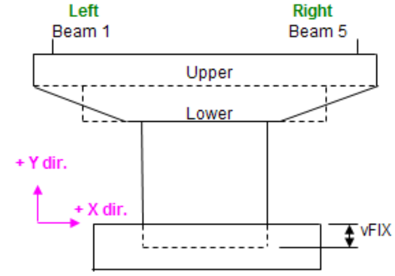
Aashto Lrfd 3.7

Up to 4 cases may be evaluated.

	Case 1	Case 2	Case 3	Case 4	
Height of Water above Top of Footing	3.400	13.780	8.590	0.000	ft
Height of Soil above Top of Footing	10.000	0.000	0.000	0.000	ft

Do not enter negative values for heights of soil and water above top of footing.

There is no Case 4.



Stream Flow

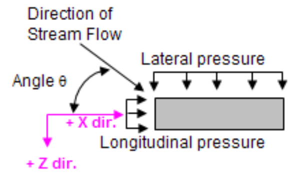
Longit. Drag Coefficients   Aashto Lrfd Table 3.7.3.1-1

Pier Nose Type	C_D
Semi-circular nosed pier	0.70
Square-ended pier	1.40
Debris lodged against the pier	1.40
Wedge nose pier: nose ang. 90 deg. or less	0.80
Longitudinal Drag Coefficient Used, C_D	1.40

BDM policy is to assume debris is present.

Lateral Drag Coefficients   Aashto Lrfd Table 3.7.3.2-1

Stream Flow Angle θ	C_L
0 degrees	0.00
5 degrees	0.50
10 degrees	0.70
20 degrees	0.90
>= 30 degrees	1.00
Lateral Drag Coefficient Used, C_L	0.00



If stream velocity at the pier is 5 ft/sec. or less and CL = 0.00 then stream pressure can be ignored.

	Case 1	Case 2	Case 3	Case 4	
Average Stream Velocity, Vavg = Q / A	5.470	5.470	5.470	0.000	ft/sec.

The maximum pressure is double the average pressure and the pressure distribution to the pier is triangular with the maximum pressure at the highest elevation. (See Aashto Std Spec 3.18.1.1)

The Aashto Std. Spec. has a better description than the Lrfd Spec.

	Case 1	Case 2	Case 3	Case 4	
Longitudinal pressure (average)	0.0419	0.0419	0.0419	0.0000	ksf
Lateral pressure (average)	0.0000	0.0000	0.0000	0.0000	ksf

The "Lower" part of the pier cap is treated like an equivalent rectangle for the determination of stream loading. The total lateral pier cap stream load is averaged over the entire pier cap length. In RC-Pier, all pier cap stream loads are applied at the mid-height of the "Upper" part of the pier cap. The loads have not been adjusted to account for the change in point of application. The user must enter the appropriate sign into RC-Pier to account for the direction of stream flow. Note: Stream flow forces on the footing are not considered. Also, it is assumed that stream velocity and pressure at the top of the footing can not be greater than 0. The column start and end fractions have been adjusted for point of fixity (vFIX).

	Stream Loads on the Pier Cap					Stream Loads on the Column						
	Type of Load	Direction	Magnitude	Start Fraction x1 / L	End Fraction x2 / L	Type of Load	Direction	Start Mag. 1	Start Fraction y1 / L	End Mag. 2	End Fraction y2 / L
Case 1	Force (k)	X	0.000	0.500	---------	Trap (k/ft)	X	0.000	0.000	0.000	0.000
	UDL (k/ft)	Z	0.000	0.000	1.000	Trap (k/ft)	Z	0.000	0.000	0.000	0.000
Case 2	Force (k)	X	0.000	0.500	---------	Trap (k/ft)	X	0.000	0.000	0.251	0.459
	UDL (k/ft)	Z	0.000	0.000	1.000	Trap (k/ft)	Z	0.000	0.000	0.000	0.459
Case 3	Force (k)	X	0.000	0.500	---------	Trap (k/ft)	X	0.000	0.000	0.251	0.286
	UDL (k/ft)	Z	0.000	0.000	1.000	Trap (k/ft)	Z	0.000	0.000	0.000	0.286
Case 4	Force (k)	X	0.000	0.500	---------	Trap (k/ft)	X	0.000	0.000	0.000	0.000
	UDL (k/ft)	Z	0.000	0.000	1.000	Trap (k/ft)	Z	0.000	0.000	0.000	0.000

Fill elev. is higher than water elev. so there are no stream forces for Case 1.

As stated earlier, stream flow forces for Case 3 will be ignored.

Bouyancy

Specific Weight of Water	0.0624	kcf

In RC-Pier, all pier cap bouyancy loads are applied at the mid-height of the "Upper" part of the pier cap. For calculating soil bouyancy the column is assumed to extend infinitely upwards and is, therefore, deducted from the soil volume (the cap is ignored). Soil is assumed to be 1/3 void. The column start and end fractions have been adjusted for point of fixity (vFIX).

	Bouyancy on the Pier Cap					Bouyancy on the Column						Bouyancy on the Soil		
	Type of Load	Direction	Magnitude	Start Fraction x1 / L	End Fraction x2 / L	Type of Load	Direction	Magnitude	Start Fraction y1 / L	End Fraction y2 / L	Total Col. Bouyant Force (k)	Type of Load	Direction	Magnitude
Case 1	Force (k)	Y	0.000	0.500	---------	UDL (k/ft)	Y	3.650	0.000	0.113	12.411	Force (k)	Y	51.131
Case 2	Force (k)	Y	0.000	0.500	---------	UDL (k/ft)	Y	3.650	0.000	0.459	50.303	Force (k)	Y	0.000
Case 3	Force (k)	Y	0.000	0.500	---------	UDL (k/ft)	Y	3.650	0.000	0.286	31.357	Force (k)	Y	0.000
Case 4	Force (k)	Y	0.000	0.500	---------	UDL (k/ft)	Y	3.650	0.000	0.000	0.000	Force (k)	Y	0.000

	Bouyancy on the Footing		
	Type of Load	Direction	Magnitude
All Cases	Force (k)	Y	104.832

Footing is assumed to be entirely immersed.

IC Force (Ice)

Aashto Lrfd 3.9

Height of Ice Force above Top of Footing	8.590	ft	Typically, halfway between design high water and average low water. The ice force is assumed to act on the column not on the cap.

Effective Ice Strength , p — Aashto Lrfd 3.9.2.1

Description	p		
Breakup at melt. temp., ice structure is substantially disinteghrated	8.00	ksf	
Breakup at melt. temp., ice structure is somewhat disinteghrated	16.00	ksf	
Breakup or major ice movement at melt. temp.; large sound ice movements	24.00	ksf	
Breakup or major ice movement when avg. ice temp. is below melt. temp.	32.00	ksf	
Effective Ice Strength Used, p	24.00	ksf	BDM Policy is to use 24 ksf for typical bridges.

Ice Thickness, t

District	t	BDM 6.6.2.9
5	1.2500	ft
1, 4, 6	1.4167	ft
2, 3	1.5833	ft
Ice Thickness Used, t	1.2500	ft

Stream Width (equal to bridge length)	223.000	ft
Longest Adjacent Span Length	91.500	ft

Red'n Factor K_l for Small Streams — Aashto Lrfd Table C3.9.2.3-1

A/r^2	K_l	
1000	1.00	
500	0.90	
200	0.70	
100	0.60	
50	0.50	
Calculated A/r^2	1298.87	
Calculated K_l	1.000	If the stream width (i.e. bridge length) exceeds 300' then K_l = 1.00.

Parallel Ice Flow

Aashto Lrfd 3.9.2.4.1

Crushing Coefficient, Ca	1.756		
Inclination of Pier Nose from Vertical, α	0.000	deg	Iowa does not typically slope the nose of T-Piers.
Flexure Coefficient, Cn	N/A		

Horizontal Crushing Ice Force, Fc	158.035	k	
Horizontal Flexure Ice Force, Fb	N/A	k	Fb is not applicable if α <= 15 or pier width to ice thickness > 6.
Long. Ice Force Used, F	158.035	k	Use the minimum of crushing or flexure.

The user must enter the appropriate sign into RC-Pier to account for the direction of stream flow. The column start and end fractions have been adjusted for point of fixity (vFIX).

Note: According to Aashto Lrfd 3.9.2.4.1 both the longitudinal and transverse ice forces shall be assumed to act at the nose of the pier. This implies that the user should enter a torque loading, My, about the column's vertical axis. Office practice does not address this effect for typical bridges.

Ice Loads on the Pier Column - Case 1

Type of Load	Direction	Magnitude	Start Fraction y1 / L	End Fraction y2 / L	
Force (k)	X	158.035	0.286	---------	Use full longitudinal value.
Force (k)	Z	23.705	0.286	---------	Transverse is 15% of longitudinal.

Pier Nose Angle in a Horizontal Plane	100.000	deg	Use 100 degrees for rounded pier nose.
Friction Angle bt. Ice and Pier Nose	6.000	deg	Assume 6 degrees -- see BDM 6.6.2.9.

Ice Loads on the Pier Column - Case 2

Type of Load	Direction	Magnitude	Start Fraction y1 / L	End Fraction y2 / L	
Force (k)	X	79.017	0.286	---------	Use 50% of full longitudinal value.
Force (k)	Z	53.298	0.286	---------	Percent of longitudinal based on nose and friction angles.

Skewed Ice Flow

Aashto Lrfd 3.9.2.4.2

The assumption here is that the ice will fail by crushing since we are using a projected area that is not likely to have an inclination angle.

Skewed ice flow is not applicable.

Skew Angle between Ice Floe and Pier	0.000	deg	If the skew angle is 0 degrees then these forces are not applicable.

Projected Column Face	3.000	ft
Crushing Coefficient, Ca	1.756	

Horizontal Crushing Ice Force, Fc	158.035	k	This force will be resolved into components along the X and Z axes. The transverse force (Z-axis) must be at least 20% of the total.

The user must enter the appropriate sign into RC-Pier to account for the direction of stream flow. The column start and end fractions have been adjusted for point of fixity (vFIX).

Ice Loads on the Pier Column

Type of Load	Direction	Magnitude	Start Fraction y1 / L	End Fraction y2 / L
Force (k)	X	158.035	0.286	---------
Force (k)	Z	31.607	0.286	---------

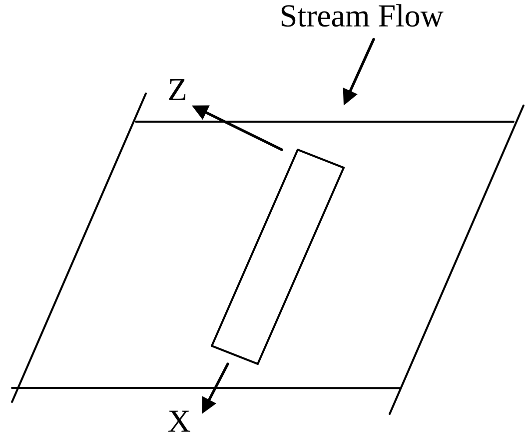
Stream Force Calculations for Case 2 Sample Calculations

V_{avg} = 5.47 ft/s

Drag Coefficients: Longitudinal, C_D = 1.40 Office policy is to assume debris is present.
Lateral, C_L = 0.00 There is no skew between pier and stream flow.

Avg Longitudinal Pressure = $[(C_D)*(V_{avg})^2]/1000 = [(1.40)*(5.47\ ft/s)^2]/1000 = 0.0419$ ksf
Avg Lateral Pressure = $[(C_L)*(V_{avg})^2]/1000 = [(0.00)*(5.47\ ft/s)^2]/1000 = 0.00$ ksf

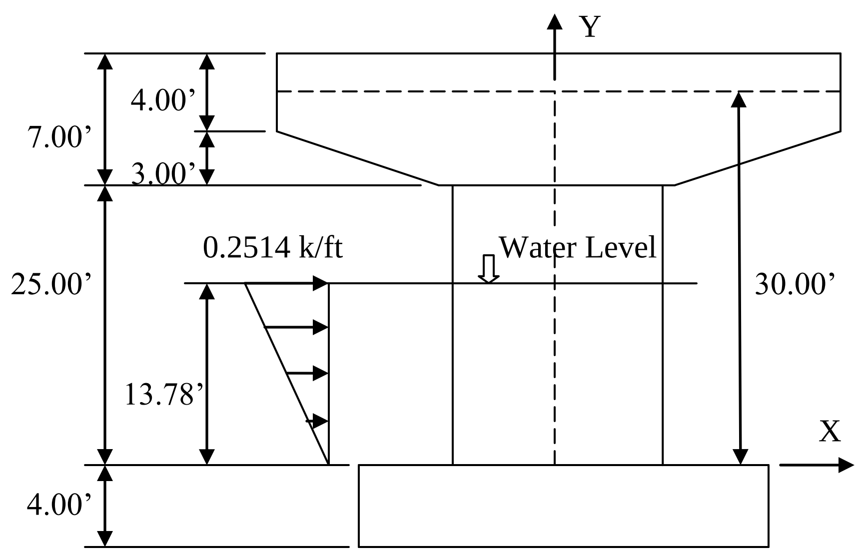
Max Longitudinal Pressure = (2)*(0.0419 ksf) = 0.0838 ksf
Max Lateral Pressure = (2)*(0.00 ksf) = 0.00 ksf



Column Depth (Z-axis) = 3.00’
Equivalent Column Width (X-axis) = 19.50’

Height of Water = 13.78’ above top of footing

Stream Force on Column
Longitudinal = (0.0838 ksf)*(3’) = 0.2514 k/ft
Lateral = (0.00 ksf)*(19.5’) = 0.00 k/ft



Note: Dashed line indicates structural model.

For Column and Cap Design:
Start Fraction = (0.00’)/(30.00’) = 0.00
End Fraction = (13.78’)/(30.00’) = 0.4593

For Footing Design: The point of fixity will move to the bottom of the footing.
Start Fraction = (4.00’)/(34.00’) = 0.1176
End Fraction = (17.78’)/(34.00’) = 0.5229

Bouyancy Calculations for Case 2 Sample Calculations

Total Column Bouyancy Force = (13.78’)*(19.50’)*(3.00’)*(0.0624 kcf) = 50.303 k up

The column buoyancy is typically applied as a distributed vertical load.

Column Bouyancy Force per foot = (19.50’)*(3.00’)*(0.0624 kcf) = 3.650 k up

For Column and Cap Design:

Start Fraction = (0.00’)/(30.00’) = 0.00

End Fraction = (13.78’)/(30.00’) = 0.4593

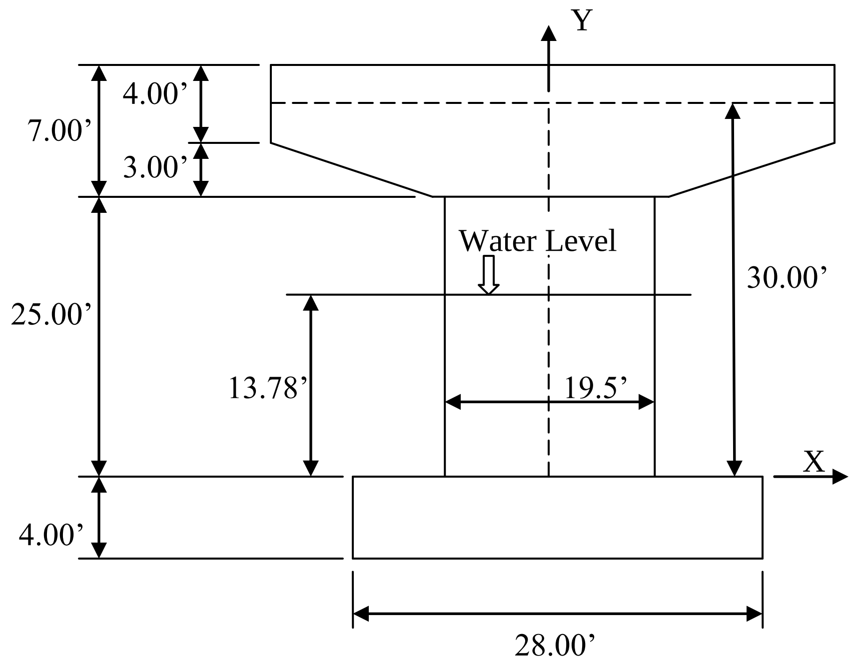
For Footing Design: The point of fixity will move to the bottom of the footing.

Start Fraction = (4.00’)/(34.00’) = 0.1176

End Fraction = (17.78’)/(34.00’) = 0.5229

Footing Bouyancy Force = (4.00’)*(28.00’)*(15.00’)*(0.0624 kcf) = 104.832 k up

Note: The soil is assumed to have been scoured away for the Case 2 condition.



Ice Load Calculations for Case 3 Sample Calculations

Ice elevation = 8.590' above top of footing
Effective ice strength, p = 24.00 ksf Office policy
Ice thickness, t = 1.25' Jefferson County is in District 5
Stream width = 223.00' Office policy is to set stream width equal to bridge length
Longest adjacent span length = 91.50'
Column width, w = 3.00'

Small Stream Reduction Factor, K_1, Aashto Lrfd 3.9.2.3

Stream width = 223.00' < 300.00' so reduction factor may be considered

Plan area of largest ice floe, $A = (\pi)*[(2/3)*(0.5)*(91.5')]^2 = 2922.5\ ft^2$

Radius of pier nose = 1.50'

$A/r^2 = (2922.5\ ft^2)/[(1.50')^2] = 1298.9 > 1000$ so $K_1 = 1.00$ No small stream reduction factor

Crushing or Flexing Ice Force, Aashto Lrfd 3.9.2.2

w/t = 3.00'/1.25' = 2.40 <= 6.0 which means the ice force, F, should be the lesser of the crushing force, F_c, or the flexing force, F_b

$F_c = (C_a)*(p)*(t)*(w)$ where $C_a = (5t/w + 1)^{0.5}$

$Fb = (C_n)*(p)*(t^2)$ where $C_n = 0.5/(\tan(\alpha - 15))$

The flexing force, F_b, is not applicable since the nose of the T-Pier is not inclined.

$C_a = [((5)*(1.25'))/(3.00') + 1]^{0.5} = 1.756$

$F_c = (1.756)*(24.00\ ksf)*(1.25')*(3.00') = 158.035\ k$

$F = F_c = 158.035\ k$

Ice Forces for Piers Parallel to Flow, Aashto Lrfd 3.9.2.4.1

a.) A longitudinal force equal to F shall be combined with a transverse force of 0.15*F

$F_x = F = 158.035\ k$

$F_z = 0.15*F = (0.15)*(158.035\ k) = 23.705\ k$

b.) A longitudinal force of 0.5*F shall be combined with a transverse force of F_t

$F_x = 0.5*F = (0.5)*(158.035\ k) = 79.017\ k$

$F_z = F_t = F/[2*\tan(\beta/2 + \theta_f)] = (158.035\ k)/[(2)*(\tan((0.5)*(100\ deg) + (6\ deg)))] = 53.298\ k$

Note: The F_z ice forces may act in both directions.

For Column and Cap Design:

Point of Column Application = (8.59')/(30.00') = 0.2863

For Footing Design: The point of fixity will move to the bottom of the footing.

Point of Column Application = (12.59')/(34.00') = 0.3703

Wind Load Cases

Simplified wind loading will be used. This is also referred to as wind on usual slab and girder bridges in Aashto Lrfd 3.8. Iowa has extended the applicability of this Lrfd code provision to cover more cases – see BDM 6.6.2.8.

There are essentially 3 different wind load cases on the substructure due to the various water and fill elevations. The different cases only affect the application of the wind load to the T-pier, not its magnitude.

Case 1: Average Low Water Elevation
- Average low water elevation = 665.11’
- Soil elevation = 671.71’ (assumed 10’ of cover on top of footing)

Case 2: Design High Water (50 year flood) Elevation
- Design high water elevation = 675.49’

Case 3: Ice Elevation
- Ice elevation = 670.30’

The footing elevations are:
- Footing thickness = 4’
- Top of footing elevation = 661.71’
- Bottom of footing elevation = 657.71’

LRFD Simplified Wind Loading for Usual Girder Bridges

Developed on 12/20/2005
Last Modified on 8/26/2010

DOT refers to the Iowa Department of Transportation.
OBS refers to the Iowa DOT Office of Bridges and Structures

The OBS will only support those persons using this software in connection with Iowa DOT related business.

Please report any spreadsheet errors to the Iowa DOT OBS.

This spreadsheet was developed to aid the design of typical Iowa DOT piers. The Iowa DOT Bridge Design Manual (BDM) should be consulted for the most up-to-date policies.

Description:
This spreadsheet is designed to generate the wind loads used as input into RC-Pier. Specifically, it generates the wind loads for the simplified wind loading case. The definition of "usual girder bridge" in AASHTO Lrfd 3.8.1.2.2 and 3.8.1.3 has been modified by the Iowa DOT in order to extend the range of applicabilty. The individual span length has been extended from 125' to 160' in order to allow this loading to be used for the BTE155s. The maximum height of 30' above low ground or water level has been increased to 100'.

RC-Pier Import Feature:
The loads generated by this spreadsheet can be exported to a text file that can be imported directly into RC-Pier.

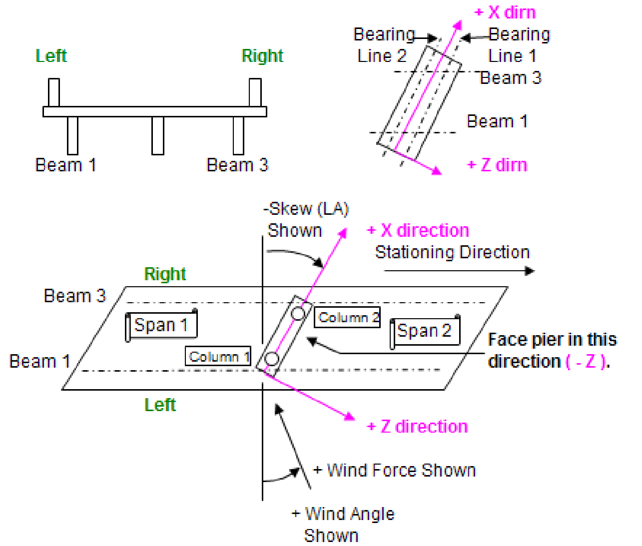
General Input Tab:
1.) The axes and direction of skew angle match the sign convention used in RC-Pier.
2.) Axes may be based on Downstation or Upstation Pier View.
3.) The spreadsheet can handle up to 10 beam lines. The beam spacings can be constant or variable.
4.) Slab and beam dimensions should be entered perpendicular to the centerline of the roadway. Do not enter them along the skew of the pier.
5.) RC-Pier does not have an option to enter haunch thickness, bearing device thickness, or average step height on its Superstructure Parameters screen. This means the auto-generated loads for W and WL will not be based on these additional dimensions.
6.) The spreadsheet can handle up to 5 columns. The column spacing input is not required.

W Force Tab:
1.) If the top of barrier rail is less than or equal to 100' above the ground or water surface then office practice is to use the simplified wind pressure values from Aashto Lrfd 3.8.1.2.2. If the top of barrier rail is above the 100' mark then the user should adjust the wind pressures upward.
2.) If the top of the pier cap is less than or equal to 100' above the ground or water surface then office practice is to use a 0.040 ksf wind pressure (Aashto Lrfd 3.8.1.2.3) in both orthogonal directions at the same time. If the top of the pier cap is above the 100' mark then the user should adjust the wind pressure upward.
3.) Currently RC-Pier's auto-generate feature for WS loads does not handle uplift forces correctly when they are reversible, nor does it restrict uplift to Strength 3 loading. Aashto Lrfd 3.8.2 also restricts vertical wind pressure to a 0 degree wind skew angle. Uplift will be used in conjuction with Strength 3 loading and the simplified wind loading. Typical piers should use a set of wind load cases both with and without uplift.

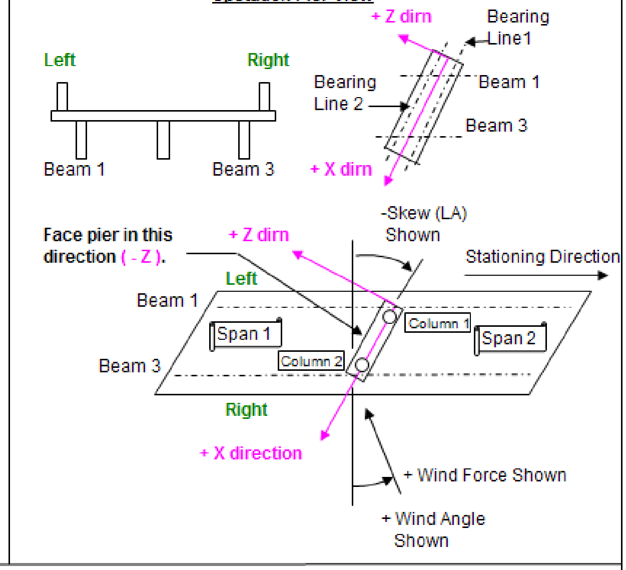
WL Force Tab:
1.) This spreadsheet uses the wind pressure values from Aashto Lrfd 3.8.1.3. The user may adjust these pressures.

Definitions

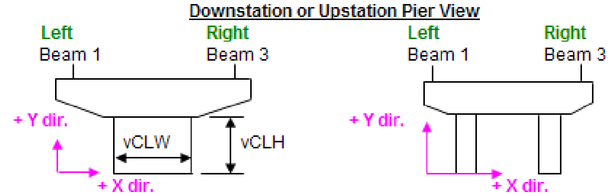
Downstation Pier View



Upstation Pier View

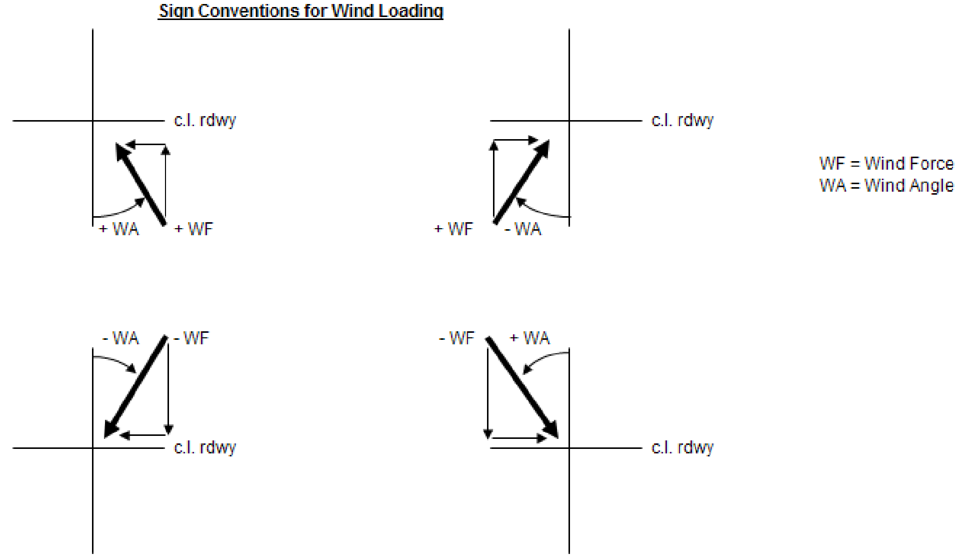


Downstation or Upstation Pier View



+ Z is out of the plane of the screen towards you.

Sign Conventions for Wind Loading



General Input

Note:	Blue text is for user input
	Red text is typ. calculated

Pier View Direction (vVIEW), D or U	U		D is downstation, U is upstation
Skew (vSKW), RA is "+" LA is "-"	-32.000	deg	

Important Note:	**Roadway dimensions and beam spacing should be taken as perpendicular to roadway.**

Out to Out Slab Width (vOOS)	43.160	ft
Roadway Width (vRW)	40.000	ft
Left Curb Width (vLCW)	1.580	ft

Barrier Rail Height (vBRH)	34.000	in	
Slab Thickness (vST)	8.000	in	
Haunch Thickness (vHT)	0.000	in	#
Beam Height (vBH)	54.000	in	
Bearing Device Thickness (vBDT)	0.000	in	#
Average Step Height (vASH)	0.000	in	#

RC-Pier does not provide the option to enter these dimensions, so you may want to set them to 0.

Number of Beams (vNB)	6	
Left Slab Edge to Beam 1 (vBM01)	3.080	ft
Beam 1 to Beam 2 (vBM12)	7.400	ft
Beam 2 to Beam 3 (vBM23)	7.400	ft
Beam 3 to Beam 4 (vBM34)	7.400	ft
Beam 4 to Beam 5 (vBM45)	7.400	ft
Beam 5 to Beam 6 (vBM56)	7.400	ft
Beam 6 to Beam 7 (vBM67)		ft
Beam 7 to Beam 8 (vBM78)		ft
Beam 8 to Beam 9 (vBM89)		ft
Beam 9 to Beam 10 (vBM910)		ft
Last Beam to Right Slab Edge	3.080	ft
Tot. Distance bet. Ext. Beams (vTBD)	37.000	ft

Important Note:	**Cap length and column spacing should be taken along the skew (X axis).**

Cap Length (vCPL)	49.000	ft	
Length of Non-Tapered Segment (vCPT)	20.500	ft	It is assumed to be centered.
Cap Min. Height (vCPMN)	48.000	in	
Cap Max. Height (vCPMX)	84.000	in	
Cap Depth (vCPD)	42.000	in	

Column Width or Diameter (vCLW)	234.000	in	
Col. Depth - enter 0 for round col. (vCLD)	36.000	in	
Col. Height (vCLH)	25.000	ft	Bottom of column to bottom of cap.

Number of Columns (vNC)	1	
Left Cap Edge to Col. 1 (vCL01)	24.500	ft
Col. 1 to Col. 2 (vCL12)		ft
Col. 2 to Col. 3 (vCL23)		ft
Col. 3 to Col. 4 (vCL34)		ft
Col. 4 to Col. 5 (vCL45)		ft
Last Column to Right Cap Edge	24.500	ft

Case 1 is input into the spreadsheet.

Distribution of W to Pier

Aashto Lrfd 3.8

V_{30}, wind velocity at 30' height	80.000	mph
V_B, base wind velocity of 100 mph at 30' hgt	100.000	mph

Office policy is to use V_{30} = 80 mph

Aashto Lrfd Table 3.8.1.1-1

Upstream Surface Condition	Open Country 1	Suburban 2	City 3	User Option 4
Vo (mph)	8.20	10.90	12.00	0.00
Zo (ft)	0.23	3.28	8.20	0.00

Enter Upstream Surface Condition (1 to 4)	1	
Vo, friction velocity	8.200	mph
Zo, friction length of upstream fetch	0.23	ft

Office policy is to use Open Country

Hgt above col. base to ground / water surf.	10.000	ft

This height is used to establish Z and is also used in determining the exposed column area for wind loading. RC-Pier always bases Z on the bottom of the column.

Aashto Lrfd Eqn 3.8.1.1-1 and 3.8.1.2.1-1

$V_{DZ} = 2.5 * Vo * (V_{30} / V_B) * \ln(Z / Zo)$ --> where V_{DZ} is the wind design velocity at elevation Z

$P_D = P_B * (V_{DZ} / V_B)^2$ --> where P_B is the base wind pressure

Superstructure Wind

Calc. Z (top of curb to ground/water surf.)	30.000	ft
User's Z	100.000	ft

V_{DZ}, calculated design velocity at User's Z	99.627	mph
User's V_{DZ}	100.000	mph

Aashto Lrfd 3.8.1.2.2

Skew Angle of Wind	Simplified Superstr. Wind Press. for Girders	
	Lateral	Longit.
Degrees	ksf	ksf
N/A	0.050	0.012

Based on User's Factor

Adjusted Simplified Superstr. Wind Press. for Girders	
Lateral	Longit.
ksf	ksf
0.050	0.012

Calc. Wind Press. Factor due to User's V_{DZ}	1.000
User's Factor	1.000

See Aashto Lrfd Eqn 3.8.1.2.1-1

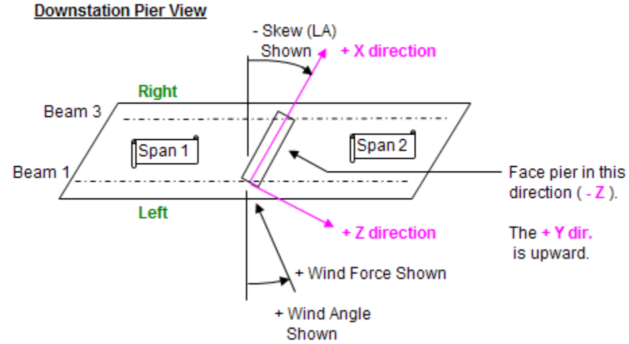
Office practice is to use the simplified wind pressures given in Aashto Lrfd 3.8.1.2.2 when individual span lengths are 160' or less and when Z is 100' or less. In other words, the Factor will typically be 1.000. **Do not use a Factor less than 1.000.** Minimum wind pressures should be 0.050 ksf lateral and 0.012 ksf longitudinal.

Above 100' pressures are to be adjusted based on V30 = 80 mph for individual span lengths less than 160'. In other words, the Factor will be greater than 1.000.

RC-Pier's auto-generate feature uses adjusted wind pressures if Z is greater than 30' and if the adjusted pressures are higher than those in Aashto Lrfd Table 3.8.1.2.2-1.

The user needs to ensure that the transverse wind loading requirement of 0.300 klf in Aashto Lrfd 3.8.1.2.1 is met. If the superstructure height (includes rail) is greater than 6.00' then this requirement is met because (0.050ksf)*(6') = 0.300 klf.

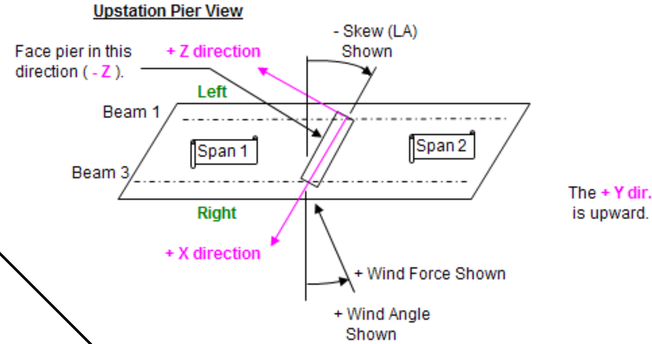
Downstation Pier View



Enter positive wind pressures to be used on the superstructure below.

User's Lateral Spstr. Wind Pressure	0.050	ksf
User's Longit. Spstr. Wind Pressure	0.012	ksf

Upstation Pier View



According to Aashto the vertical wind pressure or uplift force should only be applied when the wind skew angle is 0 degrees. Also, it should only be included in W combinations which do not involve WL (ie. Strength 3). See Aashto Lrfd 3.8.2. Office practice is to apply uplift in the Strength 3 combination for simplified wind loading. Vertical wind pressure is not to be adjusted for height or velocity.

Vertical Wind Pressure	0.020	ksf

Average Span Length	81.125	ft

Uplift Moment Arm
Enter 1 for In-House
Enter 2 for RC-Pier
2

Past in-house pier programs based moment arm on length along pier cap which will be greater for skewed bridges. RC-Pier uses perpendicular distance.

The overturning moment, Mz, is transferred to the pier by equal and opposite Fy forces acting through the beams. RC-Pier assumes that only the exterior beams are involved. User can involve all beams if desired.

How is Mz Transferred to the Pier? Enter 1 if by Exterior Beams Only Enter 2 if All Beams Participate	1

Wind forces with and without uplift will conservatively be applied to all loading combinations. This is in lieu of doing separate RC-Pier runs in order to keep the proper wind loading with the proper load combinations.

The results shown in the tables below are split into 4 groups based on combinations of the ± wind force and ± wind angle. In RC-Pier the user can vary the wind angle magnitude and sign. The wind force direction is typically varied automatically because the load, by default, is treated as a reversible load. In RC-Pier the vertical wind load, if used, is reversed as well which is undesirable. This spreadsheet always assumes vertical wind acts upward.

Wind Uplift Not Included

Beam #	W Loads to the Pier (kips)											
	+ Wind Force, + Wind Angle			+ Wind Force, - Wind Angle			- Wind Force, + Wind Angle			- Wind Force, - Wind Angle		
	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz
1	-3.899	-2.145	3.967	-5.274	-2.901	1.765	3.899	2.145	-3.967	5.274	2.901	-1.765
2	-3.899	0.000	3.967	-5.274	0.000	1.765	3.899	0.000	-3.967	5.274	0.000	-1.765
3	-3.899	0.000	3.967	-5.274	0.000	1.765	3.899	0.000	-3.967	5.274	0.000	-1.765
4	-3.899	0.000	3.967	-5.274	0.000	1.765	3.899	0.000	-3.967	5.274	0.000	-1.765
5	-3.899	0.000	3.967	-5.274	0.000	1.765	3.899	0.000	-3.967	5.274	0.000	-1.765
6	-3.899	2.145	3.967	-5.274	2.901	1.765	3.899	-2.145	-3.967	5.274	-2.901	-1.765
7												
8												
9												
10												
		Mx (k*ft)	95.202		Mx (k*ft)	42.365		Mx (k*ft)	-95.202		Mx (k*ft)	-42.365

Bridge office practice is to set the overturning moment Mx to 0.00. Currently, RC-Pier does not calculate an Mx for W, however, Leap's plans are to include it in a future version (probably as an option).

Wind Uplift Included

Beam #	W Loads to the Pier (kips)											
	+ Wind Force, + Wind Angle			+ Wind Force, - Wind Angle			- Wind Force, + Wind Angle			- Wind Force, - Wind Angle		
	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz
1	-3.899	-7.792	3.967	-5.274	-8.549	1.765	3.899	31.134	-3.967	5.274	31.891	-1.765
2	-3.899	11.671	3.967	-5.274	11.671	1.765	3.899	11.671	-3.967	5.274	11.671	-1.765
3	-3.899	11.671	3.967	-5.274	11.671	1.765	3.899	11.671	-3.967	5.274	11.671	-1.765
4	-3.899	11.671	3.967	-5.274	11.671	1.765	3.899	11.671	-3.967	5.274	11.671	-1.765
5	-3.899	11.671	3.967	-5.274	11.671	1.765	3.899	11.671	-3.967	5.274	11.671	-1.765
6	-3.899	31.134	3.967	-5.274	31.891	1.765	3.899	-7.792	-3.967	5.274	-8.549	-1.765
7												
8												
9												
10												
		Mx (k*ft)	95.202		Mx (k*ft)	42.365		Mx (k*ft)	-95.202		Mx (k*ft)	-42.365

Bridge office practice is to set the overturning moment Mx to 0.00. Currently, RC-Pier does not calculate an Mx for W, however, Leap's plans are to include it in a future version (probably as an option).

Substructure Wind

Calc. Z (pier cap top to ground/water surf.)	22.000	ft
User's Z	100.000	ft

V_{DZ}, calculated design velocity at User's Z	99.627	mph
User's V_{DZ}	100.000	mph

Calc. Wind Press. Factor due to User's V_{DZ}	1.000	See Aashto Lrfd Eqn 3.8.1.2.1-1
User's Factor	1.000	

Aashto Lrfd 3.8.1.2.3

Skew Angle of Wind	Simplified Substr. Wind Press. for Piers	
	Parallel	Perpend.
Degrees	ksf	ksf
N/A	0.040	0.040

Based on User's Factor

Adjusted Simplified Substr. Wind Press. for Piers	
Parallel	Perpend.
ksf	ksf
0.040	0.040

Office practice is to use simplified wind pressures for substructure when individual span lengths are 160' or less and when Z is 100' or less. In other words, the Factor will typically be 1.000. Do not use a Factor less than 1.000. Minimum wind pressures should be 0.040 ksf parallel (X dir.) and 0.040 ksf perpendicular (Z dir.) to the pier. This loading is unique to Iowa and cannot be found in the Aashto Specifications.

Above 100' pressures are to be adjusted based on V30 = 80 mph for individual span lengths less than 160'. In other words, the Factor will be greater than 1.000.

RC_Pier will only use the adjusted wind pressures if Z is greater than 30' and if the adjusted pressures are higher 0.040 ksf (see Aashto Lrfd 3.8.1.2.3).

Enter positive wind pressures to be used on the substructure below.

User's Parallel Wind Press. (X dir.)	0.040	ksf
User's Perpendicular Wind Press. (Z dir.)	0.040	ksf

Export Super- and Sub-structure Wind Loads to Text Files

Cap Loads

Exposed Pier Cap Area (ft^2)	Type of Load	Direction	+ WF + WA Magnitude	+ WF - WA Magnitude	- WF + WA Magnitude	- WF - WA Magnitude	Start Fraction x1 / L	End Fraction x2 / L
24.500	Force (k)	X	-0.980	-0.980	0.980	0.980	0.500	---------
300.250	UDL (k/ft)	Z	0.245	0.245	-0.245	-0.245	0.000	1.000

The sign of the substr. wind loads depends on the sign of the superstr. wind loads.

Note: UDL stands for unformly distributed load. The total load in the Z direction is averaged over the length of the pier cap.

Column Loads (apply loads to all columns in pier)

Exposed Pier Col. Area (ft^2)	Type of Load	Direction	+ WF + WA Magnitude	+ WF - WA Magnitude	- WF + WA Magnitude	- WF - WA Magnitude	Start Fraction y1 / L	End Fraction y2 / L
45.000	UDL (k/ft)	X	-0.120	-0.120	0.120	0.120	0.333	0.833
292.500	UDL (k/ft)	Z	0.780	0.780	-0.780	-0.780	0.333	0.833

The sign of the substr. wind loads depends on the sign of the superstr. wind loads.

Note: UDL stands for unformly distributed load. The start and end fractions are based on a column height that extends to the middle of of the minimum cap height.

Wind on Live Load

Aashto Lrfd 3.8.1.3

Height of WL above Top of Slab	6.000	ft

Typically, WL is assumed to act 6' above the top of the slab.

Enter positive wind loads to be used on the superstructure below.

User's Normal WL	0.100	klf
User's Parallel WL	0.040	klf

WL is not varied based on elevation or wind speed.

Aashto Lrfd 3.8.1.3

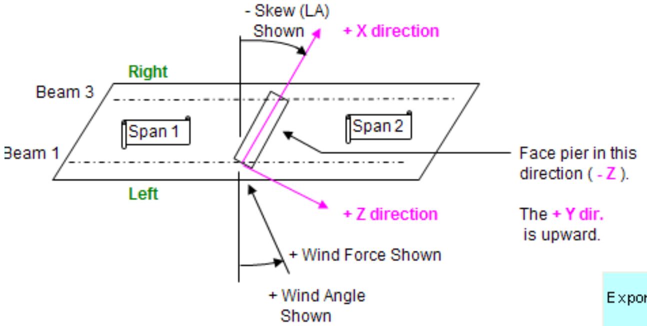
Skew Angle of Wind	Simplified Wind Components on Live Load	
	Normal	Parallel
Degrees	klf	klf
N/A	0.100	0.040

Average Span Length	81.125	ft

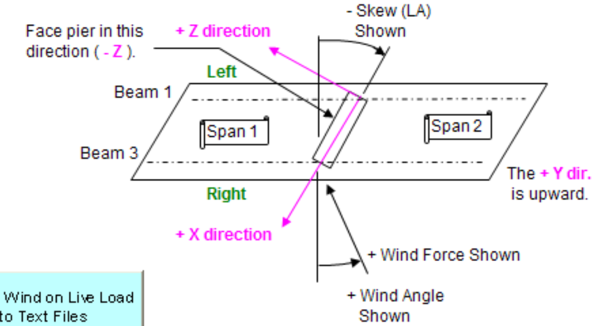
The overturning moment, Mz, is transferred to the pier by equal and opposite Fy forces acting through the beams. RC-Pier assumes that only the ext. beams are involved. User can involve all beams if desired.

How is Mz Transferred to the Pier? Enter 1 if by Exterior Beams Only Enter 2 if All Beams Participate	1

Downstation Pier View



Upstation Pier View



Export Wind on Live Load to Text Files

The results shown in the tables below are split into 4 groups based on combinations of the ± wind force and ± wind angle. In RC-Pier the user can vary the wind angle magnitude and sign. The wind force direction is typically varied automatically because the load, by default, is treated as a reversible load.

For Strength 5 and Service 1 Loading

Beam #	WL Loads to the Pier (kips)											
	+ Wind Force, + Wind Angle			+ Wind Force, - Wind Angle			- Wind Force, + Wind Angle			- Wind Force, - Wind Angle		
	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz
1	-0.860	-1.321	1.175	-1.433	-2.201	0.258	0.860	1.321	-1.175	1.433	2.201	-0.258
2	-0.860	0.000	1.175	-1.433	0.000	0.258	0.860	0.000	-1.175	1.433	0.000	-0.258
3	-0.860	0.000	1.175	-1.433	0.000	0.258	0.860	0.000	-1.175	1.433	0.000	-0.258
4	-0.860	0.000	1.175	-1.433	0.000	0.258	0.860	0.000	-1.175	1.433	0.000	-0.258
5	-0.860	0.000	1.175	-1.433	0.000	0.258	0.860	0.000	-1.175	1.433	0.000	-0.258
6	-0.860	1.321	1.175	-1.433	2.201	0.258	0.860	-1.321	-1.175	1.433	-2.201	-0.258
7												
8												
9												
10												
		Mx (k*ft)	78.735		Mx (k*ft)	17.275		Mx (k*ft)	-78.735		Mx (k*ft)	-17.275

Bridge office practice is to set the overturning moment Mx to 0.00. Currently, RC-Pier does not calculate an Mx for WL, however, Leap's plans are to include it in a future version (probably as an option).

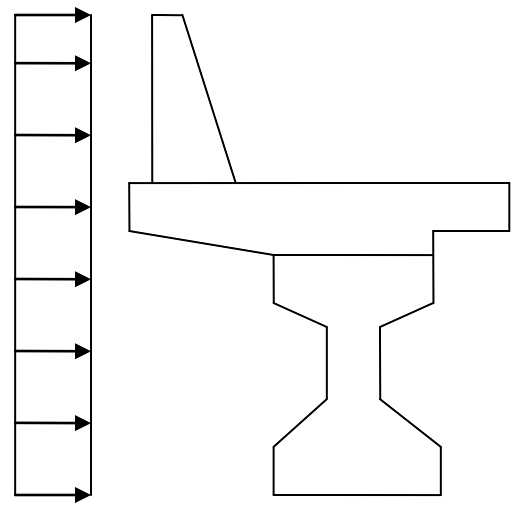
These loads will have to be used twice in RC-Pier. WL is dependent on WS and WS is applied with and without uplift.

Wind on Superstructure   Sample Calculations

Uplift = 20 psf
Lateral Pressure = 50 psf
Longitudinal Pressure = 12 psf

Superstructure Wind Area

SBC Height	34”
Slab Thickness	8”
Beam Height	54”
Total	96” = 8.00’



Average Span Length = (0.5)*(70.75’ + 91.5’) = 81.125’

$F_{x'}$ = (-0.050 ksf)*(8’)*(81.125’) = -32.450 k
$F_{z'}$ = (0.012 ksf)*(8’)*(81.125’) = 7.788 k

F_x = (-32.450 k)*(cos(32 deg)) + (7.788 k)*(sin(32 deg)) = -23.392 k
F_z = (32.450 k)*(sin(32 deg)) + (7.788 k)*(cos(32 deg)) = 23.800 k

F_x per beam = (-23.392 k)/(6 Beams) = -3.899 k
F_z per beam = (23.800 k)/(6 Beams) = 3.967 k

Assigning the sign to the results is done by observation.

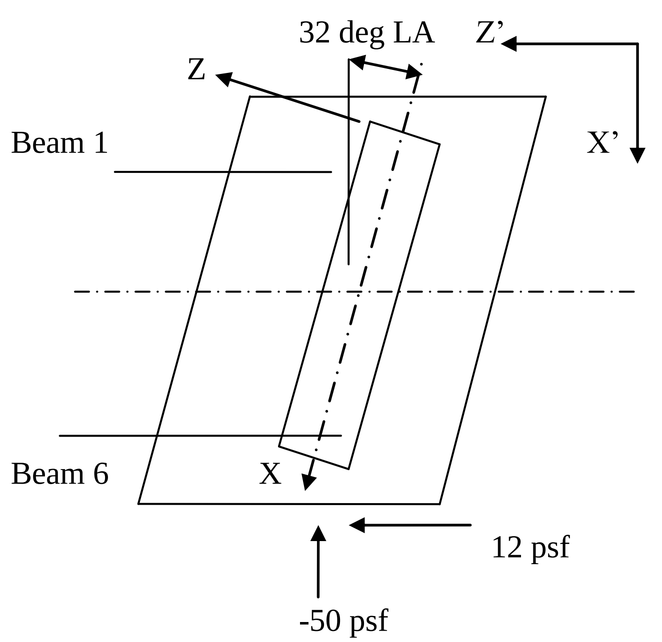
Uplift = (0.02 ksf)*(43.16)*(81.125’) = 70.027 k

F_y for Beams 2-5 = (70.027 k)/(6 Beams) = 11.671 k

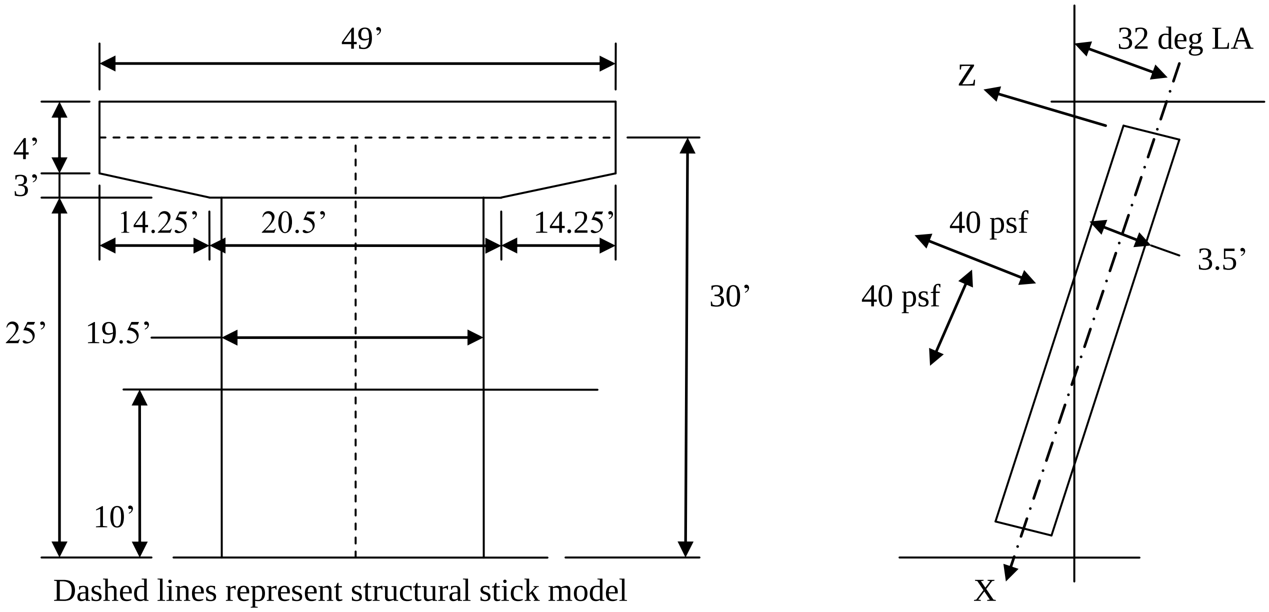
M_z = (23.392 k)*(0.5)*(8’) + (70.027 k)*(0.25)*(43.16’) = 849.160 k*ft

F_y for Beams 1 and 6 = ±(849.160 k*ft)/[(5 Beam Spa)*(7.4’)/(cos(32 deg))] + 11.671 k
Beam 1, F_y = -7.792 k
Beam 6, F_y = 31.134 k

M_x = (23.800 k)*(0.5)*(8’) = 95.200 k*ft   ← Office Policy is to ignore



Wind on Substructure Sample Calculations



Dashed lines represent structural stick model

The signs for simplified substructure wind loads are made to correspond with the sign for the superstructure wind loads.

$Acap_x$ = (7')*(3.5') = 24.5 ft^2
$Acap_z$ = (49')*(7') – (3')*(14.25') = 300.25 ft^2
$Acol_x$ = (3')*(25' – 10' fill) = 45 ft^2 per column (exposed)
$Acol_z$ = (19.5')*(25' – 10' fill) = 292.5 ft^2 per column (exposed)

$Fcap_x$ = (0.04 ksf)*(24.5 ft^2) = -0.98 k
$Fcap_z$ = (0.04 ksf)*(300.25 ft^2) = 12.01 k

Signs based on 1^{st} case sign convention for superstructure wind loads.

$Fcol_x$ = (0.04 ksf)*(45 ft^2) = -1.80 k
$Fcol_z$ = (0.04 ksf)*(292.5 ft^2) = 11.70 k

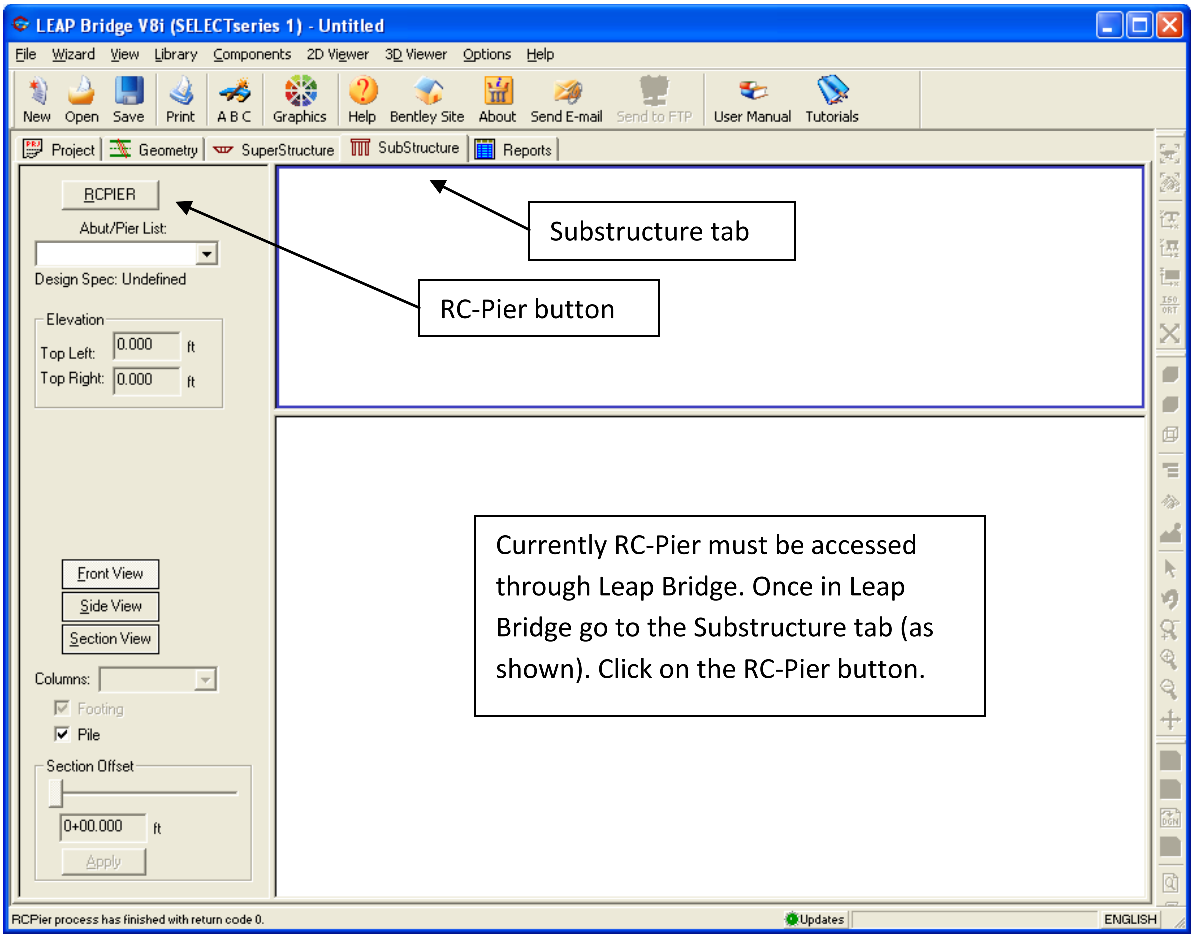
Cap Loads F_x = -0.98 k applied at midpoint of cap
UDL_z = (12.01 k)/(49') = 0.245 klf applied along cap length

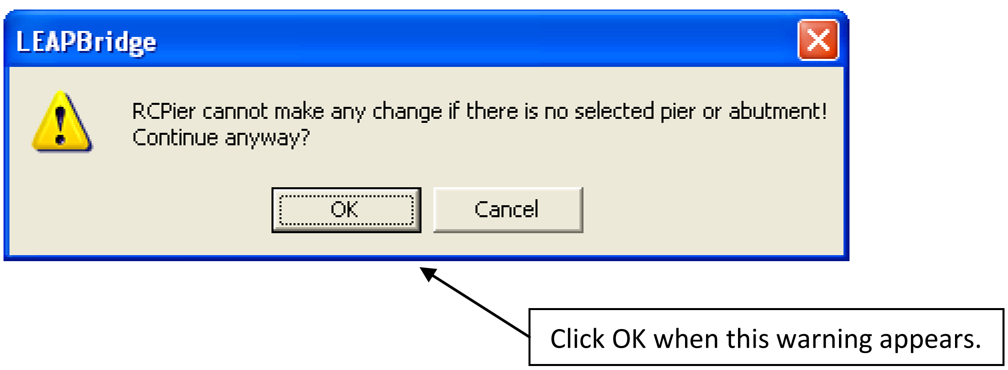
Column Load UDL_x = (-1.80 k)/(15') = -0.120 klf from (10')/(30') = 0.333
UDL_z = (11.70 k)/(15') = 0.780 klf to (25')/(30') = 0.833
Loads are applied to each column.

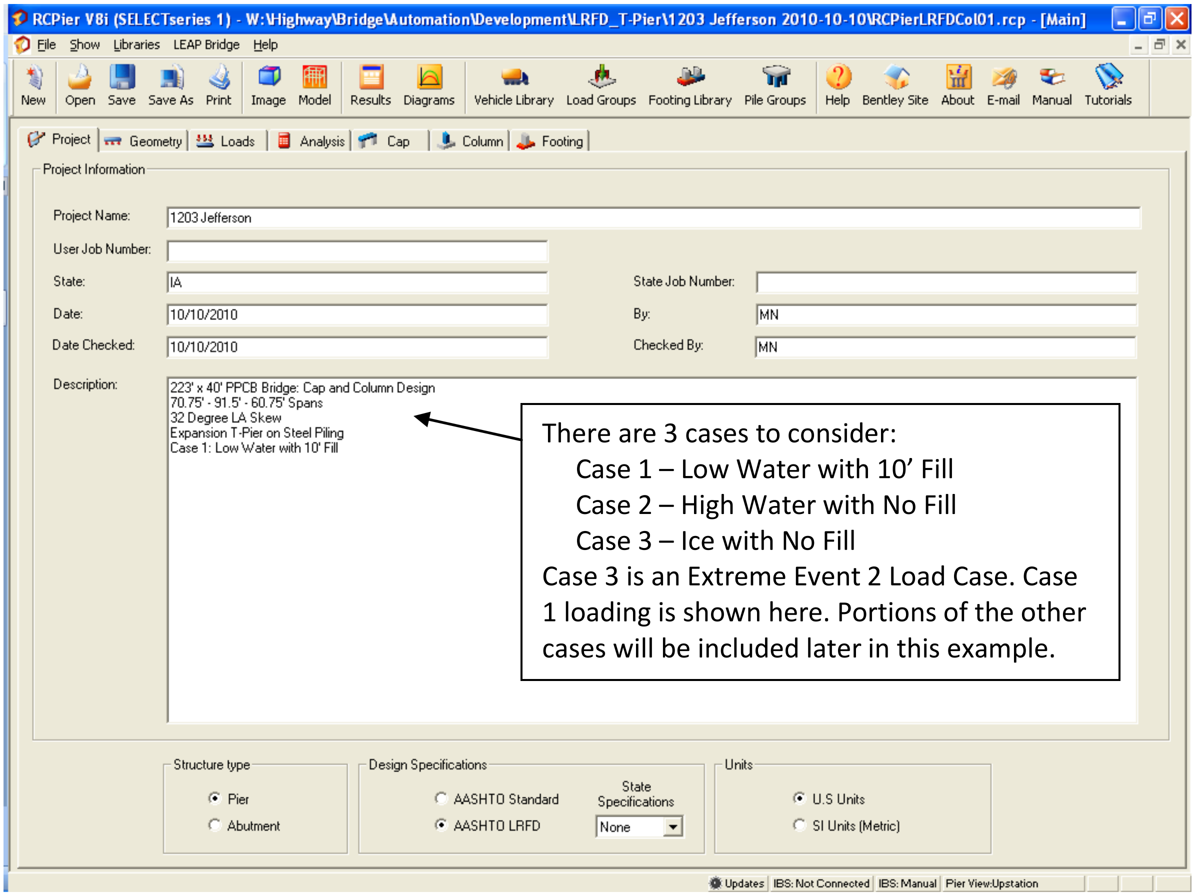
Note: The start and end fractions will change for the wind loadings on the column for the footing design because the column is extended 4.00'. The fractions are:

Start Fraction = (10' + 4')/(30' + 4') = 0.412
End Fraction = (25' + 4')/(30' + 4') = 0.853

Cap and Column Design


LEAP Bridge V8i (SELECTseries 1) - Untitled
File Wizard View Library Components 2D Viewer 3D Viewer Options Help
New Open Save Print A B C Graphics Help Bentley Site About Send E-mail Send to FTP User Manual Tutorials
Project Geometry SuperStructure SubStructure Reports
RCPIER
Abut/Pier List:
Design Spec: Undefined
Elevation
Top Left: 0.000 ft
Top Right: 0.000 ft
Front View
Side View
Section View
Columns:
Footing
Pile
Section Offset
0+00.000 ft
Apply
RCPier process has finished with return code 0.
Updates
ENGLISH
Substructure tab
RC-Pier button
Currently RC-Pier must be accessed through Leap Bridge. Once in Leap Bridge go to the Substructure tab (as shown). Click on the RC-Pier button.

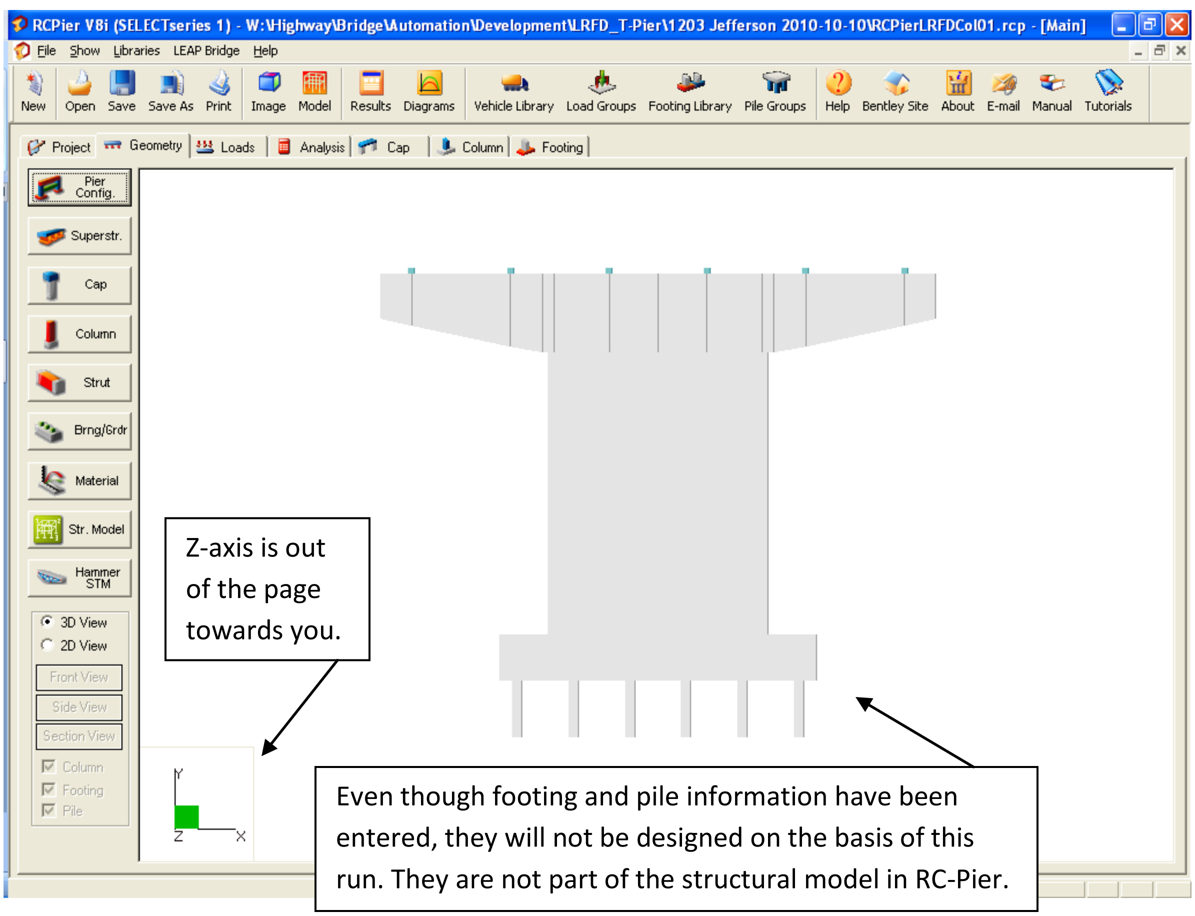

LEAPBridge
RCPier cannot make any change if there is no selected pier or abutment! Continue anyway?
OK
Cancel
Click OK when this warning appears.



There are 3 cases to consider:

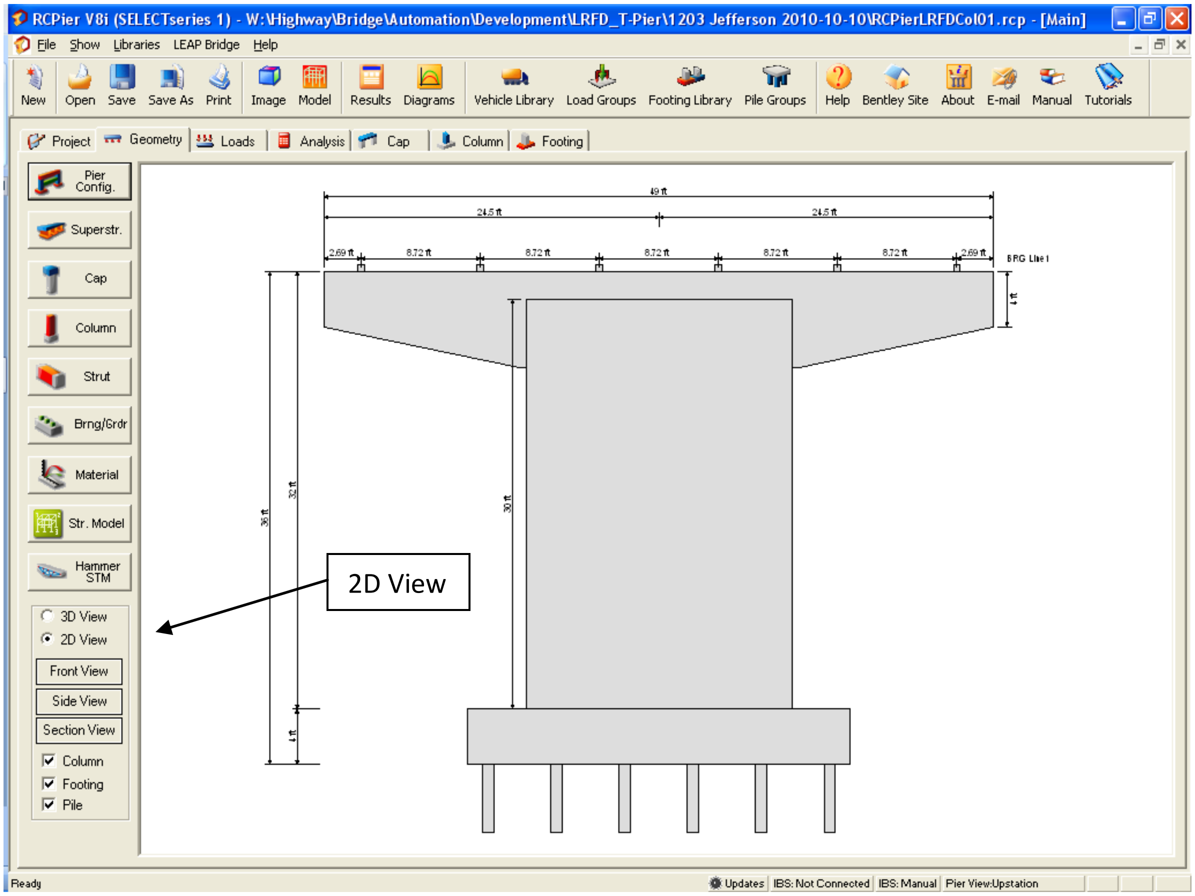
- Case 1 – Low Water with 10' Fill
- Case 2 – High Water with No Fill
- Case 3 – Ice with No Fill

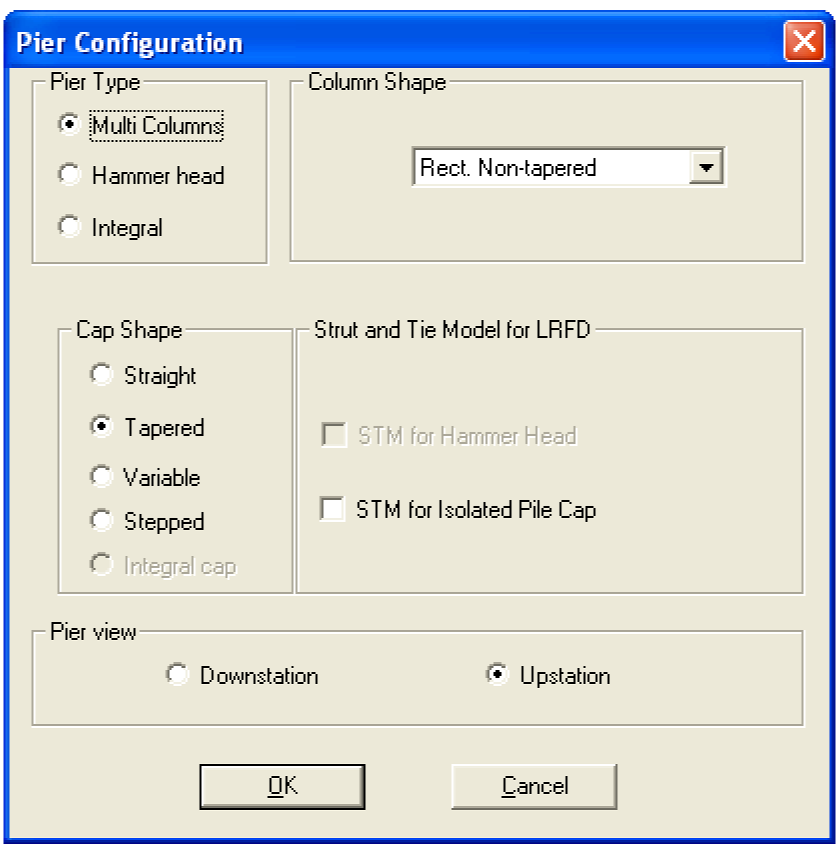
Case 3 is an Extreme Event 2 Load Case. Case 1 loading is shown here. Portions of the other cases will be included later in this example.



Z-axis is out of the page towards you.

Even though footing and pile information have been entered, they will not be designed on the basis of this run. They are not part of the structural model in RC-Pier.



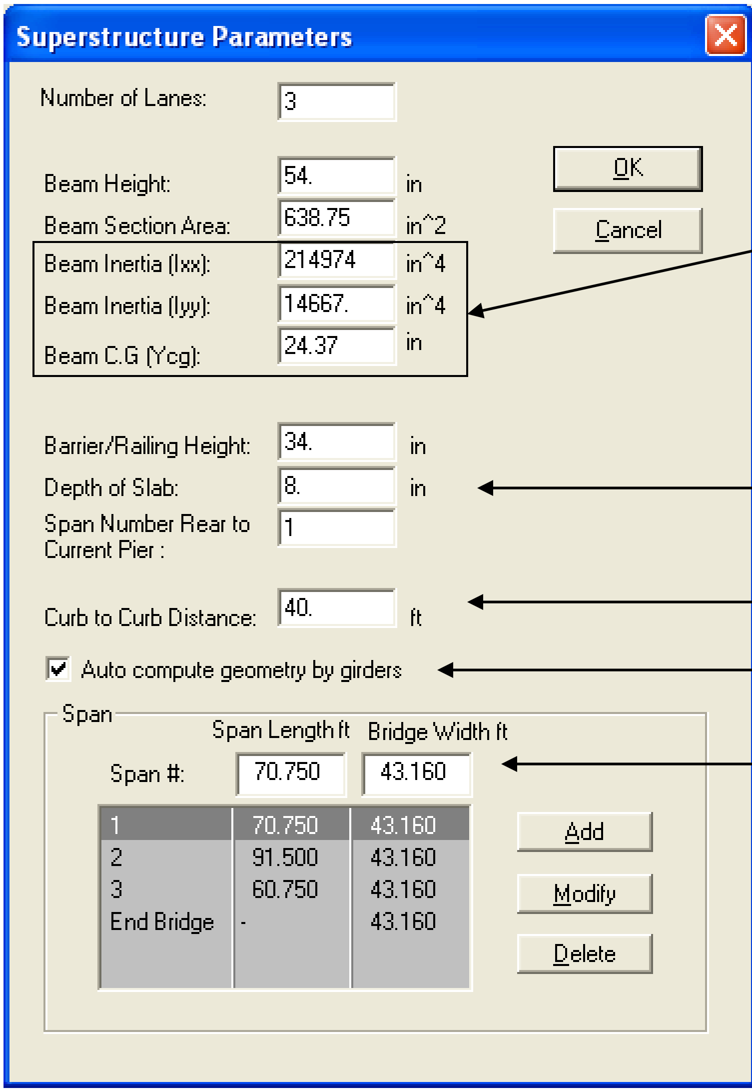


Currently it is easier to use the "Multi Columns" option to design T-piers rather than the "Hammer head" option. The "Hammer head" option requires the cap and column to be the same width.

The T-pier column shape will be modeled as an equivalent rectangle.

Typical T-piers will use the tapered cap shape.

I recommend using the "Upstation" pier view option.



This screen only needs to be filled out if you intend to auto-generate loads.

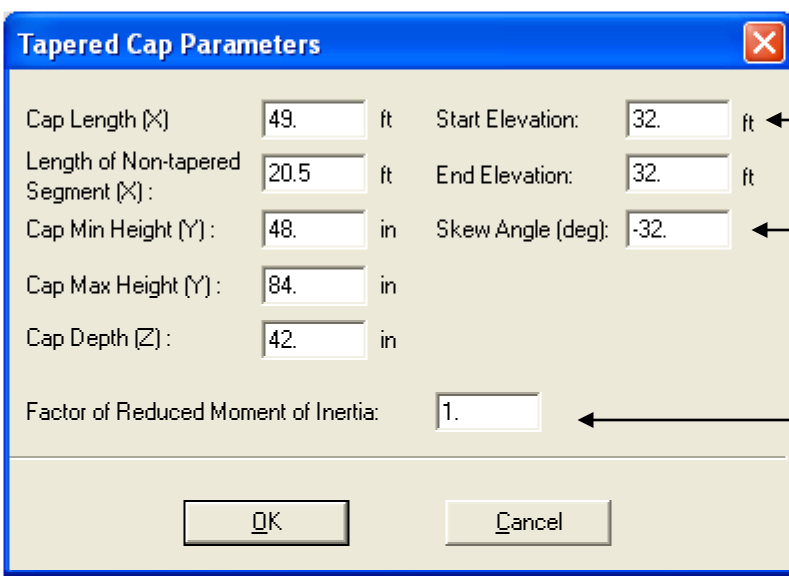
These entries are only important for auto-generation of EQ loads.

There are no entries for haunch thickness, pad thickness, or step height. This means auto-generated wind area excludes haunch. Also, lateral superstructure loads can't be elevated further above top of pier cap.

Gutter to Gutter

Not sure what this check box does.

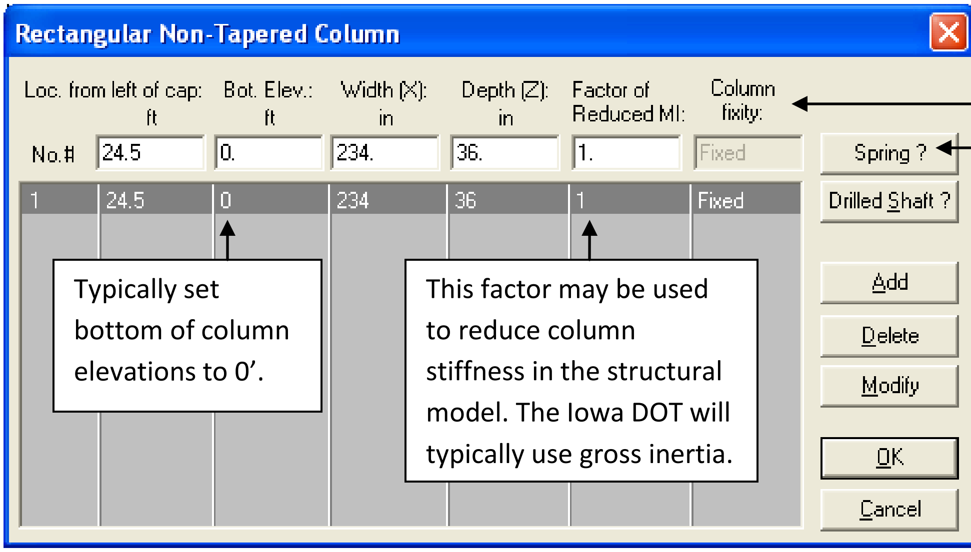
Bridge width was added to allow for flared girders.



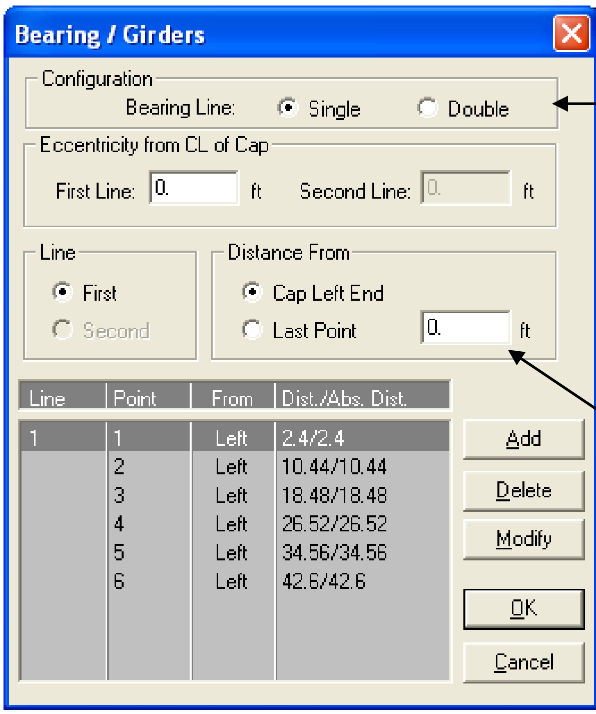
Recommend setting bottom of column elevation at 0'. This way the (top of) cap elevation will simply be the height from the bottom of the column to the top of the cap.

Left ahead skews are negative. The skew angle only needs to be input if you intend to auto-generate loads.

This factor may be used to reduce member stiffness in the structural model (i.e. simulate a cracked section). The Iowa DOT will typically use gross inertia.

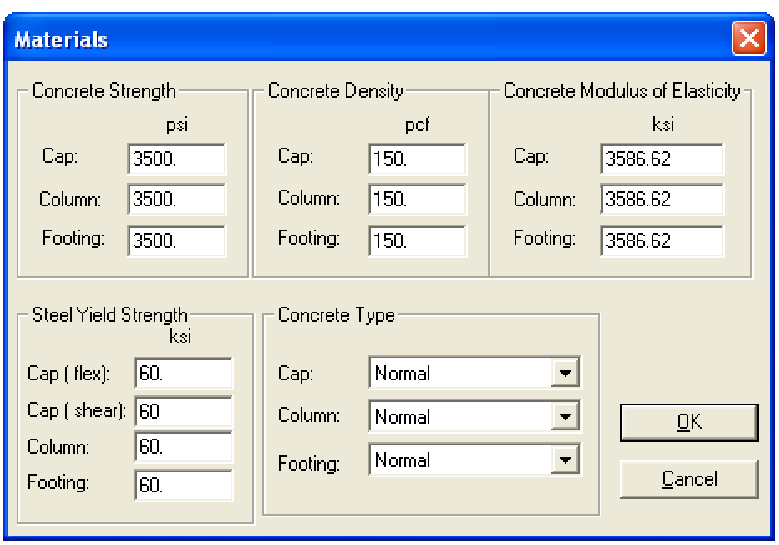


The bottom of column may have spring supports. This may be used to model pile flexibility. We will assume a fully fixed condition.

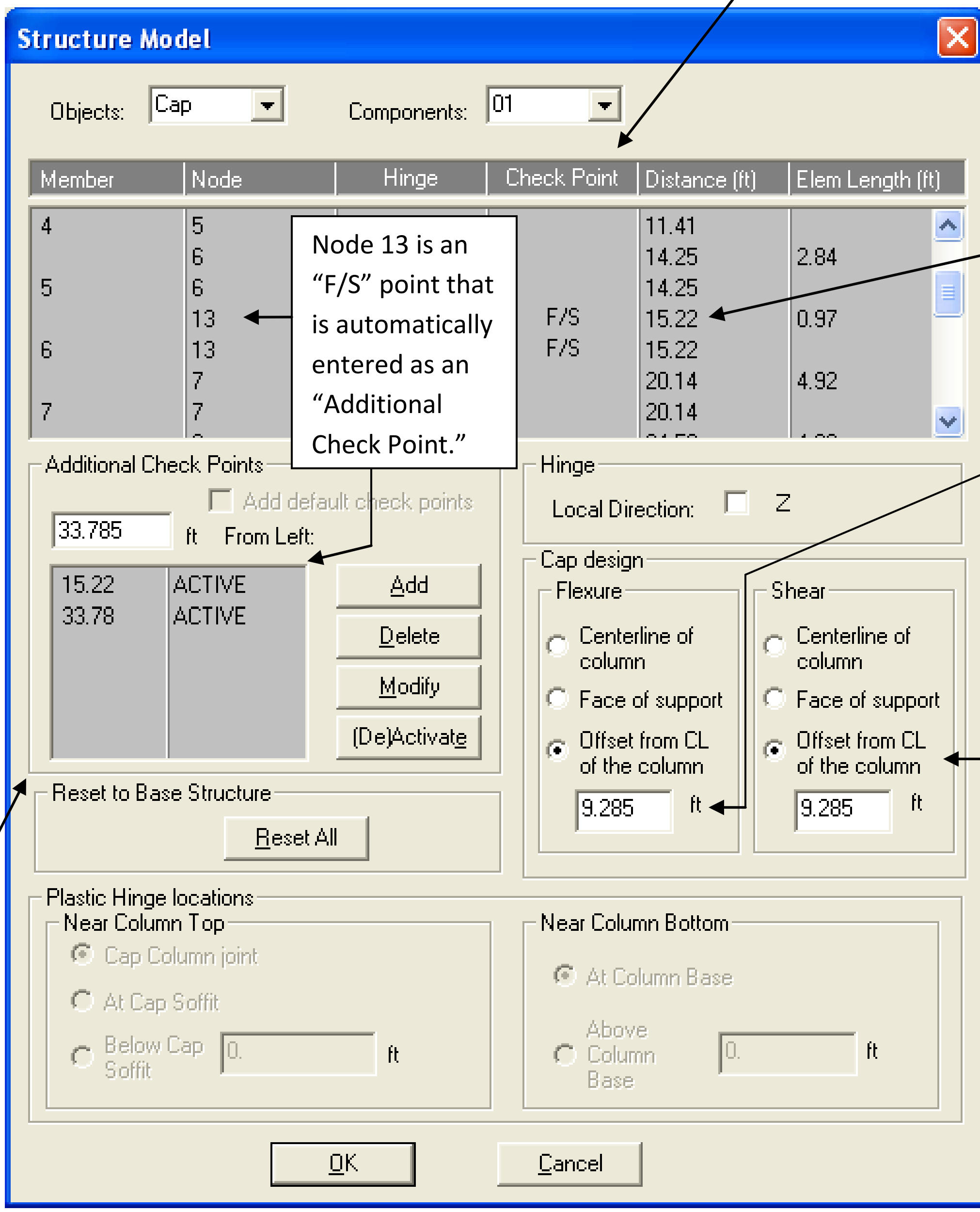


Bearing lines will typically be modeled as "Single" for both steel and prestressed bridges. Exceptions may include situations that yield a significant unsymmetrical loading about the c.l. of the cap such as would be caused by unbalanced spans or actual eccentric bearing lines. Variable width bridges that drop a beam line at a pier is another example.

Enter beam spacing along the skew of the pier cap.



Blank entries indicate a default check point generated automatically by RC-Pier. “F/S” of “f” indicates face of support points which may be generated using the option buttons under “Cap design”. Entries with an “*” indicate “Additional Check Points” that have been entered directly by the user. No “Additional Check Points” have been input since it is easier to do T-pier cap design in a spreadsheet.



Node 13 is an “F/S” point that is automatically entered as an “Additional Check Point.”

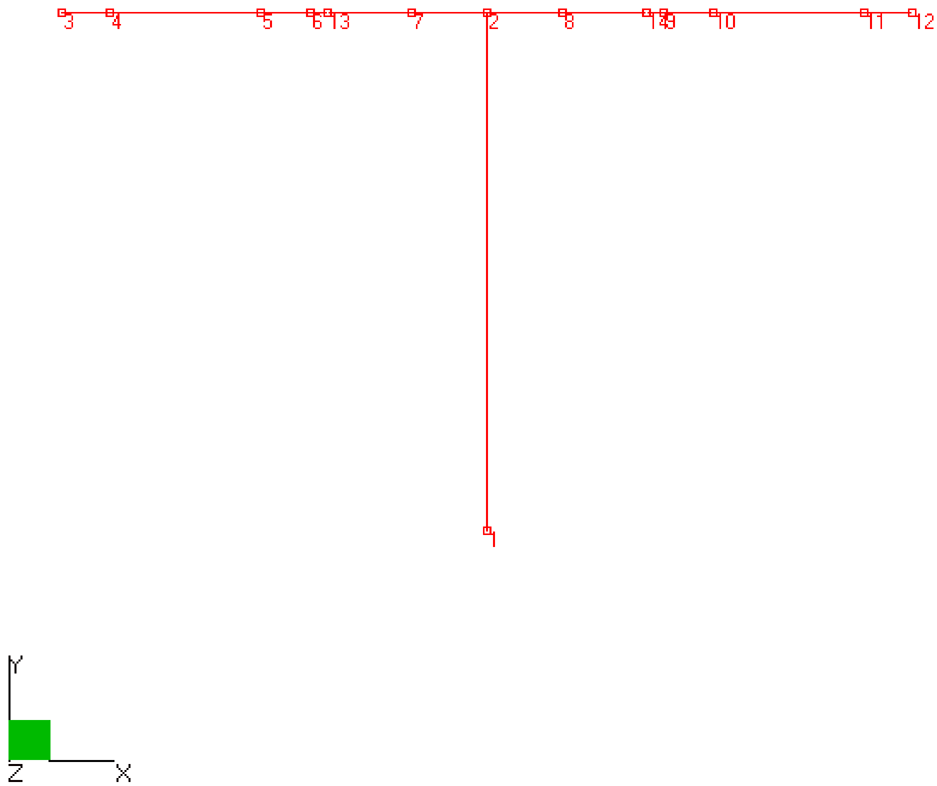
$(0.5)*(17') + (2/3)*(W_R) = 9.285'$ where $W_R = 1.178'$

24.500’ to c.l. column
- 9.285’ offset
15.215’

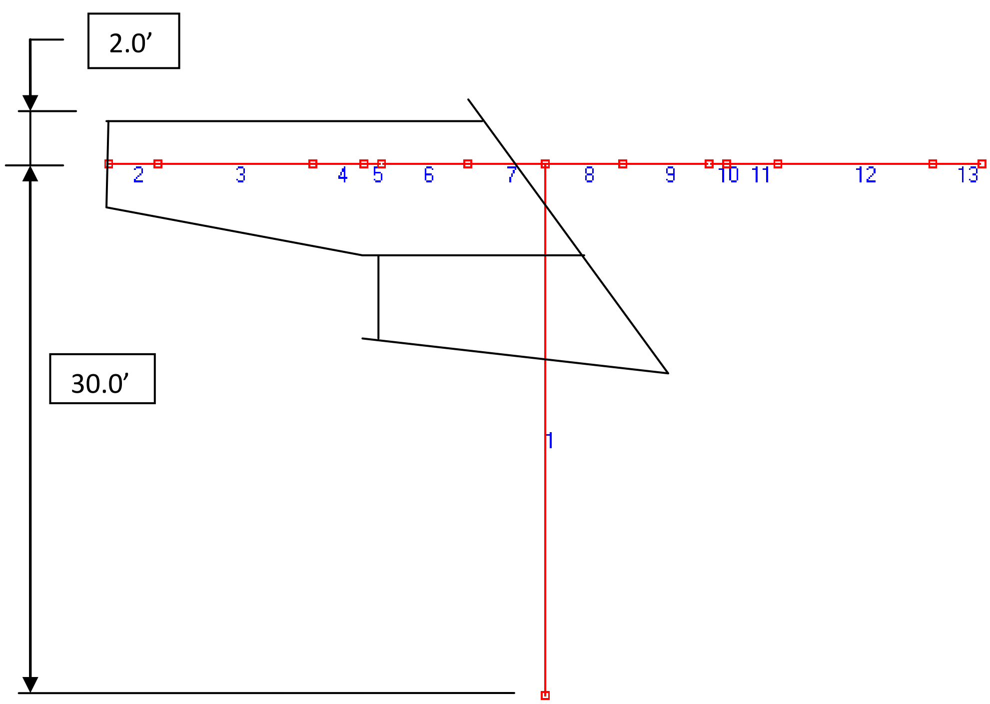
This 3rd option allows us to create additional check points on each side of each column to act as the critical section or new “Face of support”. So here we may enter the W/3 distance [(2/3)*(W_R)].

One short-coming of this 3rd option is that the c.l. of the column is still used for a cap design point when designing cap R/I on the “Cap” tab. The 2nd option, “Face of Support”, suppresses the c.l. of the column point when doing cap design. It would be nice if the 3rd option followed the pattern of the 2nd option.

The user could do a separate RC-Pier run for the cantilever with the special loading requirements and with additional check points on the cantilever, but that won’t be done in this example.

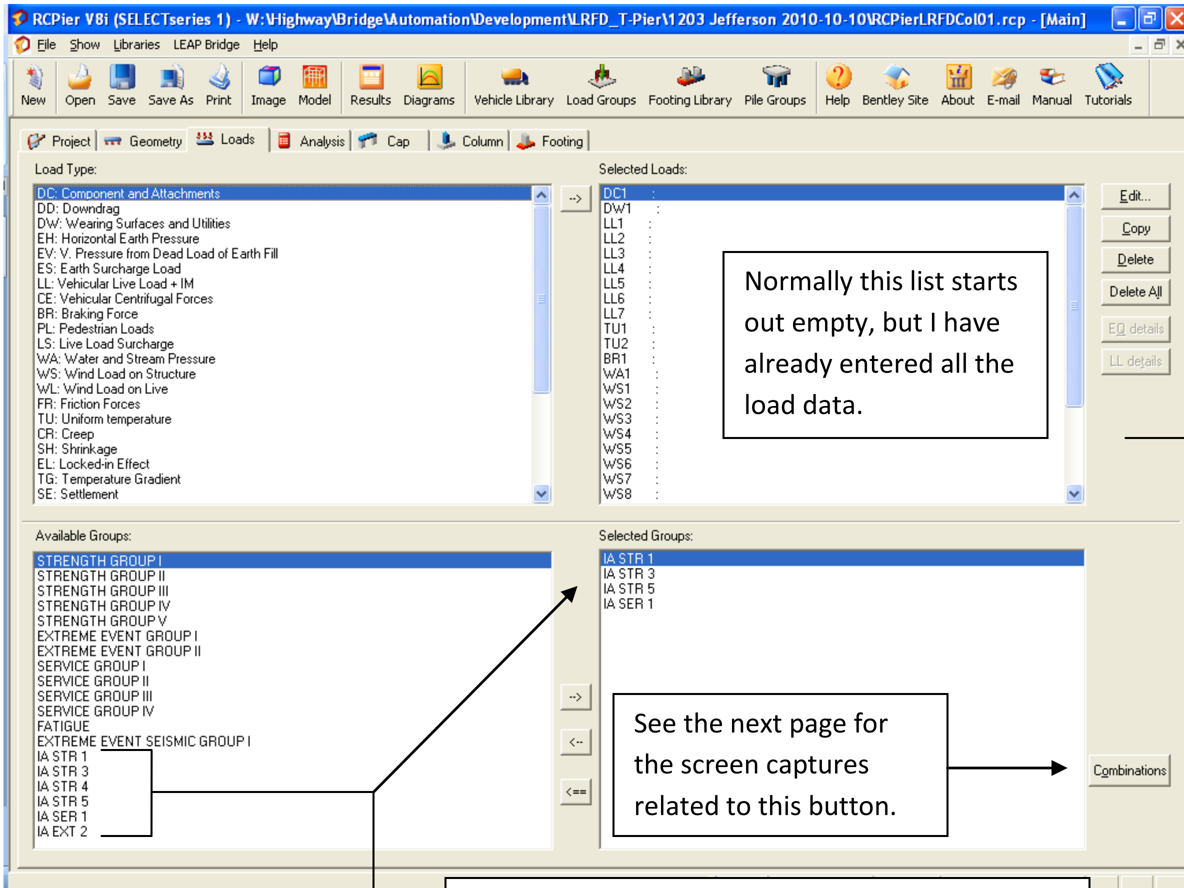


Nodes



Members

The c.l. of the cap for the structural model is placed at the midpoint of the minimum cap height. The minimum cap height is the end cap taper height.

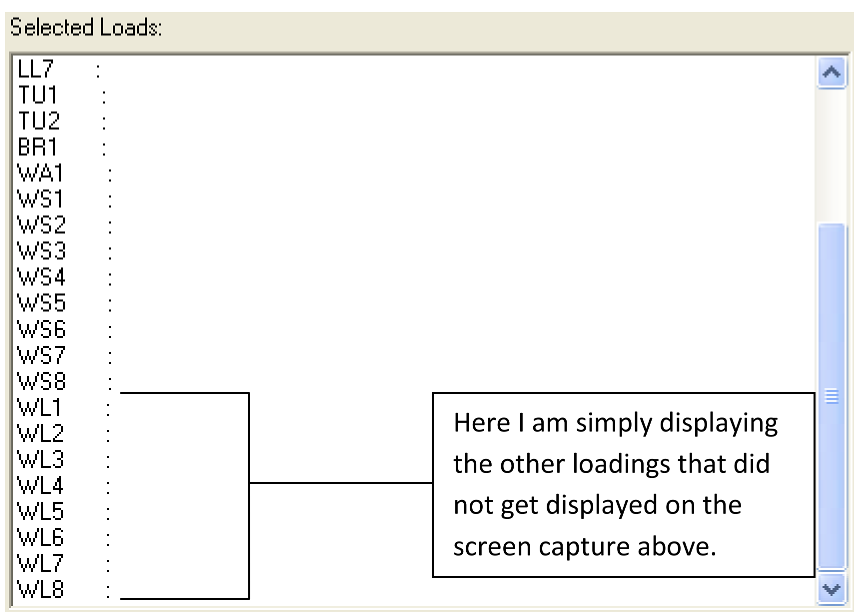


Normally this list starts out empty, but I have already entered all the load data.

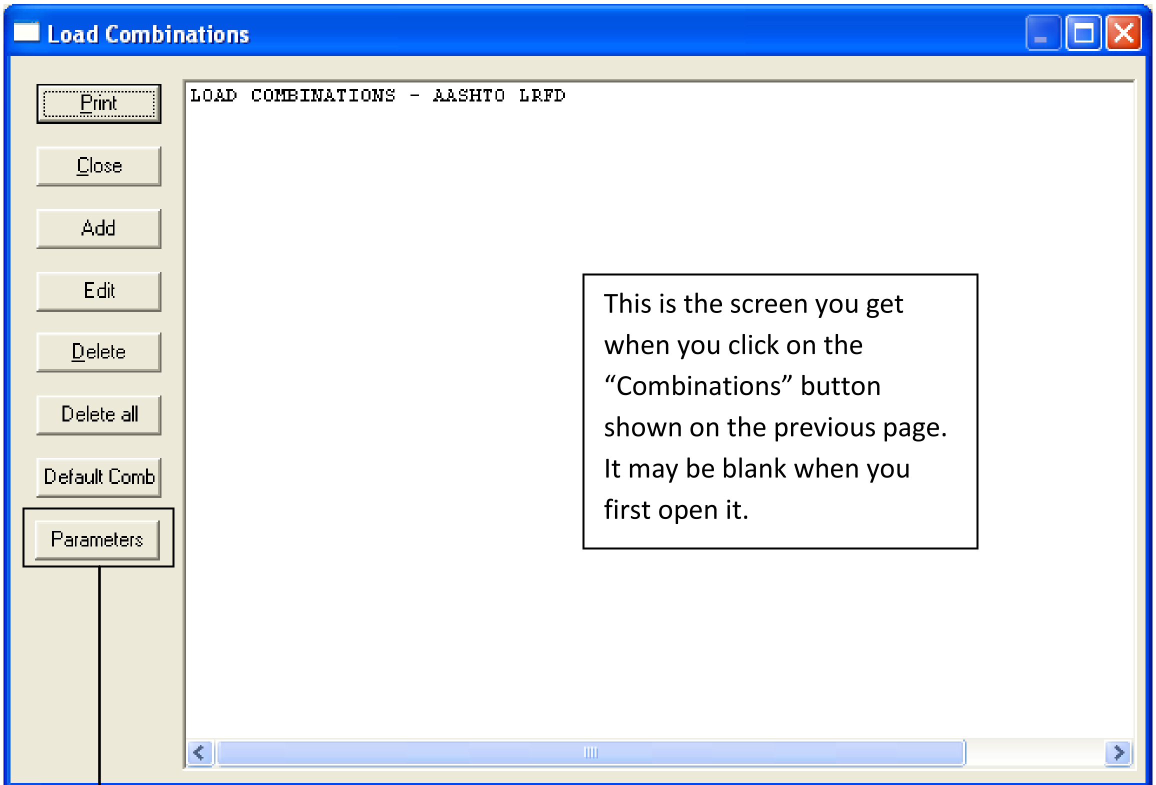
See the next page for the screen captures related to this button.

The Iowa load groups correspond with the default load groups except that the reversible feature for the wind loads has been set to uni-directional. This was done because wind uplift is uni-directional and should not be reversed as will be done in RC-Pier if the setting is not changed.

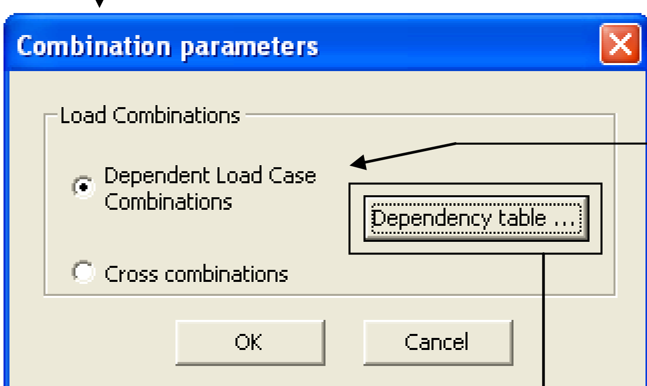
This example uses simplified wind loads. These loads will be entered twice – once without wind uplift (WS1 to WS4) and once with wind uplift (WS5 to WS8). Technically wind uplift only needs to be applied for the Strength 3 combination when the wind angle is 0 degrees. However, it is simpler and conservative to check each group with and without uplift. Since the WS loads are repeated the WL loads are also repeated due to the dependency between them.



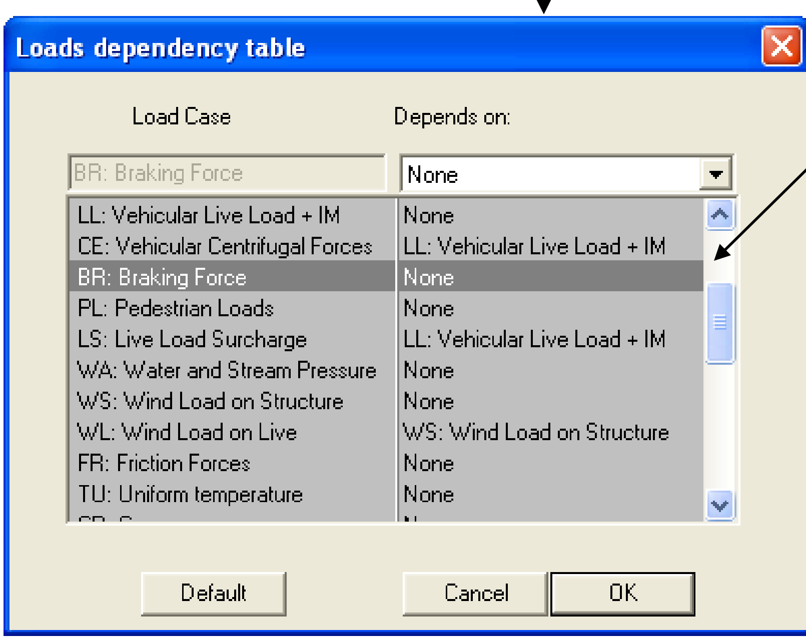
Here I am simply displaying the other loadings that did not get displayed on the screen capture above.



This is the screen you get when you click on the "Combinations" button shown on the previous page. It may be blank when you first open it.



Use "Dependent Load Case Combinations" since it will reduce the number of load cases by maintaining load dependencies.



RC-Pier defaults with a dependency of BR on LL. Often we set this to "None" because we typically use only the worst BR load irrespective of how many lanes of LL are on the bridge.

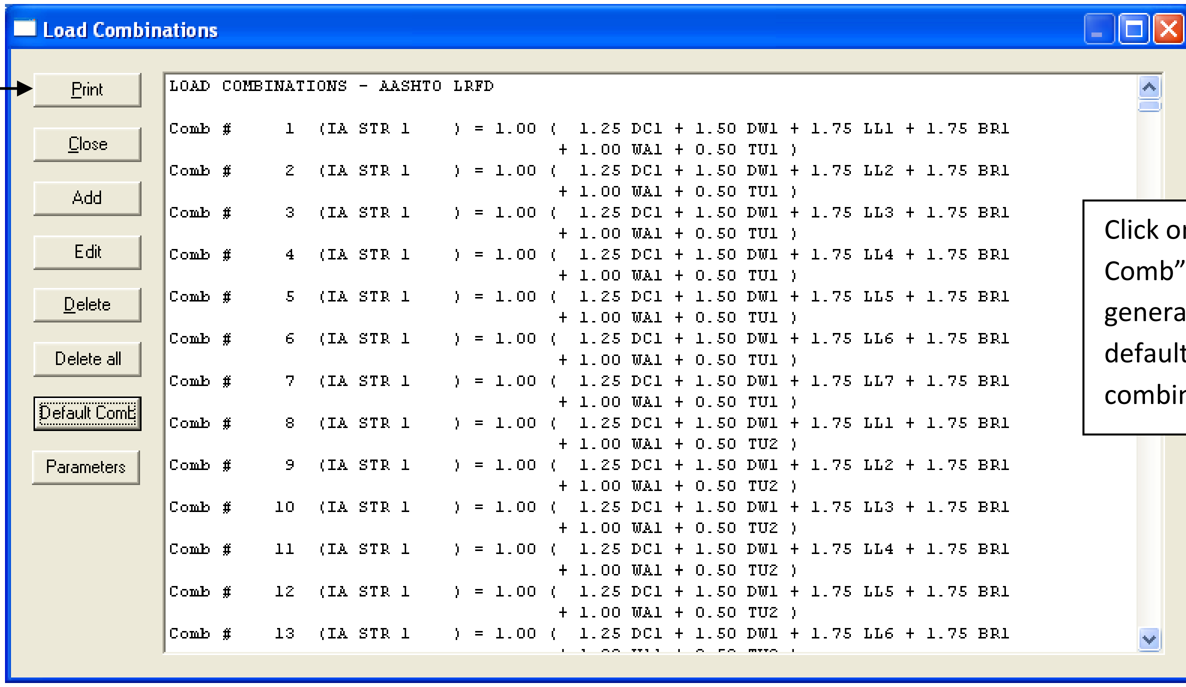
The only dependent loads we typically use for frame piers are:

CE to LL

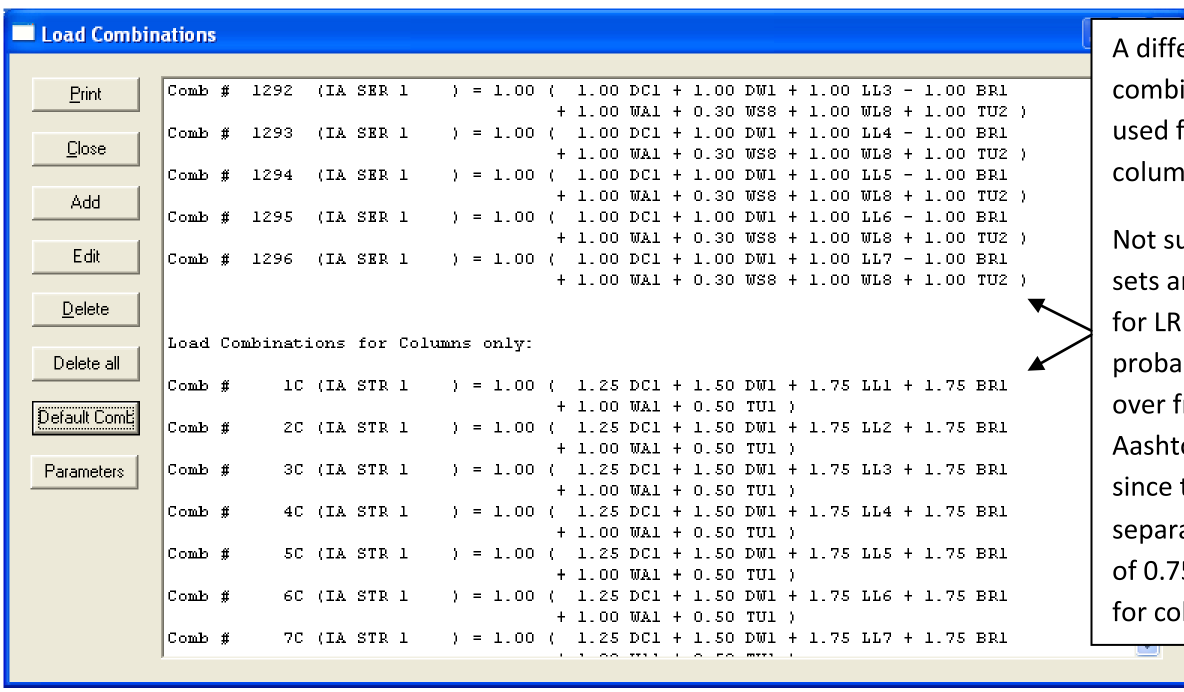
WL to WS

This means that if we have 8 WS cases then we must have 8 WL cases. Thus, WL1 is always and only associated with WS1, and WL2 is always and only associated with WS2, and so on.

CAUTION: Clicking "Print" sends ALL the load combination equations immediately to a printer.



Click on "Default Comb" to generate all the default load combinations.



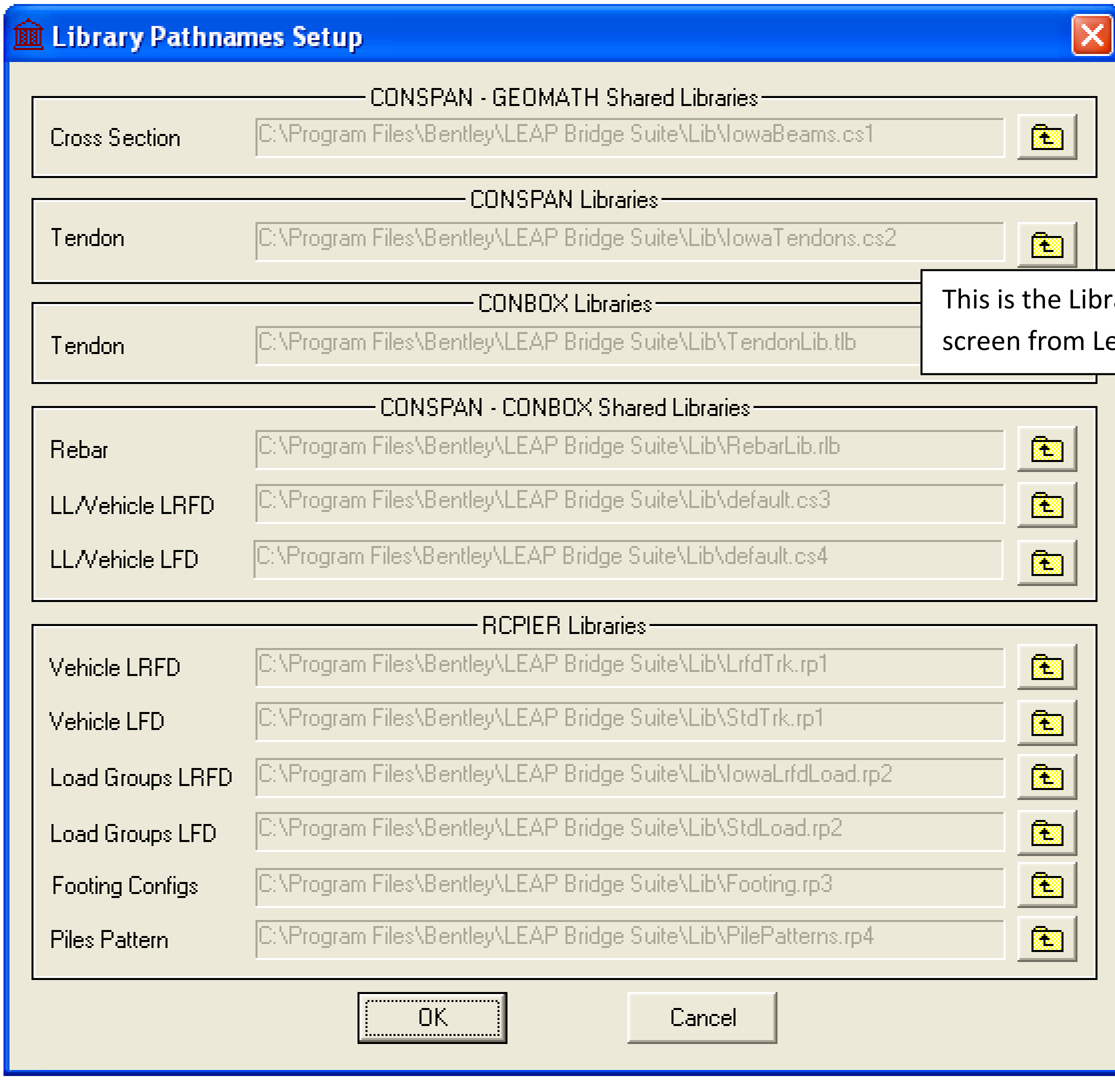
A different set of combinations is used for the column and cap.

Not sure the two sets are necessary for LRFD. It is probably a hold-over from the Aashto Std. Spec. since there was a separate βd factor of 0.75 and 1.00 for columns.

Note: There are a number of features on this screen that will not be demonstrated in this example. For instance, you can

- delete combinations
- edit combinations
- add your own combinations

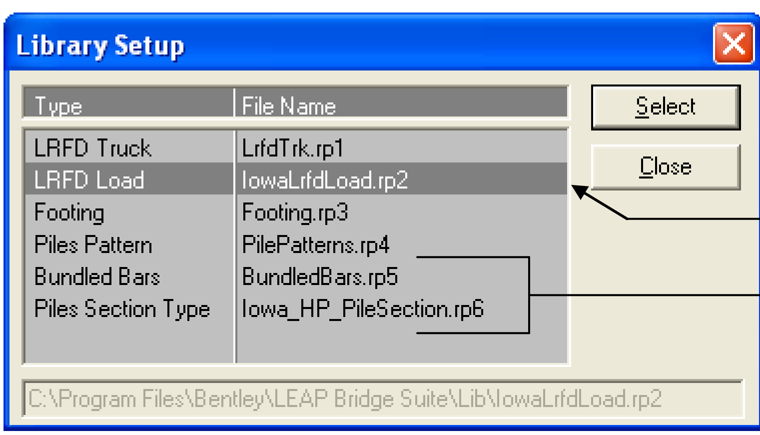
These features are particularly useful for testing loading scenarios and trouble-shooting problems.



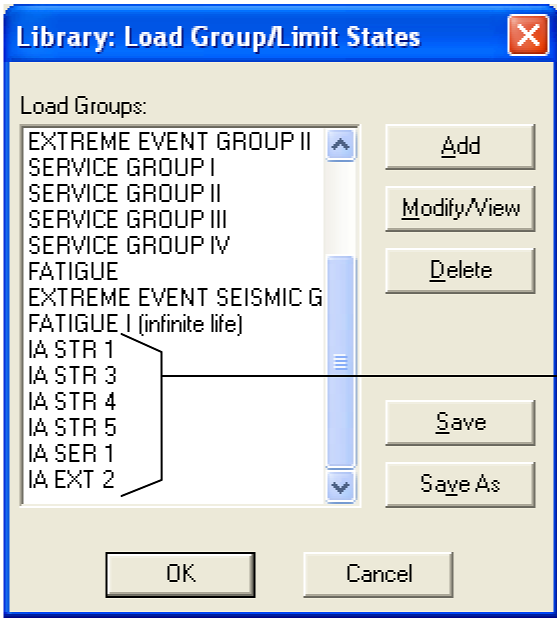
This is the Library Setup screen from Leap Bridge.

This library contains the Iowa Load Groups.

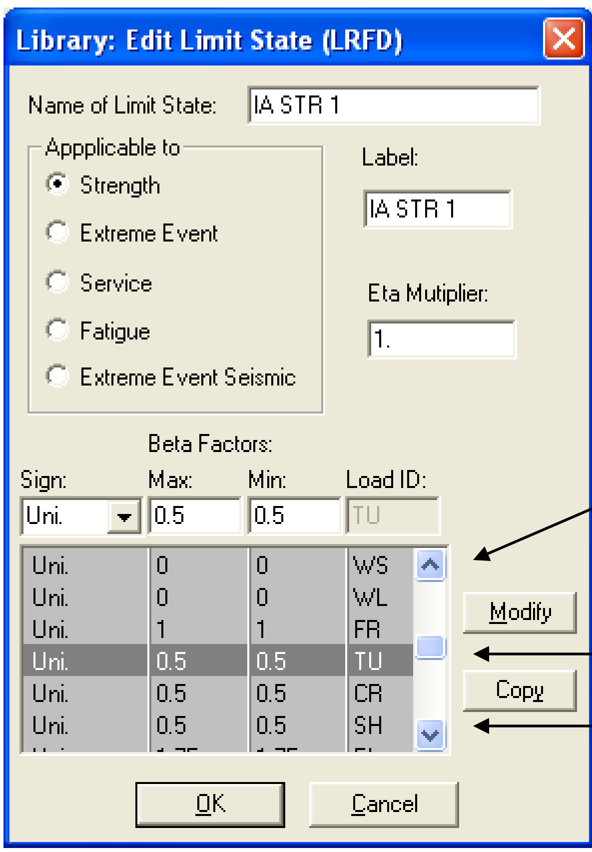
This is the Library Setup screen from RC-Pier.



Not sure why these libraries are not included in the Leap Bridge library setup screen above.



The Iowa Load Groups

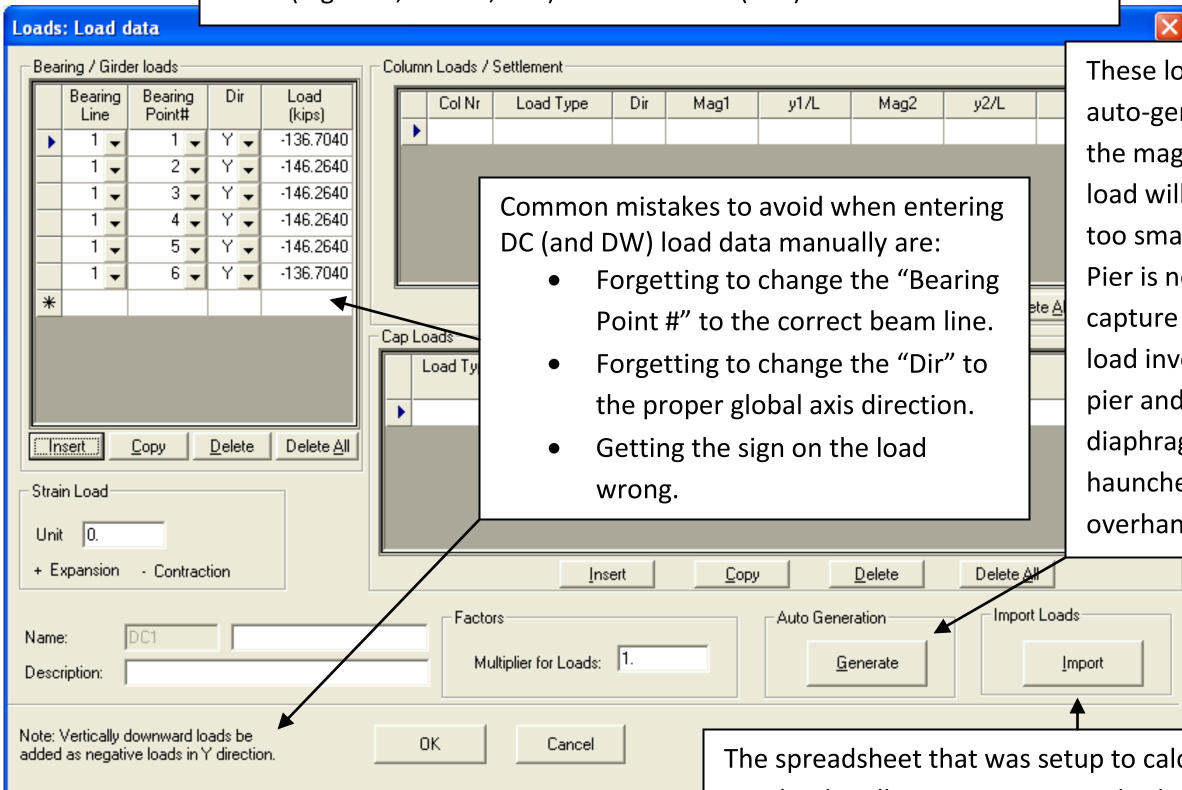


Notice that the wind loads have been switched from "Reversible" to "Uni-directional"

In general Iowa will use the smaller values for the TU and SH load factors along with gross inertia of the pier members. See Aashto Lrfd 3.4.1, the first paragraph on page 3-12 of the 5th edition (2010).

DC1

The “1” in “DC1” refers to the 1st load case number in the generic DC load type numbering sequence. So, the “DC1” load data includes DC1 loads (e.g. slab, beams, etc.) and DC2 loads (SBC).



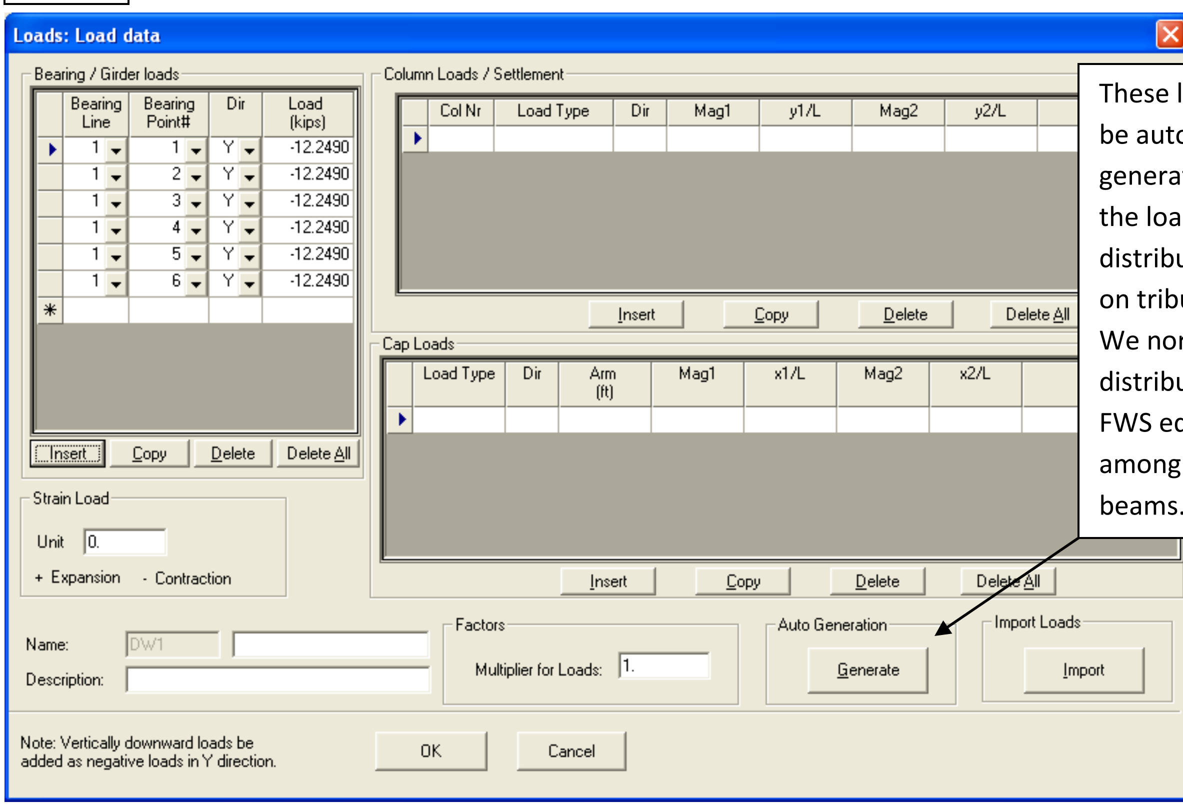
These loads can be auto-generated, but the magnitude of the load will typically be too small since RC-Pier is not able to capture all the dead load involved (e.g. pier and intermediate diaphragms, haunches, slab overhang thickening).

Common mistakes to avoid when entering DC (and DW) load data manually are:

- Forgetting to change the “Bearing Point #” to the correct beam line.
- Forgetting to change the “Dir” to the proper global axis direction.
- Getting the sign on the load wrong.

The spreadsheet that was setup to calculate DC1 loads will not generate standardized text files in order to import the loads. The DC (and DW) input is relatively minor for this load case.

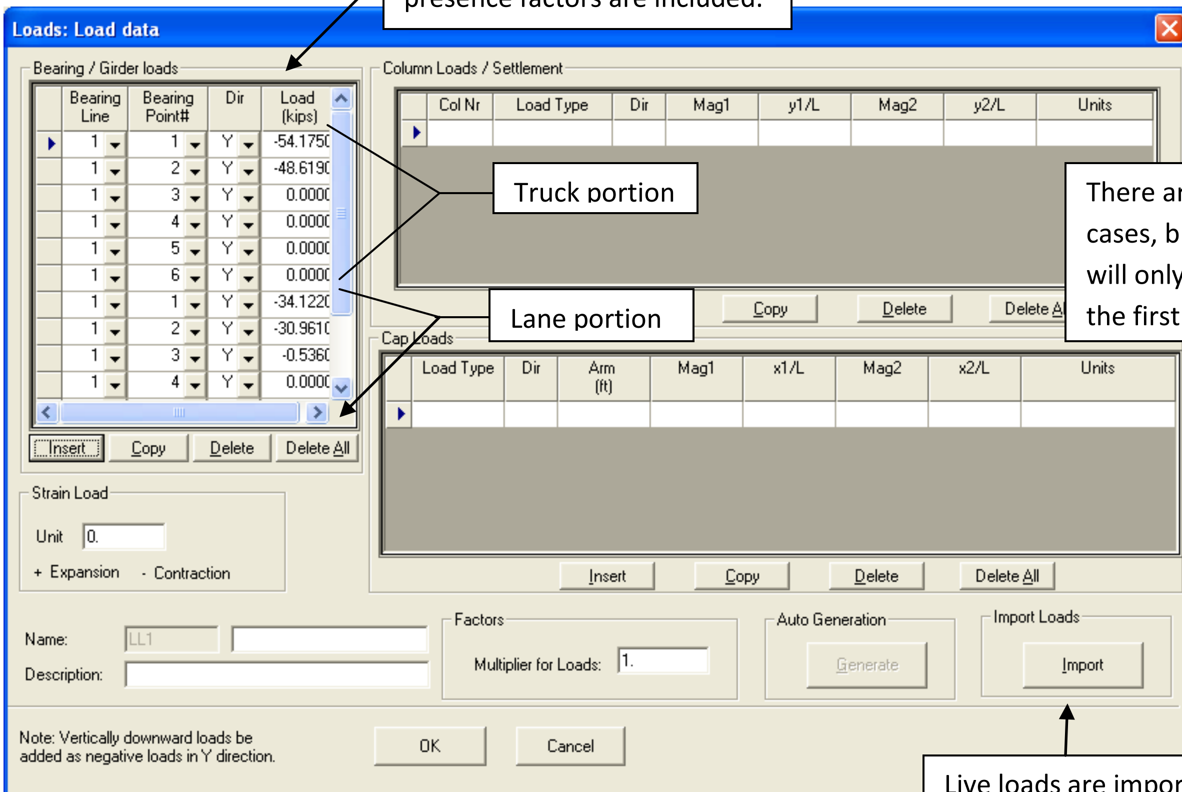
DW1



These loads can be auto-generated, but the load is distributed based on tributary area. We normally distribute the FWS equally among all the beams.

LL1

Impact is excluded. Multiple presence factors are included.

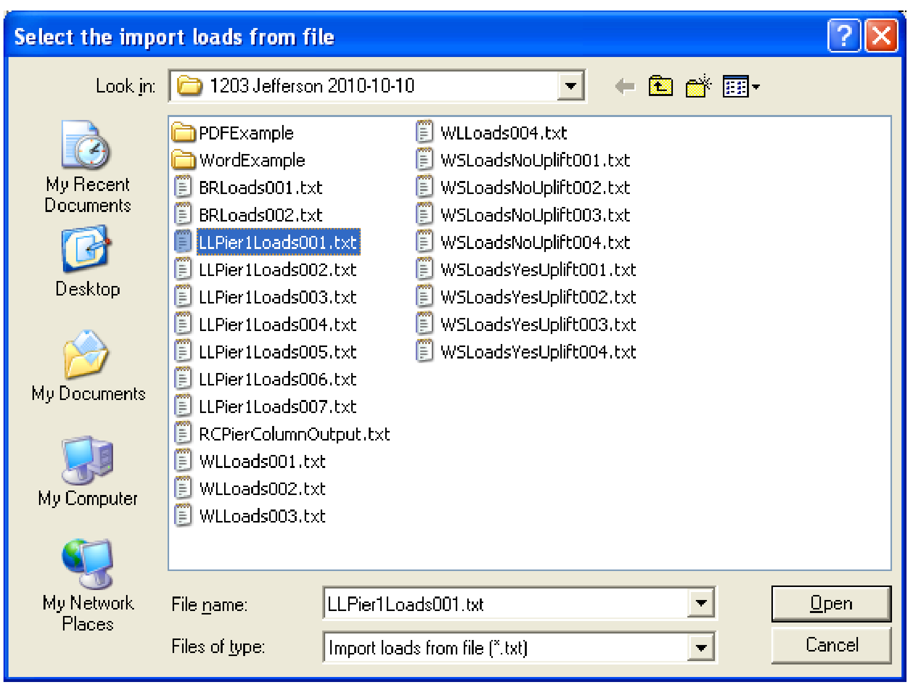


Truck portion

Lane portion

There are 7 LL cases, but I will only show the first one.

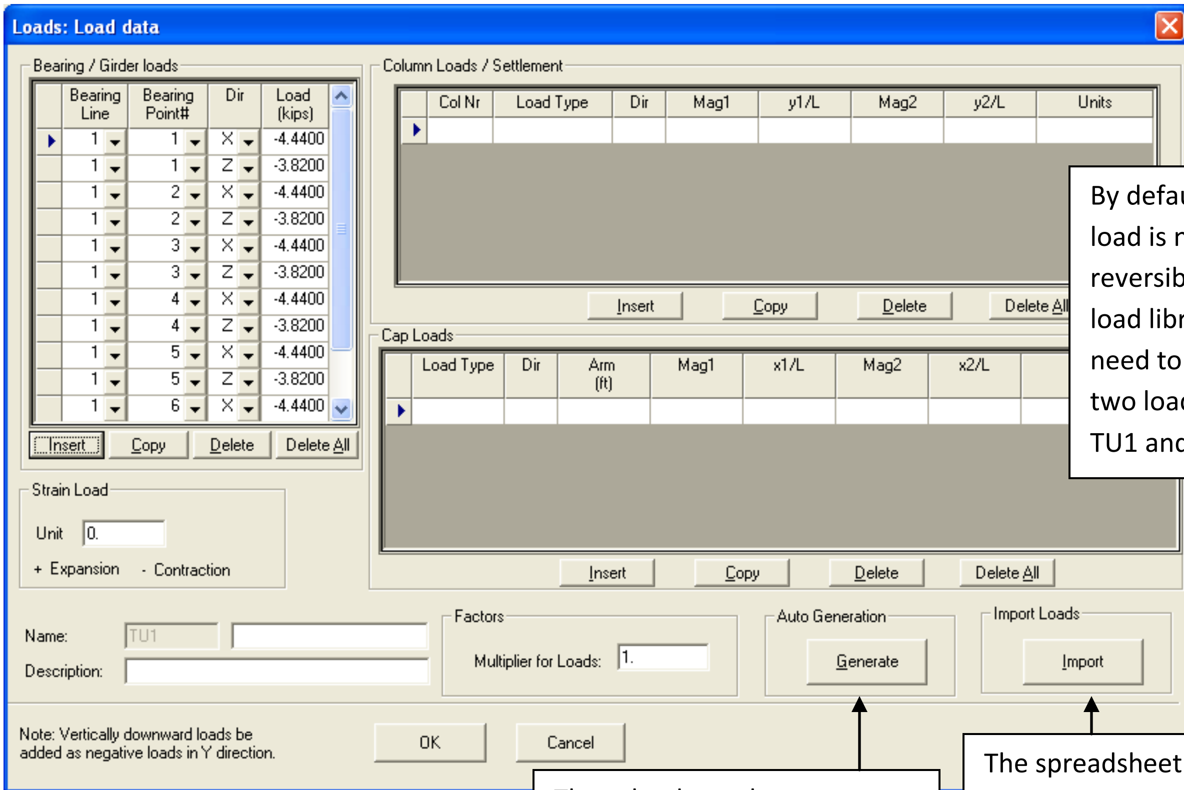
Live loads are imported from the text files generated by the in-house spreadsheet for bridge pier live loads.




```
Bearing Loads
1, 1, Y, -54.175
1, 2, Y, -48.619
1, 3, Y, 0
1, 4, Y, 0
1, 5, Y, 0
1, 6, Y, 0
1, 1, Y, -34.122
1, 2, Y, -30.961
1, 3, Y, -0.536
1, 4, Y, 0
1, 5, Y, 0
1, 6, Y, 0
```

This is the content of "LLPier1Loads001.txt" which is imported into RC-Pier for LL1.

TU1

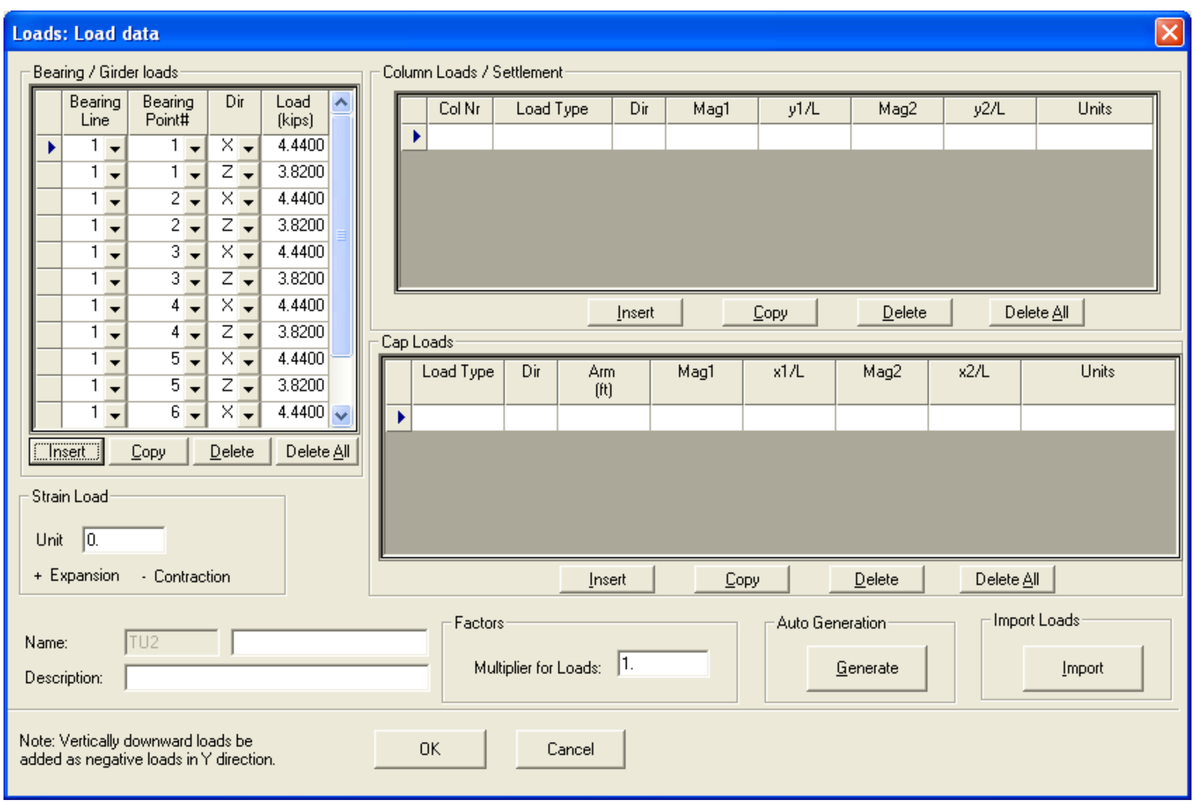


By default this load is not reversible in the load library so I need to enter two load cases: TU1 and TU2.

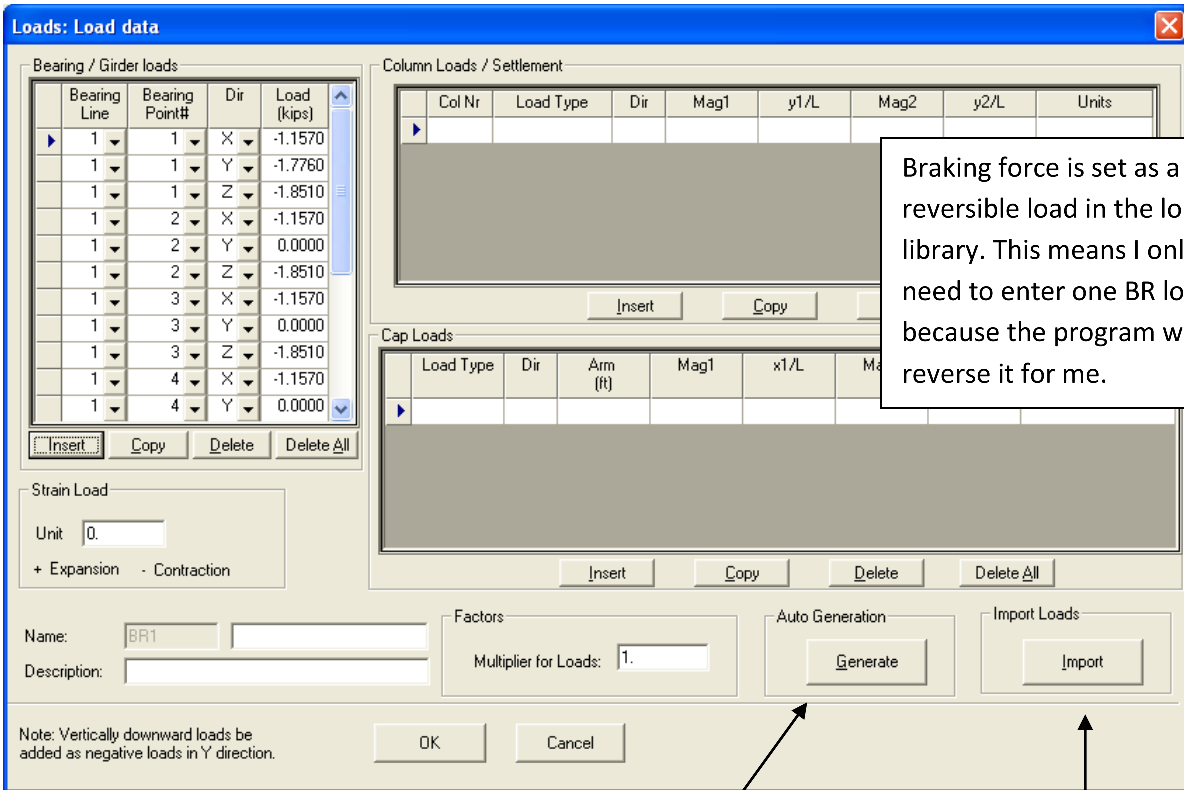
These loads can be auto-generated, but the procedure is not according to DOT policy.

The spreadsheet that was setup to calculate TU loads will not generate standardized text files in order to import the loads.

TU2



BR1



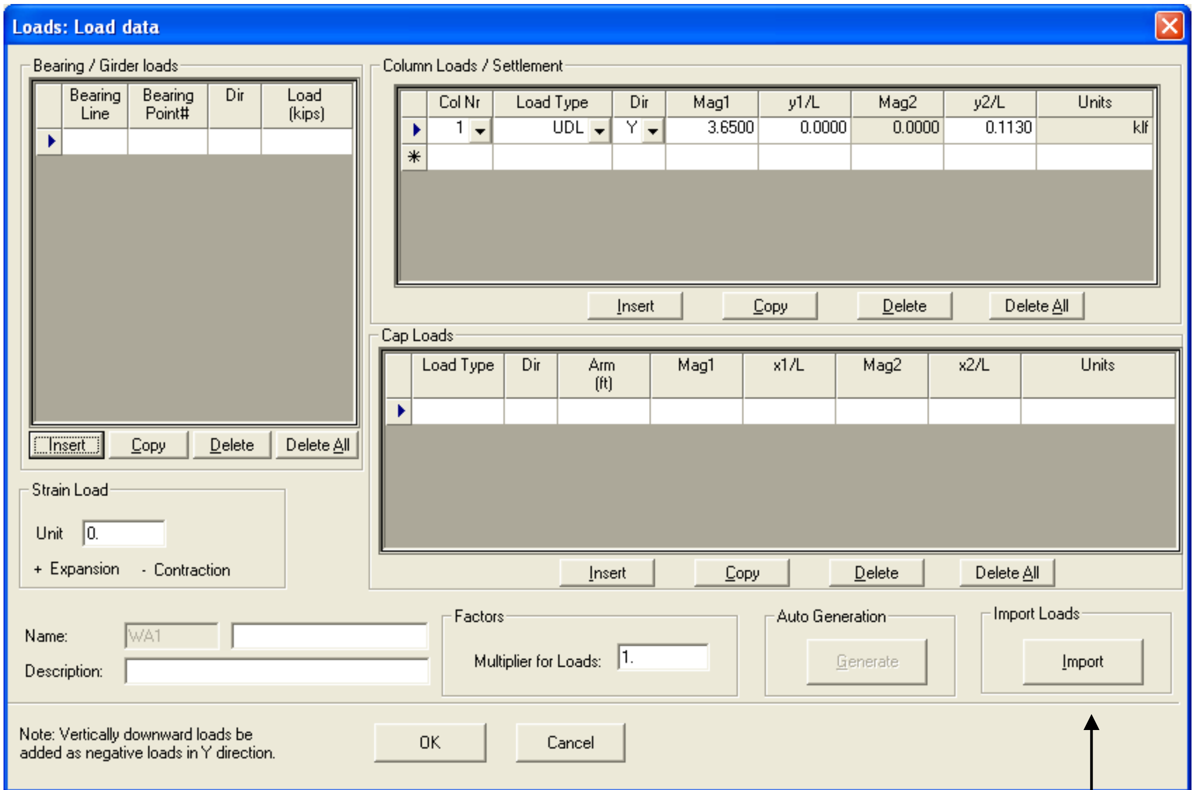
Braking force is set as a reversible load in the load library. This means I only need to enter one BR load because the program will reverse it for me.

Braking can be auto-generated. We typically distribute the concentrated truck portion of this force among the contributing bents; however, RC-Pier puts the entire load on the pier being analyzed.

These loads were imported from text file “BRLoads001.txt” generated by the spreadsheet for BR loads.

```
Bearing Loads
1, 1, X, -1.157
1, 1, Y, -1.776
1, 1, Z, -1.851
1, 2, X, -1.157
1, 2, Y, 0
1, 2, Z, -1.851
1, 3, X, -1.157
1, 3, Y, 0
1, 3, Z, -1.851
1, 4, X, -1.157
1, 4, Y, 0
1, 4, Z, -1.851
1, 5, X, -1.157
1, 5, Y, 0
1, 5, Z, -1.851
1, 6, X, -1.157
1, 6, Y, 1.776
1, 6, Z, -1.851
```

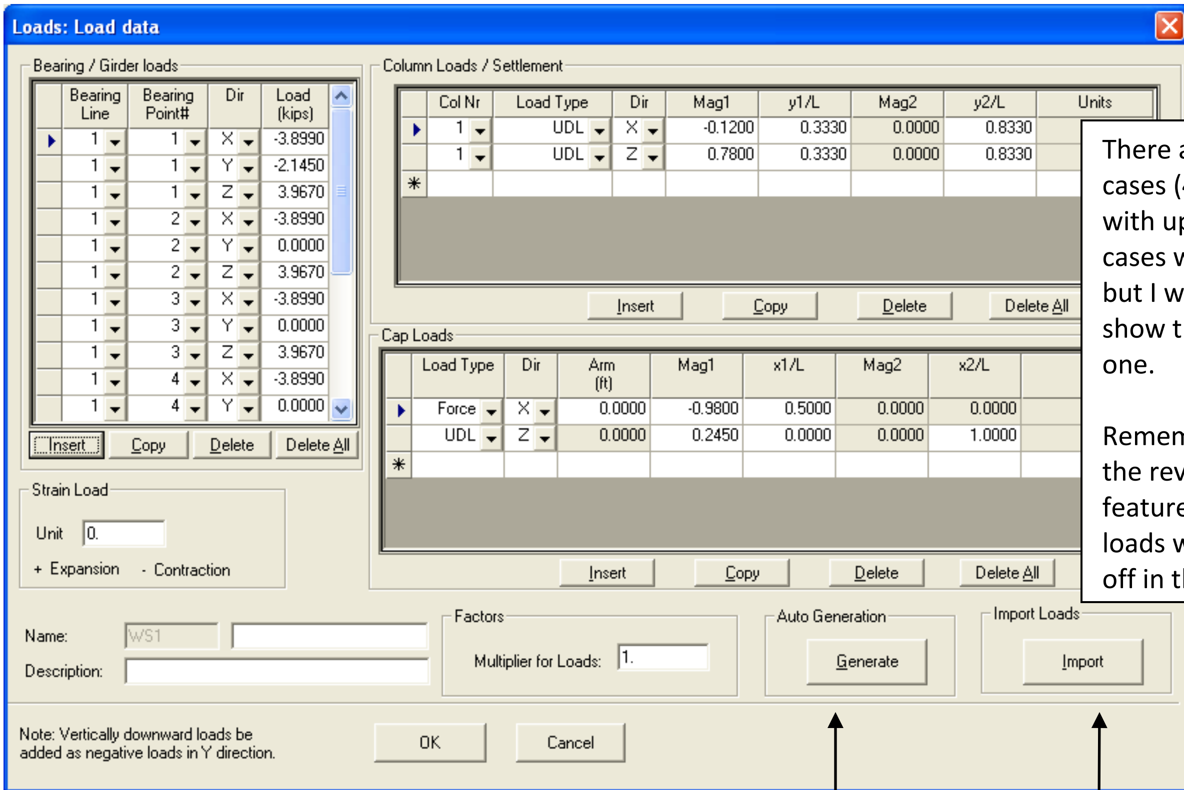
WA1



The spreadsheet that was setup to calculate WA loads will not generate standardized text files in order to import the loads.

The only water loads that affect the column and cap design for Case 1 are the buoyancy loads on the column.

WS1



There are 8 WS cases (4 cases with uplift and 4 cases without), but I will only show the first one.

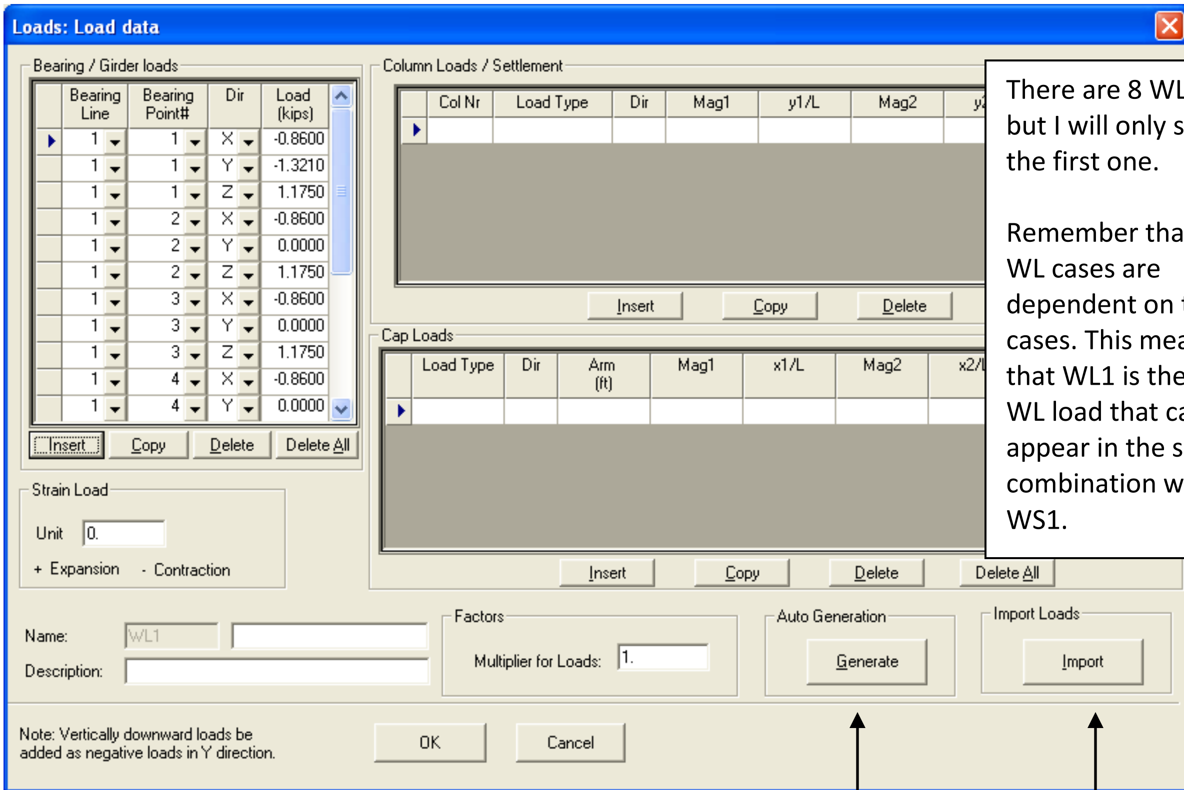
Remember that the reversible feature for wind loads was turned off in the library.

Wind loads can be auto-generated, but generating simplified wind loads requires a few tricks and some editing of the load results.

The wind loads above were imported from text file “WSLoadsNoUplift001.txt” which was generated from the in-house spreadsheet for wind loads.

```
Bearing Loads
1, 1, X, -3.899
1, 1, Y, -2.145
1, 1, Z, 3.967
1, 2, X, -3.899
1, 2, Y, 0
1, 2, Z, 3.967
1, 3, X, -3.899
1, 3, Y, 0
1, 3, Z, 3.967
1, 4, X, -3.899
1, 4, Y, 0
1, 4, Z, 3.967
1, 5, X, -3.899
1, 5, Y, 0
1, 5, Z, 3.967
1, 6, X, -3.899
1, 6, Y, 2.145
1, 6, Z, 3.967
Cap Loads
Force, X, 0, -0.98, 0.5
UDL, Z, 0.245, 0, 1
Column Loads
1, UDL, X, -0.12, 0.333, 0.833
1, UDL, Z, 0.78, 0.333, 0.833
```

WL1



There are 8 WL cases, but I will only show the first one.

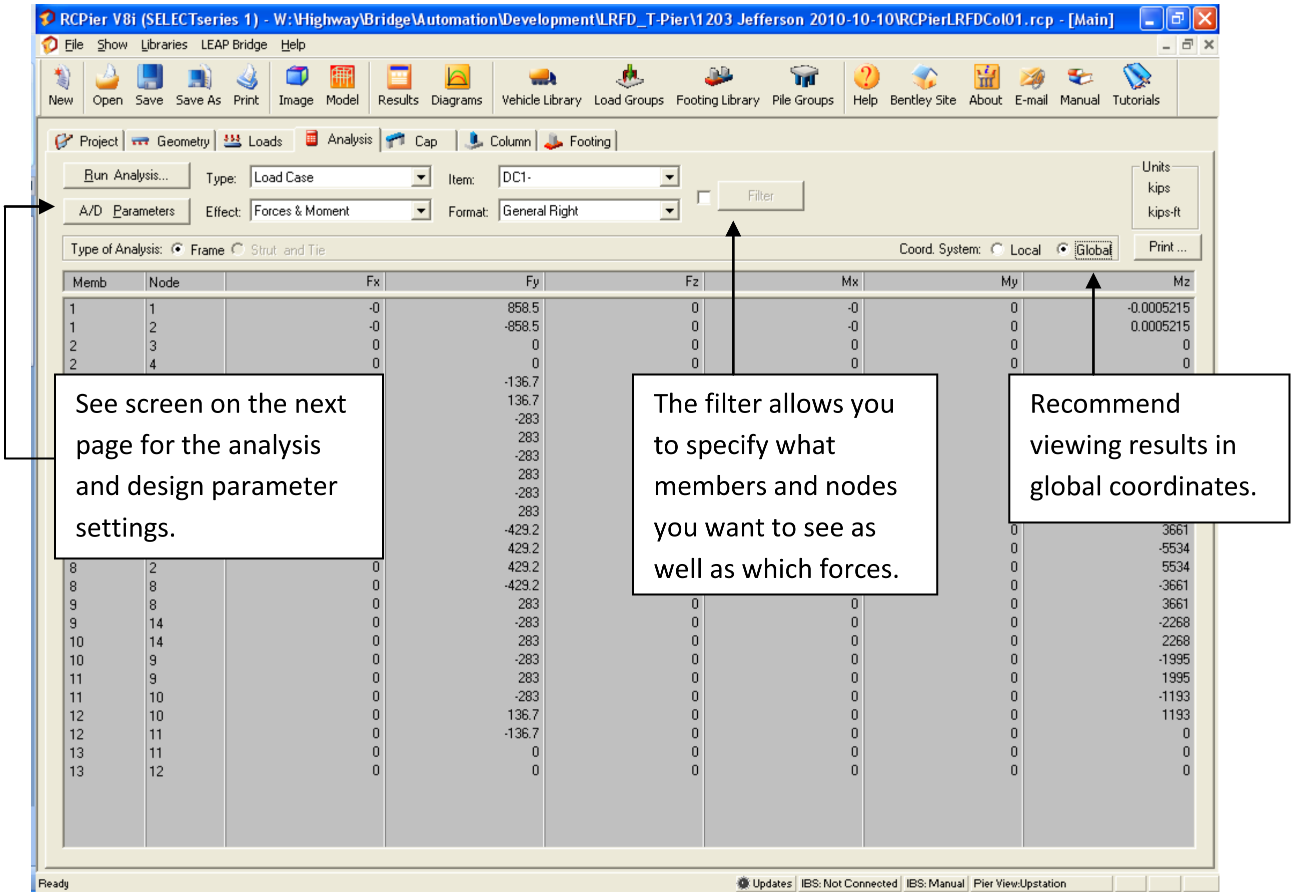
Remember that the WL cases are dependent on the WS cases. This means that WL1 is the only WL load that can appear in the same combination with WS1.

Wind loads can be auto-generated, but generating simplified wind loads requires some editing of the load results.

```
Bearing Loads
1, 1, X, -0.86
1, 1, Y, -1.321
1, 1, Z, 1.175
1, 2, X, -0.86
1, 2, Y, 0
1, 2, Z, 1.175
1, 3, X, -0.86
1, 3, Y, 0
1, 3, Z, 1.175
1, 4, X, -0.86
1, 4, Y, 0
1, 4, Z, 1.175
1, 5, X, -0.86
1, 5, Y, 0
1, 5, Z, 1.175
1, 6, X, -0.86
1, 6, Y, 1.321
1, 6, Z, 1.175
```

The wind loads above were imported from text file “WLLoads001.txt” which was generated from the in-house spreadsheet for wind loads.

Run the Analysis

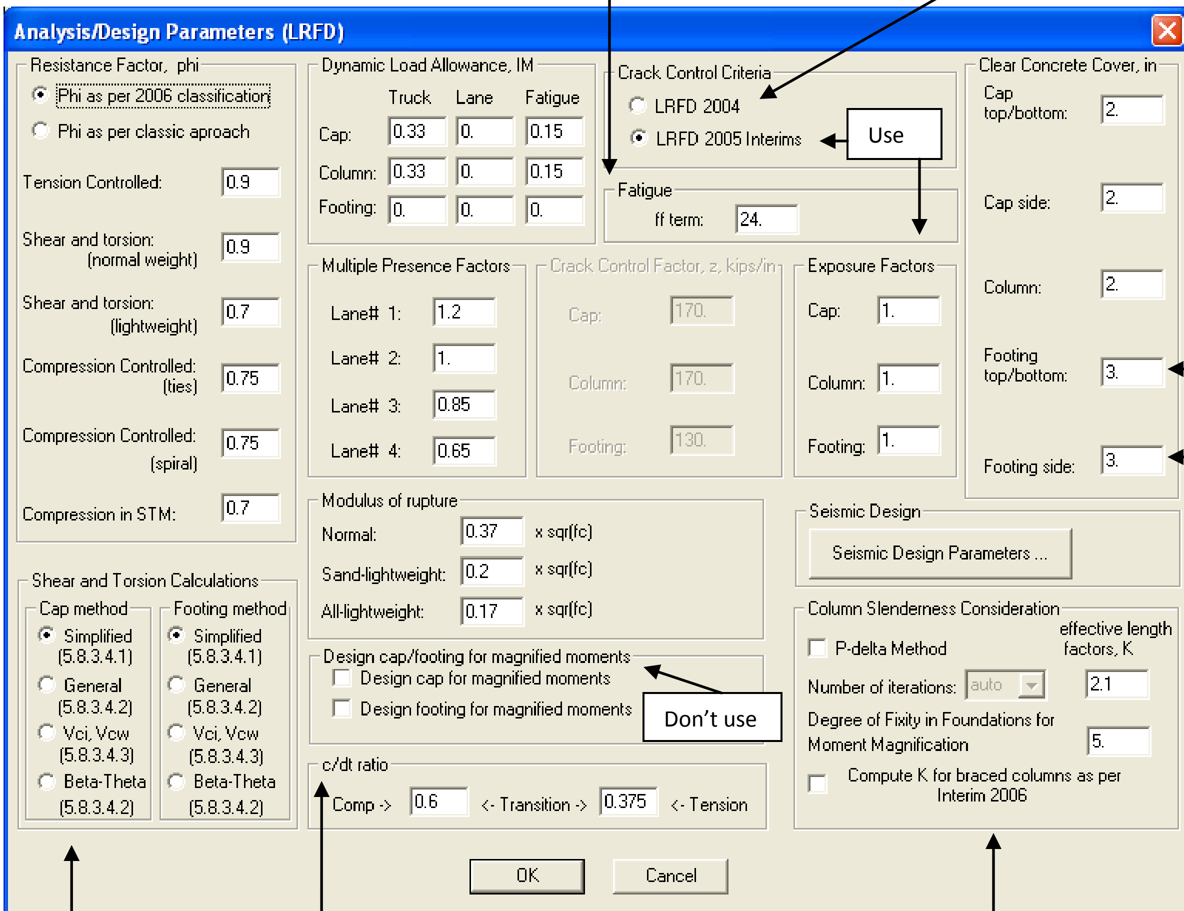


This screen is useful for checking reasonableness of results and for resolving differences among designers and checkers since you can look at load cases, load combinations, and envelopes.

Analysis and Design Parameters

Typically fatigue is not considered.

z-check



Use

Don't use

Not of interest for cap and column design.

We will use "Phi as per 2006 classification". This means we look at sections as being Tension Controlled, In-Transition, or Compression Controlled. See Aashto Lrfd Fig. C5.5.4.2.1-1 for information on how the "c/dt ratio" used in the calculation of the flexural resistance factors in transition.

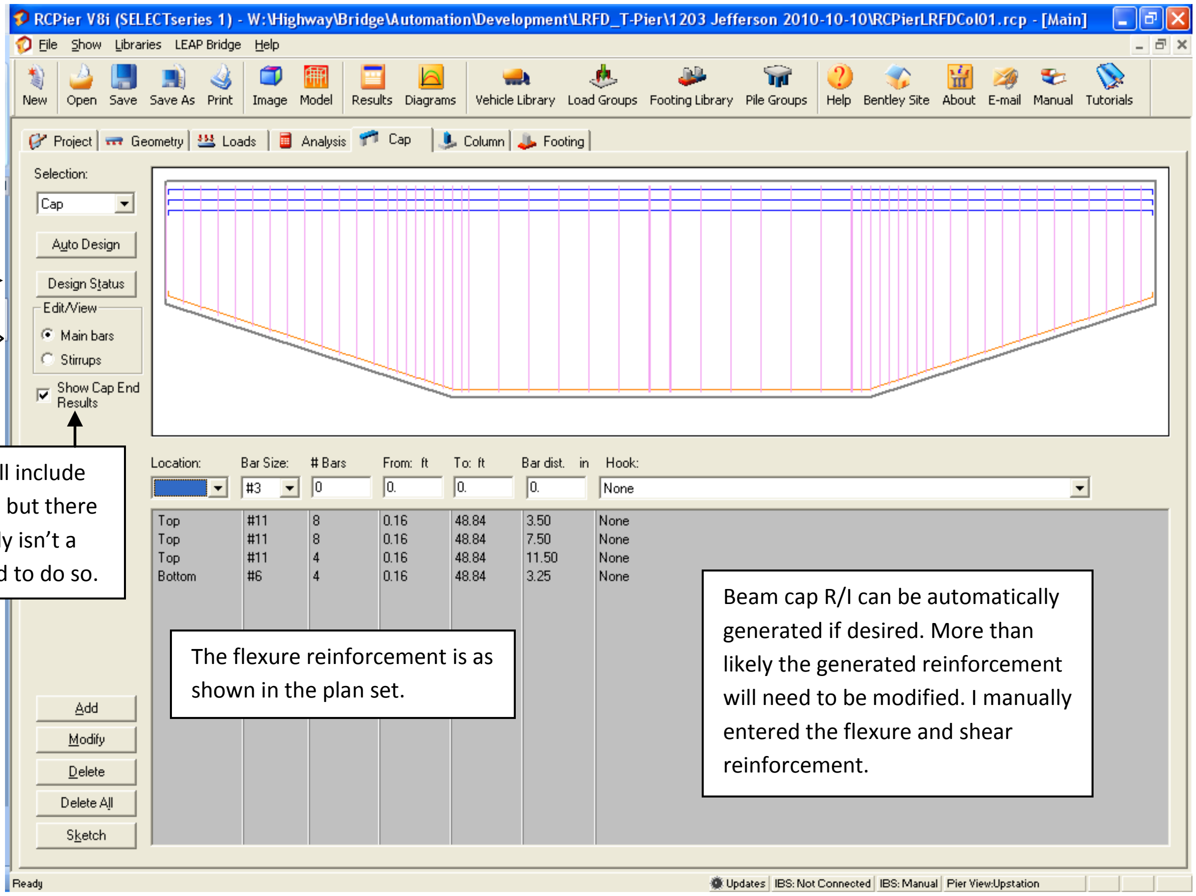
We typically use moment magnification for column design. The parameters we use can be entered on the column design screen.

The Bridge Manual does not specify which shear method to use for cap design. A general recommendation is to base shear design for the cap on the "Simplified" method or the "Beta-Theta" method. The "Beta-Theta" method is actually the procedure listed in Aashto Lrfd 5.8.3.4.2 (General Procedure with closed form solution) rather than that found in Aahto Lrfd Appendix B5 (General Procedure with tables). The "General" method listed on the screen above is the one found in Aashto Lrfd Appendix B5.

RC-Pier does not check column shear. Designers may want to verify that column shear is OK.

Pier Cap Design: RC-Pier

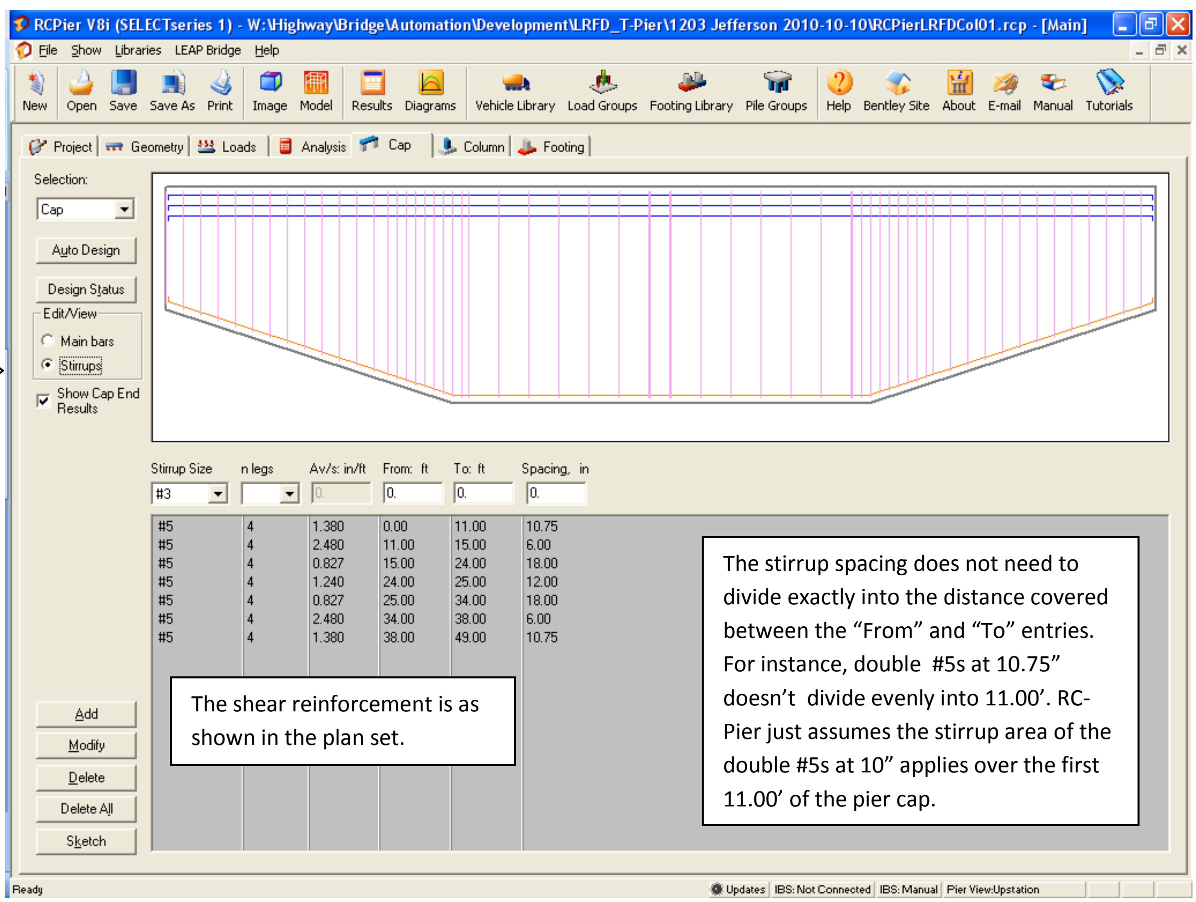
Design status report is printed out a few pages over.



We'll include this, but there really isn't a need to do so.

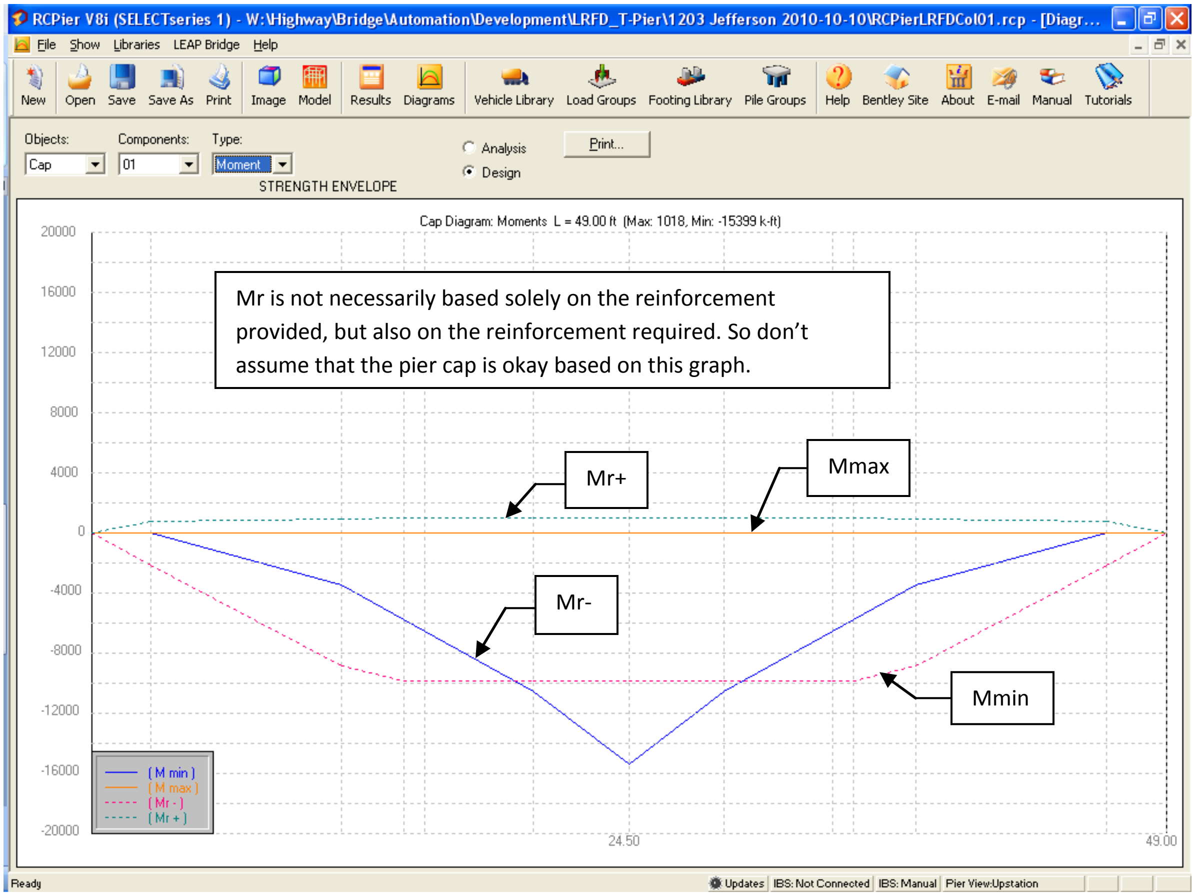
The flexure reinforcement is as shown in the plan set.

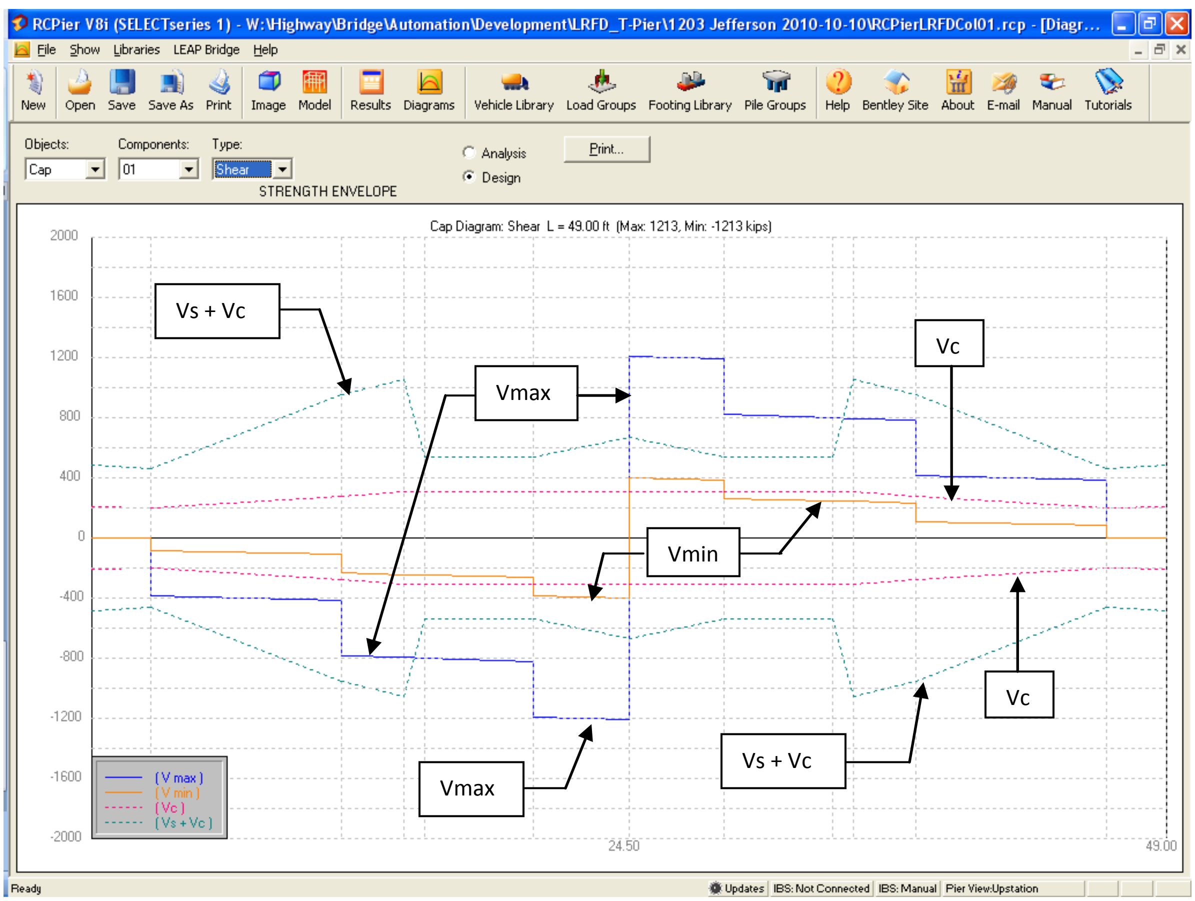
Beam cap R/I can be automatically generated if desired. More than likely the generated reinforcement will need to be modified. I manually entered the flexure and shear reinforcement.



The shear reinforcement is as shown in the plan set.

The stirrup spacing does not need to divide exactly into the distance covered between the "From" and "To" entries. For instance, double #5s at 10.75" doesn't divide evenly into 11.00'. RC-Pier just assumes the stirrup area of the double #5s at 10" applies over the first 11.00' of the pier cap.


Cap Diagram: Moments L = 49.00 ft (Max: 1018, Min: -15399 k-ft)
Mr is not necessarily based solely on the reinforcement provided, but also on the reinforcement required. So don't assume that the pier cap is okay based on this graph.
Mr+
Mmax
Mr-
Mmin
STRENGTH ENVELOPE


Cap Diagram: Shear L = 49.00 ft (Max: 1213, Min: -1213 kips)
Vs + Vc
Vmax
Vc
Vmin
Vc
Vmax
Vs + Vc
STRENGTH ENVELOPE

CAP DESIGN

I've included some portions of RC-Pier's output for the cap design.

CAP DESIGN
Code: AASHTO LRFD 2007 (with Interims)
Units: US
Pier View: Upstation.

DESIGN PARAMETERS	
f'c = 3500.0 psi	
Fy flex = 60000.0 psi	Fy shear = 60000.0 psi
phi tens = 0.90	
phi comp = 0.75	phi shear = 0.90
Tens below = 0.375	Comp Above = 0.600
Ec = 3586.6 ksi	Es = 29000.0 ksi
Crack check as per 2005 Interims	
Crack control Exposure = 1.00	
Concrete Type : Normal Weight.	
Design of cap at centerline of column.	

CAP GEOMETRY
Tapered Cap : Length(X) = 49.00 ft Depth(Z) = 42.00 in

Cap Section Properties

Sec.	Area ft ^2	Ixx in ^4	Izz in ^4
1	24.50	2074464.00	518616.00

MAIN REINFORCEMENT

	Bar size	Quantity	Bar dist. in	As total in^2	From ft	To ft	Hook
TOP							
	# 11	8	3.50	12.480	0.16	48.84	None
	# 11	8	7.50	12.480	0.16	48.84	None
	# 11	4	11.50	6.240	0.16	48.84	None
BOTTOM							
	# 6	4	3.25	1.760	0.16	48.84	None

STIRRUPS

From ft	To ft	Stirrup Size	n legs	Spacing in	Aprvls in^2 / ft
0.00	11.00	# 5	4	10.75	1.38
11.00	15.00	# 5	4	6.00	2.48
15.00	24.00	# 5	4	18.00	0.83
24.00	25.00	# 5	4	12.00	1.24
25.00	34.00	# 5	4	18.00	0.83
34.00	38.00	# 5	4	6.00	2.48
38.00	49.00	# 5	4	10.75	1.38

Iowa has special loading requirements for the pier cap overhang design which were not included in this RC-Pier run. Further on in this example is a spreadsheet design addresses these requirements.

FLEXURE DESIGN

Bottom R/I | Top R/I

Span 1: From 0.00 ft To 24.50 ft

Loc ft	AbsLoc ft	H in	Mmax Mmin kips-ft	Mr kips-ft	Comb	CL	Asb-req in^2	Asb-prv in^2	Asb-eff in^2	Ast-req in^2	Ast-prv in^2	Ast-eff in^2
0.0	0.0	48	0.0	0.0	0	T	0.85	0.00*	0.00*	0.85	0.00*	0.00*
			0.0	-0.0	0	T	0.85	0.00*	0.00*	0.85	0.00*	0.00*
2.7	2.7	55	11.9	786.7	156	T	0.90	1.76	1.76	0.90	31.20	31.20
			-29.4	-2221.7	114	T	0.90	1.76	1.76	0.90	31.20	10.82
11.4	11.4	77	0.0	961.3	0	T	1.03	1.76	1.76	1.03	31.20	31.20
			-3529.2	-8880.5	1	T	1.03	1.76	1.76	11.65	31.20	31.20
14.3	14.3	84	0.0	1018.0	0	T	1.06	1.76	1.76	1.06	31.20	31.20
			-5775.1	-9886.4	1	T	1.06	1.76	1.76	17.56	31.20	31.20
15.2	15.2	84	0.0	1018.0	0	T	1.06	1.76	1.76	1.06	31.20	31.20
			-6547.4	-9886.4	1	T	1.06	1.76	1.76	20.07	31.20	31.20
20.1	20.1	84	0.0	1018.0	0	T	1.06	1.76	1.76	1.06	31.20	31.20
			-10562.7	-9886.4*	1	T	1.06	1.76	1.76	33.94	31.20	31.20
24.5	24.5	84	0.0	1018.0	0	T	1.06	1.76	1.76	1.06	31.20	31.20
			-15399.2	-9886.4*	3	T	1.06	1.76	1.76	52.99	31.20*	31.20*

The cap end results could have been excluded if we had left the "Show Cap End Results" check box unchecked.

I will show some hand calculations for the top reinforcement at this location (15.2') a little later in the example.

Ideally the C.L. of the column would be excluded when the user specifies offsets from the C.L. of columns as we did.

Span 2: From 24.50 ft To 49.00 ft

Loc ft	AbsLoc ft	H in	Mmax Mmin kips-ft	Mr kips-ft	Comb	CL	Asb-req in^2	Asb-prv in^2	Asb-eff in^2	Ast-req in^2	Ast-prv in^2	Ast-eff in^2
0.0	24.5	84	0.0	1018.0	0	T	1.06	1.76	1.76	1.06	31.20	31.20
			-15399.2	-9886.4*	25	T	1.06	1.76	1.76	52.99	31.20*	31.20*
4.4	28.9	84	0.0	1018.0	0	T	1.06	1.76	1.76	1.06	31.20	31.20
			-10562.7	-9886.4*	23	T	1.06	1.76	1.76	33.94	31.20*	31.20*
9.3	33.8	84	0.0	1018.0	0	T	1.06	1.76	1.76	1.06	31.20	31.20
			-6547.4	-9886.4	23	T	1.06	1.76	1.76	20.07	31.20	31.20
10.3	34.8	84	0.0	1018.0	0	T	1.06	1.76	1.76	1.06	31.20	31.20
			-5775.1	-9886.4	23	T	1.06	1.76	1.76	17.56	31.20	31.20
13.1	37.6	77	0.0	961.3	0	T	1.03	1.76	1.76	1.03	31.20	31.20
			-3529.2	-8880.5	23	T	1.03	1.76	1.76	11.65	31.20	31.20
21.8	46.3	55	11.9	786.7	146	T	0.90	1.76	1.76	0.90	31.20	31.20
			-29.4	-2221.7	124	T	0.90	1.76	1.76	0.90	31.20	10.82
24.5	49.0	48	0.0	0.0	0	T	0.85	0.00*	0.00*	0.85	0.00*	0.00*
			0.0	-0.0	0	T	0.85	0.00*	0.00*	0.85	0.00*	0.00*

Flexure Design : Notes
CL: Section classification as per LRFD 2006 interims for provided reinforcement.
C = Compression controlled, I = In-Transition, T = Tension controlled.
* The provided reinforcement is not adequate, either less than required or larger than maximum allowed.

SHEAR AND TORSION DESIGN

Required Shear R/I

Provided Shear R/I

Additional longitudinal reinforcement required based on Aashto Lrfd 5.8.3.5. As of the printing of this example the Iowa DOT Bridge Design Manual requires that this provision be met all along the cap for pier cap design.

Span 1: From 0.00 ft To 24.50 ft

Loc ft	AbsLoc ft	Pos	Vu kips	Comb	Tu kips-ft	Comb	phi*Vc kips	T-lim kips-ft	Avs/s in^2/ft	2Ats/s in^2/ft	Av/s in^2/ft	Aprv/s in^2/ft	Alx in^2
0.00	0.00	R	0.0	0	0.0	0	214.7	99.0	0.00	0.00	0.00	1.38	0.00
2.69	2.69	L	7.6	1	0.0	0	203.5	120.0	0.00	0.00	0.00	1.38	0.00
		R	385.7	1	14.9	125	203.5	120.0	0.89	0.00	0.89	1.38	0.00
11.41	11.41	L	417.1	1	14.9	115	282.3	192.1	0.50	0.00	0.50	2.48	0.00
		R	785.7	1	29.9	121	282.3	192.1	1.77	0.00	1.77	2.48	0.00
14.25	14.25	L	798.1	1	29.9	115	312.2	216.6	1.55	0.00	1.55	2.48	0.00
		R	798.1	1	29.9	121	312.2	216.6	1.55	0.00	1.55	2.48	0.00
15.22	15.22	L	802.6	1	29.9	115	312.2	216.6	1.56	0.00	1.56	0.83**	2.10
		R	802.6	1	29.9	121	312.2	216.6	1.56	0.00	1.56	0.83**	2.10
20.14	20.14	L	825.2	1	29.9	115	312.2	216.6	1.63	0.00	1.63	0.83**	15.27
		R	1192.5	3	44.8	121	312.2	216.6	2.80	0.00	2.80	0.83**	20.80
24.50	24.50	L	1212.6	3	44.8	115	312.2	216.6	2.87	0.00	2.87	1.24**	36.67

Span 2: From 24.50 ft To 49.00 ft

Loc ft	AbsLoc ft	Pos	Vu kips	Comb	Tu kips-ft	Comb	phi*Vc kips	T-lim kips-ft	Avs/s in^2/ft	2Ats/s in^2/ft	Av/s in^2/ft	Aprv/s in^2/ft	Alx in^2
0.00	24.50	R	1212.6	25	44.8	115	312.2	216.6	2.87	0.00	2.87	1.24**	36.67
4.36	28.86	L	1192.5	25	44.8	121	312.2	216.6	2.80	0.00	2.80	0.83**	20.80
		R	825.2	23	29.9	115	312.2	216.6	1.63	0.00	1.63	0.83**	15.27
9.28	33.78	L	802.6	23	29.9	121	312.2	216.6	1.56	0.00	1.56	0.83**	2.10
		R	802.6	23	29.9	115	312.2	216.6	1.56	0.00	1.56	0.83**	2.10
10.25	34.75	L	798.1	23	29.9	121	312.2	216.6	1.55	0.00	1.55	2.48	0.00
		R	798.1	23	29.9	115	312.2	216.6	1.55	0.00	1.55	2.48	0.00
13.09	37.59	L	785.7	23	29.9	121	282.3	192.1	1.77	0.00	1.77	2.48	0.00
		R	417.1	23	14.9	119	282.3	192.1	0.50	0.00	0.50	2.48	0.00
21.81	46.31	L	385.7	23	14.9	121	203.5	120.0	0.89	0.00	0.89	1.38	0.00
		R	7.6	1	0.0	0	203.5	120.0	0.00	0.00	0.00	1.38	0.00
24.50	49.00	L	0.0	0	0.0	0	214.7	99.0	0.00	0.00	0.00	1.38	0.00

Torsion is usually not a factor for a typical T-pier design. There are essentially two reasons for this. The first reason is that we often use a single line of bearings centered on the pier cap. Modeling the pier this way reduces Mx cap moments. The second reason is that we generally assume lateral superstructure loading does not generate Mx cap moments between the superstructure and the top of the cap. The user needs to determine if these modeling assumptions are appropriate for their design.

Shear and Torsion Design : Notes

** Provided stirrup area (Aprv/s) is not adequate.
- Pos is the design position. L suggests the calculation is done at immediate left of "Loc" and R suggests at immediate right of it.
- T-lim is the limiting value of torsion for the concrete section. If actual torsion is higher than this value, torsional steel has to be provided.
- Avs/s is the required area of steel per unit length for shear force.
- 2Ats/s is the required area of steel per unit length for two legs of torsional reinforcement.
- Av/s is the total required area of steel per unit length due to shear plus torsion.
- Aprvs/s is the total provided area of steel per unit length due to shear (stirrups).
- Alx is the EFFECTIVE longitudinal steel required in addition to the PROVIDED EFFECTIVE flexural steel.

CRACKING/FATIGUE CHECK

Span 1: From 0.00 ft To 24.50 ft

Loc ft	AbsLoc ft	H in	Cracking Comb	Cracking fs-t fs-b ksi	Cracking dc in	Cracking Srqt Srqb in	Cracking Sprt Sprb in	Fatigue fs-t fs-b ksi	Fatigue ratio fs-t ratio fs-b	Fatigue Comb
0.00	0.0	48.0	0	0.0	0.0	42.0	0.0	0.0	0.00	0
			0	0.0	0.0	42.0	0.0	0.0	0.00	0
2.69	2.7	54.8	1080	0.6	3.5	42.0	5.0	0.0	0.00	0
			1262	1.2	3.3	42.0	12.0	0.0	0.00	0
11.41	11.4	76.8	1108	15.3	3.5	35.9	5.0	0.0	0.00	0
			0	0.0	3.3	42.0	12.0	0.0	0.00	0
14.25	14.3	84.0	1108	22.4	3.5	22.4	5.0	0.0	0.00	0
			0	0.0	3.3	42.0	12.0	0.0	0.00	0
15.22	15.2	84.0	1108	25.4	3.5	18.9	5.0	0.0	0.00	0
			0	0.0	3.3	42.0	12.0	0.0	0.00	0
20.14	20.1	84.0	1080	41.0	3.5	9.1	5.0	0.0	0.00	0
			0	0.0	3.3	42.0	12.0	0.0	0.00	0
24.50	24.5	84.0	1082	60.0	3.5	4.0	5.0*	0.0	0.00	0
			0	0.0	3.3	42.0	12.0	0.0	0.00	0

Span 2: From 24.50 ft To 49.00 ft

Loc ft	AbsLoc ft	H in	Cracking Comb	Cracking fs-t fs-b ksi	Cracking dc in	Cracking Srqt Srqb in	Cracking Sprt Sprb in	Fatigue fs-t fs-b ksi	Fatigue ratio fs-t ratio fs-b	Fatigue Comb
0.00	24.5	84.0	1265	60.0	3.5	4.0	5.0*	0.0	0.00	0
			0	0.0	3.3	42.0	12.0	0.0	0.00	0
4.36	28.9	84.0	1263	41.0	3.5	9.1	5.0	0.0	0.00	0
			0	0.0	3.3	42.0	12.0	0.0	0.00	0
9.28	33.8	84.0	1291	25.4	3.5	18.9	5.0	0.0	0.00	0
			0	0.0	3.3	42.0	12.0	0.0	0.00	0
10.25	34.8	84.0	1291	22.4	3.5	22.4	5.0	0.0	0.00	0
			0	0.0	3.3	42.0	12.0	0.0	0.00	0
13.09	37.6	76.8	1291	15.3	3.5	35.9	5.0	0.0	0.00	0
			0	0.0	3.3	42.0	12.0	0.0	0.00	0
21.81	46.3	54.8	1262	0.6	3.5	42.0	5.0	0.0	0.00	0
			1080	1.2	3.3	42.0	12.0	0.0	0.00	0
24.50	49.0	48.0	0	0.0	0.0	42.0	0.0	0.0	0.00	0
			0	0.0	0.0	42.0	0.0	0.0	0.00	0

Cracking and fatigue Check : Notes

* Provided rebar spacing is not adequate for crack control.

Hand Calculations for Top Reinforcement in Span 1 at Location 15.2’

M_{max} = -6547.4 k*ft
$\rho = A_s/(b*d) = (31.2\ in^2)/[(42”)*(77.30”)] = 0.0096101$
$\rho_b = [(0.85*B_1*f'_c)/f_y]*[87/(87+f_y)] = [(0.85*0.85*(3.5\ ksi))/(60\ ksi)]*[87/(87 + 60\ ksi)] = 0.02494345$
$\rho_{max} = 0.634*\rho_b = 0.0158141$ (See derivation below.)

RC-Pier has Mr = 9886.4 k*ft since it treats the section as doubly-reinforced.

$\rho_{max} > \rho$ which means the section is tension-controlled: $f_s = f_y$ and $\phi = 0.90$

$a = A_s*f_y/[(0.85)*(f'_c)*(b)] = (31.2\ in^2)*(60\ ksi)/[(0.85)*(3.5\ ksi)*(42”)] = 14.9820”$
$\phi M_n = \phi A_s*f_y*(d – a/2) = (0.9)*(31.2\ in^2)*(60\ ksi)*[(77.30”) – (14.9820”)/2]/(12\ in/ft) = 9801.2$ k*ft

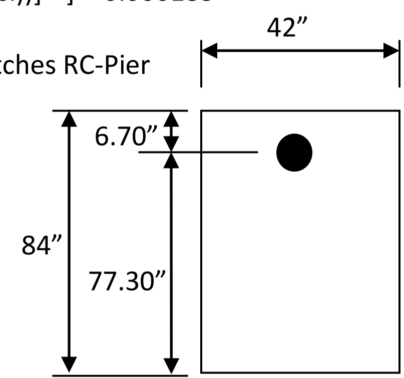
$f_r = 0.37*(f'_c)^{0.5} = 0.37*(3.5\ ksi)^{0.5} = 0.692207$ ksi
$M_{cr} = f_r*I/c = [(0.692207\ ksi)*(1/12)*(42”)*(84”)^3]/[(0.5)*(84”)*(12\ in/ft)] = 2849.12$ k*ft

$1.2M_{cr} = (1.2)*(2849.12\ k*ft) = 3418.95\ k*ft < \phi Mn = 9801.2$ k*ft

So $1.2M_{cr}$ = 1036.65 k*ft controls the design – Find required A_s based on $1.2*M_{cr}$

$R_n = R_u/\phi = M_u/(\phi*b*d^2) = (6547.4\ k*ft)*(12\ in/ft)/[(0.9)*(42”)*(77.30”)^2] = 0.34786$ ksi
$\rho = (0.85*f'_c/f_y)*[1 – (1 – (2*R_n)/(0.85*f'_c))^{0.5}]$
$= [(0.85)*(3.5\ ksi)/(60\ ksi)]*[1 – [1 – ((2)*(0.34786\ ksi))/((0.85)*(3.5\ ksi))]^{0.5}] = 0.006183$

Required $A_s = \rho*b*d = (0.006183)*(42”)*(77.30”) = 20.074\ in^2$ ← Matches RC-Pier



20 - #11s
$A_s = 31.2\ in^2$

Derivation of $\rho_{max} = 0.634*\rho_b$ [Ensuring tension controlled sections for singly-reinforced concrete beams.]

Compression Controlled		Transition		Tension Controlled
0.75	<=	$\phi = 0.65 + 0.15*(d_t/c – 1)$	<=	0.90
$\varepsilon_t <= 0.002$				$\varepsilon_t >= 0.005$
$d_t/c <= 1.667$				$d_t/c >= 2.667$
$c/d_t >= 0.600$				$c/d_t <= 0.375$

To get $\phi = 0.90$ the $\varepsilon_t >= 0.005$ and $c/d_t <= 0.375$ Note: $c/d_t = \varepsilon_u/(\varepsilon_u + \varepsilon_s)$

At yield: $\rho_b = [(0.85*B_1*f'_c)/f_y]*[87/(87+f_y)] = [(0.85*B_1*f'_c)/f_y]*[\varepsilon_u/(\varepsilon_u + \varepsilon_y)]$
$= [(0.85*B_1*f'_c)/f_y]*[0.003/(0.003 +(60\ ksi)/(29,000\ ksi))]$ $\varepsilon_y = 0.00207$ in/in
$= [(0.85*B_1*f'_c)/f_y]*(0.5918367)$
$= [(0.85*B_1*f'_c)/f_y]*(3/5)$ approximately

At $\varepsilon_s = 0.005$: $\rho_{max} = [(0.85*B_1*f'_c)/f_y]*[0.003/(0.003 + 0.005)]$
$= [(0.85*B_1*f'_c)/f_y]*(0.375)$
$= [(0.85*B_1*f'_c)/f_y]*(3/8)$ approximately

So $\rho_{max} = C_1*\rho_b$ ⇔ ~~$[(0.85*B_1*f'_c)/f_y]$~~$*(0.375) = C_1*$~~$[(0.85*B_1*f'_c)/f_y]$~~$*(0.5918367)$
$C_1 = 0.375/0.5918367 = 0.634$ which is approximately $[(3/8)/(3/5)] = 5/8 = 0.625$

So in order to ensure $\phi = 0.90$ the value of ρ must be less than the new $\rho_{max} = 0.634*p_b$

Pier Cantilever Design

There are two beams on the cantilever. Loads were calculated earlier in example.

DC Loads	Exterior Beam	Interior Beam
Beam	53.895 k	53.895 k
Slab	58.723 k	60.318 k
Haunch	1.688 k	1.688 k
Intermediate Diaphragm	0.141 k	0.281 k
Pier Diaphragm	9.213 k	14.423 k
Pier Steps	-------	2.615 k
SBC (All to exterior beams)	39.136 k	-------
Total	162.796 k	133.220 k

DW Loads	Exterior Beam	Interior Beam
FWS	12.249 k	12.249 k

Live Load

Max. LL+I Reaction = 168.615 k   Dual Truck Train + Lane Controls

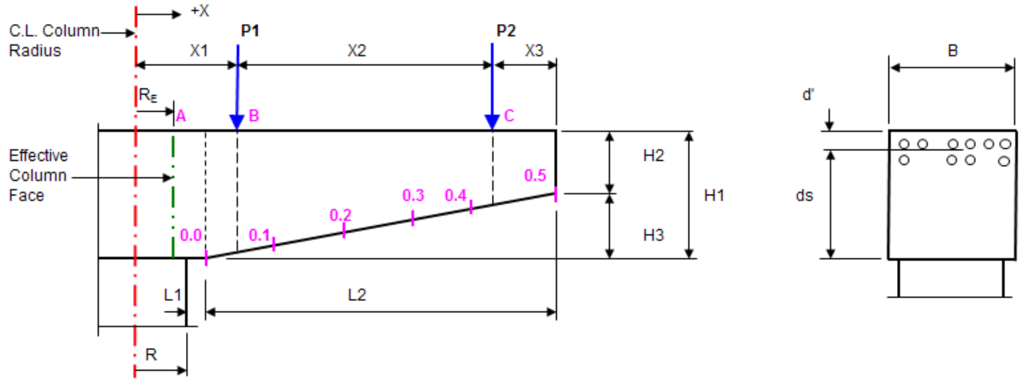
Since there are two beams on the pier cap overhang we are not required to use live load shear distribution factors to determine the beam live load reactions. The live loading for the beams may be based on the pier live loading which assumes simple supports between the beams. From the pier live load spreadsheet results it appears that one loaded lane will produce the maximum live load reactions (and maximum moment and shear in the pier cap overhang) for the beams on the overhang. The pier live load spreadsheet already includes multiple presence factors, but does not include impact for the truck portion.

Exterior Beam: (54.175 k)*(1.33) + (34.122 k) = 106.175 k

Interior Beam: (48.619 k)*(1.33) + (30.961 k) = 95.624 k

Spreadsheet for Pier Cap Overhang Design

PIER CAP OVERHANG DESIGN Includes T-Piers or Frame Piers with either one or two beams on the overhang.
Sections checked include points A, B, C and 5th points along taper.



General Input

Note: X1, H3, and R_E are calculated based on other dimensions

All dimensions are along skew of pier cap

Is this a T-Pier? Y or N	Y		This entry only affects the calculation of R_E
Edge Dist. bt. Column and Cap Taper, L1 (Typ. 3")	3.000	in	
Taper Length, L2	14.250	ft	
Column Radius, R	1.500	ft	
Cap Height, H1	7.000	ft	Note: Input items P1 and X2 shall be set to 0 if there is only one beam on the overhang. [P1 shall only be considered to be on the overhang if it falls to the right of the effective column face.]
Cap Height at End, H2	4.000	ft	
Beam Spa, X2 -- Enter 0 if only one beam on overhan	8.725	ft	
Distance bt. Exterior Beam and Cap End, X3	2.688	ft	
Pier Cap Depth, B	3.500	ft	
Estimated Dist. from Cap Top to C.G. of Top R/I, d'	6.700	in	

Concentrated Beam Loads Enter 0 kips for all Int. Beam Loads (P1 Loads) if only one beam is on the overhang.	Unfactored Loads Interior Beam, P1	 Exterior Beam, P2	Hover for extended comment	Load Factors	Factored Loads Interior Beam, P1	 Exterior Beam, P2	
DC Load (DC1 and DC2)	133.220	162.796	k	1.250	166.525	203.495	k
DW Load	12.249	12.249	k	1.500	18.374	18.374	k
LL+IM Load (Truck with Impact and Lane)	95.624	106.175	k	1.750	167.342	185.806	k
Total Load	241.093	281.220	k		352.241	407.675	k

	Unfactored Load		Load Factors	Factored Load	
Distributed Pier Diaphragm Weight	0.001	k/ft	1.250	0.001	k/ft

Bar Size for the Side Reinforcing Bars	7	Currently not used

Concrete Strength, f'c	3.500	ksi	
Reinforcement Yield Strength, fy	60.000	ksi	
Reinforcement Modulus of Elasticity, Es	29000.000	ksi	
Flexure Resistance Factor, ϕ_f	0.900		Begin by assuming a tension-controlled section, ϕ = 0.9 -- Aashto Lrfd 5.5.4.2
Shear Resistance Factor, ϕ_v	0.900		
Exposure Factor, γ_e (Typically 1.00)	1.000		Class 1 and 2 exposure factors are 1.00 and 0.75 respectively
Concrete Unit Weight, γ_c	0.150	kcf	

Intermediate Calculations

Modular Ratio, n	8.000		
Height of Tapered Section, H3	3.000	ft	
Distance from C.L. Column to Interior Beam, X1	4.588	ft	If only one beam is on the overhang then this is the distance to the exterior beam
Dist. from C.L. Column to Effective Column Face, R_E	0.785	ft	Calculation is slightly different depending on pier type

	Critical Points			Fifth Points Along Taper						
	A	B	C	0	1	2	3	4	5	
Dist. from C.L. Column to Point of Interest, X	0.785	4.588	13.313	1.750	4.600	7.450	10.300	13.150	16.000	ft
Dist. from Cap End to Point of Interest, X1+X2+X3-X	15.215	11.413	2.688	14.250	11.400	8.550	5.700	2.850	0.000	ft
Section Height, Hx	7.000	6.403	4.566	7.000	6.400	5.800	5.200	4.600	4.000	ft
Estimat'd Dist. from Cap Bot. to C.G. of Bar Group, d_s	6.442	5.844	4.007	6.442	5.842	5.242	4.642	4.042	3.442	ft
Factored Shear, Vu, due to P1	352.24	352.24	0.00	352.24	0.00	0.00	0.00	0.00	0.00	k
Factored Shear, Vu, due to P2	407.67	407.67	407.67	407.67	407.67	407.67	407.67	407.67	0.00	k
Factored Shear, Vu, due to Diaphragm	0.02	0.01	0.00	0.02	0.01	0.01	0.01	0.00	0.00	k
Factored Shear, Vu, due to Pier Cap	55.86	38.96	7.55	51.43	38.90	27.49	17.21	8.04	0.00	k
Total Factored Shear, Vu	815.80	798.88	415.23	811.37	446.59	435.18	424.89	415.72	0.00	k
Factored Moment, Mu due to P1	1339.25	0.00	0.00	999.48	0.00	0.00	0.00	0.00	0.00	k*ft
Factored Moment, Mu due to P2	5106.98	3556.96	0.00	4713.74	3551.87	2389.99	1228.12	66.25	0.00	k*ft
Factored Moment, Mu due to Diaphragm	0.14	0.08	0.00	0.13	0.08	0.05	0.02	0.01	0.00	k*ft
Factored Moment, Mu due to Pier Cap	384.90	205.17	9.93	333.15	204.69	110.34	46.91	11.19	0.00	k*ft
Total Factored Moment, Mu	6831.28	3762.22	9.93	6046.50	3756.63	2500.38	1275.05	77.45	0.00	k*ft

Estimate Flexural R/I Required

	Critical Points			Fifth Points Along Taper						
	A	B	C	0	1	2	3	4	5	
Rough Estimate of A_s required at each section	21.010	12.452	0.046	18.438	12.439	9.154	5.204	0.355	0.000	in^2

Rough Estimate of Maximum A_s required		21.010	in^2
Estimate of the number of bars required for bar sizes:	#7	36	
	#8	27	
	#9	22	
	#10	17	
	#11	14	

Note: The flexural reinforcement information on the left is an estimate of what is required for the overhang. In the next section of the spreadsheet the user can enter the actual reinforcement to be used in the design checks.

Enter Flexural and Shear R/I for Design Checks

Stirrup Bar Size (i.e. #4, #5, etc.)	5		
Number of Stirrup Legs (Typ. 4 legs for double hoops	4		
Total Area of Shear Stirrups	1.240	in^2	Stirrup spacing is entered later.

Bar Size for Flexural Reinforcement (i.e. #9, #10, etc.)	11

Layer	d' (in) by Layer	No. of Bars per Layer
1	3.5	8
2	7.5	8
3	11.5	4
4	15.5	

Total Bar Area Input, A_s provided	31.200	in^2	
Distance from Top of Cap to C.G. of Bar Group, d'	6.700	in	Total bar area is lumped at its center of gravity.

Enter Flexural R/I Development Lengths

Aashto Lrfd 5.11.2

Available Cap Length for # 11 Development Length	180.575	in	Measured from critical sxn and assumes 2" end clearance.

Straight Bar Development Length (Non-Epoxy Coated R/I)			The 0.8 factor from Aashto Lrfd 5.11.2.1.3 is not applied.
Basic Development Length for a # 11 Bar	62.539	in	The ratio of As required to As provided is applied to the
Development Length for a # 11 Bar	58.958	in	develop length as G91/G113 -- see Aashto Lrfd 5.11.2.1.3.
Enter Develop Length Used for a # 11 Bar	59.000	in	
Is Cap Long Enough for Develop Length?	YES		

Standard Hook Development Length (Non-Epoxy Coated R/I)			The 0.7 factor from Aashto Lrfd 5.11.2.4.2 is applied.
Basic Development Length for a # 11 Bar	28.640	in	The 0.8 factor from Aashto Lrfd 5.11.2.4.2 is not applied.
Development Length for a # 11 Bar	13.500	in	The ratio of As required to As provided is applied to the
Enter Develop Length Used for a # 11 Bar	14.000	in	develop length as G91/G113 -- see Aashto Lrfd 5.11.2.4.2.
Is Cap Long Enough for Develop Length?	YES		

Enter Bar End Type for Development (S = straight, H = hook)	S		
Development Length Used for a # 11 Bar	59.000	in	This is used to determine effective area of flexural R/I.

Check Flexural R/I

Flexural Capacity Check Aashto Lrfd 5.7.3.2

	Critical Points			Fifth Points Along Taper						
	A	B	C	0	1	2	3	4	5	
Bar Area Provided, A_s	31.200	31.200	31.200	31.200	31.200	31.200	31.200	31.200	0.000	in^2
Fraction of Bar Area that is Effective	1.000	1.000	0.513	1.000	1.000	1.000	1.000	0.546	0.000	
Effective Bar Area Provided, A_{se}	31.200	31.200	15.997	31.200	31.200	31.200	31.200	17.028	0.000	in^2
Factored Applied Moment, Mu_z	6831.282	3762.217	9.931	6046.498	3756.634	2500.378	1275.048	77.446	0.000	k*ft
Depth of Equivalent Stress Block, a	14.982	14.982	7.681	14.982	14.982	14.982	14.982	8.177	0.000	in
Distance from Cap Bottom to C.G. of Bar Group, d_s	77.300	70.132	48.089	77.300	70.100	62.900	55.700	48.500	41.300	in
Factored Flexural Resistance, $Mr_z = \phi Mn_z$	9801.184	8794.738	3185.235	9801.184	8790.304	7779.424	6768.544	3403.050	0.000	k*ft
Is Mr_z >= Mu_z ?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

Minimum Reinforcement Check Aashto Lrfd 5.4.2.6 and 5.7.3.3.2

Modulus of Rupture, f_r	0.692	ksi

	Critical Points			Fifth Points Along Taper						
	A	B	C	0	1	2	3	4	5	
Factored Flexural Resistance, $Mr_z = \phi Mn_z$	9801.184	8794.738	3185.235	9801.184	8790.304	7779.424	6768.544	3403.050	0.000	k*ft
Section Modulus of Cap, S_z	28.583	23.913	12.160	28.583	23.893	19.623	15.773	12.343	9.333	ft^3
120% of the Cracking Moment, $1.2*Mcr_z$	3418.947	2860.311	1454.548	3418.947	2857.961	2347.212	1886.701	1476.427	1116.391	k*ft
Is Mr_z >= $1.2*Mrc_z$?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	

---- OR ----

	Critical Points			Fifth Points Along Taper						
	A	B	C	0	1	2	3	4	5	
Effective A_{se} provided	31.200	31.200	15.997	31.200	31.200	31.200	31.200	17.028	0.000	in^2
A_s required	21.010	12.452	0.046	18.438	12.439	9.154	5.204	0.355	0.000	in^2
$1.33*A_s$ required	27.943	16.561	0.061	24.523	16.544	12.174	6.921	0.473	0.000	in^2
Is Effective A_{se} prov'd >= $1.33*A_s$ req'd ?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

Maximum Reinforcement Check Aashto Lrfd 5.5.4.2, 5.7.2.1, and 5.7.3.3

If section is in Transition, then the user may adjust the Flexural Phi Factor, ϕ, in cell G54. If the section is compression-controlled then do not use this sheet.

	Critical Points			Fifth Points Along Taper						
	A	B	C	0	1	2	3	4	5	
Stress Block Factor, $\beta 1$	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	
Location of Neutral Axis, c	17.626	17.626	9.037	17.626	17.626	17.626	17.626	9.620	0.000	in
Net Tensile Strain in the Extreme Tension Steel, ε_s	0.011	0.009	0.014	0.011	0.009	0.008	0.007	0.013	0.000	in/in
Is Section Tension Controlled? ε_s >= 0.005	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	n/a	
Is Section Compression Controlled? ε_s <= 0.002	No	No	No	No	No	No	No	No	n/a	
Is Section in Transition? 0.005 > ε_s > 0.002	No	No	No	No	No	No	No	No	n/a	
Flexure Phi Factor, ϕ, for Design	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	

	Critical Points			Fifth Points Along Taper					
	A	B	C	0	1	2	3	4	5
Is Flexural R/I Adequate?	YES	YES	YES	YES	YES	YES	YES	YES	YES

Check Shear R/I

To increase size of shear reinforcement bars go to cell G101.
Maximum stirrup spacing is 12" based on the Bridge Design Manual.

Simplified Shear Design Aashto Lrfd 5.8 and specifically 5.8.3.4.1, β = 2.0 and θ = 45 degrees

	Critical Points			Fifth Points Along Taper						
	A	B	C	0	1	2	3	4	5	
Total Factored Shear, Vu	815.799	798.885	415.232	811.367	446.592	435.179	424.889	415.721	0.000	k
Effective Shear Depth, dv	69.809	63.118	44.249	69.809	63.090	56.610	50.130	44.412	41.300	in
Max. Permissible Factored Shear Resistance, Vr_{max}	2308.933	2087.642	1463.527	2308.933	2086.702	1872.376	1658.050	1468.917	1365.998	k
Factored Concrete Shear Resistance, ϕVc	312.000	282.097	197.762	312.000	281.970	253.009	224.048	198.491	184.584	k
Req'd Factored Shear Reinforcement Resistance, ϕV	503.799	516.787	217.469	499.367	164.621	182.170	200.841	217.230	0.000	k
Stirrup Spacing, s, Aashto Lrfd Eq. 5.8.3.3-4	9.278	8.178	13.624	9.361	25.662	20.808	16.713	13.690	N/A	in
Stirrup Spacing, s, Aashto Lrfd Eq. 5.8.2.5-1	29.964	29.964	29.964	29.964	29.964	29.964	29.964	29.964	29.964	in
Stirrup Spacing, s, Aashto Lrfd Eq. 5.8.2.7-1 & 2	24.000	24.000	24.000	24.000	24.000	24.000	24.000	24.000	24.000	in
Final Stirrup Spacing, s	**9.000**	**8.000**	**12.000**	**9.000**	**12.000**	**12.000**	**12.000**	**12.000**	**12.000**	in

General Shear Design Aashto Lrfd 5.8 and specifically 5.8.3.4.2, variable β and θ

In Aashto Lrfd 5.8.3.4.2 there are a number of bulleted items that should be considerd when using this method for shear design. This spreadsheet does reduce A_s for the section under consideration based on development length. This spreadsheet does not base ε_s on the calculated value at d_v when the section under consideration is closer than d_v to the face of the support. Axial forces in the cap are not considered.

	Critical Points			Fifth Points Along Taper						
	A	B	C	0	1	2	3	4	5	
Total Factored Shear, Vu	815.799	798.885	415.232	811.367	446.592	435.179	424.889	415.721	0.000	k
Total Factored Moment, Mu	6831.282	3762.217	9.931	6046.498	3756.634	2500.378	1275.048	77.446	0.000	k*ft
Effective Shear Depth, dv	69.809	63.118	44.249	69.809	63.090	56.610	50.130	44.412	41.300	in
Max. Permissible Factored Shear Resistance, Vr_{max}	2308.933	2087.642	1463.527	2308.933	2086.702	1872.376	1658.050	1468.917	1365.998	k
Flexural R/I Strain, ε_s, Aashto Lrfd Eq. 5.8.3.4.2-4	0.00220	0.00177	0.00179	0.00205	0.00128	0.00107	0.00094	0.00168	0.00000	in/in
$\beta = 4.8/(1 + 750*\varepsilon_s)$, Aashto Lrfd Eq. 5.8.3.4.2-1	1.812	2.065	2.049	1.894	2.446	2.667	2.816	2.121	4.800	
$\theta = 29 + 3500*\varepsilon_s$, Aashto Lrfd Eq. 5.8.3.4.2-3	36.698	35.181	35.266	36.159	33.492	32.734	32.287	34.893	29.000	deg
Factored Concrete Shear Resistance, ϕVc	282.608	291.271	202.606	295.489	344.836	337.333	315.488	210.525	443.000	k
Req'd Factored Shear Reinforcement Resistance, ϕV	533.191	507.613	212.626	515.878	101.756	97.846	109.401	205.195	0.000	k
Stirrup Spacing, s, Aashto Lrfd Eq. 5.8.3.3-4	11.762	11.811	19.706	12.399	62.744	60.267	48.559	20.780	N/A	in
Stirrup Spacing, s, Aashto Lrfd Eq. 5.8.2.5-1	29.964	29.964	29.964	29.964	29.964	29.964	29.964	29.964	29.964	in
Stirrup Spacing, s, Aashto Lrfd Eq. 5.8.2.7-1 & 2	24.000	24.000	24.000	24.000	24.000	24.000	24.000	24.000	24.000	in
Final Stirrup Spacing, s	**11.500**	**11.500**	**12.000**	**12.000**	**12.000**	**12.000**	**12.000**	**12.000**	**12.000**	in

Additional Longitudinal Reinforcement

To increase the amount of longitudinal R/I go to cell G105 and following.
Aashto Lrfd 5.8.3.5

Base θ off of Shear Method 1 or 2	1	Method 1 = Simplified Shear, 2 = General Shear Design

The user has the opportunity to enter a stirrup spacing.
The user has the opportunity to enter a stirrup spacing.

	Critical Points			Fifth Points Along Taper						
The stirrup size and number of legs remain the same	A	B	C	0	1	2	3	4	5	
Stirrup Spacing Used	6.000	5.000	5.000	6.000	6.000	5.000	5.000	10.000	10.000	in
θ based on Shear Method 1	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000	deg
$Mu/(dv*\phi_f)$	1304.757	794.743	2.993	1154.865	793.921	588.913	339.131	23.251	0.000	k
Vu	815.799	798.885	415.232	811.367	446.592	435.179	424.889	415.721	0.000	k
Vu/ϕ_v	906.443	887.649	461.369	901.519	496.213	483.532	472.099	461.912	0.000	k
0.5*Vs	432.816	443.825	230.684	432.816	248.106	241.766	236.049	165.211	0.000	k
$As*fy = Mu/(dv*\phi_f) + (Vu/\phi_v - 0.5*Vs)*\cot\theta$	1778.384	1238.567	233.677	1623.568	1042.027	830.679	575.180	319.951	0.000	k
Total As Needed	29.640	20.643	3.895	27.059	17.367	13.845	9.586	5.333	0.000	in^2
Additional Longitudinal R/I Needed, Alx	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	in^2

Crack Control and S&T Reinforcement

Crack Control: Flexure R/I Aashto Lrfd 5.7.3.4. Spacing should also comply with Aashto Lrfd 5.10.3.1 and 5.10.3.2.
See cell G56 to change the Exposure Factor, γ_e, which is typically set to 1.00 (Class 1) for pier caps.

	Critical Points			Fifth Points Along Taper						
	A	B	C	0	1	2	3	4	5	
Concrete Cover Thickness to R/I Center, d_c	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	in
βs	1.062	1.068	1.097	1.062	1.068	1.076	1.085	1.097	1.112	
Service Moment, Ms due to P1	916.660	0.000	0.000	684.101	0.000	0.000	0.000	0.000	0.000	k*ft
Service Moment, Ms due to P2	3522.872	2453.645	0.000	3251.606	2450.129	1648.652	847.175	45.698	0.000	k*ft
Service Moment, Ms due to Diaphragm	0.116	0.065	0.004	0.102	0.065	0.037	0.016	0.004	0.000	k*ft
Service Moment, Ms due to Pier Cap	307.920	164.139	7.941	266.520	163.750	88.271	37.526	8.955	0.000	k*ft
Total Service Moment, Ms	4747.567	2617.849	7.945	4202.329	2613.944	1736.960	884.717	54.657	0.000	k*ft
Reinforcment Ratio, ρ	0.00961	0.01059	0.01545	0.00961	0.01060	0.01181	0.01334	0.01532	0.01799	
Factor for Distance to Neutral Axis, k	0.323	0.336	0.389	0.323	0.336	0.350	0.367	0.387	0.412	
Reinforcement Stress at Service Level	26.469	16.165	0.073	23.429	16.148	12.025	6.962	0.498	0.000	ksi
Max. Spacing of Bot Layer of Pos. Flexural R/I, s	17.9	33.5	8730.1	21.1	33.6	47.1	85.7	1275.4	n/a	in

Crack Control: Skin R/I Aashto Lrfd 5.7.3.4. Spacing should also comply with Aashto Lrfd 5.10.3.1 and 5.10.3.2.

	Critical Points			Fifth Points Along Taper						
	A	B	C	0	1	2	3	4	5	
Is Skin R/I Required ? (Is $d_e = d_s > 3.00'$?)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Area of Skin R/I Required per Face, A_{sk}	0.568	0.482	0.217	0.568	0.481	0.395	0.308	0.222	0.136	in^2/ft
Max Spacing of Skin R/I Required	12.000	11.689	8.015	12.000	11.683	10.483	9.283	8.083	6.883	in

Shrinkage and Temp. R/I Aashto Lrfd 5.10.8. Spacing should also comply with Aashto Lrfd 5.10.3.1 and 5.10.3.2.

Area of Skin R/I Required per Face, A_{sk}	0.303	0.294	0.258	0.303	0.294	0.284	0.272	0.258	0.243	in^2/ft
Max Spacing of Skin R/I Required	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000	in

Fatigue in Reinforcement

Aashto Lrfd 5.5.3

Office policy is to neglect checking fatigue.

Column Design: RC-Pier

Column Area = (17')*(3') + (π)*$(1.5')^2$ = 58.069 ft^2

The equivalent rectangular column used in RC-Pier has a slightly larger area since I rounded the column length:

Equivalent Column Area, A_g = (19.5')*(3') = 58.5 ft^2
Column R/I Area, A_s = (46 bars)*(1.27 in^2) = 58.42 in^2 = 0.40569 ft^2 from the plans

% R/I = [(0.40569 ft^2)/(58.5 ft^2)]*(100) = 0.693%

Aashto Lrfd 5.7.4.2 specifies that the minimum area of R/I shall be:

$(A_s*f_y)/(A_g*f'_c)$ >= 0.135

[(0.40569 ft^2)*(60 ksi)]/[(58.5 ft^2)*(3.5 ksi)] = 0.1189 < 0.135   -- The current column needs more R/I.

Typically f'_c = 3.5 ksi and f_y =60 ksi so that the minimum area of reinforcement equation may be rewritten as:

$(A_s*f_y)/(A_g*f'_c)$ >= 0.135
$(A_s)/(A_g)$ >= (0.135)*(f'_c / f_y) = (0.135)*[(3.5 ksi)/(60 ksi)] = 0.007875   or   0.7875%

Aashto Lrfd 5.7.4.2 does allow the area of column R/I to drop below 0.7875% for bridges in seismic zone 1, but a reduced effective column area must be used. The code says that the minimum percentage of R/I area of the reduced effective column area is to be the greater of 1% or the value from the equation above. Additionally the reduced effective area and the gross area must be capable of resisting all loads.

Note that the equation above reaches 1% when f'c = 4.444 ksi
$(A_s)/(A_g)$ >= (0.135)*(f'_c / f_y) = (0.135)*[(4.444 ksi)/(60 ksi)] = 0.0100   or   1.00%

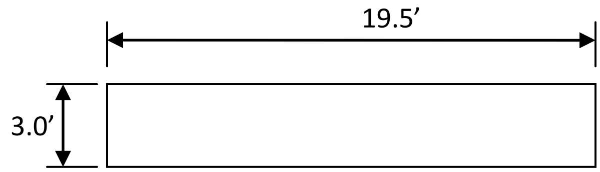
So, in order for us to achieve 1.00% our effective column area must be:
A_e = (As)/(0.01) = (0.40569 ft^2)/(0.01) = 40.57 ft^2

BDM 6.6.4.1.2.1 says, "For frame pier columns the designer shall provide the minimum reinforcing required by the AASHTO LRFD Specifications [AASHTO-LRFD Equation 5.7.4.2-3], without reduction in column cross section. For T-pier columns in Seismic Zone 1 the designer may reduce reinforcing based on a reduced cross section [AASHTO-LRFD 5.7.4.2]."

In order to mimic a reduced column area without actually reducing the cross-sectional column area is to reduce the concrete strength proportionally. RC-Pier does this automatically. spColumn does this when you specify the column as architectural rather than structural. The proportionality ratio in this case would be (0.693%)/(1%) = 0.693. [See the July 2009 Bridge Newsletter for more information.] Another way to reduce column area would be to remove some of the concrete from the center of the column; however, there doesn't appear to be a simple way to do this in a software package. One additional method that has been used by the DOT is to reduce the column dimensions. This method is typically more conservative than the other methods since changing the column dimensions changes the effective depth of the column. This method is illustrated on the following page.

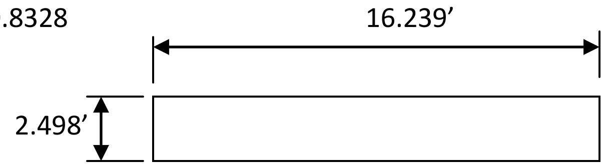
$A_g = (19.5')*(3') = 58.5\ ft^2$
$A_s = (46\ bars)*(1.27\ in^2) = 58.42\ in^2 = 0.40569\ ft^2$

$A_e = (As)/(0.01) = (0.40569\ ft^2)/(0.01) = 40.57\ ft^2$



$40.57\ ft^2 = [(3')*(Reduction\ Factor)]*[(19.5')*(Reduction\ Factor)]$
$Reduction\ Factor = [(40.57\ ft^2)/((3')*(19.5'))]^{0.5} = 0.8328$

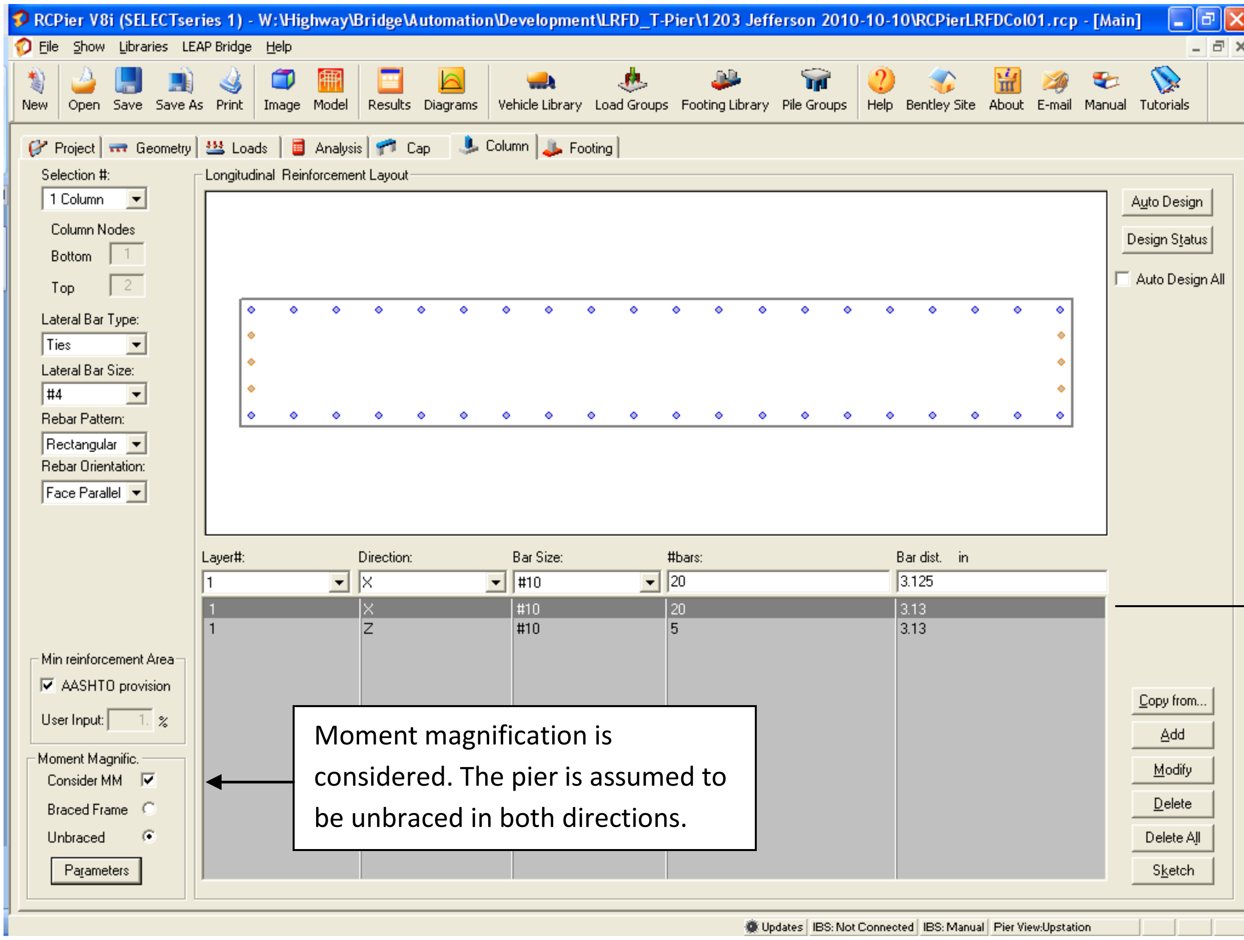
Effective Column Dimensions
Length = (19.5’)*(0.8328) = 16.239’
Width = (3.0’)*(0.8328) = 2.498’



Effective Column Area = (16.239’)*(2.498’) = 40.57 ft^2
% R/I = [(0.40569 ft^2)/(40.57 ft^2)]*(100) = 1.00%

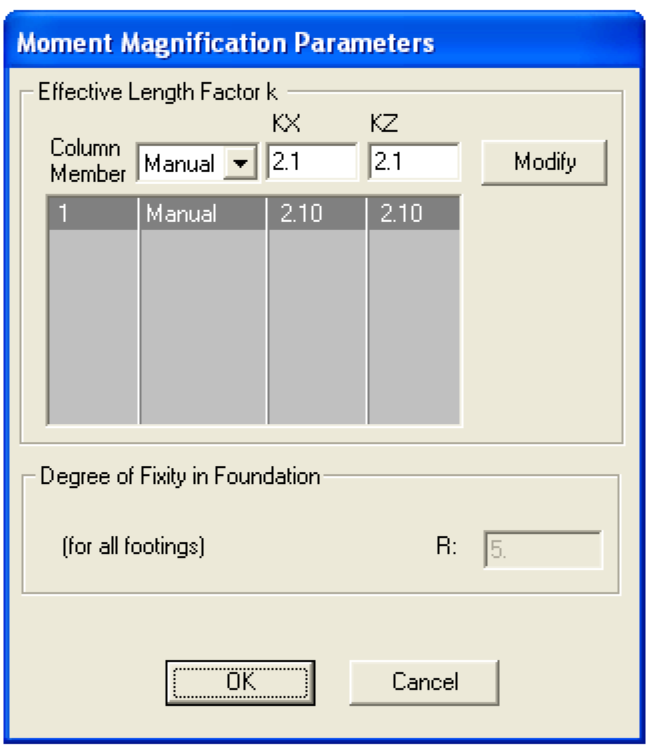
The next step with this method would involve putting the effective dimensions in spColumn along with the reinforcement. Next the user would input the column loads and check if the column performance ratios were okay.

For this example I’ll just run the equivalent column diameter with the column reinforcement shown in the plan.



Moment magnification is considered. The pier is assumed to be unbraced in both directions.

Column R/I can be auto-designed; however, I manually entered the column R/I that was specified on the plans.



The effective length factors were entered manually.

RC-Pier calculates magnification factors a little differently than Aashto. For instance, only the sidesway term is used for unbraced frames.

Column Design

COLUMN DESIGN - Column: 1
Code: AASHTO LRFD 2007
Units: US
Pier View: Upstation.
Design/Analysis Method: Moment Magnification - Unbraced Column.

I've included some portions of RC-Pier's output for the column design.

Column Type: Rectangular 234.00 x 36.00 in

Column Section Properties

Sec.	Area ft^2	Ixx in^4	Izz in^4
1	58.50	909792.00	38438712.00

DESIGN PARAMETERS	
f'c = 3500.0 psi	fy = 60000.0 psi
phi tens = 0.90	phi comp = 0.75
Tens below = 0.375	Comp Above = 0.600
Ec = 3586.6 ksi	Es = 29000 ksi
Concrete Type : Normal Weight.	

Reinforcement
Rebar Pattern: Rectangular
Rebar Orientation: Face Parallel

Reinforcement Schedule

Layer	Dir	Size	No. bars	Bar Dist. in
1	X	10	20	3.13
1	Z	10	5	3.13

Reinforcement summary
Main bars summary:
46 # 10 bars
Total number of bars in the column: 46
Ties size: # 4

Moment Magnification calculation - Mx (global)							
Loc ft	Comb	K	Cm	Beta	Delta B	Delta S	pPc kips
0.00	85	2.1000	1.0000	0.1575	—	1.1146	14604.97
30.00	85	2.1000	1.0000	0.6947	—	1.1520	9974.88
0.00	173	2.1000	1.0000	0.0700	—	1.0711	15798.65
30.00	173	2.1000	1.0000	1.0000	—	1.1139	8452.30

Moment Magnification calculation - Mz (global)							
Loc ft	Comb	K	Cm	Beta	Delta B	Delta S	pPc kips
0.00	85	2.1000	1.0000	0.0981	—	1.0023	650409.57
30.00	85	2.1000	1.0000	0.0903	—	1.0020	655084.70
0.00	173	2.1000	1.0000	0.3725	—	1.0020	520387.48
30.00	173	2.1000	1.0000	0.4731	—	1.0018	484840.86

Design values used after Moment Magnification (e-min effect included).							
Loc ft	Comb	Fx kips	Fy kips	Fz kips	Mx kips-ft	My kips-ft	Mz kips-ft
0.00	85	25.5	1501.4	30.9	1101.9	0.0	-7213.6
30.00	85	-25.5	1316.3	-30.9	-212.3	0.0	6445.8
0.00	173	23.3	1049.3	-78.0	-2381.9	-0.0	-1899.4
30.00	173	-20.8	864.2	61.6	134.8	-0.0	1229.6

COLUMN DESIGN									
Bot/Top Elev. ft	Comb	Pu kips	Mux kips-ft	Muz kips-ft	pMn kips-ft	Incl deg	pPn/Pu	pMn/Mu
0.00	173	1049.3	2381.9	1899.4	6426.1	38.57	1.00	2.10928**
30.00	85	1316.3	212.3	6445.8	34455.6	88.11	1.00	5.34252**

Column passes. The controlling combination is plotted from RC-Pier a couple of pages over.

The result is flagged because the minimum reinforcement ratio has been violated.

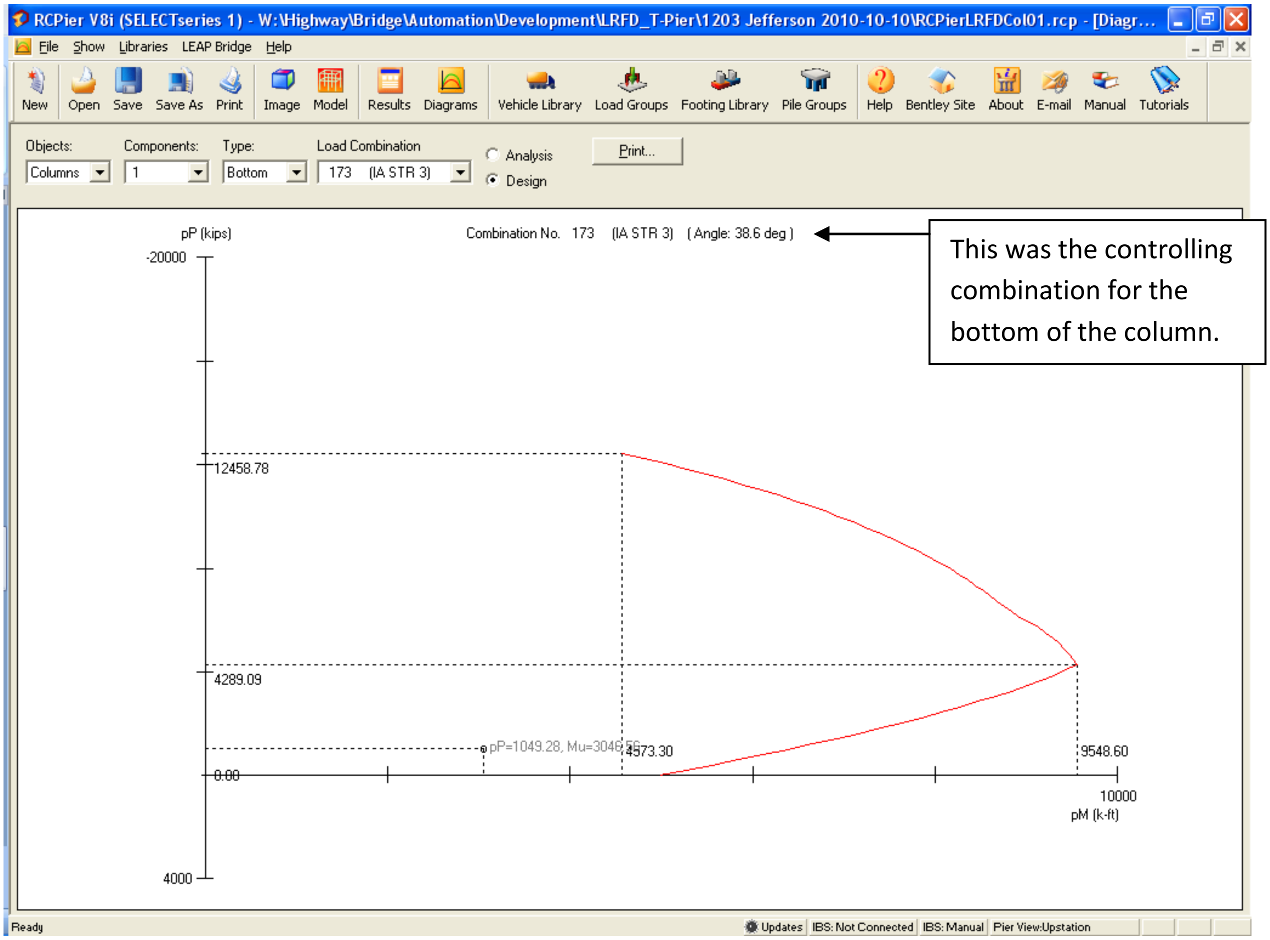
COLUMN DESIGN				
Bot/Top Elev. ft	Comb	As_min in^2	As_max in^2	As_req in^2
0.00	173	66.34	673.92	66.34
30.00	85	66.34	673.92	66.34

K values for all columns used in unbraced moment magnification

Column	Kx	Kz
1	2.10	2.10

Column Design : Notes

Min reinforcement = 0.7875 % of Ag = 66.34 in^2.
** Minimum/Maximum requirement for reinforcement ratio violated.
— Values do not exist at that location as computation is done at the top and bottom of clear length of column.



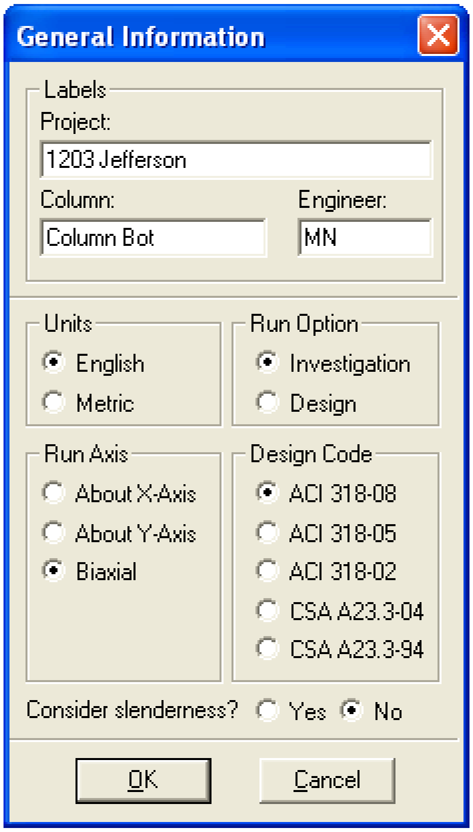
Pu = 1049.28 k

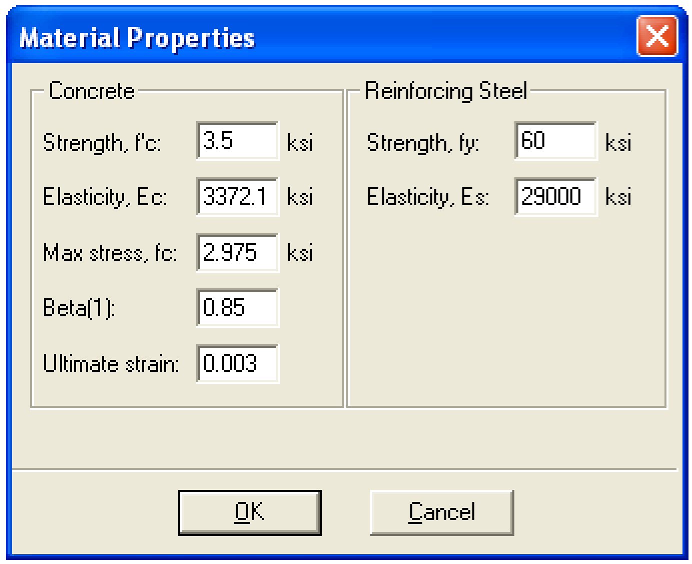
Mu = $[(2381.9\ k{*}ft)^2 + (1899.4\ k{*}ft)^2]^{0.5}$ = 3046.50 k*ft

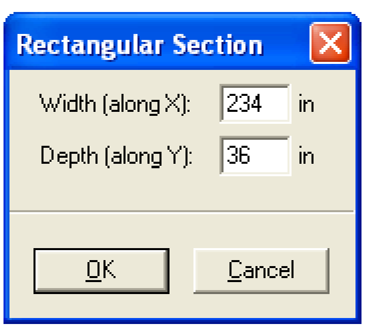
PR = ϕMn/Mu = (6426.1 k*ft)/(3046.50 k*ft) = 2.109

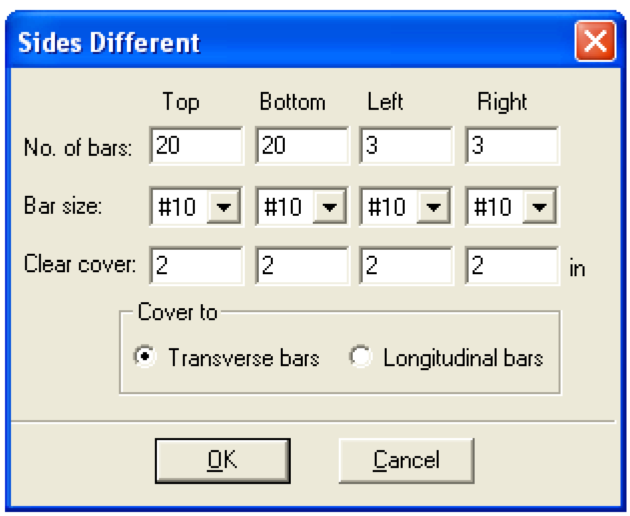
Column Design: spColumn v4.50

spColumn Input Screens

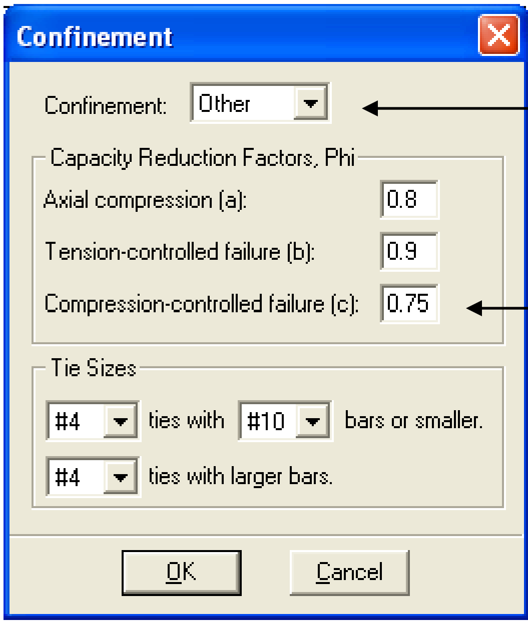




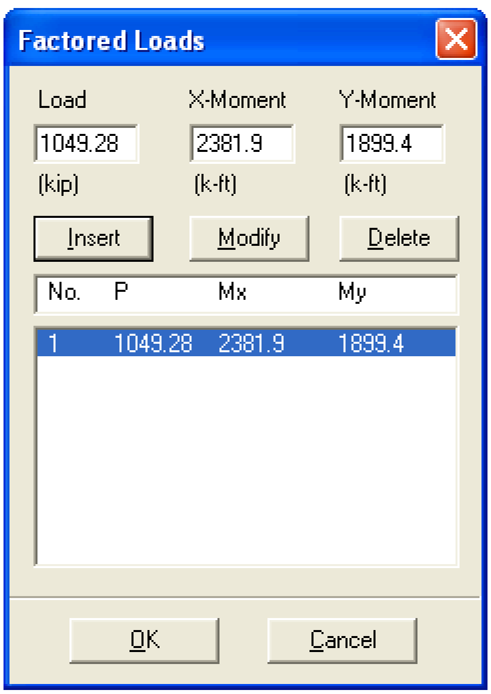




spColumn Input Screens

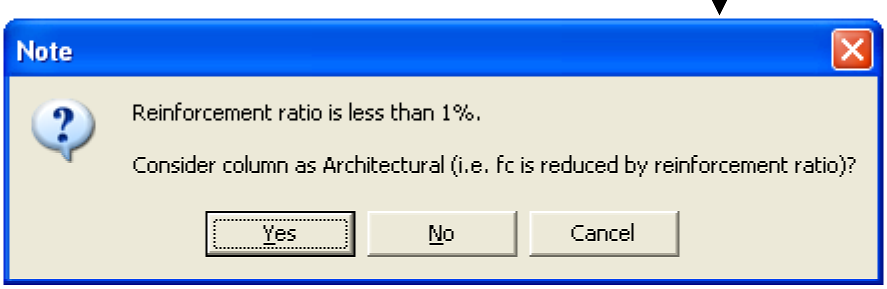


Confinement was set to "Other" in order to input modify the default Compression-controlled failure value to 0.75 for Aashto requirements.



These are the loads as found in Combination 173 from RC-Pier.

When executing the solver the program asks if the column should be treated as architectural or structural since the reinforcement ratio is less than 1%. As was done for this example, the user should generally select architectural.



spColumn Output Screens

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STRUCTUREPOINT - spColumn v4.50 (TM)                                                                     Page   1
Licensed to: Iowa Department of Transportation. License ID: 56461-1020268-4-29625-22F82                  09/29/10
W:\Highway\Bridge\Automation\Development\LRFD_T-Pier\1203 Jefferson 2010-10-10\spCol001.col              12:56 PM









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   ===========================================================================================================
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                   Computer program for the Strength Design of Reinforced Concrete Sections
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spColumn Output Screens

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STRUCTUREPOINT - spColumn v4.50 (TM)                                                              Page   2
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W:\Highway\Bridge\Automation\Development\LRFD_T-Pier\1203 Jefferson 2010-10-10\spCol001.col       12:56 PM


General Information:
====================
  File Name: W:\Highway\Bridge\Automation\Development\LRFD_T-Pier\1203 Jefferson 2010-...\spCol001.col
  Project:  1203 Jefferson
  Column:   Column Bot                          Engineer: MN
  Code:     ACI 318-08                          Units: English

  Run Option: Investigation                     Slenderness: Not considered
  Run Axis:   Biaxial                           Column Type: Architectural

Material Properties:
====================
  f'c   = 3.5 ksi                               fy   = 60 ksi
  Ec    = 3372.17 ksi                           Es   = 29000 ksi
  Ultimate strain = 0.003 in/in
  Beta1 = 0.85

Section:
========
  Rectangular: Width = 234 in                   Depth = 36 in

  Gross section area, Ag =  8424 in^2
  Ix =  909792 in^4                             Iy =  3.84387e+007 in^4
  rx =  10.3923 in                              ry =  67.55 in
  Xo =  0 in                                    Yo =  0 in

Reinforcement:
==============
  Bar Set: ASTM A615
  Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
  ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
  #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
  #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
  #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
  # 14      1.69        2.25   # 18      2.26        4.00

   Confinement: Other; #4 ties with #10 bars,  #4 with larger bars.
   phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.75

   Layout: Rectangular
   Pattern: Sides Different  (Cover to transverse reinforcement)
   Total steel area: As = 58.42 in^2 at rho = 0.69% (Note: rho < 1.0%)
   Minimum clear spacing = 6.16 in

                     Top       Bottom         Left       Right
                  --------    --------      --------    --------
    Bars          20  #10     20  #10        3  #10      3  #10
    Cover(in)           2           2              2           2

 Factored Loads and Moments with Corresponding Capacities:
 =========================================================
                Pu          Mux          Muy         fMnx         fMny   fMn/Mu NA depth Dt depth    eps_t    Phi
   No.         kip         k-ft         k-ft         k-ft         k-ft                 in       in
   --- ----------- ------------ ------------ ------------ ------------ --------- --------- --------- -------- ------
     1     1049.28      2381.90      1899.40      5093.23      4061.50     2.138      8.75     39.59  0.01341  0.900

   *** End of output ***
```
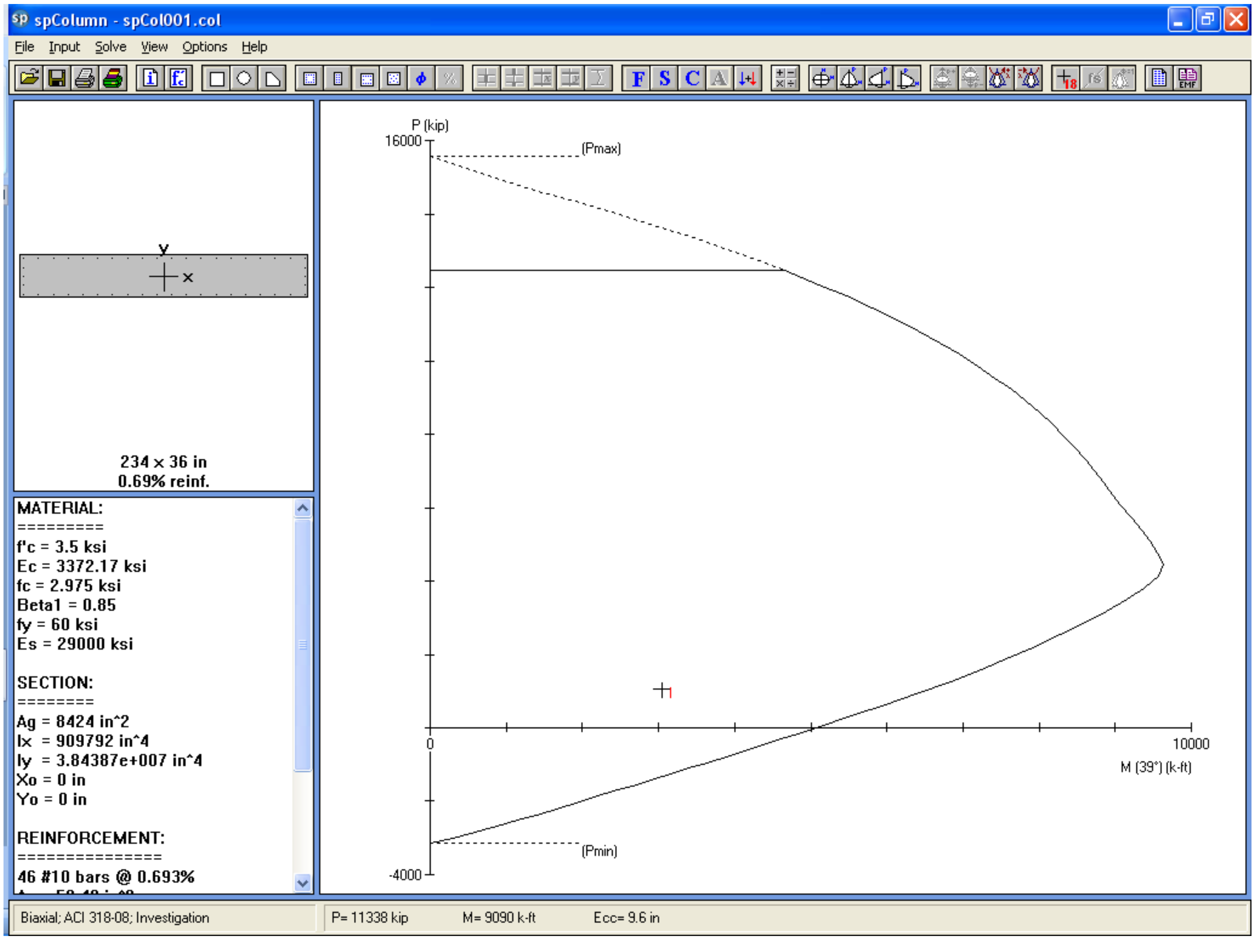
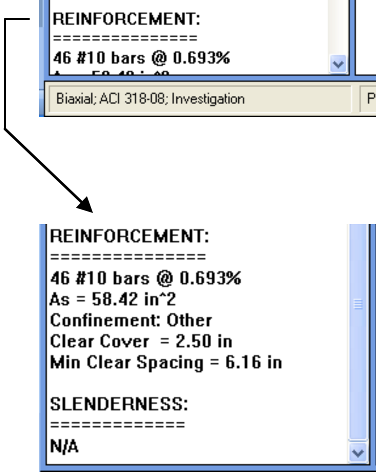

Architectural was selected.

This is a good match between the calculated performance ratios from spColumn and RC-Pier. If the column had been treated as structural rather than architectural in spColumn then the performance ratio would have been 2.204.

spColumn Interaction Diagram





Aashto Lrfd 5.7.4.4 and 5.5.4.2

$P_r = \phi P_n = \phi\phi_a P_o$ where $P_o = 0.85*f'_c*(A_g - A_{st}) + f_y*A_{st}$

Ratio f'c for Architectural column considerations – see discussion on previous pages (use ratio of 0.69349):

$P_n = 0.80*[(0.85)*(0.69349*3.5 \text{ ksi})*(8424 \text{ in}^2 - 58.42 \text{ in}^2) + (60 \text{ ksi})*(58.42 \text{ in}^2)]$
$= 16{,}611.7$ k

$\phi_b = 0.90$ for tension-controlled
$\phi_c = 0.75$ for compression-controlled
$\phi_a = 0.80$

$P_r = \phi_c P_n = (0.75)*(16{,}611.7 \text{ k}) = 12{,}458.8$ k

Moment Magnification Calculations

Moment Magnification Calculations for Load Combination 173 for Bottom of Column
Aashto Lrfd 5.7.4.3 and 4.5.3.2.2b

Factored Load Reactions from RC-Pier

F_y = 1049.28 k
M_x = -2223.75 k*ft
M_z = -1895.61 k*ft

RC-Pier assumes minimum eccentricity according to Aashto Std. Spec. 8.16.5.2.8

e_{minz} = 0.6 + 0.03*h = 0.6 + (0.03)*(234”) = 7.62” = 0.635’
M_{x_min} = (F_y)*(e_{minz}) = (1049.28 k)*(0.635’) = 666.293 k*ft

e_{minz} = 0.6 + 0.03*h = 0.6 + (0.03)*(36”) = 1.68” = 0.140’
M_{z_min} = (F_y)*(e_{minz}) = (1049.28 k)*(0.140’) = 146.899 k*ft

Factored Loads Considered

F_y = 1049.28 k
M_x = -2223.75 k*ft
M_z = -1895.61 k*ft

Moment Magnification from Aashto Lrfd 4.5.3.2.2b with RC-Pier Modifications

$M_c = \delta_b M_{2b} + \delta_s M_{2s}$ RC-Pier modifies this equation for unbraced frames by assuming
$M_c = \delta_s M_2$ that all moments are to be magnified by δ_s alone.

where $\delta_s = 1 / [1 - \Sigma P_u/(\phi_k * \Sigma P_e)]$
$\phi_k = 0.75$ Stiffness reduction factor for concrete
$P_e = \pi^2 * EI/(k * l_u)^2$ Euler buckling load
$EI = (E_c * I_g/2.5)/(1 + \beta_d)$ Flexural column stiffness
β_d is ratio of maximum factored dead load moment to maximum factored total moment, always positive

Calculate β_d = | Maximum Factored Dead Load Moment / Maximum Factored Total Load Moment |

Loads from RC-Pier
Unfactored Self-weight
F_y = 377.01 k
M_x = 0.00 k*ft
M_z = 0.00 k*ft

Unfactored DC loads
F_y = 858.46 k
M_x = 0.00 k*ft
M_z = 0.00 k*ft

Factored Self-weight (Load factor = 0.90)
F_y = 339.309 k
M_x = 0.00 k*ft
M_z = 0.00 k*ft

Factored DC loads (Load factor = 0.90)
F_y = 772.614 k
M_x = 0.00 k*ft
M_z = 0.00 k*ft

Factored Self-weight + DC loads
F_y = 1111.923 k
M_x = 0.00 k*ft
M_z = 0.00 k*ft

Check M_{min} due to minimum eccentricity (e_{minx} = 0.635’, e_{minz} = 0.140’)
M_{x_min} = (1111.923 k)*(0.140’) = 155.669 k*ft
M_{z_min} = (1111.923 k)*(0.635’) = 706.071 k*ft

Factored Loads considered for β_d
F_y = 1111.923 k
M_x = 155.669 k*ft
M_z = 706.071 k*ft

β_d Calculations
β_{dx} = | (155.669 k*ft) / (-2223.75 k*ft) | = 0.070003
β_{dz} = | (706.071 k*ft) / (-1895.61 k*ft) | = 0.372477

Calculate EI = (E_c*I_g/2.5)/(1 + β_d)
E_c = (33)*(150 pcf)$^{1.5}$*(3500 psi)$^{0.5}$*[(144 in^2/ft^2) / (1000 lb/k)] = 516,472.7 ksf
I_{gx} = (1/12)*b*h^3 = (1/12)*(19.5’)*(3.0’)^3 = 43.875 ft^4
I_{gz} = (1/12)*h*b^3 = (1/12)*(3.0’)*(19.5’)^3 = 1853.71875 ft^4

EI_x = [(516,472.7 ksf)*(43.875 ft^4) / 2.5] / (1 + 0.070003) = 8,471,093.9 k*ft^2
EI_z = [(516,472.7 ksf)*(1853.71875 ft^4) / 2.5] / (1 + 0.372477) = 279,026,935.3 k*ft^2

Calculate P_e = (π^2*EI)/(k*l_u)^2 k_x = 2.1, k_z = 2.1, l_u = 30.0’
P_{ex} = [(π^2)*(8,471,093.9 k*ft^2)] / [(2.1)*(30.0’)]^2 = 21,064.839 k
P_{ez} = [(π^2)*(279,026,935.3 k*ft^2)] / [(2.1)*(30.0’)]^2 = 693,848.695 k

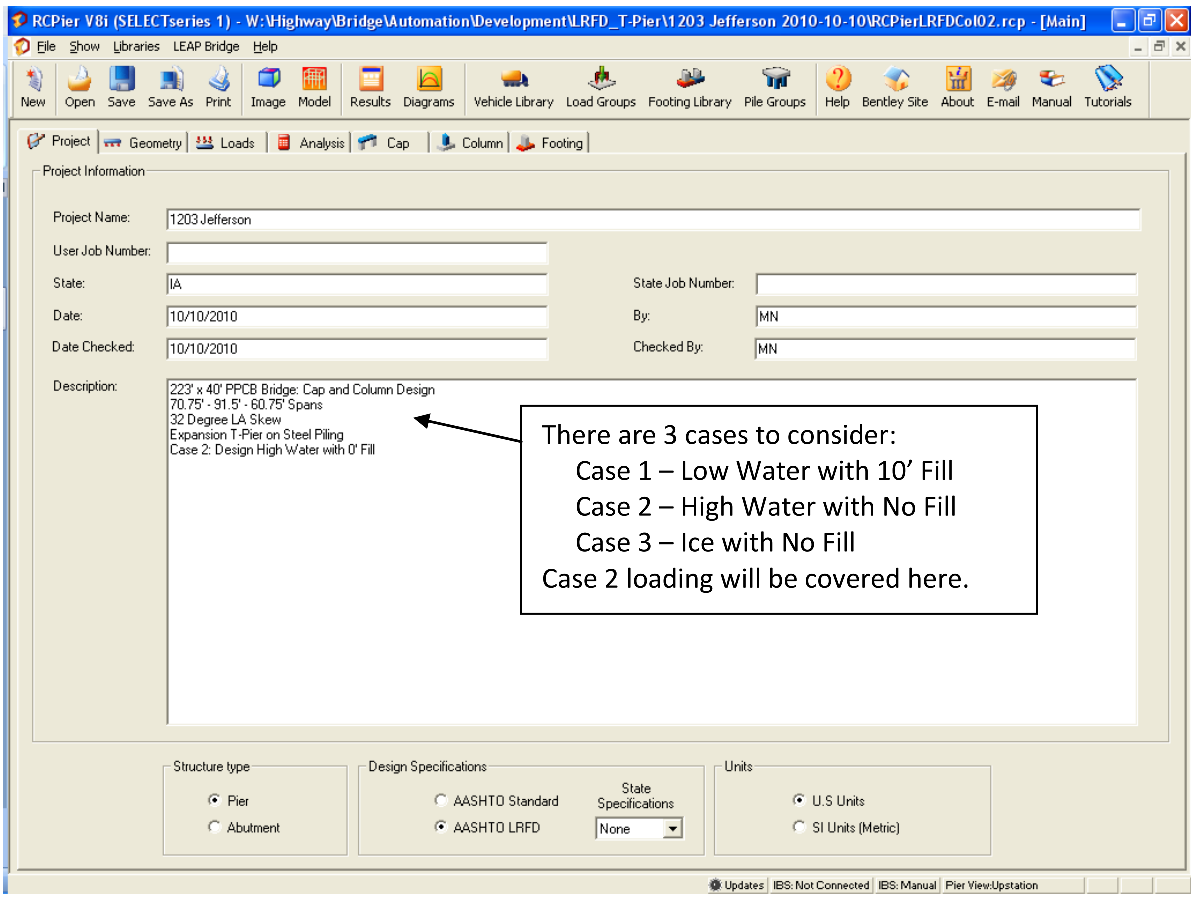
Calculate δ_s = 1 / [1 – ΣP_u/(ϕ_k*ΣP_e)]
δ_{sx} = 1 / [1 – (1049.28 k) / [(0.75)*(21,064.839 k)]]
= 1.0711

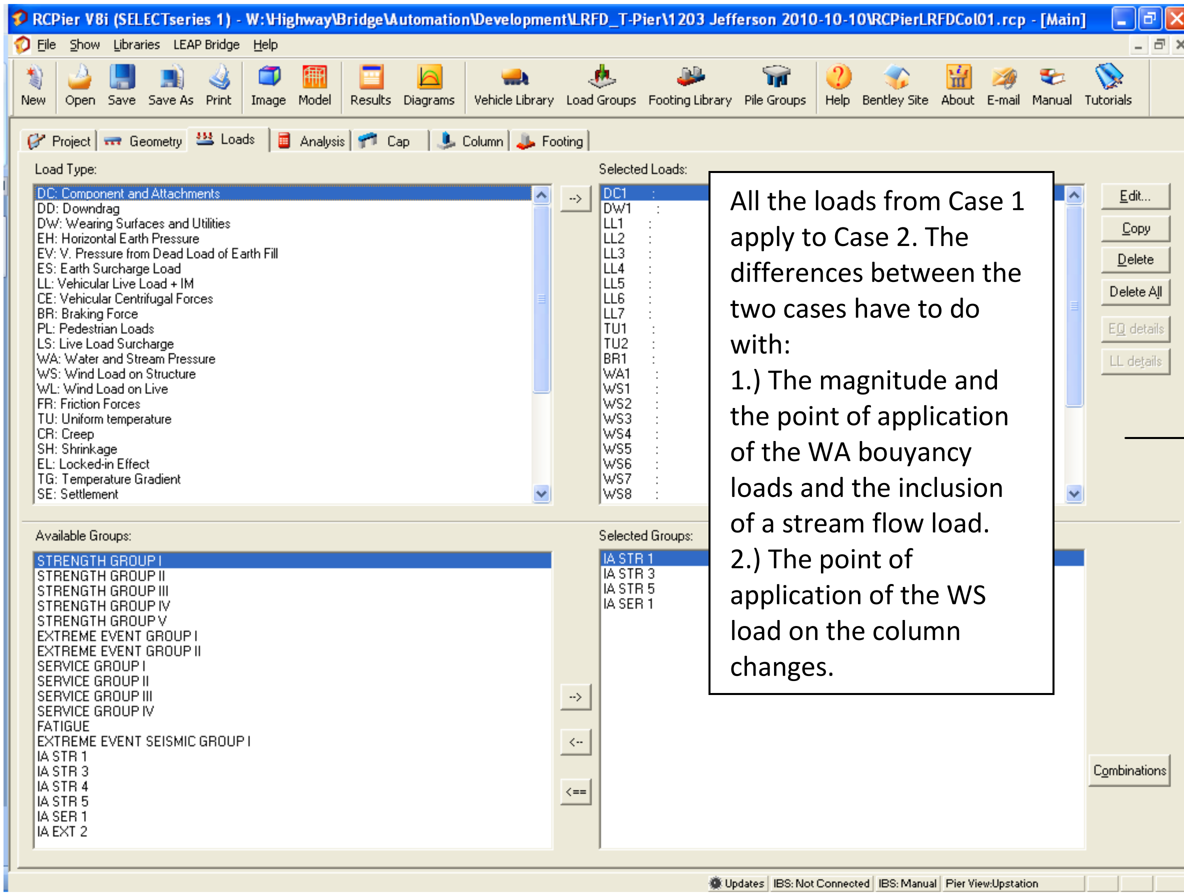
δ_{sz} = 1 / [1 – (1049.28 k) / [(0.75)*(693,848.695 k)]]
= 1.0020

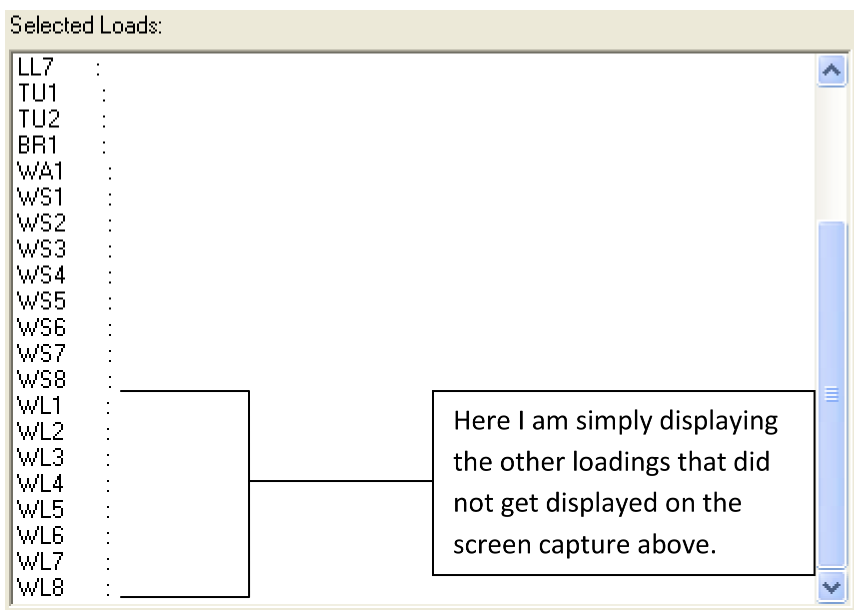
Factored Loads with Magnification for Column Bottom
F_y = 1049.28 k
M_x = (-2223.75 k*ft)*(1.0711) = -2381.9 k*ft
M_z = (-1895.61 k*ft)*(1.0020) = -1899.4 k*ft

Case 2 Loading for Cap and Column Design

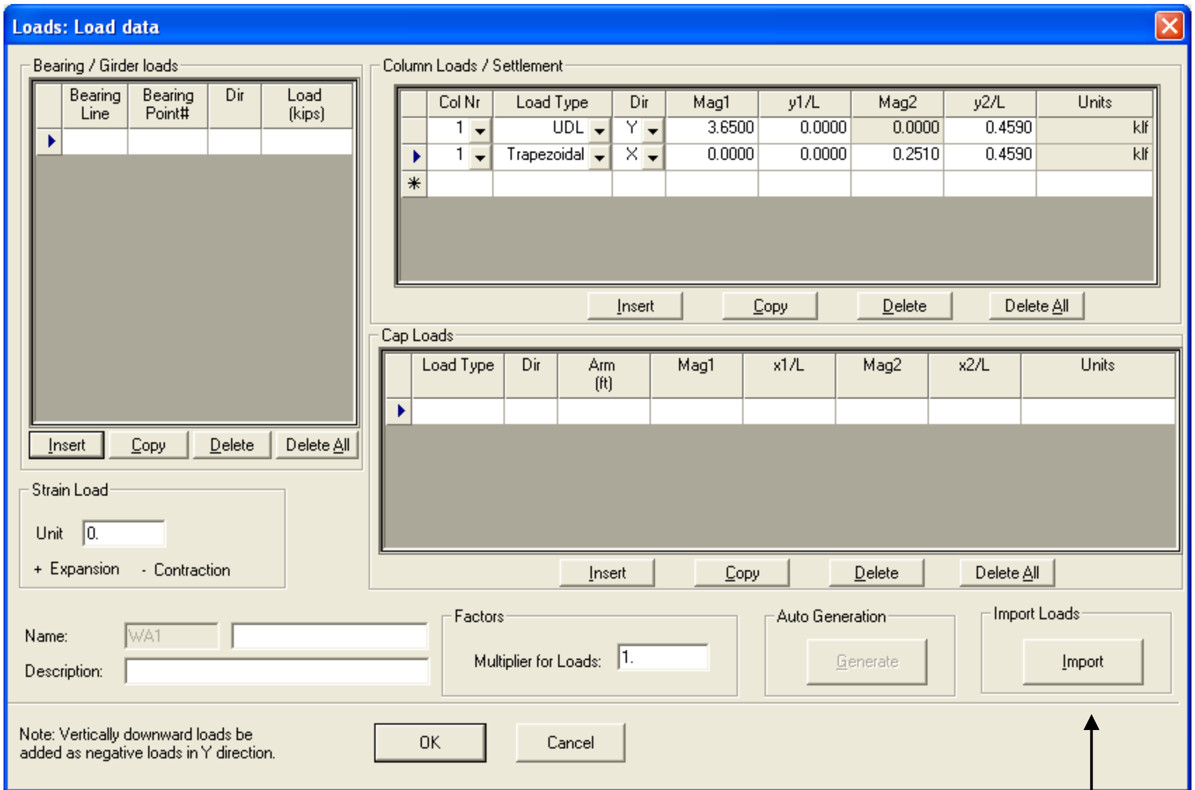
RC-Pier screen captures for Case 2 loading for the cap and column will be provided below. I'm only going to show the differences from the Case 1 loading. The only differences include the WA and WS loadings. For this example Case 2 loading does not affect the design of the cap since the cap loading between Case 1 and 2 is the same. The column loading will be different, but the difference for this example is minimal. In fact, the bottom of column design performance ratios for Case 1 and 2 are 2.10928 and 2.14158, respectively. For Case 1 load combination 173 controls whereas for Case 2 load combination 167 controls. The Case 1 and 2 loadings will display more difference with respect to the footing which is covered later in this example.




RCPier V8i (SELECTseries 1) - W:\Highway\Bridge\Automation\Development\LRFD_T-Pier\1203 Jefferson 2010-10-10\RCPierLRFDCol01.rcp - [Main]
File Show Libraries LEAP Bridge Help
New Open Save Save As Print Image Model Results Diagrams Vehicle Library Load Groups Footing Library Pile Groups Help Bentley Site About E-mail Manual Tutorials
Project Geometry Loads Analysis Cap Column Footing
Load Type:
DC: Component and Attachments
DD: Downdrag
DW: Wearing Surfaces and Utilities
EH: Horizontal Earth Pressure
EV: V. Pressure from Dead Load of Earth Fill
ES: Earth Surcharge Load
LL: Vehicular Live Load + IM
CE: Vehicular Centrifugal Forces
BR: Braking Force
PL: Pedestrian Loads
LS: Live Load Surcharge
WA: Water and Stream Pressure
WS: Wind Load on Structure
WL: Wind Load on Live
FR: Friction Forces
TU: Uniform temperature
CR: Creep
SH: Shrinkage
EL: Locked-in Effect
TG: Temperature Gradient
SE: Settlement
Selected Loads:
DC1
DW1
LL1
LL2
LL3
LL4
LL5
LL6
LL7
TU1
TU2
BR1
WA1
WS1
WS2
WS3
WS4
WS5
WS6
WS7
WS8
Edit...
Copy
Delete
Delete All
EQ details
LL details
Available Groups:
STRENGTH GROUP I
STRENGTH GROUP II
STRENGTH GROUP III
STRENGTH GROUP IV
STRENGTH GROUP V
EXTREME EVENT GROUP I
EXTREME EVENT GROUP II
SERVICE GROUP I
SERVICE GROUP II
SERVICE GROUP III
SERVICE GROUP IV
FATIGUE
EXTREME EVENT SEISMIC GROUP I
IA STR 1
IA STR 3
IA STR 4
IA STR 5
IA SER 1
IA EXT 2
Selected Groups:
IA STR 1
IA STR 3
IA STR 5
IA SER 1
Combinations
Updates
IBS: Not Connected
IBS: Manual
Pier View:Upstation
All the loads from Case 1 apply to Case 2. The differences between the two cases have to do with:
1.) The magnitude and the point of application of the WA bouyancy loads and the inclusion of a stream flow load.
2.) The point of application of the WS load on the column changes.


Selected Loads:
LL7
TU1
TU2
BR1
WA1
WS1
WS2
WS3
WS4
WS5
WS6
WS7
WS8
WL1
WL2
WL3
WL4
WL5
WL6
WL7
WL8
Here I am simply displaying the other loadings that did not get displayed on the screen capture above.

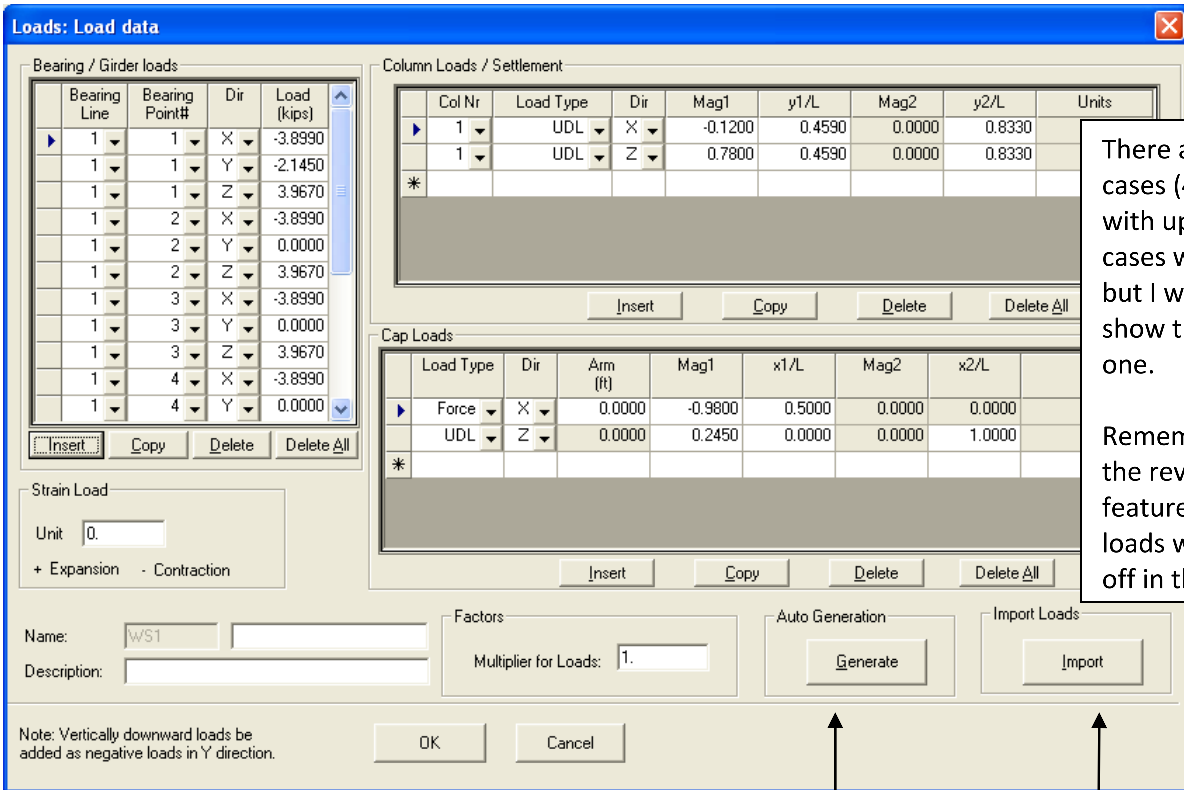
WA1



The spreadsheet that was setup to calculate WA loads will not generate standardized text files in order to import the loads.

The water loads that affect the column and cap design for Case 2 are the buoyancy and stream loads on the column. So, Case 2 is different from Case 1 in that there is a stream flow load and the depth of buoyancy has increased.

WS1



There are 8 WS cases (4 cases with uplift and 4 cases without), but I will only show the first one.

Remember that the reversible feature for wind loads was turned off in the library.

Wind loads can be auto-generated, but generating simplified wind loads requires a few tricks and some editing of the load results.

```
Bearing Loads
1, 1, X, -3.899
1, 1, Y, -2.145
1, 1, Z, 3.967
1, 2, X, -3.899
1, 2, Y, 0
1, 2, Z, 3.967
1, 3, X, -3.899
1, 3, Y, 0
1, 3, Z, 3.967
1, 4, X, -3.899
1, 4, Y, 0
1, 4, Z, 3.967
1, 5, X, -3.899
1, 5, Y, 0
1, 5, Z, 3.967
1, 6, X, -3.899
1, 6, Y, 2.145
1, 6, Z, 3.967
Cap Loads
Force, X, 0, -0.98, 0.5
UDL, Z, 0.245, 0, 1
Column Loads
1, UDL, X, -0.12, 0.459, 0.833
1, UDL, Z, 0.78, 0.459, 0.833
```

The wind loads above were imported from text file “WSLoadsCase2NoUplift001.txt” which was generated from the in-house spreadsheet for wind loads.

The only difference for Case 2 from Case 1 is the point of application of the wind loads on the column. The water elevation from Case 2 is higher than the fill elevation for Case 1.

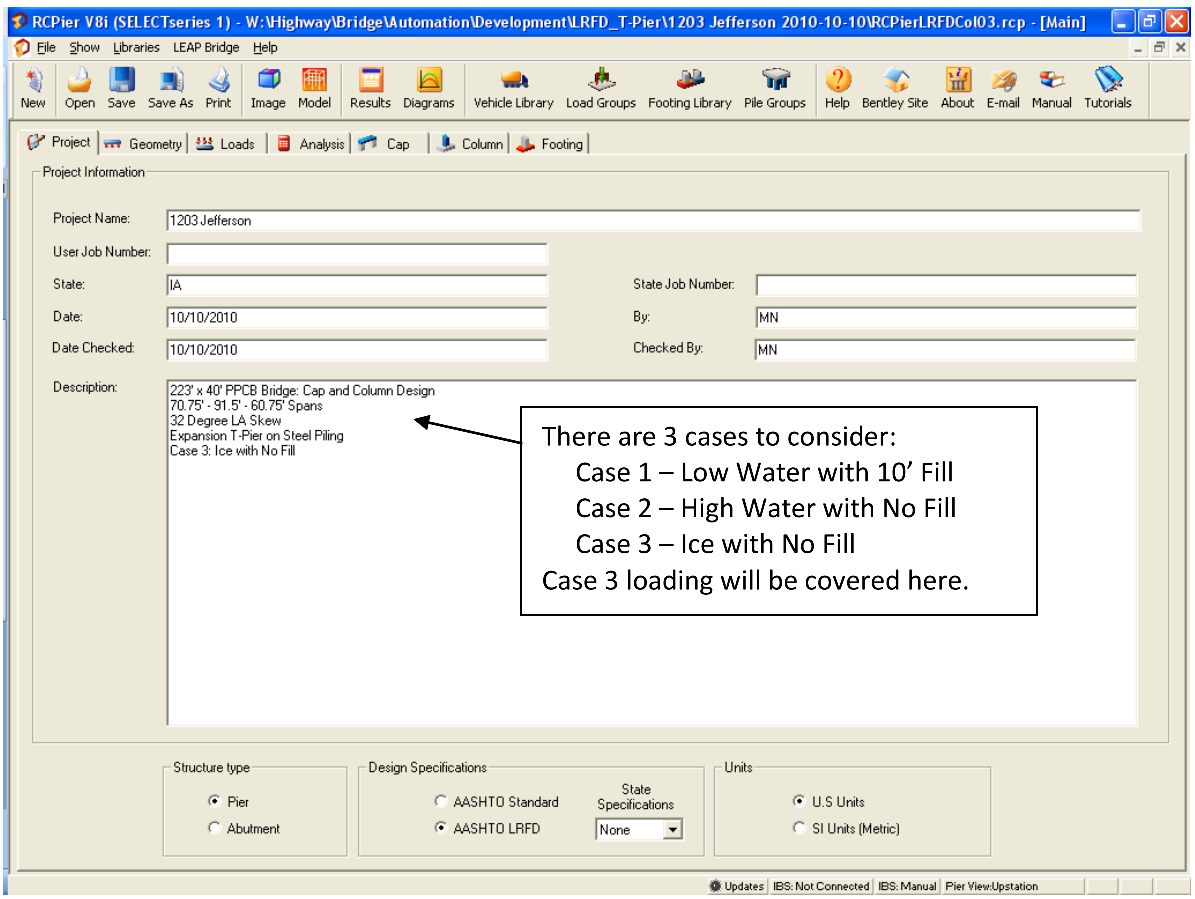
Case 3 Loading for Cap and Column Design

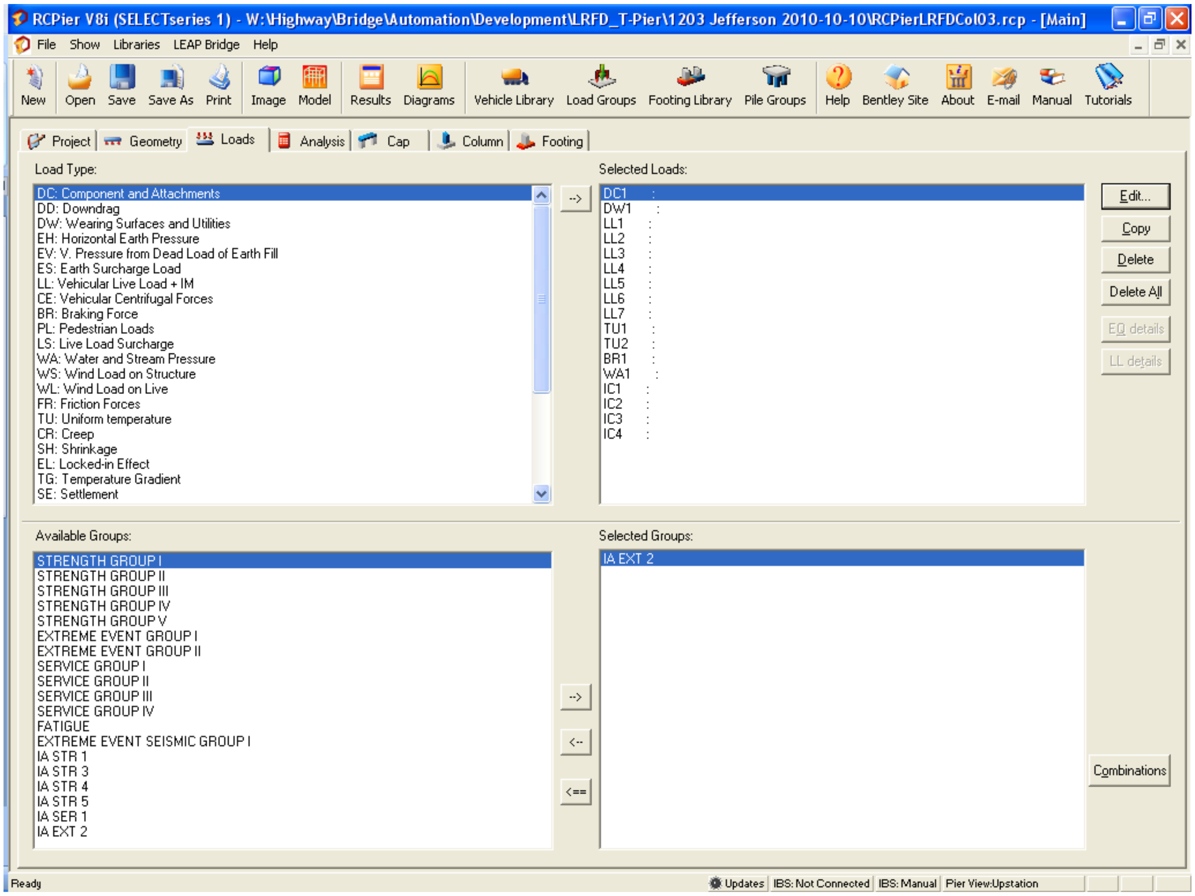
RC-Pier screen captures for Case 3 loading for the cap and column will be provided below. I'm only going to show the differences from the Case 1 loading. The only differences include:

1.) The Load Group is Extreme Event 2.
2.) Changes to the WA loadings.
3.) All wind loading can be eliminated since it is not part of Extreme Event 2.
4.) Ice loading is added.

For this example Case 3 loading does not control the design of the cap. The main reason for this is that the live load factor for Extreme Event 2 is substantially smaller and the ice loading doesn't affect the cap. For this example Case 3 does not control the column design. In fact, the bottom of column design performance ratios for Case 1 and 3 are 2.10928 and 6.06294, respectively.

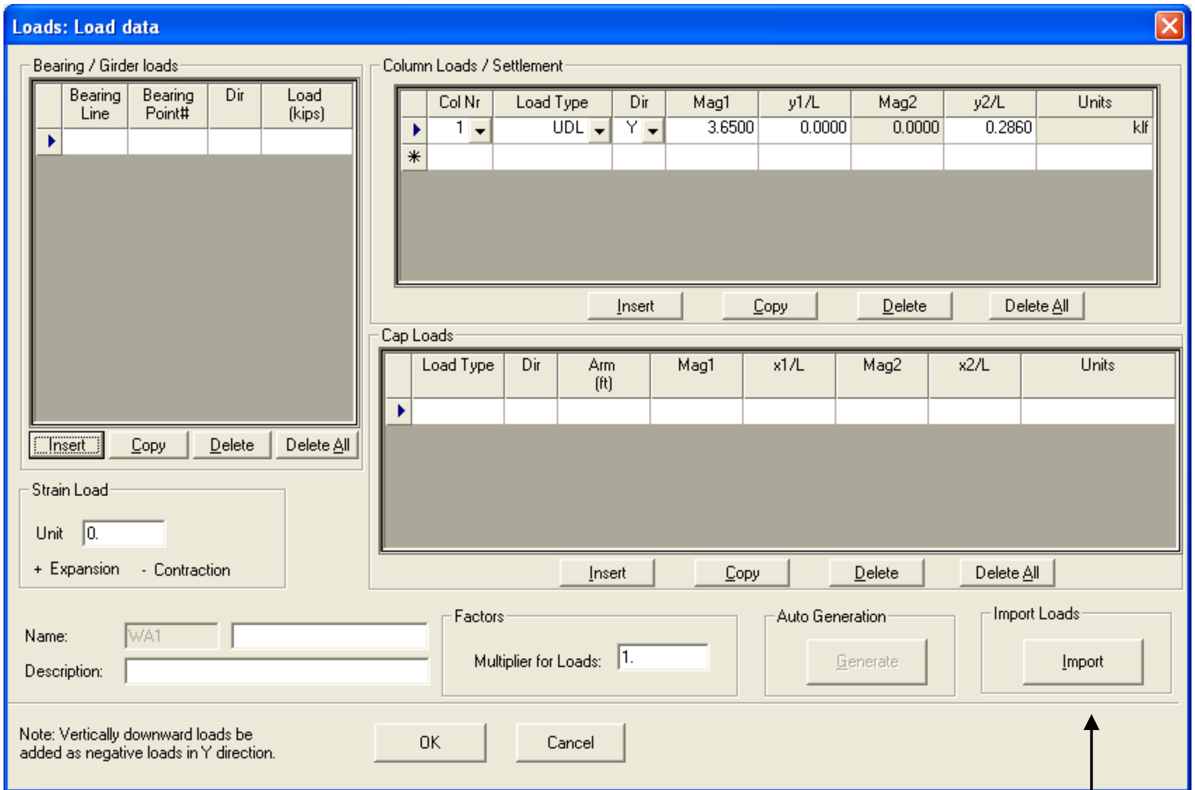
It should be noted that the Aashto Lrfd Specifications in Article 1.3.2 seem to allow the resistance factors for many components to be taken as 1.00 for Extreme Events. However, Article 5.7.2 which addresses Strength and Extreme Event Limit States seems to restrict that provision for concrete components in the 1st paragraph of Article 5.7.2.1.





The DC, DW, LL, TU, and BR loads for Case 3 are the same as those for Case 1. The WA load for Case 3 has been modified from Case 1. The WS and WL loads have been eliminated since Extreme Event 2 does not include those loads. The IC loads were added for Case 3.

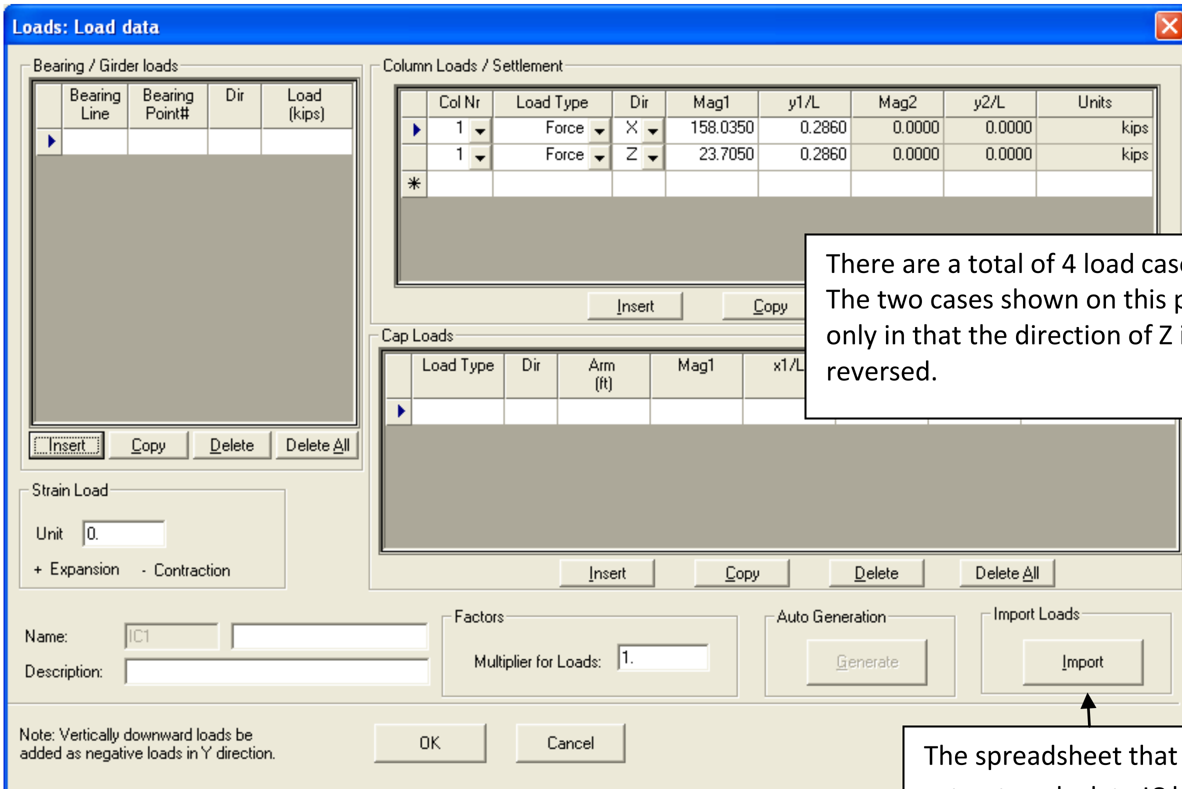
WA1



The spreadsheet that was setup to calculate WA loads will not generate standardized text files in order to import the loads.

The water loads that affect the column and cap design for Case 3 are the buoyancy on the column. Case 3 is different from Case 1 in that the depth of buoyancy has increased.

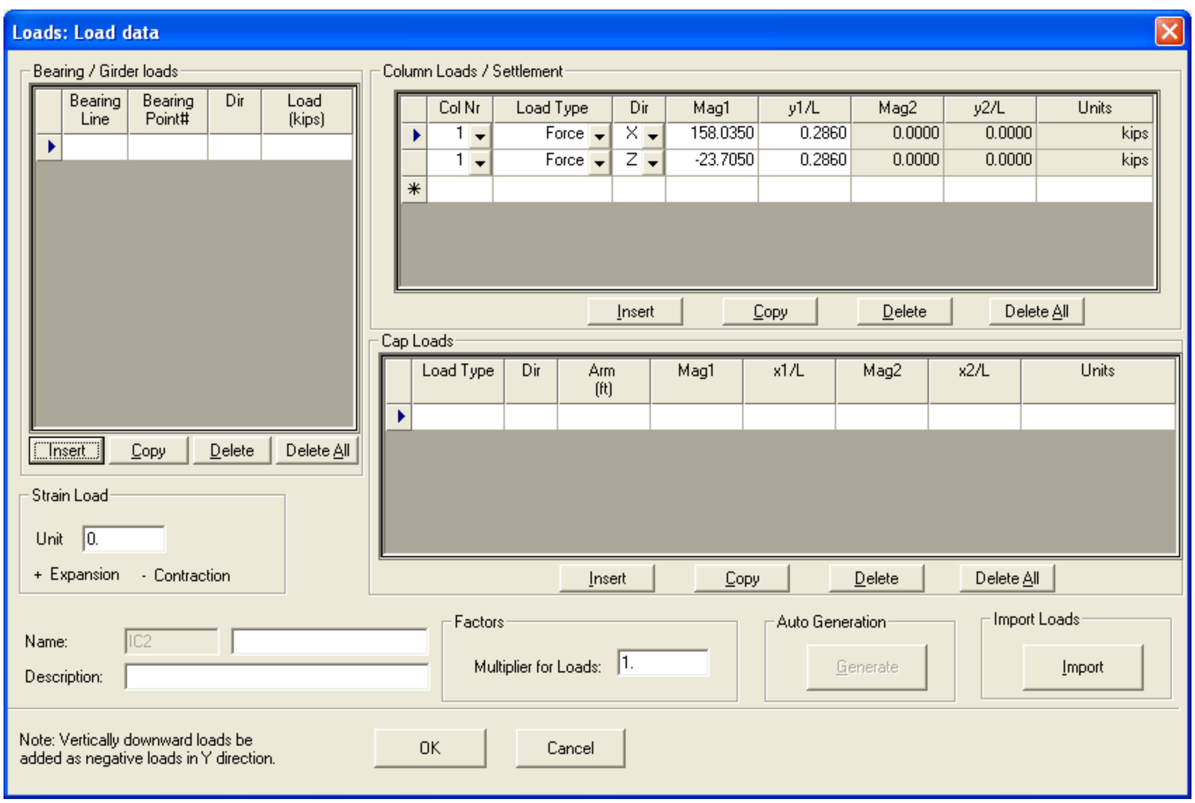
IC1



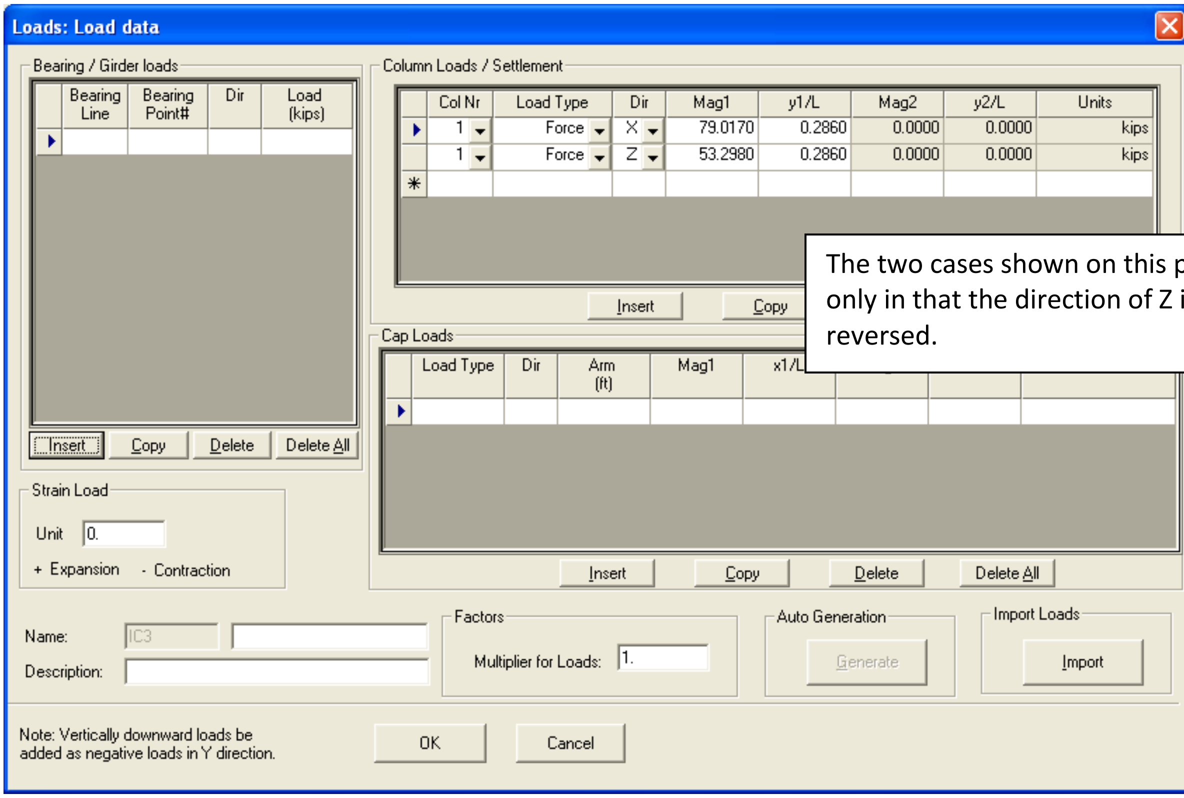
There are a total of 4 load cases for ice. The two cases shown on this page differ only in that the direction of Z ice load is reversed.

The spreadsheet that was setup to calculate IC loads will not generate standardized text files in order to import the loads.

IC2

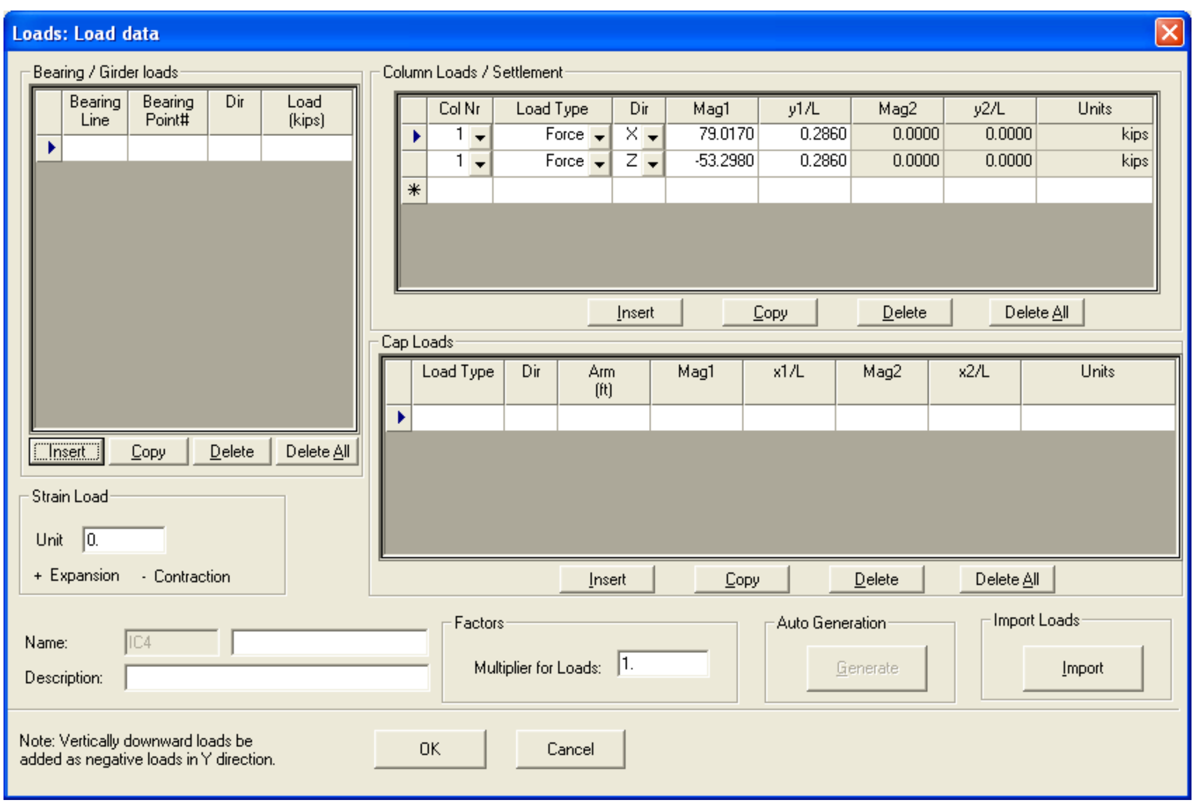


IC3

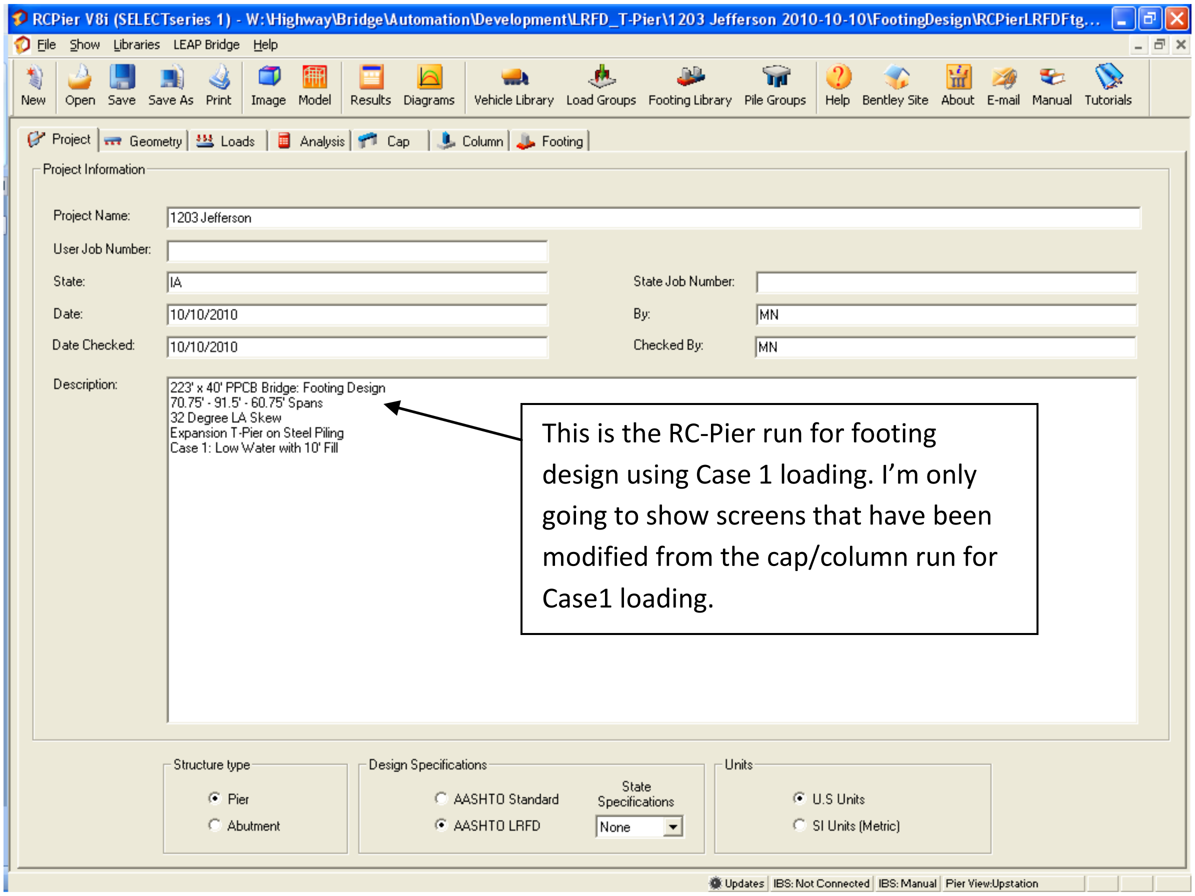


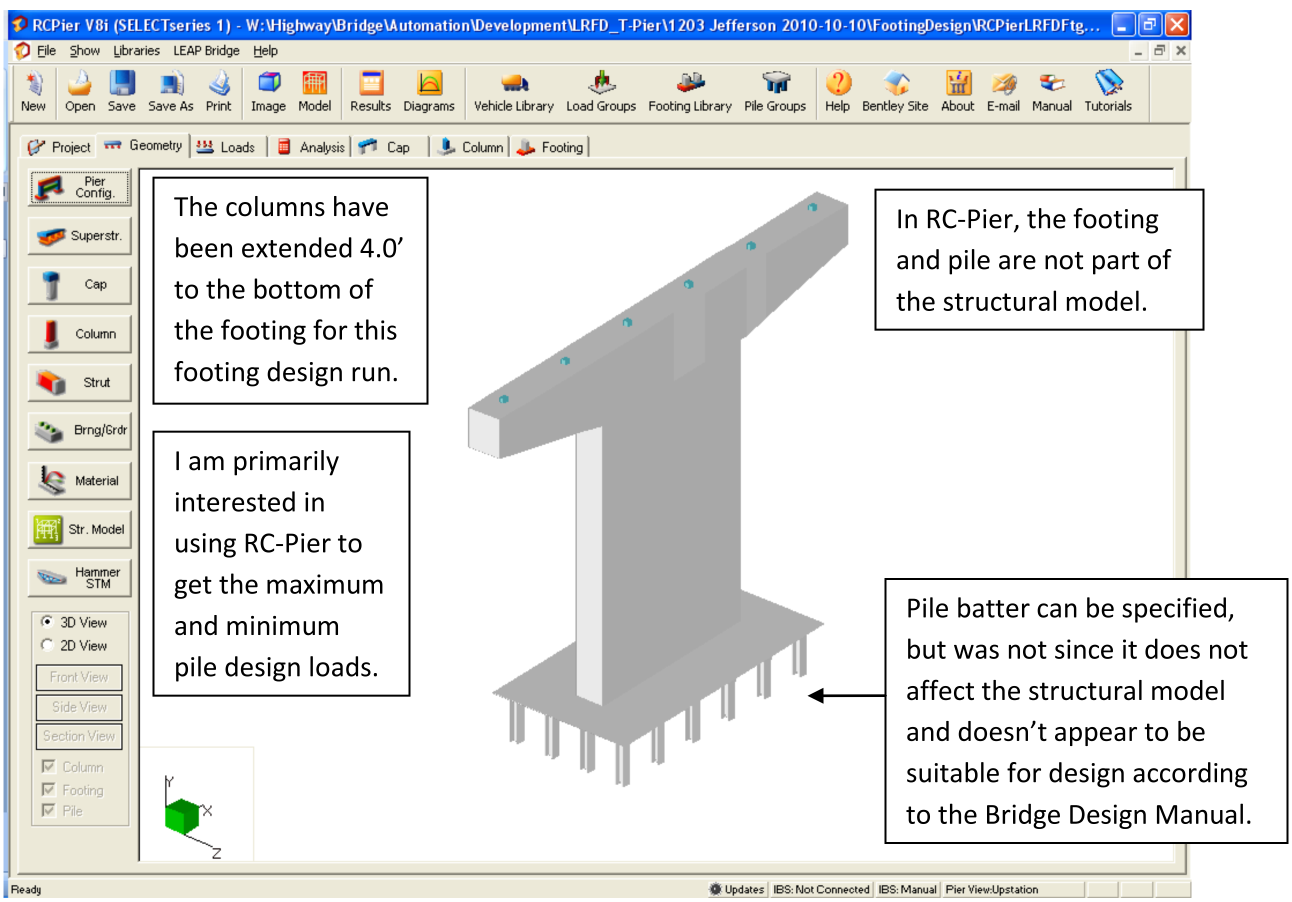
The two cases shown on this page differ only in that the direction of Z ice load is reversed.

IC4

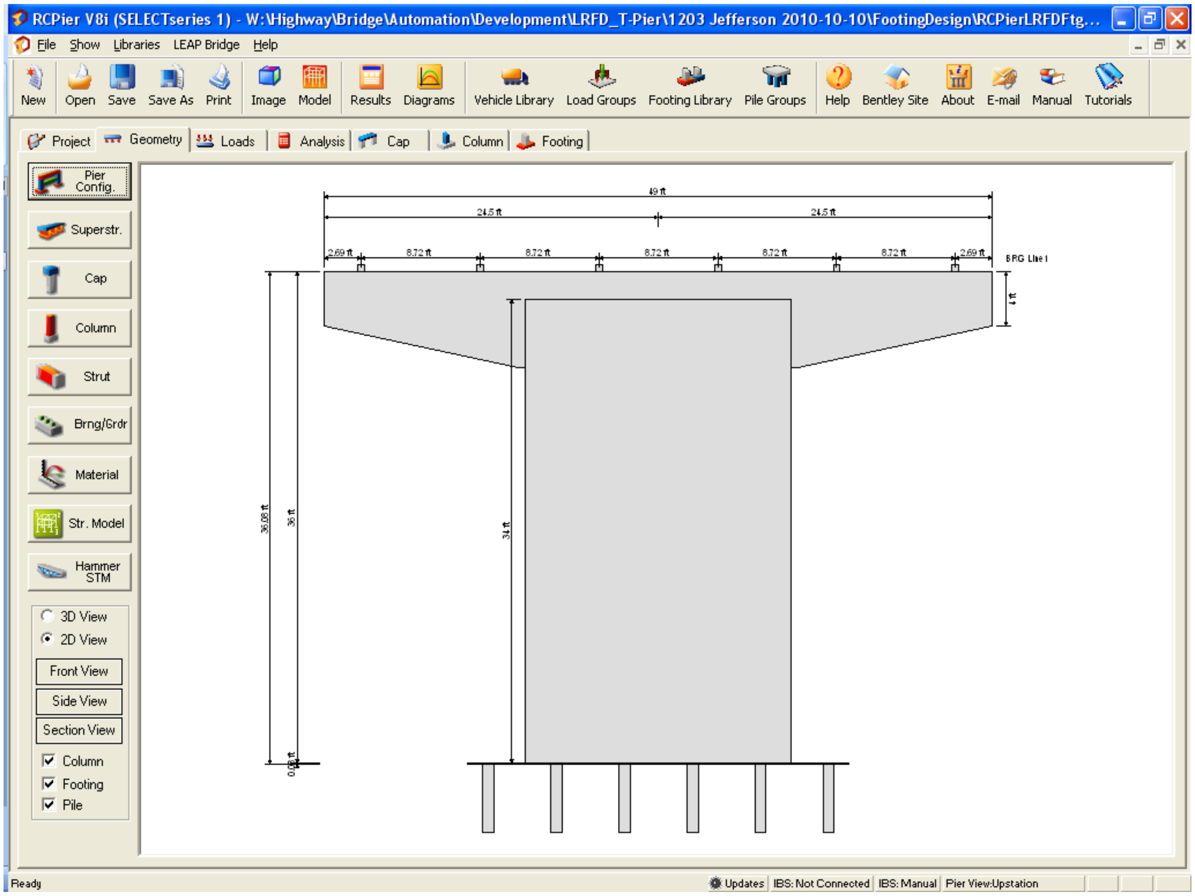


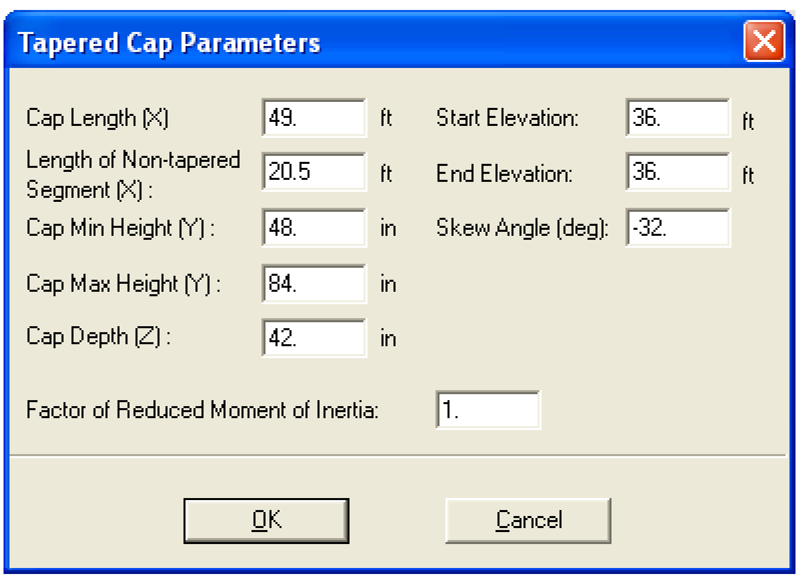
Footing Design



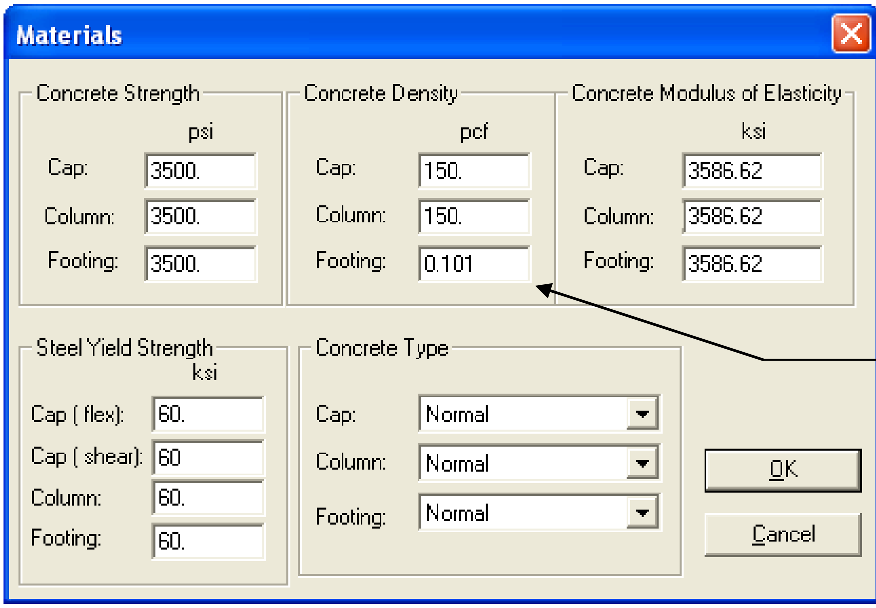


I am going to look at maximum and minimum pile loads only. The footing and fill weight will be placed on the bottom of the column from the "Loads" tab rather than through the entries on the "Footing" tab. Handling loads this way allows me to include these loads in an analysis results file if desired.

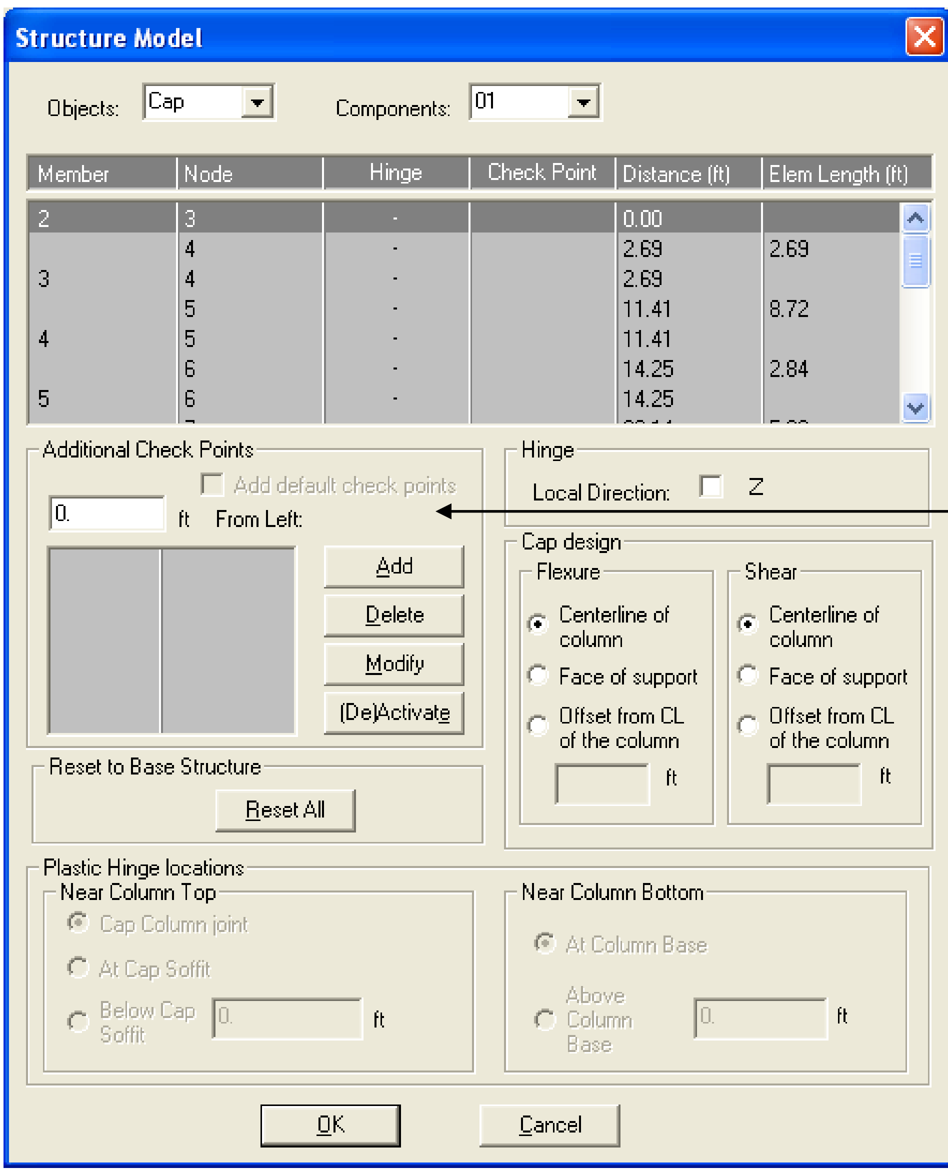




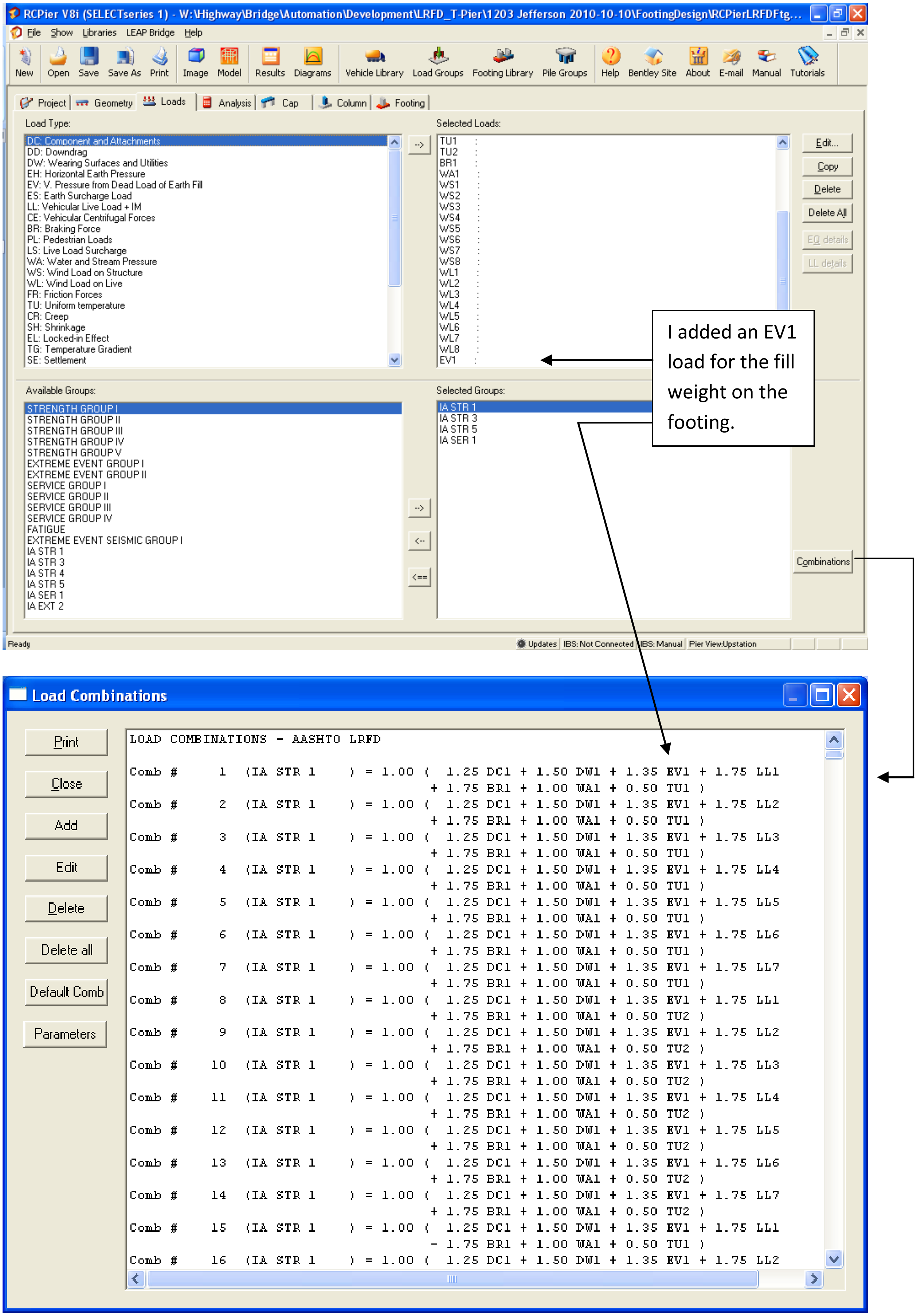
Notice that the column length has been increased by 4.0’ from 25’ to 29’.



Set the footing concrete density to a small value so that the self-weight calculated by RC-Pier is negligible.



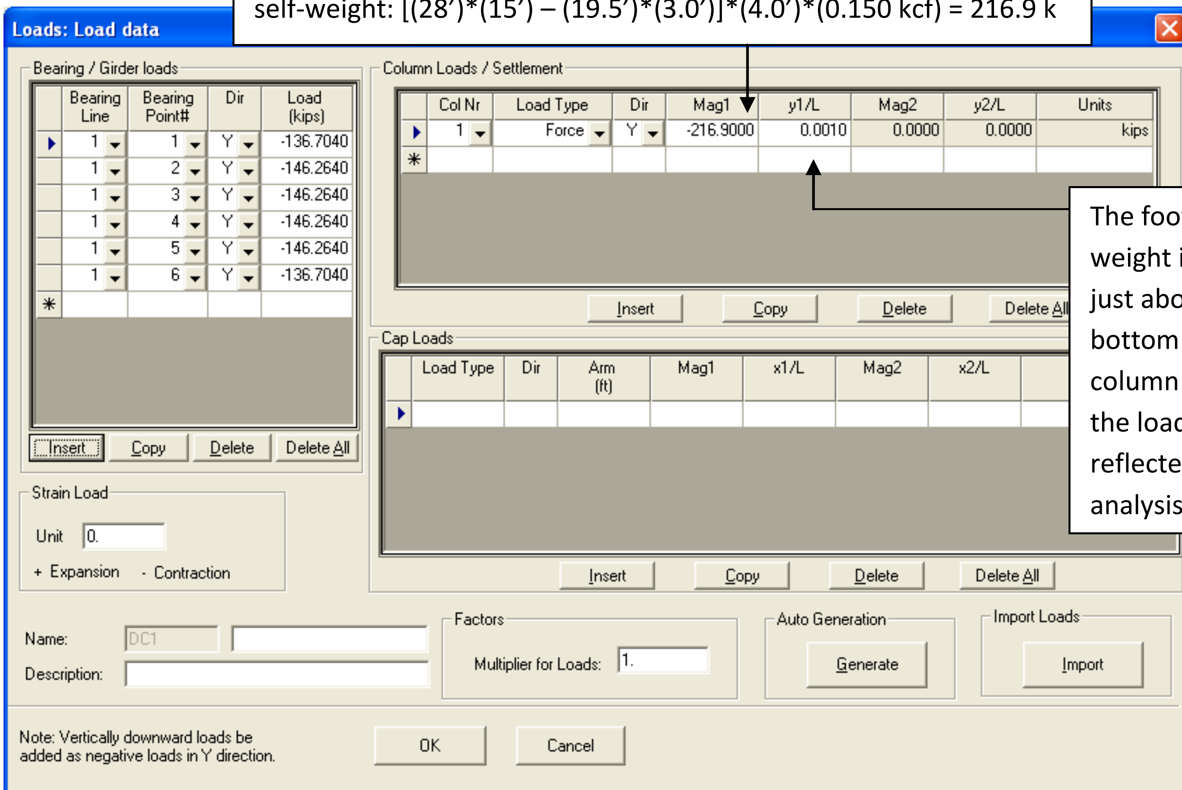
I removed all the additional pier cap check points. This helps speed up the program especially when printing analysis results to a text file.



RCPier V8i (SELECTseries 1) - W:\Highway\Bridge\Automation\Development\LRFD_T-Pier\1203 Jefferson 2010-10-10\FootingDesign\RCPierLRFDFtg...
File Show Libraries LEAP Bridge Help
New Open Save Save As Print Image Model Results Diagrams Vehicle Library Load Groups Footing Library Pile Groups Help Bentley Site About E-mail Manual Tutorials
Project Geometry Loads Analysis Cap Column Footing
Load Type:
DC: Component and Attachments
DD: Downdrag
DW: Wearing Surfaces and Utilities
EH: Horizontal Earth Pressure
EV: V. Pressure from Dead Load of Earth Fill
ES: Earth Surcharge Load
LL: Vehicular Live Load + IM
CE: Vehicular Centrifugal Forces
BR: Braking Force
PL: Pedestrian Loads
LS: Live Load Surcharge
WA: Water and Stream Pressure
WS: Wind Load on Structure
WL: Wind Load on Live
FR: Friction Forces
TU: Uniform temperature
CR: Creep
SH: Shrinkage
EL: Locked-in Effect
TG: Temperature Gradient
SE: Settlement
Selected Loads:
TU1
TU2
BR1
WA1
WS1
WS2
WS3
WS4
WS5
WS6
WS7
WS8
WL1
WL2
WL3
WL4
WL5
WL6
WL7
WL8
EV1
Edit...
Copy
Delete
Delete All
EQ details
LL details
I added an EV1 load for the fill weight on the footing.
Available Groups:
STRENGTH GROUP I
STRENGTH GROUP II
STRENGTH GROUP III
STRENGTH GROUP IV
STRENGTH GROUP V
EXTREME EVENT GROUP I
EXTREME EVENT GROUP II
SERVICE GROUP I
SERVICE GROUP II
SERVICE GROUP III
SERVICE GROUP IV
FATIGUE
EXTREME EVENT SEISMIC GROUP I
IA STR 1
IA STR 3
IA STR 4
IA STR 5
IA SER 1
IA EXT 2
Selected Groups:
IA STR 1
IA STR 3
IA STR 5
IA SER 1
Combinations
Ready
Updates IBS: Not Connected IBS: Manual Pier View:Upstation
Load Combinations
Print
Close
Add
Edit
Delete
Delete all
Default Comb
Parameters
LOAD COMBINATIONS - AASHTO LRFD
Comb # 1 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL1
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU1)
Comb # 2 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL2
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU1)
Comb # 3 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL3
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU1)
Comb # 4 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL4
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU1)
Comb # 5 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL5
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU1)
Comb # 6 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL6
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU1)
Comb # 7 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL7
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU1)
Comb # 8 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL1
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU2)
Comb # 9 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL2
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU2)
Comb # 10 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL3
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU2)
Comb # 11 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL4
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU2)
Comb # 12 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL5
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU2)
Comb # 13 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL6
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU2)
Comb # 14 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL7
+ 1.75 BR1 + 1.00 WA1 + 0.50 TU2)
Comb # 15 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL1
- 1.75 BR1 + 1.00 WA1 + 0.50 TU1)
Comb # 16 (IA STR 1) = 1.00 (1.25 DC1 + 1.50 DW1 + 1.35 EV1 + 1.75 LL2

DC1

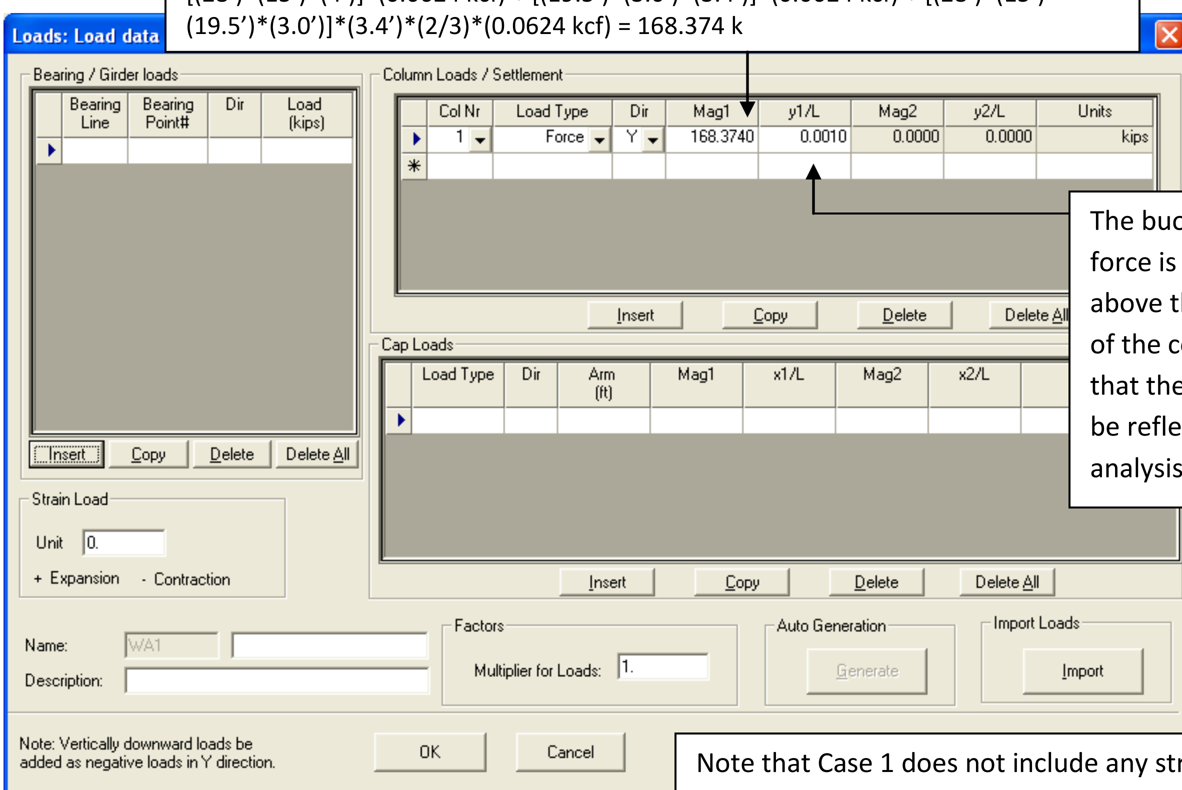
Added footing weight as a DC1 load, but also removed the weight due to the 4.0’ column extension to counteract the addition of its self-weight: [(28’)*(15’) – (19.5’)*(3.0’)]*(4.0’)*(0.150 kcf) = 216.9 k



The footing weight is placed just above the bottom of the column so that the load will be reflected in the analysis results.

WA1

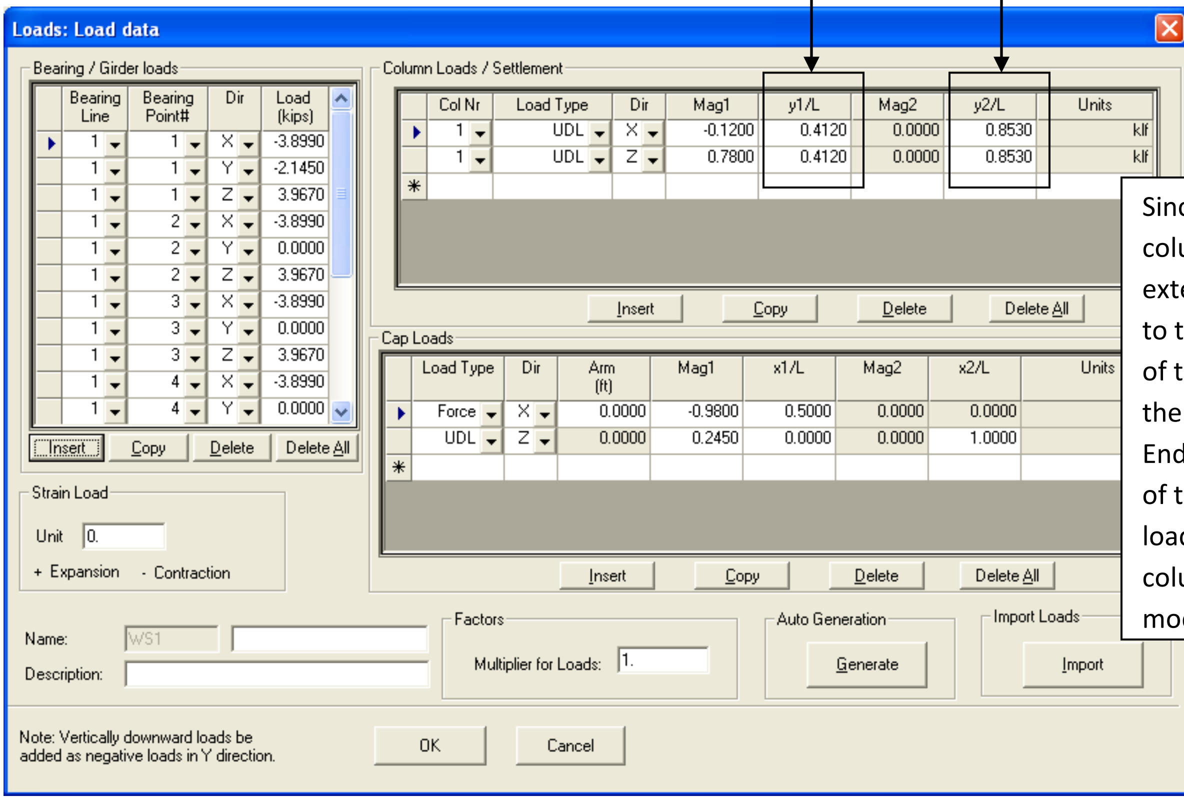
The buoyancy includes the entire submerged footing, the submerged portion of the column (excluding the 4.0’ column extension), and the submerged portion of the soil. Case 1 water depth is 3.4’ above top of footing excluding the 4.0’ column extension. The fill depth is 10’, but only 3.4’ is submerged. The soil is assumed to be 1/3 void. [(28’)*(15’)*(4’)]*(0.0624 kcf) + [(19.5’)*(3.0’)*(3.4’)]*(0.0624 kcf) + [(28’)*(15’) – (19.5’)*(3.0’)]*(3.4’)*(2/3)*(0.0624 kcf) = 168.374 k



The buoyancy force is placed just above the bottom of the column so that the load will be reflected in the analysis results.

Note that Case 1 does not include any stream flow loads. Note also that the buoyancy load can be entered as a total concentrated load since we are considering the footing.

WS1



Loads: Load data

Bearing / Girder loads

Bearing Line	Bearing Point#	Dir	Load (kips)
1	1	X	-3.8990
1	1	Y	-2.1450
1	1	Z	3.9670
1	2	X	-3.8990
1	2	Y	0.0000
1	2	Z	3.9670
1	3	X	-3.8990
1	3	Y	0.0000
1	3	Z	3.9670
1	4	X	-3.8990
1	4	Y	0.0000

Column Loads / Settlement

Col Nr	Load Type	Dir	Mag1	y1/L	Mag2	y2/L	Units
1	UDL	X	-0.1200	0.4120	0.0000	0.8530	klf
1	UDL	Z	0.7800	0.4120	0.0000	0.8530	klf

Cap Loads

Load Type	Dir	Arm (ft)	Mag1	x1/L	Mag2	x2/L	Units
Force	X	0.0000	-0.9800	0.5000	0.0000	0.0000	
UDL	Z	0.0000	0.2450	0.0000	0.0000	1.0000	

Strain Load: Unit 0. (+ Expansion - Contraction)

Name: WS1 — Description:

Factors: Multiplier for Loads: 1. — Auto Generation: Generate — Import Loads: Import

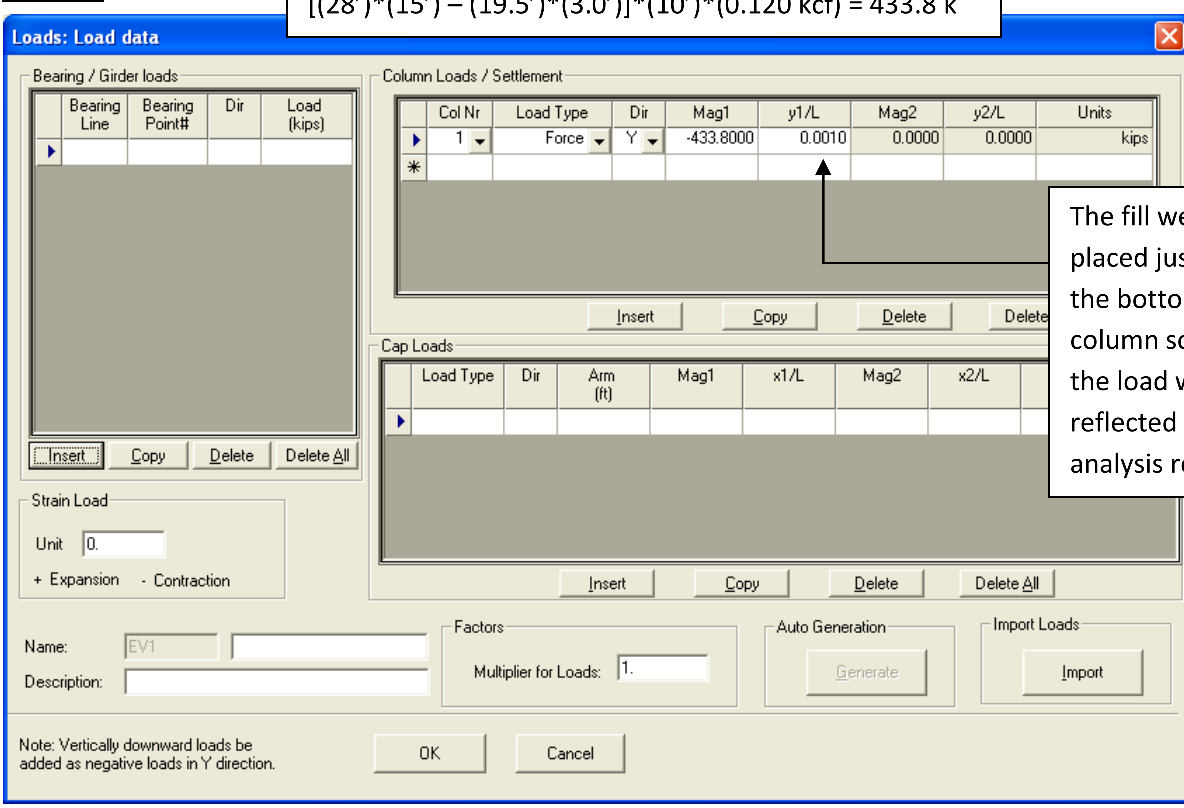
Note: Vertically downward loads be added as negative loads in Y direction.

OK — Cancel

Since the column was extended 4.0' to the bottom of the footing, the Start and End locations of the wind loads on the columns were modified.

EV1

Adding fill weight on top of the footing:
[(28')*(15') – (19.5')*(3.0')]*(10')*(0.120 kcf) = 433.8 k



Loads: Load data

Bearing / Girder loads

Bearing Line	Bearing Point#	Dir	Load (kips)

Column Loads / Settlement

Col Nr	Load Type	Dir	Mag1	y1/L	Mag2	y2/L	Units
1	Force	Y	-433.8000	0.0010	0.0000	0.0000	kips

Cap Loads

Load Type	Dir	Arm (ft)	Mag1	x1/L	Mag2	x2/L

Strain Load: Unit 0. (+ Expansion - Contraction)

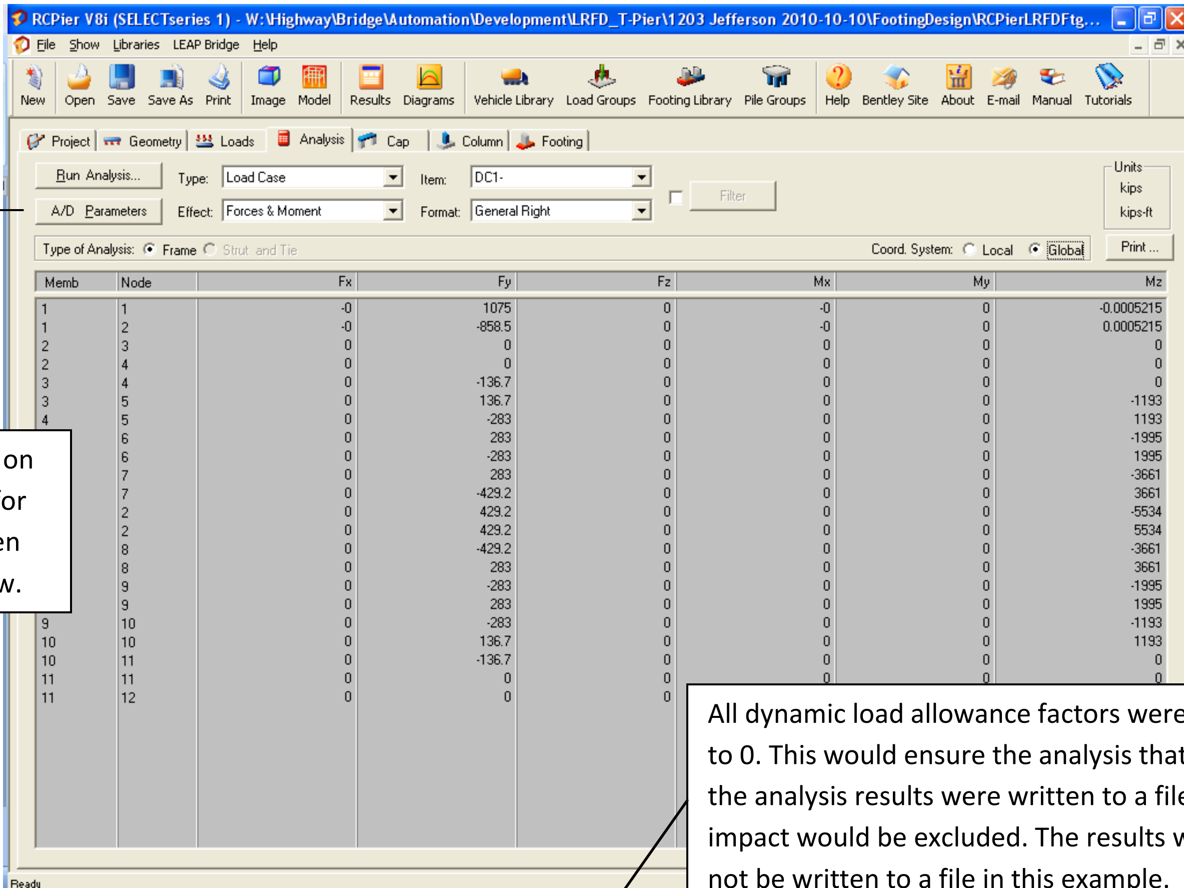
Name: EV1 — Description:

Factors: Multiplier for Loads: 1. — Auto Generation: Generate — Import Loads: Import

Note: Vertically downward loads be added as negative loads in Y direction.

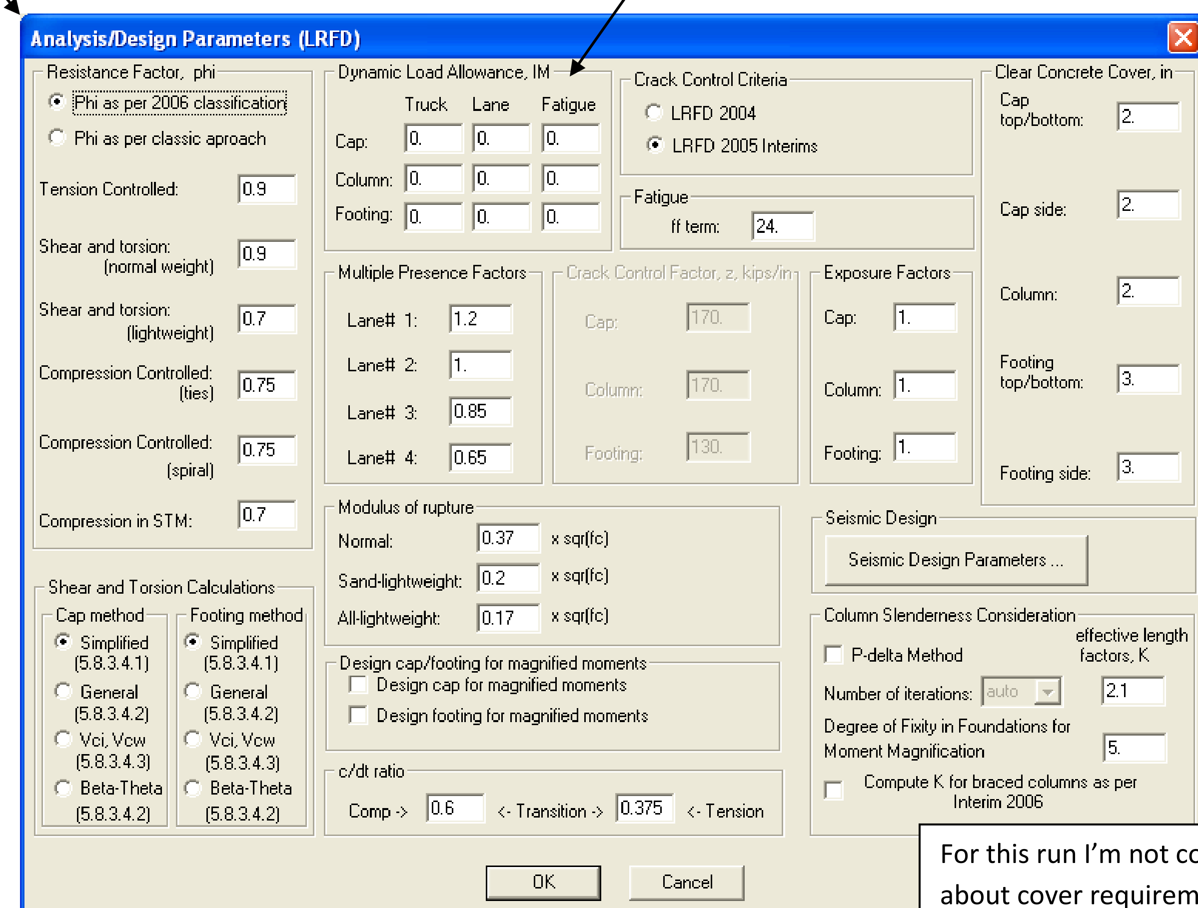
OK — Cancel

The fill weight is placed just above the bottom of the column so that the load will be reflected in the analysis results.

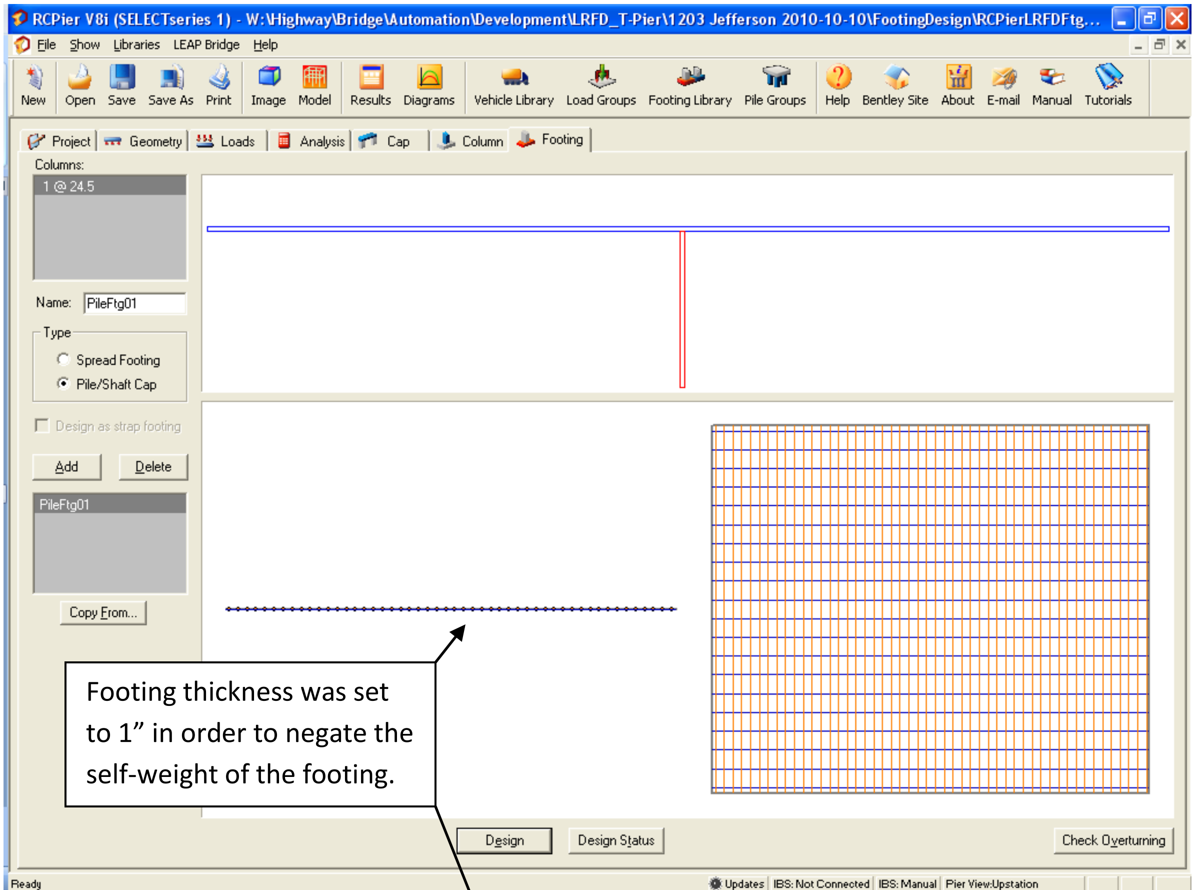


Click on this for screen below.

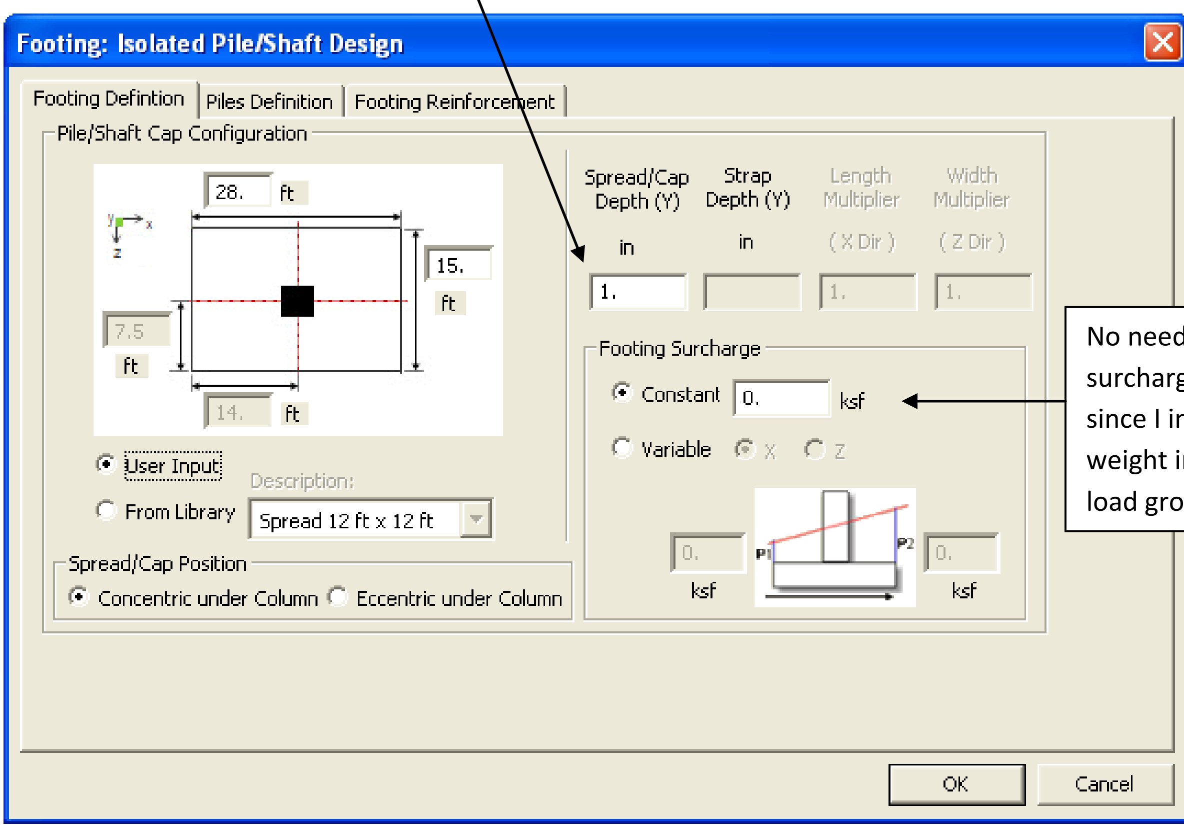
All dynamic load allowance factors were set to 0. This would ensure the analysis that if the analysis results were written to a file then impact would be excluded. The results will not be written to a file in this example.



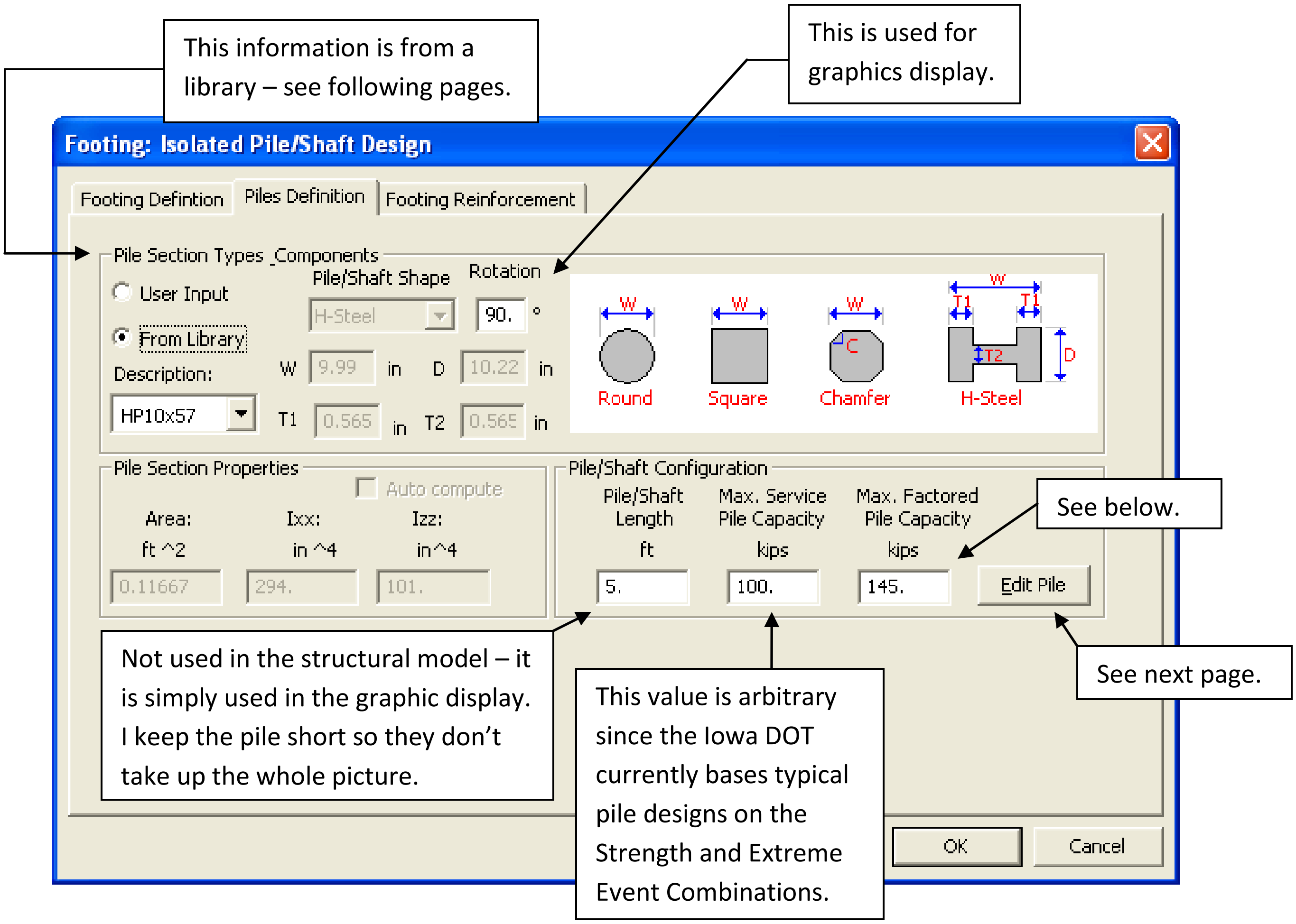
For this run I'm not concerned about cover requirements since I am not designing footing reinforcement in RC-Pier.



Footing thickness was set to 1” in order to negate the self-weight of the footing.



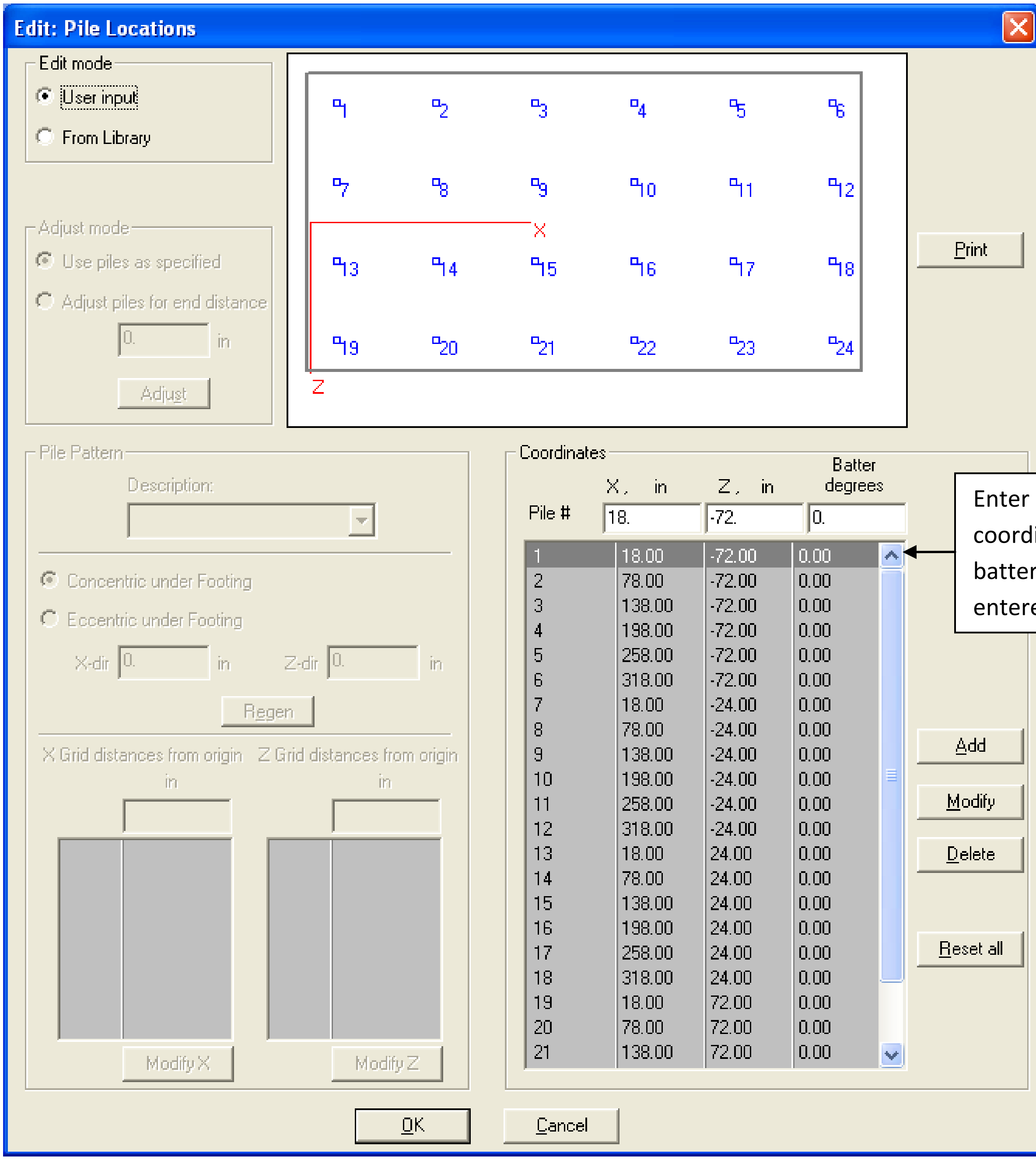
No need to enter surcharge here since I included fill weight in the EV1 load group.



<u>HP10x57 Structural Resistance Level 1</u>

Factored Resistance = (6 ksi)*(0.1167 ft^2)*(144 in^2/ft^2)*(1.45) = 146.16 k

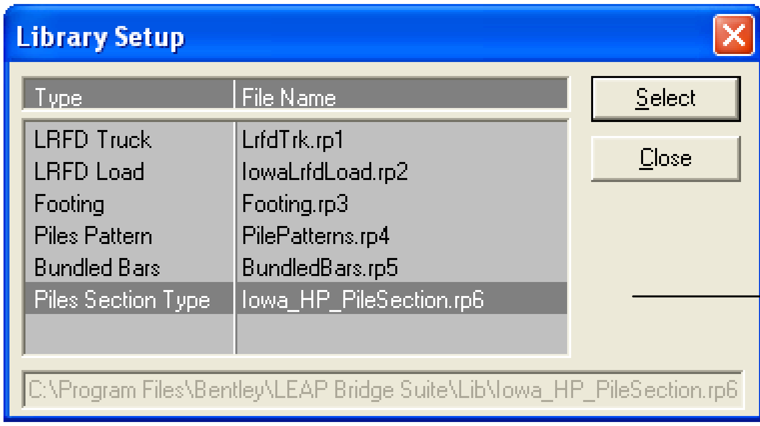
BDM Table 6.2.6.1-1 shows (0.6)*(243 k) = 145.8 k



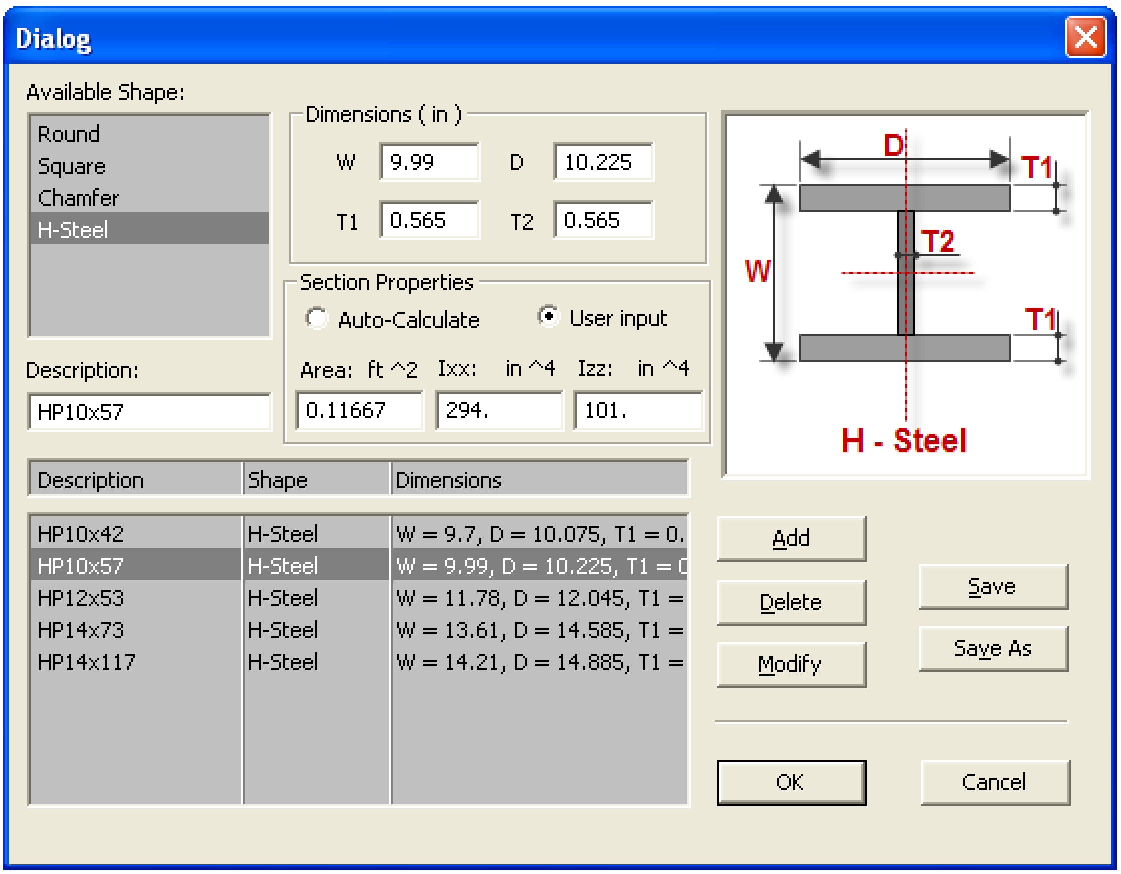
Enter pile coordinates. Pile batter was not entered.

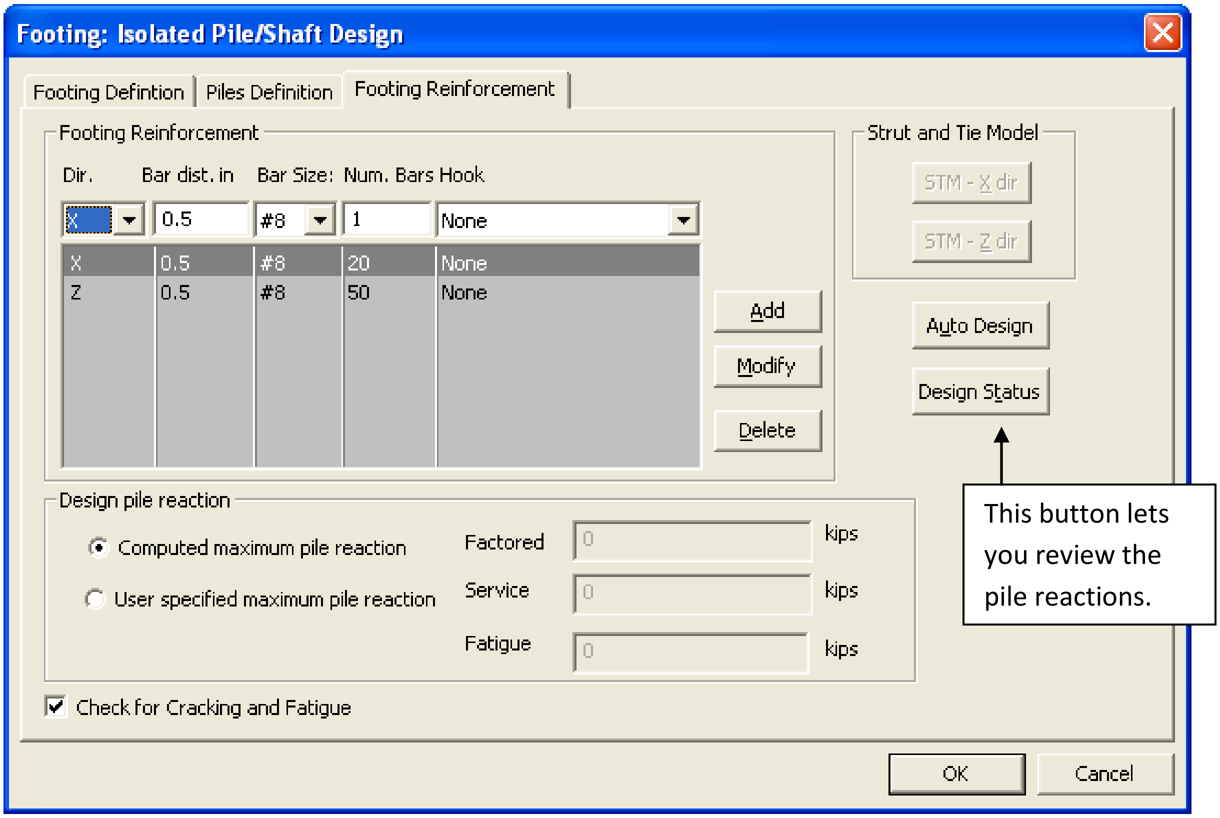
Aashto Lrfd 5.13.3.2 talks about piles being out of planned position by 6" or ¼ times the pile diameter and that the center of a group of piles may be 3" from its planned position. This provision does not need to be considered for typical pier designs. [Field construction errors are a separate issue from tolerances.]

According to the Bridge Design Manual a pile battered no more than 1:4 may be assumed to carry the same vertical load as a pile driven vertically; there need be no reduction for angle of the pile.



Pile Type Library





There is not much point in entering footing reinforcement since my footing is only 1" thick and I won't be using RC-Pier for the design of the concrete footing. However, RC-Pier requires the entry in order to get the pile reactions.

ISOLATED FOOTING DESIGN

I've included some portions of RC-Pier's output for the footing.

ISOLATED FOOTING DESIGN
Code: AASHTO LRFD 2007 (with Interims)
Units: US
Pier View: Upstation.

GEOMETRY
Name : PileFtg01
Shape : Rectangular, Type : Pile/Shaft Cap
Bf(X) = 28.00 ft, Hf(Z) = 15.00 ft, Thickness(Y) = 1.00 in
Ag = 420.00 ft^2, Ix = 480.00 ft^2, Iz = 1750.00 ft^2
Footing concentric.
Columns located on the footing:
Column No. 1 at x = 0.00 ft, Rectangular 234.00 in x 36.00 in
Surcharge = 0.00 ksf
Piles: H-Steel Size: W = 9.99 in, D = 10.23 in, T1 = 0.56 in, T2 = 0.56 in
Service Capacity: 100.00 kips Factored Capacity: 145.00 kips
Piles Section Properties: Area = 0.12 ft^2 Ix = 294.00 in^4 Iz = 101.00 in^4

DESIGN PARAMETERS	
f'c = 3500.00 psi	fy = 60000.00 psi
phi tens = 0.90	
phi comp = 0.75	phi shear = 0.90
Tens below = 0.375	Comp Above = 0.600
Ec = 3586.6 ksi	Es = 29000.0 ksi
Crack check as per 2005 Interims	
Crack control Exposure = 1.00	
Concrete Type : Normal Weight.	

Pile Reactions, Service

Pile	Loc(X) ft	Loc(Z) ft	X in	Z in	comb	Ovs	P kips	Mxx kft	Mzz kft	Pile Reac. kips
1	-12.50	-1.50	18.00	-72.0	2161	1.000	-2107.08	-1933.70	3711.64	138.48*
					2314	1.000	-1994.80	1933.70	-3710.19	32.44
2	-7.50	-1.50	78.00	-72.0	2161	1.000	-2107.08	-1933.70	3711.64	127.87*
					2314	1.000	-1994.80	1933.70	-3710.19	43.04
3	-2.50	-1.50	138.00	-72.0	2163	1.000	-2184.27	-1933.70	2000.28	118.04*
					2342	1.000	-1973.80	1933.70	-3483.57	53.09
4	2.50	-1.50	198.00	-72.0	2164	1.000	-2184.27	-1933.70	-518.86	115.92*
					2341	1.000	-1973.80	1933.70	2455.39	54.56
5	7.50	-1.50	258.00	-72.0	2190	1.000	-2086.07	-1933.70	-2456.84	121.62*
					2341	1.000	-1973.80	1933.70	2455.39	47.55
6	12.50	-1.50	318.00	-72.0	2190	1.000	-2086.07	-1933.70	-2456.84	128.64*
					2341	1.000	-1973.80	1933.70	2455.39	40.53
7	-12.50	-5.50	18.00	-24.0	2182	1.000	-2086.07	-856.93	5290.85	128.28*
					2363	1.000	-1973.80	856.93	-5289.39	40.89
8	-7.50	-5.50	78.00	-24.0	2182	1.000	-2086.07	-856.93	5290.85	113.17*
					2363	1.000	-1973.80	856.93	-5289.39	56.00
9	-2.50	-5.50	138.00	-24.0	2163	1.000	-2184.27	-1933.70	2000.28	101.93*
					2342	1.000	-1973.80	1933.70	-3483.57	69.21
10	2.50	-5.50	198.00	-24.0	2164	1.000	-2184.27	-1933.70	-518.86	99.81
					2341	1.000	-1973.80	1933.70	2455.39	70.68
11	7.50	-5.50	258.00	-24.0	2246	1.000	-2086.07	-283.46	-4374.92	106.85*
					2285	1.000	-1973.80	283.46	4373.47	62.32
12	12.50	-5.50	318.00	-24.0	2365	1.000	-2086.07	856.93	-5290.84	121.14*
					2180	1.000	-1973.80	-856.93	5289.40	48.03
13	-12.50	-9.50	18.00	24.0	2182	1.000	-2086.07	-856.93	5290.85	121.14*
					2363	1.000	-1973.80	856.93	-5289.39	48.03
14	-7.50	-9.50	78.00	24.0	2287	1.000	-2086.07	283.46	4374.93	106.85*
					2244	1.000	-1973.80	-283.46	-4373.47	62.32
15	-2.50	-9.50	138.00	24.0	2317	1.000	-2184.27	1933.70	518.86	99.81
					2188	1.000	-1973.80	-1933.70	-2455.39	70.68
16	2.50	-9.50	198.00	24.0	2318	1.000	-2184.27	1933.70	-2000.28	101.93*
					2187	1.000	-1973.80	-1933.70	3483.57	69.21
17	7.50	-9.50	258.00	24.0	2365	1.000	-2086.07	856.93	-5290.84	113.17*
					2180	1.000	-1973.80	-856.93	5289.40	56.00
18	12.50	-9.50	318.00	24.0	2365	1.000	-2086.07	856.93	-5290.84	128.28*
					2180	1.000	-1973.80	-856.93	5289.40	40.89
19	-12.50	-13.50	18.00	72.0	2343	1.000	-2086.07	1933.70	2456.85	128.64*
					2188	1.000	-1973.80	-1933.70	-2455.39	40.53
20	-7.50	-13.50	78.00	72.0	2343	1.000	-2086.07	1933.70	2456.85	121.62*
					2188	1.000	-1973.80	-1933.70	-2455.39	47.55
21	-2.50	-13.50	138.00	72.0	2317	1.000	-2184.27	1933.70	518.86	115.92*
					2188	1.000	-1973.80	-1933.70	-2455.39	54.56
22	2.50	-13.50	198.00	72.0	2318	1.000	-2184.27	1933.70	-2000.28	118.04*
					2187	1.000	-1973.80	-1933.70	3483.57	53.09
23	7.50	-13.50	258.00	72.0	2316	1.000	-2107.08	1933.70	-3711.64	127.87*
					2159	1.000	-1994.80	-1933.70	3710.19	43.04
24	12.50	-13.50	318.00	72.0	2316	1.000	-2107.08	1933.70	-3711.64	138.48*
					2159	1.000	-1994.80	-1933.70	3710.19	32.44

Not interested in the Service capacity of the piles at this time.

Pile Reactions, Factored

Pile	Loc(X) ft	Loc(Z) ft	X in	Z in	comb	Ovs	P kips	Mxx kft	Mzz kft	Pile Reac. kips
1	-12.50	-1.50	18.0	-72.0	3	—	-2878.04	-1112.24	6251.57	178.48*
					219	—	-1903.26	1112.24	-6249.03	20.76
2	-7.50	-1.50	78.0	-72.0	3	—	-2878.04	-1112.24	6251.57	160.61*
					2090	—	-1835.90	1812.73	-4283.79	35.48
3	-2.50	-1.50	138.0	-72.0	371	—	-2869.97	-1812.73	1975.42	145.06*
					349	—	-1510.50	2535.73	1988.92	34.08
4	2.50	-1.50	198.0	-72.0	372	—	-2869.97	-1812.73	-1425.42	144.28
					349	—	-1510.50	2535.73	1988.92	28.40
5	7.50	-1.50	258.0	-72.0	398	—	-2737.75	-1812.73	-4037.92	154.04*
					349	—	-1510.50	2535.73	1988.92	22.72
6	12.50	-1.50	318.0	-72.0	398	—	-2737.75	-1812.73	-4037.92	165.57*
					349	—	-1510.50	2535.73	1988.92	17.03
7	-12.50	-5.50	18.0	-24.0	3	—	-2878.04	-1112.24	6251.57	169.21*
					2139	—	-1807.89	480.22	-6173.09	29.23
8	-7.50	-5.50	78.0	-24.0	3	—	-2878.04	-1112.24	6251.57	151.35*
					2139	—	-1807.89	480.22	-6173.09	46.87
9	-2.50	-5.50	138.0	-24.0	5	—	-3013.12	-1112.24	3256.69	134.83
					349	—	-1510.50	2535.73	1988.92	55.21
10	2.50	-5.50	198.0	-24.0	6	—	-3013.12	-1112.24	-1151.81	131.83
					349	—	-1510.50	2535.73	1988.92	49.53
11	7.50	-5.50	258.0	-24.0	11	—	-2878.04	-287.12	-5105.73	143.00
					341	—	-1510.50	1710.61	2947.96	43.18
12	12.50	-5.50	318.0	-24.0	25	—	-2878.04	1112.24	-6251.56	159.94*
					1956	—	-1807.89	-480.22	6173.10	33.24
13	-12.50	-9.50	18.0	24.0	3	—	-2878.04	-1112.24	6251.57	159.94*
					2139	—	-1807.89	480.22	-6173.09	33.24
14	-7.50	-9.50	78.0	24.0	17	—	-2878.04	287.12	5105.74	143.00
					351	—	-1510.50	-1710.61	-2947.96	43.18
15	-2.50	-9.50	138.0	24.0	26	—	-3013.12	1112.24	1151.81	131.83
					343	—	-1510.50	-2535.73	-1988.92	49.53
16	2.50	-9.50	198.0	24.0	27	—	-3013.12	1112.24	-3256.69	134.83
					343	—	-1510.50	-2535.73	-1988.92	55.21
17	7.50	-9.50	258.0	24.0	25	—	-2878.04	1112.24	-6251.56	151.35*
					1956	—	-1807.89	-480.22	6173.10	46.87
18	12.50	-9.50	318.0	24.0	25	—	-2878.04	1112.24	-6251.56	169.21*
					1956	—	-1807.89	-480.22	6173.10	29.23
19	-12.50	-13.50	18.0	72.0	551	—	-2737.75	1812.73	4037.93	165.57*
					343	—	-1510.50	-2535.73	-1988.92	17.03
20	-7.50	-13.50	78.0	72.0	551	—	-2737.75	1812.73	4037.93	154.04*
					343	—	-1510.50	-2535.73	-1988.92	22.72
21	-2.50	-13.50	138.0	72.0	525	—	-2869.97	1812.73	1425.42	144.28
					343	—	-1510.50	-2535.73	-1988.92	28.40
22	2.50	-13.50	198.0	72.0	526	—	-2869.97	1812.73	-1975.42	145.06*
					343	—	-1510.50	-2535.73	-1988.92	34.08
23	7.50	-13.50	258.0	72.0	25	—	-2878.04	1112.24	-6251.56	160.61*
					1935	—	-1835.90	-1812.73	4283.80	35.48
24	12.50	-13.50	318.0	72.0	25	—	-2878.04	1112.24	-6251.56	178.48*
					197	—	-1903.26	-1112.24	6249.03	20.76

This is greater than the factored resistance of 145.80 k. So, I should modify my pile arrangement or add more piling. I won't do that at this time.

Footing Design : Notes

* Service Force in pile is greater than service pile capacity.
* Factored Force in pile is greater than factored pile capacity.
Only max. force in piles is considered for design.
Pile coordinates X and Z are from the most left edge of the footing.
Plong= Lateral load in longitudinal direction at the top of pile, Kips.
Php= Available resisting horizontal component due to batter= batter * Vertical pile reaction, Kips.
Plong-Php= Remaining lateral force required to resist by pile.

Max. Pile Reaction Used in Design: (without selfweight and surcharge)

Factored pile reaction	178.48 kips
Service pile reaction	138.48 kips

Note that the maximum factored pile reaction is still 178.48 kips in this table. This is because the footing and fill weight were input as DC1 and EV1 loads rather than entered on the footing tab.

I've included the rest of the footing output, but I'm not really interested in the concrete footing design portion since I entered a 1" thick footing. Footing design is typically done using a spreadsheet.

Reinforcement Schedule

Dir	Quantity	Size	Bar dist. in	As total in^2	Spacing in	Hook
X	20	#8	0.50	15.80	9.11	None
Z	50	#8	0.50	39.50	6.71	None

Flexure

Dir ft	Loc	d in	Mmax kft	Comb	CL	Asb_req in^2	Asb_prv in^2	Asb_eff in^2	Ast_req in^2	Ast_prv in^2	Ast_eff in^2
X	-9.75	-2.00	1963.2	25	T	0.00	0.00	0.00	0.14	15.80	15.80
X	9.75	-2.00	1963.2	25	T	0.00	0.00	0.00	0.14	15.80	15.80
Z	-1.50	-2.00	5354.3	25	T	0.00	0.00	0.00	0.25	39.50	39.50
Z	1.50	-2.00	5354.3	25	T	0.00	0.00	0.00	0.25	39.50	39.50

Flexure Note

CL: Section classification as per LRFD 2006 interims for provided reinforcement.
C = Compression controlled, I = In-Transition, T = Tension controlled.
Required reinforcement is based on phi for tension controlled sections..

Cracking check as per AASHTO LRFD 2007 with Interims (2005)

Cracking/Fatigue

Dir	Loc ft	d in	Cracking Mmax kft	Cracking Comb	Cracking fs ksi	Cracking Srq in	Cracking Spr in	Fatigue Mmax kft	Fatigue Comb	Fatigue fs ksi	Fatigue ratio fs
X	-9.75	-2.00	1523.3	2161	0.00	180.0	0.0	0.0	0	0.00	0.00
X	9.75	-2.00	1523.3	2161	0.00	180.0	0.0	0.0	0	0.00	0.00
Z	-1.50	-2.00	4154.3	2161	0.00	336.0	0.0	0.0	0	0.00	0.00
Z	1.50	-2.00	4154.3	2161	0.00	336.0	0.0	0.0	0	0.00	0.00

One Way Shear (Simplified Method)

Col	Dir	Dist ft	Comb	dv in	Vu kips	phi*Vc kips
1	X	-9.81	25	0.72	713.9 *	13.8
	X	9.81	25	0.72	713.9 *	13.8
	Z	-1.56	25	0.72	2141.7 *	25.8
	Z	1.56	25	0.72	2141.7 *	25.8

One Way Shear Note

* Shear resistance is less than applied shear force. You may increase the footing depth or provide stirrups.

Two Way Shear

#	Bo ft	Ao ft^2	Comb	Avg. dv in	Vu kips	phi*Vc kips
Columns						
1	45.24	59.85	25	0.72	4283.4*	54.2
Piles - max						
1	3.57	0.80	25	0.72	178.5*	6.5
Piles - min						
1	3.57	0.80	25	0.72	178.5*	6.5

Two Way Shear Note

* Shear resistance is less than applied punching force.

TWO WAY SHEAR IN FOOTING IS NOT DESIGNED AND STIRRUPS ARE NOT CONSIDERED.

Spreadsheet for Footing Design

Application to Design Pile Footings

Developed on 10/16/2006
Last Updated on 8/30/2010

DOT refers to the Iowa Department of Transportation.
OBS refers to the Iowa DOT Office of Bridges and Structures

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Please report any spreadsheet errors to the Iowa DOT OBS.

This spreadsheet was developed to aid the design of typical Iowa DOT piers. The Iowa DOT Bridge Design Manual (BDM) should be consulted for the most up-to-date policies.

Description:
The purpose of this spreadsheet is to give the user more versatility when designing pile footings for moment and shear. Thus this spreadsheet is not tied to RC-Pier.

Pile Footing Design

Aashto Lrfd 5.13.3

Footing Length (X direction)	28.000	feet
Footing Width (Z direction)	15.000	feet
Footing Depth (Y direction)	4.000	feet

Column Width or Diameter (X direction)	19.500	feet
Column Depth (Z direction)	3.000	feet

Enter column depth of 0 for round columns.

Pile Diameter, dp	10	inches

28 Day Concrete Strength, f'c	3500	psi

Typically 3500 psi for piers.

Only the pile locations in the positive quadrant should be entered since the pile footing is assumed to be symmetrical. The user should include any piles located on the +X and + Z axes and the pile at the center of the footing if present.

Aashto Lrfd 5.13.3.2 makes provision for the tolerance of actual pile location. Office policy is to ignore this provision in footing design.

Pile Number	Positive x-coord (feet)	Positive z-coord (feet)
1	2.5	2
2	7.5	2
3	12.5	2
4	2.5	6
5	7.5	6
6	12.5	6
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
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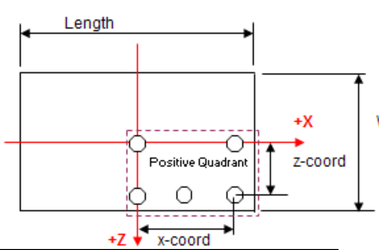
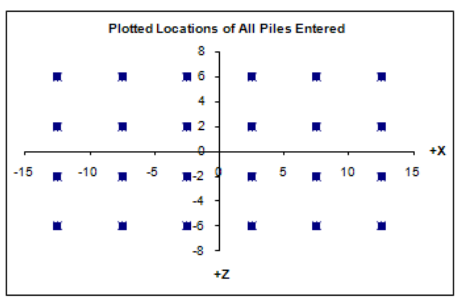
29		
30		



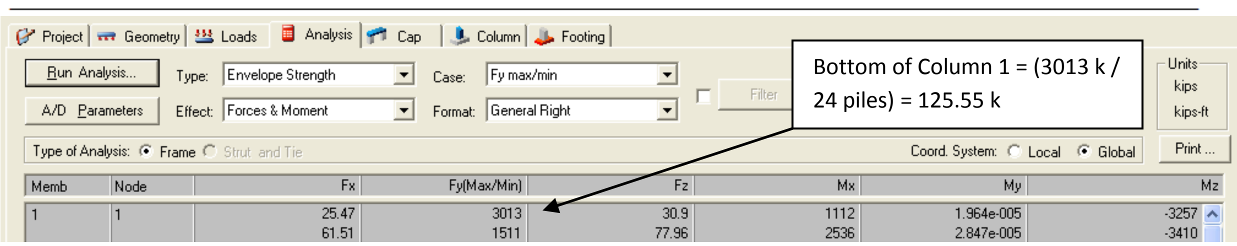


Total Number of Footing Piles	24	
Sx, Pile Section Modulus	80.000	ft
Sz, Pile Section Modulus	140.000	ft

The "Maximum Factored Pile Load, Pu_m" was taken directly from RC-Pier. The "Maximum Factored Average Pile Load, Pu_a" may be found by going to the Analysis tab in RC-Pier (see below).

User Loads for Footing Design			Used for:
Factored Pile Resistance, $R_r = \phi R_n$	145.800	kips	One-way (beam) shear
Maximum Factored Pile Load, Pu_m	178.480	kips	Flexure reinforcement
Maximum Factored Average Pile Load, Pu_a	125.550	kips	Two-way (punching) shear

Note: The user can, according to office policy, deduct the factored bouyant weight of the footing from the pile loads for flexure and shear design. Be sure to deduct only the portion of the load going to one pile. Soil load may not be deducted.



Bottom of Column 1 = (3013 k / 24 piles) = 125.55 k

Flexural Capacity Check Aashto Lrfd 5.7.3.2 and 5.13.3.4

Design Flexural R/I Parallel to X-axis (Mz moments)		
Clearance to Flexural R/I from Bottom of Footing	14.000	in
Number of Bars Required for R/I parallel to X-axis	20	
Flexural R/I Bar Size for bars parallel to X-axis	8	
Bar Diameter for # 8	1.000	in
Bar Area for # 8	0.790	in^2
Total Bar Area	15.800	in^2
Effective Depth for bars parallel to X-axis, de_x or ds_x	33.500	in

Note: de_x corresponds with design for Mz

Flexure Phi Factor, ϕ	0.900	
Factored Applied Moment, Mu_z	1963.280	k*ft
Depth of Equivalent Stress Block, a	1.770	in
Factored Flexural Resistance, $Mr_z = \phi Mn_z$	2318.916	k*ft
Is Mu_z <= Mr_z ?	**Yes**	

Design Flexural R/I Parallel to Z-axis (Mx moments)		
Clearance to Flexural R/I from Bottom of Footing	13.000	in
Number of Bars Required for R/I parallel to Z-axis	50	
Flexural R/I Bar Size for bars parallel to Z-axis	8	
Bar Diameter for # 8	1.000	in
Bar Area for # 8	0.790	in^2
Total Bar Area	39.500	in^2
Effective Depth for bars parallel to Z-axis, de_z or ds_z	34.500	in

Note: de_z corresponds with design for Mx.

Flexure Phi Factor, ϕ	0.900	
Factored Applied Moment, Mu_x	5354.400	k*ft
Depth of Equivalent Stress Block, a	2.371	in
Factored Flexural Resistance, $Mr_x = \phi Mn_x$	5921.657	k*ft
Is Mu_x <= Mr_x ?	**Yes**	

Minimum Reinforcement Check Aashto Lrfd 5.7.3.3.2 and 5.4.2.6

Enter: 1 if de + 2" is to be used to calculate Mcr 2 if the footing depth is to be used to calculate Mcr	1	If 1, then de + 2" is used to calculate Mcr; otherwise, the footing depth is used.
Modulus of Rupture, fr	0.692	ksi

Section Modulus of Concrete Footing, Sz	21.879	ft^3
120% of the Cracking Moment, $1.2{*}Mcr_z$	2617.060	k*ft
Is $1.2{*}Mcr_z$ <= Mr_z ?	**No**	

---- OR ----

As required	13.320	in^2
Is As prov'd >= 1.33*As req'd ?	**No**	

Section Modulus of Concrete Footing, Sx	43.175	ft^3
120% of the Cracking Moment, $1.2{*}Mcr_x$	5164.277	k*ft
Is $1.2{*}Mcr_x$ <= Mr_x ?	**Yes**	

---- OR ----

As required	35.591	in^2
Is As prov'd >= 1.33*As req'd ?	**No**	

Maximum Reinforcement Check Aashto Lrfd 5.5.4.2, 5.7.2.1, and 5.7.3.3

Stress Block Factor, β1	0.850	
Location of Neutral Axis, c	2.083	in
Net Tensile Strain in the Extreme Tension Steel, ε_s	0.045	in/in
Is Section Tension Controlled? ε_s >= 0.005	**Yes**	
Is Section Compression Controlled? ε_s <= 0.002	**No**	
Is Section in Transition? 0.005 > ε_s > 0.002	**No**	
Flexure Phi Factor, ϕ, for Design	0.900	

Stress Block Factor, β1	0.850	
Location of Neutral Axis, c	2.789	in
Net Tensile Strain in the Extreme Tension Steel, ε_s	0.034	in/in
Is Section Tension Controlled? ε_s >= 0.005	**Yes**	
Is Section Compression Controlled? ε_s <= 0.002	**No**	
Is Section in Transition? 0.005 > ε_s > 0.002	**No**	
Flexure Phi Factor, ϕ, for Design	0.900	

NOTE: If section is in Transition, then the user must adjust the Flexural Phi Factor, ϕ, in cell G60 or O60.
If section is Compression Controlled, then do not use this spreadsheet, but the user must do a strain compatability analysis.

Is Flexural R/I Adequate?	**NO, More R/I is Required.**

Is Flexural R/I Adequate?	**YES, Flexural R/I is Adequate.**

As indicated earlier the number of piles is not adequate to resist the maximum pile load. Additionally the existing footing reinforcement is not adequate. Remember that this pier was originally designed based on Aashto Standard Specifications.

Crack Control: Flexure R/I Aashto Lrfd 5.7.3.4.

The requirements of Aashto Lrfd 5.13.3.5 should be included. Spacing should also comply with Aashto Lrfd 5.10.3.1 and 5.10.3.2.
If uplift is present; then, as a minimum, add #5 bars at 12" to the top of the footing in both directions.

Enter: 1 if de + 2" is to be used to calculate cover 2 if the footing dpth is to be used to calculate cover	1	If 1, then de + 2" is to be used to calculate cover; otherwise, the footing depth is used.

Exposure Factor, γ_e	1.000		Exposure Factor, γ_e	1.000	
Concrete Cover Thickness to R/I Center, dc	2.000	in	Concrete Cover Thickness to R/I Center, dc	2.000	in
βs	1.085		βs	1.083	
Maximum Service Pile Load, Ps_m	138.480	kips	Maximum Service Pile Load, Ps_m	138.480	kips
Positive Service Mz	1523.280	k*ft	Positive Service Mz	4154.400	k*ft
See Aashto Lrfd 5.4.2.4 and 5.7.1 for Ec and n			See Aashto Lrfd 5.4.2.4 and 5.7.1 for Ec and n		
Reinforcment Ratio, ρ	0.00262		Reinforcment Ratio, ρ	0.00341	
Concrete Modulus of Elasticity, Ec	3586.616	ksi	Concrete Modulus of Elasticity, Ec	3586.616	ksi
Modular Ratio, n	8.000		Modular Ratio, n	8.000	
Factor for Distance to Neutral Axis, k	0.185		Factor for Distance to Neutral Axis, k	0.208	
Reinforcement Stress at Service Level	36.803	ksi	Reinforcement Stress at Service Level	39.305	ksi
Max. Spacing of Bot Layer of Pos. Flex. R/I, s	**13.526**	in	**Max. Spacing of Bot Layer of Pos. Flex. R/I, s**	**12.447**	in

Crack Control: Skin R/I Aashto Lrfd 5.7.3.4

Is Skin R/I Required ? (Is de = ds > 3.00'?)	**No**		**Is Skin R/I Required ? (Is de = ds > 3.00'?)**	**No**	
Area of Skin R/I Required per Face, Ask	**0.000**	in^2 per ft	**Area of Skin R/I Required per Face, Ask**	**0.000**	in^2 per ft
Max Spacing of Skin R/I Required	**5.583**	in	**Max Spacing of Skin R/I Required**	**5.750**	in

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Shrinkage and Temp. R/I and Structural Mass Concrete Aashto Lrfd 5.10.8

Area of Skin R/I Required per Face, Ask	**0.411**	in^2 per ft	**Area of Skin R/I Required per Face, Ask**	**0.455**	in^2 per ft
Max Spacing of Skin R/I Required	**12.000**	in	**Max Spacing of Skin R/I Required**	**12.000**	in

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Fatigue in R/I Aashto Lrfd 5.5.3

Office policy is to neglect checking fatigue.

Shear Capacity Check Aashto Lrfd 5.8.1.4, 5.13.3.6 and 5.8.3

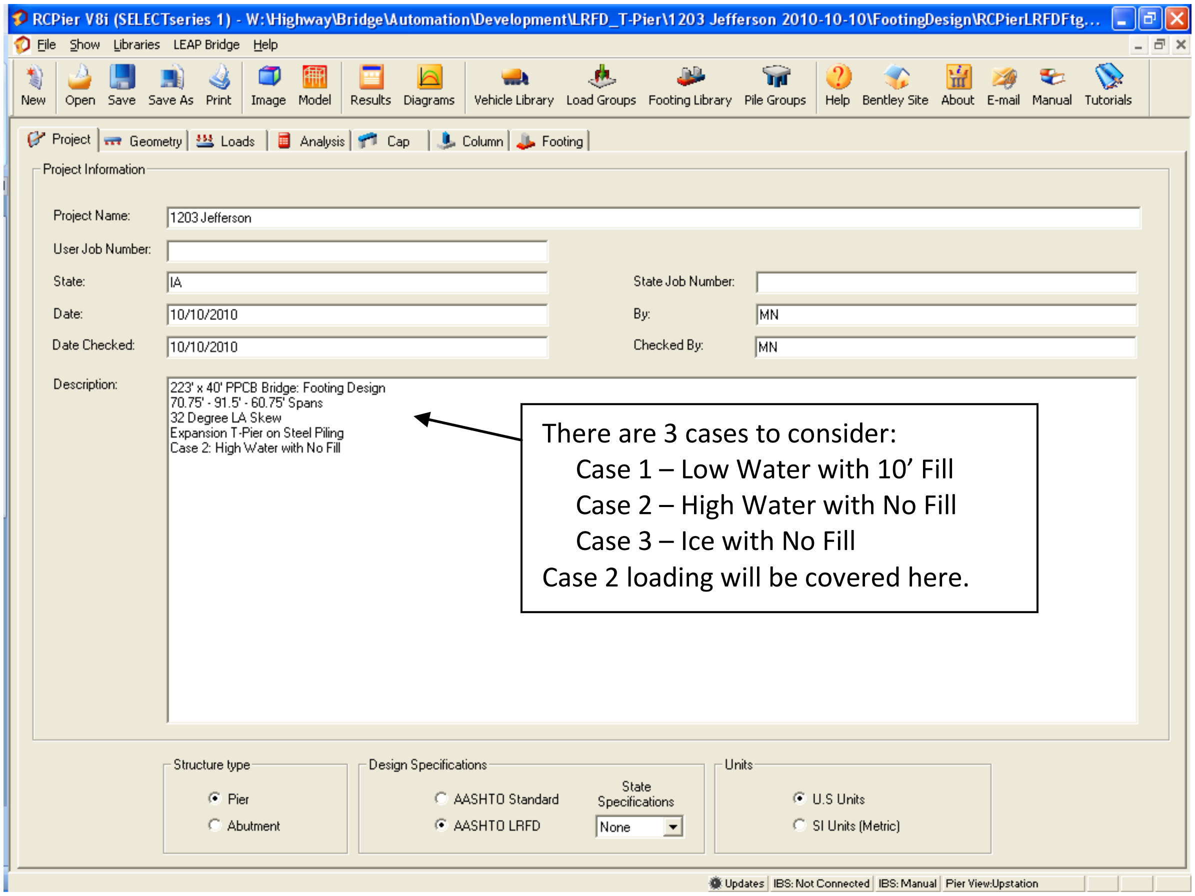
Enter 1 to check dv = 0.72*h. Enter 2 to exclude it.	2		See Aashto Lrfd 5.8.2.9.
Calculated Effective Shear Depth, dv	32.615	in	
User Entry for Effective Shear Depth, dv	32.615	in	

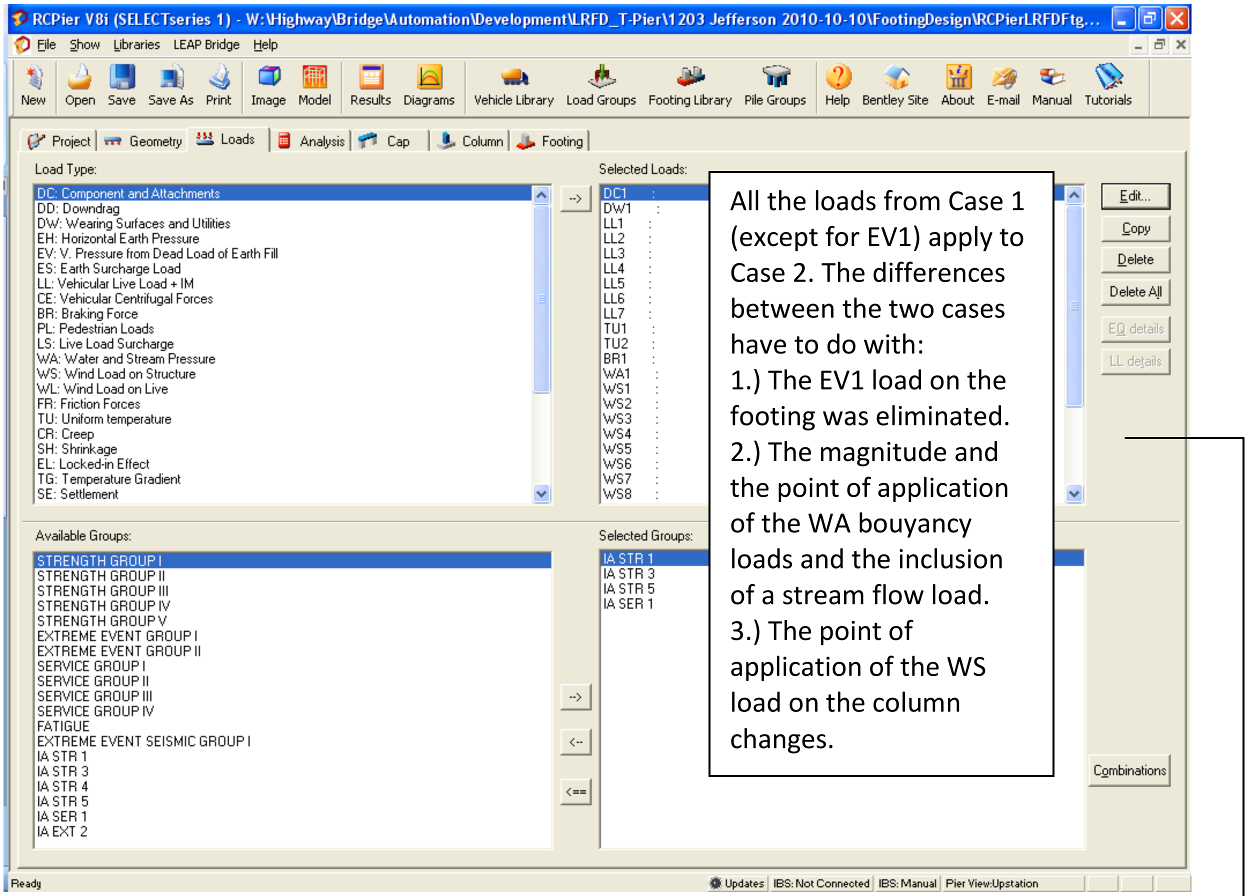
One Way Shear or Beam Shear Parallel to Z-axis			One Way Shear or Beam Shear Parallel to X-axis		
Distance from Column Center to Critical Section	12.468	ft	Distance from Column Center to Critical Section	4.218	ft
Point of 0 Shear to Equivalent Column Face	3.167	ft	Point of 0 Shear to Equivalent Column Face	4.917	ft
Distance of 3*dv	8.154	ft	Distance of 3*dv	8.154	ft
Is Point of 0 Shear to Equivalent Column Face < 3*dv?	YES		Is Point of 0 Shear to Equivalent Column Face < 3*dv?	YES	
If the above is YES then Aashto Lrfd 5.8.3.4.1 may be applied with β = 2.00.			If the above is YES then Aashto Lrfd 5.8.3.4.1 may be applied with β = 2.00.		
Factor for Tens Trans Diagonally Crack'd Concr, β	2.000		Factor for Tens Trans Diagonally Crack'd Concr, β	2.000	
Aashto Lrfd 5.8.3.3 and 5.8.3.4			Aashto Lrfd 5.8.3.3 and 5.8.3.4		
Factored Applied Shear, Vu_x	314.053	k	Factored Applied Shear, Vu_z	874.800	k
Factored Shear Resistance, $Vr_x = \phi Vn_x = \phi Vc_x$	624.717	k	Factored Shear Resistance, $Vr_z = \phi Vn_z = \phi Vc_z$	1166.139	k
Is Beam Shear OK? $Vu_x <= Vr_x$	**YES.**		**Is Beam Shear OK? $Vu_z <= Vr_z$**	**YES.**	

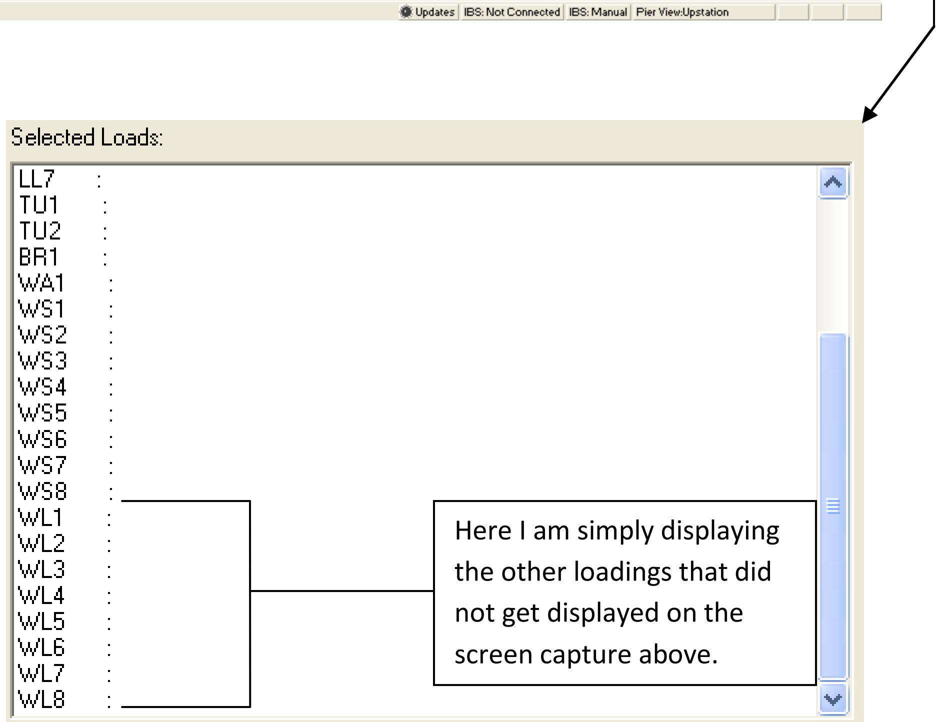
Two Way Shear or Punching Shear			
Distance from Column Center to Critical Section	11.109	ft	Parallel to Z-axis
Distance from Column Center to Critical Section	2.859	ft	Parallel to X-axis
Perimeter of the Critical Section, bo	55.872	ft	
Ratio of Long Side to Short Side, βc	6.500		
Factored Applied Shear, Vu_x	2008.800	k	
Factored Shear Resistance, $Vr_x = \phi Vn_x = \phi Vc_x$	3033.283	k	
Is Punching Shear OK? $Vu_x <= Vr_x$	**YES.**		

<u>Case 2 Loading for Footing Design</u>

RC-Pier screen captures for Case 2 loading for the footing will be provided below. I'm only going to show the differences from the Case 1 loading. The only differences include the WA and WS loadings and the removal of the EV1 load. For this example the maximum pile load for Case 2 will be different from Case 1. The maximum pile load for Case 1 and 2 are 178.48 k and 154.79 k, respectively.

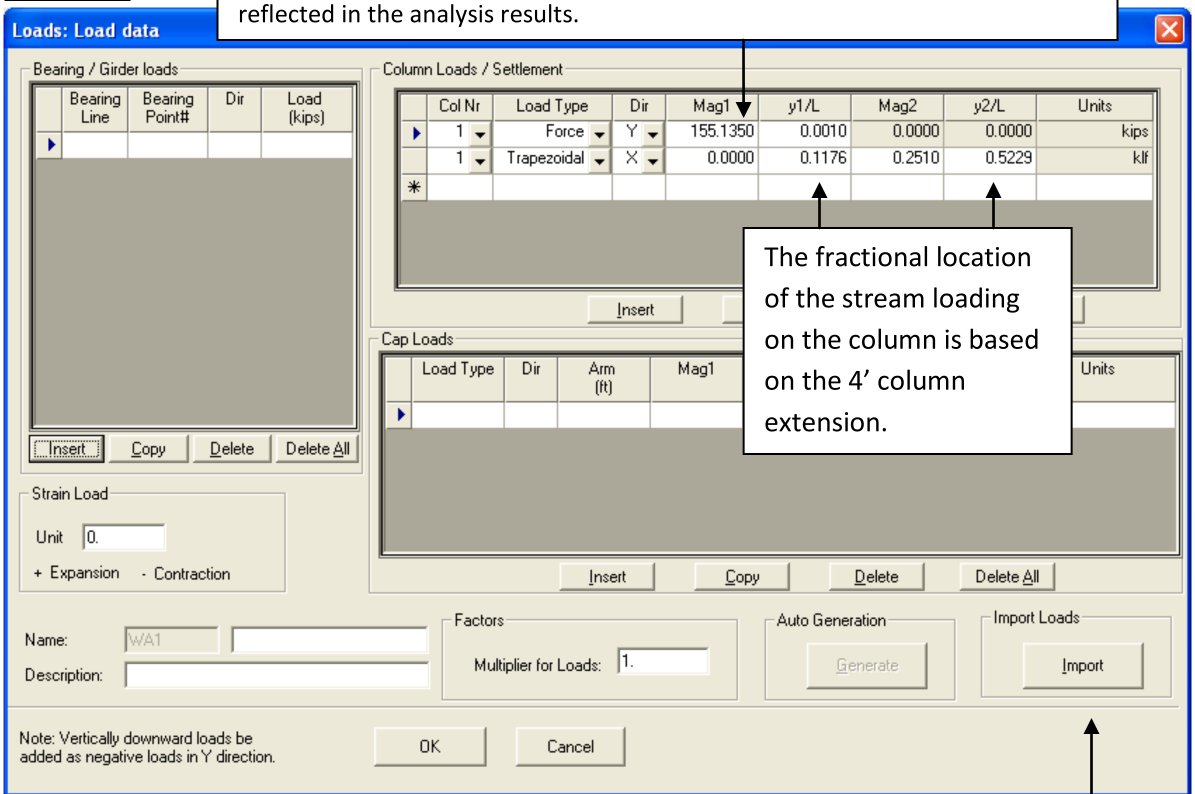



RCPier V8i (SELECTseries 1) - W:\Highway\Bridge\Automation\Development\LRFD_T-Pier\1203 Jefferson 2010-10-10\FootingDesign\RCPierLRFDFtg...
File Show Libraries LEAP Bridge Help
New Open Save Save As Print Image Model Results Diagrams Vehicle Library Load Groups Footing Library Pile Groups Help Bentley Site About E-mail Manual Tutorials
Project Geometry Loads Analysis Cap Column Footing
Load Type:
DC: Component and Attachments
DD: Downdrag
DW: Wearing Surfaces and Utilities
EH: Horizontal Earth Pressure
EV: V. Pressure from Dead Load of Earth Fill
ES: Earth Surcharge Load
LL: Vehicular Live Load + IM
CE: Vehicular Centrifugal Forces
BR: Braking Force
PL: Pedestrian Loads
LS: Live Load Surcharge
WA: Water and Stream Pressure
WS: Wind Load on Structure
WL: Wind Load on Live
FR: Friction Forces
TU: Uniform temperature
CR: Creep
SH: Shrinkage
EL: Locked-in Effect
TG: Temperature Gradient
SE: Settlement
Selected Loads:
DC1 DW1 LL1 LL2 LL3 LL4 LL5 LL6 LL7 TU1 TU2 BR1 WA1 WS1 WS2 WS3 WS4 WS5 WS6 WS7 WS8
Edit... Copy Delete Delete All EQ details LL details
All the loads from Case 1 (except for EV1) apply to Case 2. The differences between the two cases have to do with:
1.) The EV1 load on the footing was eliminated.
2.) The magnitude and the point of application of the WA bouyancy loads and the inclusion of a stream flow load.
3.) The point of application of the WS load on the column changes.
Available Groups:
STRENGTH GROUP I
STRENGTH GROUP II
STRENGTH GROUP III
STRENGTH GROUP IV
STRENGTH GROUP V
EXTREME EVENT GROUP I
EXTREME EVENT GROUP II
SERVICE GROUP I
SERVICE GROUP II
SERVICE GROUP III
SERVICE GROUP IV
FATIGUE
EXTREME EVENT SEISMIC GROUP I
IA STR 1
IA STR 3
IA STR 4
IA STR 5
IA SER 1
IA EXT 2
Selected Groups:
IA STR 1
IA STR 3
IA STR 5
IA SER 1
Combinations
Ready
Updates IBS: Not Connected IBS: Manual Pier View:Upstation


Selected Loads:
LL7 :
TU1 :
TU2 :
BR1 :
WA1 :
WS1 :
WS2 :
WS3 :
WS4 :
WS5 :
WS6 :
WS7 :
WS8 :
WL1 :
WL2 :
WL3 :
WL4 :
WL5 :
WL6 :
WL7 :
WL8 :
Here I am simply displaying the other loadings that did not get displayed on the screen capture above.

WA1

The buoyancy includes the entire submerged footing and the submerged portion of the column (excluding the 4.0’ column extension).
[(28’)*(15’)*(4’)]*(0.0624 kcf) + [(19.5’)*(3’)*(13.78’)]*(0.0624 kcf) = 155.135 k
This load is placed just above the bottom of the column so that it will be reflected in the analysis results.

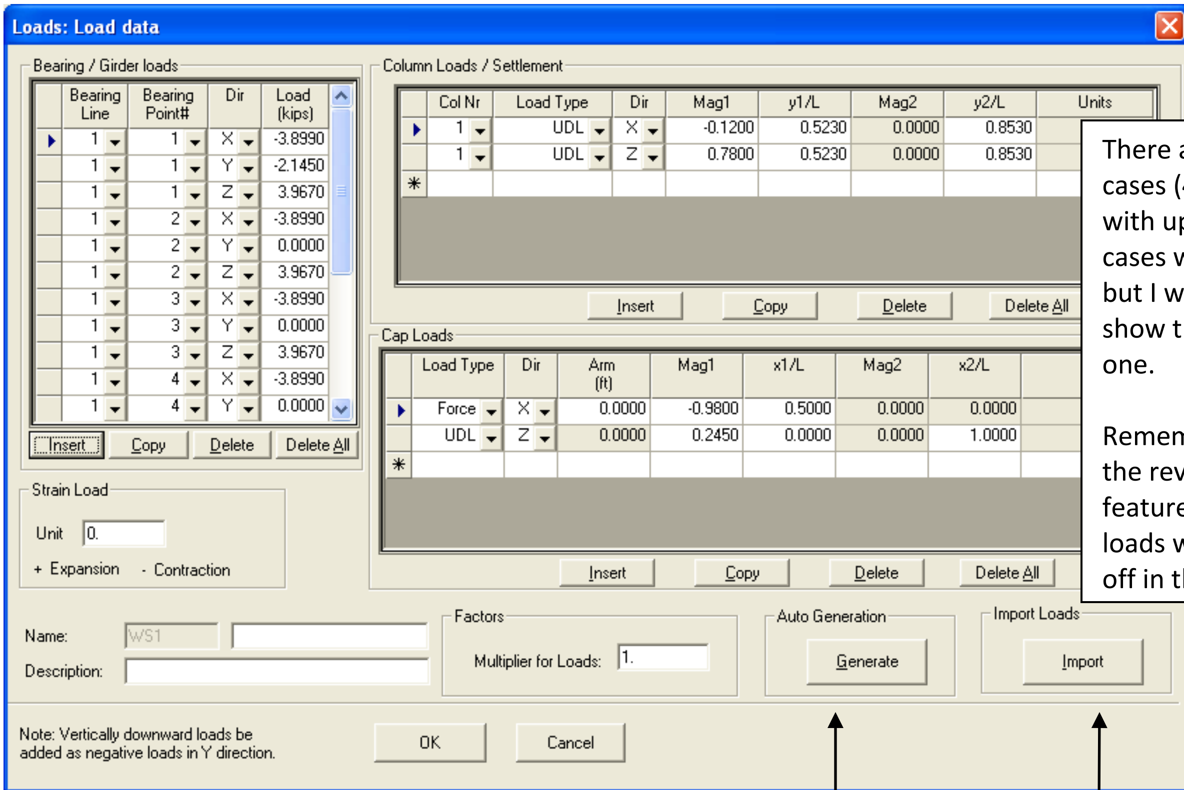


The fractional location of the stream loading on the column is based on the 4’ column extension.

The spreadsheet that was setup to calculate WA loads will not generate standardized text files in order to import the loads.

The water loads that affect the footing design for Case 2 are the buoyancy and stream loads on the column. So, Case 2 is different from Case 1 in that there is a stream flow load and the depth of buoyancy has increased.

WS1



There are 8 WS cases (4 cases with uplift and 4 cases without), but I will only show the first one.

Remember that the reversible feature for wind loads was turned off in the library.

Wind loads can be auto-generated, but generating simplified wind loads requires a few tricks and some editing of the load results.

```
Bearing Loads
1, 1, X, -3.899
1, 1, Y, -2.145
1, 1, Z, 3.967
1, 2, X, -3.899
1, 2, Y, 0
1, 2, Z, 3.967
1, 3, X, -3.899
1, 3, Y, 0
1, 3, Z, 3.967
1, 4, X, -3.899
1, 4, Y, 0
1, 4, Z, 3.967
1, 5, X, -3.899
1, 5, Y, 0
1, 5, Z, 3.967
1, 6, X, -3.899
1, 6, Y, 2.145
1, 6, Z, 3.967
Cap Loads
Force, X, 0, -0.98, 0.5
UDL, Z, 0.245, 0, 1
Column Loads
1, UDL, X, -0.12, 0.523, 0.853
1, UDL, Z, 0.78, 0.523, 0.853
```

The wind loads above were imported from text file “WSLoadsCase2NoUplift001.txt” which was generated from the in-house spreadsheet for wind loads.

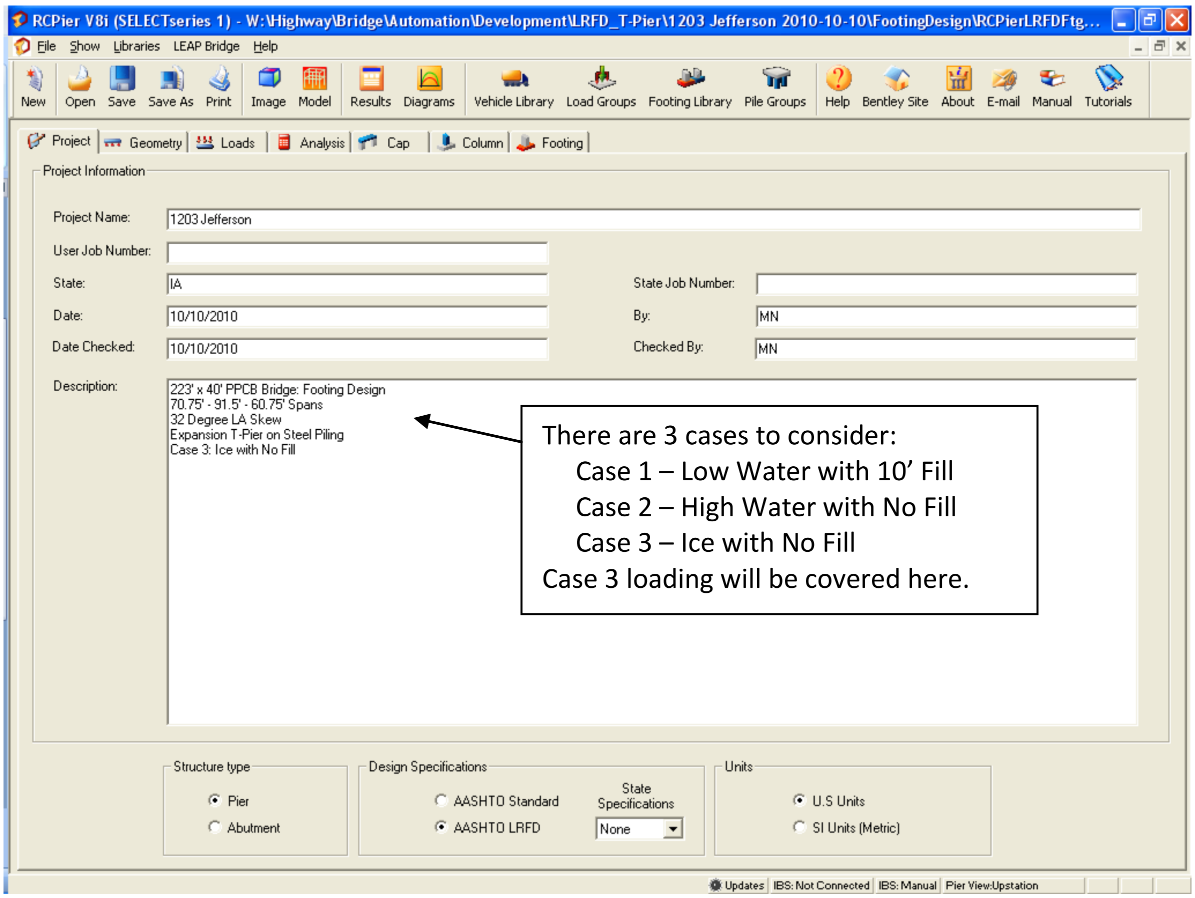
The only difference for Case 2 from Case 1 is the point of application of the wind loads on the column. The water elevation from Case 2 is higher than the fill elevation for Case 1.

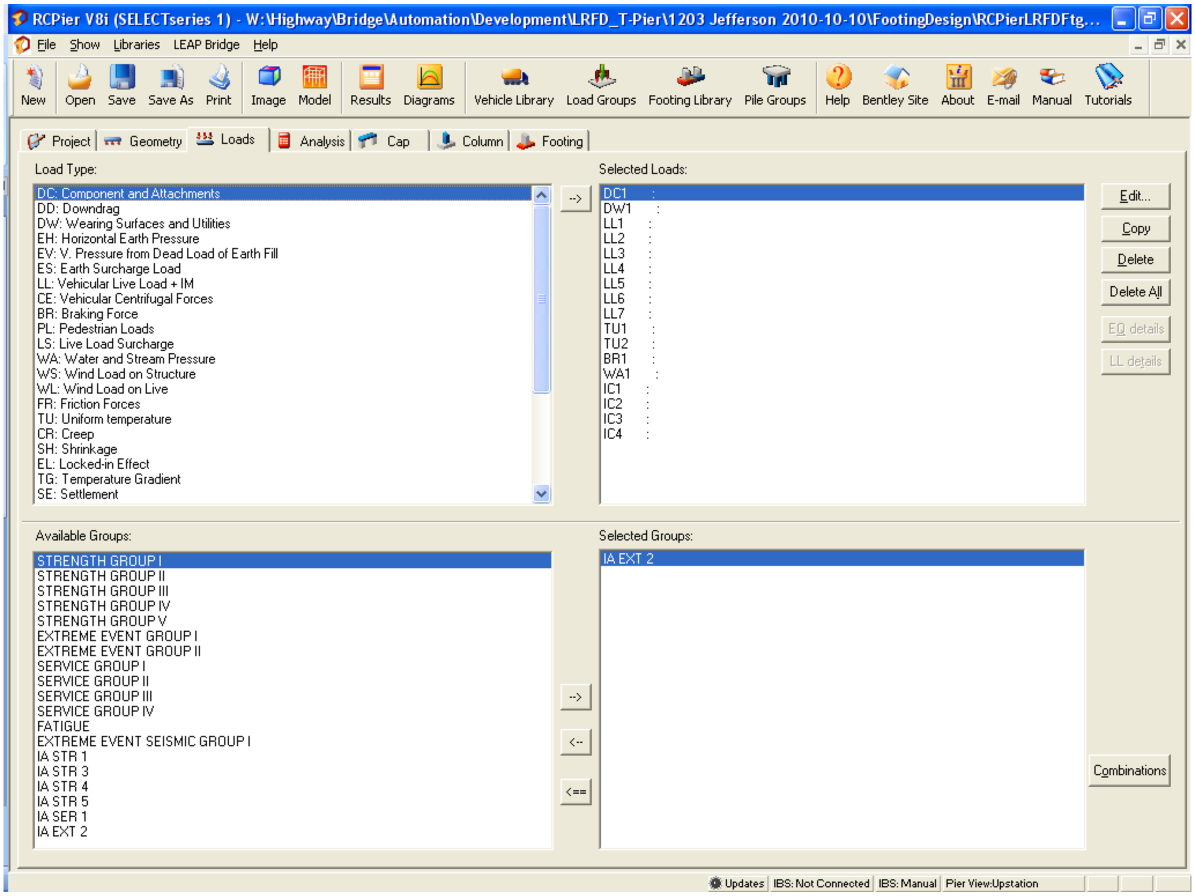
Case 3 Loading for Footing Design

RC-Pier screen captures for Case 3 loading for the footing will be provided below. I'm only going to show the differences from the Case 1 loading. The only differences include:

1.) The Load Group is Extreme Event 2.
2.) Changes to the WA loadings.
3.) All wind loading can be eliminated since it is not part of Extreme Event 2.
4.) Ice loading is added.
5.) EV1 is eliminated because soil is assumed to be scoured away.

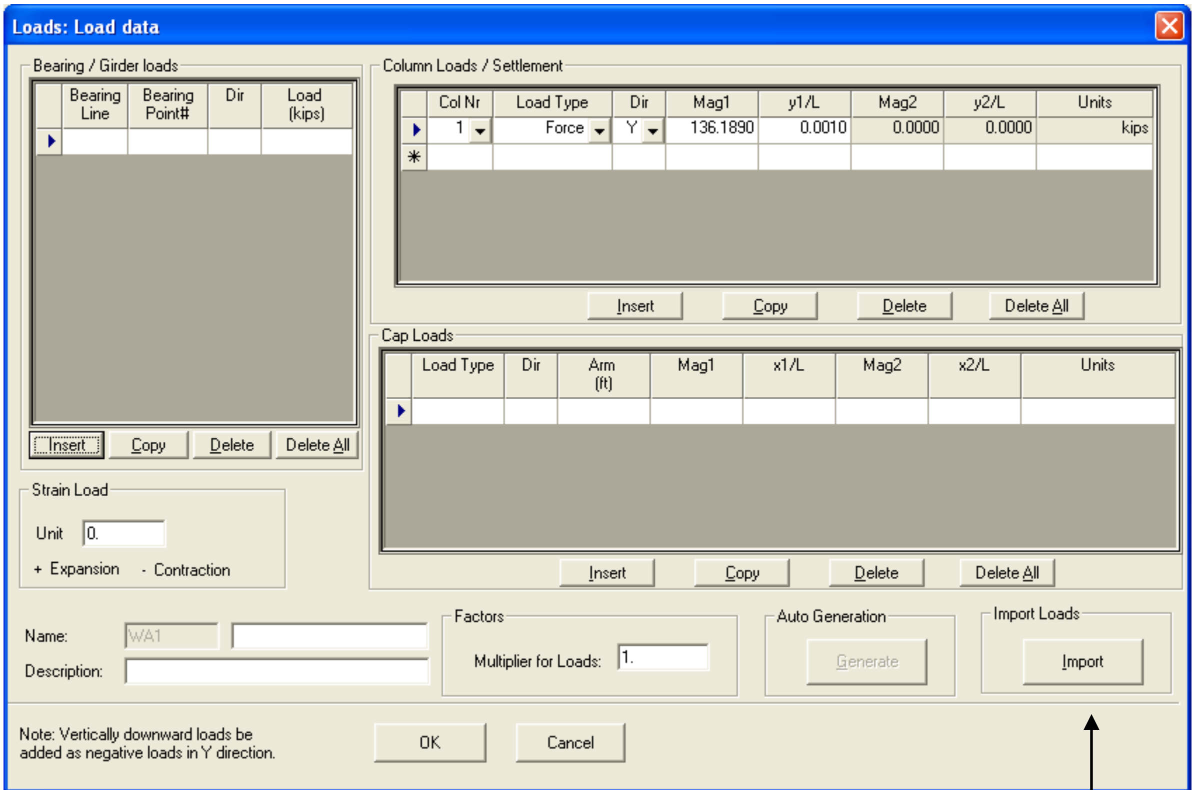
For this example the maximum pile load for Case 1 and 3 are 178.48 k and 114.46 k, respectively.





The DC, DW, LL, TU, and BR loads for Case 3 are the same as those for Case 1. The WA load for Case 3 has been modified from Case 1. The WS and WL loads have been eliminated since Extreme Event 2 does not include those loads. The IC loads were added for Case 3. The EV load was omitted.

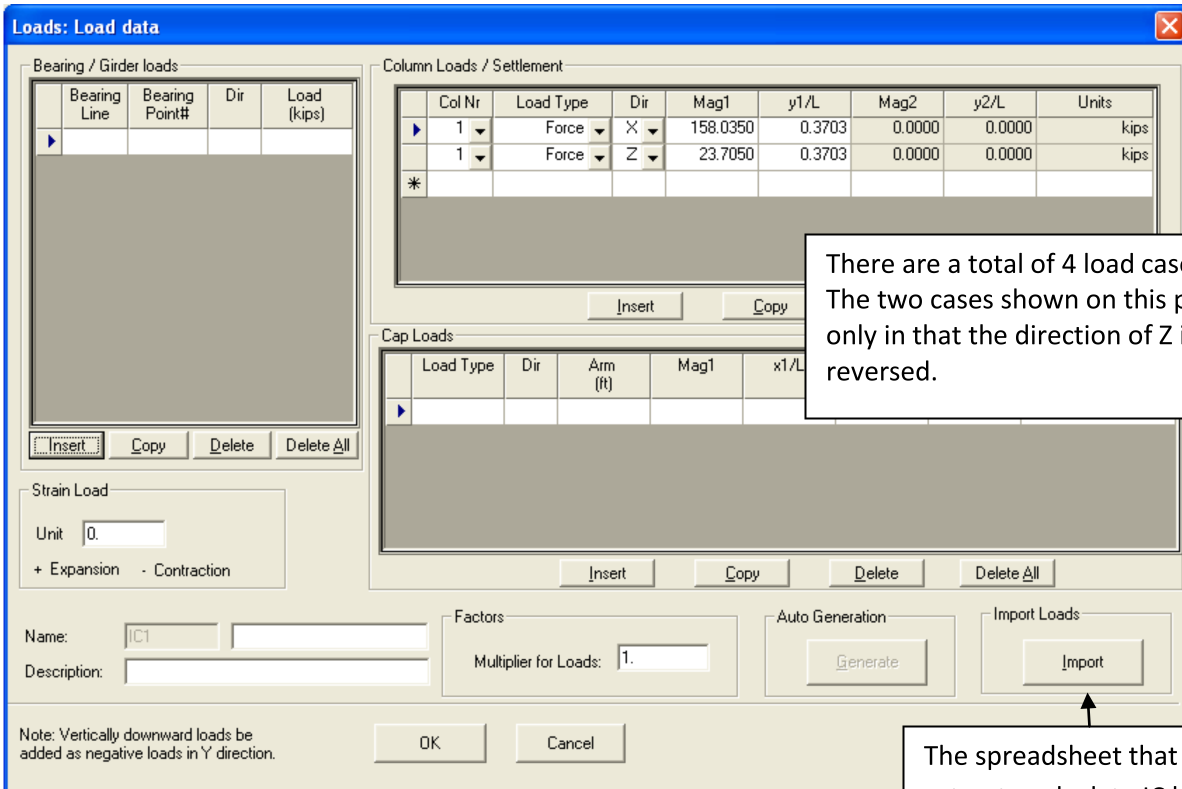
WA1



The water loads that affect the column and cap design for Case 3 are the buoyancy on the column. Case 3 is different from Case 1 in that the depth of buoyancy has increased.

The spreadsheet that was setup to calculate WA loads will not generate standardized text files in order to import the loads.

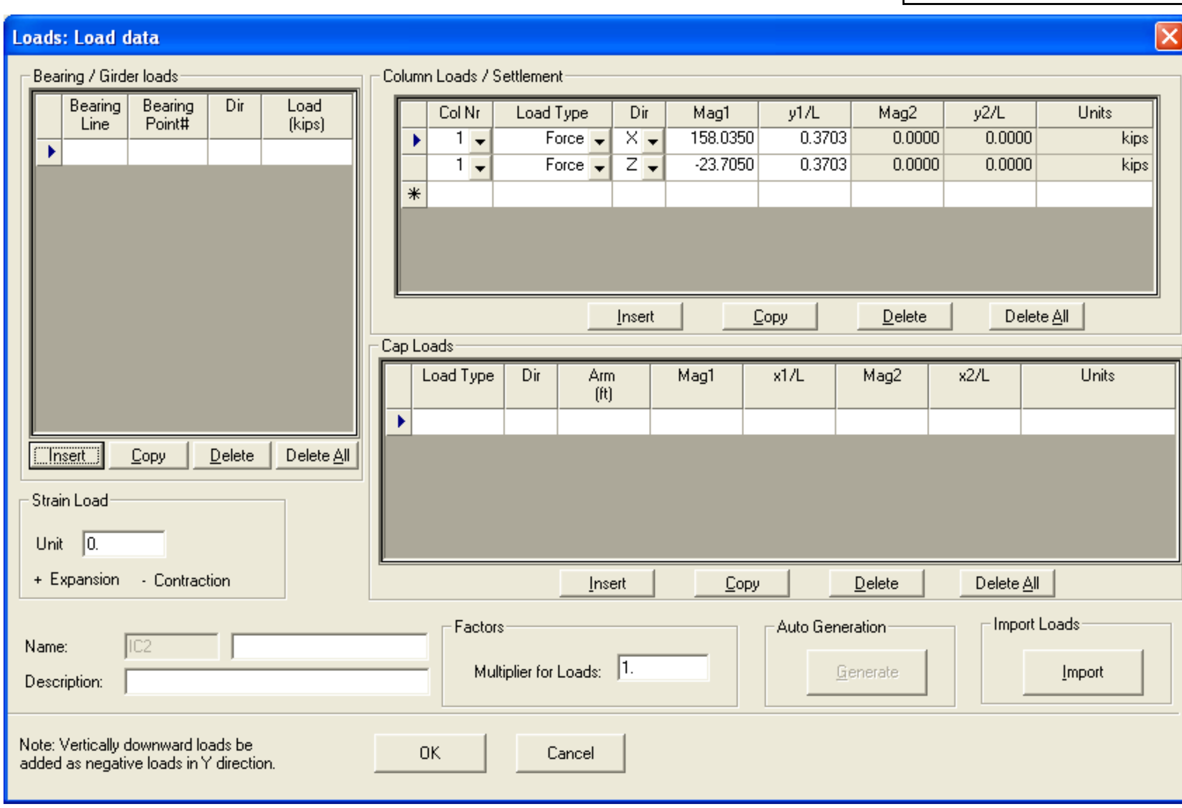
IC1



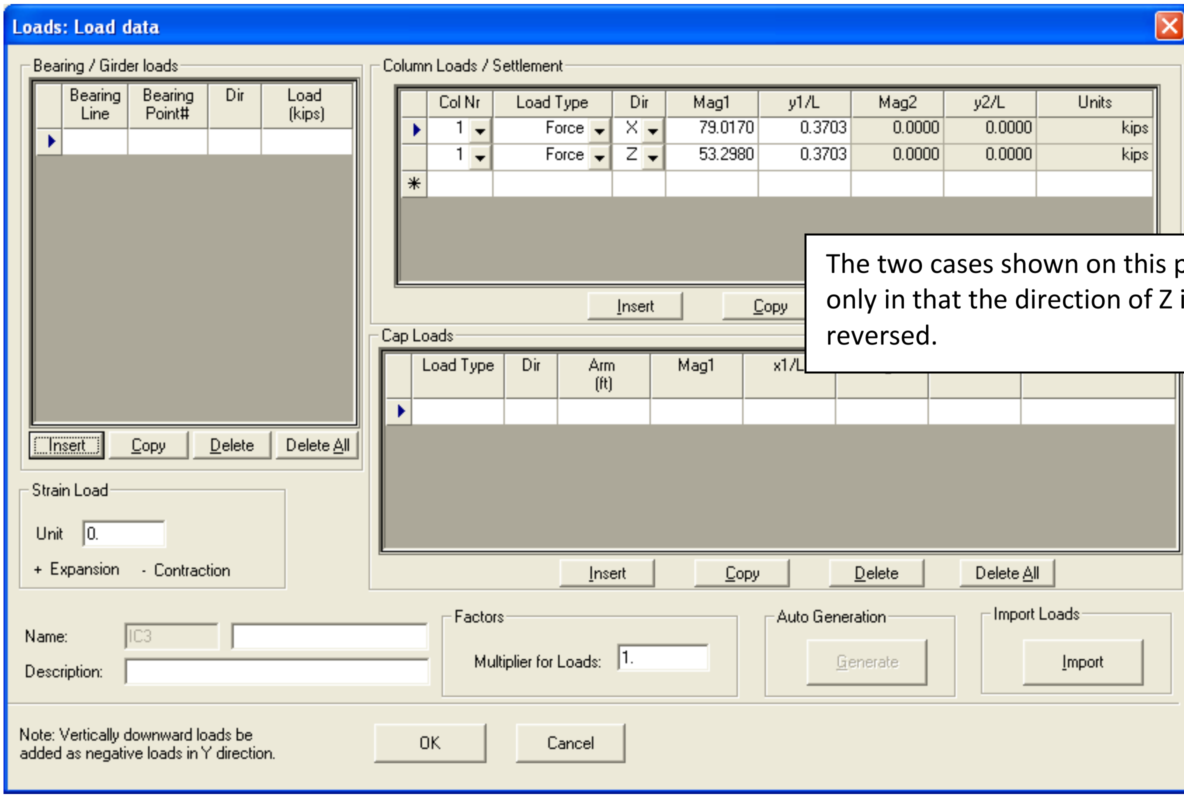
There are a total of 4 load cases for ice. The two cases shown on this page differ only in that the direction of Z ice load is reversed.

The spreadsheet that was setup to calculate IC loads will not generate standardized text files in order to import the loads.

IC2

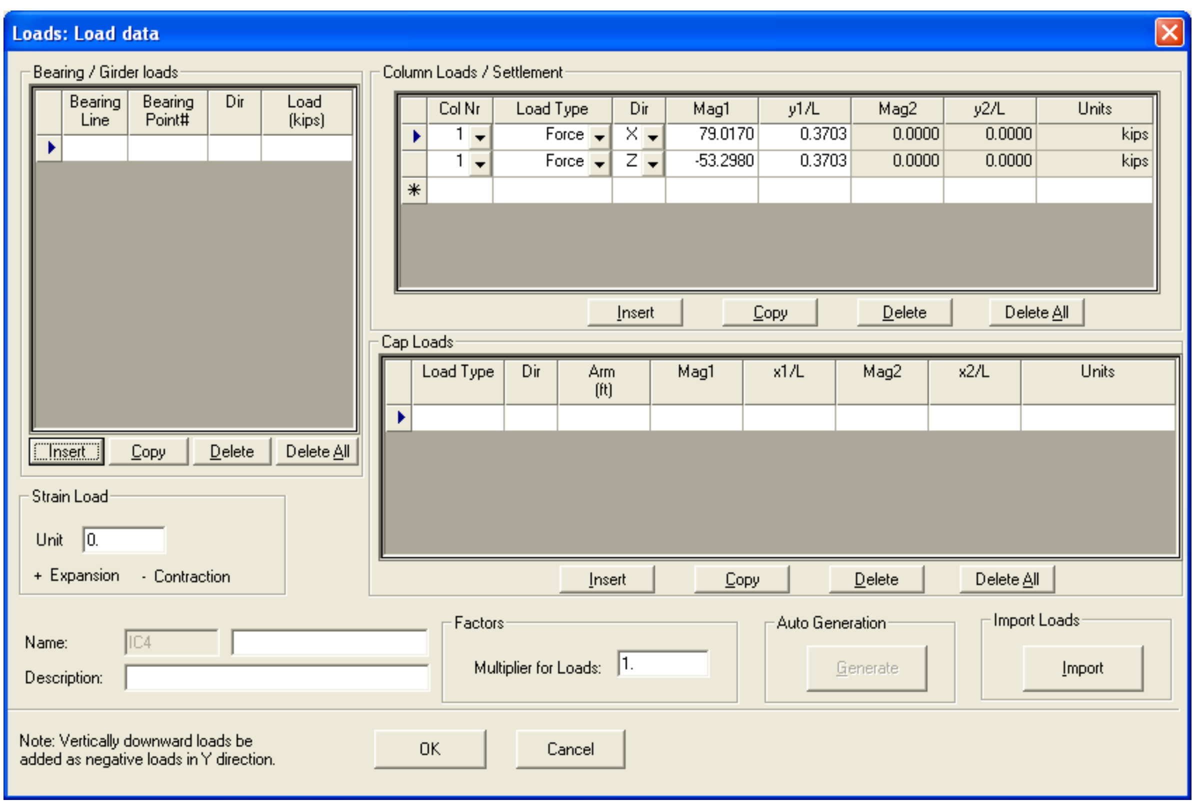


IC3



The two cases shown on this page differ only in that the direction of Z ice load is reversed.

IC4



LETTING DATE 07-18-06

BRIDGE NEW - PPCB
NHSN-034-8(105)--2R-51

JEFFERSON COUNTY

CONVENTIONAL SIGNS

- DIVIDED HIGHWAY
- PAVED ROAD
- BITUMINOUS ROAD
- GRAVEL ROAD
- EARTH ROAD
- INTERSTATE HIGHWAY
- UNITED STATES HIGHWAY
- STATE HIGHWAY
- COUNTY HIGHWAY
- RAILROAD
- PIPELINE
- AIRPORT
- HYDROLOGY
- BRIDGE
- STATE BOUNDARY
- COUNTY BOUNDARY
- CORPORATE LIMIT LINE
- TOWNSHIP LINE
- SECTION LINE

Iowa Department of Transportation
Highway Division

PLANS OF PROPOSED IMPROVEMENTS ON THE

PRIMARY ROAD SYSTEM
JEFFERSON COUNTY
BRIDGE NEW - PPCB
RELOCATED US 34 (FAIRFIELD BYPASS) OVER UNNAMED CREEK

THE IOWA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGE CONSTRUCTION, SERIES 2001, PLUS APPLICABLE GENERAL SUPPLEMENTAL SPECIFICATIONS, DEVELOPMENTAL SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS AND SPECIAL PROVISIONS SHALL APPLY TO CONSTRUCTION WORK ON THIS PROJECT.

VALUE ENGINEERING SAVES. REFER TO THE GENERAL NOTES IN THESE PLANS.

TOTAL SHEETS
45

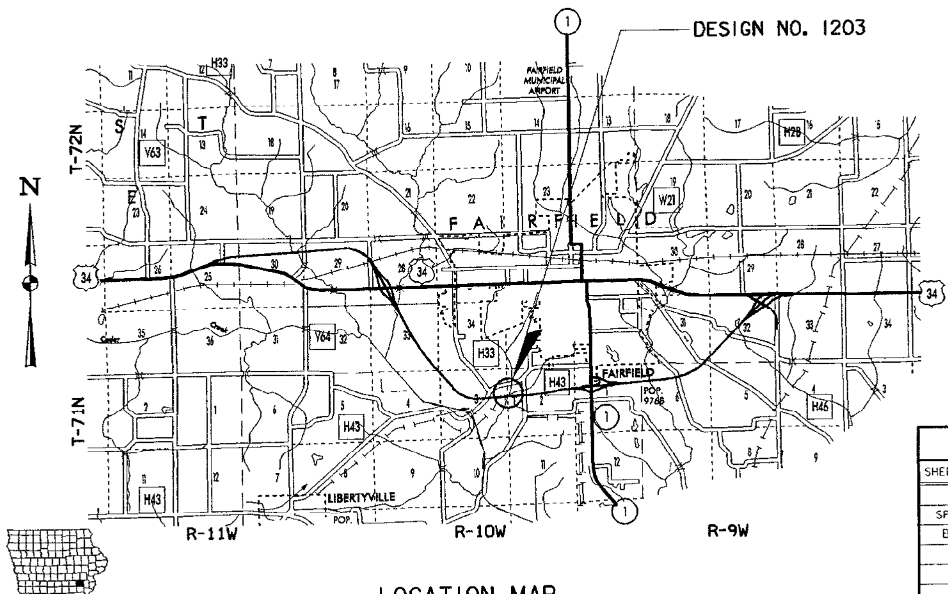
PROJECT NUMBER
NHSN-034-8(105)--2R-51
R.O.W. PROJECT NUMBER
PROJECT IDENTIFICATION NUMBER
94-51-034-030-03

INDEX OF SHEETS

ENGLISH STANDARD BRIDGE PLANS

STANDARD	ISSUED	REVISED

DESIGN NO. 1203



LOCATION MAP

STANDARD ROAD PLANS

STANDARD ROAD PLANS ARE LISTED ON SHEET C.01

DESIGN DATA RURAL

2004	AADT	4090	V.P.D.
2024	AADT	5810	V.P.D.
202	DHV		V.P.H.
TRUCKS		19	%
Total Design ESALs			

REVISIONS

SEE REVISION SHEET

INDEX OF SEALS

SHEET NO.	NAME	TYPE
1	GORDON L. PORT	STRUCTURAL DESIGN
SPS.01	MICHAEL D. RINGLER	GEOTECHNICAL DESIGN
B.01	RICHARD M. VOELKER	ROADWAY DESIGN

STRUCTURAL DESIGN

LICENSED PROFESSIONAL ENGINEER Gordon L. Port 8377 IOWA

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Signature: Gordon L. Port — Date: 04-27-06

Printed or Typed Name: Gordon L. Port

My license renewal date is December 31, 2006

Pages or sheets covered by this seal: SHEETS 1 THRU 33 OF 45

PROJECT DIRECTORY NAME: 51034030A94

LISTING OF PROJECT REVISIONS

DATE	SHEET NUMBER	DESCRIPTION OF REVISIONS	DATE	SHEET NUMBER	DESCRIPTION OF REVISIONS
07-20-06	1A OF 45	REVISION SHEET ADDED.			
07-20-06	2 OF 45	QUANTITIES CHANGED. REASON : INCORRECT.			
07-20-06	7 OF 45	QUANTITY CHANGED. REASON : INCORRECT.			
07-20-06	14 OF 45	NUMBER OF DRAINS CHANGED. REASON : INCORRECT.			

STRUCTURAL DESIGN

LICENSED PROFESSIONAL ENGINEER
Gordon L. Port
8377
IOWA

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Signature: ______ Date: 07-20-06

Printed or Typed Name: Gordon L. Port

My license renewal date is December 31, 2006

Pages or sheets covered by this seal: SHEETS 1, 1A, 2, 7, 14 OF 45

JEFFERSON COUNTY
DESIGN NO. 1203
REVISION SHEET

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN TEAM EDS/GJK/DLB | FILE NO. 29488 | JEFFERSON COUNTY | PROJECT NUMBER NHSN-034-8 (105)--2R-51 | SHEET NUMBER 1A

20-JUL-2006 11:47 rrysavy W:\Projects\51034030A94\BRFinal\51034105_1203.brg 511203s000A \\NTPPRTSVR2\BrgTif

ESTIMATED BRIDGE QUANTITIES BOTH BRIDGES

ITEM NO.	ITEM CODE	ITEM DESCRIPTION	UNIT	WESTBOUND BRIDGE	EASTBOUND BRIDGE	TOTAL	AS BUILT QUANTITY
1	2402-2720000	EXCAVATION, CL 20	CY	460	470	930	
2	2402-2721000	EXCAVATION, CL 21	CY	305	300	605	
3	2403-0100010	STRUCT CONC (BRIDGE)	CY	726.0	730.6	1,456.6	
4	2404-7775000	REINFORC STEEL	LB	~~43,627~~ 43,654	44,263	~~87,890~~ 87,917	
5	2404-7775005	REINFORC STEEL, EPOXY COATED	LB	96,529	96,529	193,058	
6	2407-0580460	BEAM, PPC, LXD60	EACH	6	6	12	
7	2407-0580470	BEAM, PPC, LXD70	EACH	6	6	12	
8	2407-0580490	BEAM, PPC, LXD90	EACH	6	6	12	
9	2408-7800000	STRUCTURAL STEEL	LB	7,106	7,106	14,212	
10	2414-6424110	CONC BARRIER RAIL	LF	500	500	1,000	
11	2501-5425057	PILE, DRIVE STEEL BEAR, HP 10X57	LF	~~900~~ 1,860	~~950~~ 1,910	~~1,850~~ 3,770	
12	2501-5550057	PILE, FURN STEEL BEAR, HP 10X57	LF	~~900~~ 1,860	~~950~~ 1,910	~~1,850~~ 3,770	
13	2501-6335010	PREBORED HOLE	LF	200	200	400	
14	2526-8285000	CONSTRUCTION SURVEY	LS	——	——	1	
15	2533-4980005	MOBILIZATION	LS	——	——	1	

ITEM NO. ESTIMATE REFERENCE INFORMATION

3 INCLUDES FURNISHING AND PLACING SUBDRAIN (INCLUDING EXCAVATION), IN GRANULAR BACKFILL, POROUS BACKFILL AND SUBDRAIN OUTLETS AT ABUTMENTS. INCLUDES ALL PREFORMED EXPANSION JOINT FILLER REQUIRED. INCLUDES FURNISHING AND PLACING ENGINEERING FABRIC, MACADAM STONE, 4"x6" TREATED TIMBERS, ½" DIAMETER STEEL PINS (OR REBARS), AND ALL REQUIRED EXCAVATING, SHAPING AND COMPACTING FOR BRIDGE WING ARMORING. INCLUDES FURNISHING AND PLACING (INCLUDING EXCAVATION) MACADAM STONE AND ENGINEERING FABRIC FOR THE DECK DRAIN SPLASH BASINS. INCLUDES FURNISHING AND PLACING 3" PVC PIPE AND EXPANDING FOAM.

6, 7 & 8 INCLUDES ABUTMENT BEARING MATERIAL AND COIL RODS. INCLUDES LAMINATED BEARING PADS WITH ANCHORED CURVED SOLE PLATES AT PIER 1 AND PLAIN TAPERED NEOPRENE PADS AT PIER 2. GRADATION OF COARSE AGGREGATES FOR PRESTRESSED CONCRETE BRIDGE UNITS SHALL MEET THE REQUIREMENTS OF SECTION 4115 CLASS III DURABILITY. GRADATION OF THE COARSE AGGREGATE SHALL MEET THE REQUIREMENTS OF SECTION 2407.02A.

9 INCLUDES 24 DRAINS AT 106 LBS. PER DRAIN. INCLUDES 1403 LBS. STRUCTURAL STEEL FOR PINTLE PLATES @ PIER 1.

10 INCLUDES 496.0 LIN. FT. OF 2"Φ RIGID STEEL CONDUIT IN NORTH BARRIER RAIL OF WESTBOUND BRIDGE AND SOUTH BARRIER OF EASTBOUND BRIDGE. INCLUDES MATERIAL AND LABOR ASSSOCIATED WITH PROVIDING AND INSTALLING RIGID STEEL CONDUIT, JUNCTION BOXES AND FITTINGS. IF PLACEMENT OF CONCRETE IS DONE BY THE SLIP FORMING METHOD, CLASS BR CONCRETE IS REQUIRED. CAST IN PLACE BARRIER RAILS SHALL USE CLASS C MIX. PRICE BID FOR THIS ITEM SHALL INCLUDE THE COST OF CAST-IN-PLACE FORMS IF REQUIRED FOR PLACEMENT OF THE CONCRETE.

THESE BRIDGE PLANS LABEL ALL REINFORCING STEEL WITH ENGLISH NOTATION (5a1 IS ⅝ INCH DIAMETER BAR). ENGLISH REINFORCING STEEL RECEIVED IN THE FIELD MAY DISPLAY THE FOLLOWING "BAR DESIGNATION". THE "BAR DESIGNATION" IS THE STAMPED IMPRESSION ON THE REINFORCING BARS, AND IS EQUIVALENT TO THE BAR DIAMETER IN MILLIMETERS.

ENGLISH SIZE	BAR DESIGNATION
3	10
4	13
5	16
6	19
7	22
8	25
9	29
10	32
11	36

SPECIFICATIONS:

DESIGN: AASHTO SERIES OF 1996.
CONSTRUCTION: IOWA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGE CONSTRUCTION, SERIES 2001, PLUS APPLICABLE GENERAL SUPPLEMENTAL SPECIFICATIONS, DEVELOPMENTAL SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS FOR CONSTRUCTION SURVEY AND SPECIAL PROVISIONS SHALL APPLY TO CONSTRUCTION WORK ON THIS PROJECT.

DESIGN STRESSES:

DESIGN STRESSES FOR THE FOLLOWING MATERIALS ARE IN ACCORDANCE WITH THE AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, SERIES OF 1996.
REINFORCING STEEL IN ACCORDANCE WITH SECTION 8, GRADE 60.
CONCRETE IN ACCORDANCE WITH SECTION 8, f'c = 3,500 PSI.
PRESTRESSED CONCRETE BEAMS, SEE DESIGN SHEETS 24 THRU 27.
STRUCTURAL STEEL IN ACCORDANCE WITH SECTION 10, ASTM A709 GRADE 36,
PRESTRESSED CONCRETE BEAM BEARINGS SEE DESIGN SHEET 22.

NOTE:
ROADWAY QUANTITIES SHOWN ELSEWHERE IN THESE PLANS.

NOTE:
POLLUTION PREVENTION PLAN SHOWN ELSEWHERE IN THESE PLANS.

REVISED : 07-20-06 ; QUANTITIES CHANGED.

TRAFFIC CONTROL PLAN ON RELOCATED IOWA 34

NOTE : THIS STRUCTURE IS BEING CONSTRUCTED ON A RELOCATION AND THE ROAD WILL NOT BE OPEN TO TRAFFIC UNTIL AFTER COMPLETION OF CONSTRUCTION. REFER TO TRAFFIC CONTROL PLAN SHOWN ELSEWHERE IN THESE PLANS.

GENERAL NOTES :

IT IS THE INTENT OF THESE PLANS TO CONSTRUCT DUAL 223'-0 x 40' PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES AT STATION 356+70.31 (ENGLISH) ON RELOCATED US 34.

THIS BRIDGE IS DESIGNED FOR HS20-44 LOADING PLUS 20 LBS. PER SQUARE FOOT OF ROADWAY FOR FUTURE WEARING SURFACE.

UTILITY COMPANIES WHOSE FACILITIES ARE SHOWN ON THE PLANS OR KNOWN TO BE WITHIN THE CONSTRUCTION LIMITS SHALL BE NOTIFIED BY THE BRIDGE CONTRACTOR OF THE STARTING DATE.

IT SHALL BE THE BRIDGE CONTRACTOR'S RESPONSIBILITY TO PROVIDE SITES FOR EXCESS EXCAVATED MATERIAL. NO PAYMENT FOR OVERHAUL WILL BE ALLOWED FOR MATERIAL HAULED TO THESE SITES.

THE APPROACH FILLS AS SHOWN ARE NOT A PART OF THIS CONTRACT, BUT ARE TO BE IN PLACE BEFORE ABUTMENT PILES ARE DRIVEN. THE BRIDGE CONTRACTOR IS TO LEVEL OFF AND SHAPE THE BERMS TO THE ELEVATIONS AND DIMENSIONS SHOWN. DRESSING OF SLOPES OUTSIDE THE BRIDGE AREA NOT DISTURBED BY THE BRIDGE CONTRACTOR SHALL BE PAID FOR AS EXTRA WORK.

EXCAVATION QUANTITIES FOR THE PIERS AND ABUTMENTS ARE BASED ON THE ASSUMPTION THAT ROADWAY FILL AND SURCHARGES WILL HAVE BEEN COMPLETED PRIOR TO STARTING CONSTRUCTION OF THE PIERS AND ABUTMENTS.

PILES SHALL NOT BE DRIVEN FOR A MINIMUM OF 60 DAYS FOLLOWING COMPLETION OF THE EAST ABUTMENT APPROACH FILLS. THE TIME PERIOD BETWEEN COMPLETION OF FILLS AND OF DRIVING PILES MAY BE CHANGED AS ORDERED BY THE ENGINEER BASED UPON REVIEW OF SETTLEMENT PLATES.

THE BRIDGE CONTRACTOR SHALL PREBORE HOLES FOR ABUTMENT PILES. HOLES SHALL BE BORED TO THE ELEVATIONS SHOWN ON THE "LONGITUDINAL SECTION ALONG CENTERLINE APPROACH ROADWAY" ON DESIGN SHEETS 2 & 3. PILES SHALL BE DRIVEN THROUGH THE HOLES TO AT LEAST THE SPECIFIED DESIGN BEARING.

THE BRIDGE CONTRACTOR IS TO INSTALL SUBDRAINS BEHIND THE ABUTMENTS, SEE DESIGN SHEET 10 FOR DETAILS.

THE BRIDGE CONTRACTOR SHALL NOTE THE STANDARD ABUTMENT DETAILS HAVE BEEN MODIFIED TO OFFSET THE ABUTMENT FOOTING FROM THE WINGWALL TO AID IN TYING THE REINFORCING STEEL BETWEEN THE FOOTING TO WINGWALL AND THE FOOTING TO BACKWALL.

GUARDRAIL IS TO BE PLACED BY OTHERS.

THE BRIDGE CONTRACTOR IS ENCOURAGED TO TAKE FULL ADVANTAGE OF SPECIFICATION 1105.15 -- VALUE ENGINEERING INCENTIVE PROPOSAL. A PAMPHLET AND CONCEPTUAL PROPOSAL FORM WILL BE AVAILABLE AT THE PRECONSTRUCTION CONFERENCE.

THE INFORMATION IN THE "BERM SLOPE LOCATION TABLE" PROVIDES THE LOCATION AND ELEVATION OF FOUR POINTS WHICH CAN BE USED TO LEVEL OFF AND SHAPE THE BERMS TO THEIR FINAL DIMENSIONS. THE 'A' POINTS ARE LOCATED WHERE THE FINISHED GRADE OF THE BERM SLOPE (OR TOP OF SLOPE PROTECTION) MEETS THE TOE OF BERM. 'A1' AND 'A3' ARE LOCATED AT THE EDGE OF THE SLOPE PROTECTION. 'A2' IS ALONG THE ℄ APPROACH ROADWAY. 'B' IS LOCATED AT THE POINT WHERE THE EXTENSION OF THE BERM SLOPE ALONG ℄ APPROACH ROADWAY INTERSECTS WITH THE TOP OF PAVEMENT AT THE ℄ APPROACH ROADWAY.

ALL BATTERED PILES SHALL BE TRIMMED TO A HORIZONTAL LINE TO AID IN THE PLACEMENT OF REINFORCING.

TRANSVERSE GROOVING OR TINING IN THE PLASTIC CONCRETE OF THE BRIDGE DECK (AND BRIDGE APPROACH SECTIONS) IS NOT ALLOWED. LONGITUDINAL GROOVES WILL BE CUT IN THE HARDENED CONCRETE USING A MECHANICAL CUTTING DEVICE. LONGITUDINAL GROOVING WILL NOT BE A PART OF THIS CONTRACT, BUT WILL BE DONE BY OTHERS PRIOR TO OPENING THE BRIDGE TO TRAFFIC.

CONCRETE BARRIER RAILS PLACED USING THE SLIPFORM METHOD WILL REQUIRE THE USE OF A CLASS BR CONCRETE IN ACCORDANCE WITH ARTICLE 2513.03B OF THE STANDARD SPECIFICATIONS. CAST-IN-PLACE BARRIER RAILS SHALL USE CLASS C MIX. CLASS D CONCRETE IS NOT PERMITTED FOR CONCRETE BARRIER RAILS (CAST-IN-PLACE OR SLIPFORMED METHOD).

THIS BRIDGE HAS BEEN CONVERTED FROM METRIC TO ENGLISH FOR DESIGN AND CONSTRUCTION. METRIC VALUES OF STATIONS AND ELEVATIONS WERE DIVIDED BY THE CONVERSION FACTOR 0.3048 TO OBTAIN ENGLISH VALUES. THE ROAD PLANS AND SURVEY REMAINED IN METRIC.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

NOTES AND QUANTITIES

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 1 OF 32 FILE NO. 29488 DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB | JEFFERSON COUNTY | PROJECT NUMBER NHSN-034-8(105)--2R-51 | SHEET NUMBER 2

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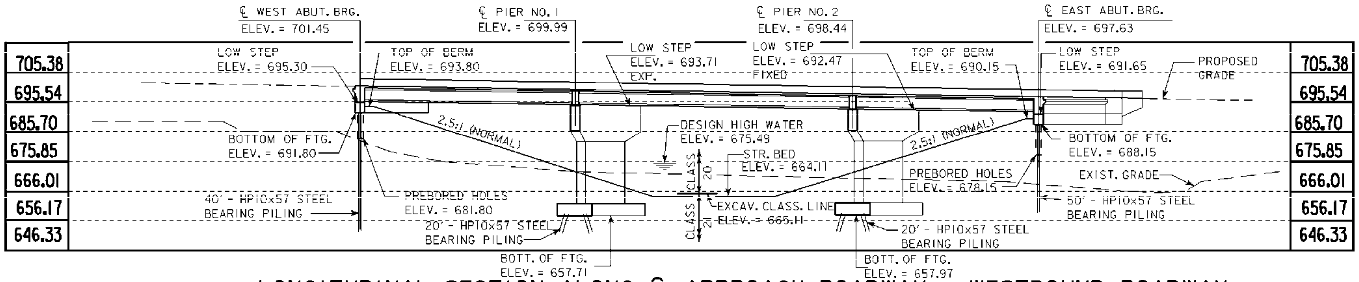
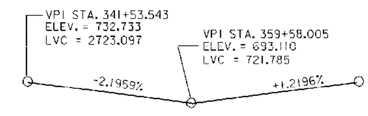
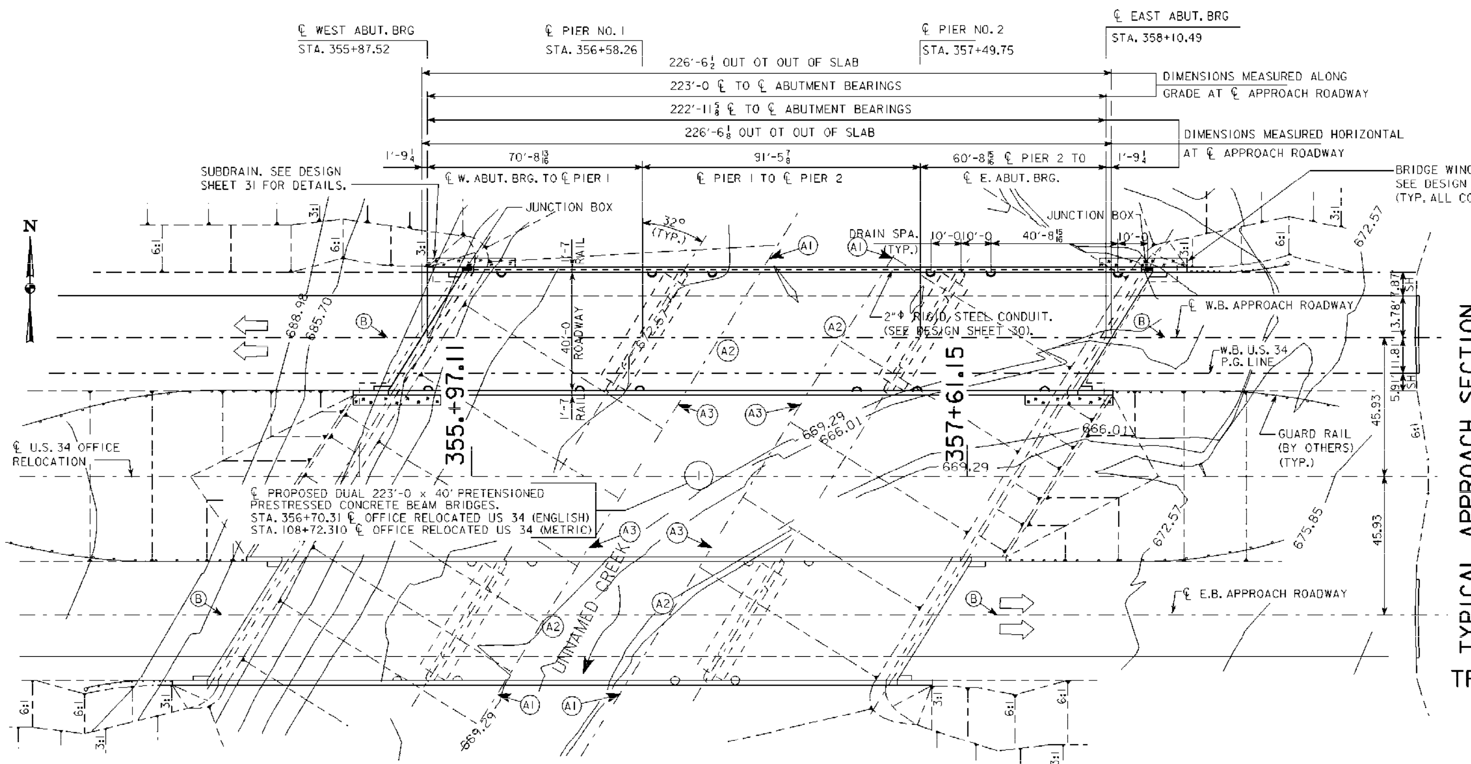


LONGITUDINAL SECTION ALONG ℄ APPROACH ROADWAY - WESTBOUND ROADWAY

BENCH MARK: 20 - 1" x 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 339+36.52, 145.93 LT. ELEV. 732.415.



PROPOSED GRADE
(RELOCATED U.S. 34)



TYPICAL APPROACH SECTION

SITUATION PLAN

NOTE: SEE DESIGN SHEET 3 FOR EASTBOUND BRIDGE.

NOTE:
ALL DIMENSIONS IN FEET UNLESS OTHERWISE NOTED OR SHOWN.

ALL STATIONS AND ELEVATIONS ARE IN FEET (UNLESS OTHERWISE SHOWN).

THIS PLAN IS NOT TO SCALE.

NOTE:
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HYDRAULIC DATA

DRAINAGE AREA = 3.75 sq mi
STREAM SLOPE = 17.424 ft/mi

Q50 = 4308.4 cfs
FREEBOARD = 18.37 ft
MAX BACKWATER DEPTH = .689 ft
NATURAL STAGE AT BRIDGE = 675.49

Q100 = 5155.94 cfs
MAX BACKWATER DEPTH = .98 ft
NATURAL STAGE AT BRIDGE = 676.12
CALCULATED SCOUR = 6.23 ft

LOCATION

U.S. 34 OVER UNNAMED CREEK
T-71 N, R-10W
SECTION 2/3
LIBERTY TWP.
JEFFERSON COUNTY
FHWA NO. 609850 (EB)
FHWA NO. 609855 (WB)

TRAFFIC ESTIMATE

(RELOCATED U.S. 34)

2004: 4,090 VPD
2024: 5,810 VPD
19% TRUCKS

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

SITUATION PLAN - WESTBOUND BRIDGE

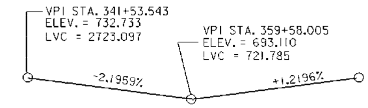
STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

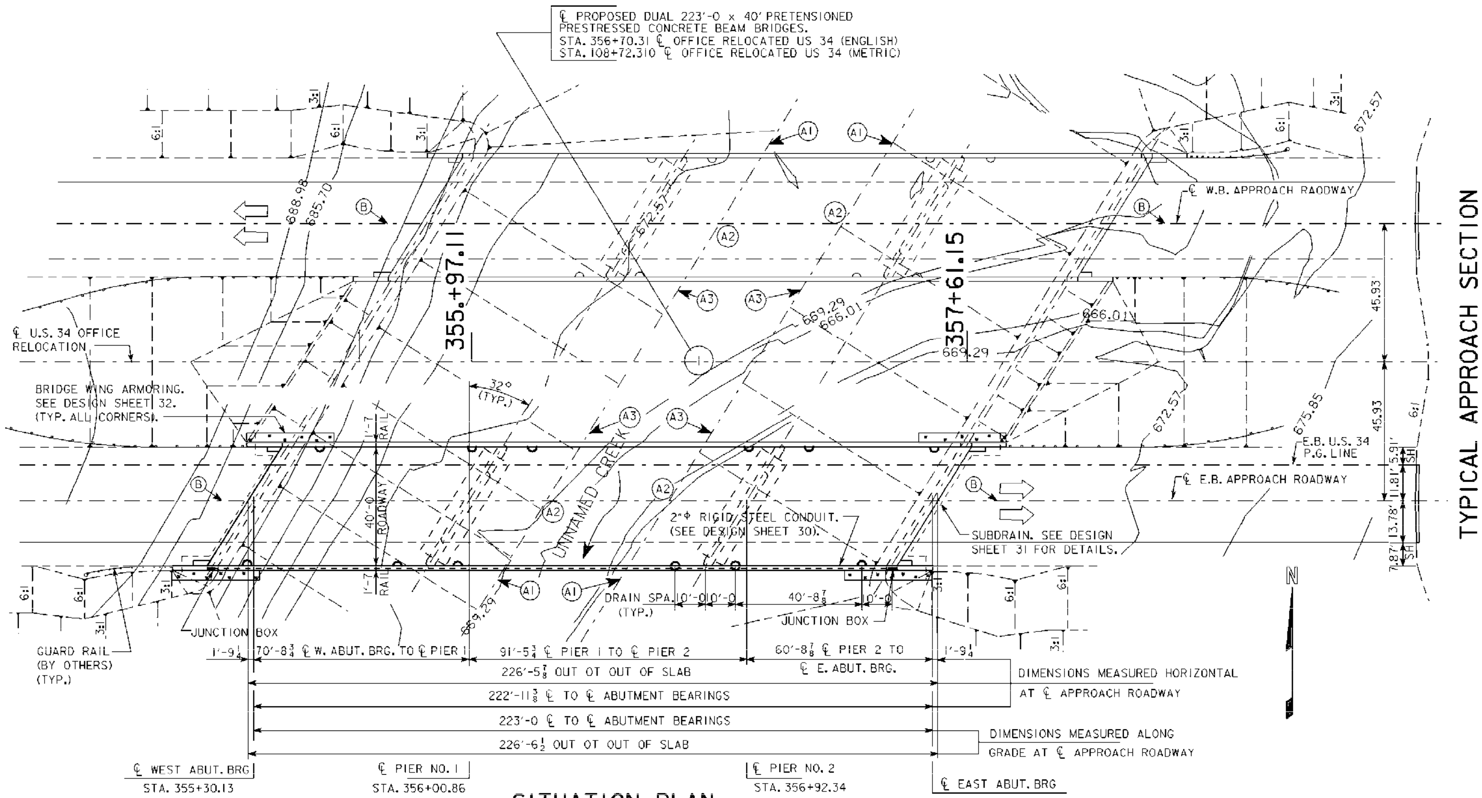
DESIGN SHEET NO. 2 OF 32 FILE NO. 29488 DESIGN NO. 1203

BENCH MARK: 20 - 1" x 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 339+36.52, 145.93 LT. ELEV. 732.415.



PROPOSED GRADE

(RELOCATED U.S. 34)



SITUATION PLAN

NOTE: SEE DESIGN SHEET 2 FOR WESTBOUND BRIDGE.

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LOCATION

U.S. 34 OVER UNNAMED CREEK
T-71 N, R-10W
SECTION 2/3
LIBERTY TWP.
JEFFERSON COUNTY
FHWA NO. 609850 (EB)
FHWA NO. 609855 (WB)

TRAFFIC ESTIMATE

(RELOCATED U.S. 34)

2004: 4,090 VPD
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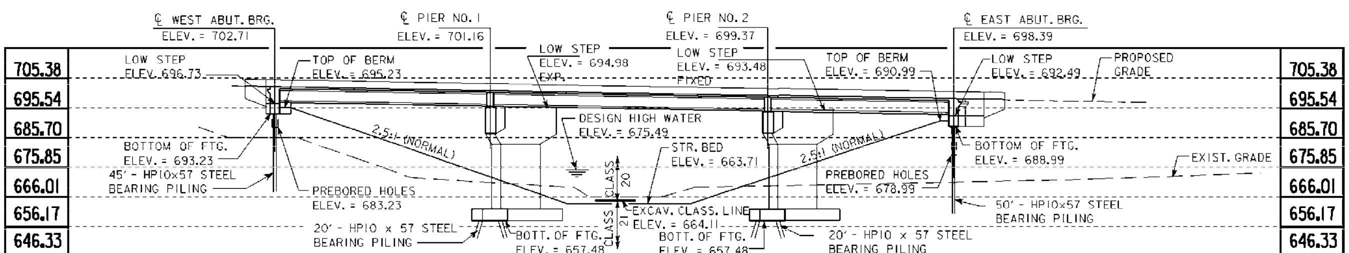
19% TRUCKS



LONGITUDINAL SECTION ALONG ℄ APPROACH ROADWAY - EASTBOUND ROADWAY

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

SITUATION PLAN - EASTBOUND BRIDGE

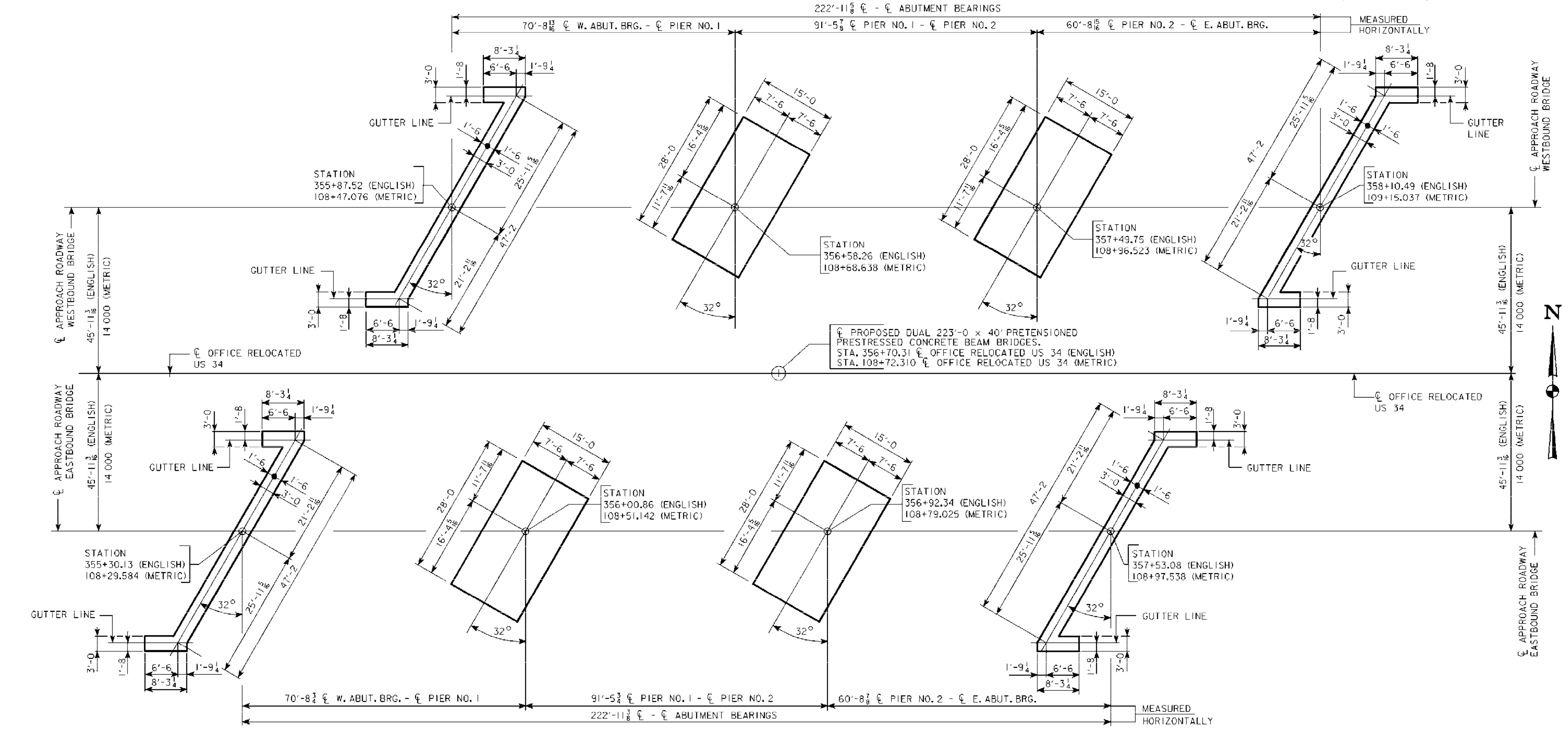
STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION
DESIGN SHEET NO. 3 OF 32 FILE NO. 29488 DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 4

METRIC BENCH MARK: 20 - 1" × 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 103+43.85, 44.479 m LT. ELEV. 223.240.
ENGLISH BENCH MARK: 20 - 1" × 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 339+36.52, 145.93 LT. ELEV. 732.415.



STAKING DIAGRAM

Δ ENGLISH BERM SLOPE LOCATION TABLE

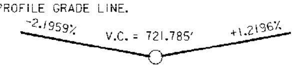
WESTBOUND BRIDGE				EASTBOUND BRIDGE		
	WEST ABUTMENT			WEST ABUTMENT		
	STATION	OFFSET*	ELEVATION	STATION	OFFSET*	ELEVATION
A1	356+95.73	72.51	664.11	356+35.86	72.51	663.71
A2	356+79.33	45.93	664.11	356+21.95	45.93	663.71
A3	356+65.42	23.35	664.11	356+05.54	23.35	663.71
B	355+69.05	45.93	701.89	355+14.27	45.93	703.09
	EAST ABUTMENT			EAST ABUTMENT		
	STATION	OFFSET*	ELEVATION	STATION	OFFSET*	ELEVATION
A1	357+36.35	72.51	664.11	356+76.48	72.51	663.71
A2	357+19.95	45.93	664.11	356+62.53	45.93	663.71
A3	357+06.04	23.35	664.11	356+46.16	23.35	663.71
B	358+26.55	45.93	697.48	357+70.92	45.93	698.17

Δ METRIC BERM SLOPE LOCATION TABLE

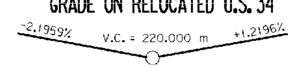
WESTBOUND BRIDGE				EASTBOUND BRIDGE		
	WEST ABUTMENT			WEST ABUTMENT		
	STATION	OFFSET*	ELEVATION	STATION	OFFSET*	ELEVATION
A1	108+80.059	22.101	202.421	108+52.57	22.101	202.299
A2	108+75.060	13.999	202.421	108+57.570	13.999	202.299
A3	108+70.820	7.117	202.421	108+61.81	7.117	202.299
B	108+40.07	13.999	213.936	108+22.99	13.999	214.34
	EAST ABUTMENT			EAST ABUTMENT		
	STATION	OFFSET*	ELEVATION	STATION	OFFSET*	ELEVATION
A1	108+92.439	22.101	202.421	108+64.95	22.101	202.299
A2	108+87.441	13.999	202.421	108+69.939	13.999	202.299
A3	108+83.201	7.117	202.421	108+74.19	7.117	202.299
B	109+19.27	13.999	212.592	109+01.54	13.999	212.82

* OFFSET FROM ℄ U.S. 34 OFFICE RELOCATION

Δ SEE GENERAL NOTES FOR USAGE OF THIS INFORMATION. SEE "SITUATION PLAN" SHEET FOR LOCATIONS OF POINTS A1, A2, A3, A4, A5 & B. THIS INFORMATION REFERENCES PROFILE GRADE LINE.



ENGLISH PROPOSED PROFILE GRADE ON RELOCATED U.S. 34



METRIC PROPOSED PROFILE GRADE ON RELOCATED U.S. 34

NOTE :
THESE BRIDGE HAVE BEEN CONVERTED FROM METRIC TO ENGLISH FOR DESIGN AND CONSTRUCTION. METRIC VALUES OF STATIONS AND ELEVATIONS WERE DIVIDED BY THE CONVERSION FACTOR 0.3048 TO OBTAIN ENGLISH VALUES.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 × 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS — 91'-6 INTERIOR SPAN

STAKING DIAGRAM

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) — MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 4 OF 32 FILE NO. 29488 DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB | JEFFERSON COUNTY | PROJECT NUMBER NHSN-034-8(105)--2R-51 | SHEET NUMBER 5

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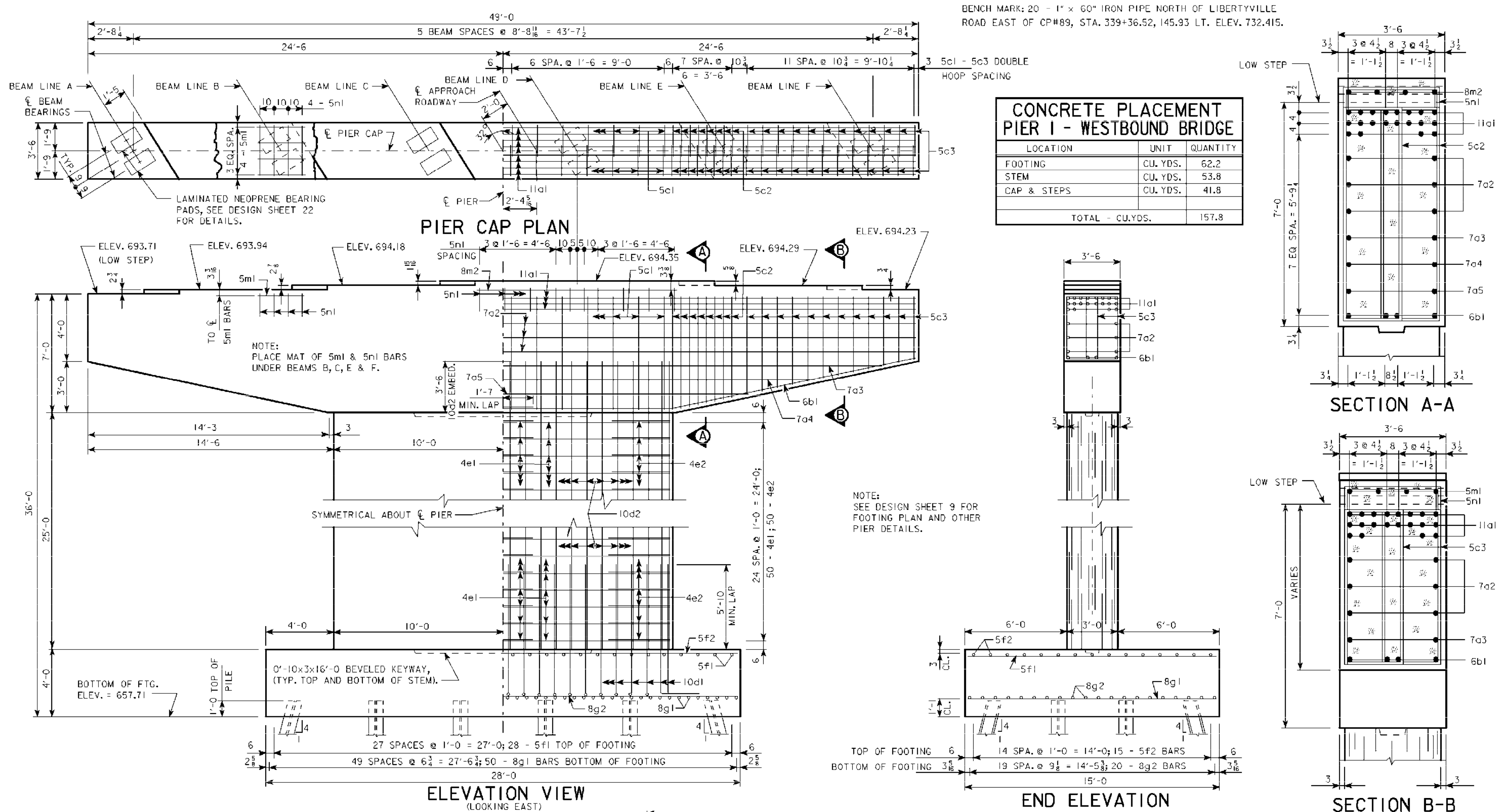
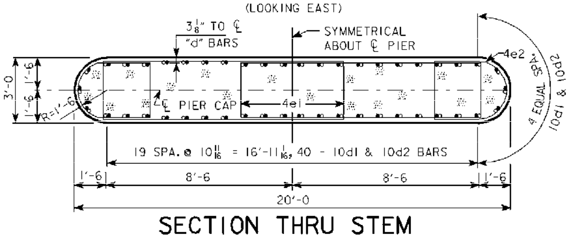
BENCH MARK: 20 - 1" x 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 339+36.52, 145.93 LT. ELEV. 732.415.



CONCRETE PLACEMENT PIER 1 - WESTBOUND BRIDGE

LOCATION	UNIT	QUANTITY
FOOTING	CU. YDS.	62.2
STEM	CU. YDS.	53.8
CAP & STEPS	CU. YDS.	41.8
TOTAL - CU.YDS.		157.8



TOTAL ESTIMATED QUANTITIES PIER 1 - WESTBOUND BRIDGE

ITEM		UNITS	QUANTITY
STRUCTURAL CONCRETE		CU.YDS	157.8
REINFORCING STEEL		LBS.	22,003
HP10x57 STEEL BEARING PILING	FURNISH 24 @ 20'	LIN.FT.	480
	DRIVE 24 @ 20'	LIN.FT.	480
CLASS 20 EXCAVATION		CU.YDS	150
CLASS 21 EXCAVATION		CU.YDS	155

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

WESTBOUND BRIDGE - PIER 1 DETAILS

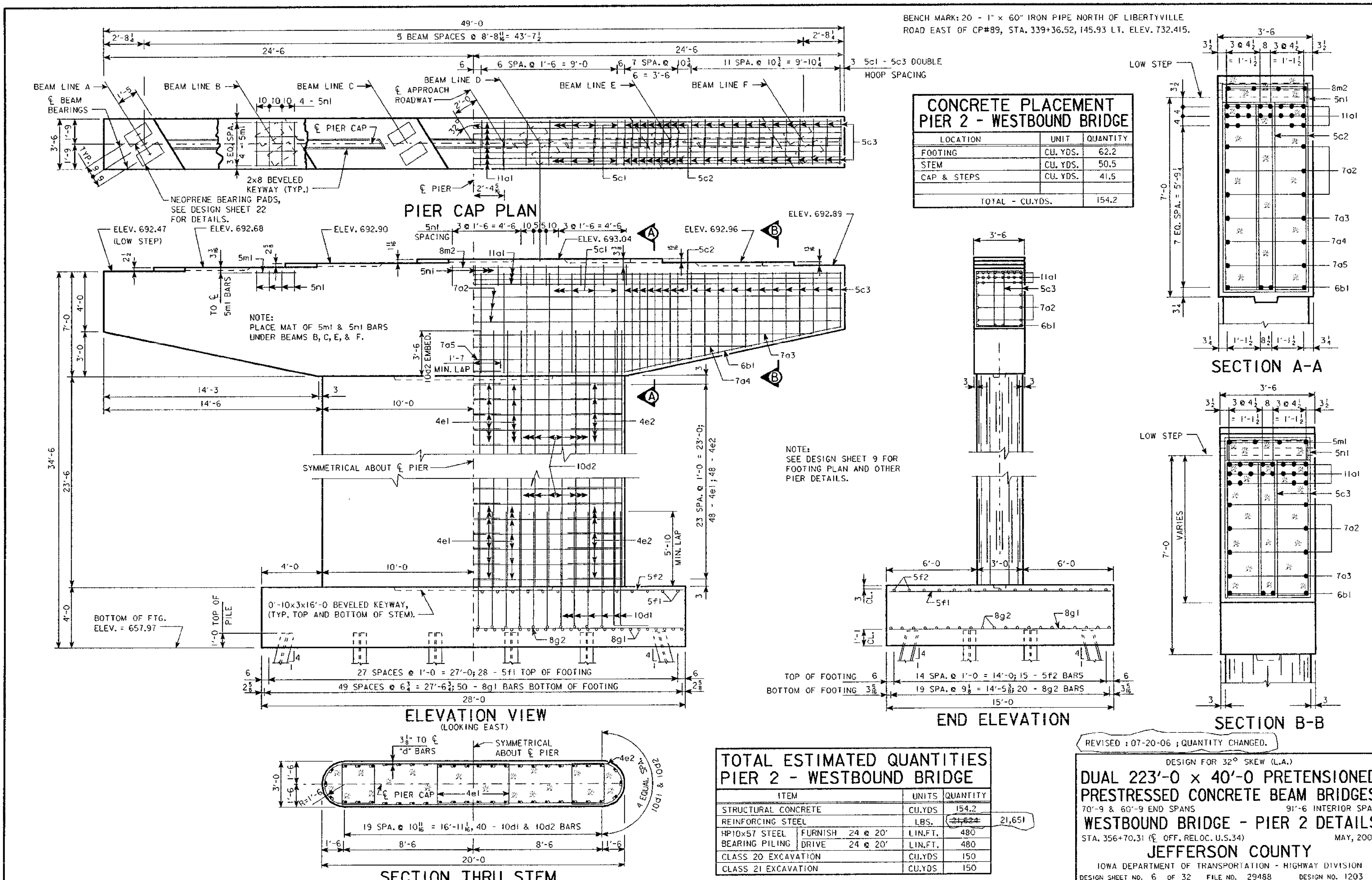
STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 5 OF 32 FILE NO. 29488 DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB | JEFFERSON COUNTY | PROJECT NUMBER NHSN-034-8(105)--2R-51 | SHEET NUMBER 6



CONCRETE PLACEMENT PIER 2 - WESTBOUND BRIDGE

LOCATION	UNIT	QUANTITY
FOOTING	CU. YDS.	62.2
STEM	CU. YDS.	50.5
CAP & STEPS	CU. YDS.	41.5
TOTAL - CU.YDS.		154.2

TOTAL ESTIMATED QUANTITIES PIER 2 - WESTBOUND BRIDGE

ITEM		UNITS	QUANTITY
STRUCTURAL CONCRETE		CU.YDS	154.2
REINFORCING STEEL		LBS.	~~21,624~~ 21,651
HP10x57 STEEL BEARING PILING	FURNISH 24 @ 20'	LIN.FT.	480
	DRIVE 24 @ 20'	LIN.FT.	480
CLASS 20 EXCAVATION		CU.YDS	150
CLASS 21 EXCAVATION		CU.YDS	150

REVISED : 07-20-06 ; QUANTITY CHANGED.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

WESTBOUND BRIDGE - PIER 2 DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

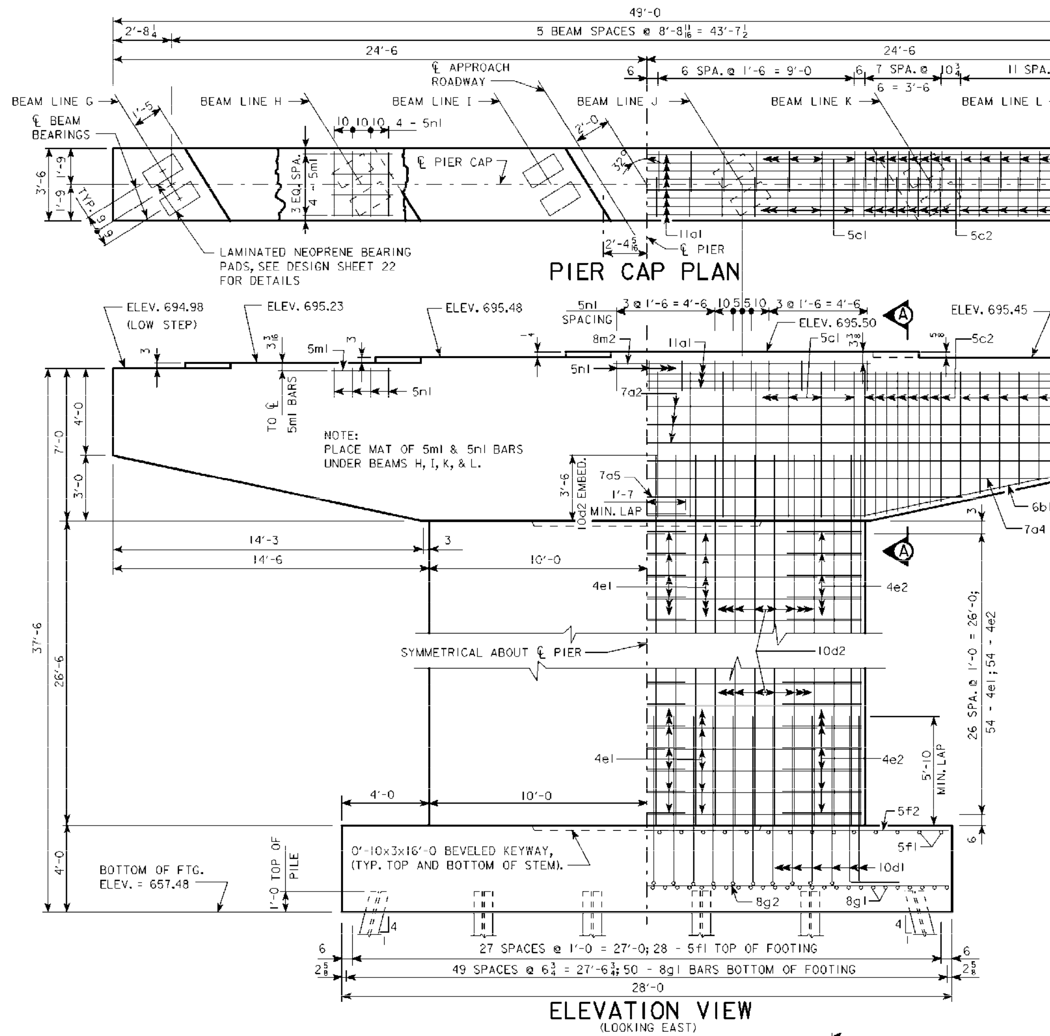
JEFFERSON COUNTY

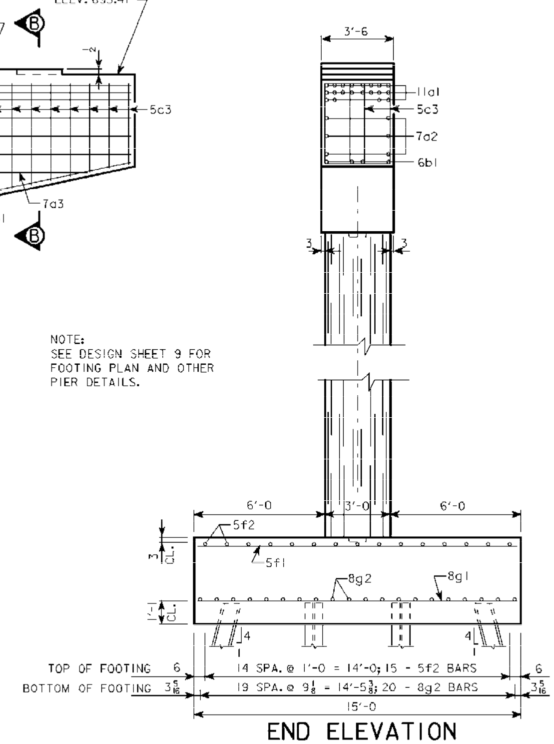
IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

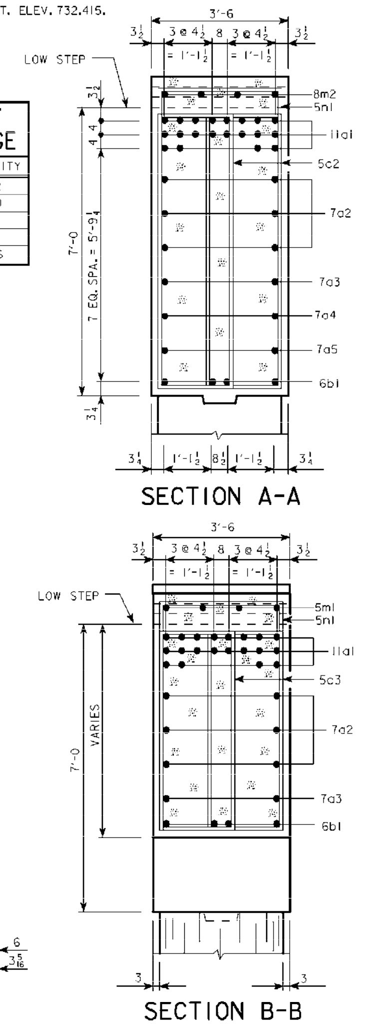
DESIGN SHEET NO. 6 OF 32 FILE NO. 29488 DESIGN NO. 1203

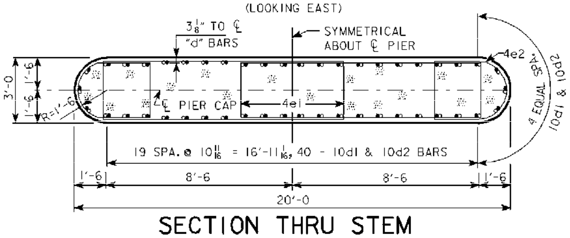
DESIGN TEAM EDS/GJK/DLB | JEFFERSON COUNTY | PROJECT NUMBER NHSN-034-8(105)--2R-51 | SHEET NUMBER 7

BENCH MARK: 20 - 1" x 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 339+36.52, 145.93 LT. ELEV. 732.415.









CONCRETE PLACEMENT
PIER 1 - EASTBOUND BRIDGE

LOCATION	UNIT	QUANTITY
FOOTING	CU. YDS.	62.2
STEM	CU. YDS.	57.0
CAP & STEPS	CU. YDS.	41.4
TOTAL - CU.YDS.		160.6

TOTAL ESTIMATED QUANTITIES
PIER 1 - EASTBOUND BRIDGE

ITEM		UNITS	QUANTITY
STRUCTURAL CONCRETE		CU.YDS	160.6
REINFORCING STEEL		LBS.	22,411
HP10x57 STEEL BEARING PILING	FURNISH 24 @ 20'	LIN.FT.	480
	DRIVE 24 @ 20'	LIN.FT.	480
CLASS 20 EXCAVATION		CU.YDS	155
CLASS 21 EXCAVATION		CU.YDS	150

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

EASTBOUND BRIDGE - PIER 1 DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 7 OF 32 FILE NO. 29488 DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB | JEFFERSON COUNTY | PROJECT NUMBER NHSN-034-8(105)--2R-51 | SHEET NUMBER 8

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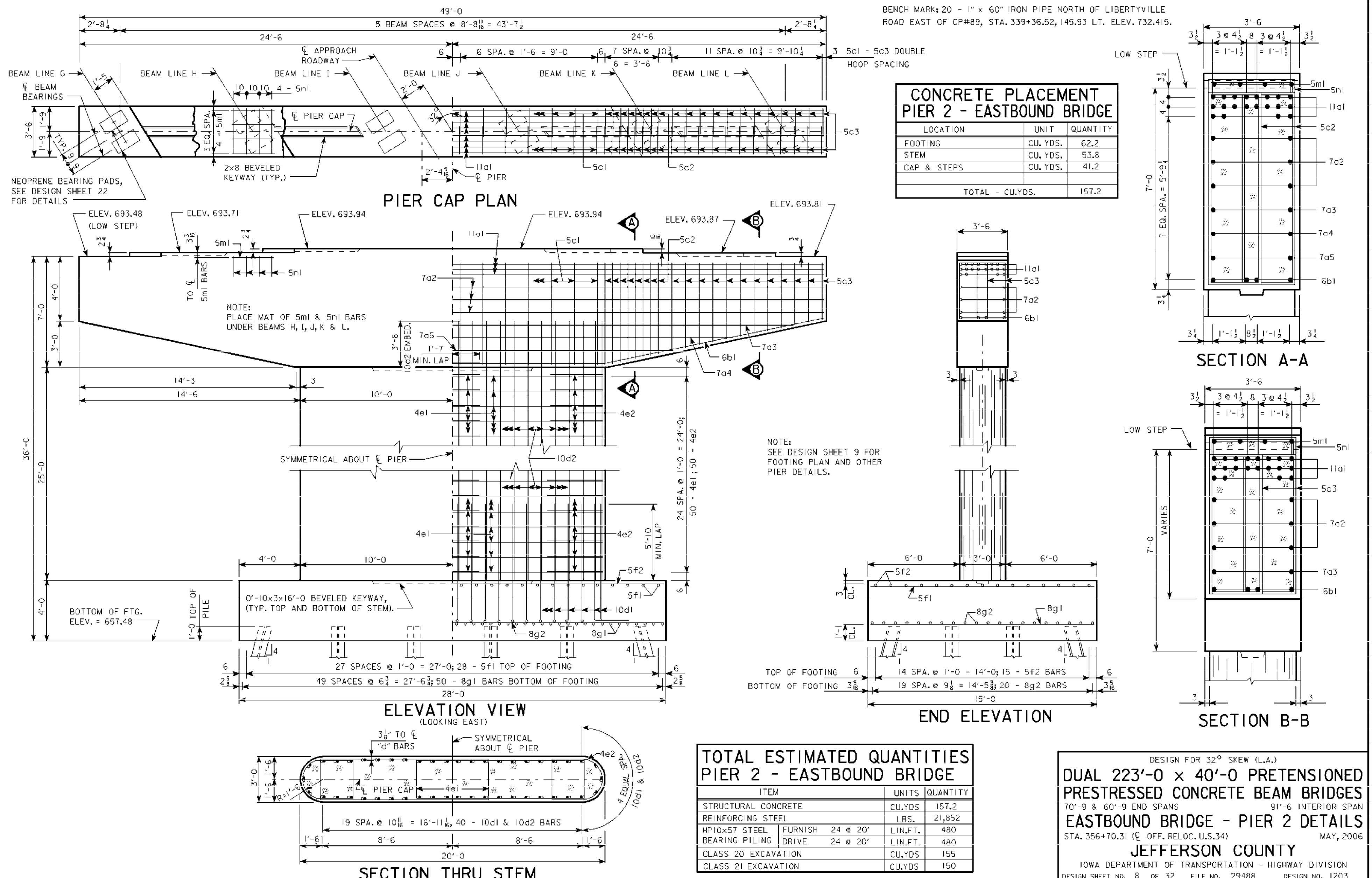

CONCRETE PLACEMENT
PIER 2 - EASTBOUND BRIDGE

LOCATION	UNIT	QUANTITY
FOOTING	CU. YDS.	62.2
STEM	CU. YDS.	53.8
CAP & STEPS	CU. YDS.	41.2
TOTAL - CU.YDS.		157.2

TOTAL ESTIMATED QUANTITIES
PIER 2 - EASTBOUND BRIDGE

ITEM		UNITS	QUANTITY
STRUCTURAL CONCRETE		CU.YDS	157.2
REINFORCING STEEL		LBS.	21,852
HP10x57 STEEL BEARING PILING	FURNISH 24 @ 20'	LIN.FT.	480
	DRIVE 24 @ 20'	LIN.FT.	480
CLASS 20 EXCAVATION		CU.YDS	155
CLASS 21 EXCAVATION		CU.YDS	150

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

EASTBOUND BRIDGE - PIER 2 DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 8 OF 32 FILE NO. 29488 DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB | JEFFERSON COUNTY | PROJECT NUMBER NHSN-034-8(105)--2R-51 | SHEET NUMBER 9

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REINF. BAR LIST - EASTBOUND PIER 1

BAR	LOCATION	SHAPE	NO.	LENGTH	WEIGHT
11a1	CAP, LONGIT., TOP	—	20	48'-8	5171
7a2	CAP, LONGIT., SIDES	—	6	48'-8	597
7a3	CAP, LONGIT., SIDES	—	2	44'-8	183
7a4	CAP, LONGIT., SIDES	—	2	36'-9	150
7a5	CAP, LONGIT., SIDES	—	2	28'-10	118
6b1	CAP, LONGIT., BOTTOM	⟋	4	26'-2	157
5c1	CAP HOOPS	□	28	18'-5	538
5c2	CAP HOOPS, CANTILEVER	□	32	VARIES	591
5c3	CAP HOOPS, CANTILEVER	□	48	VARIES	730
10d1	FOOTING TO STEM DOWELS	L	46	10'-7	2095
10d2	STEM, VERTICAL	—	46	30'-0	5938
4e1	STEM HOOPS	▭	54	28'-0	1010
4e2	STEM TIES AT ENDS	⊃	54	13'-6	487
5f1	FOOTING, TRANSV. - TOP	—	28	14'-8	428
5f2	FOOTING, LONGIT. - TOP	—	15	27'-8	433
8g1	FOOTING, TRANSV. - BOTTOM	—	50	14'-8	1958
8g2	FOOTING, LONGIT. - BOTTOM	—	20	27'-8	1477
5m1	CAP, STEPS, LONGIT.	—	16	3'-0	50
8m2	CAP, STEPS, LONGIT.	—	4	11'-7	124
5n1	CAP, STEPS, TRANSV.	⊓	26	6'-6	176
	REINFORCING STEEL TOTAL - (LBS.)				22,411

REINF. BAR LIST - EASTBOUND PIER 2

BAR	LOCATION	SHAPE	NO.	LENGTH	WEIGHT
11a1	CAP, LONGIT., TOP	—	20	48'-8	5171
7a2	CAP, LONGIT., SIDES	—	6	48'-8	597
7a3	CAP, LONGIT., SIDES	—	2	44'-8	183
7a4	CAP, LONGIT., SIDES	—	2	36'-9	150
7a5	CAP, LONGIT., SIDES	—	2	28'-10	118
6b1	CAP, LONGIT., BOTTOM	⟋	4	26'-2	157
5c1	CAP HOOPS	□	28	18'-5	538
5c2	CAP HOOPS, CANTILEVER	□	32	VARIES	591
5c3	CAP HOOPS, CANTILEVER	□	48	VARIES	730
10d1	FOOTING TO STEM DOWELS	L	46	10'-7	2095
10d2	STEM, VERTICAL	—	46	28'-6	5641
4e1	STEM HOOPS	▭	50	28'-0	935
4e2	STEM TIES AT ENDS	⊃	50	13'-6	451
5f1	FOOTING, TRANSV. - TOP	—	28	14'-8	428
5f2	FOOTING, LONGIT. - TOP	—	15	27'-8	433
8g1	FOOTING, TRANSV. - BOTTOM	—	50	14'-8	1958
8g2	FOOTING, LONGIT. - BOTTOM	—	20	27'-8	1477
5m1	CAP, STEPS, LONGIT.	—	20	3'-0	63
5n1	CAP, STEPS, TRANSV.	⊓	20	6'-6	136
	REINFORCING STEEL TOTAL - (LBS.)				21,852

REINF. BAR LIST - WESTBOUND PIER 1

BAR	LOCATION	SHAPE	NO.	LENGTH	WEIGHT
11a1	CAP, LONGIT., TOP	—	20	48'-8	5171
7a2	CAP, LONGIT., SIDES	—	6	48'-8	597
7a3	CAP, LONGIT., SIDES	—	2	44'-8	183
7a4	CAP, LONGIT., SIDES	—	2	36'-9	150
7a5	CAP, LONGIT., SIDES	—	2	28'-10	118
6b1	CAP, LONGIT., BOTTOM	⟋	4	26'-2	157
5c1	CAP HOOPS	□	28	18'-5	538
5c2	CAP HOOPS, CANTILEVER	□	32	VARIES	591
5c3	CAP HOOPS, CANTILEVER	□	48	VARIES	730
10d1	FOOTING TO STEM DOWELS	L	46	10'-7	2095
10d2	STEM, VERTICAL	—	46	28'-6	5641
4e1	STEM HOOPS	▭	50	28'-0	935
4e2	STEM TIES AT ENDS	⊃	50	13'-6	451
5f1	FOOTING, TRANSV. - TOP	—	28	14'-8	428
5f2	FOOTING, LONGIT. - TOP	—	15	27'-8	433
8g1	FOOTING, TRANSV. - BOTTOM	—	50	14'-8	1958
8g2	FOOTING, LONGIT. - BOTTOM	—	20	27'-8	1477
5m1	CAP, STEPS, LONGIT.	—	16	3'-0	50
8m2	CAP, STEPS, LONGIT.	—	4	11'-7	124
5n1	CAP, STEPS, TRANSV.	⊓	26	6'-6	176
	REINFORCING STEEL TOTAL - (LBS.)				22,003

REINF. BAR LIST - WESTBOUND PIER 2

BAR	LOCATION	SHAPE	NO.	LENGTH	WEIGHT
11a1	CAP, LONGIT., TOP	—	20	48'-8	5171
7a2	CAP, LONGIT., SIDES	—	6	48'-8	597
7a3	CAP, LONGIT., SIDES	—	2	44'-8	183
7a4	CAP, LONGIT., SIDES	—	2	36'-9	150
7a5	CAP, LONGIT., SIDES	—	2	28'-10	118
6b1	CAP, LONGIT., BOTTOM	⟋	4	26'-2	157
5c1	CAP HOOPS	□	28	18'-5	538
5c2	CAP HOOPS, CANTILEVER	□	32	VARIES	591
5c3	CAP HOOPS, CANTILEVER	□	48	VARIES	730
10d1	FOOTING TO STEM DOWELS	L	46	10'-7	2095
10d2	STEM, VERTICAL	—	46	27'-0	5344
4e1	STEM HOOPS	▭	48	28'-0	898
4e2	STEM TIES AT ENDS	⊃	48	13'-6	433
5f1	FOOTING, TRANSV. - TOP	—	28	14'-8	428
5f2	FOOTING, LONGIT. - TOP	—	15	27'-8	433
8g1	FOOTING, TRANSV. - BOTTOM	—	50	14'-8	1958
8g2	FOOTING, LONGIT. - BOTTOM	—	20	27'-8	1477
5m1	CAP, STEPS, LONGIT.	—	16	3'-0	50
8m2	CAP, STEPS, LONGIT.	—	4	11'-7	124
5n1	CAP, STEPS, TRANSV.	⊓	26	6'-6	176
	REINFORCING STEEL TOTAL - (LBS.)				21,651

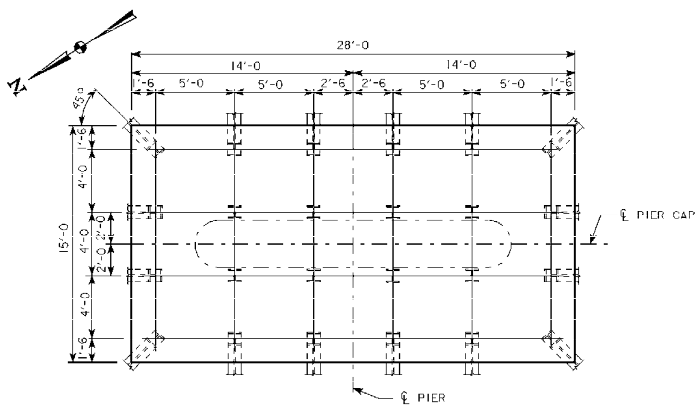
PIER NOTES :

MINIMUM CLEAR DISTANCE FROM FACE OF CONCRETE TO NEAR REINFORCING BAR IS TO BE 2 INCHES UNLESS OTHERWISE NOTED OR SHOWN

CONSTRUCTION JOINTS ARE TO BE FORMED WITH A 3 x 10 x 16'-0 DRESSED AND BEVELED STRIP.

THE DESIGN BEARING FOR THE PIER PILES IS 45 TONS.

ALL BATTERED PILES SHALL BE TRIMMED TO A HORIZONTAL LINE TO AID IN THE PLACEMENT OF REINFORCING.

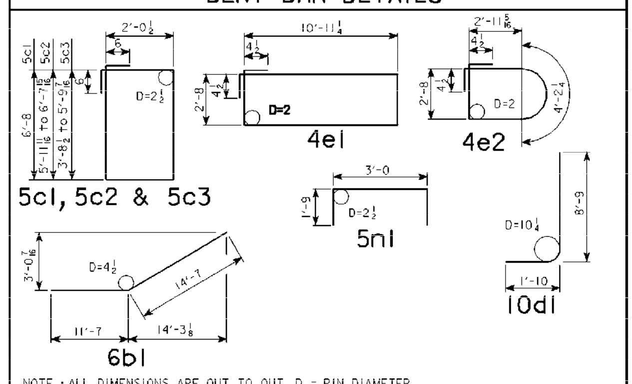


PILE PLAN
(TYPICAL FOR ALL PIERS)

NOTE :
DIMENSIONS SHOWN ARE AT BOTTOM OF FOOTING.
BATTER PILES 1:4 IN THE DIRECTION SHOWN.

24 - HP10x57 STEEL BEARING PILING REQUIRED AT EACH PIER.

BENT BAR DETAILS



NOTE : ALL DIMENSIONS ARE OUT TO OUT. D = PIN DIAMETER.

TOTAL ESTIMATED PIER QUANTITIES

ITEM		UNITS	WESTBOUND BRIDGE	EASTBOUND BRIDGE
STRUCTURAL CONCRETE		CU.YDS	312.0	317.8
REINFORCING STEEL		LBS.	43,627	44,263
HP10x57 STEEL BEARING PILING	FURNISH 48 @ 20'	LIN.FT.	960	960
	DRIVE 48 @ 20'	LIN.FT.	960	960
CLASS 20 EXCAVATION		CU.YDS	300	310
CLASS 21 EXCAVATION		CU.YDS	305	300

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

PIER DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 9 OF 32 FILE NO. 29488 DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB | JEFFERSON COUNTY | PROJECT NUMBER NHSN-034-8(105)--2R-51 | SHEET NUMBER 10

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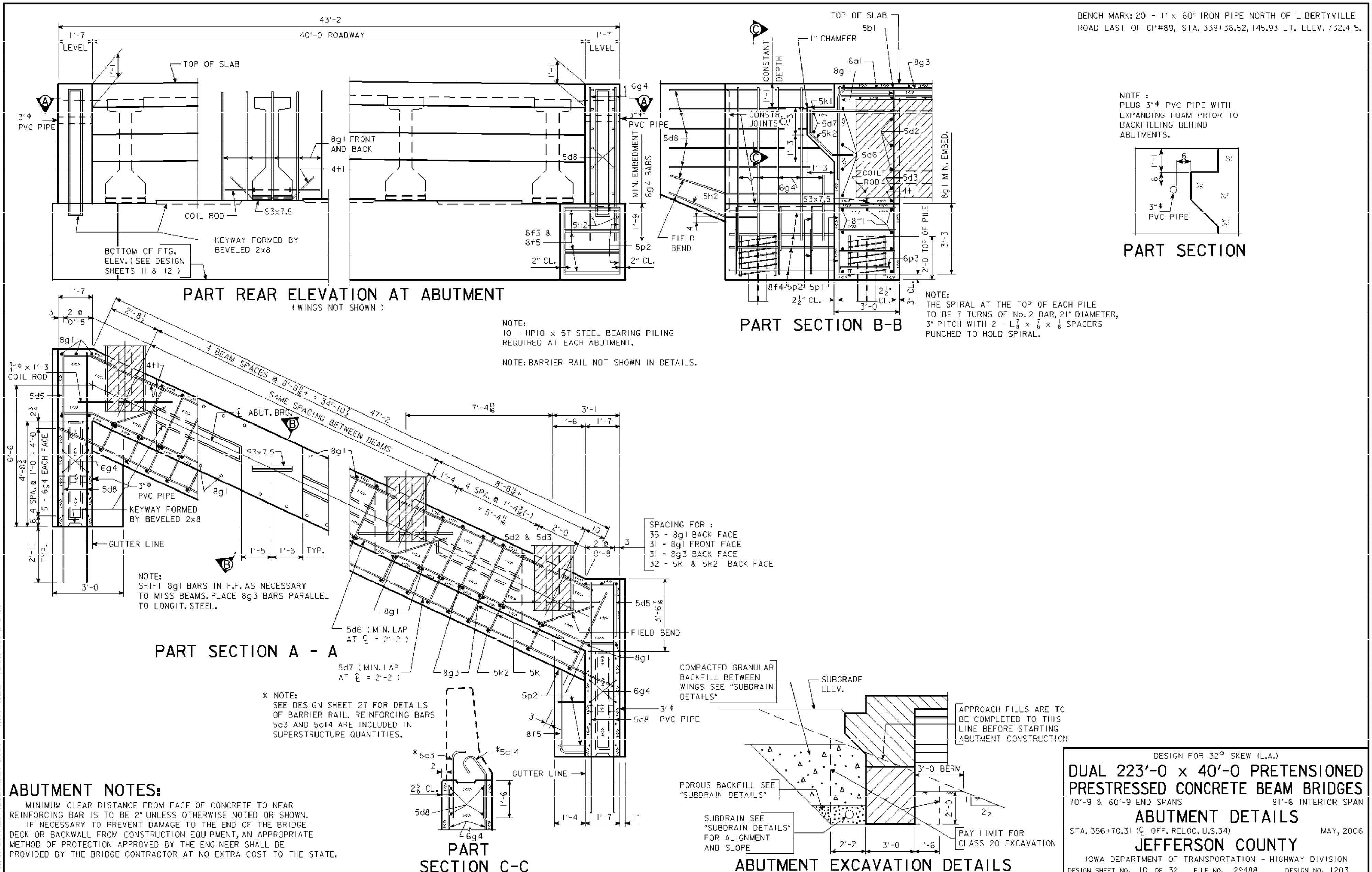

ABUTMENT NOTES:

MINIMUM CLEAR DISTANCE FROM FACE OF CONCRETE TO NEAR REINFORCING BAR IS TO BE 2" UNLESS OTHERWISE NOTED OR SHOWN.

IF NECESSARY TO PREVENT DAMAGE TO THE END OF THE BRIDGE DECK OR BACKWALL FROM CONSTRUCTION EQUIPMENT, AN APPROPRIATE METHOD OF PROTECTION APPROVED BY THE ENGINEER SHALL BE PROVIDED BY THE BRIDGE CONTRACTOR AT NO EXTRA COST TO THE STATE.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

ABUTMENT DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 10 OF 32 FILE NO. 29488 DESIGN NO. 1203

REVISED 12-04 - SIZE AND DIMENSIONS OF PAVING NOTCH CHANGED. TEMPORARY PAVING NOTCH REMOVED.
ENGLISHINTEGRALBRIDGES.DGN 2088 - THIS SHEET REDRAWN 9-8-88

DESIGN TEAM EDS/GJK/DLB	"C" OR "D" BEAMS - INTEGRAL ABUT. DETAILS - (L.A.) 15°01' - 30° SKEW	STANDARD SHEET 2088	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 11

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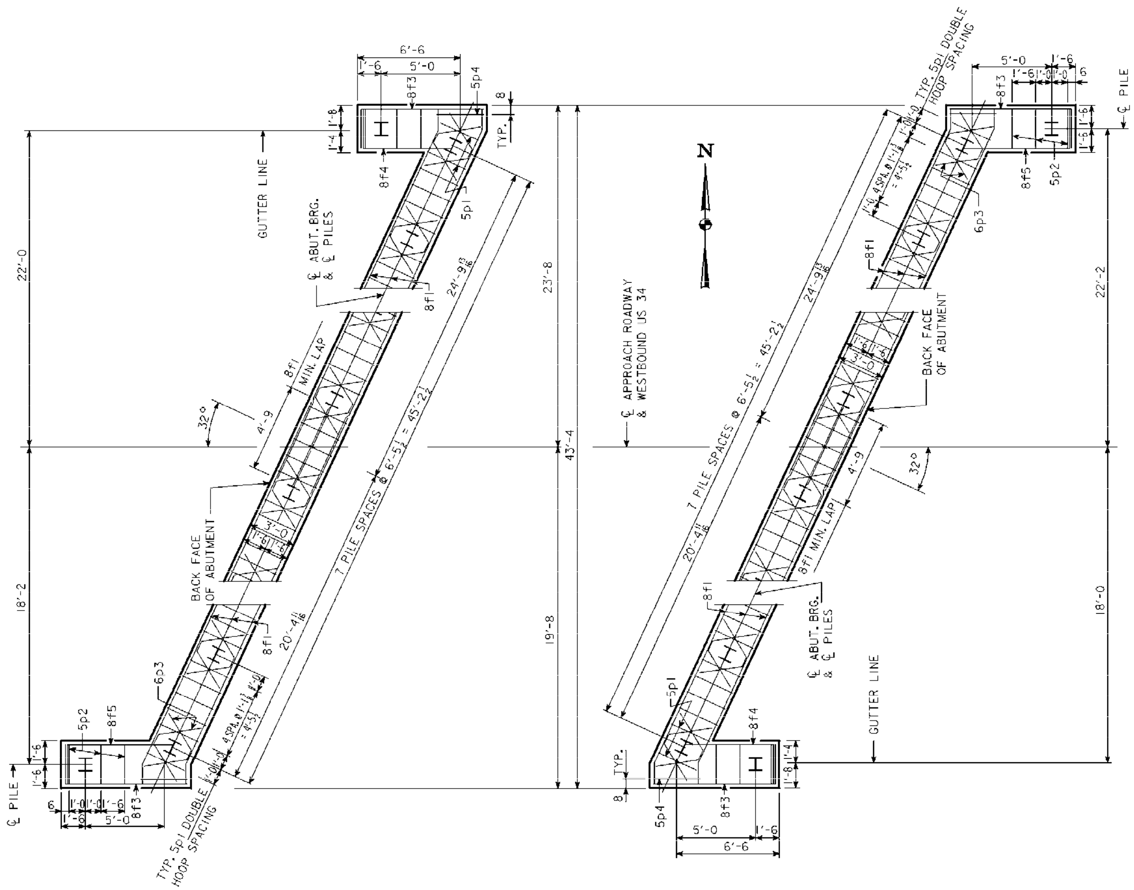
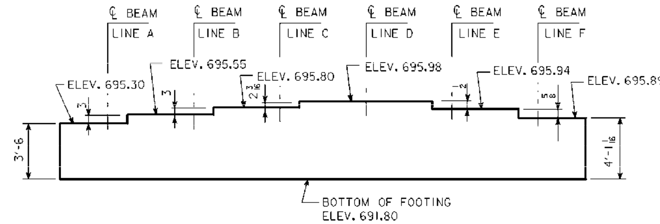
BENCH MARK: 20 - 1" × 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 339+36.52, 145.93 LT. ELEV. 732.415.



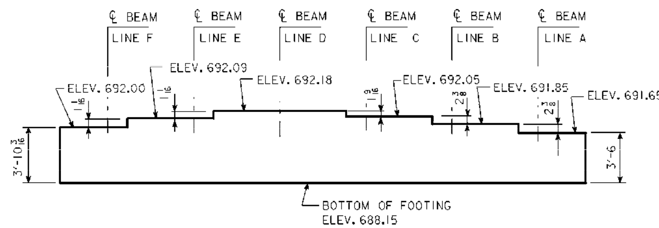
WEST ABUTMENT

EAST ABUTMENT

WESTBOUND BRIDGE - ABUTMENT PILE PLAN



REAR ELEVATION - WEST ABUTMENT
WESTBOUND BRIDGE



REAR ELEVATION - EAST ABUTMENT
WESTBOUND BRIDGE

NOTES:
10 - HP10 × 57 STEEL BEARING PILING REQUIRED AT EACH ABUTMENT.

THE DESIGN BEARING FOR THE ABUTMENT PILES IS 47 TONS.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 × 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

WESTBOUND BRIDGE ABUT. DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

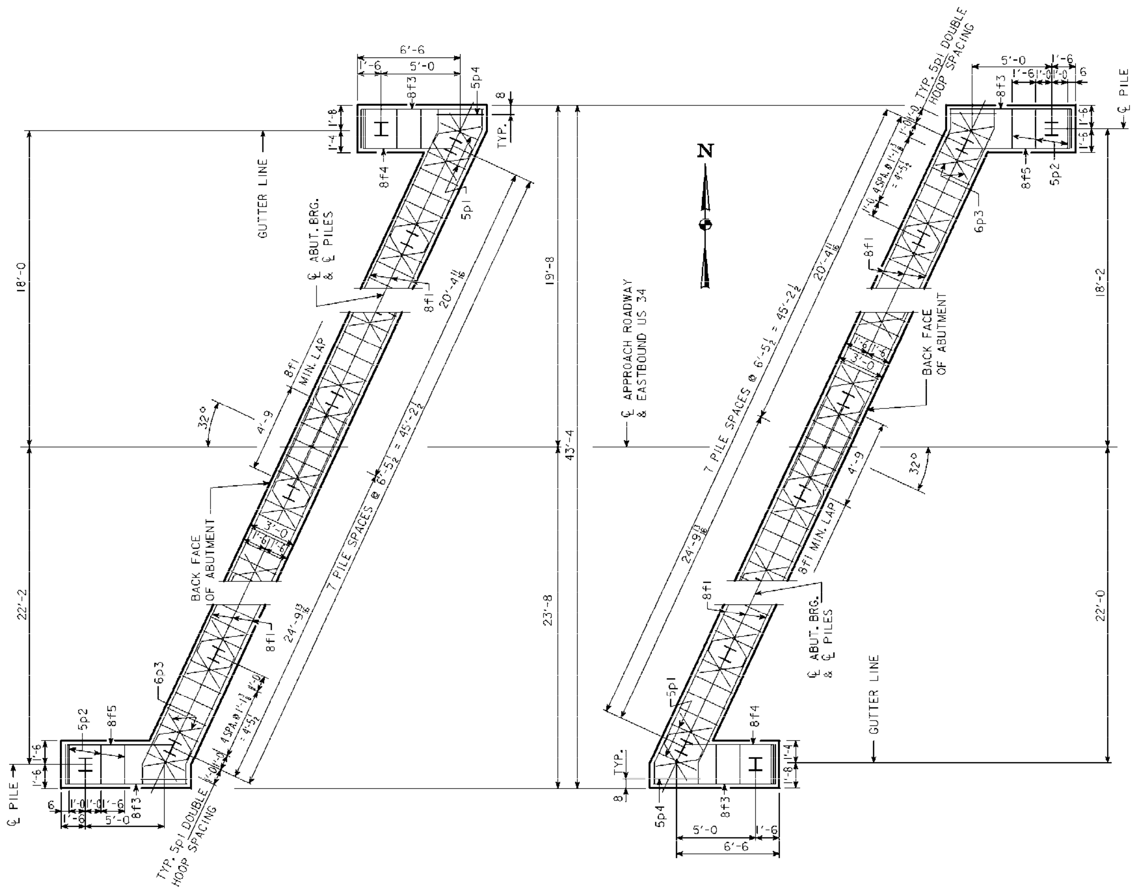
JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 11 OF 32 FILE NO. 29488 DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 12

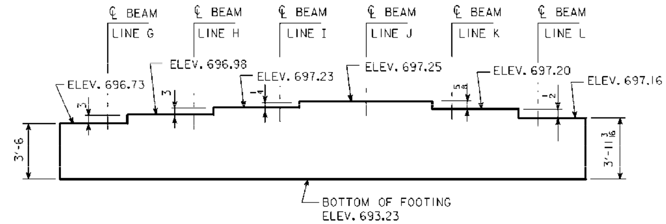
BENCH MARK: 20 - 1" x 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 339+36.52, 145.93 LT. ELEV. 732.415.



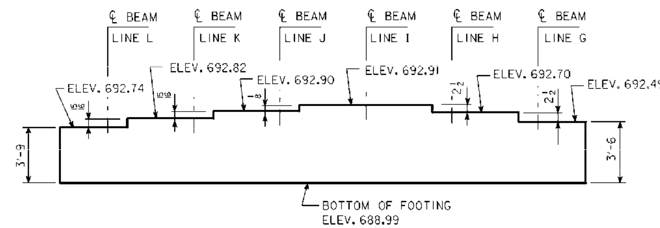
WEST ABUTMENT

EAST ABUTMENT

EASTBOUND BRIDGE - ABUTMENT PILE PLAN



REAR ELEVATION - WEST ABUTMENT
EASTBOUND BRIDGE



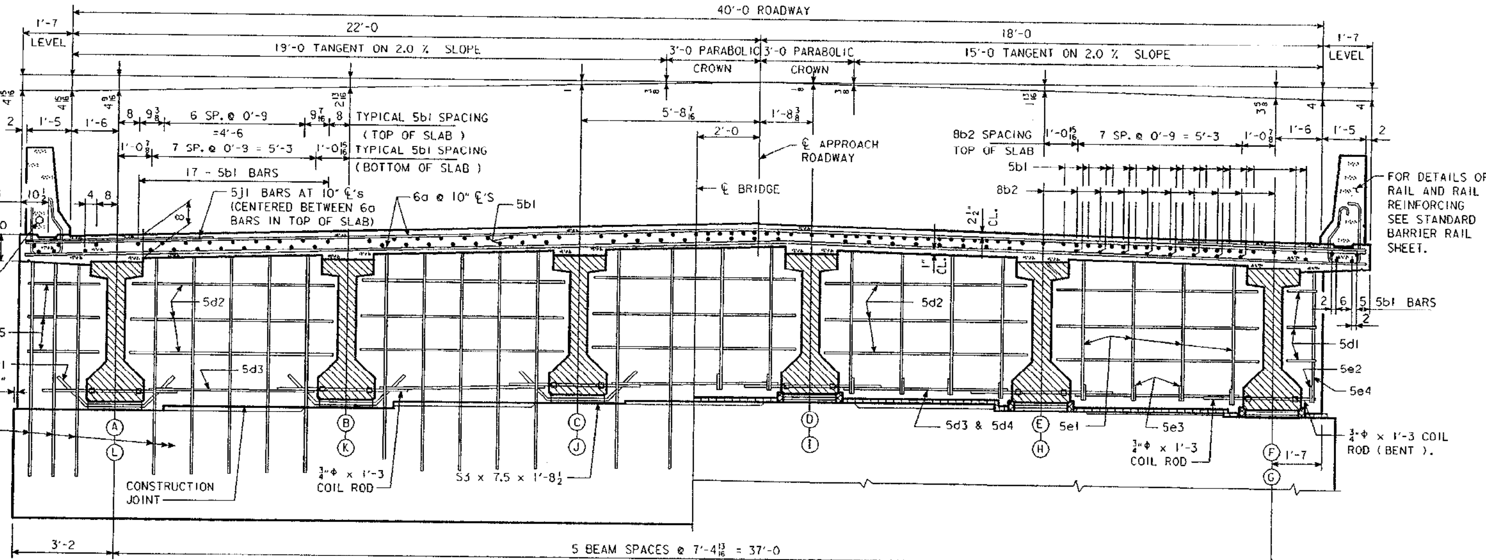
REAR ELEVATION - EAST ABUTMENT
EASTBOUND BRIDGE

NOTES:
10 - HP10 x 57 STEEL BEARING PILING REQUIRED AT EACH ABUTMENT.

THE DESIGN BEARING FOR THE ABUTMENT PILES IS 45 TONS.

DESIGN FOR 32° SKEW (L.A.)
DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES
70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN
EASTBOUND BRIDGE ABUT. DETAILS
STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006
JEFFERSON COUNTY
IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION
DESIGN SHEET NO. 12 OF 32 FILE NO. 29488 DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB | JEFFERSON COUNTY | PROJECT NUMBER NHSN-034-8(105)--2R-51 | SHEET NUMBER 13

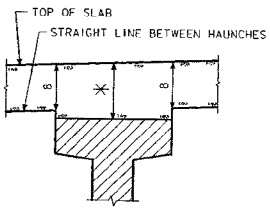


HALF SECTION NEAR ABUTMENT

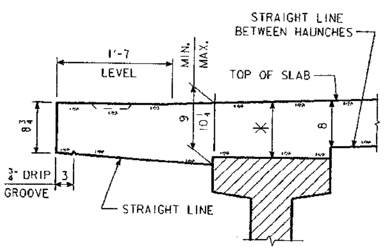
HALF SECTION NEAR PIER NO. 2

NOTE : FOR DETAILS OF INTERMEDIATE DIAPHRAGMS SEE DESIGN SHEET 23.

(A)-(F) WESTBOUND BRIDGE - LOOKING EAST
(G)-(L) EASTBOUND BRIDGE - LOOKING WEST



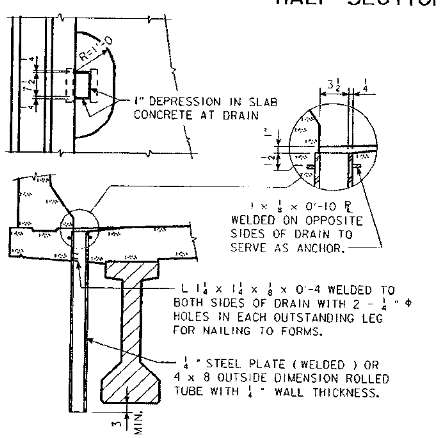
INTERIOR BEAMS



EXTERIOR BEAMS

TYPICAL SLAB AND HAUNCH DETAIL

* FOR SLAB THICKNESS OVER BEAMS SEE "SLAB THICKNESS DETAILS" ON DESIGN SHEET NO. 17 AND 18.



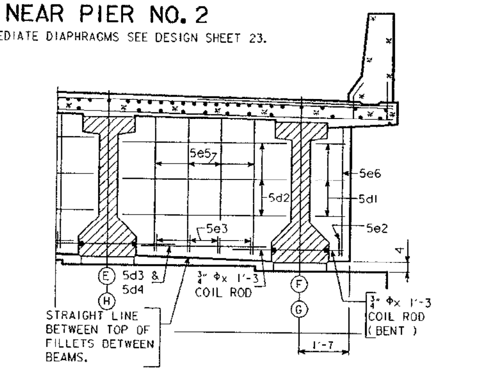
DRAIN DETAILS

NOTE :
DRAINS ARE TO BE GALVANIZED. ~~16~~ 24 DRAINS REQUIRED. SEE "SITUATION PLAN" ON DESIGN SHEET 2 FOR LOCATION.
WEIGHT OF DRAINS IS INCLUDED IN THE QUANTITY FOR "STRUCTURAL STEEL". WEIGHT (106 LBS./DRAIN) IS BASED ON ROLLED TUBE. (LENGTH = 5'-5½)

REVISED : 07-20-06 ; NUMBER OF DRAINS CHANGED.

SUPERSTRUCTURE NOTES:

THE FLOOR SLAB AS SHOWN INCLUDES ½" INTEGRAL WEARING SURFACE.
THE PIER AND ABUTMENT DIAPHRAGM CONCRETE IS TO BE PLACED MONOLITHICALLY WITH THE FLOOR SLAB.
COST OF ALL PREFORMED EXPANSION JOINT FILLER MATERIAL IS TO BE INCLUDED IN THE PRICE BID FOR "STRUCTURAL CONCRETE (BRIDGE)".
ALL BEAMS ARE TO BE SET VERTICAL.
FORMS FOR THE SLAB AND BARRIER RAIL ARE TO BE SUPPORTED BY THE PRESTRESSED CONCRETE BEAMS.
CLEAR DISTANCE FROM FACE OF CONCRETE TO NEAR REINFORCING BAR SHALL BE 2 INCHES UNLESS OTHERWISE NOTED OR SHOWN.
ALL SLAB AND DIAPHRAGM REINFORCING IS TO BE WIRED IN PLACE AND ADEQUATELY SUPPORTED BEFORE CONCRETE IS PLACED.
TOP TRANSVERSE REINFORCING STEEL IS TO BE PARALLEL TO AND 2½" CLEAR BELOW TOP OF SLAB. BOTTOM TRANSVERSE REINFORCING STEEL IS TO BE PARALLEL TO AND 1" CLEAR ABOVE BOTTOM OF SLAB. TOP AND BOTTOM REINFORCING STEEL IS TO BE SUPPORTED BY INDIVIDUAL EPOXY COATED METAL BAR CHAIRS SPACED AT NOT MORE THAN 3'-0 CENTERS LONGITUDINALLY AND TRANSVERSELY, OR BY CONTINUOUS ROWS OF EPOXY COATED METAL BAR HIGH CHAIRS OR SLAB BOLSTERS SPACED 4'-0 APART.
COST OF BEARING MATERIAL IS TO BE INCLUDED IN THE PRICE BID FOR "PRETENSIONED PRESTRESSED CONCRETE BEAMS".



PART SECTION NEAR PIER NO. 1

NOTE:
SOLE PLATE AND PINTLE PLATES NOT SHOWN. SEE DESIGN SHEET 22.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS — 91'-6 INTERIOR SPAN

SUPERSTRUCTURE DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) — MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 13 OF 32 — FILE NO. 29488 — DESIGN NO. 1203

REVISED 09-03 - FOOTING EXTENDED 1" TO ACCOMMODATE C AND D BEAMS. NOTE ADDED TO ADJUST FOR A AND B BEAMS. 110'& 115'b2 BARS ADDED.
ENGLISH\INTEGRALBRIDGES.DGN 4383 - THIS SHEET REDRAWN 9-8-88

DESIGN TEAM EDS/GJK/DLB	40' RDWY. PPCB (ALL BEAMS - INTEGRAL ABUT.) CROSS SECTION	STANDARD SHEET 4383 MODIFIED	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 14

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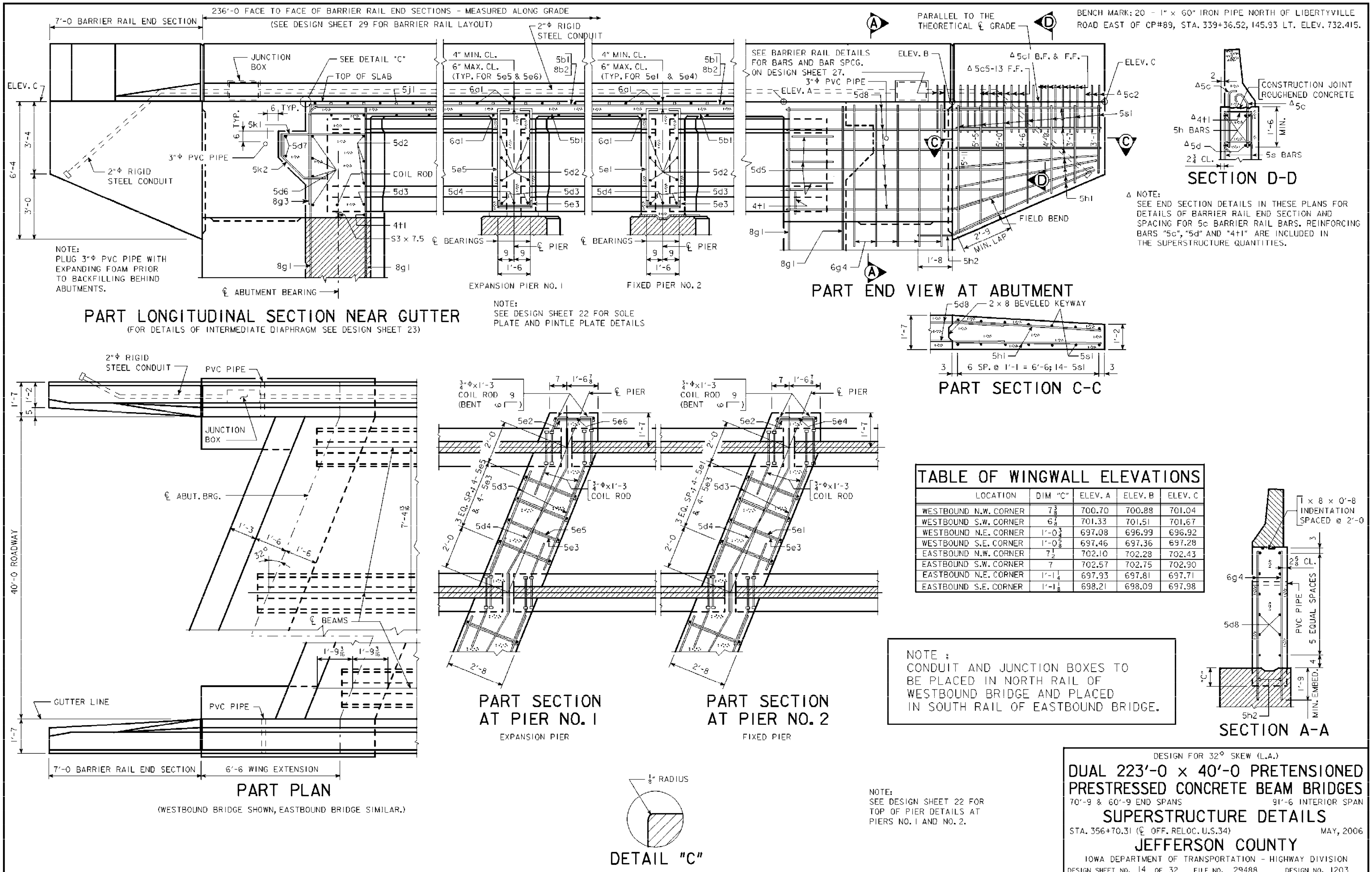

TABLE OF WINGWALL ELEVATIONS

LOCATION	DIM "C"	ELEV. A	ELEV. B	ELEV. C
WESTBOUND N.W. CORNER	7 3/8	700.70	700.88	701.04
WESTBOUND S.W. CORNER	6 7/8	701.33	701.51	701.67
WESTBOUND N.E. CORNER	1'-0 3/4	697.08	696.99	696.92
WESTBOUND S.E. CORNER	1'-0 5/8	697.46	697.36	697.28
EASTBOUND N.W. CORNER	7 1/2	702.10	702.28	702.43
EASTBOUND S.W. CORNER	7	702.57	702.75	702.90
EASTBOUND N.E. CORNER	1'-1 1/4	697.93	697.81	697.71
EASTBOUND S.E. CORNER	1'-1 1/8	698.21	698.09	697.98

NOTE :
CONDUIT AND JUNCTION BOXES TO BE PLACED IN NORTH RAIL OF WESTBOUND BRIDGE AND PLACED IN SOUTH RAIL OF EASTBOUND BRIDGE.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

SUPERSTRUCTURE DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 14 OF 32 FILE NO. 29488 DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB	"C" OR "D" BEAMS PART PLAN & LONGIT. SECTION - (L.A.) 15°01'-30° SKEW	STANDARD SHEET 4510 MODIFIED	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 15

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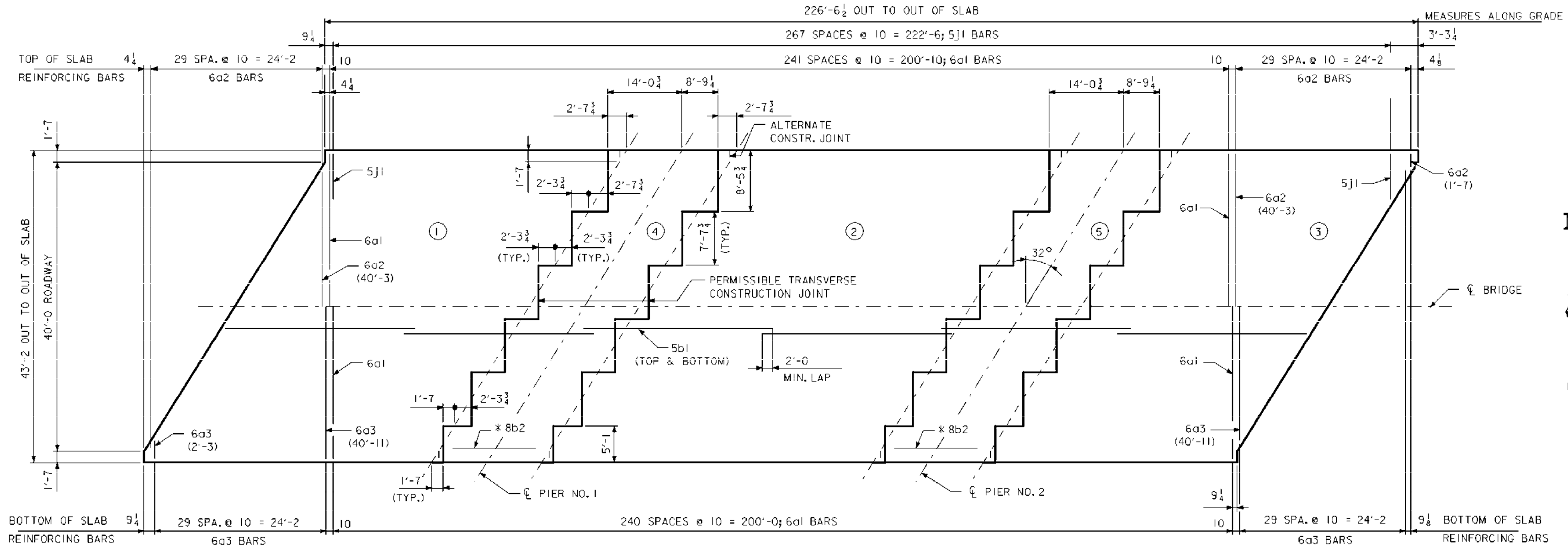
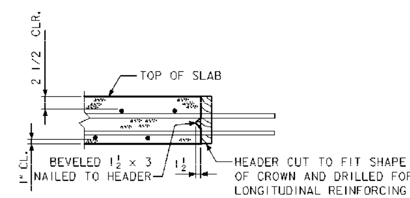


CONCRETE PLACEMENT DIAGRAM AND LONGITUDINAL REINFORCING LAYOUT

NOTE:
ROADWAY SLAB SHALL BE PLACED IN SECTIONS AND IN SEQUENCE INDICATED. ALTERNATE PROCEDURES FOR PLACING SLAB CONCRETE MAY BE SUBMITTED FOR APPROVAL TOGETHER WITH A STATEMENT OF THE PROPOSED METHOD AND EVIDENCE THAT THE CONTRACTOR POSSESSES THE NECESSARY EQUIPMENT AND FACILITIES TO ACCOMPLISH THE REQUIRED RESULT.

* BARS SHALL BE CENTERED OVER PIER



TRANSVERSE SLAB CONSTRUCTION JOINT

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS — 91'-6 INTERIOR SPAN

SUPERSTRUCTURE DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) — MAY, 2006

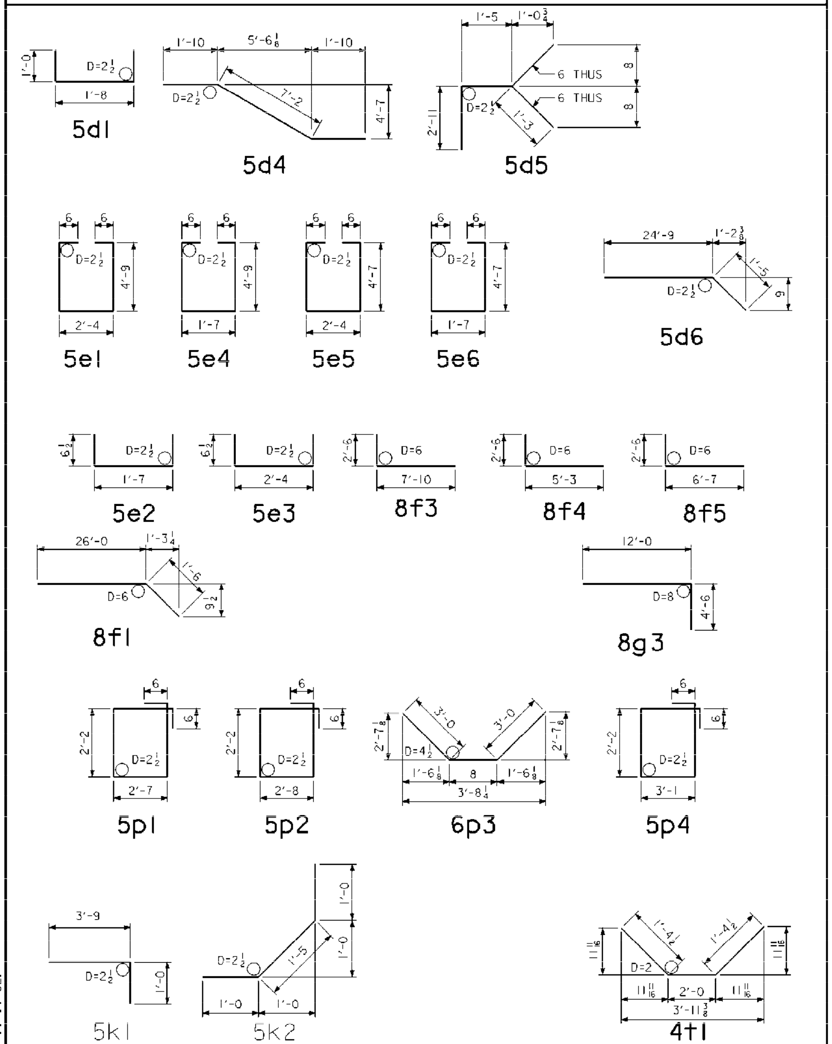
JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 15 OF 32 — FILE NO. 29488 — DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 16

BENT BAR DETAILS



NOTE: ALL DIMENSIONS ARE OUT TO OUT. D= PIN DIAMETER.

REINFORCING BAR LIST - EPOXY COATED
(ONE SUPERSTRUCTURE AND TWO ABUTMENTS)

BAR	LOCATION	SHAPE	NO.	LENGTH	WEIGHT
6a1	SLAB TRANSV. TOP & BOTT.		483	42'-10	31,074
6a2	SLAB TRANSV. TOP ENDS		60	VARIES	1,885
6a3	SLAB TRANSV. BOTT. ENDS		60	VARIES	1,945
5b1	SLAB LONGITUDINAL, TOP & BOTT.		582	39'-5	23,927
8b2	SLAB LONGITUDINAL @ PIER 1		92	22'-6	5,527
5d1	PIER DIAPH. ENDS		12	3'-8	46
5d2	PIER & ABUT. DIAPH. LONGIT.		90	7'-10	735
5d3	PIER & ABUT. DIAPH. LONGIT.		30	6'-4	198
5d4	PIER DIAPH. LONGIT.		10	10'-10	113
5d5	ABUT. DIAPH. ENDS		12	5'-7	70
5d6	ABUT. DIAPH. LONGIT. B.F.		16	26'-2	437
5d7	PAVING NOTCH LONGIT.		8	26'-6	221
5d8	ABUT. DIAPH. WING EXT. LONGIT.		48	11'-0	551
5e1	PIER DIAPH. HOOPS - PIER 2		20	12'-10	268
5e2	PIER DIAPH. TIES ENDS		4	2'-8	11
5e3	PIER DIAPH. TIES		40	3'-5	143
5e4	PIER DIAPH. HOOPS ENDS - PIER 2		2	12'-1	25
5e5	PIER DIAPH. HOOPS - PIER 1		20	12'-6	261
5e6	PIER DIAPH. HOOPS ENDS - PIER 1		2	11'-9	25
8f1	ABUT. FOOTING LONGIT.		36	27'-6	2,643
8f3	ABUT. EXTENSION LONGIT.		16	10'-4	441
8f4	ABUT. EXTENSION LONGIT.		8	7'-9	166
8f5	ABUT. EXTENSION LONGIT.		8	9'-1	194
8g1	ABUT. VERT.		132	8'-6	2,996
8g3	ABUT. DIAPH. VERT. B.F.		62	16'-6	2,731
6g4	ABUT. DIAPH. WING EXT. VERT.		40	7'-3	436
5h1	ABUT. WING HORIZ.		56	6'-8	389
5h2	ABUT. TO WING ANCHOR		8	4'-7	38
5j1	TOP OF SLAB TRANSV. (AT RAIL)		536	6'-3	3,494
5k1	PAVING NOTCH TRANSV.		64	4'-9	317
5k2	PAVING NOTCH TRANSV.		64	3'-5	228
5p1	ABUTMENT HOOPS		148	10'-6	1,621
5p2	ABUT. EXTENSION HOOPS		24	10'-8	267
6p3	ABUT. BOTT. AT PILES		32	6'-8	320
5p4	ABUT. HOOPS AT ENDS		8	11'-6	96
5s1	WING VERT.		56	VARIES	263
4t1	UNDER BEAMS AT ABUTMENTS		12	4'-9	38
#2	PILE SPIRAL		20	38'-6	129
	SPIRAL SPACERS, L 7/8 x 7/8 x 1/8 x 0.70		40	1'-10	51
	BARRIER RAIL - SEE DESIGN SHT. NO. 29				12,209
	REINFORCING STEEL (EPOXY COATED) - TOTAL (LBS.)				96,529

CONCRETE PLACEMENT QUANTITIES - C.Y.
(ONE SUPERSTRUCTURE AND TWO ABUTMENTS)

SECTION	TOTAL
SECTION 1 - SLAB, ABUT. DIAPH., WINGWALLS	99.9
SECTION 2 - SLAB	76.3
SECTION 3 - SLAB, ABUT. DIAPH., WINGWALLS	88.6
SECTION 4 - SLAB, PIER DIAPH.	44.8
SECTION 5 - SLAB, PIER DIAPH.	45.6
WEST ABUTMENT FOOTING	26.4
EAST ABUTMENT FOOTING	25.6
ABUT. WINGS 4 AT 1.7 CU.YDS. EACH	6.8
TOTAL C.Y.	414.0

ESTIMATED QUANTITIES - SUPERSTRUCTURE
(ONE SUPERSTRUCTURE AND TWO ABUTMENTS)

ITEM		UNIT	QUANTITY
STRUCTURAL CONCRETE (BRIDGE)		CU.YD.	414.0
STRUCTURAL STEEL		LBS.	7106
REINFORCING STEEL EPOXY COATED		LBS.	96,529
PRETENSIONED PRESTRESSED CONCRETE BEAMS LXD60		EACH	6
PRETENSIONED PRESTRESSED CONCRETE BEAMS LXD70		EACH	6
PRETENSIONED PRESTRESSED CONCRETE BEAMS LXD90		EACH	6
CLASS 20 EXCAVATION		CU.YD.	160
HP10x57 STEEL BEARING PILING	FURNISH 10 @ 40' W. A.; 10 @ 50' E.A.	L.F.	900
	DRIVE 10 @ 40' W. A.; 10 @ 50' E.A.	L.F.	900
PREBORED HOLES	20 @ 10'	L.F.	200

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

SUPERSTRUCTURE DETAILS-WESTBOUND BRIDGE

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

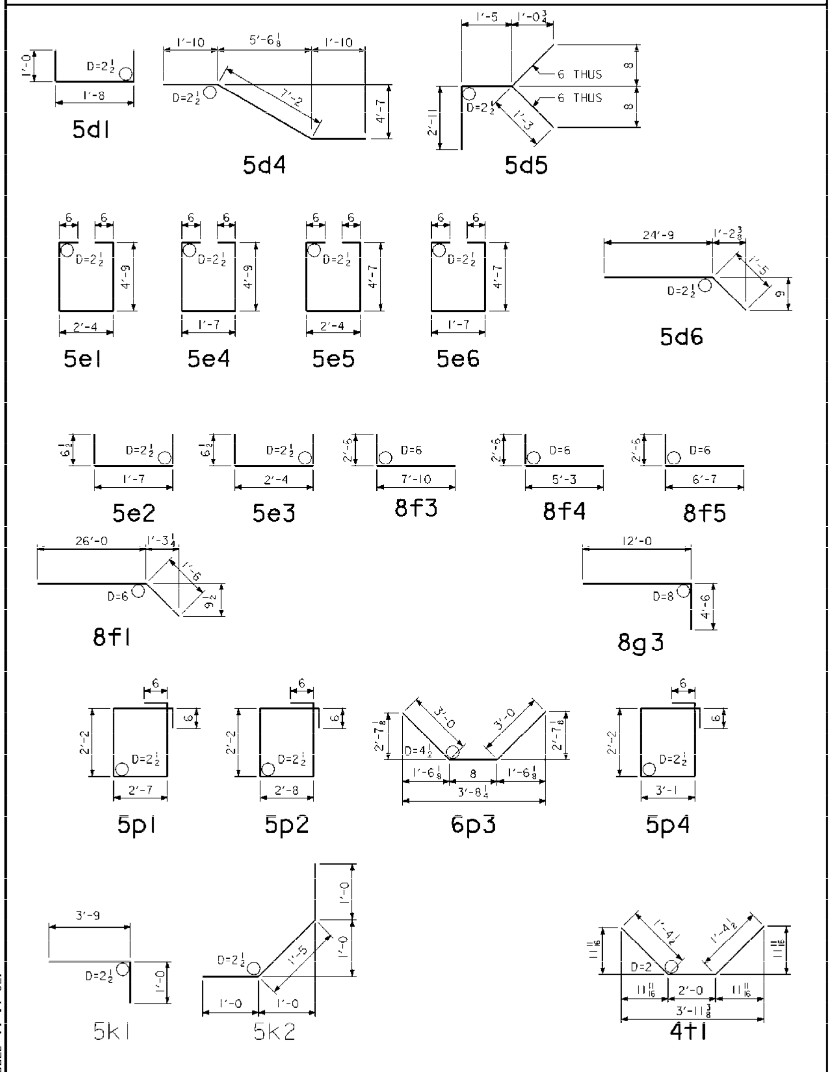
JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 16 OF 32 FILE NO. 29488 DESIGN NO. 1203

HE52 .SOI; THIS SHEET ISSUED ??-??-02.

BENT BAR DETAILS



NOTE: ALL DIMENSIONS ARE OUT TO OUT. D= PIN DIAMETER.

REINFORCING BAR LIST - EPOXY COATED

(ONE SUPERSTRUCTURE AND TWO ABUTMENTS)

BAR	LOCATION	SHAPE	NO.	LENGTH	WEIGHT
6a1	SLAB TRANSV. TOP & BOTT.		483	42'-10	31,074
6a2	SLAB TRANSV. TOP ENDS		60	VARIES	1,885
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5b1	SLAB LONGITUDINAL, TOP & BOTT.		582	39'-5	23,927
8b2	SLAB LONGITUDINAL @ PIER 1		92	22'-6	5,527
5d1	PIER DIAPH. ENDS		12	3'-8	46
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5d4	PIER DIAPH. LONGIT.		10	10'-10	113
5d5	ABUT. DIAPH. ENDS		12	5'-7	70
5d6	ABUT. DIAPH. LONGIT. B.F.		16	26'-2	437
5d7	PAVING NOTCH LONGIT.		8	26'-6	221
5d8	ABUT. DIAPH. WING EXT. LONGIT.		48	11'-0	551
5e1	PIER DIAPH. HOOPS - PIER 2		20	12'-10	268
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8f4	ABUT. EXTENSION LONGIT.		8	7'-9	166
8f5	ABUT. EXTENSION LONGIT.		8	9'-1	194
8g1	ABUT. VERT.		132	8'-6	2,996
8g3	ABUT. DIAPH. VERT. B.F.		62	16'-6	2,731
6g4	ABUT. DIAPH. WING EXT. VERT.		40	7'-3	436
5h1	ABUT. WING HORIZ.		56	6'-8	389
5h2	ABUT. TO WING ANCHOR		8	4'-7	38
5j1	TOP OF SLAB TRANSV. (AT RAIL)		536	6'-3	3,494
5k1	PAVING NOTCH TRANSV.		64	4'-9	317
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5s1	WING VERT.		56	VARIES	263
4t1	UNDER BEAMS AT ABUTMENTS		12	4'-9	38
#2	PILE SPIRAL		20	38'-6	129
	SPIRAL SPACERS, L 7/8 x 7/8 x 1/8 x 0.70		40	1'-10	51
	BARRIER RAIL - SEE DESIGN SHT. NO. 29				12,209
	REINFORCING STEEL (EPOXY COATED) - TOTAL (LBS.)				96,529

CONCRETE PLACEMENT QUANTITIES - C.Y.

(ONE SUPERSTRUCTURE AND TWO ABUTMENTS)

SECTION	TOTAL
SECTION 1 - SLAB, ABUT. DIAPH., WINGWALLS	99.8
SECTION 2 - SLAB	76.3
SECTION 3 - SLAB, ABUT. DIAPH., WINGWALLS	88.6
SECTION 4 - SLAB, PIER DIAPH.	44.8
SECTION 5 - SLAB, PIER DIAPH.	45.5
WEST ABUTMENT FOOTING	25.8
EAST ABUTMENT FOOTING	25.2
ABUT. WINGS 4 AT 1.7 CU.YDS. EACH	6.8
TOTAL C.Y.	412.8

ESTIMATED QUANTITIES - SUPERSTRUCTURE

(ONE SUPERSTRUCTURE AND TWO ABUTMENTS)

ITEM		UNIT	QUANTITY
STRUCTURAL CONCRETE (BRIDGE)		CU.YD.	412.8
STRUCTURAL STEEL		LBS.	7106
REINFORCING STEEL EPOXY COATED		LBS.	96,529
PRETENSIONED PRESTRESSED CONCRETE BEAMS LXD60		EACH	6
PRETENSIONED PRESTRESSED CONCRETE BEAMS LXD70		EACH	6
PRETENSIONED PRESTRESSED CONCRETE BEAMS LXD90		EACH	6
CLASS 20 EXCAVATION		CU.YD.	160
HP10x57 STEEL BEARING PILING	FURNISH 10 @ 45' W. A.; 10 @ 50' E.A.	L.F.	950
	DRIVE 10 @ 45' W. A.; 10 @ 50' E.A.	L.F.	950
PREBORED HOLES	20 @ 10'	L.F.	200

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS — 91'-6 INTERIOR SPAN

SUPERSTRUCTURE DETAILS-EASTBOUND BRIDGE

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) — MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 17 OF 32 FILE NO. 29488 DESIGN NO. 1203

HE52 .S01; THIS SHEET ISSUED ??-??-02.

DESIGN TEAM EDS/GJK/DLB | AUTOBRIDGE OUTPUT MODEL | JEFFERSON COUNTY | PROJECT NUMBER NHSN-034-8(105)--2R-51 | SHEET NUMBER 18

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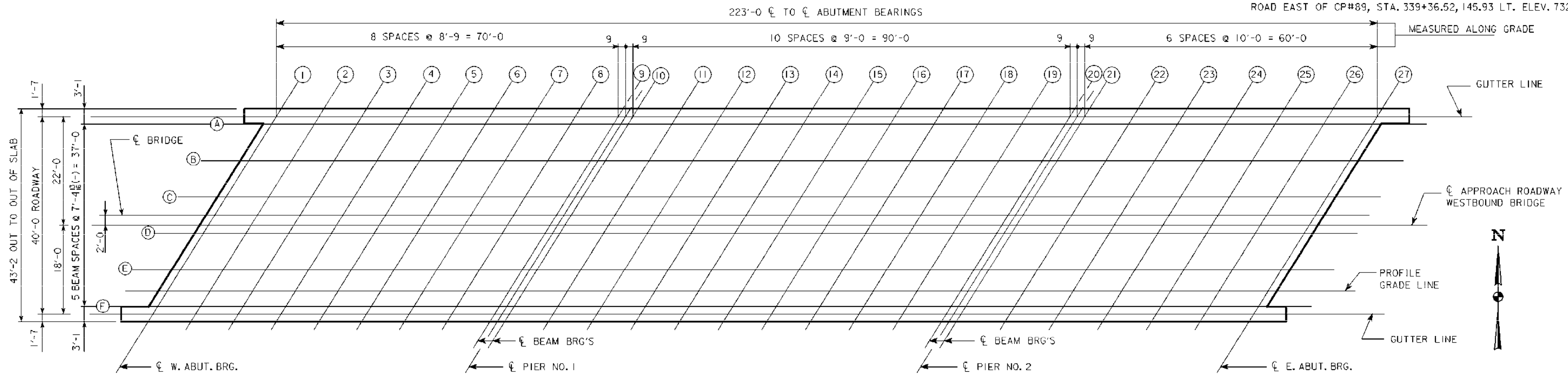
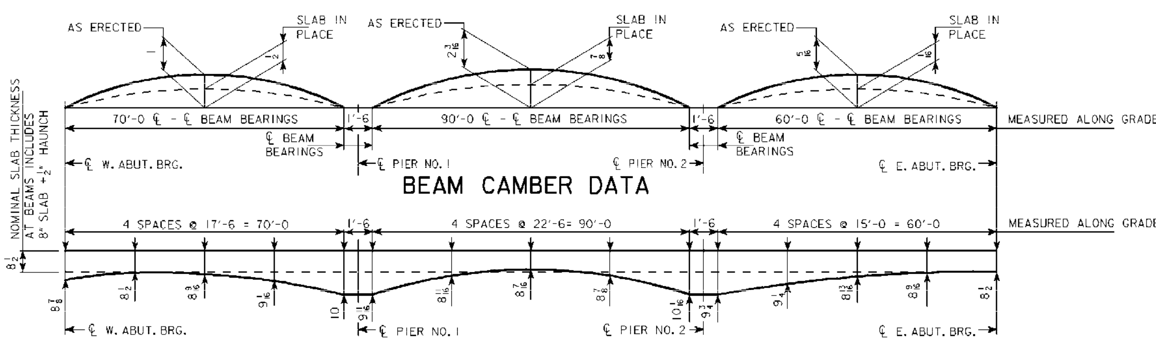
BENCH MARK: 20 - 1" x 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 339+36.52, 145.93 LT. ELEV. 732.415.



TOP OF SLAB ELEVATION LAYOUT

TABLE OF TOP OF SLAB ELEVATIONS - WESTBOUND BRIDGE

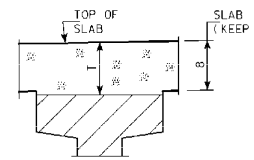
	℄ W. ABUT. BRG.								℄ PIER NO. 1 BEARINGS											℄ PIER NO. 2 BEARINGS							℄ E. ABUT. BRG
LOCATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
GUTTER LINE	700.74	700.55	700.37	700.19	700.01	699.83	699.66	699.50	699.33	699.31	699.14	698.98	698.83	698.67	698.53	698.38	698.24	698.11	697.97	697.84	697.82	697.68	697.55	697.42	697.30	697.18	697.06
BEAM LINE A	700.79	700.60	700.42	700.24	700.06	699.88	699.71	699.54	699.38	699.35	699.19	699.03	698.87	698.72	698.57	698.43	698.29	698.15	698.02	697.89	697.87	697.73	697.59	697.46	697.34	697.22	697.10
BEAM LINE B	701.04	700.85	700.66	700.48	700.30	700.12	699.95	699.78	699.61	699.59	699.42	699.26	699.10	698.95	698.80	698.65	698.51	698.37	698.23	698.10	698.08	697.94	697.80	697.67	697.54	697.42	697.31
BEAM LINE C	701.29	701.10	700.91	700.72	700.54	700.36	700.19	700.02	699.85	699.82	699.65	699.49	699.33	699.17	699.02	698.87	698.73	698.59	698.45	698.32	698.29	698.15	698.01	697.88	697.75	697.63	697.51
℄ APPROACH ROADWAY	701.45	701.26	701.07	700.88	700.70	700.52	700.34	700.17	700.00	699.97	699.80	699.64	699.48	699.32	699.17	699.02	698.87	698.73	698.59	698.45	698.43	698.29	698.15	698.01	697.88	697.75	697.63
BEAM LINE D	701.47	701.28	701.09	700.90	700.72	700.54	700.36	700.19	700.02	699.99	699.82	699.65	699.49	699.33	699.18	699.03	698.88	698.74	698.60	698.46	698.44	698.30	698.15	698.02	697.89	697.76	697.64
BEAM LINE E	701.43	701.23	701.04	700.85	700.67	700.48	700.31	700.13	699.96	699.93	699.76	699.59	699.43	699.27	699.11	698.96	698.81	698.66	698.52	698.38	698.36	698.22	698.07	697.93	697.80	697.67	697.55
BEAM LINE F	701.38	701.19	700.99	700.80	700.62	700.43	700.25	700.07	699.90	699.87	699.70	699.53	699.36	699.20	699.04	698.89	698.74	698.59	698.45	698.31	698.28	698.13	697.99	697.85	697.71	697.58	697.46
GUTTER LINE	701.37	701.18	700.99	700.79	700.61	700.42	700.24	700.06	699.89	699.86	699.69	699.52	699.35	699.19	699.03	698.87	698.72	698.57	698.43	698.29	698.27	698.12	697.97	697.83	697.70	697.57	697.44



BEAM CAMBER DATA

SLAB THICKNESS AT BEAMS (T)

(USED TO DETERMINE BEAM SEAT ELEVATIONS)



SLAB THICKNESS DETAILS

NOTE : THE SLAB THICKNESS (T) AT BEAMS IS BASED ON THE ANTICIPATED BEAM CAMBER AND DEFLECTIONS. THESE VALUES ARE USED BY THE DESIGNER TO SET BEAM ELEVATIONS AND ESTIMATE CONCRETE QUANTITIES. REFER TO HAUNCH DATA DETAIL SHEET FOR ADDITIONAL INFORMATION TO AID THE CONTRACTOR IN SETTING THE FIELD HAUNCHES REQUIRED FOR CONSTRUCTION.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

SUPERSTRUCTURE DETAILS - WESTBOUND

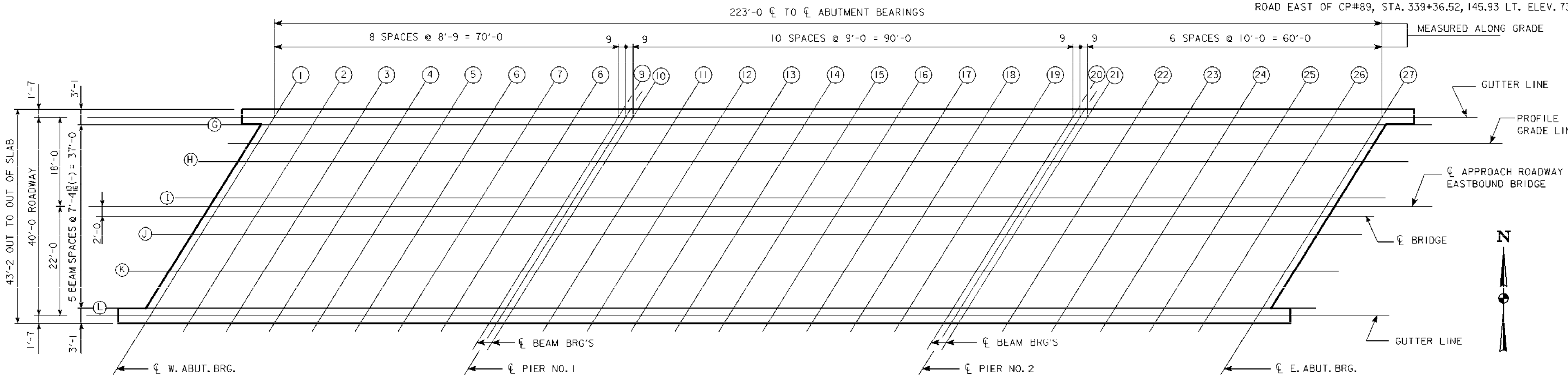
STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 18 OF 32 FILE NO. 29488 DESIGN NO. 1203

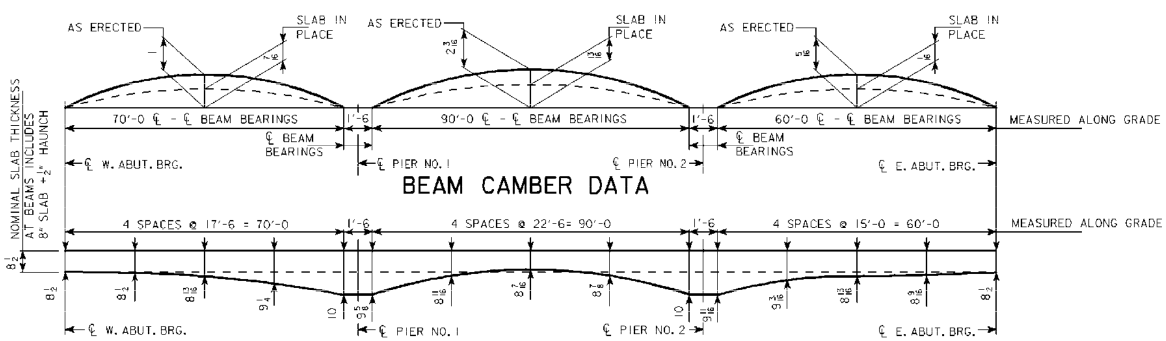
BENCH MARK: 20 - 1" x 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 339+36.52, 145.93 LT. ELEV. 732.415.



TOP OF SLAB ELEVATION LAYOUT

TABLE OF TOP OF SLAB ELEVATIONS - EASTBOUND BRIDGE

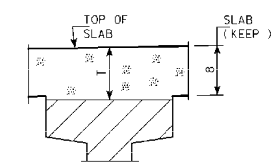
	℄ W. ABUT. BRG.								℄ PIER NO. 1 BEARINGS											℄ PIER NO. 2 BEARINGS							℄ E. ABUT. BRG
LOCATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
GUTTER LINE	702.14	701.94	701.75	701.56	701.37	701.17	700.98	700.79	700.60	700.57	700.38	700.20	700.02	699.84	699.66	699.49	699.33	699.17	699.01	698.85	698.83	698.66	698.50	698.34	698.19	698.04	697.90
BEAM LINE G	702.19	701.99	701.80	701.61	701.42	701.23	701.03	700.84	700.65	700.62	700.43	700.25	700.06	699.89	699.71	699.54	699.38	699.21	699.05	698.90	698.87	698.71	698.54	698.39	698.23	698.09	697.94
BEAM LINE H	702.44	702.24	702.05	701.86	701.67	701.47	701.28	701.09	700.90	700.87	700.68	700.49	700.31	700.13	699.95	699.78	699.61	699.44	699.28	699.13	699.10	698.93	698.77	698.61	698.45	698.30	698.16
BEAM LINE I	702.68	702.49	702.30	702.11	701.92	701.72	701.53	701.34	701.15	701.11	700.92	700.73	700.55	700.36	700.19	700.01	699.84	699.68	699.51	699.35	699.33	699.16	698.99	698.83	698.67	698.52	698.37
℄ APPROACH ROADWAY	702.71	702.52	702.33	702.14	701.94	701.75	701.56	701.37	701.18	701.14	700.95	700.76	700.57	700.39	700.21	700.04	699.87	699.70	699.54	699.38	699.35	699.18	699.01	698.85	698.69	698.54	698.39
BEAM LINE J	702.71	702.51	702.32	702.13	701.94	701.75	701.55	701.36	701.17	701.14	700.94	700.75	700.56	700.38	700.20	700.02	699.85	699.68	699.52	699.36	699.33	699.16	698.99	698.82	698.66	698.51	698.36
BEAM LINE K	702.66	702.47	702.28	702.08	701.89	701.70	701.51	701.32	701.12	701.09	700.89	700.70	700.51	700.32	700.14	699.96	699.79	699.62	699.45	699.29	699.26	699.09	698.92	698.75	698.59	698.43	698.28
BEAM LINE L	702.61	702.42	702.23	702.04	701.85	701.65	701.46	701.27	701.08	701.04	700.85	700.65	700.46	700.27	700.09	699.91	699.73	699.56	699.39	699.23	699.20	699.02	698.85	698.68	698.51	698.36	698.20
GUTTER LINE	702.60	702.41	702.22	702.03	701.84	701.64	701.45	701.26	701.07	701.03	700.84	700.64	700.45	700.26	700.08	699.90	699.72	699.55	699.38	699.21	699.18	699.01	698.83	698.66	698.50	698.34	698.19



BEAM CAMBER DATA

SLAB THICKNESS AT BEAMS (T)

(USED TO DETERMINE BEAM SEAT ELEVATIONS)



SLAB THICKNESS DETAILS

NOTE : THE SLAB THICKNESS (T) AT BEAMS IS BASED ON THE ANTICIPATED BEAM CAMBER AND DEFLECTIONS. THESE VALUES ARE USED BY THE DESIGNER TO SET BEAM ELEVATIONS AND ESTIMATE CONCRETE QUANTITIES. REFER TO HAUNCH DATA DETAIL SHEET FOR ADDITIONAL INFORMATION TO AID THE CONTRACTOR IN SETTING THE FIELD HAUNCHES REQUIRED FOR CONSTRUCTION.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

SUPERSTRUCTURE DETAILS - EASTBOUND

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 19 OF 32 FILE NO. 29488 DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB | JEFFERSON COUNTY | PROJECT NUMBER NHSN-034-8(105)--2R-51 | SHEET NUMBER 20

BENCH MARK: 20 - 1" x 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 339+36.52, 145.93 LT. ELEV. 732.415.

TABLE OF BEAM LINE HAUNCH ELEVATIONS - WESTBOUND BRIDGE (SEE NOTE 1)

	℄ W. ABUT. BEARING							℄ PIER #1 BEARINGS					
	1	2	3	4	5	6	7	8	9	10	11	12	13
BEAM LINE A	700.12	699.95	699.78	699.61	699.43	699.26	699.08	698.90	698.71	698.69	698.56	698.43	698.30
BEAM LINE B	700.37	700.20	700.03	699.85	699.67	699.50	699.31	699.13	698.95	698.92	698.79	698.66	698.52
BEAM LINE C	700.62	700.45	700.27	700.10	699.92	699.74	699.55	699.37	699.18	699.15	699.03	698.89	698.75
BEAM LINE D	700.80	700.63	700.45	700.27	700.09	699.91	699.72	699.54	699.35	699.32	699.19	699.06	698.91
BEAM LINE E	700.76	700.58	700.41	700.22	700.04	699.86	699.67	699.48	699.29	699.26	699.13	698.99	698.85
BEAM LINE F	700.71	700.54	700.36	700.18	699.99	699.80	699.62	699.43	699.23	699.20	699.07	698.93	698.79

							℄ PIER #2 BEARINGS							℄ E. ABUT. BEARING
	14	15	16	17	18	19	20	21	22	23	24	25	26	27
BEAM LINE A	698.16	698.01	697.86	697.71	697.55	697.39	697.22	697.20	697.07	696.95	696.82	696.69	696.57	696.44
BEAM LINE B	698.38	698.24	698.09	697.93	697.77	697.60	697.43	697.41	697.28	697.16	697.03	696.90	696.77	696.64
BEAM LINE C	698.61	698.46	698.31	698.15	697.99	697.82	697.65	697.63	697.50	697.37	697.24	697.10	696.97	696.84
BEAM LINE D	698.77	698.62	698.46	698.30	698.14	697.97	697.80	697.77	697.64	697.51	697.38	697.24	697.11	696.97
BEAM LINE E	698.70	698.55	698.39	698.23	698.07	697.89	697.72	697.70	697.56	697.43	697.29	697.16	697.02	696.88
BEAM LINE F	698.64	698.48	698.32	698.16	697.99	697.82	697.64	697.62	697.48	697.34	697.21	697.07	696.93	696.79

MISCELLANEOUS DATA TABLE

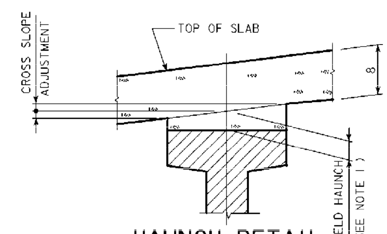
	BEAM LINE		℄ W. ABUT. BEARING							℄ PIER #1 BEARINGS				
			1	2	3	4	5	6	7	8	9	10	11	12	13
ANTICIPATED DEFLECTION DUE TO SLAB (in.)	ALL		0	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{4}$	0	0	$\frac{1}{2}$	$\frac{13}{16}$	$1\frac{1}{8}$

	℄ PIER #2 BEARINGS													℄ E. ABUT. BEARING
	14	15	16	17	18	19	20	21	22	23	24	25	26	27
ANTICIPATED DEFLECTION DUE TO SLAB (in.)	$1\frac{1}{4}$	$1\frac{5}{16}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$\frac{13}{16}$	$\frac{1}{2}$	0	0	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{3}{16}$	0

	BEAM LINE		ALL LOCATIONS (1–27)
CROSS SLOPE ADJUSTMENTS	A, B, C, E, F		$+\frac{3}{16}, -\frac{3}{16}$
	D		$+\frac{1}{16}, -\frac{1}{8}$
ALLOWABLE FIELD HAUNCH	MAX.	ALL	2
	MIN.	ALL	$-\frac{5}{16}$

NOTE 1:
TO CALCULATE FIELD HAUNCH REQUIRED AT EACH LOCATION, SURVEY THE BEAM TOPS CONSISTENT WITH THE SPACINGS SHOWN ON THE "TOP OF SLAB ELEVATIONS LAYOUT" ON DESIGN SHEET 18. SUBTRACT THE SURVEYED BEAM SHOT FROM THE "BEAM LINE HAUNCH ELEVATION". THIS VALUE WILL BE THE HAUNCH NEEDED (SEE "FIELD HAUNCH" IN HAUNCH DETAIL). THE "BEAM LINE HAUNCH ELEVATION" INCLUDES ADJUSTMENTS FOR SLAB THICKNESSES AND ANTICIPATED DEFLECTIONS. NO ADDITIONAL CALCULATIONS ARE REQUIRED. IF THE FIELD HAUNCH EXCEEDS THE MAXIMUMS AND MINIMUMS INDICATED IN THE MISCELLANEOUS DATA TABLE, ADJUSTMENTS TO THE GRADE OR ADDITIONAL HAUNCH REINFORCEMENT WILL BE REQUIRED.

NOTE :
HAUNCH LOCATIONS ARE AT THE SAME LOCATION AS THE ENCIRCLED LETTERS AND NUMBERS SHOWN ON DESIGN SHEET 18.



HAUNCH DETAIL

NOTE:
BRIDGE SEAT ELEVATIONS ARE SET BASED ON THEORETICAL CAMBER AND BEAM DEFLECTIONS. THESE BRIDGE SEATS WILL PROVIDE A THEORETICAL BEAM HAUNCH WITHIN DESIGN PARAMETERS. ACTUAL HAUNCHES ARE DETERMINED USING SURVEYED TOP OF BEAM ELEVATIONS AND "BEAM LINE HAUNCH ELEVATION" DATA. ALLOWABLE MAXIMUM AND MINIMUM "FIELD HAUNCH" VALUES ARE GIVEN IN THE "MISCELLANEOUS DATA" TABLE. "CROSS SLOPE ADJUSTMENT" VALUES FROM THE "MISCELLANEOUS DATA" TABLE WILL AID THE CONTRACTOR IN DETERMINING ACTUAL FORMED HAUNCH DIMENSIONS AT THE EDGES OF THE TOP FLANGE.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS — 91'-6 INTERIOR SPAN

HAUNCH DATA DETAILS - WESTBOUND

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) — MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 20 OF 32 FILE NO. 29488 DESIGN NO. 1203

BENCH MARK: 20 - 1" × 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 339+36.52, 145.93 LT. ELEV. 732.415.

TABLE OF BEAM LINE HAUNCH ELEVATIONS - EASTBOUND BRIDGE (SEE NOTE 1)

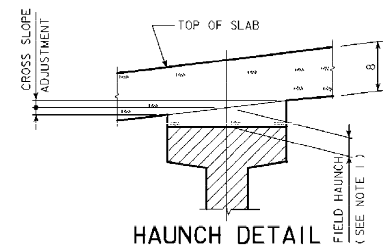
	℄ W. ABUT. BEARING								℄ PIER #1 BEARINGS											℄ PIER #2 BEARINGS							℄ E. ABUT. BEARING
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
BEAM LINE G	701.52	701.35	701.17	700.99	700.80	700.60	700.40	700.20	699.99	699.95	699.81	699.65	699.49	699.33	699.16	699.99	699.81	698.62	698.43	698.23	698.21	698.05	697.90	697.75	697.59	697.43	697.28
BEAM LINE H	701.77	701.60	701.42	701.24	701.05	700.85	700.65	700.44	700.23	700.20	700.05	700.90	699.74	699.57	699.40	699.22	699.04	698.85	698.66	698.46	698.43	698.28	698.12	697.97	697.81	697.65	697.49
BEAM LINE I	702.02	701.85	701.67	701.48	701.30	701.10	700.90	700.69	700.48	700.45	700.30	700.14	699.98	699.81	699.63	699.46	699.27	699.08	698.89	698.69	698.66	698.50	698.35	698.19	698.03	697.87	697.70
BEAM LINE J	702.04	701.87	701.69	701.51	701.32	701.12	700.92	700.72	700.50	700.47	700.32	700.16	699.99	699.82	699.65	699.47	699.28	699.09	698.89	698.69	698.66	698.50	698.34	698.18	698.02	697.86	697.69
BEAM LINE K	701.99	701.82	701.64	701.46	701.27	701.08	700.88	700.67	700.46	700.42	700.27	700.11	699.94	699.77	699.59	699.41	699.22	699.03	698.83	698.62	698.60	698.43	698.27	698.11	697.94	697.78	697.61
BEAM LINE L	701.95	701.78	701.60	701.41	701.23	701.03	700.83	700.62	700.41	700.38	700.22	700.06	699.89	699.72	699.54	699.35	699.16	698.97	698.76	698.56	698.53	698.37	698.20	698.04	697.87	697.70	697.54

MISCELLANEOUS DATA TABLE

	BEAM LINE		℄ W. ABUT. BEARING								℄ PIER #1 BEARINGS											℄ PIER #2 BEARINGS							℄ E. ABUT. BEARING
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
ANTICIPATED DEFLECTION DUE TO SLAB (in.)	ALL		0	$\frac{1}{4}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{1}{2}$	$\frac{7}{16}$	$\frac{1}{4}$	0	0	$\frac{1}{2}$	$\frac{7}{8}$	$1\frac{3}{16}$	$1\frac{5}{16}$	$1\frac{3}{8}$	$1\frac{5}{16}$	$1\frac{3}{16}$	$\frac{7}{8}$	$\frac{1}{2}$	0	0	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{3}{16}$	0
CROSS SLOPE ADJUSTMENTS	L, K, J, H, G		$+\frac{3}{16}, -\frac{3}{16}$																										
	I		$+\frac{1}{16}, -\frac{1}{8}$																										
ALLOWABLE FIELD HAUNCH	MAX.	ALL	2																										
	MIN.	ALL	$-\frac{5}{16}$																										

NOTE 1:
TO CALCULATE FIELD HAUNCH REQUIRED AT EACH LOCATION, SURVEY THE BEAM TOPS CONSISTENT WITH THE SPACINGS SHOWN ON THE "TOP OF SLAB ELEVATIONS LAYOUT" ON DESIGN SHEET 19. SUBTRACT THE SURVEYED BEAM SHOT FROM THE "BEAM LINE HAUNCH ELEVATION". THIS VALUE WILL BE THE HAUNCH NEEDED (SEE "FIELD HAUNCH" IN HAUNCH DETAIL). THE "BEAM LINE HAUNCH ELEVATION" INCLUDES ADJUSTMENTS FOR SLAB THICKNESSES AND ANTICIPATED DEFLECTIONS. NO ADDITIONAL CALCULATIONS ARE REQUIRED. IF THE FIELD HAUNCH EXCEEDS THE MAXIMUMS AND MINIMUMS INDICATED IN THE MISCELLANEOUS DATA TABLE, ADJUSTMENTS TO THE GRADE OR ADDITIONAL HAUNCH REINFORCEMENT WILL BE REQUIRED.

NOTE:
HAUNCH LOCATIONS ARE AT THE SAME LOCATION AS THE ENCIRCLED LETTERS AND NUMBERS SHOWN ON DESIGN SHEET 19.



HAUNCH DETAIL

NOTE:
BRIDGE SEAT ELEVATIONS ARE SET BASED ON THEORETICAL CAMBER AND BEAM DEFLECTIONS. THESE BRIDGE SEATS WILL PROVIDE A THEORETICAL BEAM HAUNCH WITHIN DESIGN PARAMETERS. ACTUAL HAUNCHES ARE DETERMINED USING SURVEYED TOP OF BEAM ELEVATIONS AND "BEAM LINE HAUNCH ELEVATION" DATA. ALLOWABLE MAXIMUM AND MINIMUM "FIELD HAUNCH" VALUES ARE GIVEN IN THE "MISCELLANEOUS DATA" TABLE. "CROSS SLOPE ADJUSTMENT" VALUES FROM THE "MISCELLANEOUS DATA" TABLE WILL AID THE CONTRACTOR IN DETERMINING ACTUAL FORMED HAUNCH DIMENSIONS AT THE EDGES OF THE TOP FLANGE.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 × 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

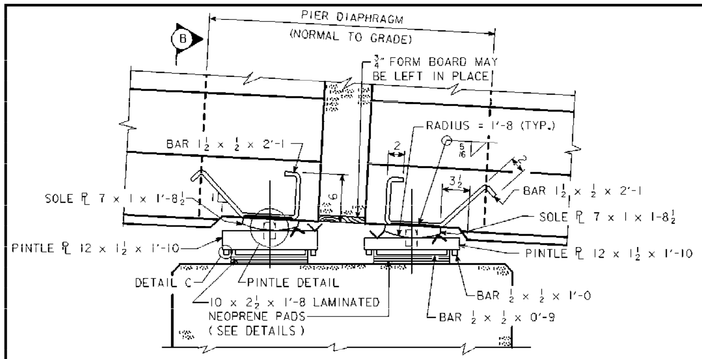
HAUNCH DATA DETAILS - EASTBOUND

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

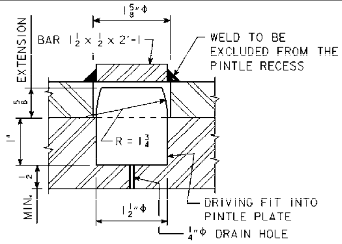
JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

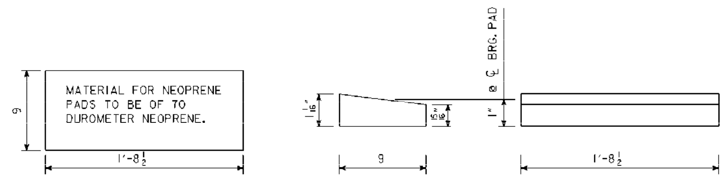
DESIGN SHEET NO. 21 OF 32 FILE NO. 29488 DESIGN NO. 1203



PART ELEVATION (LOOKING NORTH)

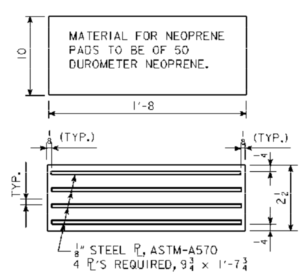


PINTLE DETAIL

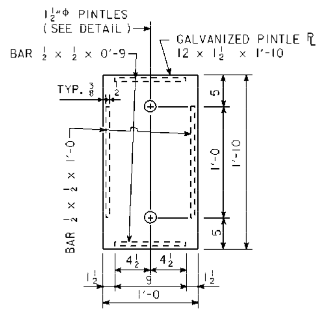


NOTE:
COST OF TAPERED NEOPRENE PADS SHALL BE INCLUDED IN THE PRICE BID FOR "PRETENSIONED PRESTRESSED CONCRETE BEAMS".

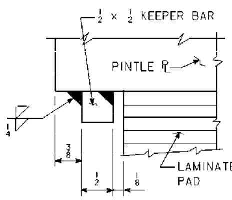
FIXED PIER 2



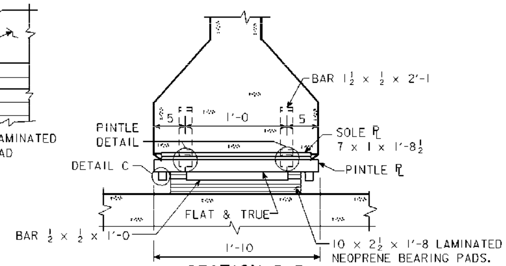
LAMINATED NEOPRENE PADS



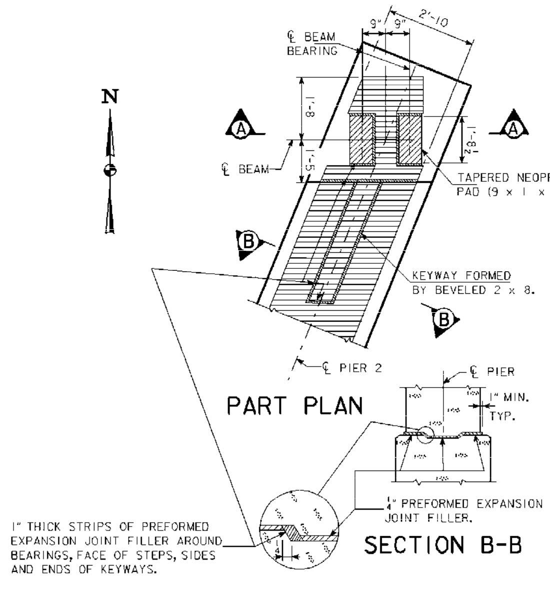
PLAN OF PINTLE PLATE



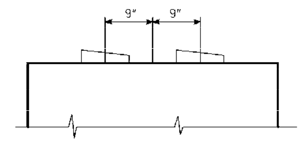
DETAIL C



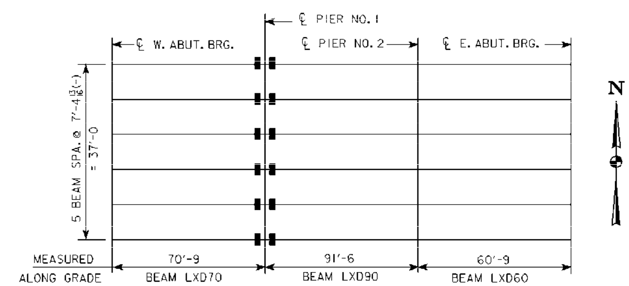
SECTION B-B
(DIAPHRAGM CONCRETE NOT SHOWN)



TOP OF PIER DETAILS
FIXED PIER NO. 2



PART SECTION A-A
SHOWING ORIENTATION OF PAD TAPER
(LOOKING NORTH)



NOTE: ▮ INDICATES LOCATION OF SOLE PLATES.

SOLE PLATE LOCATIONS

EXPANSION PIER BEARING NOTES:

SURFACES MARKED "V" SHALL BE FINISHED ANSI 250.

PINTLE PLATES ARE A PART OF THE SUPERSTRUCTURE "STRUCTURAL STEEL QUANTITY".

COSTS OF ANCHORED CURVED SOLE PLATES AND NEOPRENE PADS ARE TO BE INCLUDED IN THE PRICE BID FOR "PRETENSIONED PRESTRESSED CONCRETE BEAMS".

THE SOLE PLATES AND PINTLE PLATES SHALL BE GALVANIZED. ALL WELDING SHALL BE COMPLETED PRIOR TO GALVANIZING. THE SURFACE OF THE PINTLE PLATE IN CONTACT WITH THE LAMINATED NEOPRENE PADS SHALL BE FREE OF PROJECTIONS DUE TO THE GALVANIZING.

SOLE PLATES ARE TO BE SET IN FORMS WHEN BEAMS ARE CAST AND THE BOTTOM OF BEAMS FORMED OUT AS SHOWN TO EXCLUDE CONCRETE.

SOLE PLATES SHALL COMPLY WITH ONE OF THE FOLLOWING :

- ASTM A 852
- ASTM A 514 GRADE B
- ASTM A 709 GRADE 70 W

EXPANSION PIER 1

REVISED 09-03 -1/4"φ DRAIN HOLE ADDED TO PINTLE DETAIL.
ENGLISHBEAMS.DGN 4541A - THIS SHEET ISSUED 5-23-91

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS — 91'-6 INTERIOR SPAN

PIER BEARING DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) — MAY, 2006

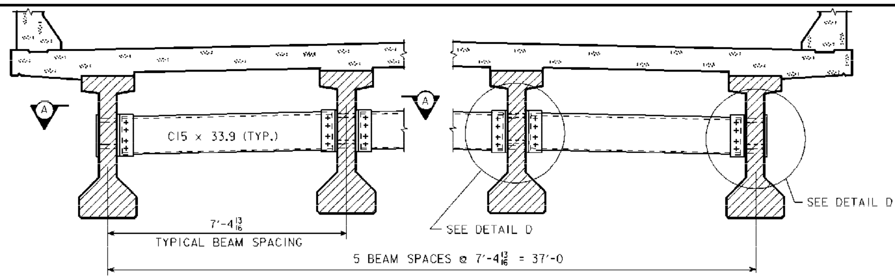
JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

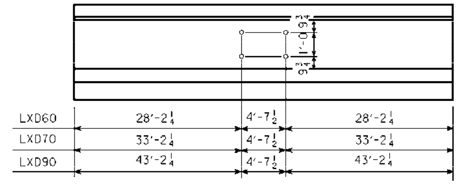
DESIGN SHEET NO. 22 OF 32 — FILE NO. 29488 — DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB	PPC BEAM BRIDGES - PIER BEARING DETAILS	STANDARD SHEET 4541A	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 23

27-APR-2006 07:13 dbackou W:\Projects\51034030A94\BRFinal\51034105_1203.brg 511203s022 \\NTPPRTSVR2\BrgTif



SECTION SHOWING INTERMEDIATE DIAPHRAGM



INTERMEDIATE DIAPHRAGM BOLT LOCATIONS

NOTES:

ALL DIAPHRAGM MATERIALS, INCLUDING BOLTS, NUTS AND WASHERS SHALL BE GALVANIZED.

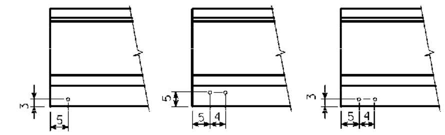
SHOP DRAWINGS OF THE STEEL DIAPHRAGMS SHOWING LAYOUT AND DETAILS OF THE DIAPHRAGMS SHALL BE SUBMITTED FOR APPROVAL.

ALL COSTS FOR FURNISHING AND INSTALLING STEEL INTERMEDIATE DIAPHRAGMS SHALL BE INCLUDED IN THE PRICE BID FOR STRUCTURAL STEEL.

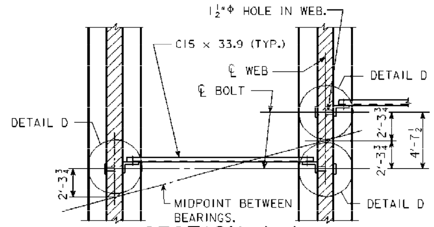
THE 1 1/2"Φ HOLES FOR THE 7/8"Φ H.T.S. BOLTS SHALL BE CAST INTO THE WEB. DRILLING IS NOT ALLOWED.

THE 7/8"Φ H.T.S. BOLTS THROUGH THE WEB SHALL HAVE A THREAD LENGTH OF 3" MIN. AND 4" MAX. AND SHALL MEET THE REQUIREMENTS OF ASTM A449.

ALL BOLTS ARE TO BE TIGHTENED PRIOR TO PLACING BRIDGE FLOOR CONCRETE WITH THE FOLLOWING EXCEPTION : BOLTS IN DIAPHRAGMS LOCATED UNDER LONGITUDINAL BRIDGE FLOOR CONSTRUCTION JOINTS SHALL NOT BE TIGHTENED UNTIL STAGE TWO OF THE BRIDGE FLOOR HAS BEEN PLACED.



BEAM COIL TIE LOCATIONS



SECTION A-A

INTERMEDIATE DIAPHRAGM STRUCTURAL STEEL

ONE CONNECTION DETAIL "D"

2 - 7/8"Φx LENGTH H.T.S. BOLTS WITH NUTS AND WASHERS

WEB THICKNESS	LENGTH OF H.T.S. BOLTS	WEIGHT PER DETAIL "D"	NUMBER OF DETAIL "D"	
7"	10"	4.66 LB	30	140
1 - BACKING ℘ 4 × 3/8 × 1′-3 1/4 = 6.5 LB			30	195
1 - L 6 × 4 × 1/2 × 1′-3 1/4 = 20.6 LB			30	618

ONE C15 × 33.9 DIAPHRAGM

BEAM SPACING / WEB THICKNESS	7′-4 13/16 * LENGTH	7′-4 13/16 UNIT WEIGHT (LB)
7"	6′-6 7/16	221.5

* THE LENGTH OF THE C15 × 33.9 SHOWN IN THE TABLE IS BASED ON A VARIABLE CLEARANCE OF 1 11/16 TO 2 1/16 BETWEEN THE FACE OF BEAM WEB AND END OF C15 × 33.9.

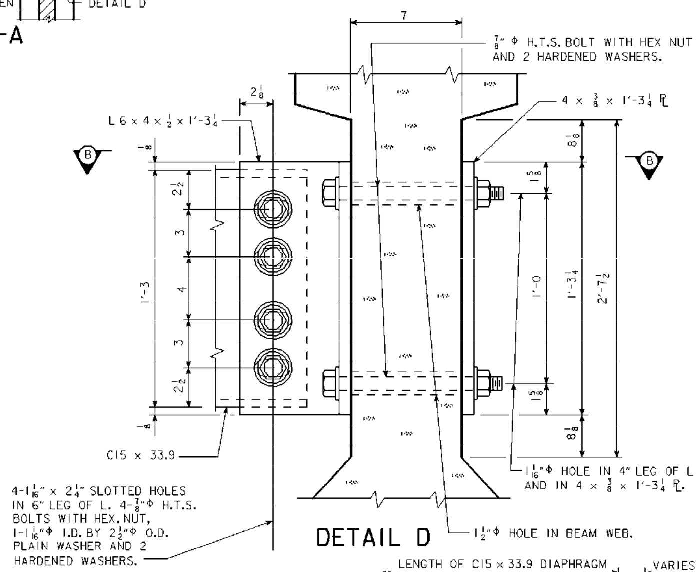
DIAPHRAGM WEIGHTS

UNIT WEIGHT	NUMBER OF DIAPHRAGMS	
221.5 LB	15	3323

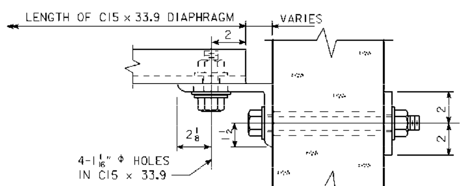
DIAPHRAGM CONNECTION BOLTS

8 - 7/8"Φ × 0′-2 3/4 H.T.S. BOLTS WITH NUTS AND WASHERS, PER UNIT DIAPHRAGM	NUMBER OF DIAPHRAGMS	
10.3 LB	15	155

WESTBOUND BRIDGE INTERMEDIATE DIAPHRAGM STRUCTURAL STEEL (TOTAL LB) =	4431
EASTBOUND BRIDGE INTERMEDIATE DIAPHRAGM STRUCTURAL STEEL (TOTAL LB) =	4431



DETAIL D



SECTION B-B

DESIGN FOR 32° SKEW (L.A.)

DUAL 223′-0 × 40′-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70′-9 & 60′-9 END SPANS 91′-6 INTERIOR SPAN

STEEL INTERMEDIATE DIAPHRAGM DETAILS

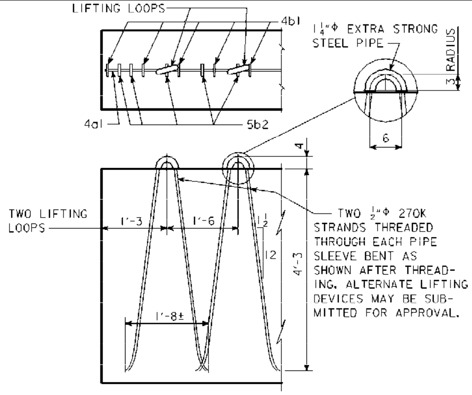
STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

JEFFERSON COUNTY

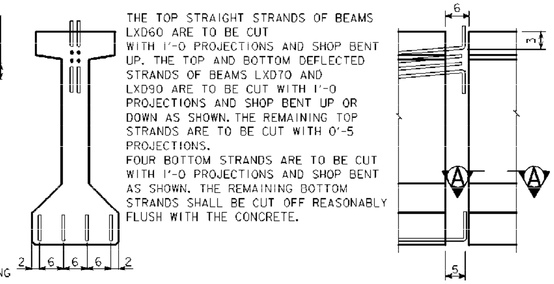
IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 23 OF 32 FILE NO. 29488 DESIGN NO. 1203

REVISED 09-03 - MINOR WASHER SIZE CHANGED, CHANGE TO NOTES ABOUT BOLT REQUIREMENTS, SEAL END OF BEAM AT STUB ABUTMENTS.
ENGLISHBEAMS.DGN 1036 - THIS SHEET ISSUED 9-8-88

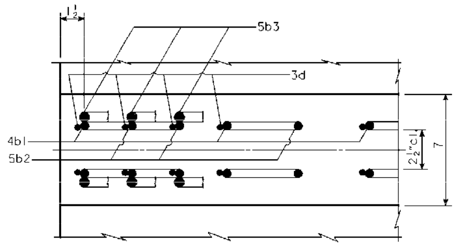


LIFTING LOOP DETAIL



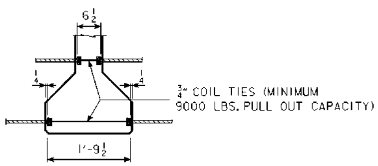
THE TOP STRAIGHT STRANDS OF BEAMS LXD60 ARE TO BE CUT WITH 1'-0 PROJECTIONS AND SHOP BENT UP. THE TOP AND BOTTOM DEFLECTED STRANDS OF BEAMS LXD70 AND LXD90 ARE TO BE CUT WITH 1'-0 PROJECTIONS AND SHOP BENT UP OR DOWN AS SHOWN. THE REMAINING TOP STRANDS ARE TO BE CUT WITH 0'-5 PROJECTIONS.
FOUR BOTTOM STRANDS ARE TO BE CUT WITH 1'-0 PROJECTIONS AND SHOP BENT AS SHOWN. THE REMAINING BOTTOM STRANDS SHALL BE CUT OFF REASONABLY FLUSH WITH THE CONCRETE.

STRAND PROJECTION AT BEAM ENDS WHEN EMBEDDED IN CONCRETE END DIAPHRAGMS



SECTION A-A SHOWING PLACEMENT OF STIRRUPS NEAR END OF BEAM

NUMBER AND EXACT LOCATION OF COIL TIES TO BE AS DETAILED ON SPECIFIC BRIDGE DESIGN.



COIL TIE DETAIL

DESIGN STRESSES:

DESIGN STRESSES FOR THE FOLLOWING MATERIALS ARE TO BE IN ACCORDANCE WITH A.A.S.H.T.O. STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, SERIES OF 1989:
REINFORCING STEEL IN ACCORDANCE WITH SECTION 8, GRADE 60.
CONCRETE IN ACCORDANCE WITH SECTION 9, f'c = 5000 psi.
PRESTRESSING STEEL IN ACCORDANCE WITH SECTION 9, f's = 270,000 psi.

SPECIFICATIONS:

CONSTRUCTION: STANDARD SPECIFICATIONS OF THE IOWA DEPARTMENT OF TRANSPORTATION, CURRENT SERIES, WITH CURRENT APPLICABLE SPECIAL PROVISIONS AND SUPPLEMENTAL SPECIFICATIONS.

DESIGN: A.A.S.H.T.O., SERIES OF 1989, WITH MINOR MODIFICATIONS.

ΔΔ 4b1 BARS TO BE EPOXY COATED

A/B: A=SIZE, B=NO.

LXD BEAM DATA

BEAM	SPAN LENGTH ℄-℄ BEARING	OVERALL BEAM LENGTH (L)	# STRAND SIZE	NO. OF STRANDS: STRAIGHT	NO. OF STRANDS: DEFLECTED	TOTAL INITIAL PRESTRESS KIPS ③	HOLD DOWN FORCE-KIPS	CAMBER (in.) AT RELEASE		CAMBER (in.) AFTER LOSSES		DEFLECTION (in.) Δ_D IMMEDIATE ① (ELASTIC) Δ_I	STEEL DIAPH.	DEFLECTION TIME ② (PLASTIC) Δ_T	STEEL DIAPH.	PERMISSIBLE SPACING		HS20 LOADING	STEEL DIAPH.	WEIGHT (TONS)		CONCRETE (C.Y.)	REINFORCING STEEL - (lbs.)
LXD60	60'-0	61'-0	$\frac{1}{2}$"Φ	19	—	570	——	0.20		0.34			0.24		0.06				7'-6	20.3		10.0	623
LXD70	70'-0	71'-0	$\frac{1}{2}$"Φ	14	6	600	24.6	0.58		1.02			0.43		0.11				7'-6	23.6		11.7	902
LXD90	90'-0	91'-0	$\frac{1}{2}$"Φ	20	8	867	27.7	1.24		2.17			1.16		0.29				7'-6	30.4		15.0	1227

① DEFLECTIONS AT MID-SPAN DUE TO WEIGHT OF SLAB AND DIAPHRAGM. THE DEFLECTIONS SHOWN ARE FOR A SLAB WEIGHT OF 760 #/FT. (8" SLAB AND 7'-6 BEAM SPACING) AND ONE CONCRETE DIAPHRAGM (3191 #) OR ONE STEEL DIAPHRAGM (285 #) AT ℄ OF SPAN. FOR DIFFERENT SLAB AND DIAPHRAGM WEIGHTS, DEFLECTIONS WILL BE DIRECTLY PROPORTIONAL.

② DEFLECTIONS DUE TO THE COMBINED EFFECT OF CREEP DUE TO WEIGHT OF SLAB AND SHRINKAGE OF SLAB.

TOTAL BEAM DEFLECTIONS AT ℄ OF SPAN, Δ_D, DUE TO WEIGHT OF SLAB AND DIAPHRAGMS FOR DETAILING PURPOSE:
(A) $\Delta_D = \Delta_I + \Delta_T$ FOR SIMPLE SPAN.
(B) $\Delta_D = \Delta_I + \frac{3}{4}\Delta_T$ FOR END SPANS OF CONTINUOUS BRIDGE.
(C) $\Delta_D = \Delta_I + \frac{1}{2}\Delta_T$ FOR INTERIOR SPANS OF CONTINUOUS BRIDGE.

③ TOTAL INITIAL PRESTRESS FOR LXD60 AND LXD70 IS BASED ON 72.664% f's, AND FOR LXD90 ON 75% f's.
f's = 270 ksi AND As = 0.153 sq. in.

NOTES: (CONTINUED)

HOLES MUST BE CAST IN THE WEB TO ACCOMMODATE THE STEEL DIAPHRAGM ATTACHMENTS AS DETAILED ON THE STEEL DIAPHRAGM DETAIL SHEET.

IF SOLE PLATE IS REQUIRED FOR BEARING, SOLE PLATE IS TO BE SET IN FORMS WHEN BEAM IS CAST AND FORMED OUT BELOW TO EXCLUDE CONCRETE AS DETAILED ON THE BEARING SHEET.

NOTES:

THESE BEAMS ARE DESIGNED FOR AASHTO LIVE LOADS AS INDICATED IN ABOVE TABLE WITH AN ALLOWANCE OF 20 lb. PER SQUARE FOOT OF ROADWAY FOR FUTURE WEARING SURFACE.

HOLD DOWN POINTS FOR DEFLECTED STRANDS MAY BE MOVED TOWARD ENDS OF BEAM A DISTANCE OF 0.05 L MAXIMUM AT PRODUCER'S OPTION.

ALL PRESTRESSING STRANDS SHALL CONFORM TO ASTM A416 GRADE 270 LOW RELAXATION STRANDS.

TOPS OF BEAMS ARE TO BE STRUCK OFF LEVEL & INTENTIONALLY ROUGHENED TRANSVERSELY TO A FULL AMPLITUDE OF APPROXIMATELY $\frac{1}{4}$" EXCEPT A 2 INCH WIDE FINISH SHALL BE PROVIDED ON THE TOP EDGE ON ONE SIDE ONLY OF THE BEAM.

BEARINGS SHALL BE AS DETAILED ON OTHER DESIGN SHEETS.

BEAMS TO BE USED IN BRIDGES MADE CONTINUOUS BY THE POURED IN PLACE FLOOR, ARE TO BE AT LEAST 28 DAYS OLD BEFORE THE FLOOR IS PLACED UNLESS A SHORTER CURING TIME IS APPROVED BY THE BRIDGE ENGINEER.

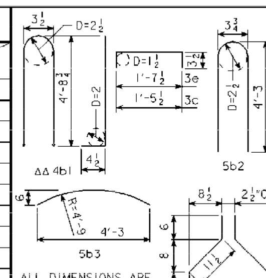
THE PORTIONS OF THE PRESTRESS BEAMS THAT ARE TO BE EMBEDDED IN THE ABUTMENT AND PIER DIAPHRAGMS SHALL BE ROUGHENED FOR A DISTANCE OF 10" FROM THE BEAM END BY SANDBLASTING OR OTHER APPROVED METHODS TO PROVIDE SUITABLE BOND BETWEEN THE BEAM AND THE DIAPHRAGM IN IN ACCORDANCE WITH ARTICLE 2403.14 OF THE SPECIFICATIONS.

UNLESS OTHERWISE NOTED ALL BEAMS ARE TO BE INCREASED IN LENGTH BY .0005L TO COMPENSATE FOR ELASTIC SHORTENING, CREEP AND SHRINKAGE.

FOR TRANSPORTING, THE OVERHANG SHALL BE IN ACCORDANCE WITH ART. 2407.13 OF STD. SPEC., EXCEPT THE OVERHANG MAY BE INCREASED TO A MAXIMUM OF 9 FEET FOR THE LXD90 BEAM.

REINFORCING BAR LIST

BAR	SHAPE	LXD60 60'-0 NO.	LXD60 LENGTH	LXD70 70'-0 NO.	LXD70 LENGTH	LXD90 90'-0 NO.	LXD90 LENGTH
4a1		2	4'-0	2	4'-0	2	18'-0
a2		—	——	5/4	24'-4	5/4	30'-10
a3		—	——	6/2	27'-0	7/2	34'-0
ΔΔ4b1		51	10'-4	57	10'-4	74	10'-4
5b2		8	8'-8	10	8'-8	12	8'-8
5b3		8	4'-4	12	4'-4	20	4'-4
3c		51	2'-1	57	2'-1	74	2'-1
3d		51	5'-7	57	5'-7	74	5'-7
3e		12	2'-3	14	2'-3	14	2'-3



ALL DIMENSIONS ARE OUT TO OUT.
RADIUS TO ℄ BAR.
D = PIN DIAMETER.

$\frac{1}{2}$" DIAMETER STRANDS STRESSED TO NOT MORE THAN 3,000 LBS. EACH MAY BE USED IN LIEU OF THE a BARS WHICH RUN THE FULL LENGTH OF THE BEAM IN THE TOP FLANGE.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 × 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS — 91'-6 INTERIOR SPAN

LXD BEAM DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) — MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 24 OF 32 — FILE NO. 29488 — DESIGN NO. 1203

REVISED 05-04 - BARS 4b1 CHANGED TO EPOXY COATED. ENGLISHBEAMS.DGN 4630 - THIS SHEET ISSUED 06-01-90

DESIGN TEAM EDS/GJK/DLB	LXD BEAMS	STANDARD SHEET 4630	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 25

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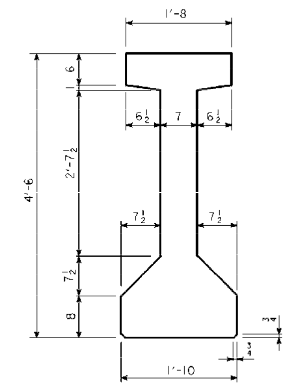
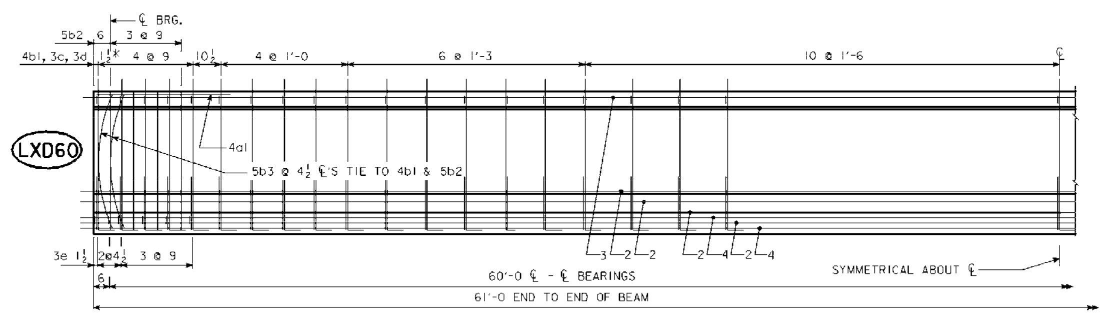
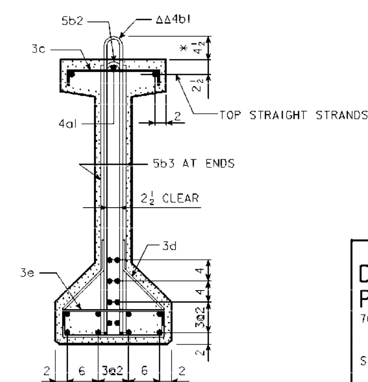


TYPICAL "LXD" BEAM CROSS SECTION

AREA = 638.75 in.^{2}
Y_b = 24.37 in.
I = 214,974 in.^{4}





BEAM LXD60

* KEEP
ΔΔ EPOXY COATED BARS

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 × 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS — 91'-6 INTERIOR SPAN

LXD60 BEAM DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) — MAY, 2006

JEFFERSON COUNTY

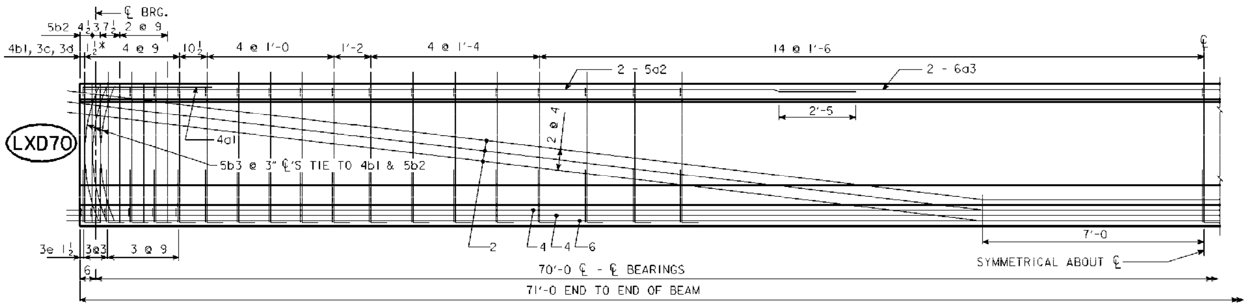
IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

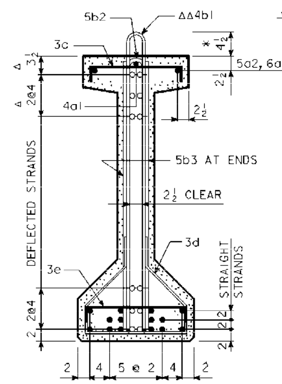
DESIGN SHEET NO. 25 OF 32 FILE NO. 29488 DESIGN NO. 1203

REVISED 05-04 - BARS 4b1 CHANGED TO EPOXY COATED. ENGLISHBEAMS.DGN 4632 - THIS SHEET ISSUED 06-01-90

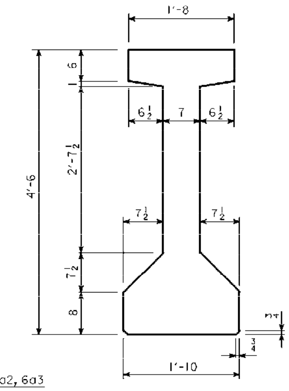
DESIGN TEAM EDS/GJK/DLB	LXD BEAMS	STANDARD SHEET 4632	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 26

NOTE: DIMENSIONS FOR THE LOCATION OF THE DEFLECTED STRANDS ARE AT ℄ BEAM AND END OF BEAM.





BEAM LXD70



TYPICAL "LXD" BEAM CROSS SECTION

AREA = 638.75 in.^{2}
Y_b = 24.37 in.
I = 214,974 in.^{4}

○ DEFLECTED STRANDS
* KEEP
Δ DIMENSIONS AT END OF BEAM
ΔΔ EPOXY COATED BARS

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS — 91'-6 INTERIOR SPAN

LXD70 BEAM DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) — MAY, 2006

JEFFERSON COUNTY

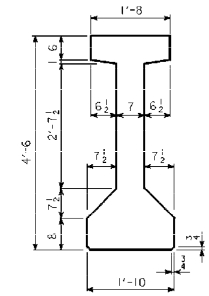
IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 26 OF 32 FILE NO. 29488 DESIGN NO. 1203

REVISED 05-04 - BARS 4b1 CHANGED TO EPOXY COATED.
ENGLISHBEAMS.DGN 4633 - THIS SHEET ISSUED 06-01-90

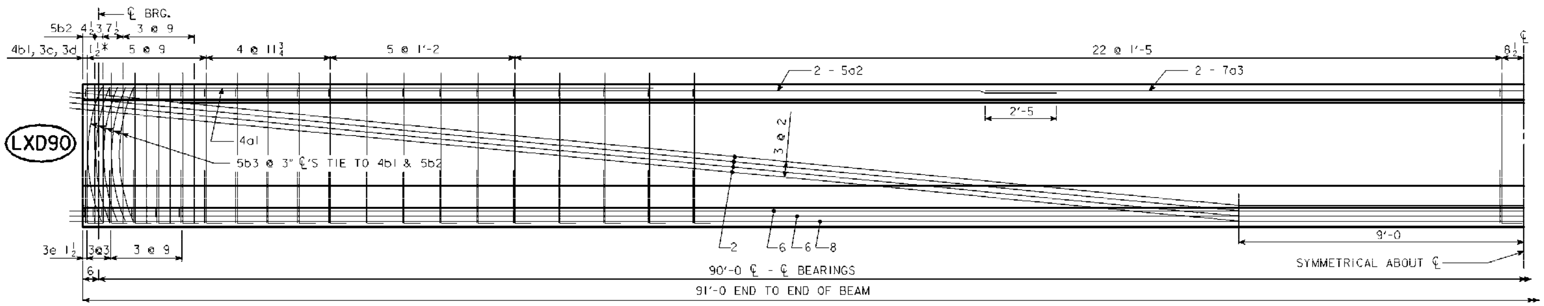
DESIGN TEAM EDS/GJK/DLB	LXD BEAMS	STANDARD SHEET 4633	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 27

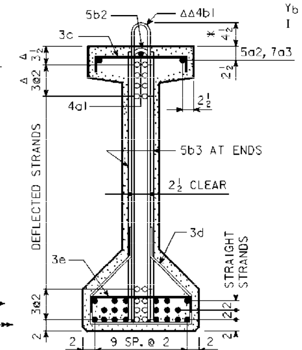
NOTE: DIMENSIONS FOR THE LOCATION OF THE DEFLECTED STRANDS ARE AT ℄ BEAM AND END OF BEAM.



TYPICAL "LXD" BEAM CROSS SECTION

AREA = 638.75 in.²
Yb = 24.37 in.
I = 214,974 in.⁴





BEAM LXD90

○ DEFLECTED STRANDS
* KEEP
Δ DIMENSIONS AT END OF BEAM
ΔΔ EPOXY COATED BARS

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

LXD90 BEAM DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

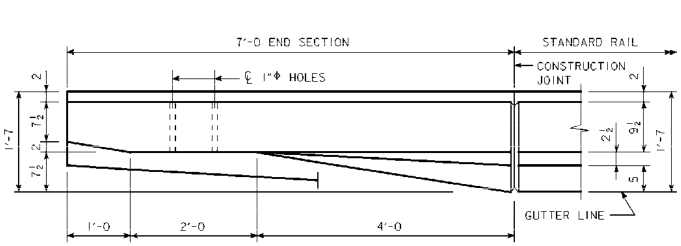
JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

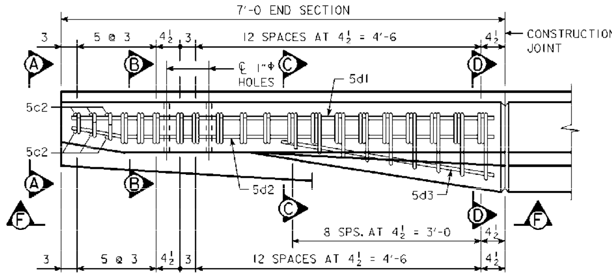
DESIGN SHEET NO. 27 OF 32 FILE NO. 29488 DESIGN NO. 1203

REVISED 05-04 - BARS 4b1 CHANGED TO EPOXY COATED.
ENGLISHBEAMS.DGN 4634 - THIS SHEET ISSUED 06-01-90

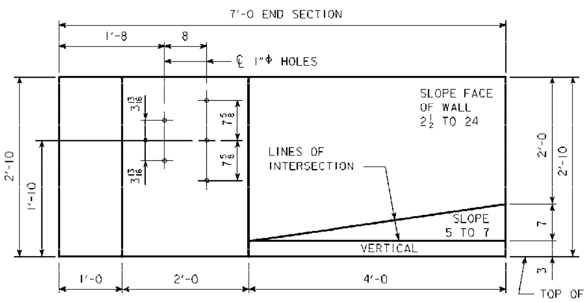
DESIGN TEAM EDS/GJK/DLB	LXD BEAMS	STANDARD SHEET 4634	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 28



PART PLAN VIEW

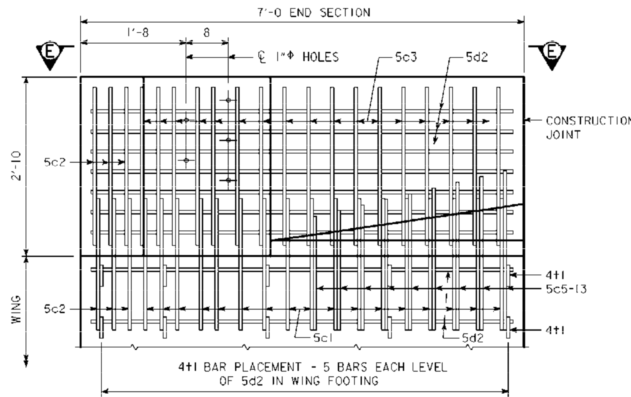


PART VIEW E-E

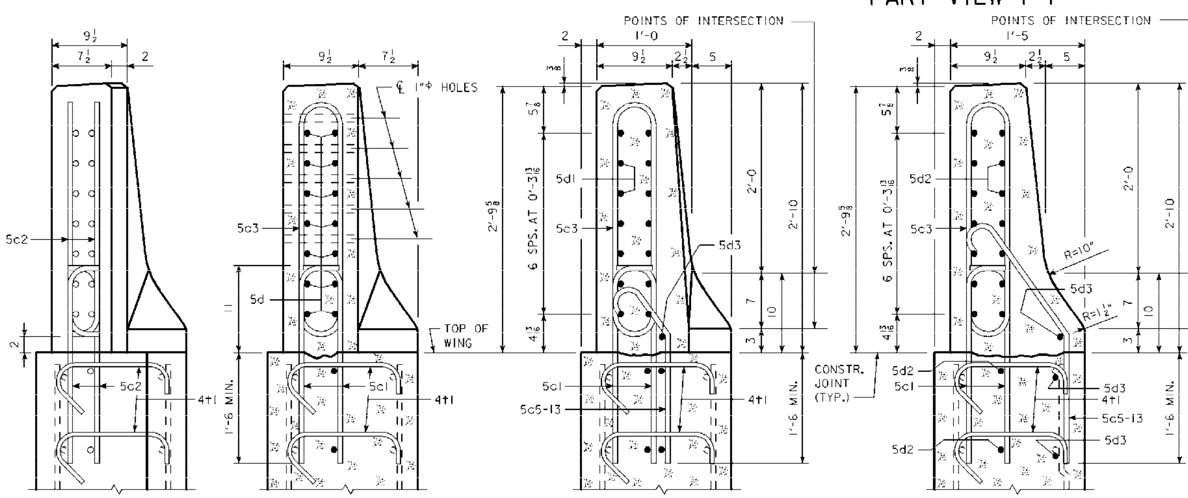


PART ELEVATION VIEW

PROVIDE 5 HOLES FORMED WITH 1"Φ PLASTIC CONDUIT. COST TO BE INCLUDED IN PRICE BID FOR CONCRETE BARRIER RAILING.



PART VIEW F-F



VIEW A-A

SECTION B-B

SECTION C-C

SECTION D-D

NOTE:
CONSTRUCTION JOINT BETWEEN TOP OF WING AND BARRIER RAIL IS ROUGHENED CONCRETE.

NOTE:
THE 10" RADIUS AND 1½" RADIUS ARE TYPICAL AND SHALL BE USED WHEN CONSTRUCTING THE CORNERS FOR VIEW A-A, SECTION B-B, SECTION C-C AND SECTION D-D.

NOTE:
THE 5c1, 6 - 5c2, 5c5-13, 2 - 5d2, 2 - 5d3 AND 4t1 BARS ARE TO BE PLACED WITH THE ABUTMENT WING FOOTING. THE DETAILS FOR PLACEMENT ARE SHOWN ON THE SUPERSTRUCTURE DETAIL SHEET.

NOTE:
DASHED LINES BELOW THE TOP OF WING ARE THE ABUTMENT WING REINFORCING STEEL. SEE SUPERSTRUCTURE DETAIL SHEETS FOR PLACEMENT.

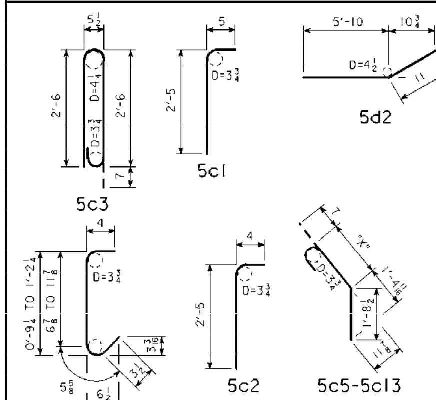
EPOXY REINFORCING STEEL - ONE END SECTION

BAR	LOCATION	SHAPE	NO.	LENGTH	WEIGHT
5c1	VERTICAL, RAIL TO WING FOOTING		34	2'-10	100
5c2	VERTICAL AT NOSE, RAIL TO WING FOOTING		12	2'-9	34
5c3	VERTICAL		17	6'-1	108
5c5-13	VERTICAL		9	VARIES	35
5d1	HORIZONTAL		7	6'-8	49
5d2	HORIZONTAL		9	6'-9	63
5d3	HORIZONTAL		3	3'-5	11
4t1	WING FOOTING TIE BARS		10	VARIES	13
(INCLUDE WITH BARRIER RAIL REINFORCING)				TOTAL WEIGHT (LBS.)	413

CONCRETE PLACEMENT SUMMARY

SECTION	TOTAL
BARRIER RAIL ONE END SECTION	0.62 CU. YD.

BENT BAR DETAILS



NOTE: ALL DIMENSIONS ARE OUT TO OUT.
D = PIN DIAMETER.

BAR	"X"
5c5	1'-0 3/16
5c6	1'-1 7/16
5c7	1'-2 11/16
5c8	1'-3 15/16
5c9	1'-4 1/8
5c10	1'-6 3/8
5c11	1'-7 5/8
5c12	1'-8 7/8
5c13	1'-10 1/8

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 × 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS   91'-6 INTERIOR SPAN

END SECTION DETAILS - WEST & EAST BOUND

STA. 356+70.31 (℄ OFF. RELOC. U.S.34)   MAY, 2006

JEFFERSON COUNTY

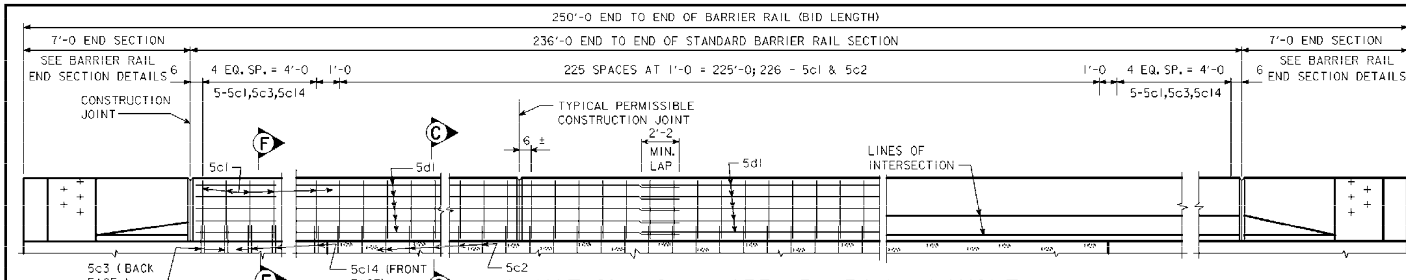
IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 28 OF 32   FILE NO. 29488   DESIGN NO. 1203

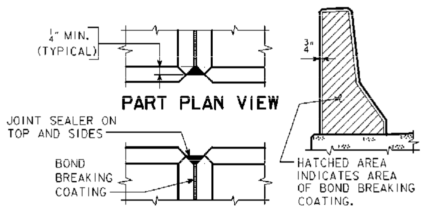
CORRECTIONS 09-03 - MINOR CHANGES TO NOTES.
ENGLISHDECKRAILBRIDGES.DGN 1017 - THIS SHEET ISSUED 09-01

DESIGN TEAM EDS/GJK/DLB	BARRIER RAIL END SECTION DETAILS WITH 7'-0 WING	STANDARD SHEET 1017	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 29

27-APR-2006 07:15   dbackou   W:\Projects\51034030A94\BRFinal\51034105_1203.brg   511203s028   \\NTPPRTSVR2\BrgTif



ELEVATION OF BARRIER RAIL LAYOUT



BARRIER RAIL JOINT DETAILS

NOTE:
ALL DIMENSIONS ARE MEASURED ALONG GRADE.

NOTE :
CONDUIT AND JUNCTION BOXES TO BE PLACED IN NORTH RAIL OF WESTBOUND BRIDGE AND PLACED IN SOUTH RAIL OF EASTBOUND BRIDGE.

REINFORCING BAR LIST - F-SHAPE BARRIER RAIL
(ONE BRIDGE WITH WING EXTENSIONS - TWO RAILS)

	SECTION	BAR	LOCATION	SHAPE	NO.	LENGTH	WEIGHT
EPOXY COATED	STD. SECT.	5c1	VERTICAL		472	5'-11	2,913
		5c2	VERTICAL		452	6'-0	2,829
		5c3	VERTICAL		20	2'-10	59
		5c14	VERTICAL		20	3'-10	80
		5d1	LONGITUDINAL		126	35'-7	4,676
	END SECT.	BARRIER RAIL END SECTIONS 4 @ 413					1,652
		(INCLUDE WITH SUPERSTRUCTURE REINFORCING)				TOTAL (LB)	12,209

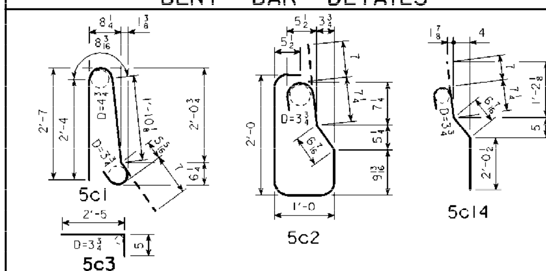
CONCRETE PLACEMENT SUMMARY
(ONE BRIDGE WITH WING EXTENSIONS - TWO RAILS)

SECTION	TOTAL
STANDARD SECTION 472 FT. AT 0.1052 C.Y. PER FT.	49.7
BARRIER RAIL END SECTIONS 4 AT 0.62 C.Y.	2.5
TOTAL C.Y.	52.2

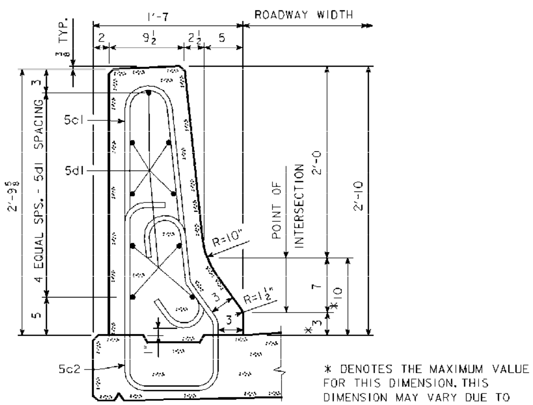
CONCRETE BARRIER RAIL QUANTITIES

ITEM	UNIT	QUANTITY
CONCRETE BARRIER RAILING	L.F.	500

BENT BAR DETAILS

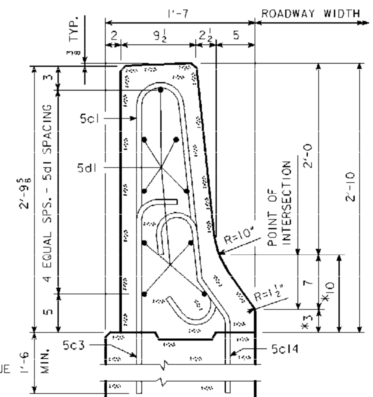


ALL DIMENSIONS ARE OUT TO OUT. D = PIN DIAMETER.



PART SECTION C-C

* DENOTES THE MAXIMUM VALUE FOR THIS DIMENSION. THIS DIMENSION MAY VARY DUE TO CONSTRUCTION INACCURACIES.



PART SECTION F-F

BARRIER RAIL NOTES:

MINIMUM CLEAR DISTANCE FROM FACE OF CONCRETE TO NEAR REINFORCING BAR IS TO BE 2" UNLESS OTHERWISE NOTED OR SHOWN.

THE PERMISSIBLE CONSTRUCTION JOINTS ARE TO BE PLACED BETWEEN VERTICAL BARS AT A MINIMUM SPACING OF 20 FEET. CONSTRUCTION JOINT CONTACT SURFACES ARE TO BE COATED WITH AN APPROVED BOND BREAKER.

COST OF THE JOINT SEALER AND BOND BREAKER SHALL BE CONSIDERED INCIDENTAL TO OTHER CONSTRUCTION.

ALL BARRIER RAIL REINFORCING STEEL IS TO BE EPOXY COATED.

THE CONCRETE BARRIER RAIL IS TO BE BID ON A LINEAL FOOT BASIS. THE NUMBER OF LINEAL FEET OF BARRIER RAIL INSTALLED WILL BE PAID FOR AT THE CONTRACT PRICE PER LINEAL FOOT BASED ON PLAN QUANTITIES. PRICE BID FOR CONCRETE BARRIER RAILING SHALL BE FULL COMPENSATION FOR FURNISHING ALL MATERIAL, EXCLUDING REINFORCING STEEL, AND ALL OF THE EQUIPMENT AND LABOR REQUIRED TO ERECT THE RAIL IN ACCORDANCE WITH THESE PLANS AND CURRENT SPECIFICATIONS. IF CONDUIT IS REQUIRED IN THIS PLAN THE RIGID STEEL CONDUIT, JUNCTION BOXES AND FITTINGS INCLUDING LABOR AND ANY ADDITIONAL WORK TO DO THE INSTALLATION IS CONSIDERED INCIDENTAL TO THE COST OF THE RAILING.

ALL BARRIER RAIL REINFORCING STEEL IS TO BE INCLUDED WITH THE SUPERSTRUCTURE REINFORCING STEEL.

THE JOINT SEALER SHALL BE LIGHT GRAY NONSAG LATEX CAULKING SEALER MARKETED FOR OUTDOOR USE. NO TESTING OR CERTIFICATION IS REQUIRED.

TOP OF THE BARRIER RAIL IS TO BE PARALLEL TO THE THEORETICAL ℄ GRADE.

CROSS SECTIONAL AREA OF THE STANDARD SECTION OF THE BARRIER RAIL = 2.84 SQUARE FEET.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS — 91'-6 INTERIOR SPAN

BARRIER RAIL DETAILS

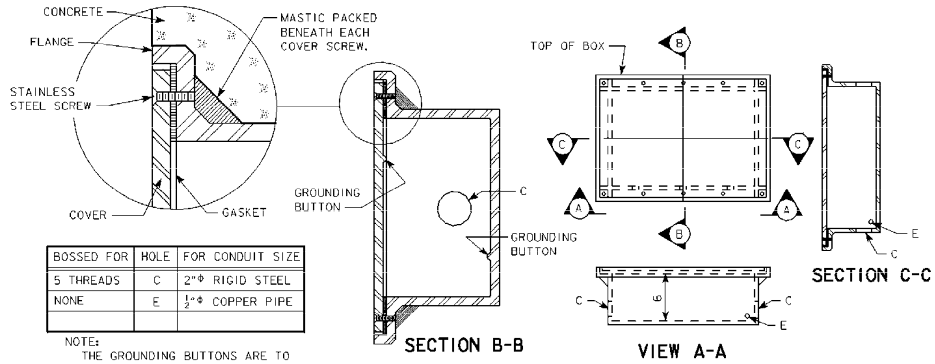
STA. 356+70.31 (℄ OFF. RELOC. U.S.34) — MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 29 OF 32 FILE NO. 29488 DESIGN NO. 1203

REVISED 09-03 - JUNCTION BOX DETAILS CHANGED. ANCHOR BOLTS TO BE GALVANIZED. CONDUIT USED FOR LIGHT POLE CHANGED FROM 1" TO 2". ANCHOR PLATE CHANGED TO 3" SLOT.
HE1030A.S01 (HSTD1030A.S01--LEP: THIS SHEET REDRAWN, DEVICE:ZHA0:(200,004) ARCH.TAPE NO. 15 DATE 9-8-88)



BOSSED FOR	HOLE	FOR CONDUIT SIZE
5 THREADS	C	2"Φ RIGID STEEL
NONE	E	½"Φ COPPER PIPE

NOTE:
THE GROUNDING BUTTONS ARE TO BE BLIND DRILLED AND TAPPED FOR ⅜"Φ x 0'-0¾ BOLTS.

RM-37, TYPE I JUNCTION BOX

WATERTIGHT, CAST IRON - FLUSH MOUNT

(SEE STANDARD ROAD PLAN RM-37 FOR ADDITIONAL DETAILS)

LIGHTING NOTES:

SEE RM-37 STANDARD ROAD PLAN FOR ADDITIONAL INFORMATION ON JUNCTION BOXES.

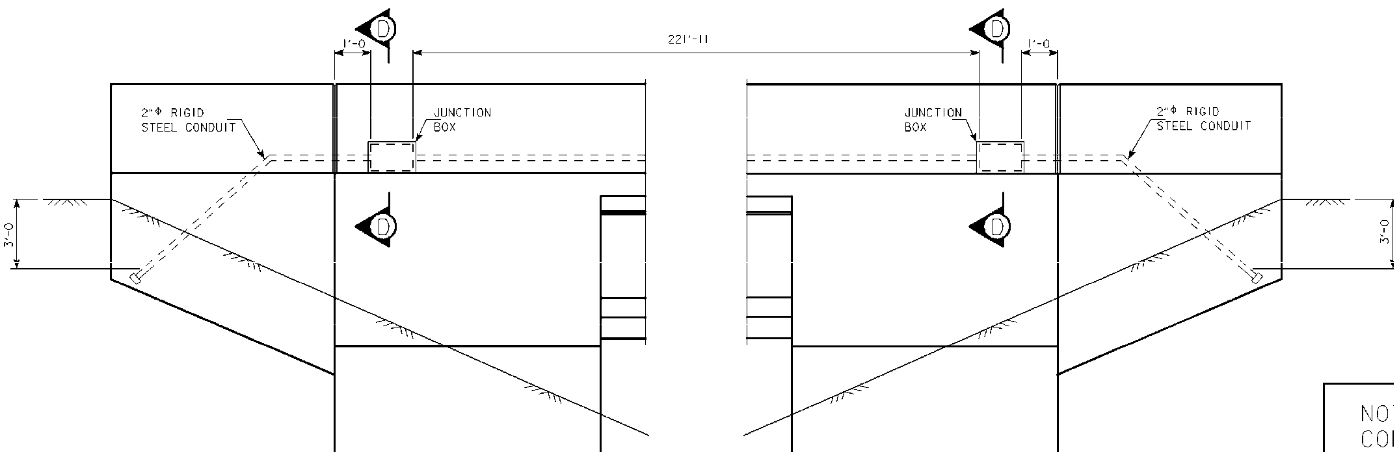
CONSTRUCTION SHALL CONFORM TO THE CURRENT IOWA D.O.T. STANDARD AND SUPPLEMENTAL SPECIFICATIONS AND SPECIAL PROVISIONS.

CONDUIT INSTALLATION SHALL COMPLY WITH THE ARTICLE "ELECTRICAL DUCTS", SECTION 2523.

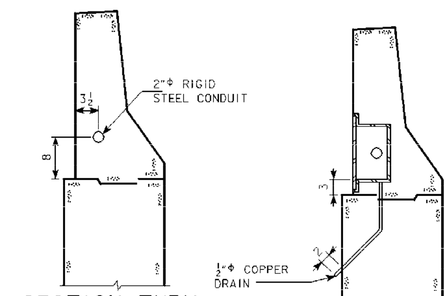
ALL "C" ENTRANCE HOLES IN JUNCTION BOXES SHALL BE DRILLED AND TAPPED FOR THE SPECIFIED CONDUIT SIZE. ALL OTHER HOLES SHALL HAVE A CONCRETE - TIGHT SLIP FIT. CONDUIT ENDS SHALL NOT PROTRUDE INTO JUNCTION BOX MORE THAN ¼". DRAIN PIPE END SHALL BE FLUSH WITH INSIDE SURFACE OF BOX. GROUNDING BUTTONS SHALL BE LOCATED APPROXIMATELY 3" FROM THE INSIDE SURFACE OF THE BOX WALL, AND NOT CLOSER THAN 3" TO THE EDGE OF ANY HOLE IN THE BOX FLOOR. HOLES FOR DRAIN PIPE SHALL BE PLACED IN THE LOW CORNER OF THE BOX, WITH A MINIMUM CLEARANCE OF 1" BETWEEN THE EDGE OF THE HOLE AND THE INSIDE SURFACE OF THE BOX WALL. TYPICAL DETAILS ARE SHOWN ON THIS SHEET.

THE RIGID STEEL CONDUIT, JUNCTION BOXES AND FITTINGS INCLUDING LABOR AND ANY ADDITIONAL WORK TO DO THE INSTALLATION IS CONSIDERED INCIDENTAL TO THE COST OF THE RAILING.

CONDUIT LENGTH		
2"Φ RIGID STEEL CONDUIT - WESTBOUND BRIDGE	248.0	LIN. FT.
2"Φ RIGID STEEL CONDUIT - EASTBOUND BRIDGE	248.0	LIN. FT.



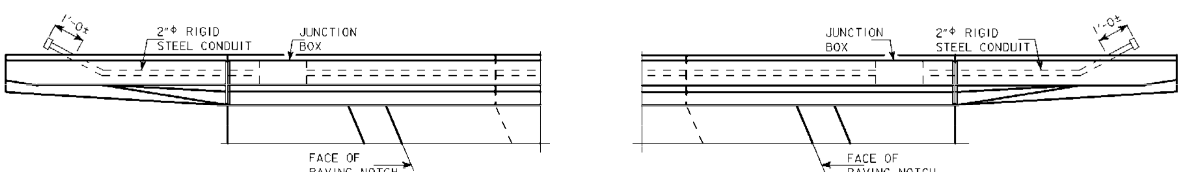
WESTBOUND EXTERIOR ELEVATION - NORTH BARRIER RAIL - LOOKING SOUTH
EASTBOUND EXTERIOR ELEVATION - SOUTH BARRIER RAIL - LOOKING NORTH



SECTION THRU BARRIER RAIL

SECTION D-D

NOTE :
CONDUIT AND JUNCTION BOXES TO BE PLACED IN NORTH RAIL OF WESTBOUND BRIDGE AND PLACED IN SOUTH RAIL OF EASTBOUND BRIDGE.



PART PLAN

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

LIGHTING DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

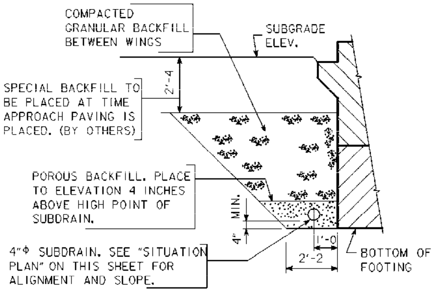
JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 30 OF 32 FILE NO. 29488 DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB	LIGHTING DETAILS	STANDARD SHEET 1030A	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 31

BENCH MARK: 20 - 1" x 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 339+36.52, 145.93 LT. ELEV. 732.415.



SECTION A-A

NOTE: SPECIAL BACKFILL MAY BE SUBSTITUTED FOR GRANULAR BACKFILL.

GRANULAR BACKFILL DETAILS

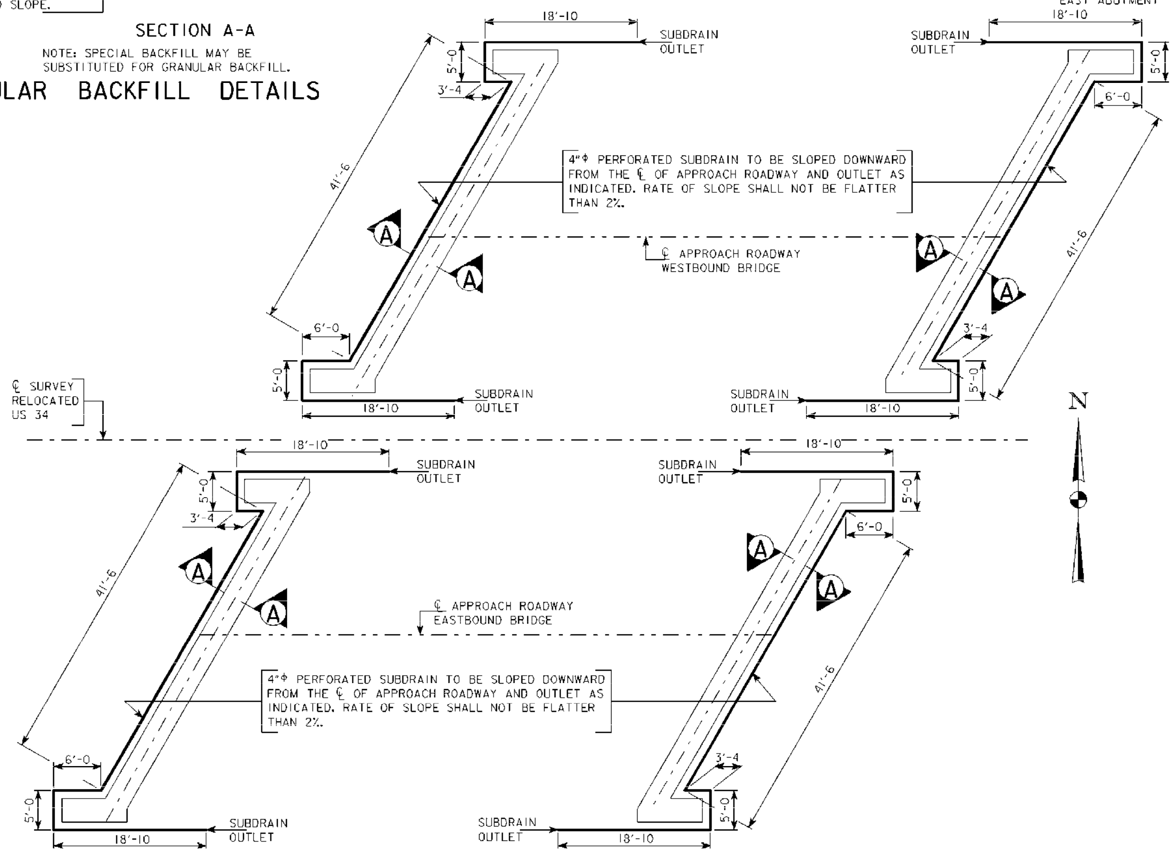
SUBDRAIN NOTES:

THIS PLAN SHEET SHOWS DETAILS FOR PLACING ALL SUBDRAINS AND SUBDRAIN OUTLETS REQUIRED FOR THIS STRUCTURE.

THE SUBDRAINS SHALL BE 4" IN DIAMETER AND MEET THE REQUIREMENTS OF SECTION 4143.01 B OF THE CURRENT I.D.O.T. STANDARD SPECIFICATION. THE SUBDRAIN OUTLET SHALL CONSIST OF A 6'-0 LENGTH OF PIPE WITH A REMOVABLE RODENT GUARD AS DETAILED ON THIS SHEET.

THE COST OF FURNISHING AND PLACING SUBDRAIN (INCLUDING EXCAVATION), GRANULAR BACKFILL, POROUS BACKFILL, AND SUBDRAIN OUTLET IS TO BE INCLUDED IN THE PRICE BID FOR "STRUCTURAL CONCRETE (BRIDGE)". NO EXTRA PAYMENT WILL BE MADE.

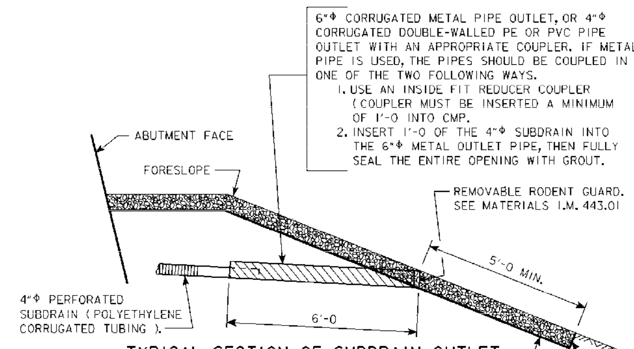
THE DIMENSIONS SHOWN FOR THE PROPOSED SUBDRAINS ARE BASED ON THE PROPOSED GRADING LAYOUT OF BRIDGE BERMS. THE DIMENSIONS SHOWN ARE FOR ESTIMATING ONLY. REQUIRED LENGTHS AND GENERAL LOCATIONS OF SUBDRAINS ARE SUBJECT TO CHANGE DUE TO FIELD ADJUSTMENTS OF THE GRADING LAYOUT.



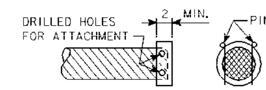
PART SITUATION PLAN

SHOWING SUBDRAIN LOCATION.

SUBDRAIN OUTLET ELEVATIONS		
LOCATION		ELEVATION
WESTBOUND BRIDGE	WEST ABUTMENT	691.75
	EAST ABUTMENT	688.10
EASTBOUND BRIDGE	WEST ABUTMENT	693.18
	EAST ABUTMENT	688.94



TYPICAL SECTION OF SUBDRAIN OUTLET



REMOVABLE RODENT GUARD DETAILS

OUTLET DETAILS

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS 91'-6 INTERIOR SPAN

SUBDRAIN DETAILS

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 31 OF 32 FILE NO. 29488 DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB	SUBDRAIN DETAILS (WATER CROSSING)	STANDARD SHEET 1007C	JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 32

ENGLISHFORESLOPEPROTECTIONBRIDGES.DGN 1007C - THIS SHEET ISSUED 06-02 FOR WATER CROSSINGS.

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GENERAL NOTES:

MACADAM STONE SHALL BE PLACED ALONG THE SIDE OF THE WING AND ABUTMENT FOOTING AS SHOWN IN DETAIL "A". THIS IS TYPICAL AT EACH CORNER OF THE BRIDGE UNLESS OTHERWISE NOTED IN THE PLANS. THE MACADAM STONE AT THESE LOCATIONS SHALL BE UNDERLAYED WITH ENGINEERING FABRIC MEETING THE REQUIREMENTS OF 4196.01 C.

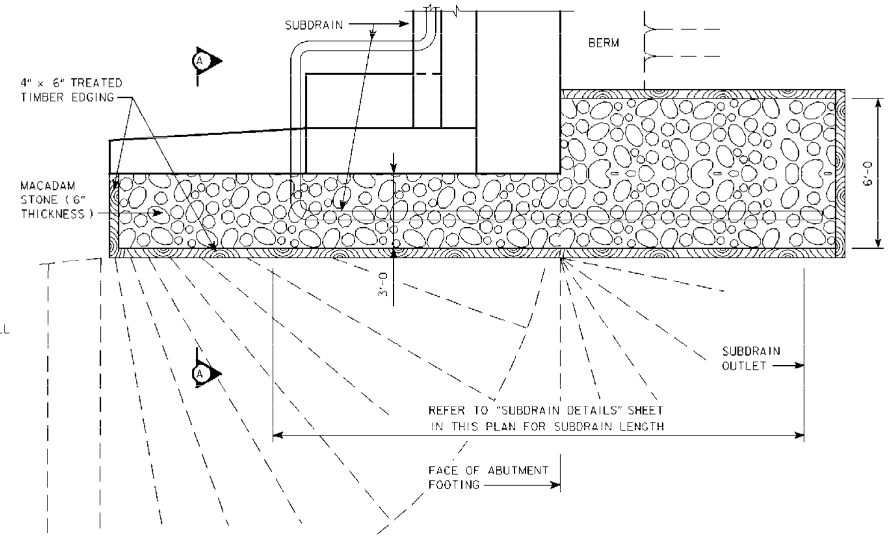
THE MACADAM STONE SHALL MEET THE REQUIREMENTS OF 4122.02, COARSE MATERIAL (NO CHOKE STONE IS ALLOWED).

WOOD PRESERVATIVE TREATMENT FOR THE TIMBER EDGING SHALL MEET THE REQUIREMENTS FOR GUARDRAIL POSTS, SAWED FOUR SIDES, AS SPECIFIED IN 4161.

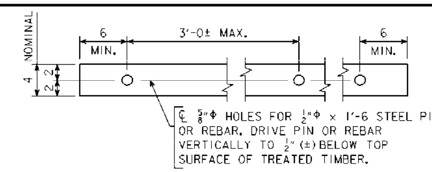
THE MACADAM STONE SHALL BE DEPOSITED, SPREAD, CONSOLIDATED AND SHAPED BY MECHANICAL OR HAND METHODS THAT WILL PROVIDE UNIFORM 6" DEPTH AND DENSITY AND PROVIDE UNIFORM SURFACE APPEARANCE.

PAYMENT FOR THE BRIDGE WING ARMORING AND MACADAM STONE SPLASH BASINS, SHALL BE INCIDENTAL TO THE BID ITEM "STRUCTURAL CONCRETE (BRIDGE)" AND SHALL INCLUDE COSTS OF ALL MATERIAL AND LABOR TO CONSTRUCT THE WING ARMORING AND SPLASH BASINS AS SHOWN ON THESE PLANS.

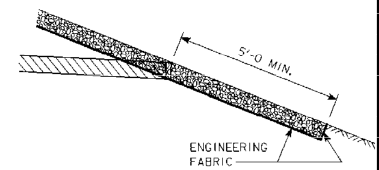
MACADAM STONE SPLASH BASINS AS DETAILED ON THIS SHEEET SHALL BE PLACED UNDER EACH DECK DRAIN. THE MACADAM STONE AT THESE LOCATIONS SHALL BE UNDERLAYED WITH ENGINEERING FABRIC MEETING THE REQUIREMENTS OF 4196.01C.



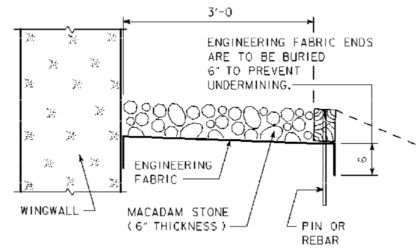
TOP VIEW OF WING ARMORING WITH WING EXTENSION



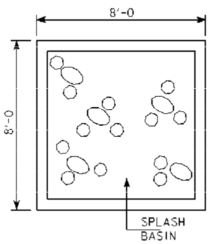
4" x 6" TREATED TIMBER EDGING DETAILS



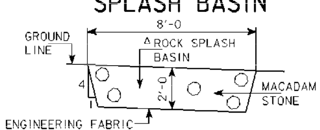
TYPICAL SECTION OF SUBDRAIN OUTLET



SECTION A-A

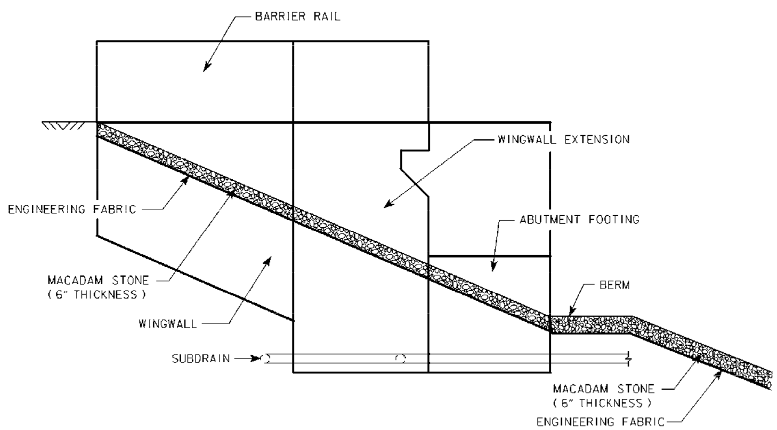


PLAN VIEW OF SPLASH BASIN



ELEVATION VIEW OF SPLASH BASIN

ΔMACADAM STONE SPLASH BASIN SHALL BE CENTERED DIRECTLY UNDER THE BRIDGE DRAIN, WHERE WATER WOULD OTHERWISE LAND ON SOIL.



PROFILE VIEW OF WING ARMORING WITH WING EXTENSION

REVISED 09-03 - DETAIL "A" CHANGED TO SECTION A-A.
ENGLISHFORESLOPEPROTECTIONBRIDGES.DGN 1005A - THIS SHEET ISSUED 06-02.

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

70'-9 & 60'-9 END SPANS — 91'-6 INTERIOR SPAN

BRIDGE WING ARMORING & SPLASH BASINS - WEST & EAST

STA. 356+70.31 (℄ OFF. RELOC. U.S.34) — MAY, 2006

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 32 OF 32 — FILE NO. 29488 — DESIGN NO. 1203

DESIGN TEAM EDS/GJK/DLB				JEFFERSON COUNTY	PROJECT NUMBER NHSN-034-8(105)--2R-51	SHEET NUMBER 33

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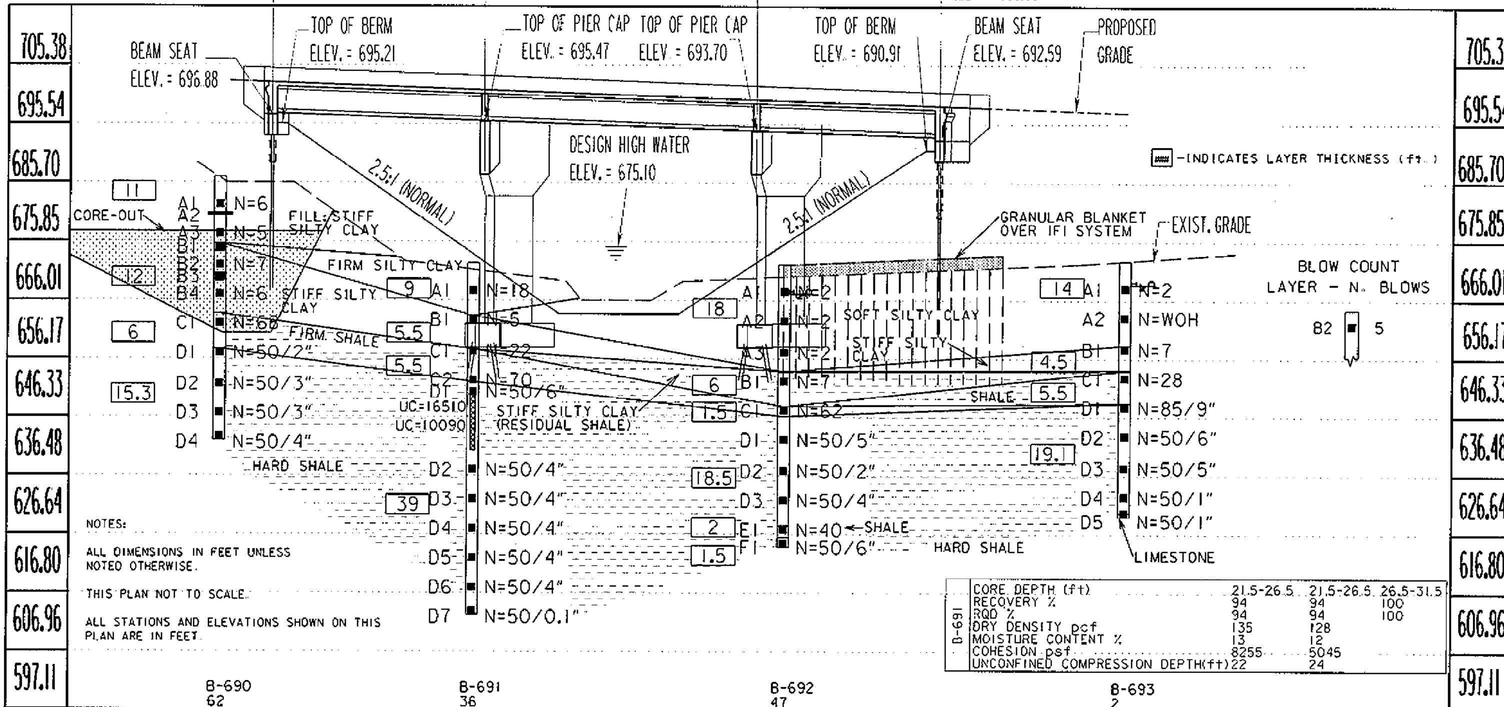
CUT MOISTURE	B-690	21,
CUT DENSITY (pcf)		104,
PLASTIC LIMIT		,

BENCH MARK: 20 - 1" x 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA. 339+09.097, 460.814 LT. ELEV 732.415

THIS SHEET IS INCLUDED TO SHOW SOIL INFORMATION. DETAILS AND NOTES SHOWN ELSEWHERE IN THESE PLANS SHALL BE USED FOR STRUCTURE CONSTRUCTION.



NOTES:

ALL DIMENSIONS IN FEET UNLESS NOTED OTHERWISE.

THIS PLAN NOT TO SCALE.

ALL STATIONS AND ELEVATIONS SHOWN ON THIS PLAN ARE IN FEET.

B-691			
CORE DEPTH (ft)	21.5-26.5	21.5-26.5	26.5-31.5
RECOVERY %	94	94	100
RQD %	94	94	100
DRY DENSITY pcf	135	128	
MOISTURE CONTENT %	13	12	
COHESION psf	8255	5045	
UNCONFINED COMPRESSION DEPTH(ft)	22	24	

LONGITUDINAL SECTION ALONG P. G. EASTBOUND ROADWAY

Previous Grading Contract included design and installation of Intermediate Foundation Improvement (IFI) system at east abutment. After installation of IFI system at east abutment, Grading Contractor to have installed 2 feet of granular blanket over IFI system. Grading contractor also to have placed 2 feet of surcharge (overload) fill over the subgrade at the top of the embankment. Approximate outline of IFI system is shown on the plan and profile of this sheet and surcharge fill is shown on the plan view of this sheet. Design criteria for the IFI system to have included less than 0.4 inches of remaining settlement after a delay of 60 days after fill placement. Settlement magnitude and rate to be evaluated and verified by a geotechnical engineer/IFI system designer using field data from Settlement Plates installed at the indicated locations by the Grading Contractor, prior to installing abutment piles.

Previous Grading Contract included installation of Core-out and replacement procedure at the west abutment. Approximate outline of the core-out and replacement is shown on this sheet.

Intermediate Foundation Improvement system was installed at East Abutment as part of previous Grading Contract. NHSX-34-8(94)--3H-51. Core-out and replacement procedure was performed at West Abutment as part of the previous Grading Contract NHSX-34-8(94)--3H-51. See sheets Q.08, Q.09, Q.10 and Q.11 of the Grading Contract, included as SPS sheets for this bridge, and which are included for informational purposes only, for additional information

NHSX-34-8(94)--3H-51 Q.08 on SPS.03
NHSX-34-8(94)--3H-51 Q.09 on SPS.04
NHSX-34-8(94)--3H-51 Q.10 on SPS.05
NHSX-34-8(94)--3H-51 Q.11 on SPS.06

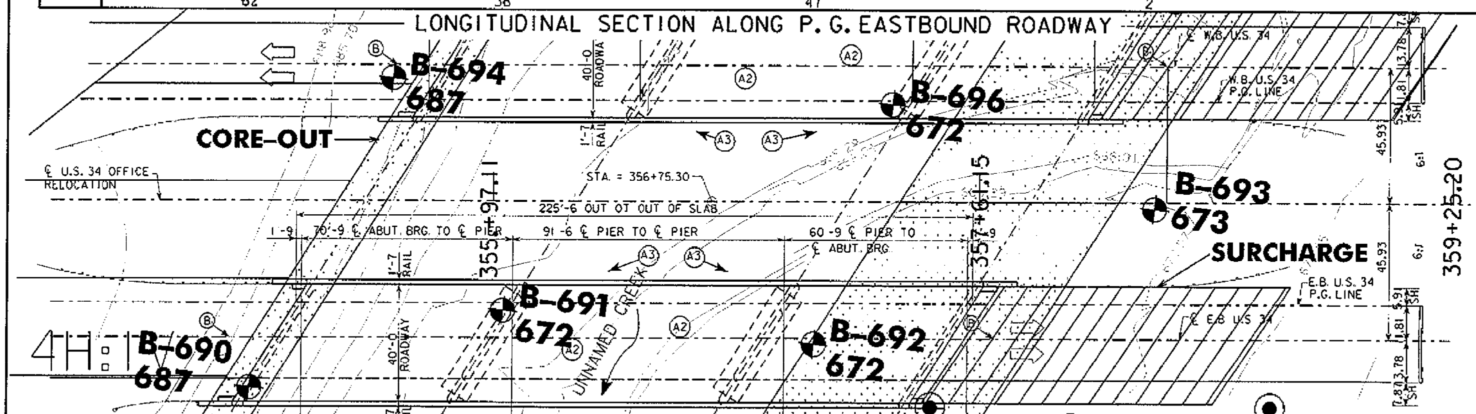
LOCATION

JEFFERSON COUNTY
T-71 N, R-10W
SECTION 2/3
LIBERTY TWP.
U.S. HWY OVER UNNAMED CREEK

Settlement Plate Detail
See Standard RL-6
Station 357+45, RT 69 feet
Station 358+60, RT 69 feet
Station 358+27, LT 69 feet
Station 360+07, LT 69 feet

SHELBY TUBE CORE DATA

BORING NO.	B-690	B-690
DEPTH IN FEET	11	16
CLASSIFICATION [AASHTO]	--	--
COEFF. CONSOL. sq.ft./DAY	--	--
TRIAXIAL COMPRESSION	UC	UC
COHESION - psf	1100	2820
FRICTION COEFF.	--	--
MOISTURE CONTENT %	18	19
DENSITY - pcf	104	110
UC-UNCONFINED COMPRESSION (c=1/2 Qu)		



SITUATION PLAN

CENS CORE · BLOW* · PLUGGED · SELECT SOIL · SELECT SAND · SHALE · SAMPLE · SHELBY · WATER · MOISTURE · UNSUITABLE · SANDY SOIL · ROCK

*140-lb CME Automatic SPT Hammer

GEOTECHNICAL DESIGN

I hereby certify that this plan was prepared under my supervision and that engineering decisions with regard to the design were made by me or by other duly licensed Professional Engineers under the laws of the State of Iowa.

Signature: Michael D. Ringler Date: Aug. 22, 2005
Printed or Typed Name: MICHAEL D. RINGLER
My license renewal date is December 31, 2005
Pages or sheets covered by this seal: SPS.01 - SPS.06

DESIGN FOR 32° SKEW (L.A.)

DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGE

INTEGRAL ABUTMENTS 70'-9, 60'-9 END SPANS
TEE PIERS 91'-6 CENTER SPAN

SOILS PROFILE SHEET

STA. 356+75.30

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 1 OF 6 · FILE NO. 29488 · DESIGN NO. 1203

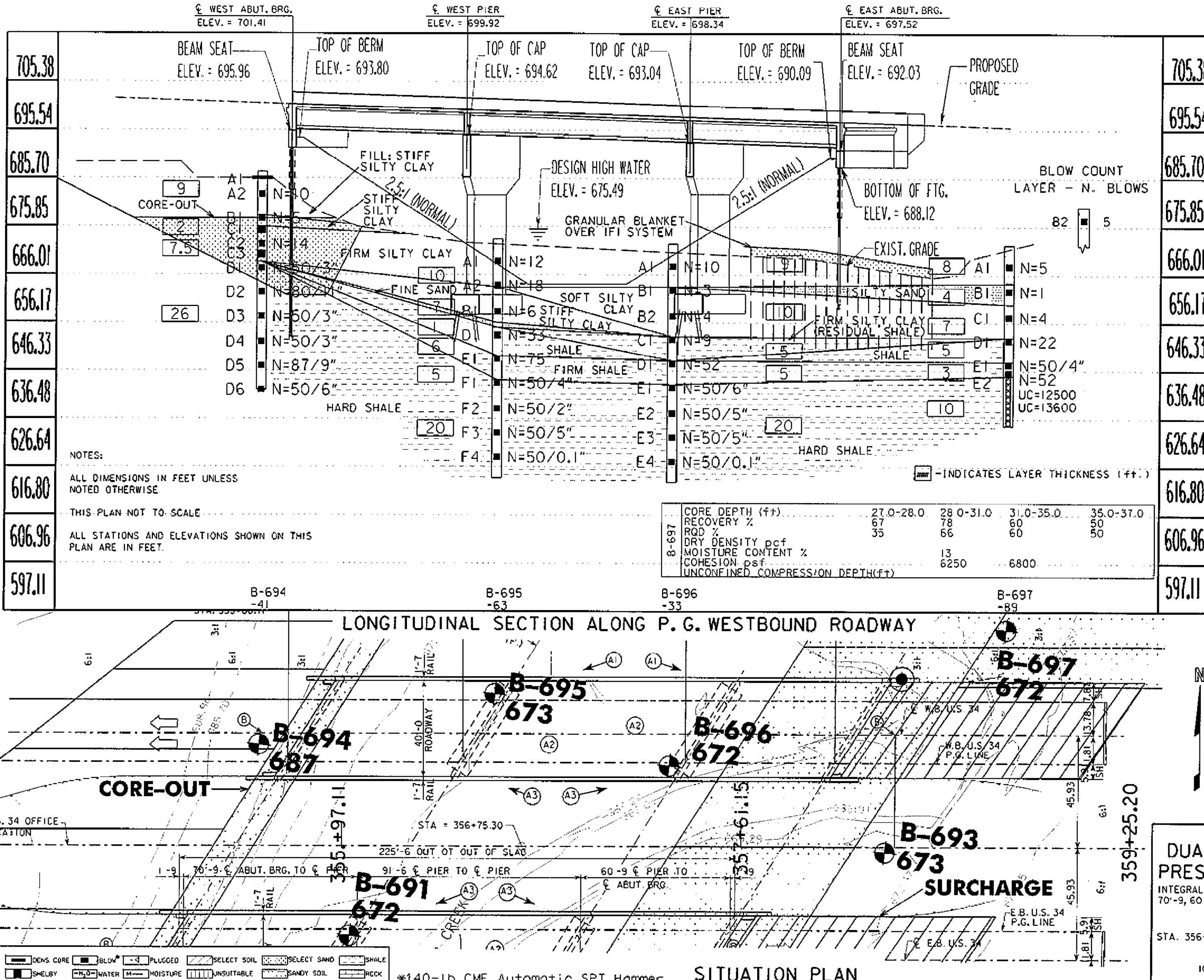
SHUCK-BRITSON INC · S.B.I. NO. 18797L · Terracon · JEFFERSON COUNTY · PROJECT NUMBER NHSX-034-8(105)--3H-51 · SHEET NUMBER SPS.01

CUT MOISTURE
CUT DENSITY (pcf)
PLASTIC LIMIT

B-694	12, 122, ,

BENCH MARK: 20 - 1" x 60" IRON PIPE NORTH OF LIBERTYVILLE ROAD EAST OF CP#89, STA 339+09.097, 460.814 LT ELEV 732.415

THIS SHEET IS INCLUDED TO SHOW SOIL INFORMATION. DETAILS AND NOTES SHOWN ELSEWHERE IN THESE PLANS SHALL BE USED FOR STRUCTURE CONSTRUCTION.



-■- INDICATES LAYER THICKNESS (ft.)

NOTES:

ALL DIMENSIONS IN FEET UNLESS NOTED OTHERWISE

THIS PLAN NOT TO SCALE

ALL STATIONS AND ELEVATIONS SHOWN ON THIS PLAN ARE IN FEET.

B-697				
CORE DEPTH (ft)	27.0-28.0	28.0-31.0	31.0-35.0	35.0-37.0
RECOVERY %	67	78	60	50
RQD %	35	66	60	50
DRY DENSITY pcf				
MOISTURE CONTENT %		13		
COHESION psf		6250	6800	
UNCONFINED COMPRESSION DEPTH(ft)				

Previous Grading Contract included design and installation of Intermediate Foundation Improvement (IFI) system at east abutment. After installation of IFI system at east abutment, Grading Contractor to have installed 2 feet of granular blanket over IFI system. Grading contractor also to have placed 2 feet of surcharge (overload) fill over the subgrade at the top of the embankment. Approximate outline of IFI system is shown on the plan and profile of this sheet and surcharge fill is shown on the plan view of this sheet. Design criteria for the IFI system to have included less than 0.4 inches of remaining settlement after a delay of 60 days after fill placement. Settlement magnitude and rate to be evaluated and verified by a geotechnical engineer/IFI system designer using field data from Settlement Plates installed at the indicated locations by the Grading Contractor, prior to installing abutment piles.

Previous Grading Contract included installation of Core-out and replacement procedure at the west abutment. Approximate outline of the core-out and replacement is shown on this sheet.

Intermediate Foundation Improvement system was installed at East Abutment as part of previous Grading Contract. NHSX-34-8(94)--3H-51. Core-out and replacement procedure was performed at West Abutment as part of the previous Grading Contract NHSX-34-8(94)--3H-51. See sheets Q.08, Q.09, Q.10 and Q.11 of the Grading Contract, included as SPS sheets for this bridge, and which are included for informational purposes only, for additional information.

NHSX-34-8(94)--3H-51 Q.08 on SPS.03
NHSX-34-8(94)--3H-51 Q.09 on SPS.04
NHSX-34-8(94)--3H-51 Q.10 on SPS.05
NHSX-34-8(94)--3H-51 Q.11 on SPS.06

◉ Settlement Plate Detail
See Standard RL-6
Station 357+45, RT 69 feet
Station 358+60, RT 69 feet
Station 358+27, LT 69 feet
Station 360+07, LT 69 feet

SHELBY TUBE CORE DATA

BORING NO.	B-694	B-694
DEPTH IN FEET	11	16
CLASSIFICATION [AASHTO]	A-6(15)	A-7-6(19)
COEFF.CONSOL. sq.ft. /DAY	0.75	--
TRIAXIAL COMPRESSION	--	UU
COHESION - psf	--	1730
FRICTION COEFF.	--	--
MOISTURE CONTENT %	21	18
DENSITY - pcf	103	110

UU-UNCONSOLIDATED & UNDRAINED
UC-UNCONFINED COMPRESSION (c=1/2 Qu)

LOCATION
JEFFERSON COUNTY
T-71 N, R-10W
SECTION 2/3
LIBERTY TWP.
U.S. HWY. OVER UNNAMED CREEK

DESIGN FOR 32° SKEW (L.A.)
DUAL 223'-0 x 40'-0 PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGE
INTEGRAL ABUTMENTS 70'-9, 60'-9 END SPANS
TEE PIERS 91'-6 CENTER SPAN

SOILS PROFILE SHEET

STA. 356+75.30

JEFFERSON COUNTY

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 2 OF 6 FILE NO. 29488 DESIGN NO. 1203

DENS CORE, BLOW, PLUGGED, SELECT SOIL, SELECT SAND, SHALE, SAMPLE, SHELBY, WATER, MOISTURE, UNSUITABLE, SANDY SOIL, ROCK

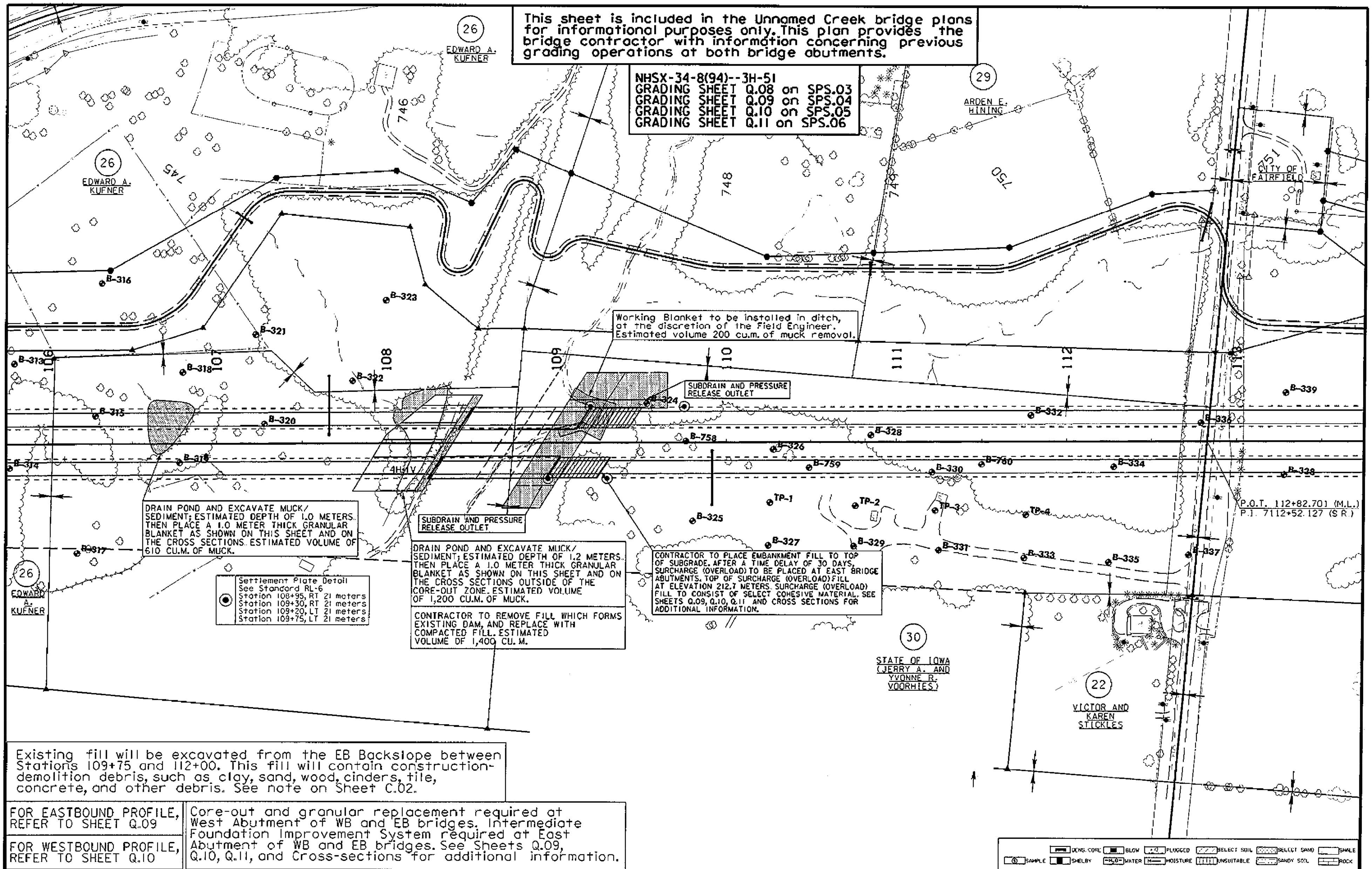
*140-lb CME Automatic SPT Hammer

SHUCK-BRITSON INC. 2405 GRAND AVENUE DES MOINES, IOWA 50312 515 243-1447

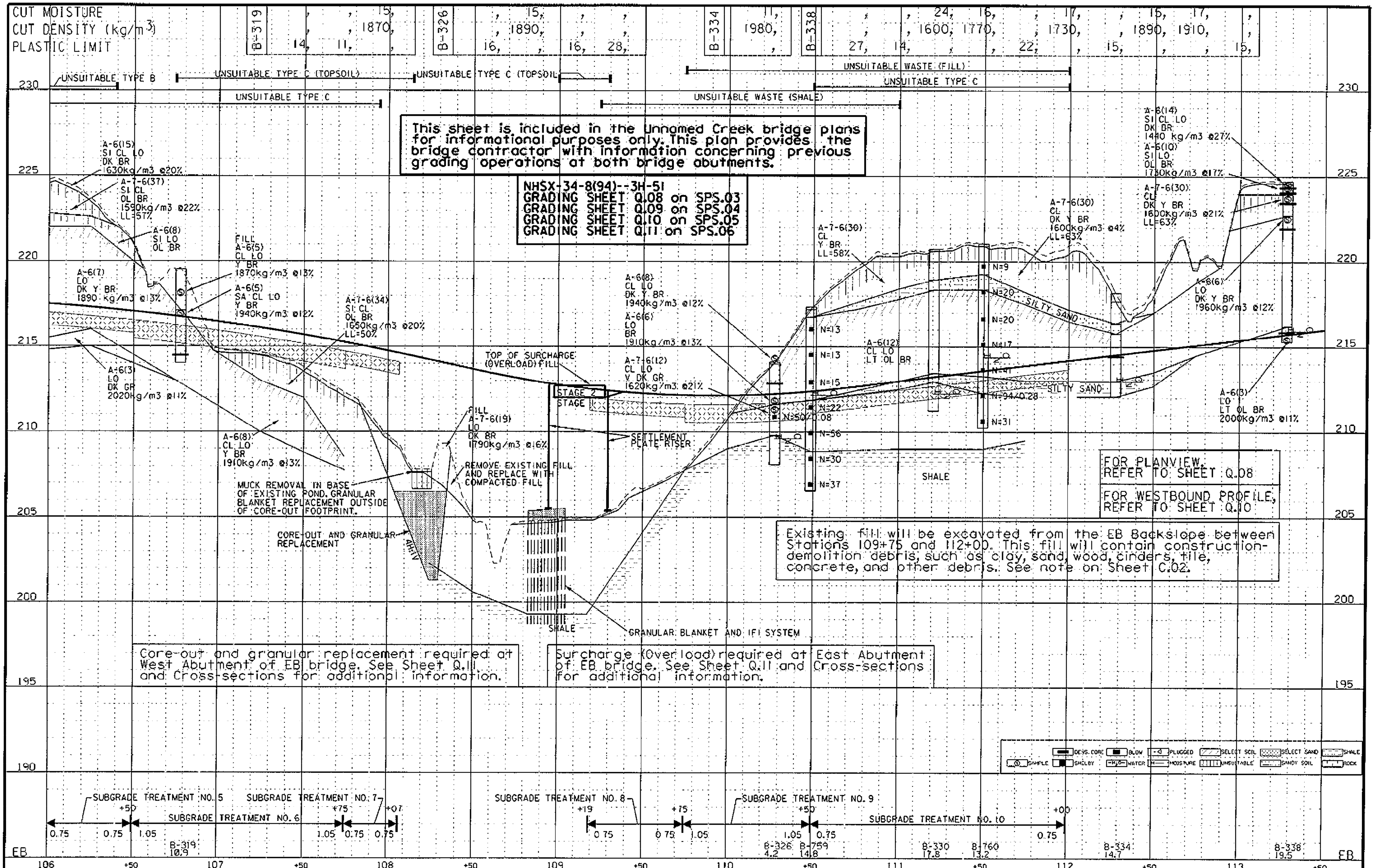
S.B.I. NO. 18797L

Terracon

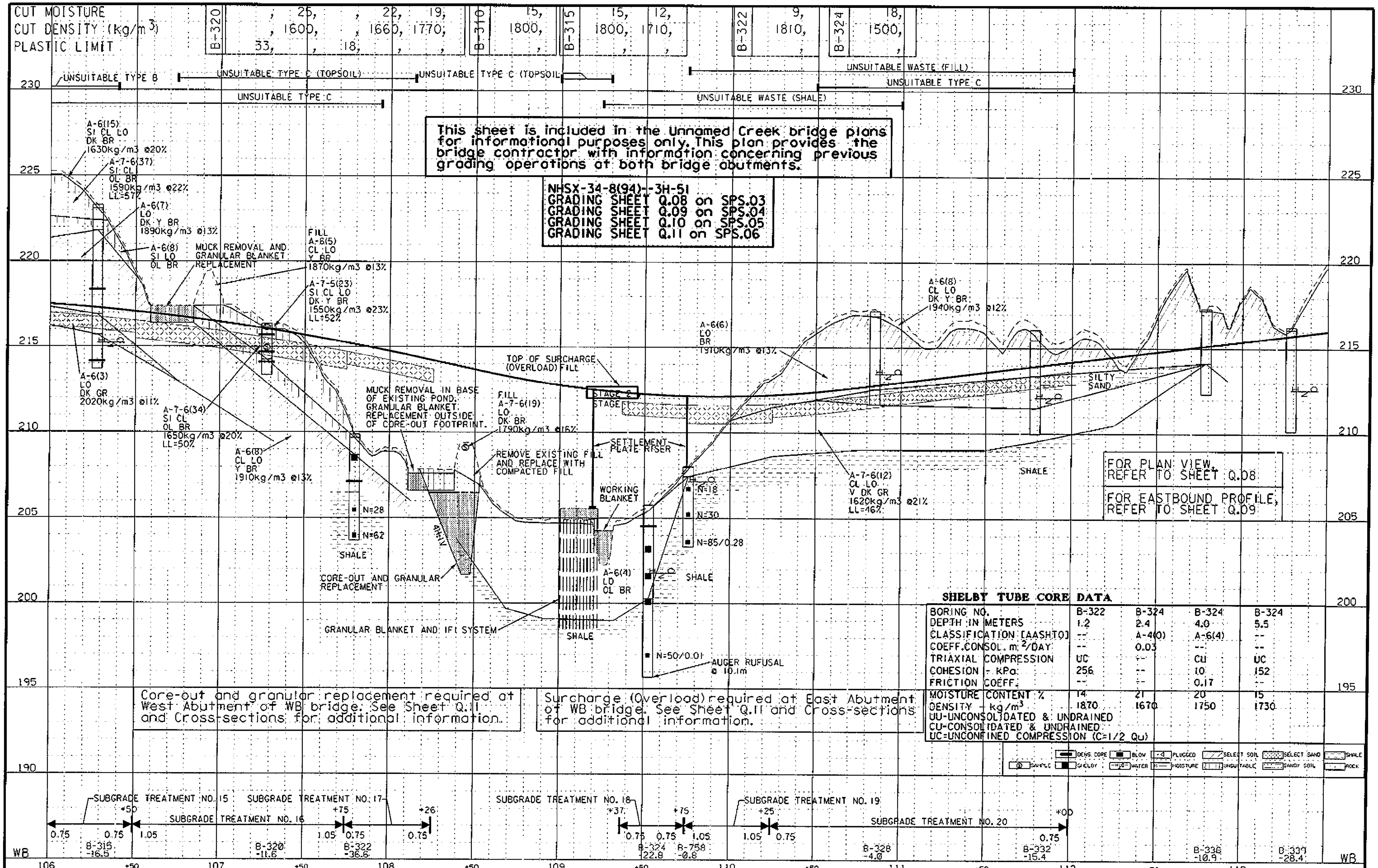
JEFFERSON COUNTY | PROJECT NUMBER NHSX-034-8(105)--3H-51 | SHEET NUMBER SPS 02



DESIGN TEAM SNYDER & ASSOCIATES, INC. | METRIC | IOWA DOT • OFFICE OF DESIGN | JEFFERSON COUNTY | PROJECT NUMBER | SHEET NUMBER SPS.03



DESIGN TEAM SNYDER & ASSOCIATES, INC.	METRIC	IOWA DOT • OFFICE OF DESIGN	JEFFERSON COUNTY	PROJECT NUMBER	SHEET NUMBER SPS.04



SHELBY TUBE CORE DATA

BORING NO.	B-322	B-324	B-324	B-324
DEPTH IN METERS	1.2	2.4	4.0	5.5
CLASSIFICATION [AASHTO]	--	A-4(0)	A-6(4)	--
COEFF.CONSOL. m^2/DAY	--	0.03	--	--
TRIAXIAL COMPRESSION	UC	--	CU	UC
COHESION - KPa	256	--	10	152
FRICTION COEFF.	--	--	0.17	--
MOISTURE CONTENT %	14	21	20	15
DENSITY - kg/m^3	1870	1670	1750	1730

UU-UNCONSOLIDATED & UNDRAINED
CU-CONSOLIDATED & UNDRAINED
UC=UNCONFINED COMPRESSION (C=1/2 Qu)

DESIGN TEAM SNYDER & ASSOCIATES, INC. | METRIC | IOWA DOT • OFFICE OF DESIGN | JEFFERSON COUNTY | PROJECT NUMBER | SHEET NUMBER SPS.05

Core-out and granular replacement required at west abutment of both WB and EB bridges. Base of core-out to be sized according to the limits (Station and Offset) shown on this sheet, and will extend 1 meter into shale. Granular Material (Gradation 4133) to be used to backfill excavation to elevation 206.5 meters. Above the granular material, backfill in the core-out to consist of Class-10 embankment fill. West edge of excavation to be sloped at a 4H:1V or flatter. Remaining sides of excavation to be sloped as needed for safety and construction purposes. Fill to be benched into sideslopes, as described in Section 2107.03, Standard Specification series of 2001.

This sheet is included in the Unnamed Creek bridge plans for informational purposes only. This plan provides the bridge contractor with information concerning previous grading operations at both bridge abutments.

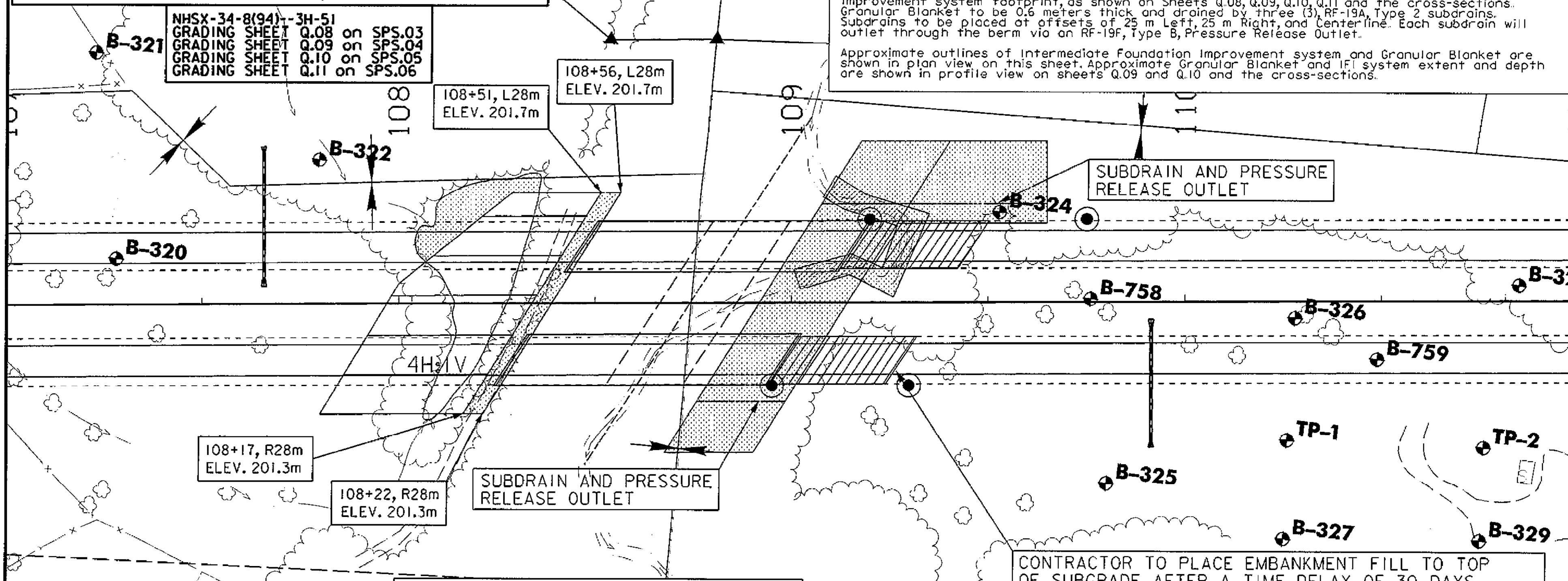
Grading Contract to include design and installation of Intermediate Foundation Improvement (IFI) System (by Special Provision) below embankment of East Abutments of new Bridges to carry Highway 34 over Unnamed Creek, and under North foreslope of approach embankment West of Station 109+65. Minimum design criteria for the abutment foreslope (parallel to Highway 34 centerline) and under approach berm slope after installation of the IFI System are as follows:

* Global Stability - short-term safety factor: minimum 1.3
* Total settlement at and within 6 meters of the bridge abutments shall be less than 125 mm
* Total settlement shall be essentially complete (less than 0.01 meters remaining) at 60 days following embankment fill placement.
* In the transition away from the improved zone, differential settlement shall not exceed 0.1 meters in 10 meters.
* Each individual intermediate foundation element shall penetrate a minimum of 0.6 m into the foundation soil (shale).

After installation of Intermediate Foundation Improvement system, Grading Contractor to install Granular Blanket (Gradation 4133) over the entire footprint of the Intermediate Foundation Improvement system footprint, as shown on Sheets Q.08, Q.09, Q.10, Q.11 and the cross-sections. Granular Blanket to be 0.6 meters thick and drained by three (3), RF-19A, Type 2 subdrains. Subdrains to be placed at offsets of 25 m Left, 25 m Right, and Centerline. Each subdrain will outlet through the berm via an RF-19F, Type B, Pressure Release Outlet.

Approximate outlines of Intermediate Foundation Improvement system and Granular Blanket are shown in plan view on this sheet. Approximate Granular Blanket and IFI system extent and depth are shown in profile view on sheets Q.09 and Q.10 and the cross-sections.

NHSX-34-8(94)--3H-51
GRADING SHEET Q.08 on SPS.03
GRADING SHEET Q.09 on SPS.04
GRADING SHEET Q.10 on SPS.05
GRADING SHEET Q.11 on SPS.06



CONTRACTOR TO PLACE EMBANKMENT FILL TO TOP OF SUBGRADE. AFTER A TIME DELAY OF 30 DAYS, SURCHARGE (OVERLOAD) TO BE PLACED AT EAST BRIDGE ABUTMENTS. TOP OF SURCHARGE (OVERLOAD) FILL AT ELEVATION 212.7 METERS. SURCHARGE (OVERLOAD) FILL TO CONSIST OF SELECT COHESIVE MATERIAL. SEE SHEETS Q.09, Q.10, Q.11 AND CROSS SECTIONS FOR ADDITIONAL INFORMATION.

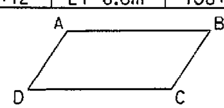
Settlement Plate Detail
See Standard RL-6
Station 108+95, RT 21 meters
Station 109+30, RT 21 meters
Station 109+20, LT 21 meters
Station 109+75, LT 21 meters

FOR EASTBOUND PROFILE, REFER TO SHEET Q.09

FOR WESTBOUND PROFILE, REFER TO SHEET Q.10

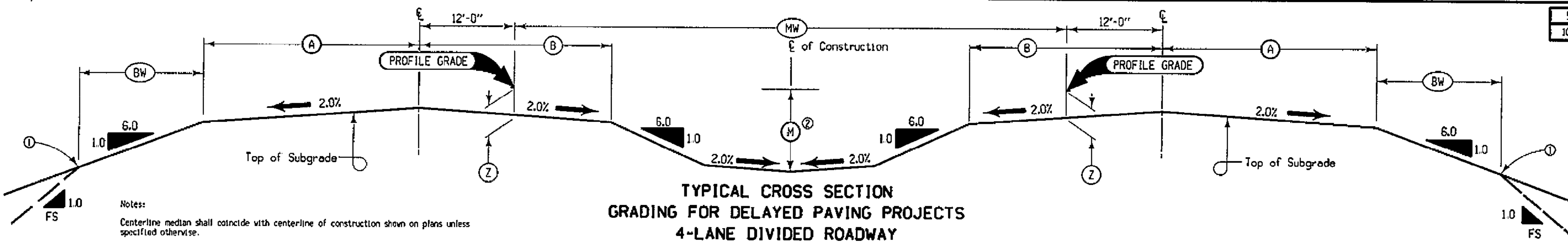
SURCHARGE (OVERLOAD) COORDINATES

POINT	EASTBOUND LANE STATION	EASTBOUND LANE OFFSET	WESTBOUND LANE STATION	WESTBOUND LANE OFFSET
A	109+20	LT 20.6m	109+02	RT 8.6m
B	109+50	LT 20.6m	109+32	RT 8.6m
C	109+42	LT 8.6m	109+24	RT 20.6m
D	109+12	LT 8.6m	108+94	RT 20.6m



DESIGN TEAM SNYDER & ASSOCIATES, INC. | METRIC | IOWA DOT • OFFICE OF DESIGN | JEFFERSON COUNTY | PROJECT NUMBER | SHEET NUMBER SPS.06

5104
10-21-03



Notes:

Centerline median shall coincide with centerline of construction shown on plans unless specified otherwise.

① Refer to Detail Project Plan and Cross Sections for specific locations of foreslope changes.

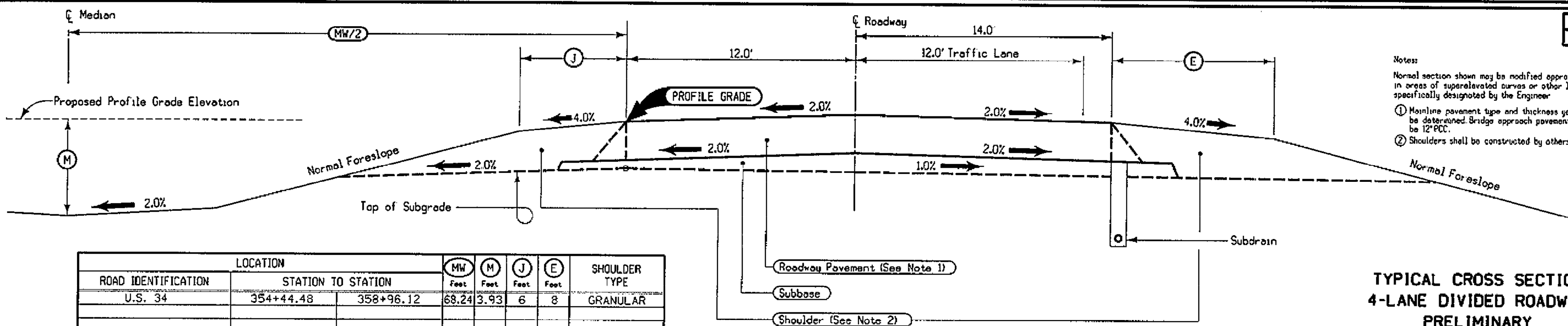
② Median Ditch is measured from Profile Grade at the centerline of construction. Design depth of median ditch.

TYPICAL CROSS SECTION
GRADING FOR DELAYED PAVING PROJECTS
4-LANE DIVIDED ROADWAY

Location			A	B	MW	Z	M	BW	Slope
Road Identification	Station to Station		Feet	Feet	Feet	Inches	Feet	Feet	FS
U.S. 34	87+00.000 (M)	111+75.000 (M)	32.15	27.89	68.24	16.5	3.93	15.42	3

FOR INFORMATION ONLY

3220
MODIFIED



Notes:

Normal section shown may be modified appropriately in areas of superelevated curves or other locations specifically designated by the Engineer.

① Mainline pavement type and thickness yet to be determined. Bridge approach pavement shall be 12" PCC.

② Shoulders shall be constructed by others.

LOCATION			MW	M	J	E	SHOULDER TYPE
ROAD IDENTIFICATION	STATION TO STATION		Feet	Feet	Feet	Feet	
U.S. 34	354+44.48	358+96.12	68.24	3.93	6	8	GRANULAR

TYPICAL CROSS SECTION
4-LANE DIVIDED ROADWAY
PRELIMINARY

Design No: 1203
File No: 29488

LICENSED PROFESSIONAL ENGINEER
RICHARD M. VOELKER
13853
IOWA

I hereby certify that this Engineering Document was prepared by me or under my direct personal supervision and that I am a duly Licensed Professional Engineer under the Laws of the State of Iowa.

Richard M. Voelker, P.E. 4/25/06 Date

License Number 13853

My License Renewal Date is December 31 2006

Pages or sheets covered by this seal:
B.01, C.01-C.03, D.01-D.02

ESTIMATED ROADWAY QUANTITIES

100-0A
10-28-97

Item No.	Item Code	Item	Unit	Total	As Built Quan.
1	2122-5190501	PAVED SHOULDER, PCC (PAVED SHOULDER FOR BRIDGE END DRAIN)	SY	31.11	
2	2301-0690200	BRIDGE APPROACH, RK-20	SY	1,155.47	
3	2499-0695040	BRIDGE END DRAIN, RF-40	EACH	4.00	
4	2519-3300139	FIELD FENCE, TYPE 39	STA	9.12	
5	2602-0000020	SILT FENCE	LF	200.00	
6	2602-0000060	REMOVAL OF SILT FENCE	LF	1,240.00	
7	2602-0000090	CLEAN OUT OF SILT FENCE	LF	1,240.00	

STANDARD ROAD PLANS

105-4
12-03-96

The following Standard Road Plans shall be considered applicable to construction work on this project.

NUMBER	DATE	NUMBER	DATE	NUMBER	DATE
RC-8A	4-15-03	RH-50	4-18-06	RK-20(2)	4-18-06
RC-8B(1)	4-18-06	RH-51	4-20-04	RK-20(3)	10-18-05
RC-8B(2)	4-18-06	RH-52	10-18-05	RK-21	10-18-05
RC-9B	4-15-03	RH-55(1)	4-20-04	RK-30	10-18-05
RC-17	4-18-06	RH-55(2)	4-18-06	RL-17	4-19-05
RF-19E	4-18-06	RK-20(1)	10-18-05	RM-37	4-27-99
RF-40	4-19-05			RP-2	10-3-00

TRAFFIC CONTROL PLAN

108-23
04-04-89

1. U.S. 34 will be closed to traffic during construction.

2. Traffic control devices have been installed by the grading contractor and shall remain in place through bridge construction. The bridge contractor shall be responsible for maintaining U.S. 34 closures during bridge construction. The cost of maintaining the traffic control shall be considered incidental to the project and no extra compensation will be allowed.

3. Traffic control on this project will be in accordance with the RS series of Standard Road Plans as referenced. For additional complimentary information, refer to the Manual on Uniform Traffic Control Devices and current Standard and Supplementary Specifications.

4. The location for storage of equipment by the Contractor during non-working hours shall be as approved by the engineer in charge of construction.

5. Proposed changes in the traffic control plan shall be reviewed with the Office of Construction before changes are made.

01-20-84 203-1

Plan and profile sheets included in the project are for the purpose of alignment, location and specific directions for the work to be performed under this contract. Irrelevant data on these sheets is not to be considered a part of this contract.

04-03-01 203-2

During construction of this project, the contractor will be required to coordinate his operations with those of other contractors working within the same area. Other work in progress during the same period of the time will include construction of the following projects:

Project	Type of Work
NHSX-34-8(94)--3H-51	GRADING

10-29-02 213-1

It shall be the contractor's responsibility to provide waste areas or disposal sites for excess material (excavated material or broken concrete) which is not desirable to be incorporated into the work involved on this project. These areas shall not impact wetlands or "Waters Of The U.S." No payment for overhaul will be allowed for material hauled to these sites. No material shall be placed within the right-of-way, unless specifically stated in the plans.

01-20-84 204-2

All holes resulting from operations of the contractor, including removal of guardrail posts, fence posts, utility poles, or foundation studies, shall be filled and consolidated to finished grade as directed by the engineer to prevent future settlement. The voids shall be filled as soon as practical - preferably the day created and not later than the following day. Any portion of the right-of-way or project limits (including borrow areas and operation sites) disturbed by any such operations shall be restored to an acceptable condition. This operation shall be considered incidental to other bid items in project.

01-20-84 212-1

Sounding and test boring data shown on plans were accumulated for designing and estimating purposes. Their appearance on the plan does not constitute a guarantee that conditions other than those indicated will not be encountered.

01-20-84 232-5

The contractor shall not disturb desirable grass areas and desirable trees outside the construction limits. The contractor will not be permitted to park or service vehicles and equipment or use these areas for storage of materials. Storage, parking and service area(s) will be subject to the approval of the resident engineer.

ESTIMATE REFERENCE INFORMATION

100-4A
10-29-02

Item No.	Item Code	Description
1	2122-5190501	PAVED SHOULDER, PCC (PAVED SHOULDER FOR BRIDGE END DRAIN) Refer to Tab. 104-8A, Sheet C.02, for locations.
2	2301-0690200	BRIDGE APPROACH, RK-20 Refer to Tab. 112-6, Sheet C.02, for further information.
4	2519-3300139	FIELD FENCE, TYPE 39 Refer to Tab. 1077-7A, Sheet C.02, for locations
5	2602-0000020	SILT FENCE Silt fence was instralled at bridge abutments during the grading project, and should be in place at the beginning of the bridge project. Item is for replacements as necessary.

Design No: 1203
File No: 29488

SNYDER & ASSOCIATES | STATE OF IOWA | FISCAL YEAR | JEFFERSON COUNTY | PROJECT NUMBER NHSN-34-8(105)--2R-51 | SHEET NUMBER C.01

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ALIGNMENT COORDINATES

NOTE: ALL INFORMATION IN THIS TABULATION IS IN METRIC UNITS

101-16
10-29-02

Name	Location	Begin Spiral			Begin Curve			Simple Curve PI or Master PI of SCS			End Curve			End Spiral		
		Station	Coordinates		Station	Coordinates		Station	Coordinates		Station	Coordinates		Station	Coordinates	
			Y (Northing)	X (Easting)		Y (Northing)	X (Easting)		Y (Northing)	X (Easting)		Y (Northing)	X (Easting)		Y (Northing)	X (Easting)
OR8-5	BYPASS CENTERLINE	94+88.588	110348 020	625995.038	95+64.588	110291.520	626045.854	98+94.016	110041.721	626260.656	101+65.024	110079.231	626587 968	103+42 024	110086.200	626663.638
OR8-6	BYPASS CENTERLINE				137+45.439	110473.730	630174 718	139+18.784	110492.747	630347.016	140+92.120	110508.775	630519.618			

SPIRAL/CIRCULAR CURVE DATA

NOTE: ALL INFORMATION IN THIS TABULATION IS IN METRIC UNITS

101-17
10-29-02

Name	Location	△	D	R	T	L	E	θs	L.T.	S.T.	Ls	Ts	Es	Xc	Yc
OR8-5	BYPASS CENTERLINE	49°08'46.99"		700.000	320.089	600.436	69.712	3°06'37.23"	50.674	25.340	76.000	405.428	90.878	75.978	1.375
OR8-6	BYPASS CENTERLINE	0°59'35.40"		20,000.000	173.345	346.681	0.751								

BRIDGE APPROACH SECTION

Refer to the RK-Series Standard Road Plans.

112-6
04-19-05

* Not a bid item

Location		Approach Pavement						Subdrain								
Bridge Station	End	(T) Thickness	Pay Length	Non-Reinf. Pavement Area	Single-Reinf. Pavement Area	Double-Reinf. Pavement Area	Fixed or Movable Abutment	Perforated Subdrain 4" *	Subdrain Outlet *		Porous Backfill *	Class 'A' Crushed Stone Backfill *	Modified Subbase *	Polymer Grid *	Remarks
		Inches	Feet	Sq. Yds.	Sq. Yds.	Sq. Yds.	F or M	Lin. Ft.	Station	Side	Cu. Yds.	Cu. Yds.	Tons	Sq. Yds.	
356+75.30 EBL	W	12	70	86.67	57.78	144.42	M	48	354+54.48	R	1.4		310.57	328.64	
356+75.30 EBL	E	12	70	86.67	57.78	144.42	M	48	358+25.98	R	1.4		310.57	328.64	
356+75.30 WBL	W	12	70	86.67	57.78	144.42	M	48	355+14.61	L	1.4		310.57	328.64	
356+75.30 WBL	E	12	70	86.67	57.78	144.42	M	48	358+86.12	L	1.4		310.57	328.64	

TABULATION OF SOD OR ROCK FLUME FOR BRIDGE END DRAIN

Refer to Standard Road Plan RF-39 or RF-40

① Not a Bid Item
② Sod Flume
③ Rock Flume

104-8A
10-21-03

Location			Shoulder				Macadam Stone Base Material ①	Engineering Fabric ①	Sodding Squares ①②	Class E Erosion Stone	Remarks
Bridge Station	Bridge Corner	Distance DI-1 or DI-2	Panels Required A B C or D	PCC Sq. Yds.	Polymer Grid ① Sq. Yds.	Modified Subbase ① Tons	Tons	Sq. Yds.		Tons①③	
356+75.30 EBL	NE	24.92	1	13.33	13.33	8.40	0.59	29.68		18.26	
356+75.30 EBL	SE	29.92	-	-	-	-	0.59	123.82		84.57	
356+75.30 WBL	NE	22.94	1	17.78	17.78	11.20	0.59	116.26		79.25	
356+75.30 WBL	SE	29.19	-	-	-	-	0.59	29.68		18.26	

STAGE 1 FENCING BY GRADING CONTRACTOR

100-7A
MODIFIED

Before completing of Grading Work

Div.	Location		Side	Length (Station)	Remarks
1	353+60.24, 220.41 Rt.	355+02.73, 68.90 Rt.	R	2.08	
1	357+52.73, 68.90 Rt.	359+24.38, 250.49 Rt.	R	2.50	
1	355+27.73, 25.66 Rt.	355+62.86, 25.66 Lt.	M	0.62	
1	357+77.73, 25.66 Rt.	358+12.86, 25.66 Lt.	M	0.62	
1	354+78.38, 189.14 Lt.	355+87.87, 68.90 Lt.	L	1.63	
1	358+37.87, 68.90 Lt.	359+84.25, 150.07 Lt.	L	1.67	

Design No: 1203
File No: 29488

POLLUTION PREVENTION PLAN

110-12A

All contractors/subcontractors shall conduct their operations in a manner that minimizes erosion and prevents sediments from leaving the highway right-of-way. The prime contractor shall be responsible for compliance and implementation of the Pollution Prevention Plan (PPP) for their entire contract. This responsibility shall be further shared with subcontractors whose work is a source of potential pollution as defined in this PPP.

1. SITE DESCRIPTION

This Pollution Prevention Plan (PPP) is for the construction of a four lane divided highway, bridges, sideroads, entrances, recreational trail, and interchange ramps from the Cedar View Trail to Crow Creek.

This PPP covers approximately 502 acres with an estimated 213 acres being disturbed. The portion of the PPP covered by this contract has 3 acres disturbed.

The PPP is located in an area of Haig-Grundy-Clarinda, Pershing-Lindley-Rinda, Weller-Lindley, and Nodaway-Coppock soil associations. The estimated average SCS runoff curve number for this PPP after completion will be 79.

Refer to the grading plans for locations of typical slopes, ditch grades, and major structural and non-structural controls. A copy of this plan will be on file at the Resident Construction engineer's office. Runoff from this work will flow into Cedar Creek, Crow Creek and Unnamed Creek.

POTENTIAL SOURCES OF POLLUTION:
Site sources of pollution generated as a result of this work relate to silts and sediment which may be transported as a result of a storm event. However, this PPP provides conveyance for other (non-project related) operations. These other operations have storm water runoff, the regulation of which is beyond the control of this PPP. Potentially this runoff can contain various pollutants related to site-specific land uses. Examples are:

Rural Agricultural Activities:
Runoff from agricultural land use can potentially contain chemicals including herbicides, pesticides, fungicides and fertilizers.

Commercial and Industrial Activities:
Runoff from commercial, industrial, and commerce land use may contain constituents associated with the specific operation. Such operations are subject to potential leaks and spills which could be commingled with run-off from the facility. Pollutants associated with commercial and industrial activities are not readily available since they are typically proprietary.

2. CONTROLS

At locations where runoff can move offsite, silt fence shall be placed along the perimeter of the areas to be disturbed prior to beginning grading, excavation or clearing and grubbing operations. Vegetation in areas not needed for construction shall be preserved. As areas reach their final grade, additional silt fences, silt basins, intercepting ditches, sod flumes, letdowns, bridge end drains, and earth dikes shall be installed as specified in the plans and/or as required by the project engineer. This will include using silt fence as ditch checks and to protect intakes. Temporary stabilizing seeding shall be completed as the disturbed areas are constructed. If construction activity is not planned to occur in a disturbed area for at least 21 days, the area shall be stabilized by temporary seeding or mulching within 14 days. Other stabilizing methods shall be used outside the seeding time period.

This work shall be done in accordance with Section 2602 of the Standard Specification. If the work involved is not applicable to any contract items the work shall be paid for according to Article 1109.03 paragraph B.

As the work progresses additional erosion control items may be required as determined by the contractor after field investigation. The contractor will complete the construction with the establishment of permanent perennial vegetation of all disturbed areas.

3. OTHER CONTROLS

Contractor disposal of unused construction materials and construction material wastes shall comply with applicable state and local waste disposal, sanitary sewer, or septic system regulations. In the event of a conflict with other governmental laws, rules and regulations, the more restrictive laws, rules or regulations shall apply.

APPROVED STATE OR LOCAL PLANS:
During the course of this construction, it is possible that situations will arise where unknown materials will be encountered. When such situations are encountered, they will be handled according to all federal, state, and local regulations in effect at the time.

4. MAINTENANCE

The contractor is required to maintain all temporary erosion control measures in proper working order, including cleaning, repairing, or replacing them throughout the contract period. Cleaning of silt control devices shall begin when the features have lost 50% of their capacity.

5. INSPECTIONS

Inspections shall be made jointly by the contractor and the contracting authority every seven calendar days and after each rain event that is ½" or greater. The contractor shall immediately begin corrective action on all deficiencies found. The findings of this inspection shall be recorded in the project diary. This PPP may be revised based on the findings of the inspection. The contractor shall implement all revisions. All corrective actions shall be completed within 3 calendar days of the inspection.

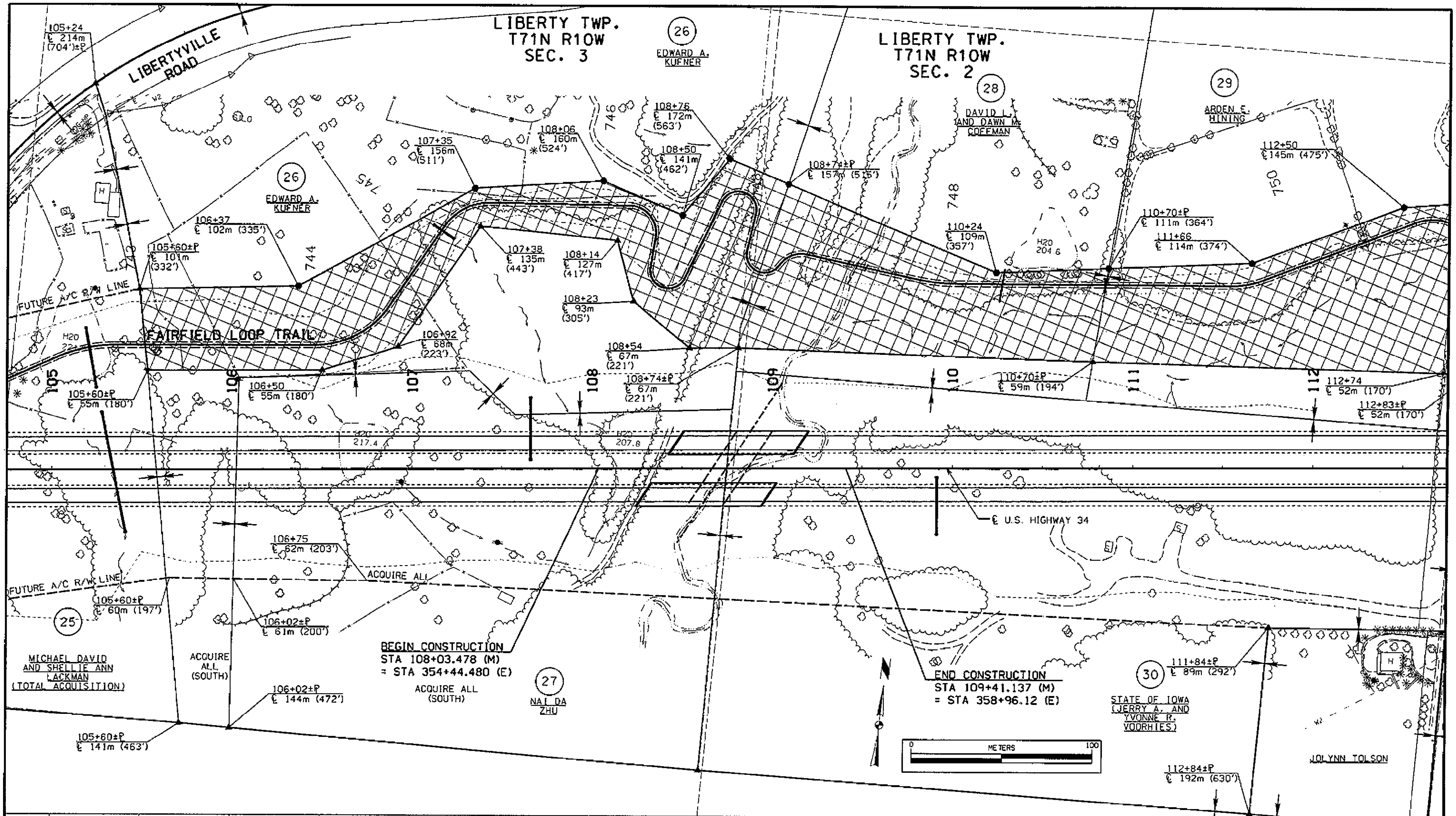
POLLUTION PREVENTION PLAN

110-12A

6. NON-STORM DISCHARGES

This includes subsurface drains (i.e. longitudinal and standard subdrains), slope drains and bridge end drains. The velocity of the discharge from these features may be controlled by the use of patio blocks, Class A stone or erosion stone.

Design No: 1203
File No: 29488



FOR PROFILE INFORMATION REFER TO SHEET D.02

FOR INFORMATION ONLY

Design No: 1203
File No: 29488

105	+50	106	+50	107	+50	108	+50	109	+50	110	+50	111	+50	112	+50

DESIGN TEAM	SNYDER & ASSOCIATES	METRIC	IOWA DOT * OFFICE OF DESIGN	JEFFERSON	COUNTY	PROJECT NUMBER	NHSN-34-8(105)--2R-51	SHEET NUMBER	D.01

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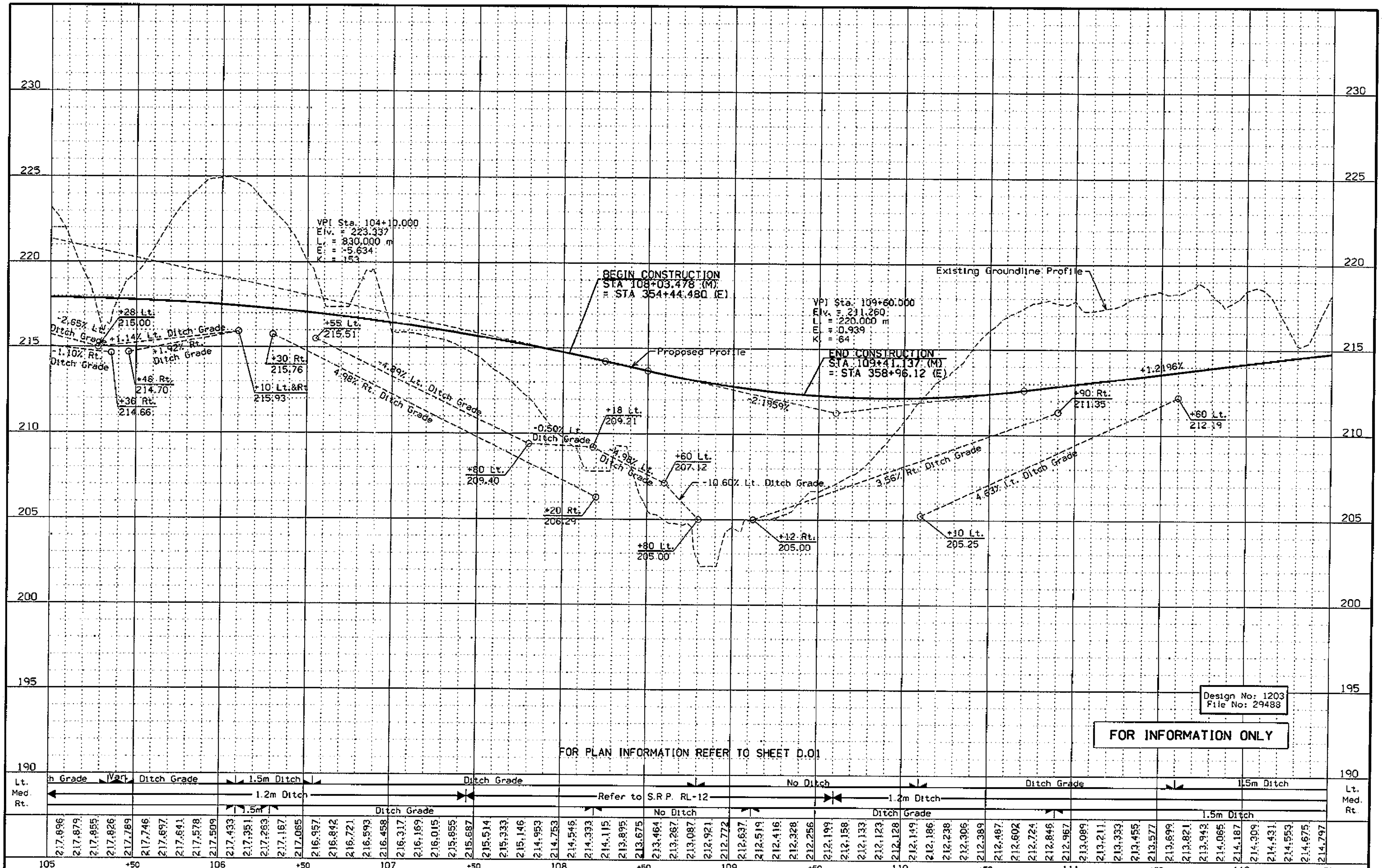

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