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April 14, 2025

ODOT District 11
2201 Reiser Avenue S.E.
New Philadelphia, Ohio 44663
Attn: Adrienne N. Slanina, P.E.

RE: D11-General Engineering Services, PID 117666, Agr. 38652
Task-11-I PID 111085 HOL-179-3.89
Pier Analysis Report

Dear Ms. Slanina,

ms consultants presents the attached pier cap analysis report for the subject project.

The existing piers were analyzed and have adequate capacity to carry the loads from the replacement slab superstructure without any modifications.

There is no need to authorize the second task, (fiber wrapping system).

Please review and let us know if you have any questions or concerns.

Regards,

Jonathan Hren, PE
Project Manager

Attachments: As noted
cc: A. Urankar, W. Ruggles (ms); M. Clark (ODOT)
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HOL-179-3.89
PID 111085
Existing Pier Analysis for Reuse
Analysis Methodology and Index
ms consultants, inc.

Introduction:
The existing slab bridge is to be rehabilitated with a superstructure replacement. The existing pier caps are to be salvaged and re-used. The following analysis checks the adequacy of the existing pier cap for the replacement deck and HL-93 Live Load. Enercalc and and QConBridge were used to perform the analysis. Note, existing Pier 1 and Pier 2 have identical section properties and span / loading configurations. This analysis is valid for both piers. Below are the analysis steps as follows:

1. Section properties for the entire transverse section of the slab superstructure were calculated in Enercalc.

2. Span data and section properties were input into QConBridge. The Dead Load reaction at the pier is output as a distributed load in the transverse direction. The Live Load is output as the total reaction from the truck / lane combination for a single lane. This reaction is divided by two to represent a wheel load. The wheel load is later input as a point load on the pier cap at midspan between all piles to simulate both lanes loaded simultaneously. This approach is conservative as it ignores any distribution or consideration of actual wheel spacing possibilities.

3. Assumed material properties were based on BDM Table 926-1

4. Existing pier cap section properties, material properties and loading was input into Enercalc to check moment and shear demands.

Conclusion / Enercalc Output:
The existing pier has an adequate bending capacity with a utilization ratio of approximately 0.2. Based on the shear analysis the required maximum stirrup spacing is 16.5". Between the piles the existing stirrups are spaced at 12". While the region of the cap directly above the pile has a stirrup spacing greater than 16.5", a typical strut and tie load path methodology would indicate that this zone is essentially pure compression and stirrups would not be required directly above the pile and the cap has adequate shear capacity.

This analysis is predicated on the assumption that the existing pier caps are in good condition and are not damaged during rehabilitation / construction.

Enercalc for Slab Section Properties

General Section Property Calculator

Project File: Enercalc Pier Analysis.ec6

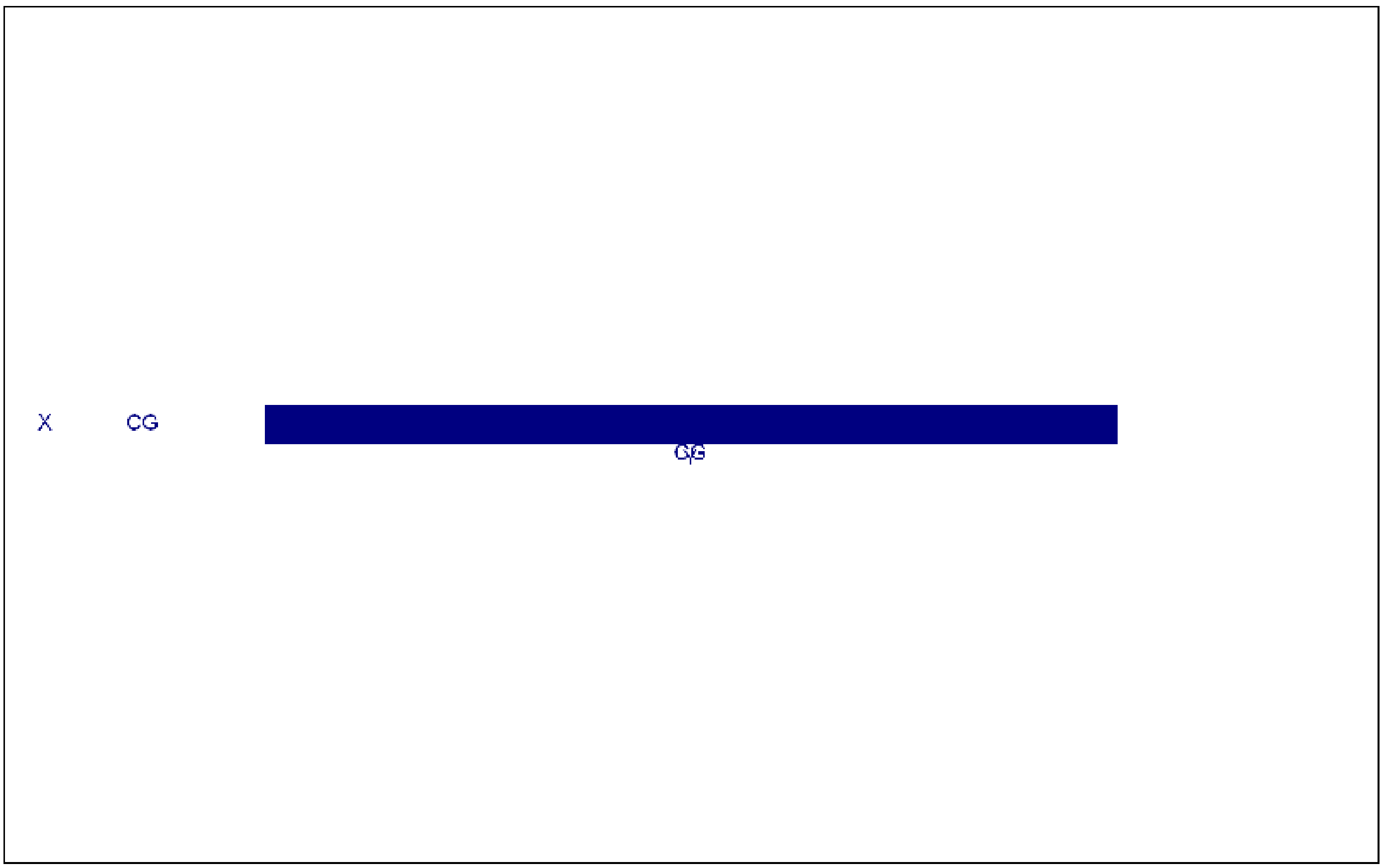
LIC# : KW-06014802, Build:20.22.8.17 MS CONSULTANTS

DESCRIPTION: Slab Properties

Final Section Properties

Total Area	:	6,912.0 in^2	Ixx	:	186,616 in^4	Sxx : - Y :	20,735.1 in^3
			Iyy	:	84,930,881 in^4	Sxx : +Y :	20,735.1 in^3
Calculated final C.G. distance from Datum							
X cg Dist.	:	0.0 in	Zxx	:	31,104.0 in^3	Syy : - X :	442,348 in^3
Y cg Dist.	:	0.0 in	Zyy	:	663,552 in^3	Syy : +X :	442,348 in^3
Edge Distances from CG. :							
						r xx :	5.196 in
+X	:	192.0 in	+Y	:	9.0 in	r yy :	110.849 in
-X	:	-192.0 in	-Y	:	-9.0 in		

Rotation of All Components @ 0.00 deg CCW



Rectangular & Circular Shapes

Rectangular Shape : 1	Height =	18.000 in	Width =	384.000 in	Rotation =	0 deg CCW
	Area =	6,912.000 in^2	Xcg =	0.000 in		
			Ycg =	0.000 in		

QConBridge Input

```
Span Data
---------

Span  1  Length:     28.000 ft

Section Properties
Location      Ax           Iz           Mod. E      Unit Wgt
  (ft)      (in^2)       (in^4)        (psi)       (pcf)
   0.000  6.912e+03    186.615e+03  3.599e+03    149.999e+00

Live Load Distribution Factors
Location  Str/Serv Limit States  Fatigue Limit State
  (ft)         gM        gV          gM        gV
   0.000       1.000     1.000       1.000     1.000

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


Span  2  Length:     35.000 ft

Section Properties
Location      Ax           Iz           Mod. E      Unit Wgt
  (ft)      (in^2)       (in^4)        (psi)       (pcf)
   0.000  6.912e+03    186.615e+03  3.599e+03    149.999e+00

Live Load Distribution Factors
Location  Str/Serv Limit States  Fatigue Limit State
  (ft)         gM        gV          gM        gV
   0.000       1.000     1.000       1.000     1.000

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


Span  3  Length:     28.000 ft

Section Properties
Location      Ax           Iz           Mod. E      Unit Wgt
  (ft)      (in^2)       (in^4)        (psi)       (pcf)
   0.000  6.912e+03    186.615e+03  3.599e+03    149.999e+00

Live Load Distribution Factors
Location  Str/Serv Limit States  Fatigue Limit State
  (ft)         gM        gV          gM        gV
   0.000       1.000     1.000       1.000     1.000

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

Support Data

QConBridge Input, cont.

Support 1 Pinned

Support 2 Roller

Support 3 Roller

Support 4 Roller

Loading Data

DC Loads
- Self Weight Generation Enabled
- Traffic Barrier Load Disabled

DW Loads
- Utility Load Disabled
- Wearing Surface Load Disabled

Live Load Data

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

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

Pedestrian Live Load 0.000e+00 plf

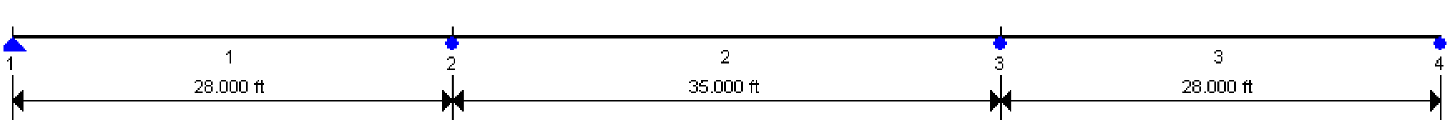
Load Factors

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		

Editor

HScale: 10. ft/inch - VScale: 0.0 ft/inch

DC Dead Load	DW Dead Load	Self Weight : Enabled
Traffic Barrier : Disabled	Utility : Disabled	Overlay : Disabled
Pedestrian Ld : 0.000e+00 lbs/ft		



QConBridge Output

=253k/31' cap
=8.2k/ft (input as DL along full length of pier cap)

DC Dead Load

Pier	Fx(lbs)	Fy(lbs)	Mz(ft-lbs)
1	0.000e+00	74.915e+03	0.000e+00
2	0.000e+00	252.684e+03	0.000e+00
3	0.000e+00	252.684e+03	0.000e+00
4	0.000e+00	74.915e+03	0.000e+00

Live Load Envelopes (Per Lane)

Pier	FxMin(lbs)	FxMax(lbs)	FyMin(lbs)	FyMax(lbs)	MzMin(ft-lbs)	MzMax(ft-lbs)
1	0.000e+00	0.000e+00	-9.056e+03	69.099e+03	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	-9.085e+03	108.031e+03	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	-9.085e+03	108.031e+03	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	-9.056e+03	69.099e+03	0.000e+00	0.000e+00

=108k per truck
=54k per wheel line
(input as LL point load at midspan between each pile)

Material Properties

Table 926-1: Custom Allowable Stresses in Bending

		Type of Rating							
Material of Construction	Year of Construction	Fy / Fc' (ksi)	Fy / Fc' (MPa)	Inventory (ksi)	Inventory (MPa)	Operating (ksi)	Operating (MPa)	Posting (ksi)	Posting (MPa)
Structural Steel (SS),(CSC)	< 1900	26.00	179	14.00	97	19.00	131	19.00	131
	1901 To 1930	30.00	207	16.00	110	22.00	152	22.00	152
	1931 To 1965	33.00	228	18.00	124	25.00	172	25.00	172
	1966 To 1990	36.00	248	20.00	138	27.00	186	27.00	186
	1991 To Date	50.00	345	27.00	186	37.50	259	37.50	259
Reinforcing Steel (RC)	< 1935	32.00	221	16.00	110	24.00	165	24.00	165
	1936 To 1950	36.00	248	18.00	124	27.00	186	27.00	186
	1951 To 1983	40.00	276	20.00	138	30.00	207	30.00	207
	1984 To Date	60.00	414	24.00	165	36.00	248	36.00	248
Prestress. Strands (Fs') (CPS),(PSC)	All Years	270.0	1862	-	-	-	-	-	-
Cast-in-Place Reinf. Conc. (Compression in Bending) (RC),(CSC)	< 1930	2.00	14	0.70	5	1.30	9	1.30	9
	931 To 1950	3.00	21	1.00	7	1.50	10	1.50	10
	1951 To 1980	4.00	28	1.30	9	2.00	14	2.00	14
	1981 To Date	4.50	31	1.50	10	2.20	15	2.20	15
Prestressed Concrete (Fc') (PSC),(CPS)	All Years	5.50	38	-	-	-	-	-	-
Cast-in-Place Comp. Slab for Prestress. Conc. (Fc') (CPS)	All Years	4.00	28	-	-	-	-	-	-
Timber (fb) (TMB)	All Years	-	-	1.6	11	2.128	15	2.128	15
Cast-in-Place Slab for Composite Reinforced Concrete	< 1930	2.00	14	0.70	5	1.30	9	1.30	9
	1931 To 1950	3.00	21	1.00	7	1.50	10	1.50	10
	1951 To 1980	4.00	28	1.30	9	2.00	14	2.00	14
	1981 To Date	4.50	31	1.50	10	2.20	15	2.20	15

Enercalc Input

DESCRIPTION

Change Beam Material To ...

Cap Analysis (No Flange)

Steel	Wood

DESIGN VALUES

f'c	4.0	ksi	fy - Main Rebar	40.0	ksi
$fr = f'c^{1/2}$ *	7.50	ksi	E - Main Rebar	29,000.0	ksi
			ASTM A615 Bars Used		
ψ Density	150.0	pcf			
λ Lightweight Factor	1.0		fy - Stirrups	40.0	ksi
ϕ : Phi Values Flexure :	0.90		E - Stirrups	29,000.0	ksi
Shear :	0.750		Stirrup Bar Size #	5	
			Number of Resisting Legs Per Stirrup	2	
E - Concrete	3,122.0	ksi			

$57000 * f'c^{1/2}$ $w^{1.5} * 33 * f'c^{1/2}$

β = 0.850

Min. Allow Transient Load Deflection Ratio :	360.0	: 1
Min. Allow Total Load Deflection Ratio :	180.0	: 1

Enercalc Input, cont.

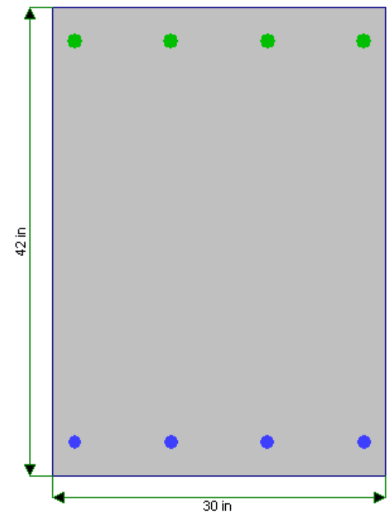
Select Span : 1 | 2 | 3 | 4 | 5 | 6

Span Length = 4.670 ft

Beam Shape

Total Height 42.0 in

Width 30.0 in

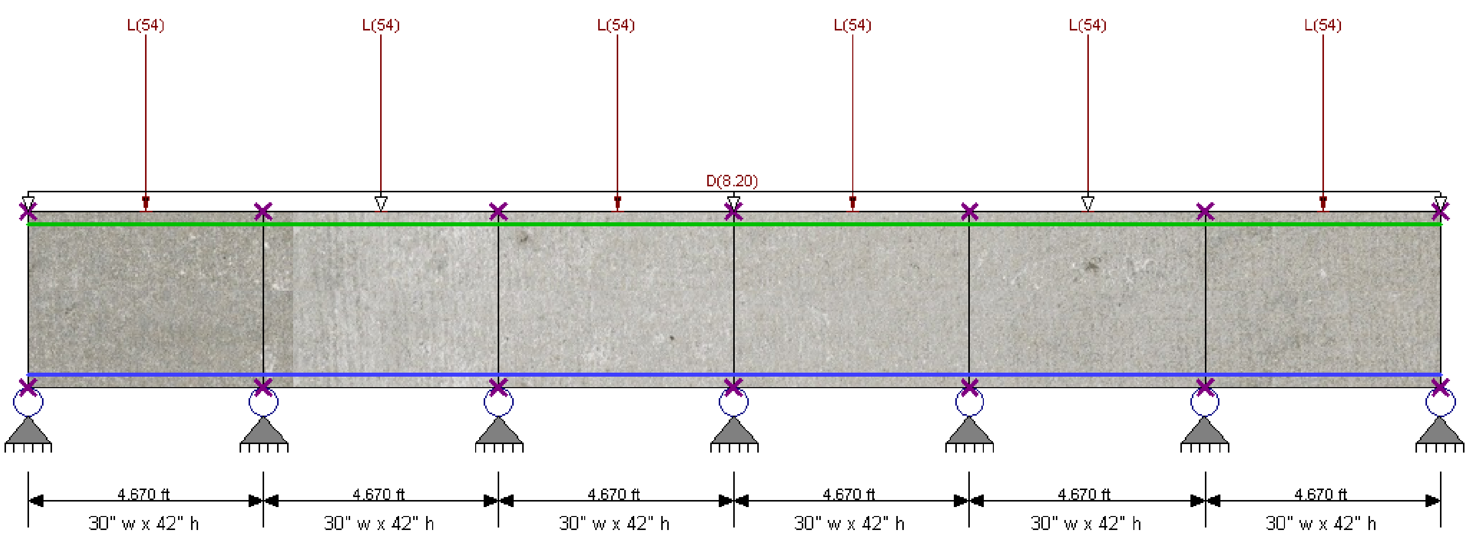


Section cut location 0.000 ft

Start & End Distances measured from end of this span

Rebar Locations, Sizes, Quantities

	# Bars	Size #	Dist of bar center...	from...		Bar Position This Span Start (ft)	End	
Bar Set #1	4	9	3.0	Top	Bot			FL
Bar Set #2	4	10	3.0	Top	Bot			FL



Enercalc Output

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	**0.187** : 1	
Section used for this span	**Typical Section**	
Mu : Applied	86.602	k-ft
Mn * Phi : Allowable	464.084	k-ft
Location of maximum on span	2.335	ft
Span # where maximum occurs	Span # 1	

Maximum Deflection

Max Downward Transient Deflection	0.000 in	Ratio =	0	<360.0	
Max Upward Transient Deflection	0.000 in	Ratio =	0	<360.0	
Max Downward Total Deflection	0.000 in	Ratio =	0	<180.0	Span: 6 : +1.250D+1.750L
Max Upward Total Deflection	0.000 in	Ratio =	0	<180.0	Span: 6 : +1.250D+1.750L

Detailed Shear Information

Span Number	Distance (ft)	'd' (in)	Vu (k) Actual	Vu (k) Design	Mu (k-ft)	d*Vu/Mu	Phi*Vc (k)	Comment	Phi*Vs (k)	Phi*Vn (k)	Spacing (in) Req'd	Spacing (in) Suggest
1	0.00	39.00	50.42	50.42	0.00	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
1	0.64	39.00	43.15	43.15	29.79	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
1	1.27	39.00	35.88	35.88	54.95	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
1	1.91	39.00	28.61	28.61	75.49	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
1	2.55	39.00	-65.06	65.06	73.48	1.00	112.95	PhiVc/2 < Vu <=	Min 11.5.6.3	158.3	16.5	16.0
1	3.18	39.00	-72.33	72.33	29.73	1.00	112.95	PhiVc/2 < Vu <=	Min 11.5.6.3	158.3	16.5	16.0
1	3.82	39.00	-79.60	79.60	18.64	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
1	4.46	39.00	-86.87	86.87	71.65	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
2	5.09	39.00	70.19	70.19	59.52	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
2	5.73	39.00	62.92	62.92	17.13	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
2	6.37	39.00	55.65	55.65	20.62	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
2	7.01	39.00	48.38	48.38	53.75	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
2	7.64	39.00	-45.29	45.29	27.66	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
2	8.28	39.00	-52.55	52.55	3.50	1.00	114.97	Vu < PhiVc/2	t Reqd 9.6.	115.0	0.0	0.0
2	8.92	39.00	-59.82	59.82	39.28	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
3	9.55	39.00	65.58	65.58	51.53	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
3	10.19	39.00	58.31	58.31	12.08	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
3	10.83	39.00	51.04	51.04	22.74	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
3	11.46	39.00	43.77	43.77	52.93	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
3	12.10	39.00	-49.90	49.90	42.24	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
3	12.74	39.00	-57.17	57.17	8.15	1.00	112.95	PhiVc/2 < Vu <=	Min 11.5.6.3	158.3	16.5	16.0
3	13.37	39.00	-64.44	64.44	30.57	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
4	14.01	39.00	71.52	71.52	73.92	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
4	14.65	39.00	64.25	64.25	30.69	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
4	15.28	39.00	56.98	56.98	7.91	1.00	112.95	PhiVc/2 < Vu <=	Min 11.5.6.3	158.3	16.5	16.0
4	15.92	39.00	49.71	49.71	41.89	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
4	16.56	39.00	-43.96	43.96	53.32	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
4	17.19	39.00	-51.23	51.23	23.01	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
4	17.83	39.00	-58.50	58.50	11.92	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
4	18.47	39.00	-65.76	65.76	51.49	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
5	19.10	39.00	59.64	59.64	39.36	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
5	19.74	39.00	52.37	52.37	3.69	1.00	114.97	Vu < PhiVc/2	t Reqd 9.6.	115.0	0.0	0.0
5	20.38	39.00	45.10	45.10	27.34	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
5	21.02	39.00	37.83	37.83	53.75	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
5	21.65	39.00	-55.84	55.84	20.94	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
5	22.29	39.00	-63.11	63.11	16.94	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
5	22.93	39.00	-70.38	70.38	59.44	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
6	23.56	39.00	86.68	86.68	71.69	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
6	24.20	39.00	79.42	79.42	18.80	1.00	114.97	PhiVc/2 < Vu <=	Min 11.5.6.3	160.3	16.5	16.0
6	24.84	39.00	72.15	72.15	29.46	1.00	112.95	PhiVc/2 < Vu <=	Min 11.5.6.3	158.3	16.5	16.0
6	25.47	39.00	64.88	64.88	73.09	1.00	112.95	PhiVc/2 < Vu <=	Min 11.5.6.3	158.3	16.5	16.0
6	26.11	39.00	-28.79	28.79	75.84	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
6	26.75	39.00	-36.06	36.06	55.19	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
6	27.38	39.00	-43.33	43.33	29.91	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0
6	28.02	39.00	-50.60	50.60	0.00	1.00	112.95	Vu < PhiVc/2	t Reqd 9.6.	112.9	0.0	0.0