Structural Steel Surface Area Calculations for Painting

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Arch Columns	38
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STATE OF OHIO
DANIEL E. KENT, JR.
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REGISTERED PROFESSIONAL ENGINEER

November 4, 2019

Gannett Fleming

Summary Sheet

Project: Lorain Road over Rocky River

Designer: KAC
Date: 8/5/2019

Checker: VTD
Date 8/6/2019

Paint Quantity

Above the Deck

	Surface Area (ft^2)	Reference
Light Poles	599	Appendix Page 2
Tower Lights	722	Appendix Page 2
End Posts	278	Appendix Page 2
Railing and Architectural Features	23824	Appendix Page 2
Sidewalk Manholes	24	Appendix Page 12
Sidewalk Exp. Joint Plates	106	Appendix Page 12
Curb Plates	2456	Appendix Page 12
Utility Supports	2847	Appendix Page 22
Total =	30856	

Superstructure

	Surface Area (ft^2)	Reference
Beams and Girders	80772	Appendix Page 22
Cantilevers and Diaphragms	37113	Appendix Page 22
Arch-Columns	23431	Appendix Page 38
Arches (Exterior)	42619	Appendix Page 49
Arches (Interior)	928	(1.25ft + 3ft + 3ft) x (2ft + 3ft + 3ft) = $58ft^2$ per opening x 16 total openings = 928ft
Arch-Diaphragms	14507	Appendix Page 49
Total =	199370	

Substructure

	Surface Area (ft^2)	Reference
Towers (Exterior)	33461	Appendix Pages 59 and 68
Towers (Interior)	49824	Appendix Pages 59 and 68
Total =	83285	

Total Area Calculations

	Surface Area (ft^2)
Exterior Area =	**262759**
Interior Area =	**50752**

Gannett Fleming

Calculation Sheet

Project: Lorain Road over Rocky River

Designer: DSC
Date: 2/4/2019

Checker: ASM
Date: 3/5/2019

Paint Quantity - Post and Railings

Light Poles

		Diameter (ft)	Height (ft)		No.	Factor	Assumption	Surface Area (ft^2)
North Sidewalk	Vertical Pole	1.60	27.00		6	1.02	(1)	264
	Arm Components	0.52	20.00		6	1.00	(2)	63
South Sidewalk	Vertical Pole	1.60	27.00		5	1.02	(1)	220
	Arm Components	0.52	20.00		5	1.00	(2)	52
							Total =	599

Tower Lights (light attachment was removed)

		Perimeter (ft)	Height (ft)		No.	Factor	Assumption	Surface Area (ft^2)
East Abutment	18"x18" section	6.00	4.08		2	1.00	(3)	49
	22"x23" section	7.50	1.67		2	1.00	(3)	25
	22"x32" section	9.00	1.75		2	1.00	(3)	32
	22"x41" section	10.50	2.50		2	1.00	(3)	53
	28"x41" section	11.50	3.00		2	1.00	(3)	69
	28"x72" section	16.67	4.00		2	1.00	(3)	133
West Abutment	18"x18" section	6.00	4.08		2	1.00	(3)	49
	22"x23" section	7.50	1.67		2	1.00	(3)	25
	22"x32" section	9.00	1.75		2	1.00	(3)	32
	22"x41" section	10.50	2.50		2	1.00	(3)	53
	28"x41" section	11.50	3.00		2	1.00	(3)	69
	28"x72" section	16.67	4.00		2	1.00	(3)	133
							Total =	722

End Posts

		Perimeter (ft)	Height (ft)		No.	Factor	Assumption	Surface Area (ft^2)
East Abutment	22"x38" section	10.00	1.63		2	1.00	(4)	33
	22"x60" section	13.67	3.88		2	1.00	(4)	106
West Abutment	22"x38" section	10.00	1.63		2	1.00	(4)	33
	22"x60" section	13.67	3.88		2	1.00	(4)	106
							Total =	278

Railing and Architectural Features

		Perimeter (ft)	Length / Height (ft)	Area (ft^2)	No.	Factor	Assumption	Surface Area (ft^2)
North Railing	Rails (TS4x4)	1.33	1250.00		3	1.00	-	5000
	Interim Posts (W8x31)	4.00	2.92		187	1.20	(5)	2618
	Main Posts (TS16x8)	4.00	3.25		71	1.20	(5)	1108
	Iron Railing Grill Panels			8.50	250	1.50	(6)	3186
South Railing	Rails (TS4x4)	1.33	1250.00		3	1.00	-	5000
	Interim Posts (W8x31)	4.00	2.92		187	1.20	(5)	2618
	Main Posts (TS16x8)	4.00	3.25		71	1.20	(5)	1108
	Iron Railing Grill Panels			8.50	250	1.50	(6)	3186
							Total =	23824

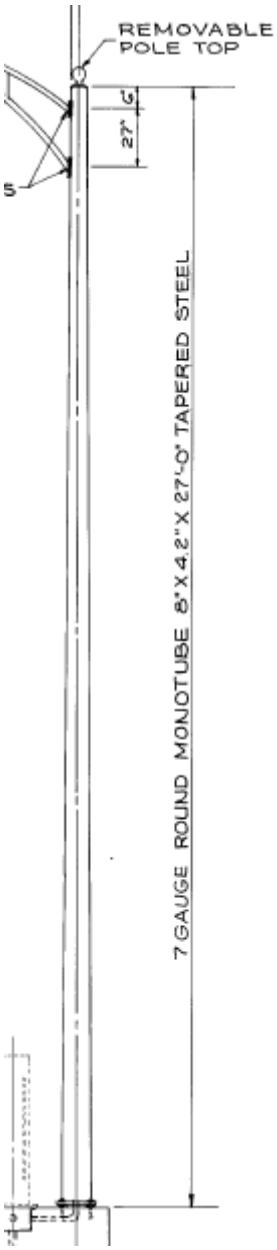
Assumptions

All Elements	Increase the "Factor" to account for connections (splice plates, connection plates, stiffeners, bolts, washers)
(1)	Assume an average diameter of 6.1 inches
(2)	Assume a collective length of 20 ft. for the arm components
(3)	Approximate the tower light sections to be square
(4)	Approximate the end post sections to be square
(5)	Factor = 1.20 to account for the top and bottom connection plates and fasteners
(6)	Factor = 1.50 to account for the surrounding connection plates and fasteners

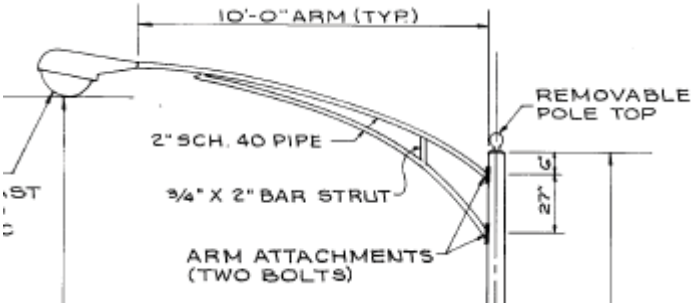
Paint Area Calculations: Light Poles

1986 CUY-10-0869 Rehab Plans:

Sheet 105 of 113 shows the dimensions and specifications for the light poles.



Veritical Pole: The diameter varies from 8" to 4.2", therefore assume an average diamter of 6.1". The length of the pole is shown as 27'-0".



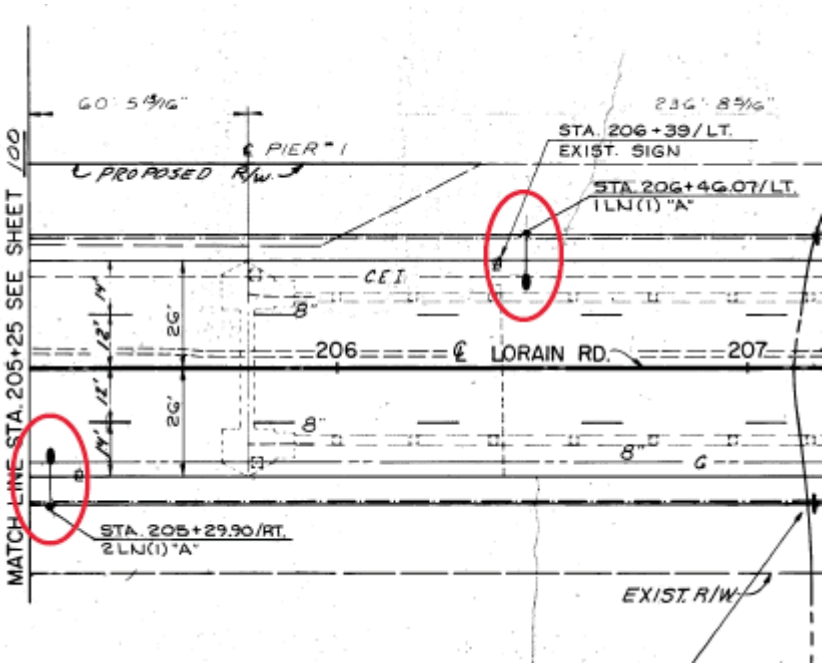
Arm Components: The diameter is shown as 2". Assume the total length of all arm components is approximately 20'-0".

1986 CUY-10-0869 Rehab Plans:

Sheet 101 of 113 - shows 5 light poles on the bridge. (Shown below)

Sheet 102 of 113 - shows 4 light poles on the bridge.

Sheet 103 of 113 - shows 2 light poles on the bridge.



There are a total of 11 Light Poles shown.

6 along the North sidewalk.
5 along the South sidewalk.

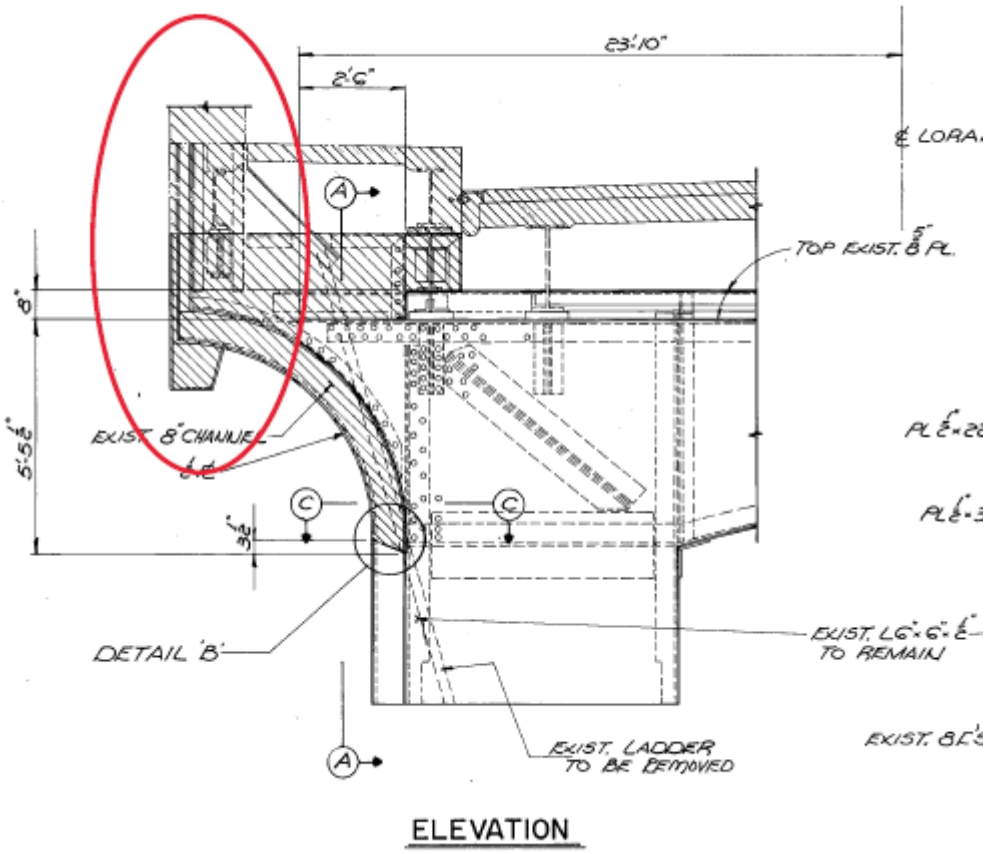
Paint Area Calculations: Tower Lights (light attachment removed)

1986 CUY-10-0869 Rehab Plans:

Sheet 67 of 113 shows the tower light at Piers 1 & 5 have been removed. (Shown below)

Sheet 69 of 113 shows the tower light at Piers 2, 3 & 4 have been removed.

Note: Confirmed by viewing the street view on google maps.

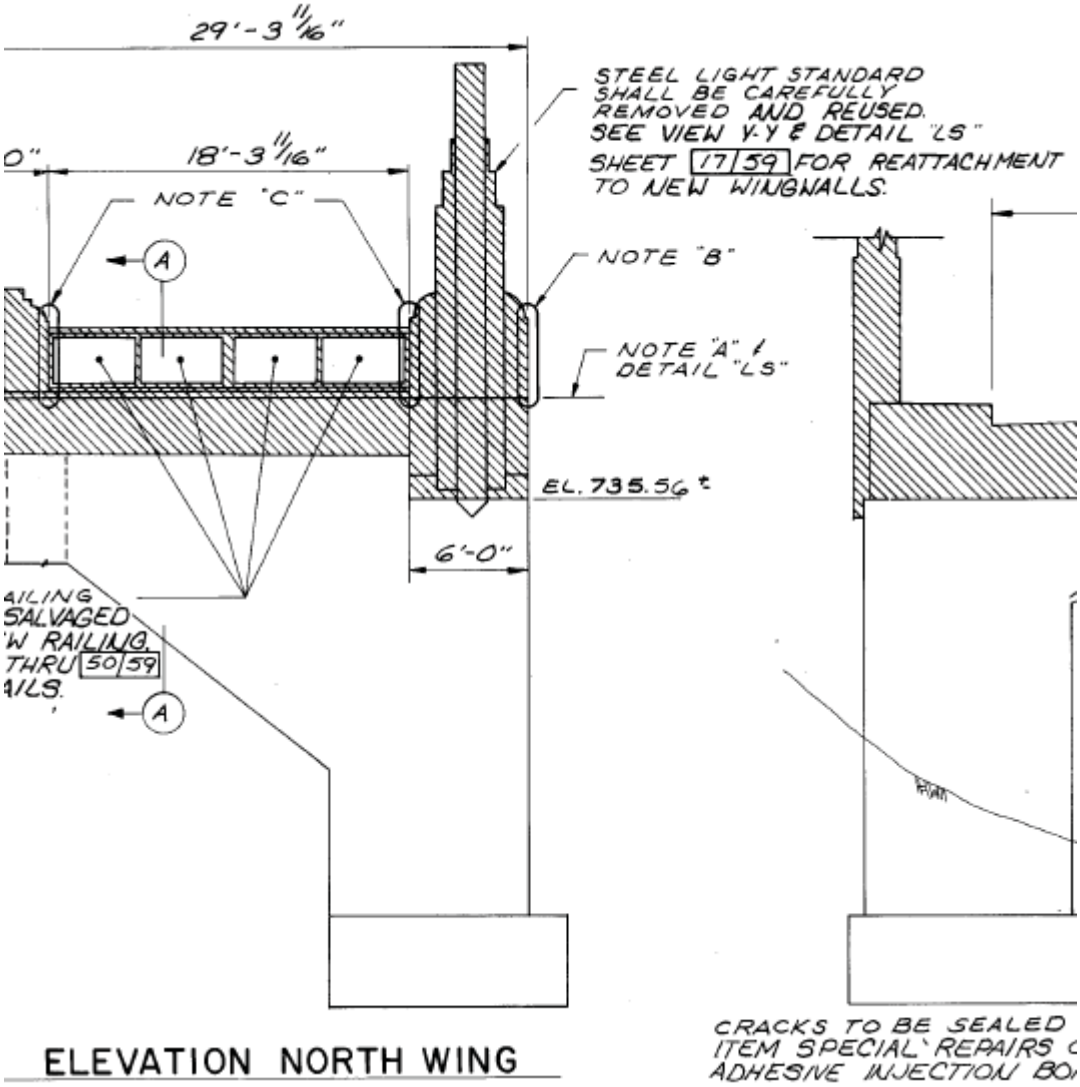


1986 CUY-10-0869 Rehab Plans:

Sheet 52 of 113 shows the Tower Light at the East Abutment being carefully removed and reused. (Shown below)

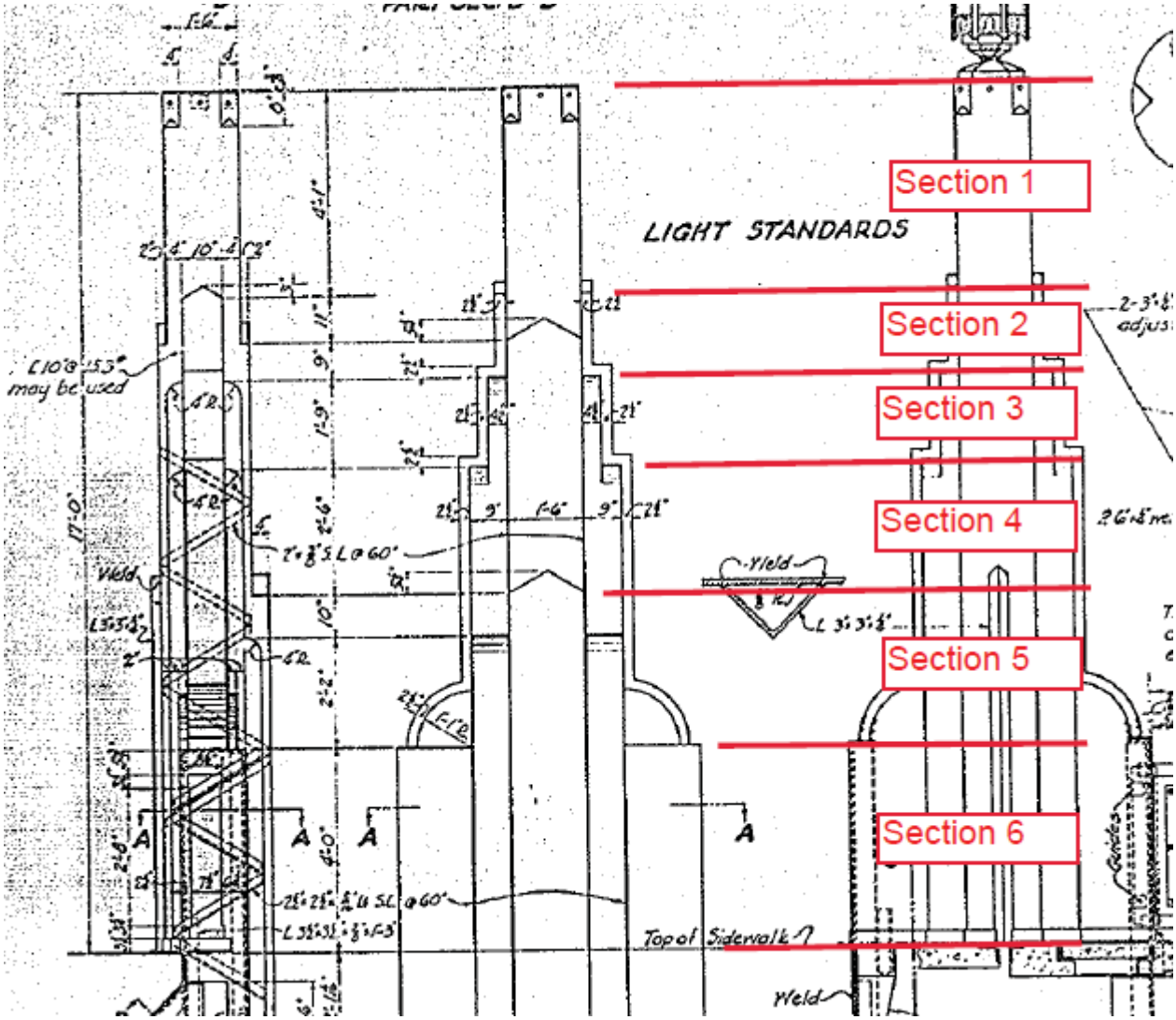
Sheet 57 of 113 shows the Tower Light at the West Abutment being carefully removed and reused.

Note: Confirmed by viewing the street view on google maps.



1934 CUY-10-0869 Original Plans:

Sheet 27 of 51 shows the dimensions for the Tower Lights.



Section 1 = Approximately 18"x18" (Height = 4'-1")
Section 2 = Approximately 22"x23" (Height = 1'-8")
Section 3 = Approximately 22"x32" (Height = 1'-9")
Section 4 = Approximately 22"x41" (Height = 2'-6")
Section 5 = Approximately 28"x41" (Height = 3'-0")
Section 6 = Approximately 28"x72" (Height = 4'-0")

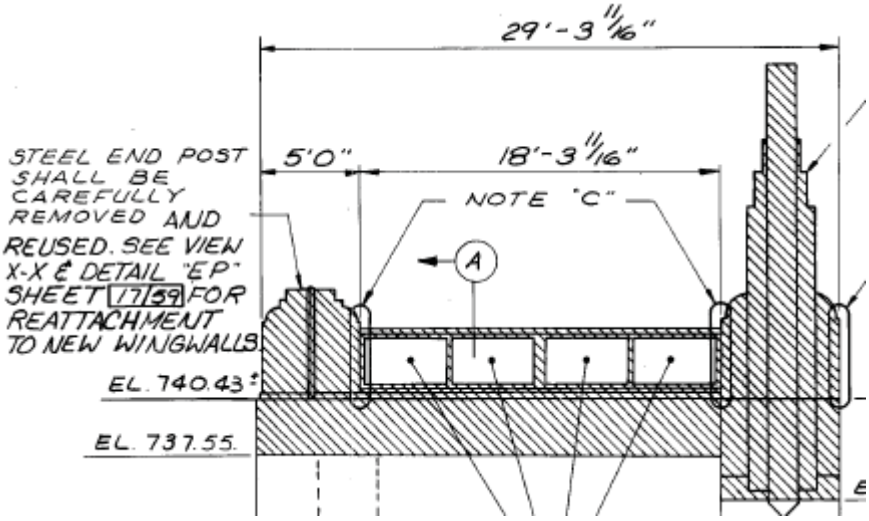
Paint Area Calculations: End Posts

1986 CUY-10-0869 Rehab Plans:

Sheet 52 of 113 shows the End Post at the East Abutment being carefully removed and reused. (Shown below)

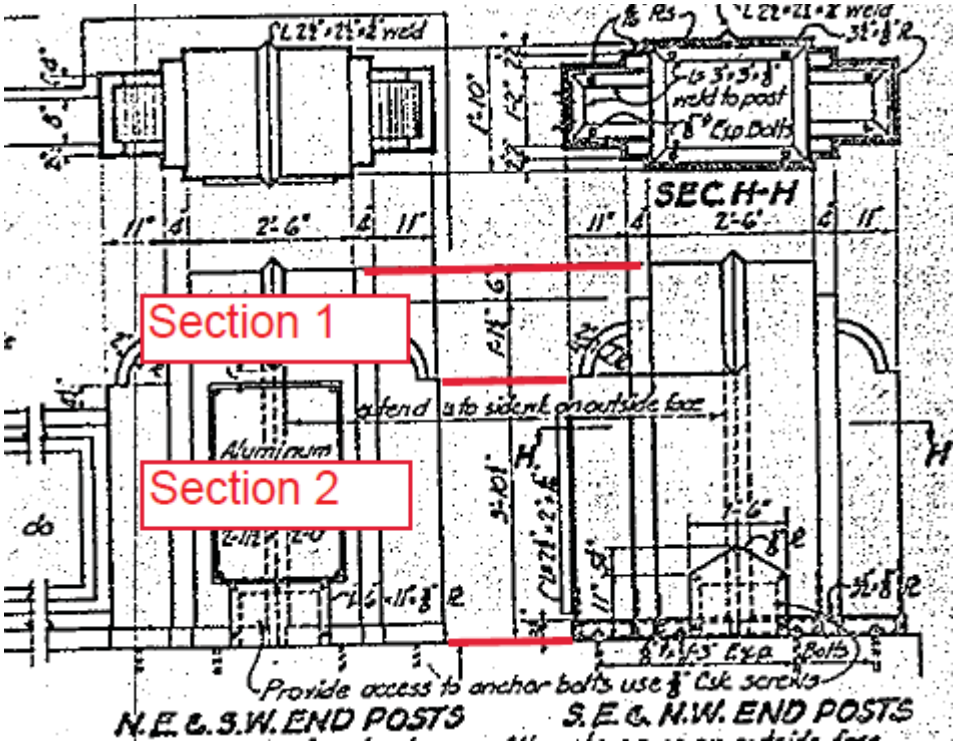
Sheet 57 of 113 shows the End Post at the West Abutment being carefully removed and reused.

Note: Confirmed by viewing the street view on google maps.



1934 CUY-10-0869 Original Plans:

Sheet 27 of 51 shows the dimensions for the End Post at Abutment locations.



Section 1 = Approximately 22"x38" (Height = 1'-7.5")

Section 2 = Approximately 22"x60" (Height = 3'-10.5")

Paint Area Calculations: Railing and Architectural Treatment

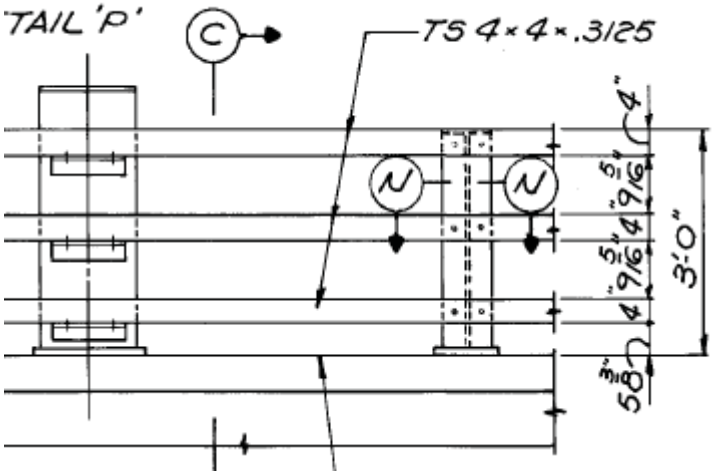
1986 CUY-10-0869 Rehab Plans:

Sheet 86 of 113 shows the layout of all Railing and Architectural Treatment.

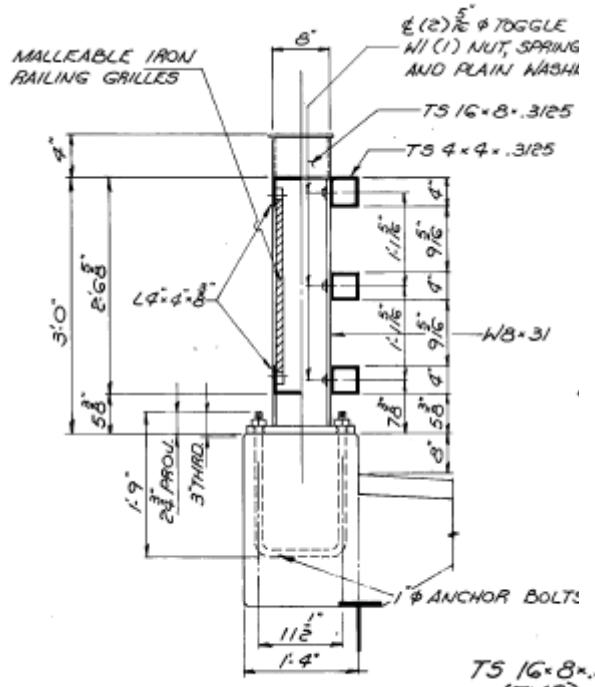
Sheet 87 of 113 shows the dimensions of the TS4x4 Rails. (Shown below)

Sheet 87 of 113 shows the dimensions of the W8x31 Interm Posts. (Shown below)

Sheet 87 of 113 shows the dimensions of the TS16x8 Main Posts. (Shown below)



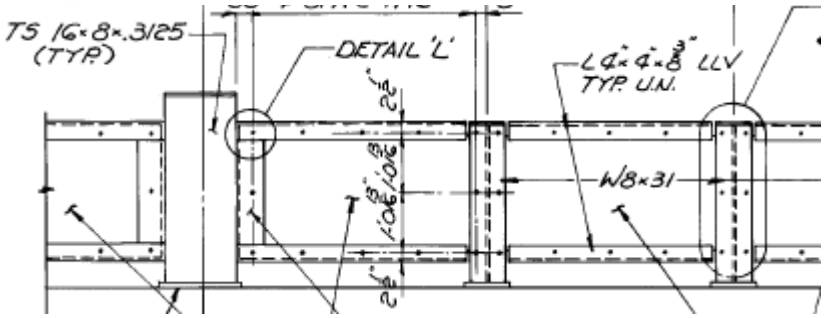
The perimeter of a 4"x4" TS section is 16 in. (1.33 ft.)
The length is approximately 1250'-0".



SECTION C-C

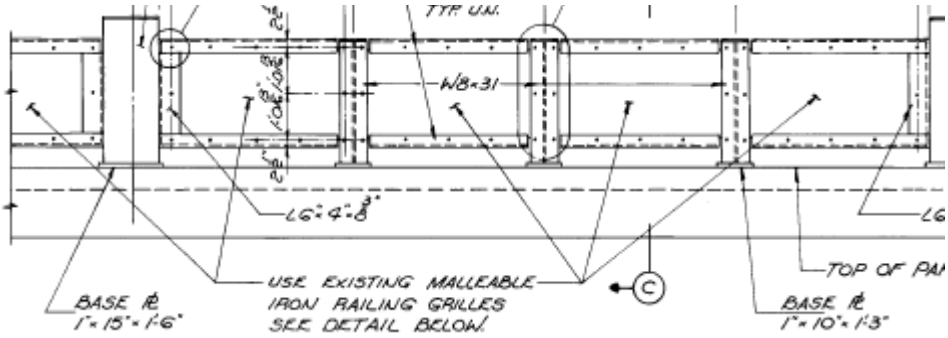
The perimeter of a W8x31 is approximately 48 in. (4.00 ft.)
The height is 2'-11".

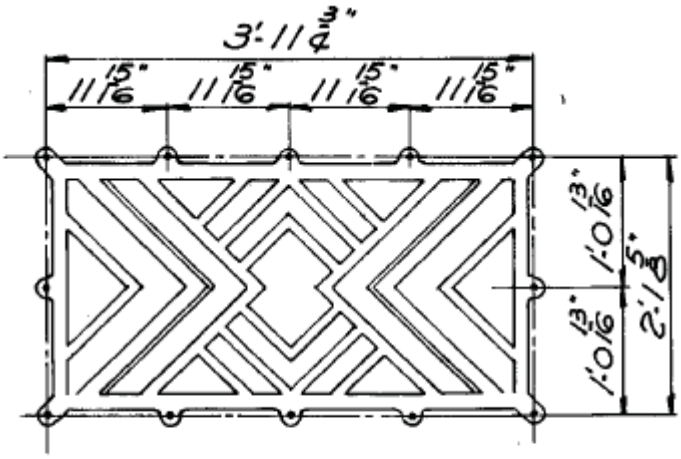
The perimeter of a 8"x16" TS section is 48 in. (4.00 ft.)
The height is 3'-3".



1986 CUY-10-0869 Rehab Plans:

Sheet 52 of 113 states the Malleable Iron Railing Grilles shall be salvaged for reuse at the East Abutment.
Sheet 57 of 113 states the Malleable Iron Railing Grilles shall be salvaged for reuse at the West Abutment.
Sheet 87 of 113 states that the Exising Malleable Iron Railing Grilles are being reused. (Shown below)
Sheet 87 of 113 shows the dimensions of the Existing Malleable Iron Railing Grille. (Shown below)





EXISTING MALLEABLE IRON RAILING GRILLES

To account for the holes in the panel, use 50% of the panel's total surface area.

Therefore, the approximate surface area of one 2-sided Malleable Iron Railing Grille Panel (3'-11.75" x 2'-1.625") is 8.50 sq. ft.

Gannett Fleming

Calculation Sheet

Project: Lorain Road over Rocky River

Designer: DSC
Date: 2/4/2019

Checker: ASM
Date: 3/5/2019

Paint Quantity - Sidewalk Features

Sidewalk Manholes

	Width (ft)	Length (ft)		No.	Factor	Assumption	Surface Area (ft^2)
South Sidewalk	2.08	2.33		5	1.00	(1)	24

Sidewalk Plates for Expansion Joints

	Width (ft)	Length (ft)		No.	Factor	Assumption	Surface Area (ft^2)
North Sidewalk	1.50	5.00		7	1.00	-	53
South Sidewalk	1.50	5.00		7	1.00	-	53
						Total =	106

Curb Plates

	Height (ft)	Length (ft)			Factor	Assumption	Surface Area (ft^2)
North Sidewalk	1.00	1228.00			1.00	-	1228
South Sidewalk	1.00	1228.00			1.00	-	1228
						Total =	2456

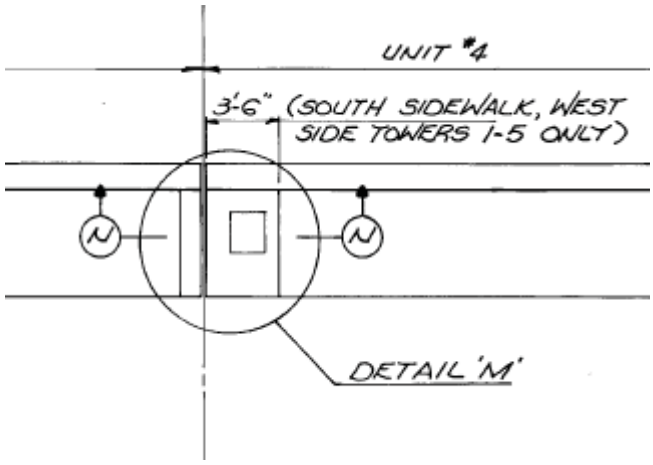
Assumptions

All Elements	Increase the "Factor" to account for connections (splice plates, connection plates, stiffeners, bolts, washers)
(1)	Assume a 3" lip for the manhole cover

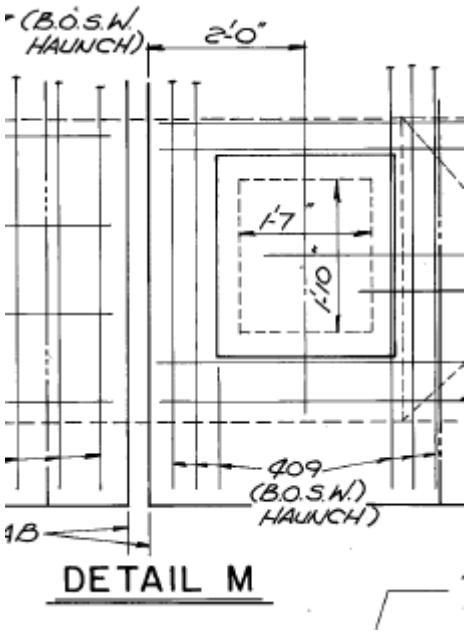
Paint Area Calculations: Sidewalk Manholes

1986 CUY-10-0869 Rehab Plans:

Sheet 80 of 113 shows the dimensions and number of sidewalk manholes.



There are a total of 5 Sidewalk Manholes shown.



Assume a 3" lip for the manhole opening shown. Therefore, the manhole is 2'-4" x 2'-1".

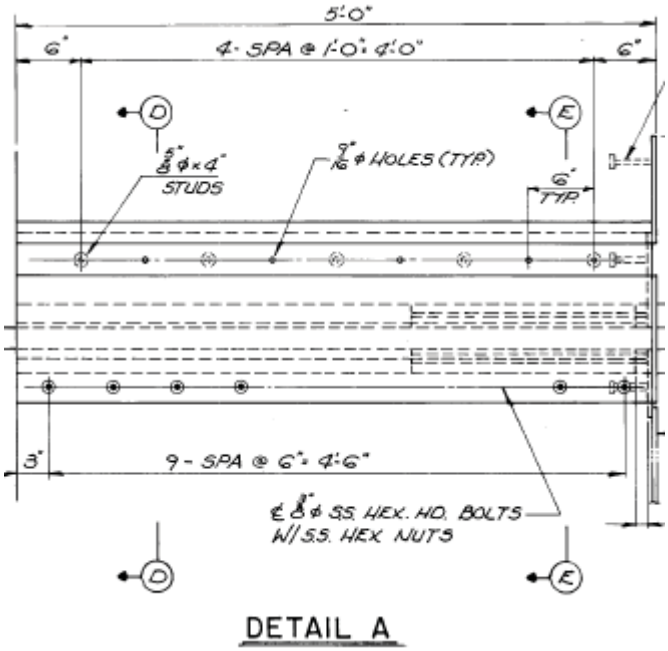
Paint Area Calculations: Sidewalk Plates for Expansion Joints

1986 CUY-10-0869 Rehab Plans:

Sheet 84 of 113 specifies the locations of expansion joints. (7 total per sidewalk)

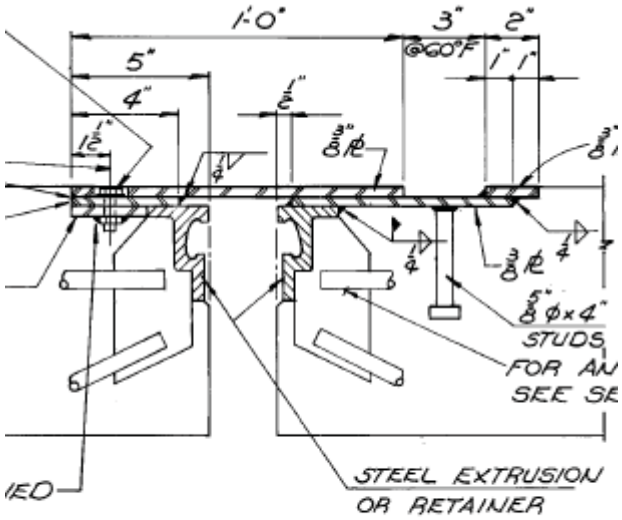
Sheet 85 of 113 shows the dimensions of the Sidewalk Plates for Expansion Joints. (Shown below)

Note: Confirmed by viewing the street view on google maps.



DETAIL A

The length of the Sidewalk Plates is 5'-0".

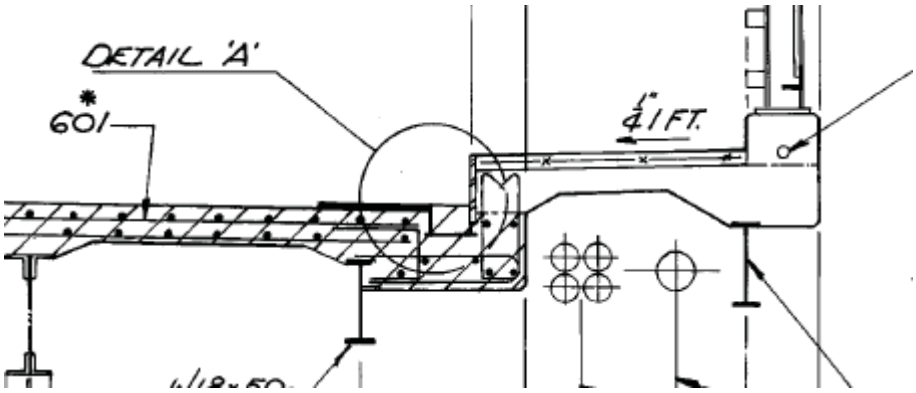


SECTION D-D

The width of the top surface is approximately 1'-6".

Paint Area Calculations: Curb Plates

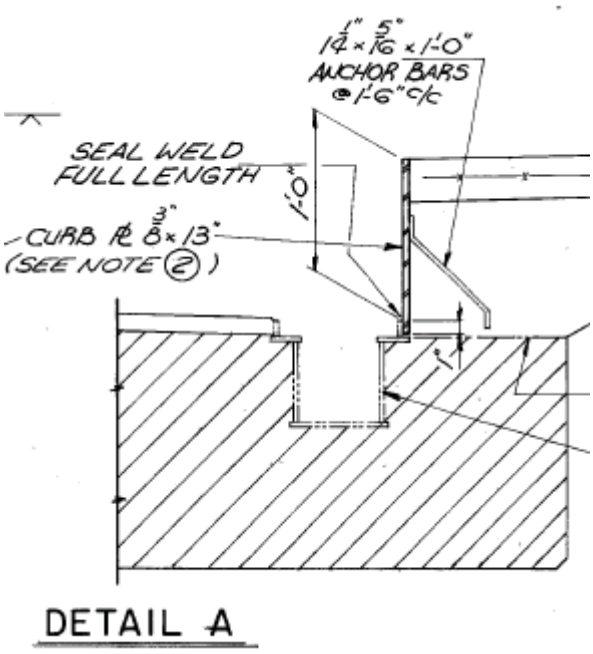
1986 CUY-10-0869 Rehab Plans:
Sheet 79 of 113 shows the dimensions of the Curb Plates.



The length of the Curb Plates span from the East Abutment Tower Light to the West Abutment End Post.

The length is approximately 1228'-0".

Note: Confirmed by viewing the street view on google maps.

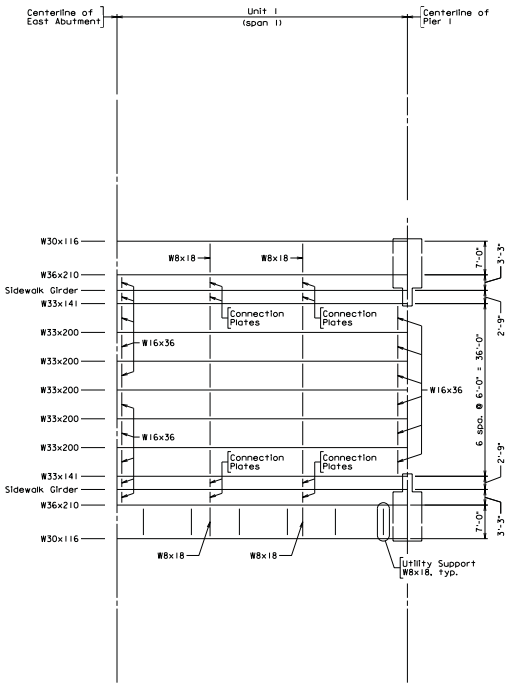


The height of the Curb Plate is 1'-0".

SHEET NO. 1

Notes:

All diaphragms are W18x47, unless otherwise shown.



Not to scale

FRAMING PLAN:
UNIT 1

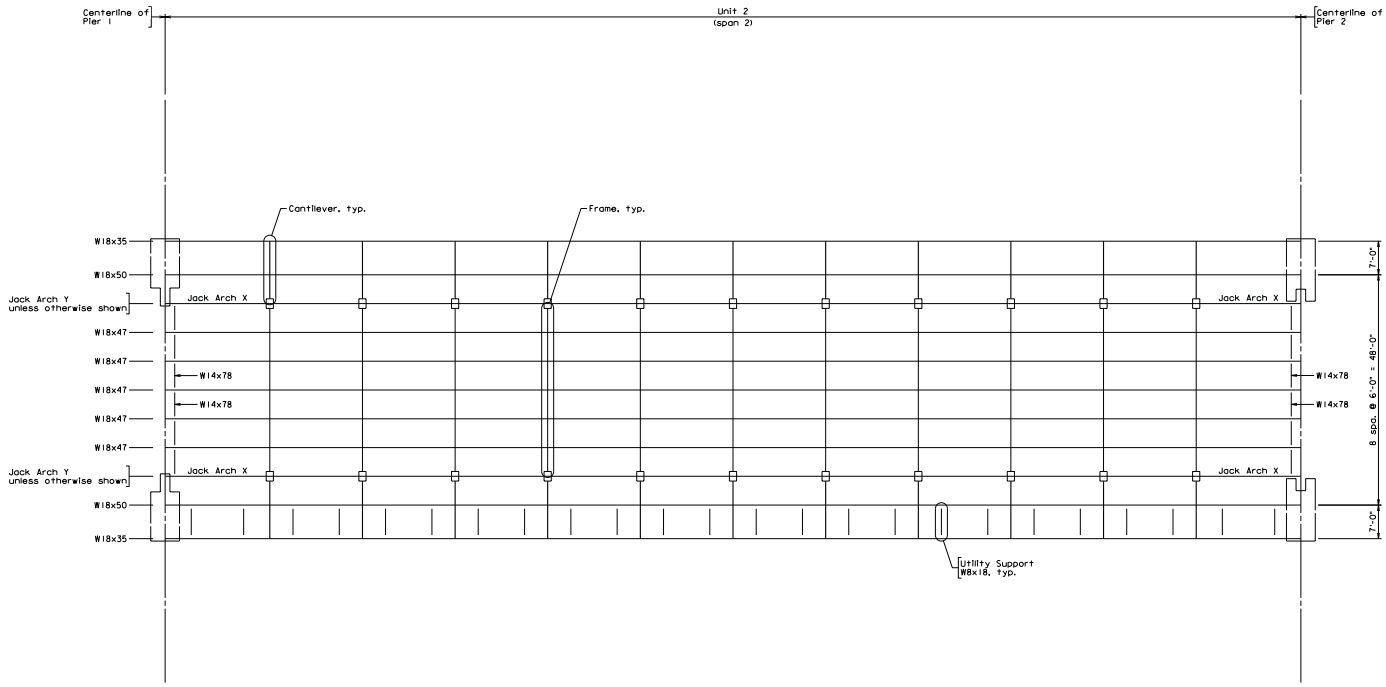
Drawn: DSC Checked: ASM	Date	Sheet No.
	Feb. 2019	1 of 6

Unit 1.dgn

SHEET NO. 2

Notes:

All diaphragms at pier locations are W14x43, unless otherwise shown.



Not to scale

FRAMING PLAN: UNIT 2

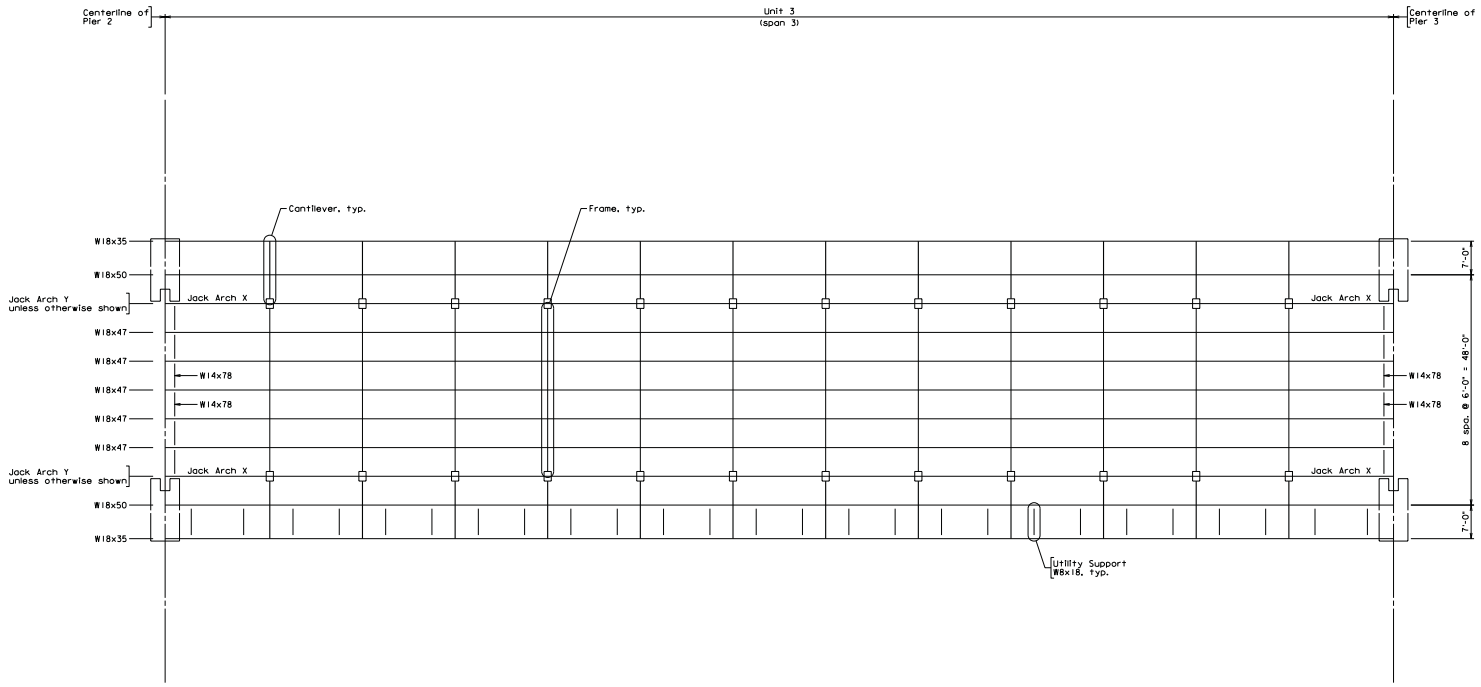
Drawn: DSC Checked: ASM	Date	Sheet No.
	Feb. 2019	2 of 6

Unit 2.dgn

SHEET NO. 3

Notes:

All diaphragms at pier locations are W14x43, unless otherwise shown.



Not to scale

FRAMING PLAN: UNIT 3

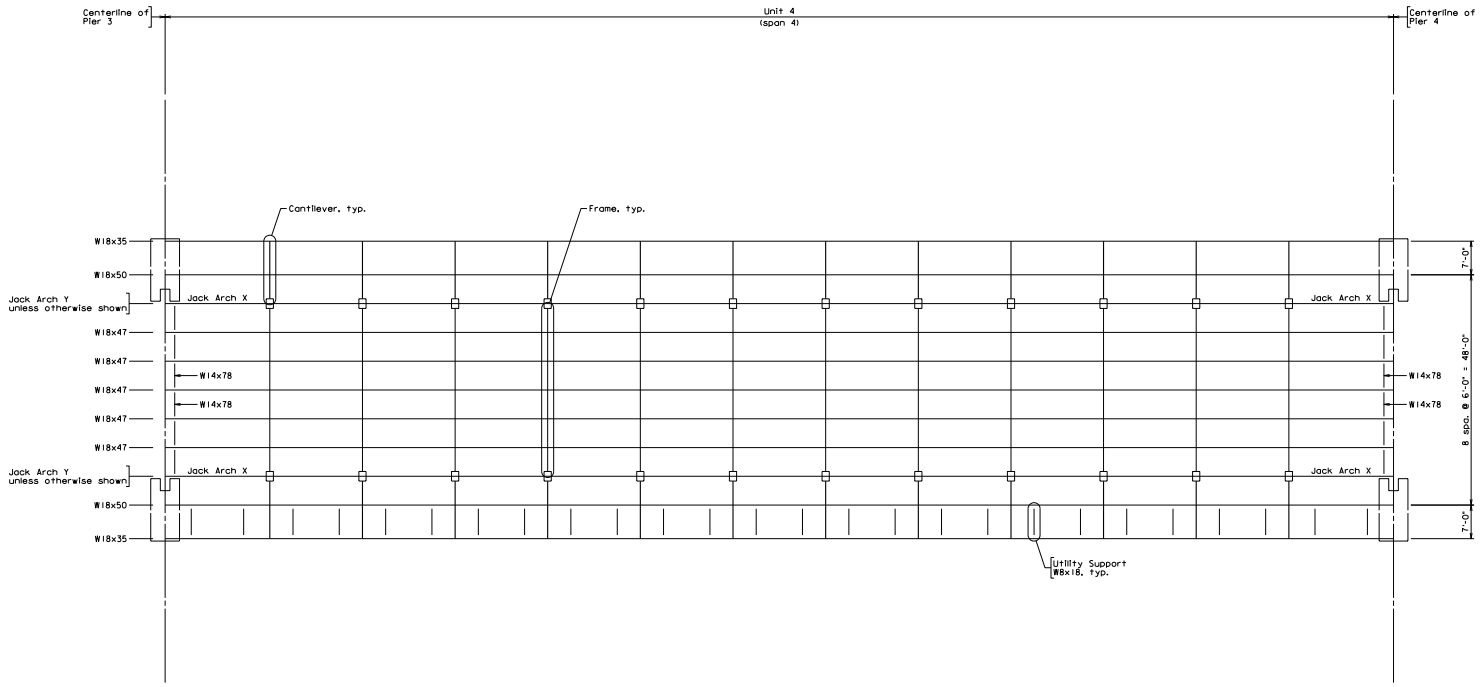
Drawn: DSC Checked: ASM	Date	Sheet No.
	Feb. 2019	3 of 6

Unit 3.dgn

SHEET NO. 4

Notes:

All diaphragms at pier locations are W14x43, unless otherwise shown.



Not to scale

FRAMING PLAN: UNIT 4

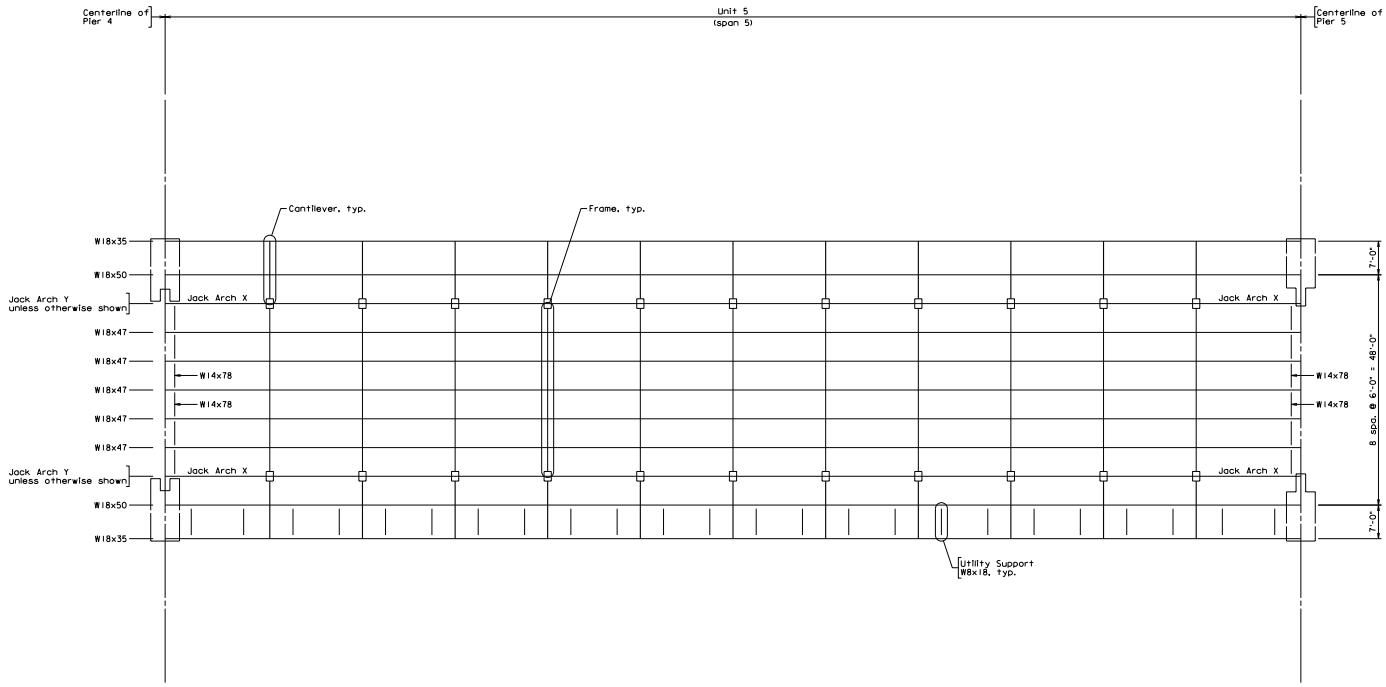
Drawn: DSC Checked: ASM	Date	Sheet No.
	Feb. 2019	4 of 6

Unit 4.dgn

SHEET NO. 5

Notes:

All diaphragms at pier locations are W14x43, unless otherwise shown.



Not to scale

FRAMING PLAN: UNIT 5

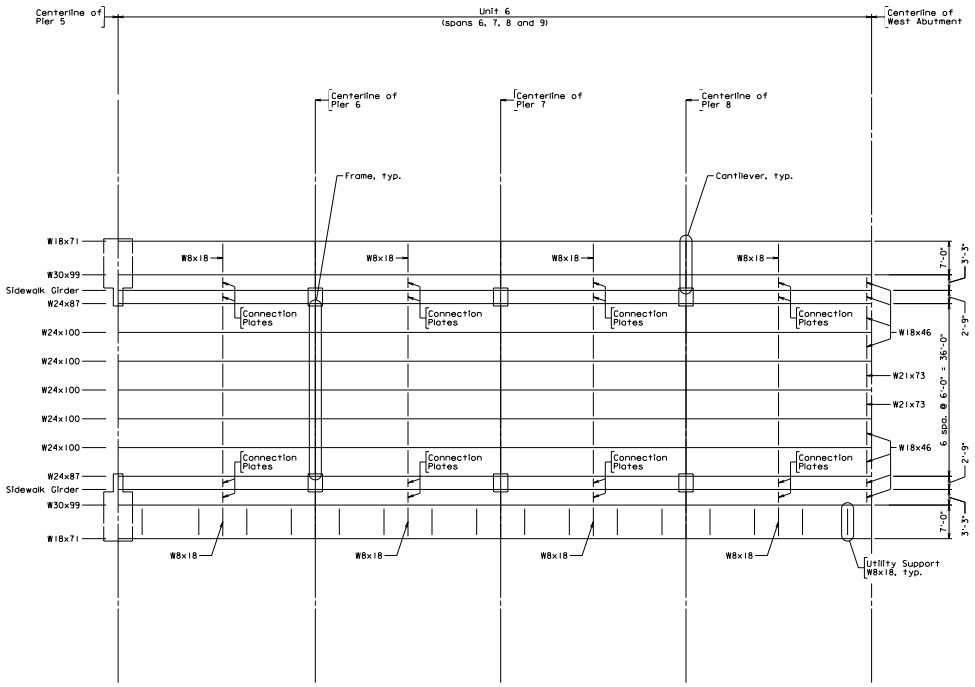
Drawn: DSC Checked: ASM	Date	Sheet No.
	Feb. 2019	5 of 6

Unit 5.dgn

SHEET NO. 6

Notes:

All diaphragms are W18x47, unless otherwise shown.



Not to scale

FRAMING PLAN:
UNIT 6

Drawn: DSC / Checked: ASM	Date	Sheet No.
	Feb. 2019	6 of 6

Unit 6.dgn

Gannett Fleming

Calculation Sheet

Project: Lorain Road over Rocky River

Designer: DSC
Date: 2/4/2019

Checker: ASM
Date: 3/5/2019

Paint Quantity - Superstructure

Beams and Girders

		Perimeter (ft)	Length (ft)		No.	Factor	Assumption	Surface Area (ft^2)
(1934) Unit 1	Sidewalk Girder	10.13	60.48		2	1.10	-	1347
	W33x141	8.42	20.16		6	1.05	-	1069
	W33x200	9.54	20.16		15	1.05	-	3030
(1934) Units 2 thru 5	Jack Arch "X"	8.17	18.00		16	1.10	-	2587
	Jack Arch "Y"	8.17	17.67		84	1.10	-	13331
	W18x47	4.50	19.71		250	1.05	(1)	23280
(1934) Unit 6	Sidewalk Girder	9.50	39.26		8	1.10	-	3282
	W24x87	6.25	19.63		16	1.05	-	2061
	W24x100	6.33	19.63		40	1.05	-	5221
(1986) Unit 1	W30x116 (Ext)	7.63	20.16		6	1.05	-	969
	W36x210 (Int)	9.13	20.16		6	1.05	-	1159
(1986) Units 2 thru 5	W18x35 (Ext)	4.46	19.71		100	1.05	-	9226
	W18x50 (Int)	4.88	19.71		100	1.05	-	10088
(1986) Unit 6	W18x71 (Ext)	4.96	19.63		16	1.05	-	1635
	W30x99 (Int)	7.54	19.63		16	1.05	-	2487
							Total =	80772

Utility Supports

		Perimeter (ft)	Length (ft)		No.	Factor	Assumption	Surface Area (ft^2)
W8x18	Unit 1	3.13	7.00		6	1.03	-	135
	Unit 2	3.13	7.25		24	1.03	-	560
	Unit 3	3.13	7.25		26	1.03	-	607
	Unit 4	3.13	7.25		26	1.03	-	607
	Unit 5	3.13	7.25		24	1.03	-	560
	Unit 6	3.13	7.33		16	1.03	-	378
							Total =	2847

Cantilevers and Diaphragms

		Perimeter (ft)	Length (ft)		No.	Factor	Assumption	Surface Area (ft^2)
(1934) Unit 1	W16x36	5.00	6.00		12	1.05	-	378
	W18x47	5.00	6.00		12	1.05	(1)	378
	Connection Plates	8.67	6.00		4	1.05	(2)	218
(1934) Units 2 thru 5	Frame	9.63	32.08		46	1.15	-	16336
	W14x43	4.96	6.00		32	1.05	-	1000
	W14x78	5.75	6.00		16	1.05	(3)	580
(1934) Unit 6	Frame	10.92	35.08		3	1.15	-	1321
	W18x46	5.00	6.00		2	1.05	-	63
	W18x47	5.00	6.00		24	1.05	-	756
	W21x73	6.29	6.00		1	1.05	-	40
	Connection Plates	8.33	6.00		8	1.05	(2)	420
(1986) Unit 1	W16x36	5.00	6.00		2	1.05	-	63
	W8x18	3.13	7.25		4	1.05	-	95
(1986) Units 2 thru 5	Cantilever	11.33	13.08		92	1.05	-	14324
(1986) Unit 6	W8x18	3.13	7.25		8	1.05	-	190
	W18x46	5.00	6.00		4	1.05	(2)	126
	W21x73	6.29	6.00		1	1.05	-	40
	Cantilever	12.67	9.83		6	1.05	-	785
							Total =	37113

Assumptions

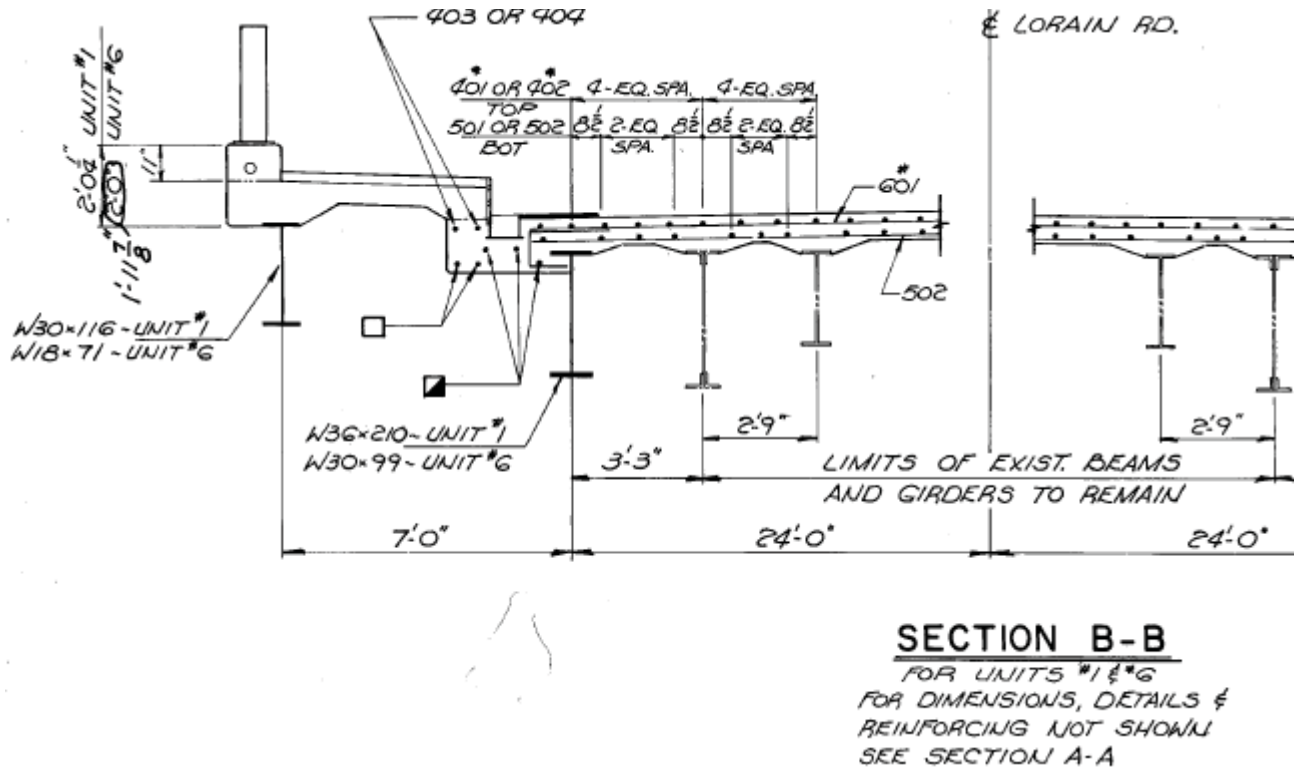
All Elements	Increase the "Factor" to account for connections (splice plates, connection plates, stiffeners, bolts, washers)
(1)	W18x47 section no longer exists, therefore W18x46 is used to estimate dimensions
(2)	The 6'-0" Length may account for 2 bays between the sidewalk girder (2.75' + 3.25')
(3)	W14x78 section no longer exists, therefore W14x82 is used to estimate dimensions

Paint Area Calculations: Beams and Girders

1986 CUY-10-0869 Rehab Plans:

Sheet 61 of 113 shows the Framing plan and limits of existing beams and girders to remain.

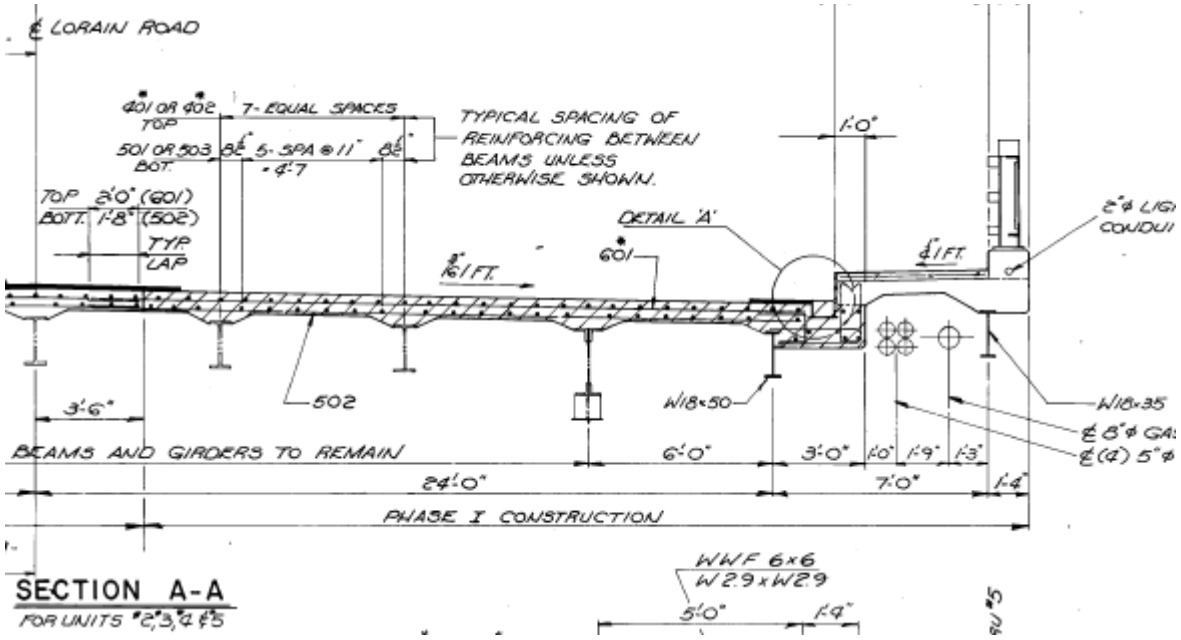
Sheet 79 of 113 shows the transverse section and limits of existing beams and girders to remain. (shown below)



A partial clip of the detail above shows the proposed girders:

Unit 1: W30x116, perimeter = 91.5 in. (7.63 ft.)
W36x210, perimeter = 109.5 in. (9.13 ft.)

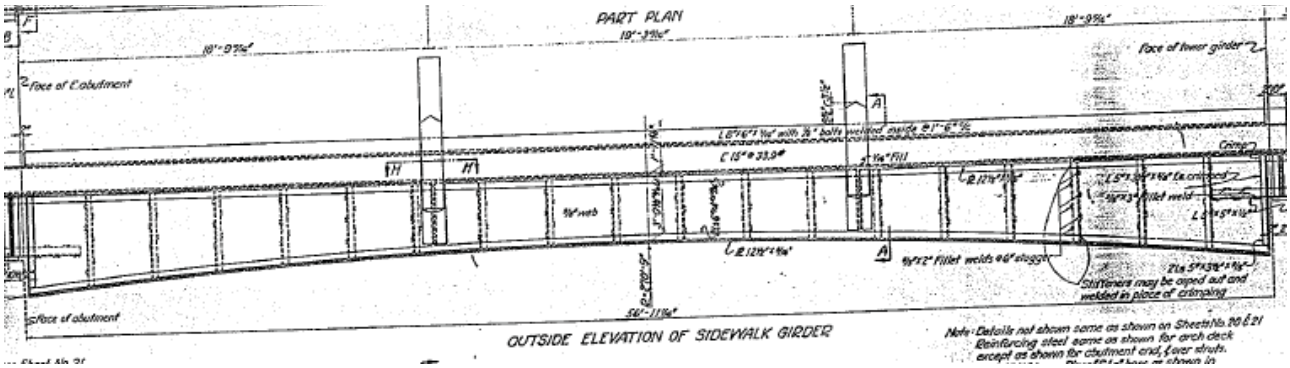
Unit 6: W18x71, perimeter = 59.5 in. (4.96 ft.)
W30x99, perimeter = 90.5 in. (7.54 ft.)



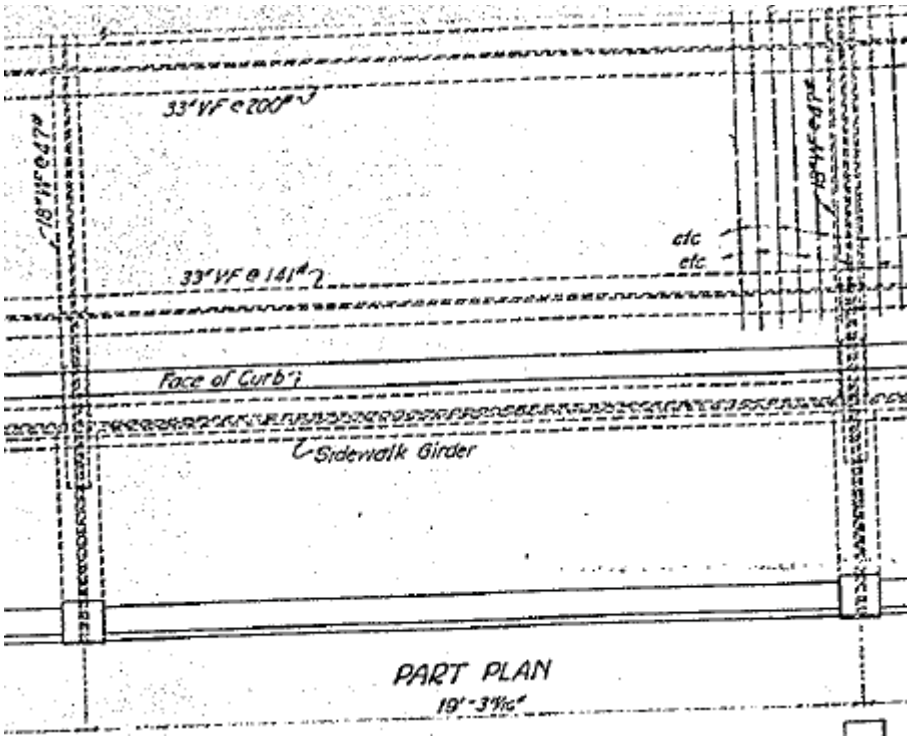
A partial clip of the detail above shows the proposed girders:
Units 2 thru 5: W18x35, perimeter = 53.5 in. (4.46 ft.)
W18x50, perimeter = 58.5 in. (4.88 ft.)

1934 CUY-10-0869 Original Plans:

Sheet 22 of 51 shows the Beams and Girders for the East Approach Span (Unit 1).



Assume the average depth of the girder is approximately 3'-6".



A partial clip of the details above show the existing girders:

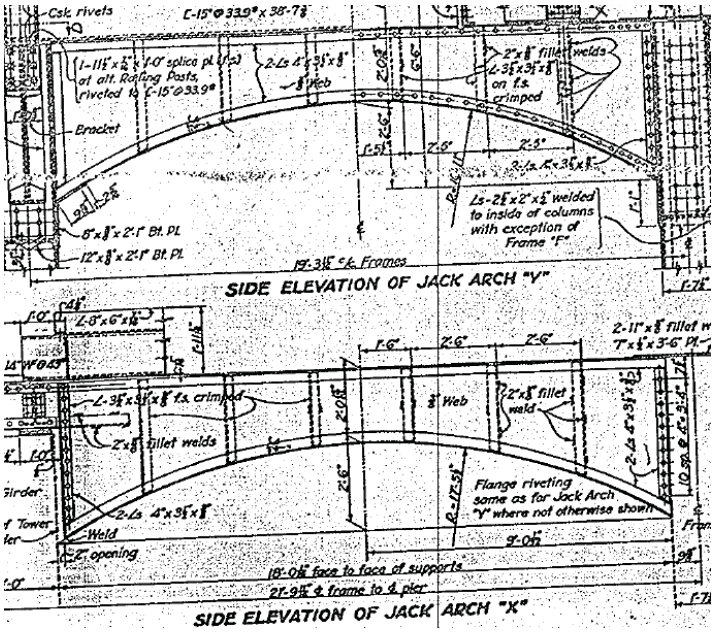
Unit 1: Sidewalk Girder, perimeter = 121.5 in. (10.13 ft.)

W33x141, perimeter = 101.0 in. (8.42 ft.)

W33x200, perimeter = 114.5 in. (9.54 ft.)

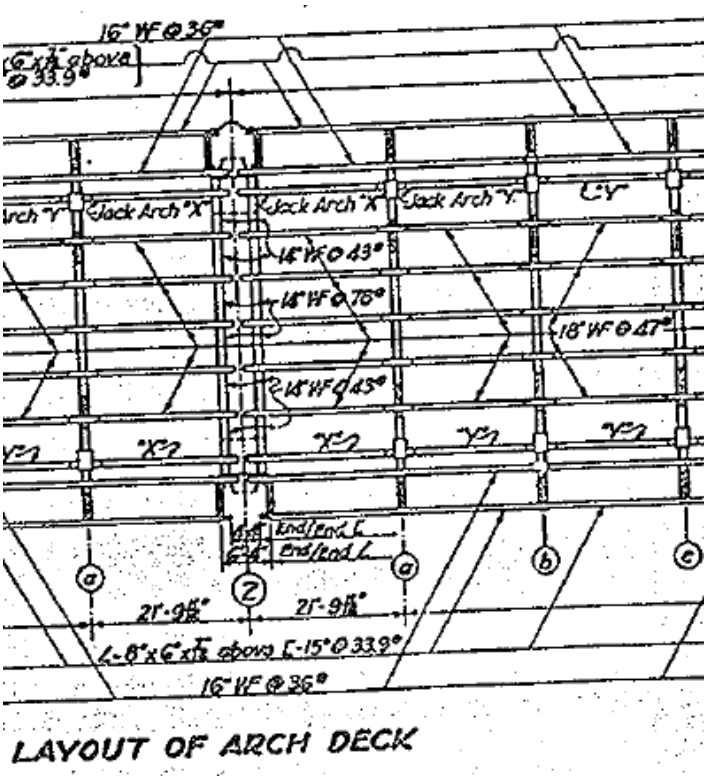
1934 CUY-10-0869 Original Plans:

Sheet 20 of 51 shows the Beams and Girders for the Arch Deck Portion (Units 2 thru 5).



Assume the average depth of Jack Arch Y is approximately 3'-1".

Assume the average depth of Jack Arch X is approximately 3'-1".



A partial clip of the details above shows the existing girders:

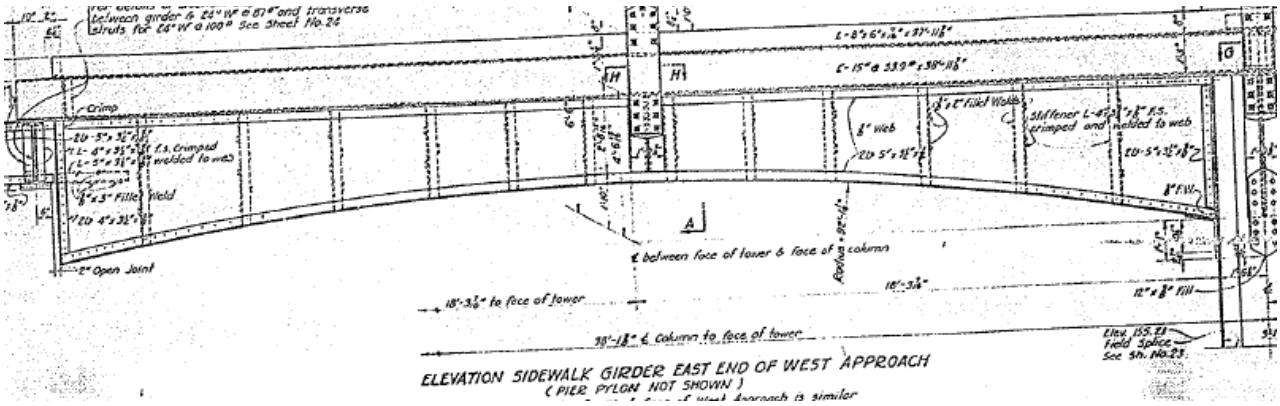
Units 2 thru 5: Jack Arch Y, perimeter = 98.0 in. (8.17 ft.)

Jack Arch X, perimeter = 98.0 in. (8.17 ft.)

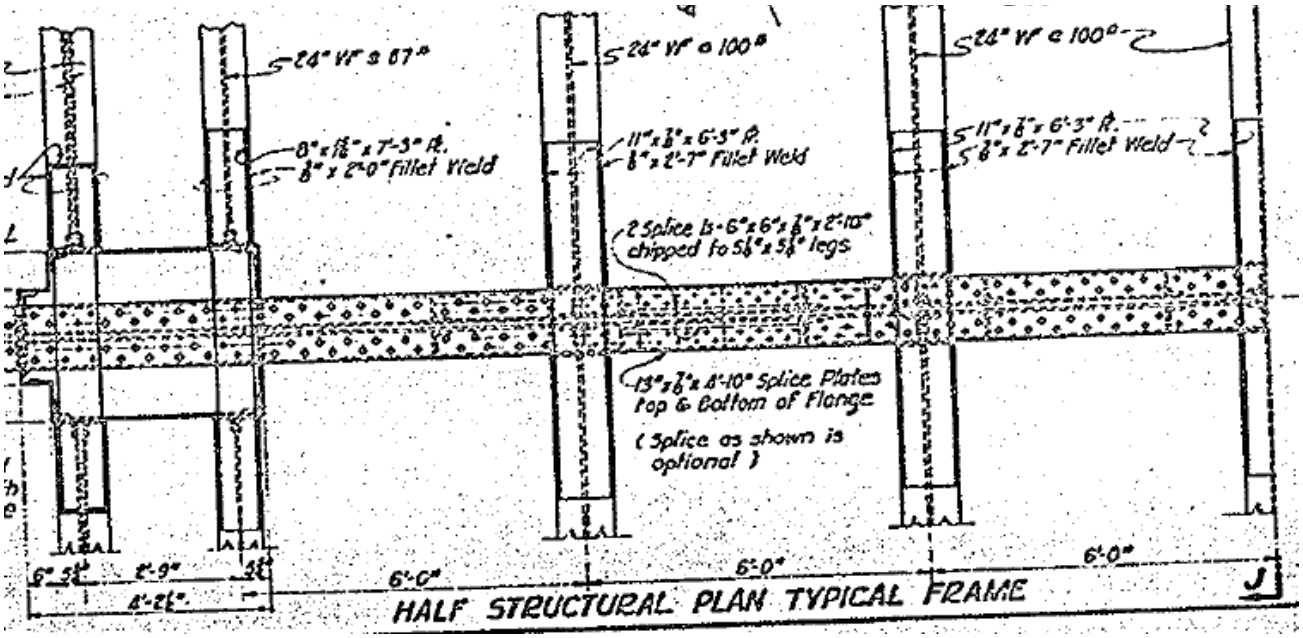
W18x47, perimeter = 54.0 in. (4.50 ft.)

1934 CUY-10-0869 Original Plans:

Sheet 25 of 51 shows the Beams and Girders for the West Approach Spans (Unit 6).



Assume the average depth of the girder is approximately 3'-6".



A partial clip of the details above show the existing girders:

Unit 6: Sidewalk Girder, perimeter = 114 in. (9.50 ft.)

W24x87, perimeter = 75.0 in. (6.25 ft.)

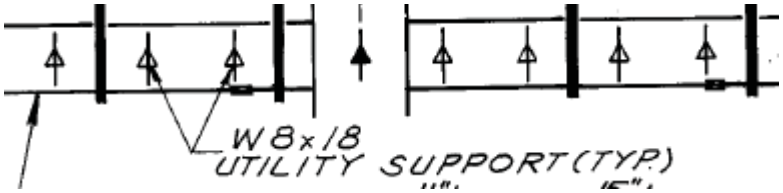
W24x100, perimeter = 76.0 in. (6.33 ft.)

Paint Area Calculations: Utility Supports

1986 CUY-10-0869 Rehab Plans:

Sheet 61 of 113 shows the Framing plan and limits of existing beams and girders to remain.

Sheet 66 of 113 shows the framing details for the Utility Support.



A partial clip of the detail above shows the Utility Supports:
W8x18, *perimeter = 37.5 in. (3.13 ft.)*

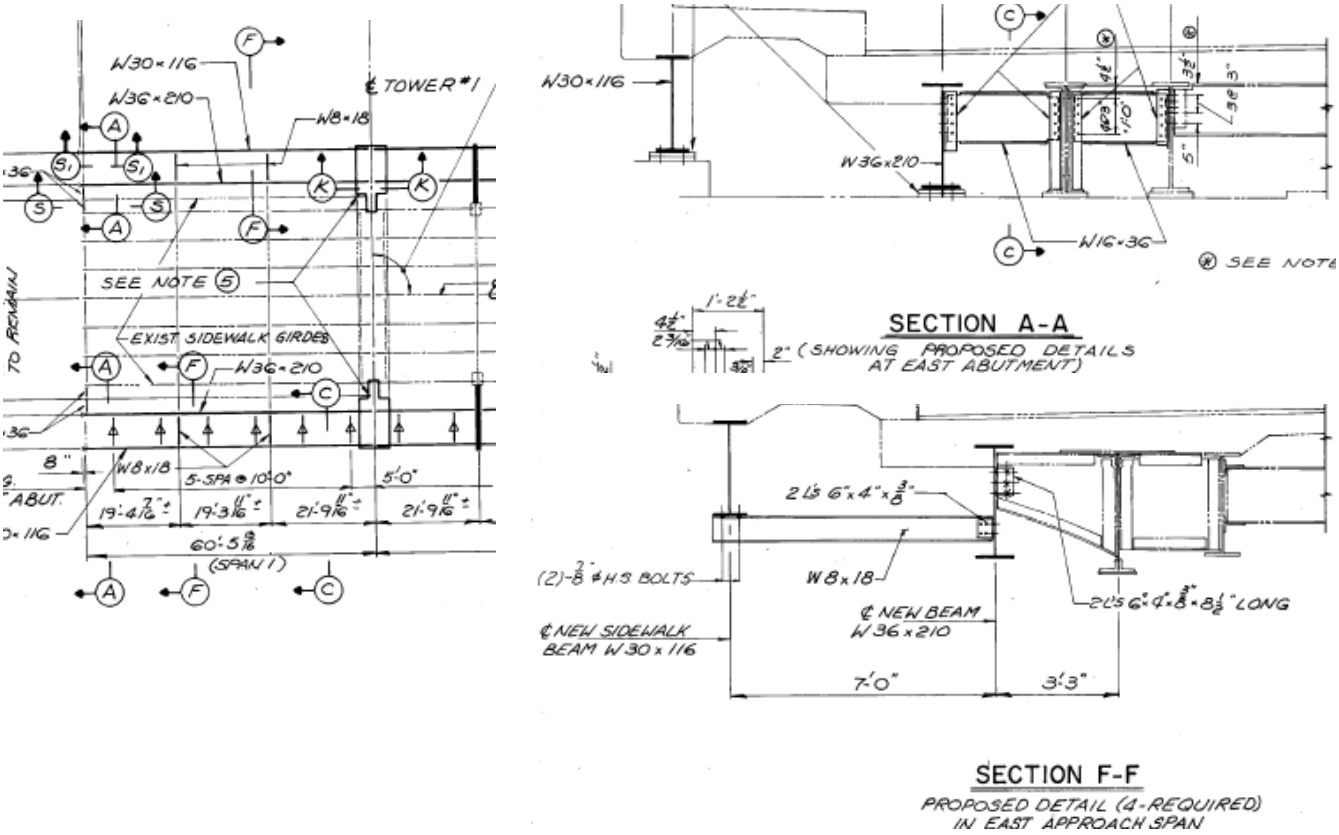
Paint Area Calculations: Cantilevers and Diaphragms

1986 CUY-10-0869 Rehab Plans:

Sheet 61 of 113 shows the layout of the propsed Diaphragms within Unit 1.

Sheet 63 of 113 shows the proposed Diaphragms along the East Abutment within Unit 1.

Sheet 64 of 113 shows the proposed Diaphragms outside the existing limits at intermediate locations within Unit 1.



A partial clip of the details above show the proposed diaphragms:

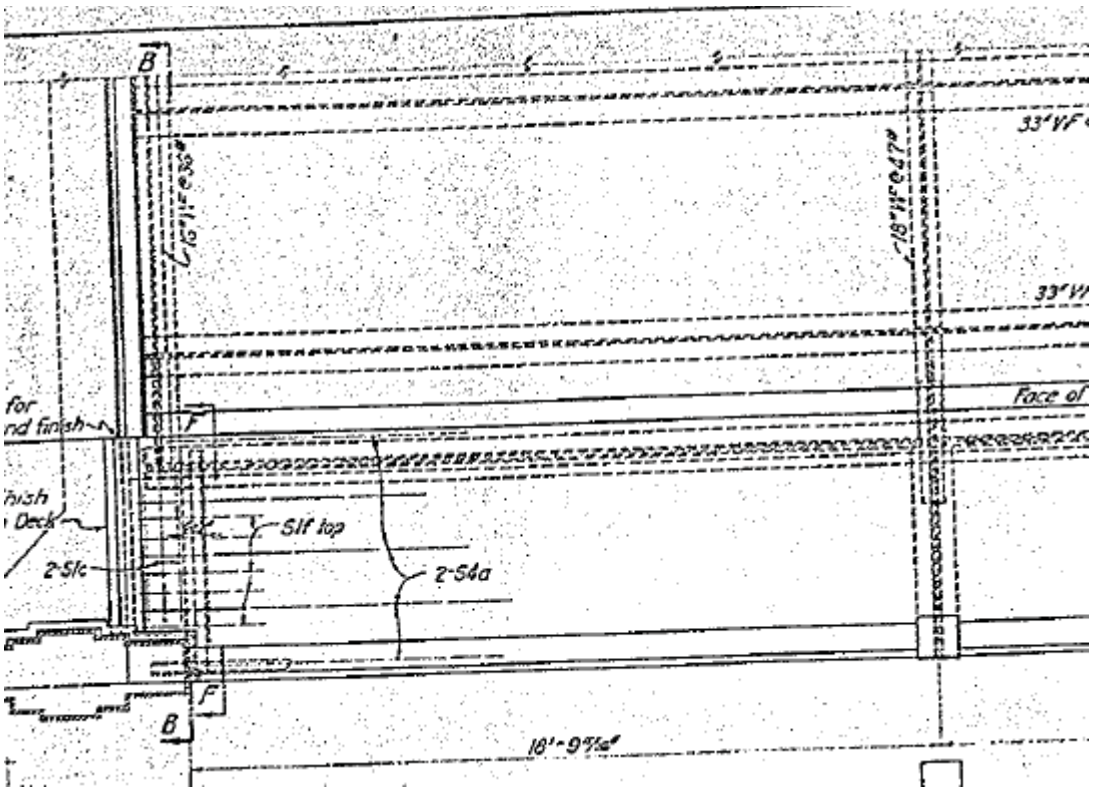
Unit 1: W8x18, perimeter = 37.5 in. (3.13 ft.)

W16x36, perimeter = 60.0 in. (5.00 ft.)

Connectinon Plates, perimeter = 152.0 in. (12.67 ft.)

1934 CUY-10-0869 Original Plans:

Sheet 22 of 51 shows the existing Diaphragms within Unit 1.



A partial clip of the details above show the existing Diaphragms:

Unit 1: W16x36, perimeter = 60.0 in. (5.00 ft.)

W18x47, perimeter = 60.5 in. (5.00 ft.)

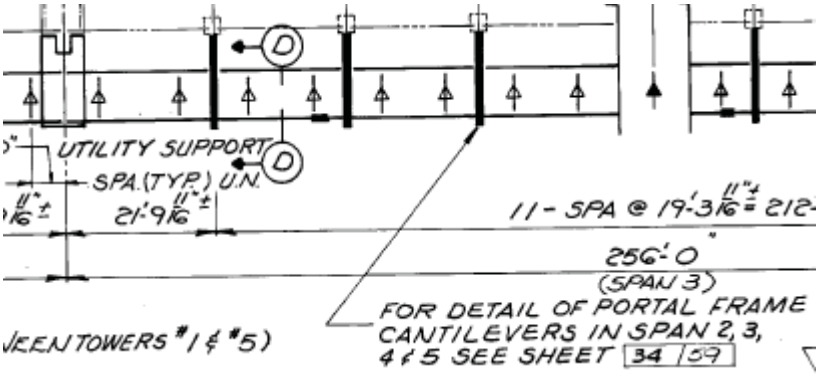
Assume an average depth of 3'-0" for the existing Connection Plates:

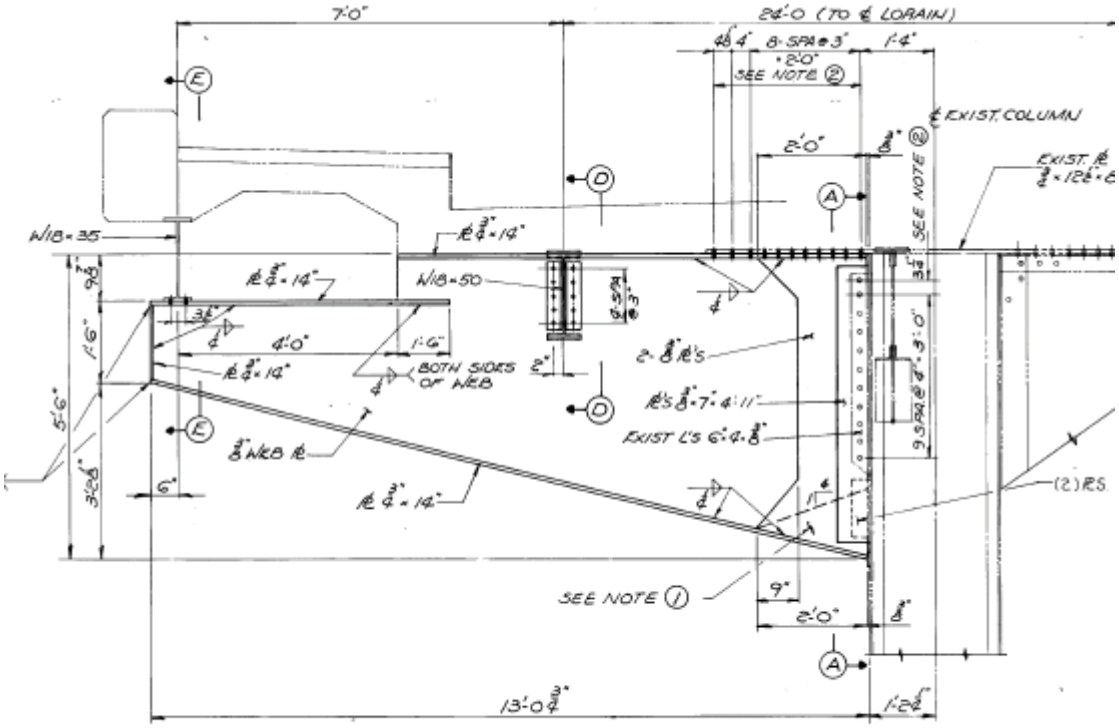
Unit 1: Connection Plates, perimeter = 104.0 in. (8.67 ft.)

1986 CUY-10-0869 Rehab Plans:

Sheet 61 of 113 shows the layout of the proposed Cantilevers within Units 2 thru 5.

Sheet 72 of 113 shows details about the proposed Cantilever.





ELEVATION - PROPOSED CANTILEVER

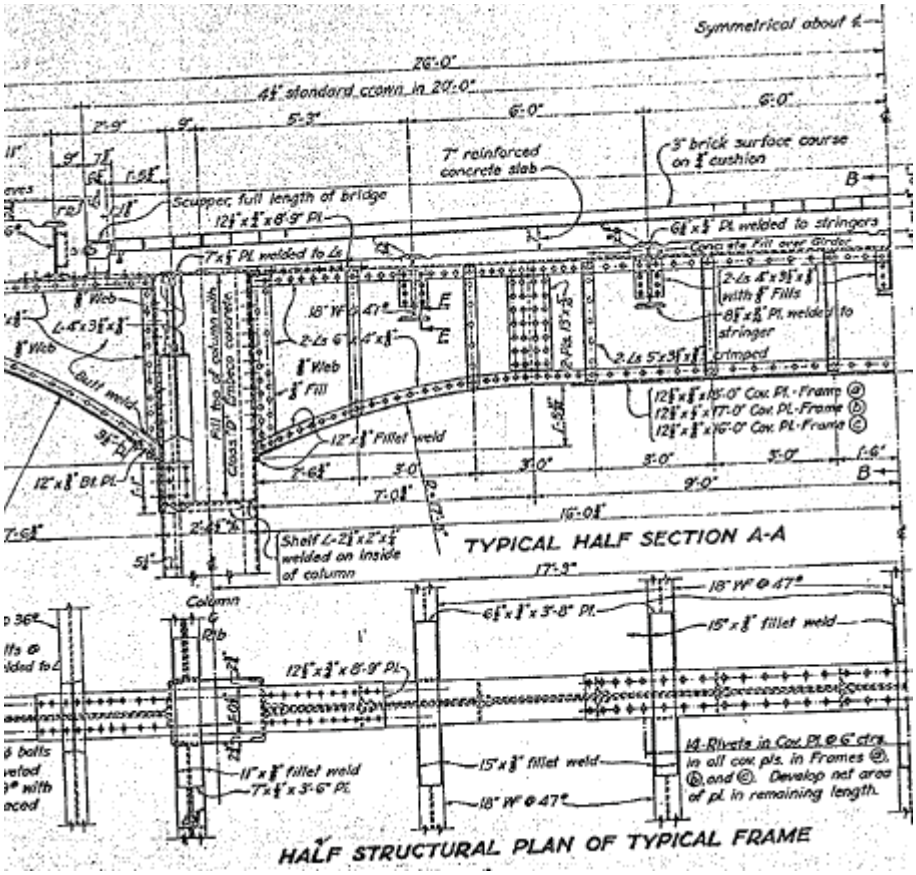
(92 REQUIRED)

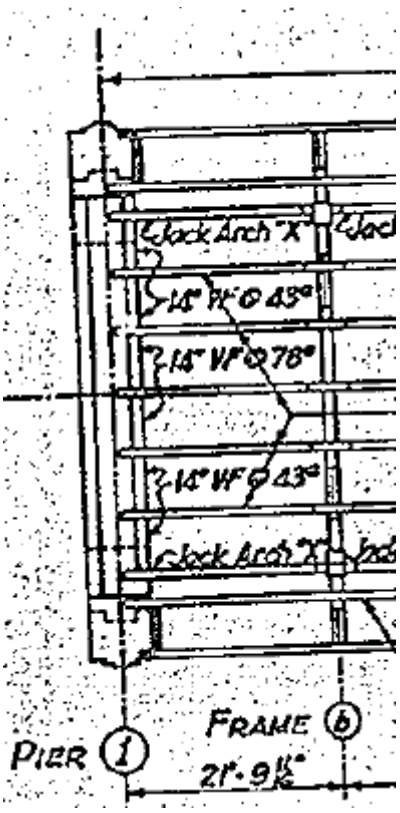
Assume an average depth of 3'-11" for the proposed Cantilever:

Unit 2 thru 5: Cantilever, perimeter = 136 in. (11.33 ft.)

1934 CUY-10-0869 Original Plans:

Sheet 20 of 51 shows the Framing Plan of the Arch Deck Layout (Units 2 thru 5).





Assume an average depth of 3'-3" for the existing Frame:

Unit 2 thru 5: Frame, perimeter = 115.5 in. (9.63 ft.)

The structural layout shows the existing diaphragms at the pier locations:

Unit 2 thru 5: W14x43, perimeter = 59.5 in. (4.96 ft.)

W14x78, perimeter = 69.0 in. (5.75 ft.)

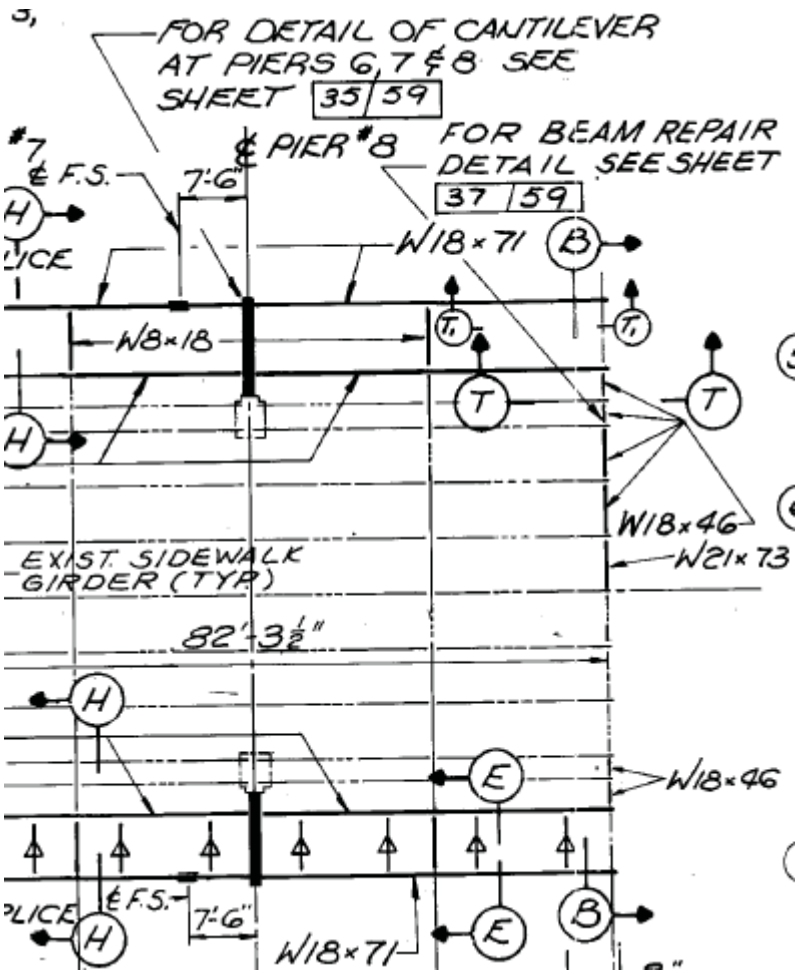
1986 CUY-10-0869 Rehab Plans:

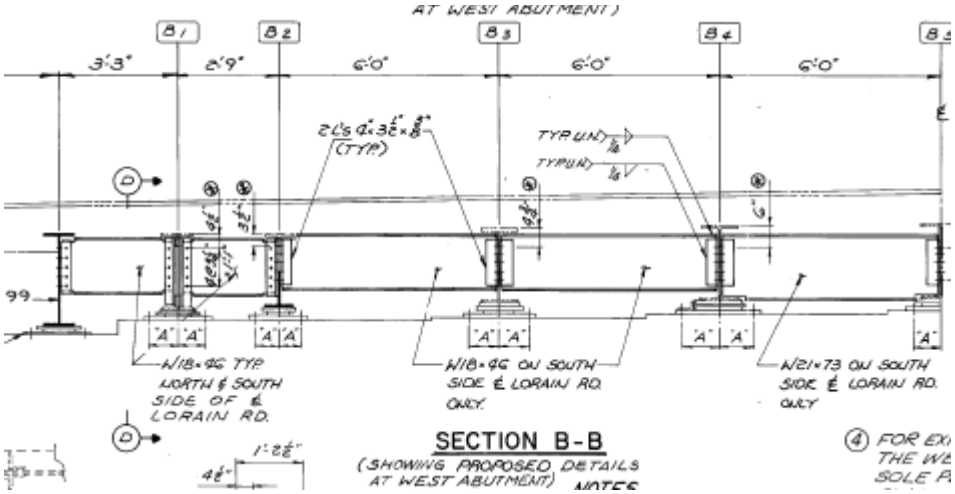
Sheet 61 of 113 shows the layout of the proposed Cantilevers and proposed Diaphragms within Unit 6.

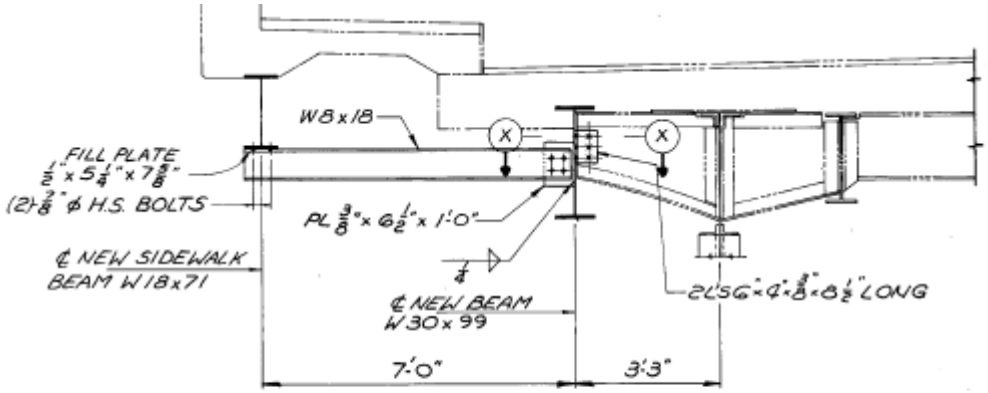
Sheet 63 of 113 shows the proposed Diaphragms along the West Abutment within Unit 6.

Sheet 64 of 113 shows the proposed Diaphragms outside the existing limits at intermediate locations within Unit 6.

Sheet 72 of 113 shows details about the proposed Cantilever.

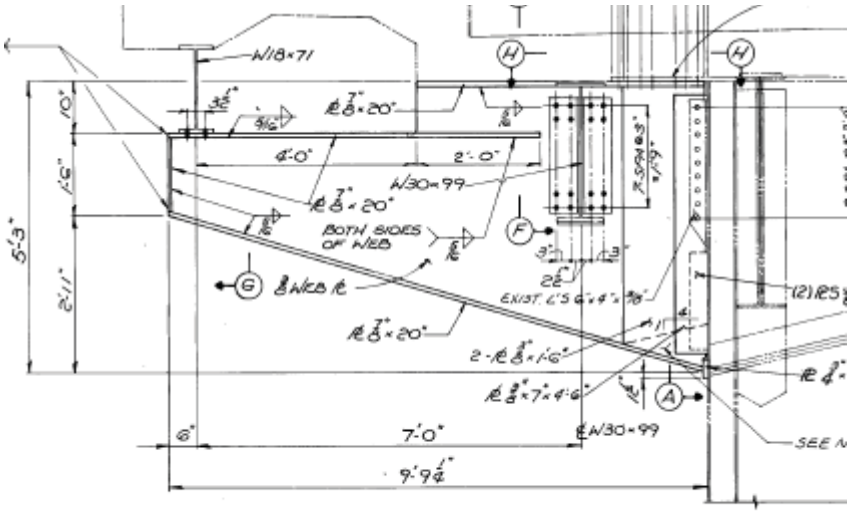






SECTION H-H

PROPOSED DETAIL (8-REQUIRED)
IN WEST APPROACH SPANS



ELEVATION - PROPOSED CANTILEVER

(G - REQUIRED)

Note: Not all West Abutment Diaphragms were replaced. Please see Section B-B on sheet 63 of 113 for details.

A partial clip of the Framing Plan above shows the proposed diaphragms:
Unit 6: W8x18, perimeter = 37.5 in. (3.13 ft.)
W18x46, perimeter = 60.0 in. (5.00 ft.)
W21x73, perimeter = 75.5 in. (6.29 ft.)

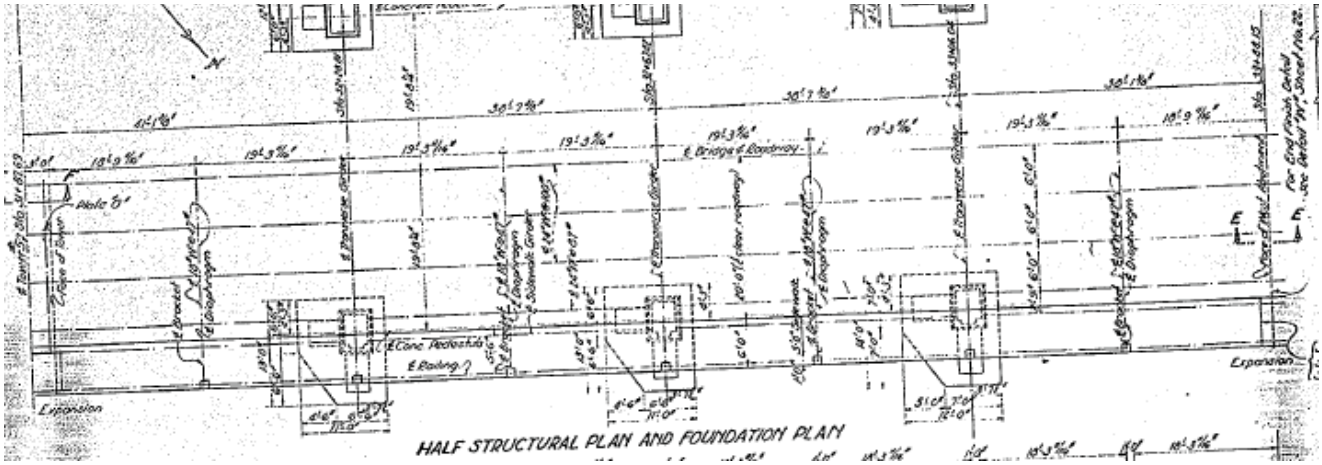
Assume an average depth of 3'-10" for the proposed Cantilever:
Unit 6: Cantilever, perimeter = 152 in. (12.67 ft.)

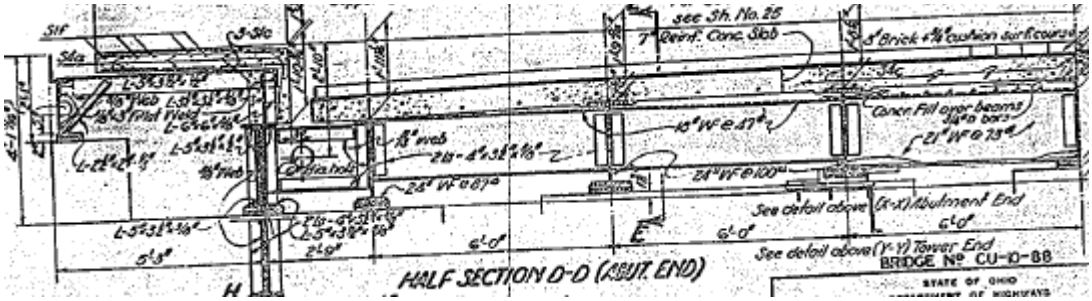
1934 CUY-10-0869 Original Plans:

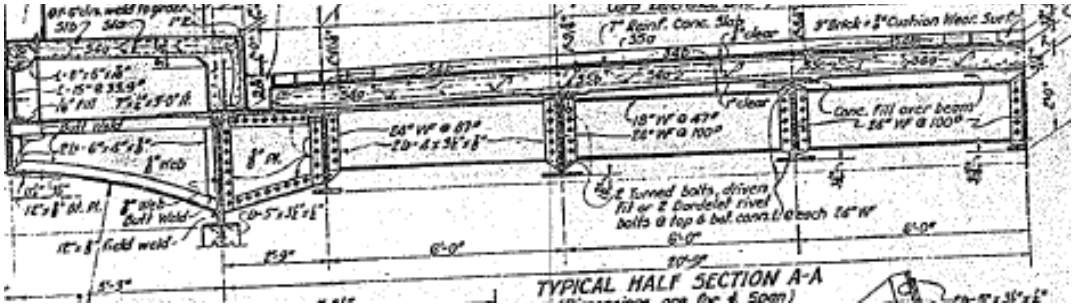
Sheet 22 of 51 shows the existing Diaphragms within Unit 6.

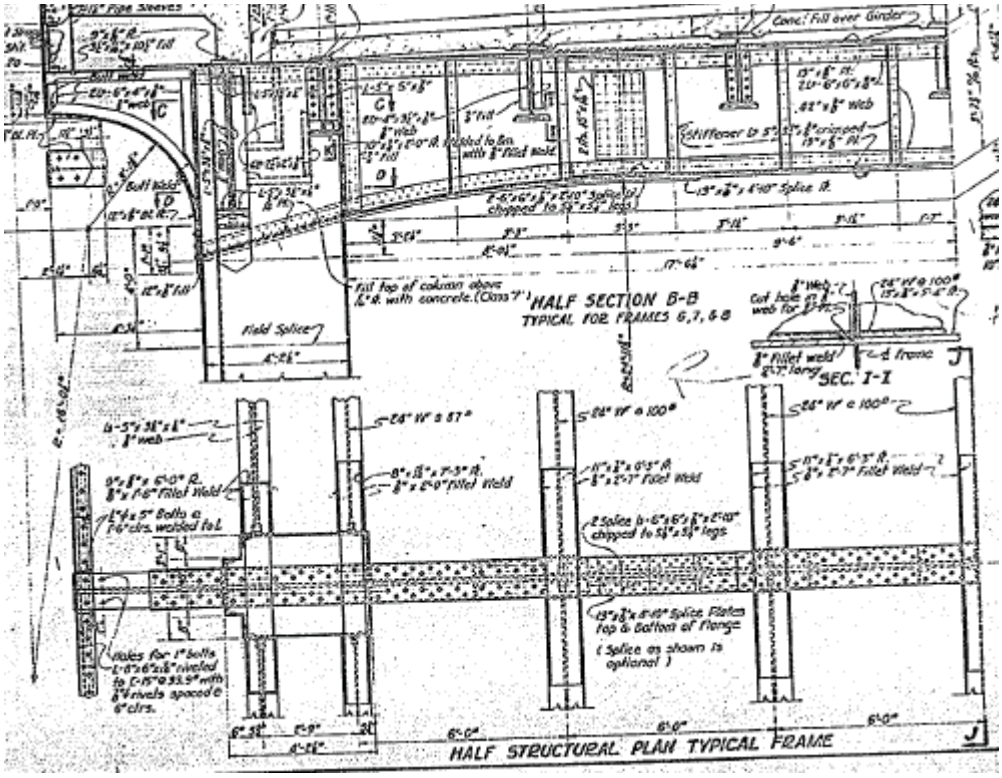
Sheet 24 of 51 shows the existing Diaphragms to remain along the West Abutment within Unit 6.

Sheet 25 of 51 shows the existing Frames at pier locations and existing Diaphragms at intermediate locations within Unit 6.









Assume an average depth of 3'-10" for the existing Frame:
Unit 6: Frame, perimeter = 131.0 in. (10.92 ft.)

A partial clip of the Framing Plan above shows the existing Diaphragms:
Unit 6: W18x46, perimeter = 60.0 in. (5.00 ft.)
W18x47, perimeter = 60.0 in. (5.00 ft.)
W21x73, perimeter = 75.5 in. (6.29 ft.)

Assume an average depth of 2'-2" for the existing Connection Plates:
Unit 6: Connectinon Plates, perimeter = 100.0 in. (8.33 ft.)

Gannett Fleming

Calculation Sheet

Project: Lorain Road over Rocky River

Designer: DSC/KAC
Date: 2/4/2019

Checker: ASM/VTD
Date: 3/5/2019

Arch Columns (Exterior)

	Area (ft^2)			No.	Factor	Assumption	Surface Area (ft^2)
Column A	616.98			12	1.00	-	7404
Column B	422.59			16	1.00	-	6761
Column C	272.25			16	1.00	-	4356
Column D	155.61			16	1.00	-	2490
Column E	92.18			16	1.00	-	1475
Column F	59.06			16	1.00	-	945
						Total =	23431

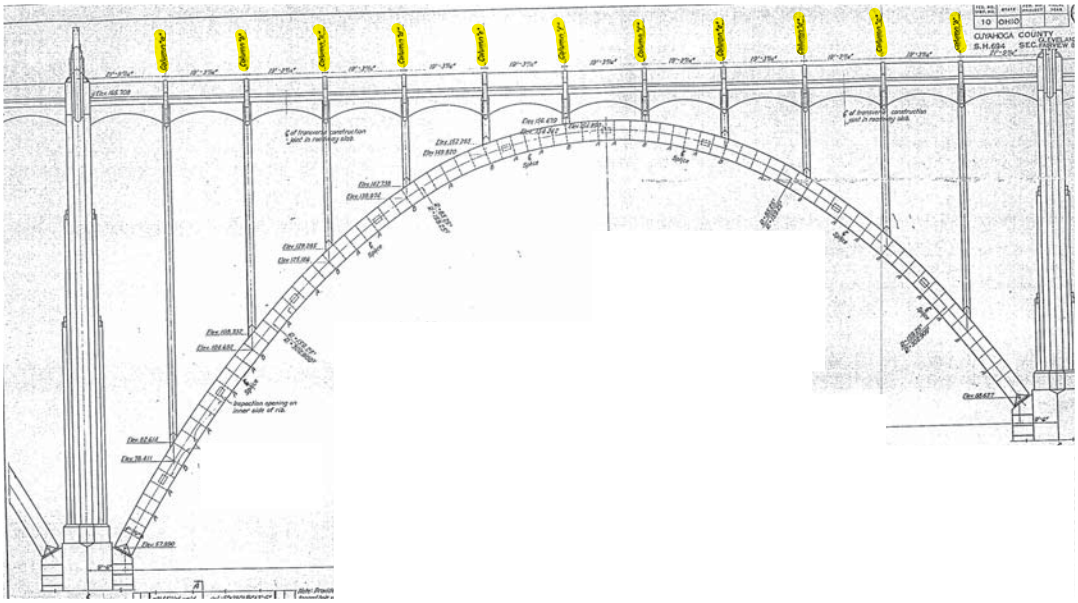
Arch Columns (Interior)

	Area (ft^2)			No.	Factor	Assumption	Surface Area (ft^2)
Column A	543.10			12	1.00	-	6517
Column B	359.27			16	1.00	-	5748
Column C	217.10			16	1.00	-	3474
Column D	106.77			16	1.00	-	1708
Column E	-			16	1.00	-	0
Column F	-			16	1.00	-	0
						Total =	17447

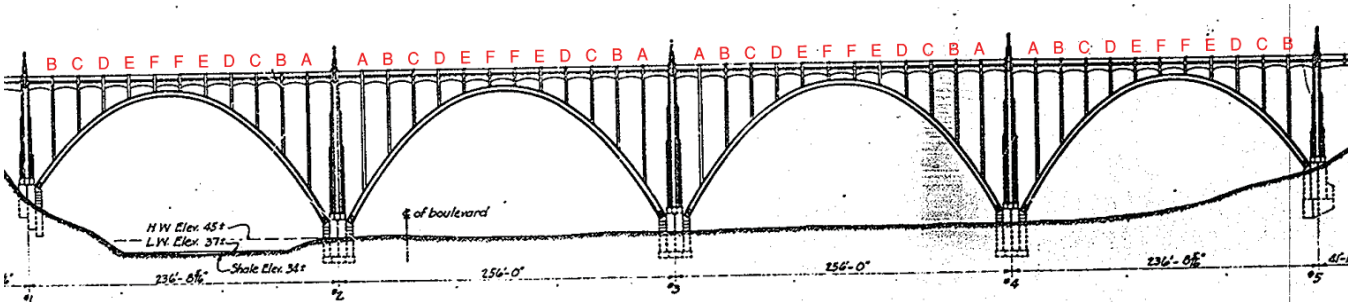
Column Area Calculations

Column Layout

By: KAC
Date: 2/13/2019
Checked: VTD
Date: 2/14/2019



1934 CUY-10-0869 Original Plans - Sheet 17 (column layout for span 4)



1934 CUY-10-0869 Original Plans - Sheet 2 (column layout for entire structure)

Columns carrying the floorbeam loads down to the arches are ID'd A-F throughout the structure.

Column Quantities:

- Column A: 12
- Column B: 16
- Column C: 16
- Column D: 16
- Column E: 16
- Column F: 16

Column Area Calculations

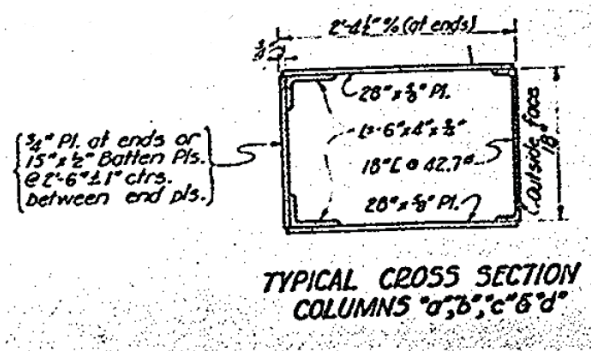
Columns A – D Interior Perimeter

By: KAC

Date: 2/13/2019

Checked: VTD

Date: 2/14/2019



1934 CUY-10-0869 Original Plans - Sheet 19

Interior Perimeter Calculation (enclosed section)

P = 2 x 18" + (28.5" - 3/4" - 0.45") x 2

P = 90.60"

P = 7.55'

(Note: Perimeter equals twice the exterior length of the channel member plus twice the exterior length of the column minus thickness of the channel member minus the thickness of the exterior plate)

Interior Perimeter Calculation (open section)

P = 90.60" - (18" - 2 x 4")

P = 80.60"

P = 6.72'

(Note: For open sections, the space between the short legs of the angle members is removed. Perimeter equals enclosed section perimeter minus the opening between the angle members, so enclosed perimeter minus the difference between the column width and twice the short angle leg lengths)

Column Area Calculations

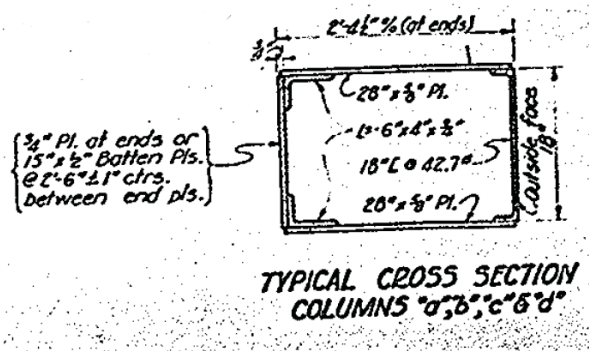
Columns A – D Exterior Perimeter

By: KAC

Date: 2/13/2019

Checked: VTD

Date: 2/14/2019



1934 CUY-10-0869 Original Plans - Sheet 19

Exterior Perimeter Calculation (enclosed section)

P = 2 x 18" + 4 x 5/8" + 2 x 28.5"

P = 95.50"

P = 7.96'

Exterior Perimeter Calculation (open section)

P = 95.50" - (18" - 2 x 4")

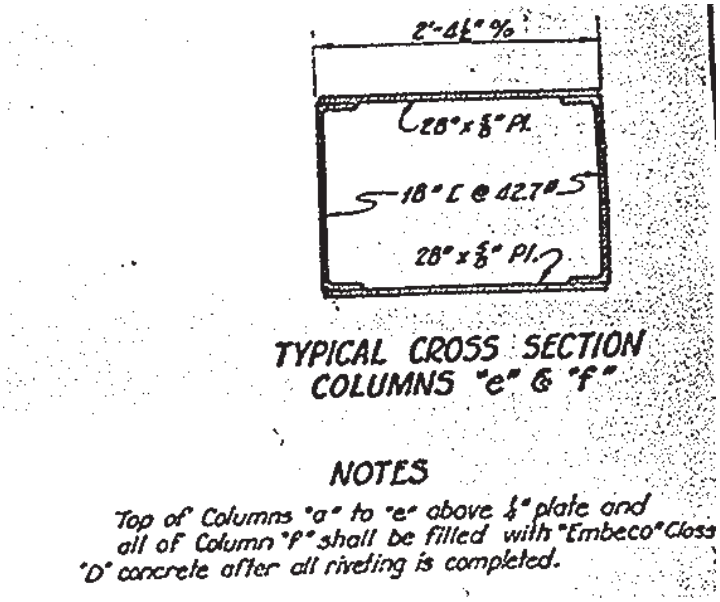
P = 85.50"

P = 7.13'

Column Area Calculations

Columns E&F – Exterior Perimeter

By: KAC
Date: 2/13/2019
Checked: VTD
Date: 2/14/2019



1934 CUY-10-0869 Original Plans - Sheet 19

Columns E and F are completely filled with concrete with no openings, therefore we only need to calculate the exterior perimeter

<u>Exterior Perimeter Calculation</u>

P = 2 x 18" + 4 x 5/8" + 2 x 28.5"

P = 95.50"

P = 7.96'

Column Area Calculations

Arch-Column – Perimeter Summary

By: KAC
Date: 2/13/2019
Checked: VTD
Date: 2/14/2019

Column	A	B	C	D	E	F
Interior Perimeter (Open)	6.72'	6.72'	6.72'	6.72'	N/A	N/A
Interior Perimeter (Closed)	7.55'	7.55'	7.55'	7.55'	N/A	N/A
Exterior Perimeter (Open)	7.13'	7.13'	7.13'	7.13'	N/A	N/A
Exterior Perimeter (Closed)	7.96'	7.96'	7.96'	7.96'	7.96'	7.96'

Column Interior Area Calculations

Column A – Paint Calculation

By: KAC
Date: 2/13/2019
Checked: VTD
Date: 2/14/2019

Note: Nominal spacing of 15"x½" batten plates = 2'-6" This spacing may vary a maximum of 1" but shall be uniform for full length of column.

NOTES

Top of Columns "a" to "e" above ¼" plate and all of Column "f" shall be filled with "Embeco" Class "D" concrete after all riveting is completed.

Notes:

Columns are enclosed with openings measuring 1'-3" long x 10" wide (1'-3" plates spaced at 2'-6" feet apart center-center) (28 openings total).

Obtained through Google Earth

Length of Column A = 81.16' (measured along centerline of the column)

- **5.83' filled with concrete** (no interior area)
- **35' is open** (28 x 1'-3")
- **40.33' is enclosed and hollow** (81.16 - 5.83 - 35)

Area = Perimeter x Length

Open Section Calculations:

Interior Area (A_{int}) = Interior perimeter x Open Section Length
A_{int} = 6.72' x 35' = **235.20ft²**

Exterior Area (A_{ext}) = Exterior perimeter x Open Section Length
A_{ext} = 7.13 x 35' = **249.55ft²**

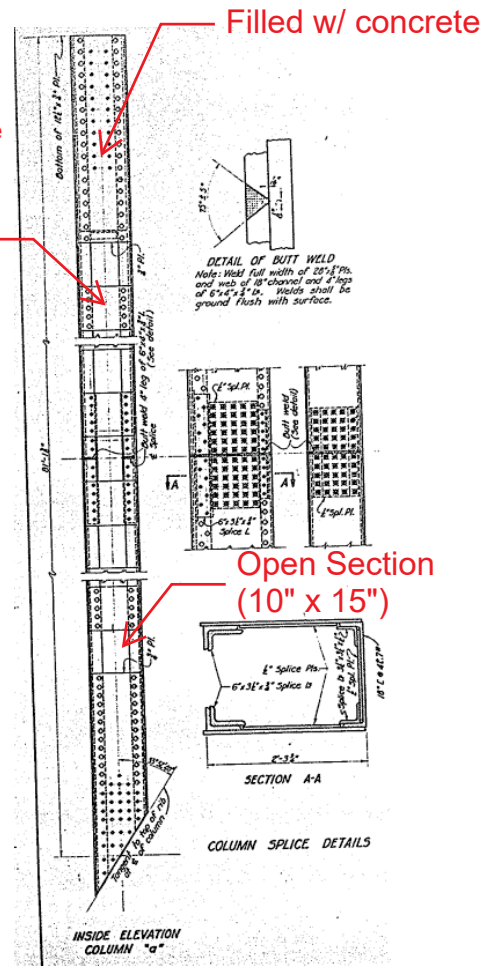
Closed Section Calculations:

Interior Area (A_{int}) = Interior perimeter x Closed Section Length
A_{int} = 7.55' x 40.33' = **304.49ft²**

Exterior Area (A_{ext}) = Exterior perimeter x (Closed Section Length + Length filled with concrete)
A_{ext} = 7.96 x (40.33' + 5.83') = **367.43ft²**

Interior plate below concrete

Interior 1/4" Plate Area = 18" x 27.3" = **3.41ft²**



1934 CUY-10-0869 Original Plans - Sheet 19

Interior Area to be Painted = 543.10ft²

Exterior Area to be Painted = 616.98ft²

Column Area Calculations

Column B – Paint Calculation

By: KAC
Date: 2/13/2019
Checked: VTD
Date: 2/14/2019

Note: Nominal spacing of 15"x¼" batten plates = 2'-6" This spacing may vary a maximum of 1" but shall be uniform for full length of column.

NOTES

Top of Columns "a" to "e" above ½" plate and all of Column "f" shall be filled with "Embeco" Class 'D' concrete after all riveting is completed.

Notes:

Columns are enclosed with openings measuring 1'-3" long x 10" wide (1'-3" plates spaced at 2'-6" feet apart center-center) (18 openings total).

Obtained through Google Earth

Length of Column B = 55.41' (measured along centerline of the column)
- **5.83' filled with concrete** (no interior area)
- **22.25' is open** (18 x 1'-3")
- **27.33' is enclosed and hollow** (55.41 - 5.83 - 22.25)

Area = Perimeter x Length

Open Section Calculations:

Interior Area (A_{int}) = Interior perimeter x Open Section Length
A_{int} = 6.72' x 22.25' = **149.52ft²**

Exterior Area (A_{ext}) = Exterior perimeter x Open Section Length
A_{ext} = 7.13 x 22.25' = **158.64ft²**

Closed Section Calculations:

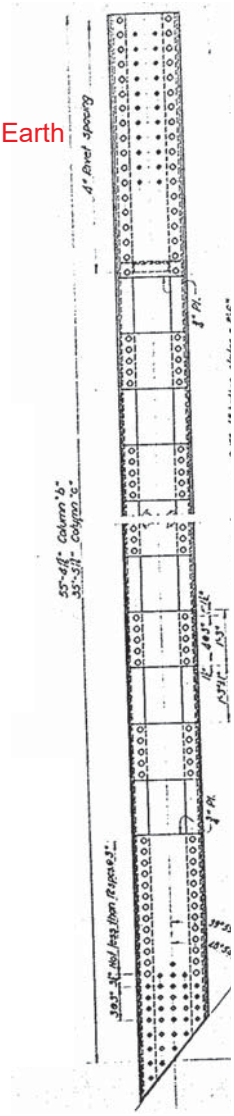
Interior Area (A_{int}) = Interior perimeter x Closed Section Length
A_{int} = 7.55' x 27.33' = **206.34ft²**

Exterior Area (A_{ext}) = Exterior perimeter x (Closed Section Length + Length filled with concrete)
A_{ext} = 7.96' x (27.33' + 5.83') = **263.95ft²**

Interior 1/4" Plate Area = 18" x 27.3" = **3.41ft²**

Interior Area to be Painted = 359.27ft²

Exterior Area to be Painted = 422.59ft²



1934 CUY-10-0869 Original Plans - Sheet 19

Column Area Calculations

Column C – Paint Calculation

By: KAC

Date: 2/13/2019

Checked: VTD

Date: 2/14/2019

Note: Nominal spacing of 15" x ¼" batten plates = 2'-6" This spacing may vary a maximum of 1" but shall be uniform for full length of column.

NOTES

Top of Columns "a" to "e" above ½" plate and all of Column "f" shall be filled with "Embeco" Class 'D' concrete after all riveting is completed.

Notes:

Columns are enclosed with openings measuring 1'-3" long x 10" wide (1'-3" plates spaced at 2'-6" feet apart center-center) (10 openings total).

Obtained through Google Earth

Length of Column C = 35.48' (measured along centerline of the column)

- **5.83' filled with concrete** (no interior area)
- **12.25' is open** (10 x 1'-3")
- **17.40' is enclosed and hollow** (35.48 - 5.83 - 12.25)

Area = Perimeter x Length

Open Section Calculations:

Interior Area (A_{int}) = Interior perimeter x Open Section Length
A_{int} = 6.72' x 12.25' = **82.32ft²**

Exterior Area (A_{ext}) = Exterior perimeter x Open Section Length
A_{ext} = 7.13 x 12.25' = **87.34ft²**

Closed Section Calculations:

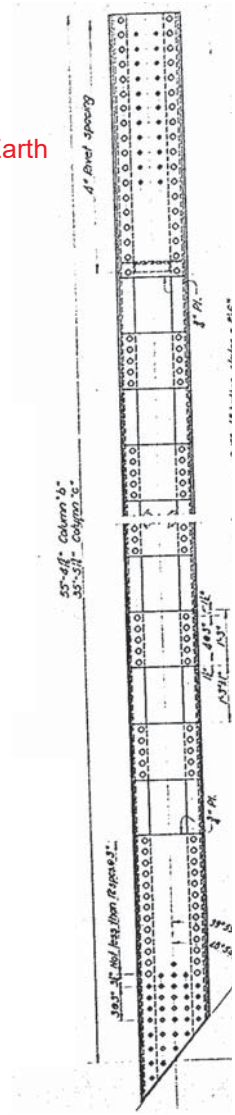
Interior Area (A_{int}) = Interior perimeter x Closed Section Length
A_{int} = 7.55' x 17.40' = **131.37ft²**

Exterior Area (A_{ext}) = Exterior perimeter x (Closed Section Length + Length filled with concrete)
A_{ext} = 7.96 x (17.40' + 5.83') = **184.91ft²**

Interior 1/4" Plate Area = 18" x 27.3" = **3.41ft²**

Interior Area to be Painted = 217.10ft²

Exterior Area to be Painted = 272.25ft²



1934 CUY-10-0869 Original Plans - Sheet 19

Column Area Calculations

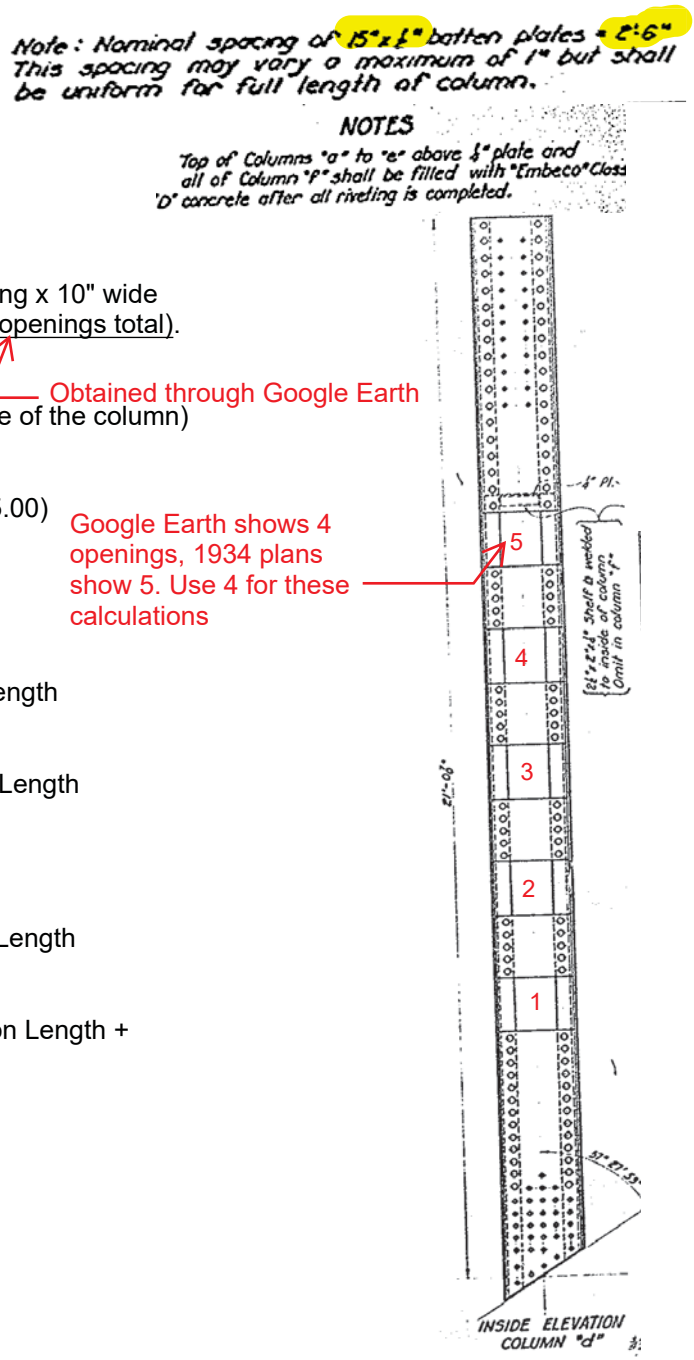
Column D – Paint Calculation

By: KAC

Date: 2/13/2019

Checked: VTD

Date: 2/14/2019



1934 CUY-10-0869 Original Plans - Sheet 19

Notes:

Columns are enclosed with openings measuring 1'-3" long x 10" wide (1'-3" plates spaced at 2'-6" feet apart center-center) (4 openings total).

Obtained through Google Earth

Length of Column D = 20.07' (measured along centerline of the column)

- **5.83' filled with concrete** (no interior area)
- **5.00' is open** (4 x 1'-3")
- **9.24' is enclosed and hollow** (20.07 - 5.83 - 5.00)

Google Earth shows 4 openings, 1934 plans show 5. Use 4 for these calculations

Area = Perimeter x Length

Open Section Calculations:

Interior Area (A_{int}) = Interior perimeter x Open Section Length
A_{int} = 6.72' x 5.00' = **33.60ft²**

Exterior Area (A_{ext}) = Exterior perimeter x Open Section Length
A_{ext} = 7.13 x 5.00' = **35.65ft²**

Closed Section Calculations:

Interior Area (A_{int}) = Interior perimeter x Closed Section Length
A_{int} = 7.55' x 9.24' = **69.76ft²**

Exterior Area (A_{ext}) = Exterior perimeter x (Closed Section Length + Length filled with concrete)
A_{ext} = 7.96 x (9.24' + 5.83') = **119.96ft²**

Interior 1/4" Plate Area = 18" x 27.3" = **3.41ft²**

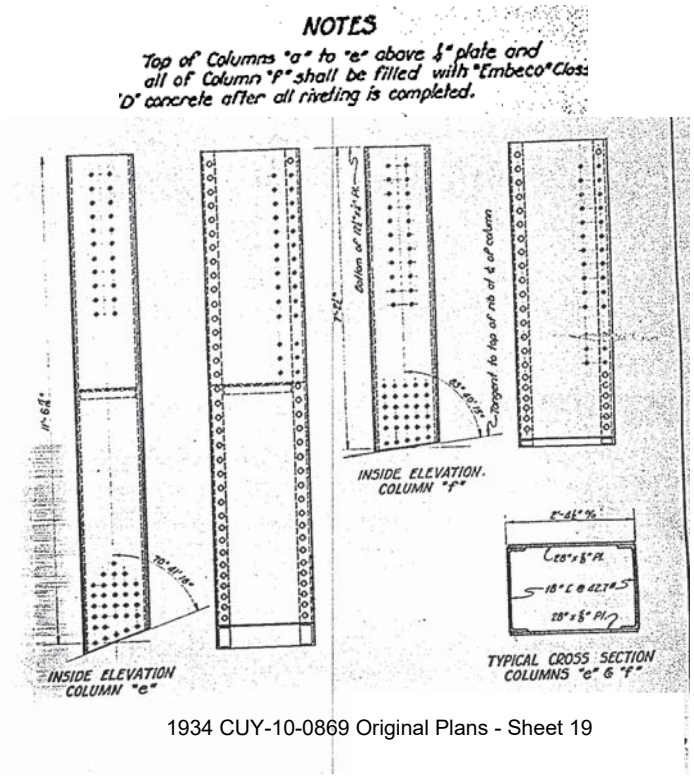
Interior Area to be Painted = 106.77ft²

Exterior Area to be Painted = 155.61ft²

Column Area Calculations

Columns E & F – Paint Calculation

By: KAC
Date: 2/13/2019
Checked: VTD
Date: 2/14/2019



1934 CUY-10-0869 Original Plans - Sheet 19

Notes:

Column E is filled with concrete for approximately half of its length and the non-filled portion has no openings, therefore assume the interior of Column E cannot be painted.

Column F is filled with concrete full length, therefore interior of Column F cannot be painted.

Length of Column E = 11.58' (measured along centerline of the column)

Length of Column F = 7.42' (measured along centerline of the column)

Area = Perimeter x Length

Column E Calculations:

Exterior Area (A_{ext}) = Exterior perimeter x Column Length
A_{ext} = 7.96 x 11.58' = **92.18ft²**

Column F Calculations:

Exterior Area (A_{ext}) = Exterior perimeter x Column Length
A_{ext} = 7.96 x 7.42' = **59.06ft²**

Column E Exterior Area to be Painted = 92.18ft²

Column F Exterior Area to be Painted = 59.06ft²

Gannett Fleming

Calculation Sheet

Project: Lorain Road over Rocky River

Designer: DSC/KAC
Date: 2/4/2019

Checker: ASM/VTD
Date: 3/5/2019

Arches (Exterior)

	Area (ft^2)			No.	Factor	Assumption	Surface Area (ft^2)
Span 2&5 Arch	5008.71			4	1.00	-	20035
Span 3&4 Arch	5646.13			4	1.00	-	22585
						Total =	42619

Arches (Interior)

	Area (ft^2)			No.	Factor	Assumption	Surface Area (ft^2)
Span 2&5 Arch	4875.47			4	1.00	-	19502
Span 3&4 Arch	5499.82			4	1.00	-	21999
						Total =	41501

Arch Diaphragms

	Area (ft^2)			No.	Factor	Assumption	Surface Area (ft^2)
Span 2 Diaphragm	315.37			11	1.00	-	3469
Span 3 Diaphragm	315.37			12	1.00	-	3784
Span 4 Diaphragm	315.37			12	1.00	-	3784
Span 5 Diaphragm	315.37			11	1.00	-	3469
						Total =	14507

Arch Area Calculations

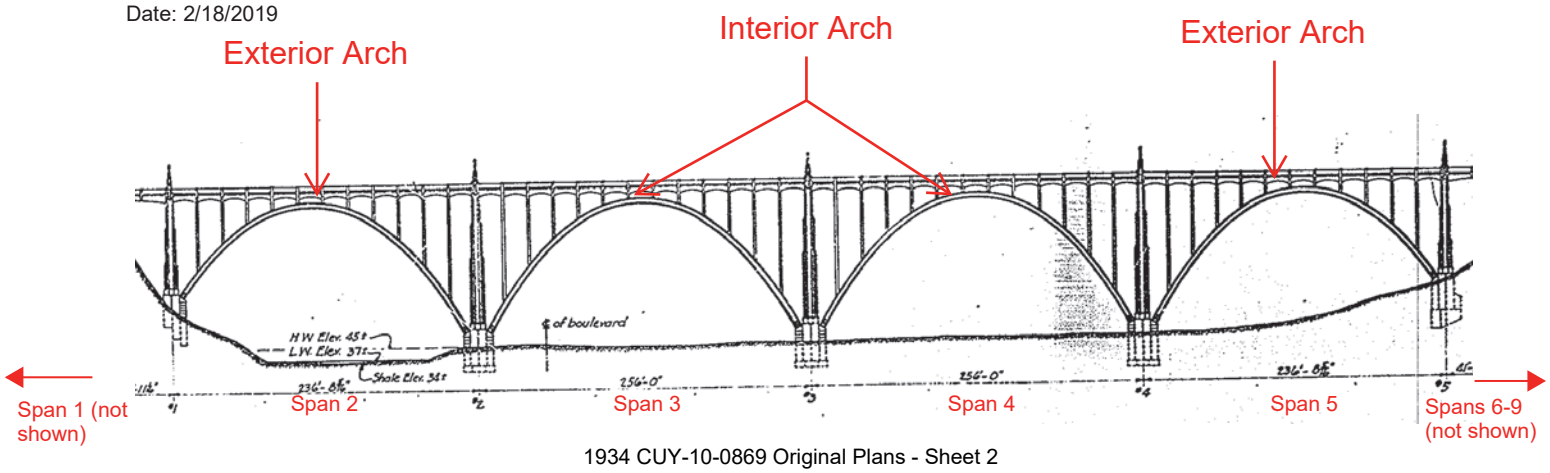
Arch Layout

By: KAC

Date: 2/17/2019

Checked: VTD

Date: 2/18/2019



1934 CUY-10-0869 Original Plans - Sheet 2

There are 4 identical interior arches (Spans 3&4) and 4 identical exterior arches (Spans 2&5)

- 2 arches per span

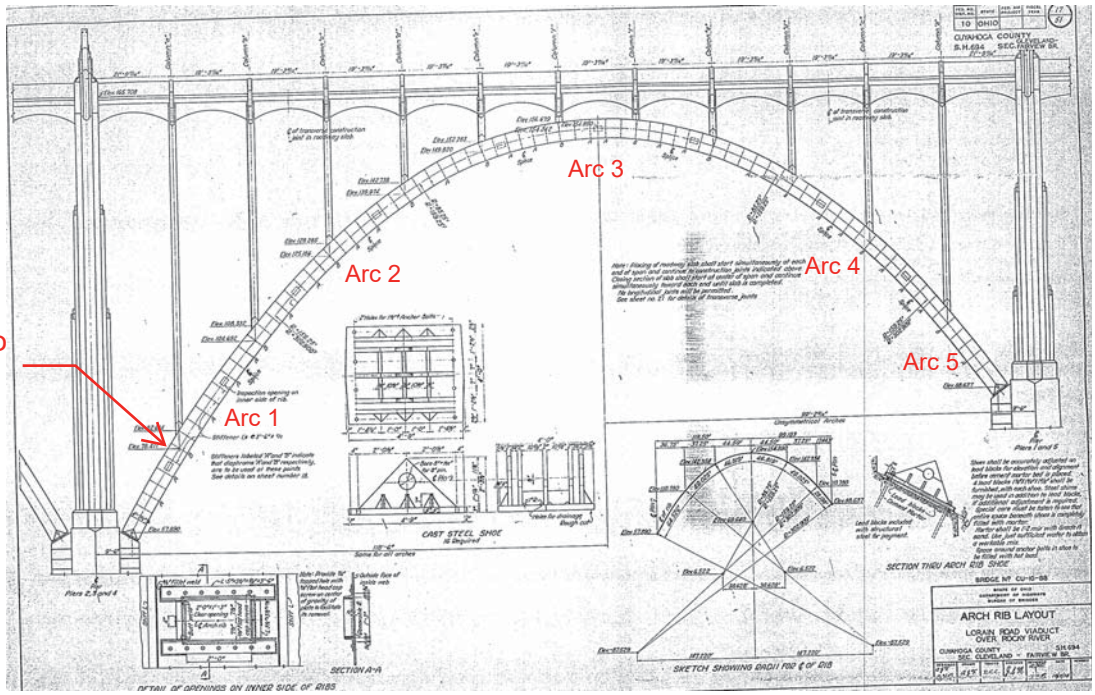
*Span 1, 6, 7, 8 and 9 do not use arch superstructure configuration

Arch Area Calculations

Arch Length Calculations

By: KAC
Date: 2/17/2019
Checked: VTD
Date: 2/18/2019

Left half of this exterior arch can be repeated to form an interior arch



1934 CUY-10-0869 Original Plans - Sheet 17

Notes:

Sheet 17 shows arch length for a typical exterior arch, however the left half of this arch can be repeated to construct a typical interior arch.

Each arch is broken up into 5 arcs (separated where the plans reference different radii) each with an upper arc length and lower arc length.

Interior Arch Length Calculations:

Interior (Span 3&4) Arch Length (L_{int}) = (64.526' + 49.025' + 46.819') x 2
L_{int} = 320.74'

Exterior Arch Length Calculations:

Exterior (Span 2&5) Arch Length (L_{ext}) = 64.526' + 49.025' + 46.819' + 46.819' + 49.025' + 28.198'
L_{ext} = 284.41'

Arch Area Calculations

Arch Length Calculations

By: KAC
Date: 2/17/2019
Checked: VTD
Date: 2/18/2019

Notes:

Arch Section Height = 4.646' (typical for all arches)
Arc Length = Radius x Sweep Angle (in radians)
Shown below for Exterior Arch (Spans 2&5)

Arc 1 Length Calculation:
Sweep Angle = 64.526' / 302.909' = 0.213 radians
Top Face Arc Length = (302.909' + 4.646'/2) x 0.213 radians = **65.01'**
Bottom Face Arc Length = (302.909' - 4.646'/2) x 0.213 radians = **64.02'**

Arc 2 Length Calculation:
Sweep Angle = 49.025' / 159.25' = 0.308 radians
Top Face Arc Length = (159.25' + 4.646'/2) x 0.308 radians = **49.76'**
Bottom Face Arc Length = (159.25' - 4.646'/2) x 0.308 radians = **48.33'**

Arc 3 Length Calculation:
Sweep Angle = 93.638' / 85.25' = 1.098 radians
Top Face Arc Length = (85.25' + 4.646'/2) x 1.098 radians = **96.16'**
Bottom Face Arc Length = (85.25' - 4.646'/2) x 1.098 radians = **91.05'**

Arc 4 Length Calculation:
Same as Arc 2 by inspection

Arc 5 Length Calculation:
Sweep Angle = 28.198' / 302.909' = 0.093 radians
Top Face Arc Length = (302.909' + 4.646'/2) x 0.093 radians = **28.39'**
Bottom Face Arc Length = (302.909' - 4.646'/2) x 0.093 radians = **27.95'**

***For interior arches (spans 3&4), Arc 5 is the same as Arc 1**

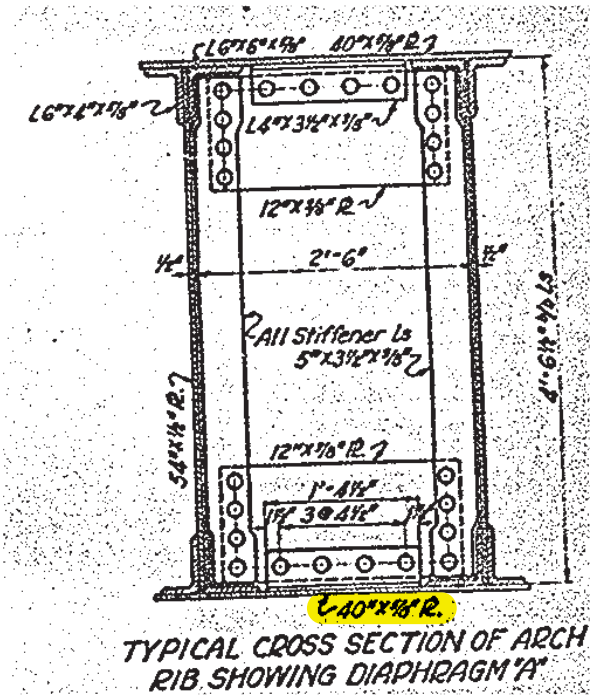
Total Top Face Arc Length (Exterior Arch) = 289.08'
Total Bottom Face Arc Length (Exterior Arch) = 279.68'

Total Top Face Arc Length (Interior Arch) = 325.70'
Total Bottom Face Arc Length (Interior Arch) = 315.75'

Arch Area Calculations

Arch Face Paint Calculations

By: KAC
Date: 2/17/2019
Checked: VTD
Date: 2/18/2019



1934 CUY-10-0869 Original Plans - Sheet 18

Notes:

Top and Bottom plates on the arches are 40" wide (3.33')

Top Outside Face Area Calculation:
Exterior Arch Area = 4.08' x 289.08' = **1179.45ft²**
Interior Arch Area = 4.08' x 325.70' = **1328.86ft²**

Bottom Outside Face Area Calculation:
Exterior Arch Area = 4.08' x 279.68' = **1141.09ft²**
Interior Arch Area = 4.08' x 315.75' = **1288.26ft²**

Perimeter Calculations:
Exterior Vertical Perimeter = (2 x 54.5") + (2 x 5/8")
Exterior Vertical Perimeter = 111.5" = **9.30'**

2 x Inside Height = 2 x 54.5" = 109" = **9.08'**

Inside Width Top and Bottom Faces = **2.5'**

Upper arc length is used for the interior side area to remain conservative

Inside Area Calculations (Interior Arch):
Interior Area to be Painted = (9.08' x 325.70') + (2.5' x 325.70') + (2.5' x 315.75')
Interior Area to be Painted = **4560.98ft²**

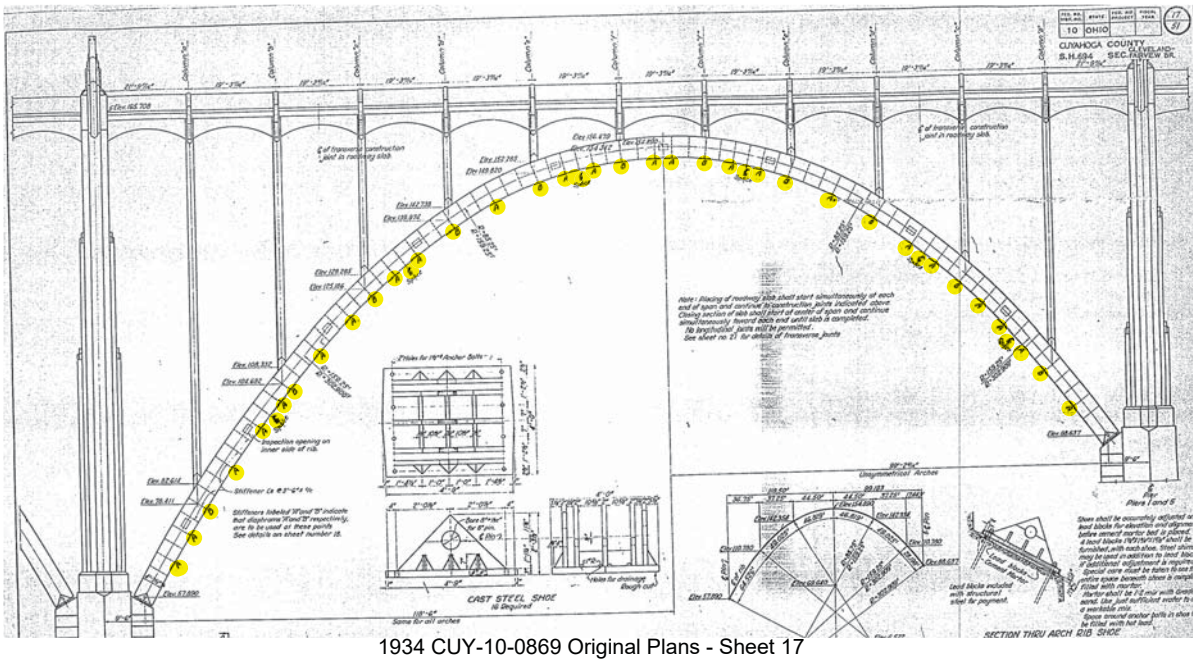
Inside Area Calculations (Exterior Arch):
Interior Area to be Painted = (9.08' x 289.08') + (2.5' x 289.08') + (2.5' x 279.68')
Interior Area to be Painted = **4046.75ft²**

Outside Vertical Area Calculations:
Outside Vertical Area to be Painted (Interior Arch) = 9.30' x 325.70' = **3029.01ft²**
Outside Vertical Area to be Painted (Exterior Arch) = 9.30' x 289.05' = **2688.17ft²**

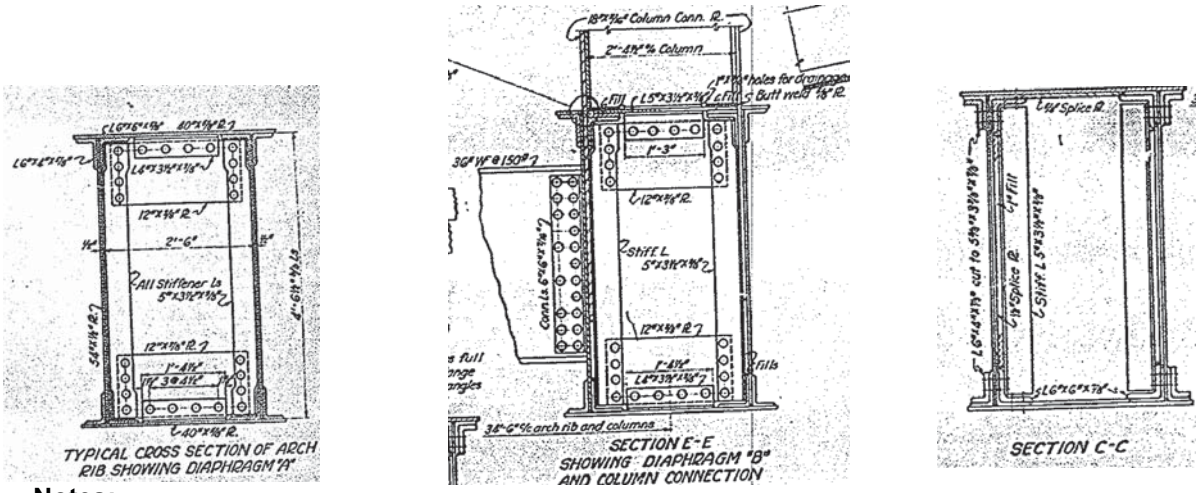
Arch Area Calculations

Arch Interior Misc. Member Area Calculations

By: KAC
Date: 2/17/2019
Checked: VTD
Date: 2/18/2019



1934 CUY-10-0869 Original Plans - Sheet 17



1934 CUY-10-0869 Original Plans - Sheet 18

Notes:

Interior Arch members are made up of angles, stiffeners, and plates at "Diaphragm A", "Diaphragm B" (Section E-E), and stiffener angles typically spaced at 3'-6" +/- center-center (Section C-C)

Total number of "Diaphragm A" sections = **23 (exterior arch), 26 (interior arch)**
Total number of "Diaphragm B" sections = **11 (exterior arch), 12 (interior arch)**
Total number of Stiffeners = **45 (exterior arch), 52 (interior arch)**

Arch Area Calculations

Arch Interior Misc. Member Area Calculations

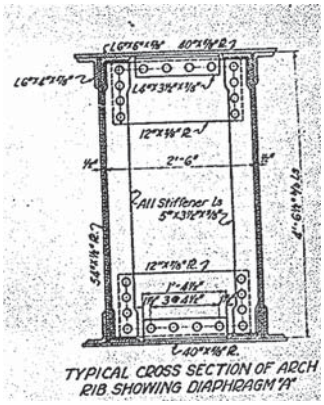
By: KAC

Date: 2/17/2019

Checked: VTD

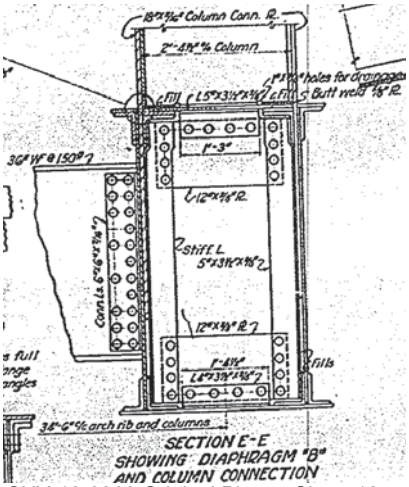
Date: 2/18/2019

"Diaphragm A" Interior Misc. Member Area Calculations:
Total "Diaphragm A" Interior Misc. Member Area = (2.5' x (54.5"/12) - (20"/12) x (29.25"/12)) x 2 faces
Total "Diaphragm A" Interior Misc. Member Area = (11.35' - 4.06') x 2 faces
Total "Diaphragm A" Interior Misc. Member Area = 14.58ft²



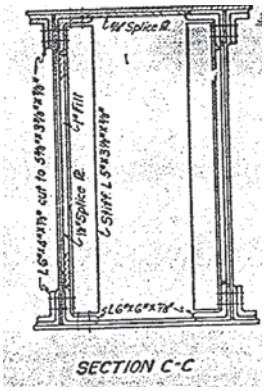
1934 CUY-10-0869 Original Plans - Sheet 18

"Diaphragm B" Interior Misc. Member Area Calculations:
Diaphragm B Interior Misc. Member Area is the same as Diaphragm A by inspection
Total "Diaphragm B" Interior Misc. Member Area = 14.58ft²



1934 CUY-10-0869 Original Plans - Sheet 18

Typical Stiffener Area Calculations:
Stiffener Area = 2 x 53.25" x 5" x 2 faces /144
Stiffener Area = 7.40ft²



1934 CUY-10-0869 Original Plans - Sheet 18

Arch Area Calculations

Arch Area Total Quantities

By: KAC
Date: 2/17/2019
Checked: VTD
Date: 2/18/2019

Spans 3&4 Arch Total Area to be Painted:

Exterior Area to be Painted

Component	Area to be Painted (ft^2)
Top Outside Face	1328.86
Bottom Outside Face	1288.26
Outside Vertical Area	3029.01
Total	**5646.13**

Interior Area to be Painted

Component	Area (ft^2)	Quantity	Area to be Painted (ft^2)
"Diaphragm A" Interior Misc. Member	14.58	26	379.08
"Diaphragm B" Interior Misc. Member	14.58	12	174.96
Typical Stiffener	7.40	52	384.8
Inside Area	4560.98	1	4560.98
Total			**5499.82**

Spans 2&5 Arch Total Area to be Painted:

Exterior Area to be Painted

Component	Area to be Painted (ft^2)
Top Outside Face	1179.45
Bottom Outside Face	1141.09
Outside Vertical Area	2688.17
Total	**5008.71**

Interior Area to be Painted

Component	Area (ft^2)	Quantity	Area to be Painted (ft^2)
"Diaphragm A" Interior Misc. Member	14.58	23	335.34
"Diaphragm B" Interior Misc. Member	14.58	11	160.38
Typical Stiffener	7.40	45	333.00
Inside Area	4046.75	1	4046.75
Total			**4875.47**

Arch-Diaphragm Area Calculations

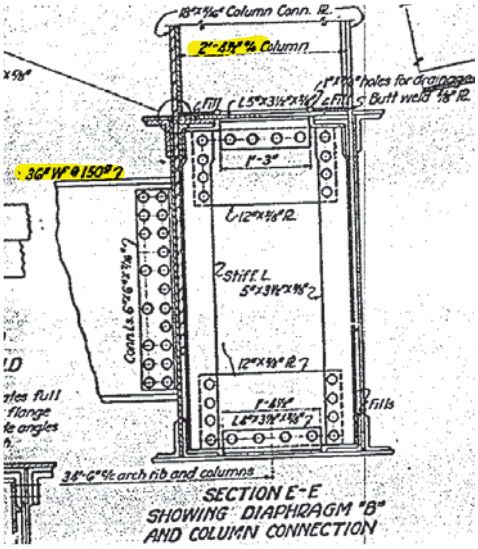
Arch-Diaphragm Layout

By: KAC

Date: 2/18/2019

Checked: VTD

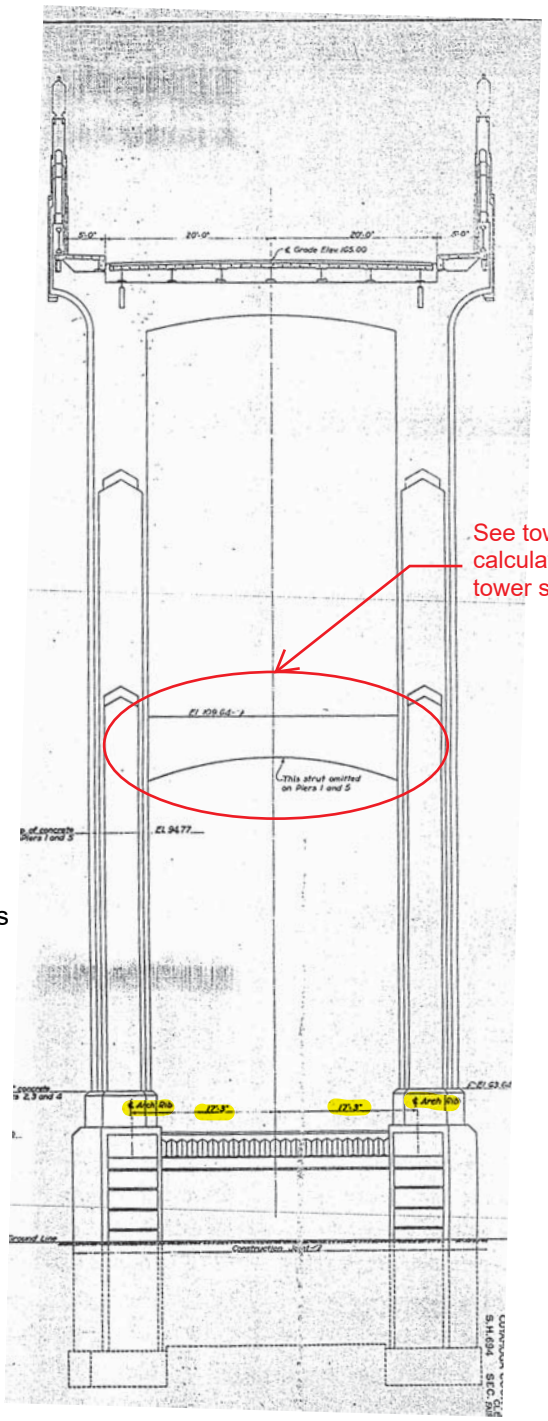
Date: 2/18/2019



1934 CUY-10-0869 Original Plans - Sheet 18

Between the 34'-6" spaced arches there are W beams at every arch-column location (12 per Arch Spans 3, 4 and 11 per Arch Spans 2, 5) that serve as the Arch-Diaphragms.

Total Number of Diaphragms = (12 x 2) + (11 x 2) = **46 Diaphragms**

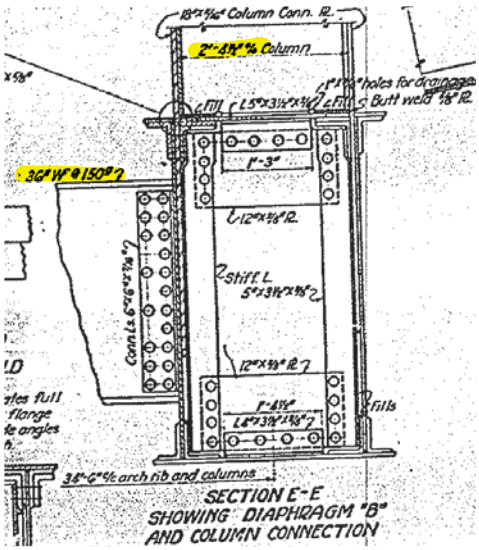


1934 CUY-10-0869 Original Plans - Sheet 11

Arch-Diaphragm Area Calculations

Arch-Diaphragm Area Calculations

By: KAC
Date: 2/18/2019
Checked: VTD
Date: 2/18/2019



1934 CUY-10-0869 Original Plans - Sheet 18

Notes:

Each Arch-Diaphragm is a W36x150 member framing into the face of each arch.

From AISC Steel Construction Manual Table 1-1:
d = 35.9"
t_w = 0.625"
b_f = 12"
t_f = 0.94"

Arch-Diaphragm Length Calculation:

Arch-Diaphragm Length = Arch Spacing - 2 x (Distance from Arch centerline to Arch face)
Arch-Diaphragm Length = 34.5' - 2 x (1/2 x 2.583') = **31.917'**

Arch-Diaphragm Area Calculation:
W36x150 Perimeter = 2 x 35.9" + 4 x 12" - 2 x 0.625"
W36x150 Perimeter = 118.55"= **9.88'**

Area to be Painted per Arch-Diaphragm = 9.88' x 31.92' = **315.37ft^2**

Total Arch-Diaphragm Area to be Painted = 315.37ft^2 x 46 diaphragms
Total Arch-Diaphragm Area to be Painted = 14507ft^2

Gannett Fleming

Calculation Sheet

Project: Lorain Road over Rocky River

Designer: DSC/KAC
Date: 2/4/2019

Checker: ASM/VTD
Date: 3/5/2019

Approach Columns (Exterior)

	Area (ft^2)			No.	Factor	Assumption	Surface Area (ft^2)
Pier 6 (South of Roadway)	871.86			1	1.00	-	872
Pier 6 (North of Roadway)	784.37			1	1.00	-	784
Pier 7 (South of Roadway)	696.89			1	1.00	-	697
Pier 7 (North of Roadway)	624.00			1	1.00	-	624
Pier 8 (South of Roadway)	303.24			1	1.00	-	303
Pier 8 (North of Roadway)	303.24			1	1.00	-	303
						Total =	3584

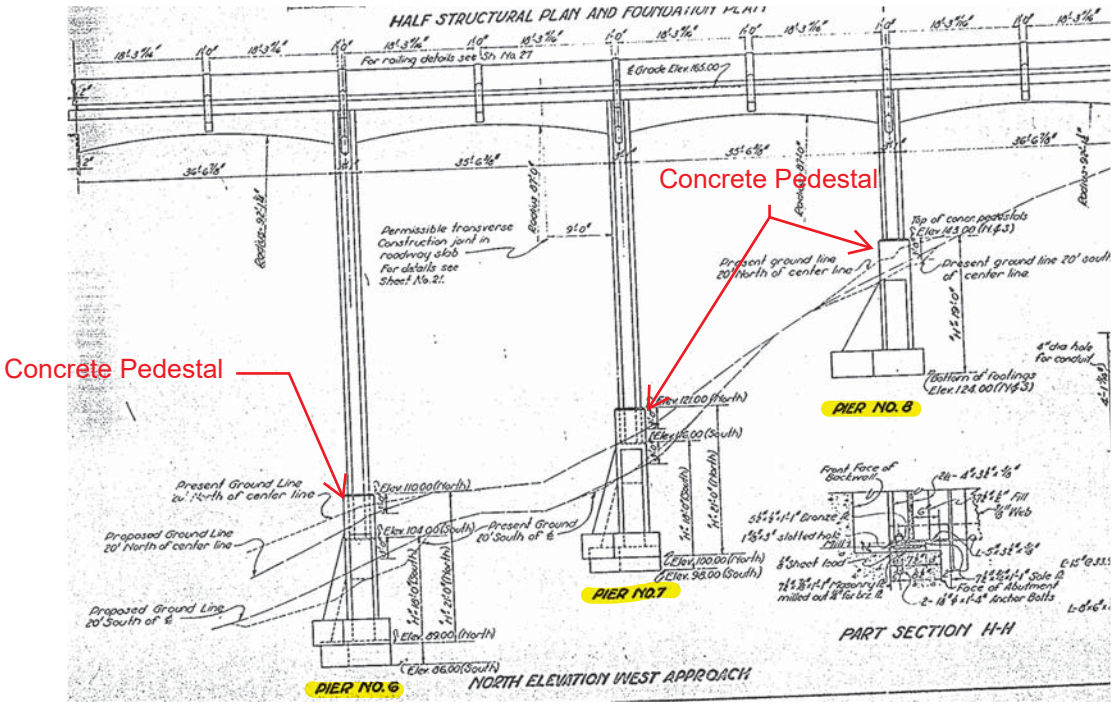
Approach Columns (Interior)

	Area (ft^2)			No.	Factor	Assumption	Surface Area (ft^2)
Pier 6 (South of Roadway)	979.75			1	1.00	-	980
Pier 6 (North of Roadway)	862.41			1	1.00	-	862
Pier 7 (South of Roadway)	759.97			1	1.00	-	760
Pier 7 (North of Roadway)	672.14			1	1.00	-	672
Pier 8 (South of Roadway)	276.73			1	1.00	-	277
Pier 8 (North of Roadway)	276.73			1	1.00	-	277
						Total =	3828

West Approach Column Calculations

West Approach Column Layout

By: KAC
Date: 2/22/2019
Checked: VTD
Date: 2/25/2019



1934 CUY-10-0869 Original Plans - Sheet 24

Notes:

Piers 6, 7, and 8 are hollow "West Approach Columns"

The bottom of the West Approach Columns have a concrete pedestal, below which the interior cannot be painted

The region where the interior and exterior are to be painted is from the top of the concrete pedestal to approximately 2' below the top of curb

West Approach Column Calculations

Pier 6 Column Calculations

By: KAC

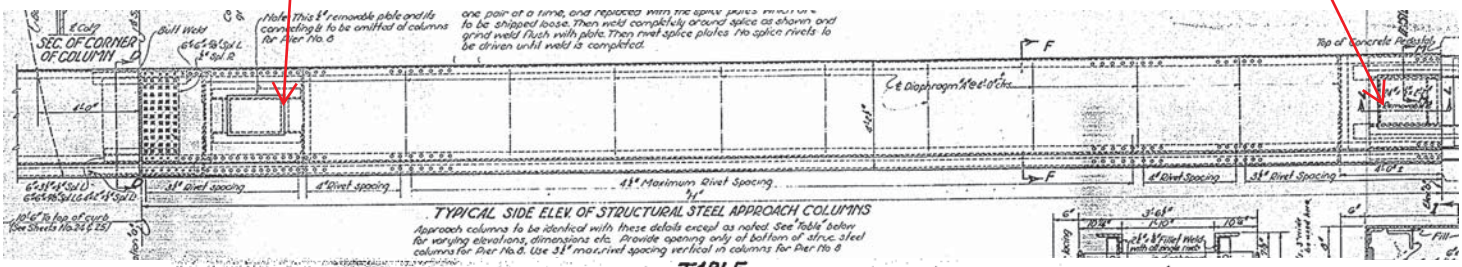
Date: 2/22/2019

Checked: VTD

Date: 2/25/2019

2'-0" x 1'-3" clear opening

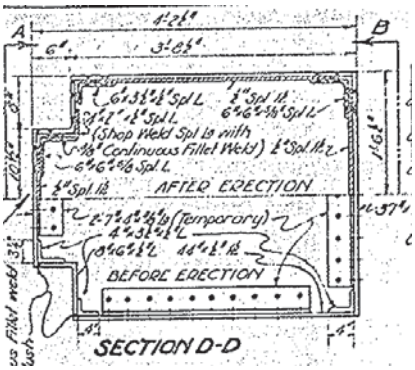
2'-0" x 2'-2" clear opening



TABLE

		Columns South Of ℄ Roadway							Columns North Of ℄ Roadway						
℄ Column Sta.	Pier No.	"Elev. "a"	Elev. "b"	Elev. "c"	"H"	"h"	No. "A" Diaph.	No. "B" Diaph.	Elev. "a"	Elev. "b"	Elev. "c"	"H"	"h"	No. "A" Diaph.	No. "B" Diaph.
32+28.81	6	155.21	104.00	89.50	51'-2½"	14'-6"	12	4	155.21	110.00	92.50	45'-2½"	17'-6"	10	5
32+67.42	7	155.21	116.00	101.50	39'-2½"	14'-6"	9	4	155.21	121.00	103.50	34'-2½"	17'-6"	8	5
33+06.04	8	155.21	143.00	127.50	12'-2½"	15'-6"	3	4	155.21	143.00	127.50	12'-2½"	15'-6"	9	4

1934 CUY-10-0869 Original Plans - Sheet 23



1934 CUY-10-0869 Original Plans - Sheet 23

Notes:

Exterior Area = Exterior Perimeter x ("H" + 10'-6" - 1'-11") = 8.59'

Exterior Area Calculations:

Exterior Perimeter = (2 x 4.208') + (4 x 1.542') = **14.58'**

Exterior Area (South of Roadway) = 14.58' x (51.208 + 8.59')
Exterior Area (South of Roadway) = 871.86ft²

Exterior Area (North of Roadway) = 14.58' x (45.208 + 8.59')
Exterior Area (North of Roadway) = 784.37ft²

West Approach Column Calculations

Pier 6 Column Calculations

By: KAC

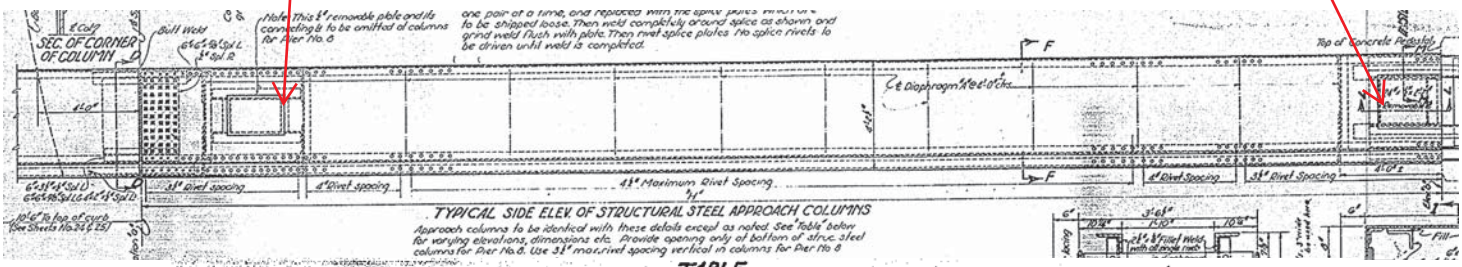
Date: 2/22/2019

Checked: VTD

Date: 2/25/2019

2'-0" x 1'-3" clear opening

2'-0" x 2'-2" clear opening



TABLE

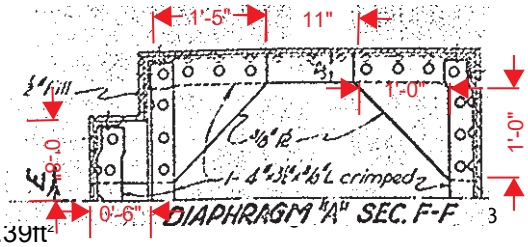
		Columns South Of ℄ Roadway							Columns North Of ℄ Roadway						
℄ Column Sta.	Pier No.	"Elev. "a"	Elev. "b"	Elev. "c"	"H"	"h"	No. "A" Diaph.	No. "B" Diaph.	Elev. "a"	Elev. "b"	Elev. "c"	"H"	"h"	No. "A" Diaph.	No. "B" Diaph.
32+28.81	6	155.21	104.00	89.50	51'-2 7/8"	14'-6"	12	4	155.21	110.00	92.50	45'-2 1/2"	17'-6"	10	5
32+67.42	7	155.21	116.00	101.50	39'-2 7/8"	14'-6"	9	4	155.21	121.00	103.50	34'-2 7/8"	17'-6"	8	5
33+06.04	8	155.21	143.00	127.50	12'-2 7/8"	15'-6"	3	4	155.21	143.00	127.50	12'-2 7/8"	15'-6"	9	4

1934 CUY-10-0869 Original Plans - Sheet 23

Notes:

Interior Area is made up of interior wall area plus "Diaphragm A" area times the number of "Diaphragm A" sections in the column

The upper portion of the section that is encased in concrete cannot be painted



Diaphragm A Area Calculations:

Interior Area per "Diaphragm A" section = (Plate Area) + (Angle Area)
Plate Area = ((17"x17" + 8"x6" - 12"x12"x1/2) + (17"x17" - 12"x12"x1/2))/144 = 13.39ft^2
Remaining Angle Area = 4"/12 x 2 faces x [(0.91 x 2) + (3.0833 - 2 x 1.42) x 2] = 1.54ft^2
Interior Area per "Diaphragm A" section = 13.39ft^2 + 1.54ft^2 = **14.93ft^2**

Interior Area Calculations:

Interior Area = Interior Face Area + "Diaphragm A" area x number of "Diaphragm A" sections

Interior Perimeter = **14.58'**

Interior H (South of Roadway) = 51.208' + 1/2 x [(4 - 9.5"/12) + 4 + (11 7/8" -9.5)/12)] = 51.208' + 3.7' = 54.91'
Interior H (North of Roadway) = 45.208' + 3.7' = 48.91'

Interior Area (South of Roadway) = (14.58' x 54.91') + (12 x 14.93ft^2)
Interior Area (South of Roadway) = 979.75ft^2

Interior Area (North of Roadway) = (14.58' x 48.91') + (10 x 14.93ft^2)
Interior Area (North of Roadway) = 862.41ft^2

West Approach Column Calculations

Pier 7 Column Calculations

By: KAC

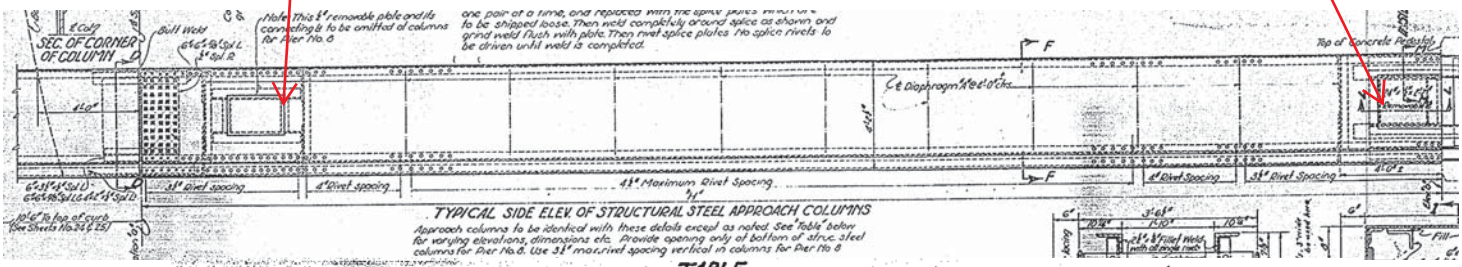
Date: 2/22/2019

Checked: VTD

Date: 2/25/2019

2'-0" x 1'-3" clear opening

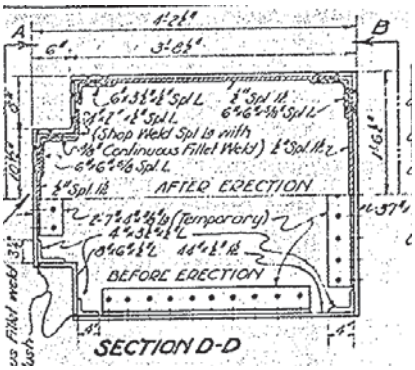
2'-0" x 2'-2" clear opening



TABLE

		Columns South Of ℄ Roadway							Columns North Of ℄ Roadway						
℄ Column Sta.	Pier No.	"Elev. "a"	Elev. "b"	Elev. "c"	"H"	"h"	No. "A" Diaph.	No. "B" Diaph.	Elev. "a"	Elev. "b"	Elev. "c"	"H"	"h"	No. "A" Diaph.	No. "B" Diaph.
32+28.81	6	155.21	104.00	89.50	51'-2 7/16"	14'-6"	12	4	155.21	110.00	92.50	45'-2 1/2"	17'-6"	10	5
32+67.42	7	155.21	116.00	101.50	39'-2 7/16"	14'-6"	9	4	155.21	121.00	103.50	34'-2 7/16"	17'-6"	8	5
33+06.04	8	155.21	143.00	127.50	12'-2 7/16"	15'-6"	3	4	155.21	143.00	127.50	12'-2 7/16"	15'-6"	9	4

1934 CUY-10-0869 Original Plans - Sheet 23



1934 CUY-10-0869 Original Plans - Sheet 23

Notes:

Exterior Area = Exterior Perimeter x ("H" + 10'-6" - 1'-11") = 8.59'

Exterior Area Calculations:

Exterior Perimeter = **14.58'**

Exterior Area (South of Roadway) = 14.58' x (39.208' + 8.59')
Exterior Area (South of Roadway) = 696.89ft^2

Exterior Area (North of Roadway) = 14.58' x (34.208' + 8.59')
Exterior Area (North of Roadway) = 624.00ft^2

West Approach Column Calculations

Pier 7 Column Calculations

By: KAC

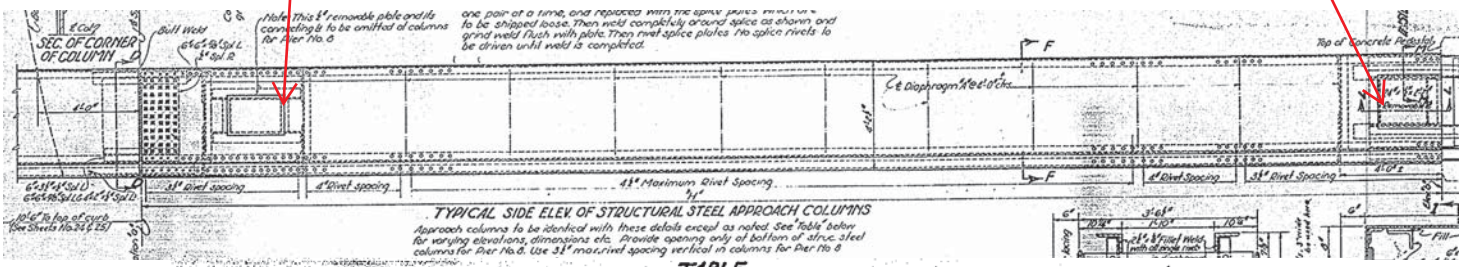
Date: 2/22/2019

Checked: VTD

Date: 2/25/2019

2'-0" x 1'-3" clear opening

2'-0" x 2'-2" clear opening



TABLE

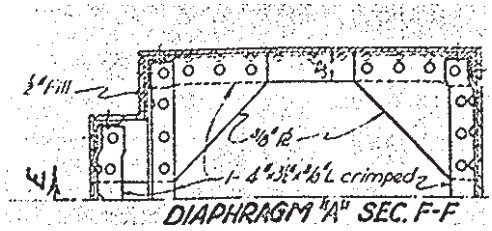
		Columns South Of ℄ Roadway							Columns North Of ℄ Roadway						
℄ Column Sta.	Pier No.	"Elev. "a"	Elev. "b"	Elev. "c"	"H"	"h"	No. "A" Diaph.	No. "B" Diaph.	Elev. "a"	Elev. "b"	Elev. "c"	"H"	"h"	No. "A" Diaph.	No. "B" Diaph.
32+28.81	6	155.21	104.00	89.50	51'-2½"	14'-6"	12	4	155.21	110.00	92.50	45'-2½"	17'-6"	10	5
32+67.42	7	155.21	116.00	101.50	39'-2½"	14'-6"	9	4	155.21	121.00	103.50	34'-2½"	17'-6"	8	5
33+06.04	8	155.21	143.00	127.50	12'-2½"	15'-6"	3	4	155.21	143.00	127.50	12'-2½"	15'-6"	3	4

1934 CUY-10-0869 Original Plans - Sheet 23

Notes:

Interior Area is made up of interior wall area plus "Diaphragm A" area times the number of "Diaphragm A" sections in the column

The upper portion of the section that is encased in concrete cannot be painted



1934 CUY-10-0869 Original Plans - Sheet 23

Diaphragm A Area Calculations:

Interior Area per "Diaphragm A" section = 3.36ft^2 + 10.21ft^2 = **14.93ft^2**

Interior Area Calculations:

Interior Area = Interior Face Area + "Diaphragm A" area x number of "Diaphragm A" sections

Interior Perimeter = **14.58'**

Interior Area (South of Roadway) = (39.208' + 3.7')x14.58' + 9 x 14.93ft^2
Interior Area (South of Roadway) = 759.97ft^2

Interior Area (North of Roadway) = (34.208' + 3.7')x14.58' + 8 x 14.93ft^2
Interior Area (North of Roadway) = 672.14ft^2

West Approach Column Calculations

Pier 8 Column Calculations

By: KAC

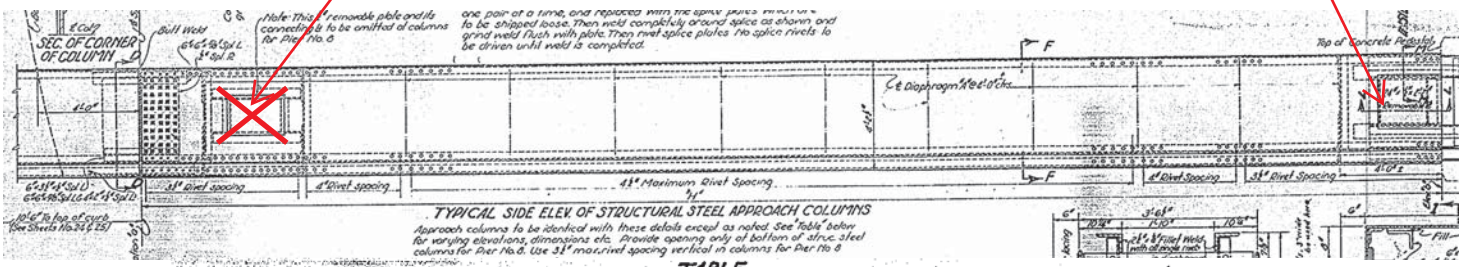
Date: 2/22/2019

Checked: VTD

Date: 2/25/2019

No opening at the top of Pier 8 columns

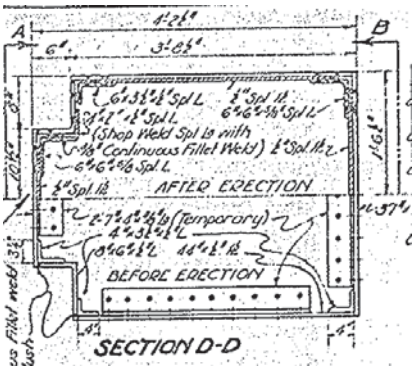
2'-0" x 2'-2" clear opening



TABLE

		Columns South Of ℄ Roadway							Columns North Of ℄ Roadway						
℄ Column Sta.	Pier No.	"Elev. "a"	Elev. "b"	Elev. "c"	"H"	"h"	No. "A" Diaph.	No. "B" Diaph.	Elev. "a"	Elev. "b"	Elev. "c"	"H"	"h"	No. "A" Diaph.	No. "B" Diaph.
32+28.81	6	155.21	104.00	89.50	51'-2 7/16"	14'-6"	12	4	155.21	110.00	92.50	45'-2 1/2"	17'-6"	10	5
32+67.42	7	155.21	116.00	101.50	39'-2 7/16"	14'-6"	9	4	155.21	121.00	103.50	34'-2 7/16"	17'-6"	8	5
33+06.04	8	155.21	143.00	127.50	12'-2 7/16"	15'-6"	3	4	155.21	143.00	127.50	12'-2 7/16"	15'-6"	9	4

1934 CUY-10-0869 Original Plans - Sheet 23



1934 CUY-10-0869 Original Plans - Sheet 23

Notes:

Exterior Area = Exterior Perimeter x ("H" + 10'-6" - 1'-11") = 8.59'

Exterior Area Calculations:

Exterior Perimeter = **14.58'**

Exterior Area (South of Roadway) = 14.58' x (12.208 + 8.59')
Exterior Area (South of Roadway) = 303.24ft^2

Exterior Area (North of Roadway) = 14.58' x (12.208 + 8.59')
Exterior Area (North of Roadway) = 303.24ft^2

West Approach Column Calculations

Pier 8 Column Calculations

By: KAC

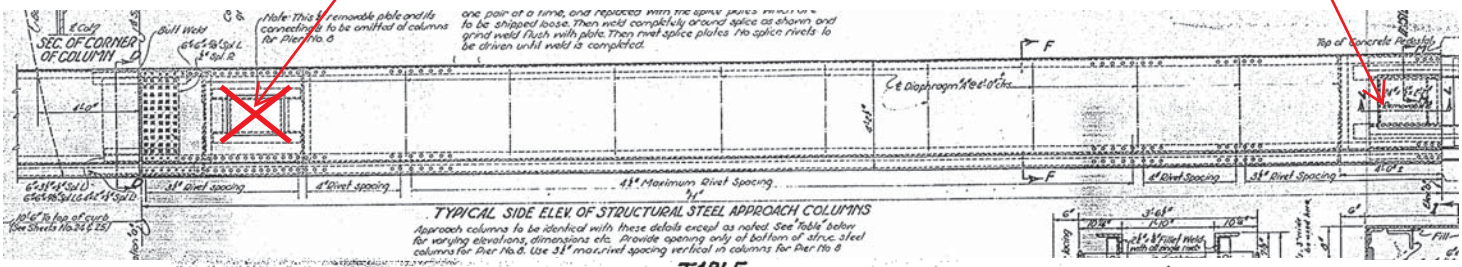
Date: 2/22/2019

Checked: VTD

Date: 2/25/2019

2'-0" x 2'-2" clear opening

No opening at the top of Pier 8 columns



TABLE

		Columns South Of ℄ Roadway							Columns North Of ℄ Roadway						
℄ Column Sta.	Pier No.	"Elev. 'a'"	"Elev. 'b'"	"Elev. 'c'"	"H"	"h"	No. "A" Diaph.	No. "B" Diaph.	"Elev. 'a'"	"Elev. 'b'"	"Elev. 'c'"	"H"	"h"	No. "A" Diaph.	No. "B" Diaph.
32+28.81	6	155.21	104.00	89.50	51'-2 7/16"	14'-6"	12	4	155.21	110.00	92.50	45'-2 1/2"	17'-6"	10	5
32+67.42	7	155.21	116.00	101.50	39'-2 7/16"	14'-6"	9	4	155.21	121.00	103.50	34'-2 7/16"	17'-6"	8	5
33+06.04	8	155.21	143.00	127.50	12'-2 7/16"	15'-6"	3	4	155.21	143.00	127.50	12'-2 7/16"	15'-6"	9	4

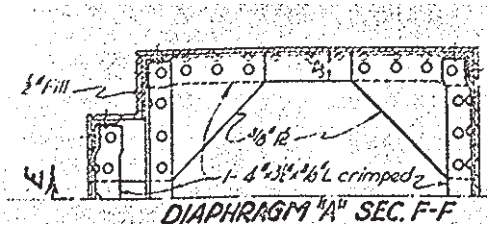
1934 CUY-10-0869 Original Plans - Sheet 23

For Pier 8 north of the roadway we will assume 3 diaphragms instead of 9. The use of 9 is inconsistent with the column south of the roadway.

Notes:

Interior Area is made up of interior wall area plus "Diaphragm A" area times the number of "Diaphragm A" sections in the column

The upper portion of the section that is encased in concrete cannot be painted



1934 CUY-10-0869 Original Plans - Sheet 23

Diaphragm A Area Calculations:

Interior Area per "Diaphragm A" section = 3.36ft^2 + 10.21ft^2 = **14.93ft^2**

Interior Area Calculations:

Interior Area = Interior Face Area + "Diaphragm A" area x number of "Diaphragm A" sections

Interior Perimeter = **14.58'**

Interior Area (South of Roadway) = (12.208' + 3.7')x14.58' + 3 x 14.93ft^2
Interior Area (South of Roadway) = 276.73ft^2

Interior Area (North of Roadway) = (12.208' + 3.7')x14.58' + 3 x 14.93ft^2
Interior Area (North of Roadway) = 276.73ft^2

West Approach Column Calculations

West Approach Column Summary

By: KAC
Date: 2/22/2019
Checked: VTD
Date: 2/25/2019

Exterior Area to be Painted	
Pier	Area to be Painted (ft^2)
Pier 6 (South of Roadway)	871.86
Pier 6 (North of Roadway)	784.37
Pier 7 (South of Roadway)	696.89
Pier 7 (North of Roadway)	624.00
Pier 8 (South of Roadway)	303.24
Pier 8 (North of Roadway)	303.24
Total Exterior Area	**3583.60**

Interior Area to be Painted	
Pier	Area to be Painted (ft^2)
Pier 6 (South of Roadway)	979.75
Pier 6 (North of Roadway)	862.41
Pier 7 (South of Roadway)	759.97
Pier 7 (North of Roadway)	672.14
Pier 8 (South of Roadway)	276.73
Pier 8 (North of Roadway)	276.73
Total Interior Area	**3827.73**

Gannett Fleming

Calculation Sheet

Project: Lorain Road over Rocky River

Designer: DSC/KAC
Date: 2/4/2019

Checker: ASM/VTD
Date: 3/5/2019

Towers (Exterior)

	Area (ft^2)			No.	Factor	Assumption	Surface Area (ft^2)
Tower 1	1773.40			2	1.00	-	3547
Tower 2	2798.93			2	1.00	-	5598
Tower 3	2798.93			2	1.00	-	5598
Tower 4	2798.93			2	1.00	-	5598
Tower 5	1773.40			2	1.00	-	3547
Tower Girder 1	805.22			1	1.00	-	805
Tower Girder 2	859.65			1	1.00	-	860
Tower Girder 3	859.65			1	1.00	-	860
Tower Girder 4	859.65			1	1.00	-	860
Tower Girder 5	805.22			1	1.00	-	805
Tower Struts	600.00			3	1.00	-	1800
						Total =	29877

Towers (Interior)

	Area (ft^2)			No.	Factor	Assumption	Surface Area (ft^2)
Tower 1	2961.67			2	1.00	-	5923
Tower 2	4608.42			2	1.00	-	9217
Tower 3	4608.42			2	1.00	-	9217
Tower 4	4608.42			2	1.00	-	9217
Tower 5	2961.67			2	1.00	-	5923
Tower Girder 1	885.75			1	1.00	-	886
Tower Girder 2	945.62			1	1.00	-	946
Tower Girder 3	945.62			1	1.00	-	946
Tower Girder 4	945.62			1	1.00	-	946
Tower Girder 5	885.75			1	1.00	-	886
Tower Struts	630.00			3	1.00	-	1890
						Total =	45996

Tower Area Calculations

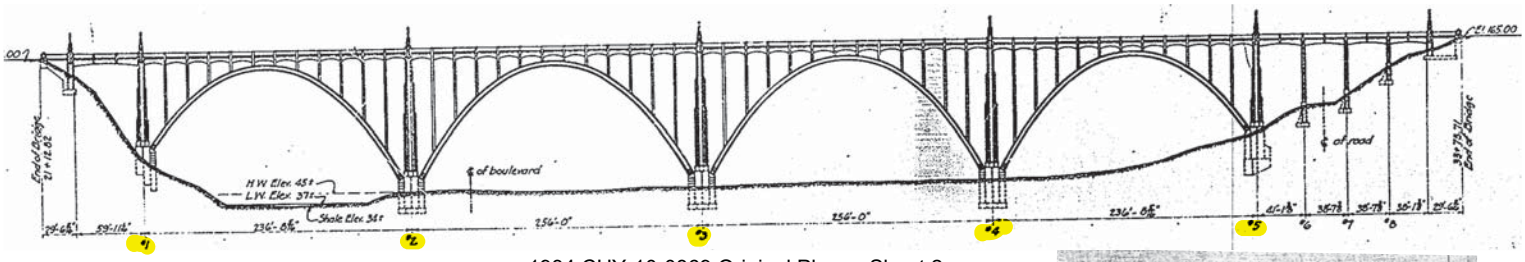
Tower Layout

By: KAC

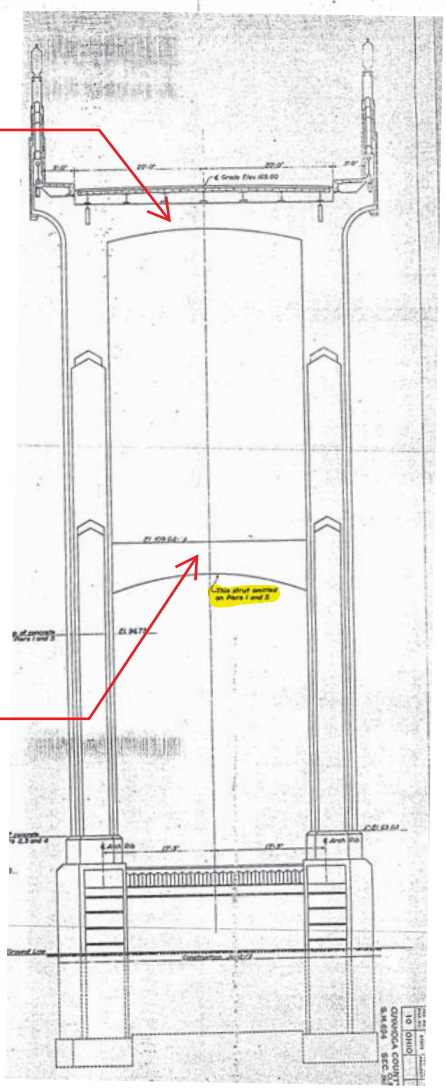
Date: 2/28/2019

Checked: VTD

Date: 3/6/2019



1934 CUY-10-0869 Original Plans - Sheet 2



1934 CUY-10-0869 Original Plans - Sheet 11

Notes:

Towers are ID'd 1-5 from the east and N/S for North/South of the roadway centerline

All towers are hollow with variable cross sections and numerous internal plates/angles/stiffeners and repairs.

Towers 1-5 have a hollow "tower girder" spanning between the towers below the floorbeams

Towers 2-4 also have a hollow transverse strut spanning between the towers approximately halfway up the towers

The 1934 plans divide each tower into an upper and a lower section, with the lower section running from the concrete cap to a field splice above the strut, and the upper section extending from the field splice to the bottom of the tower girder.

Tower Area Calculations

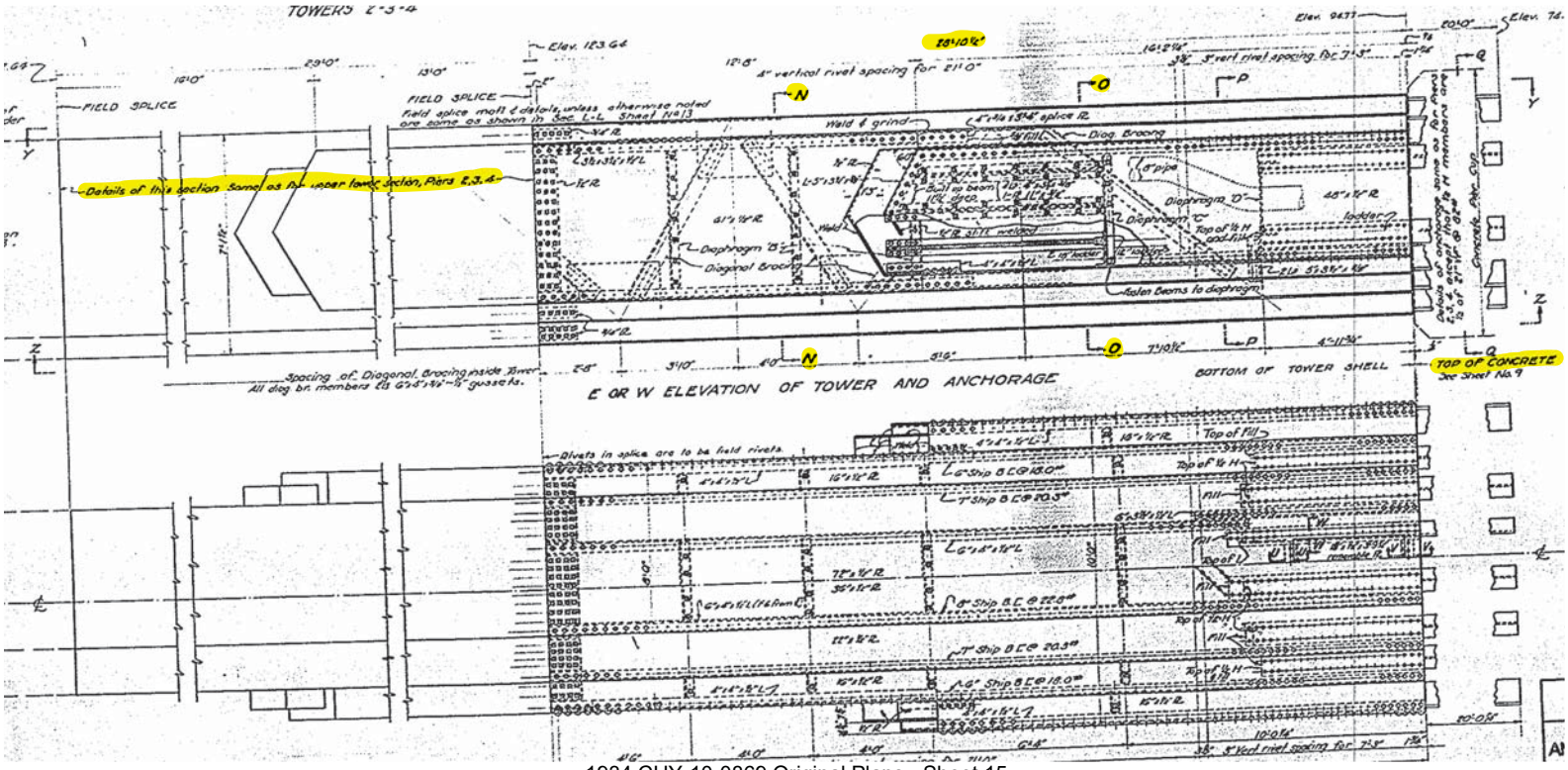
Towers 1&5 Lower Section Exterior Area Calculations

By: KAC

Date: 2/28/2019

Checked: VTD

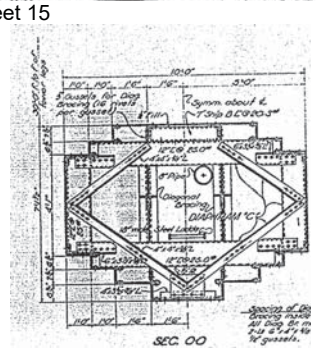
Date: 3/6/2019



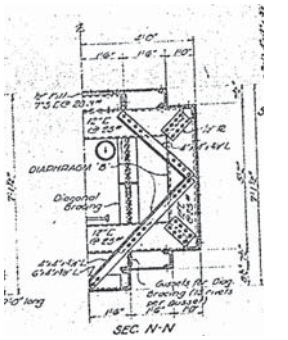
1934 CUY-10-0869 Original Plans - Sheet 15

Notes:

Approximately 18'-6" up the tower it tapers from 10' (section O-O) in width to 8' (section N-N)



1934 CUY-10-0869 Original Plans Sheet 12



1934 CUY-10-0869 Original Plans Sheet 13

Exterior Area Calculation:

Section O-O Perimeter = (2 x 7.125') + (2 x 10') = 34.25'
Section O-O Length = 18.5'
Section N-N Perimeter = (2 x 7.125') + (2 x 8') = 30.25'
Section N-N Length = 28.875' - 18.5' = 10.375'

Towers 1&5 Lower Section Exterior Area = (34.25' x 18.5') + (30.25' x 10.375')
Towers 1&5 Lower Section Exterior Area = 947.47ft^2

Tower Area Calculations

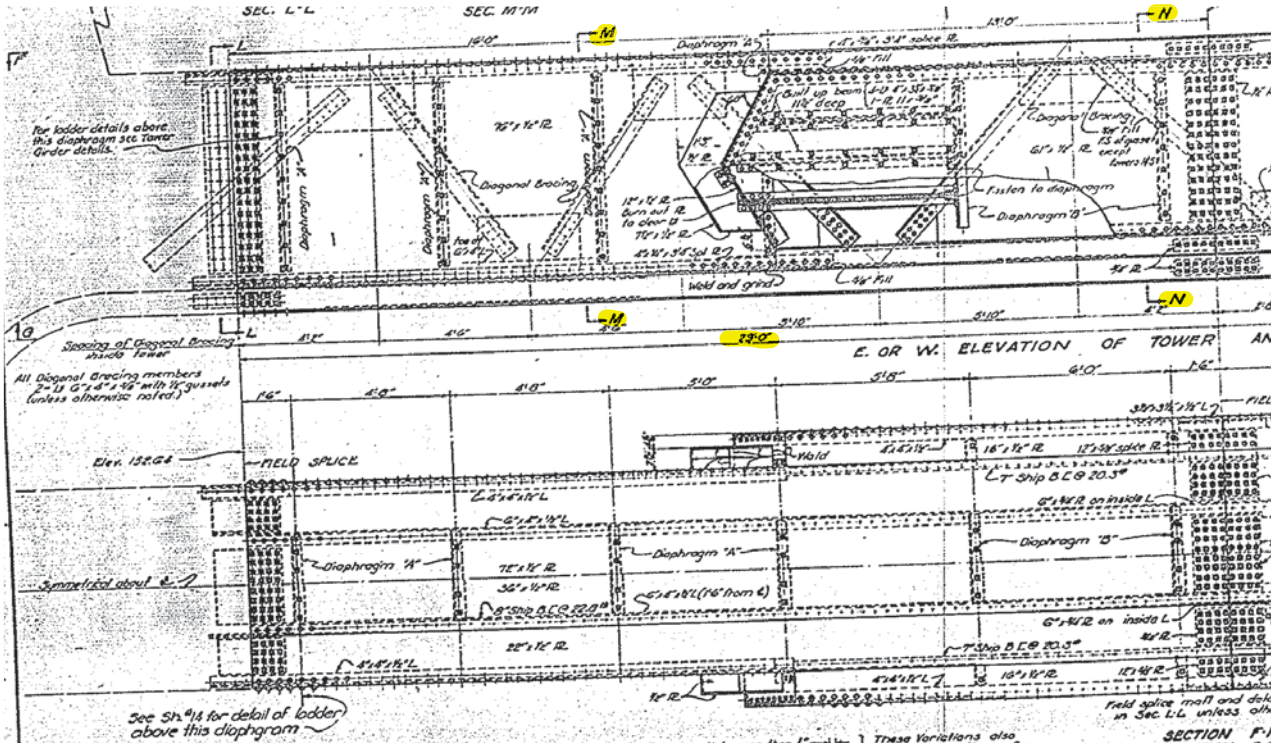
Towers 1&5 Upper Section Exterior Area Calculations

By: KAC

Date: 2/28/2019

Checked: VTD

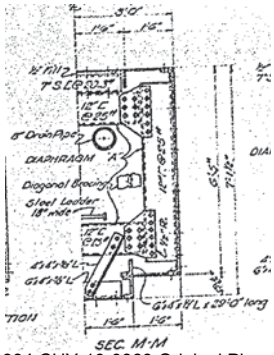
Date: 3/6/2019



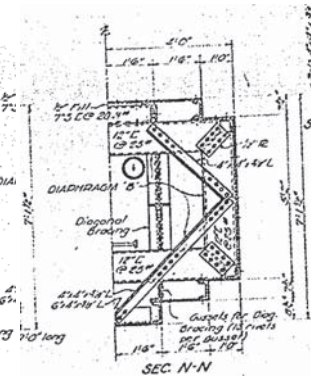
1934 CUY-10-0869 Original Plans Sheet 13

Notes:

Approximately 16'-2" up this section the tower tapers from 8' (section N-N) in width to 6' (section M-M)



1934 CUY-10-0869 Original Plans Sheet 13



1934 CUY-10-0869 Original Plans Sheet 13

Exterior Area Calculation:

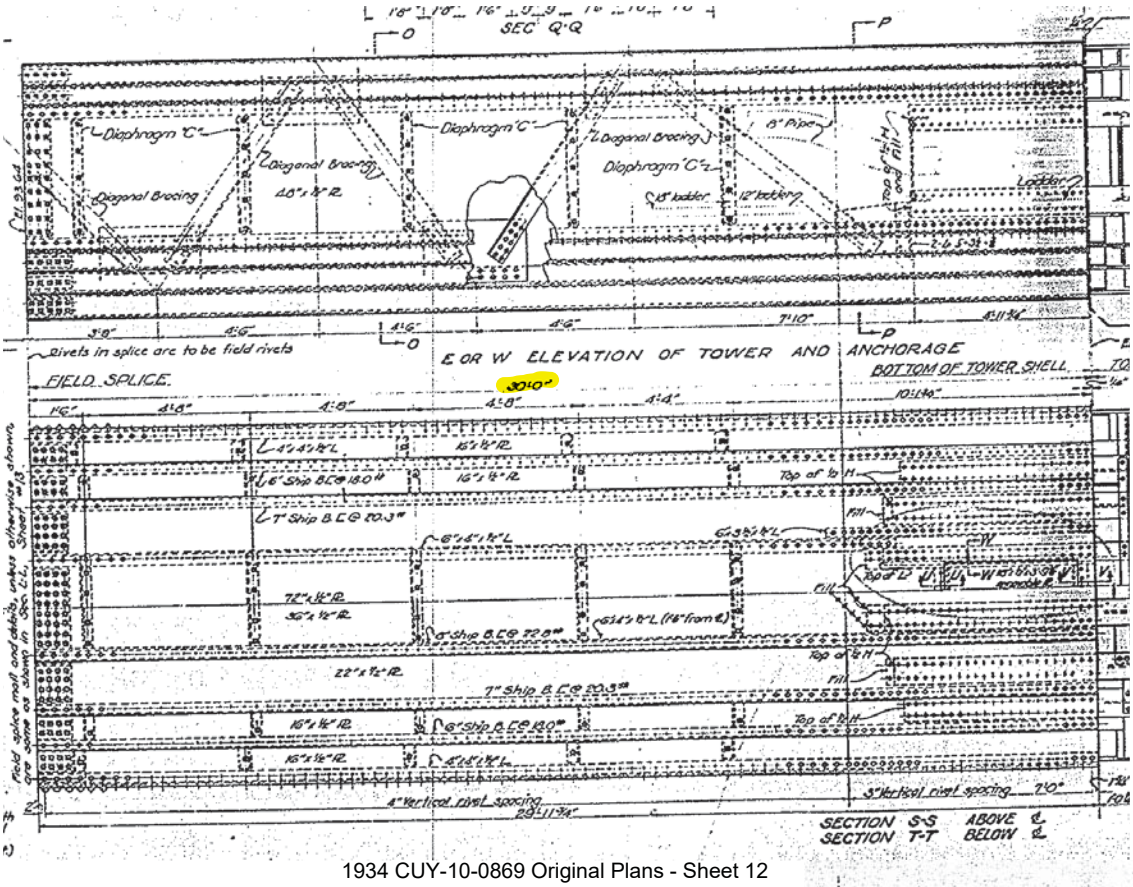
Section N-N Perimeter = (2 x 7.125') + (2 x 8') = 30.25'
Section N-N Length = 16.17'
Section M-M Perimeter = (2 x 7.125') + (2 x 6') = 26.25'
Section M-M Length = 29' - 16.17' = 12.83'

Towers 1&5 Upper Section Exterior Area = (30.25' x 16.17') + (26.25' x 12.83')
Towers 1&5 Upper Section Exterior Area = 825.93ft^2

Tower Area Calculations

Towers 2-4 Lower Section Exterior Area Calculations

By: KAC
Date: 2/28/2019
Checked: VTD
Date: 3/6/2019



1934 CUY-10-0869 Original Plans - Sheet 12

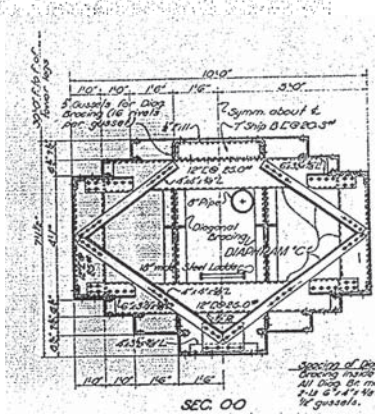
Notes:

The exterior perimeter remains constant throughout the 30' length of the lower section in Towers 2-4.

Exterior Area Calculation:

Section O-O Perimeter = (2 x 7.125') + (2 x 10') = 34.25'
Section O-O Length = 30'

Towers 2-4 Lower Section Exterior Area = 34.25' x 30'
Towers 2-4 Lower Section Exterior Area = 1027.50ft^2



1934 CUY-10-0869 Original Plans Sheet 12

Tower Area Calculations

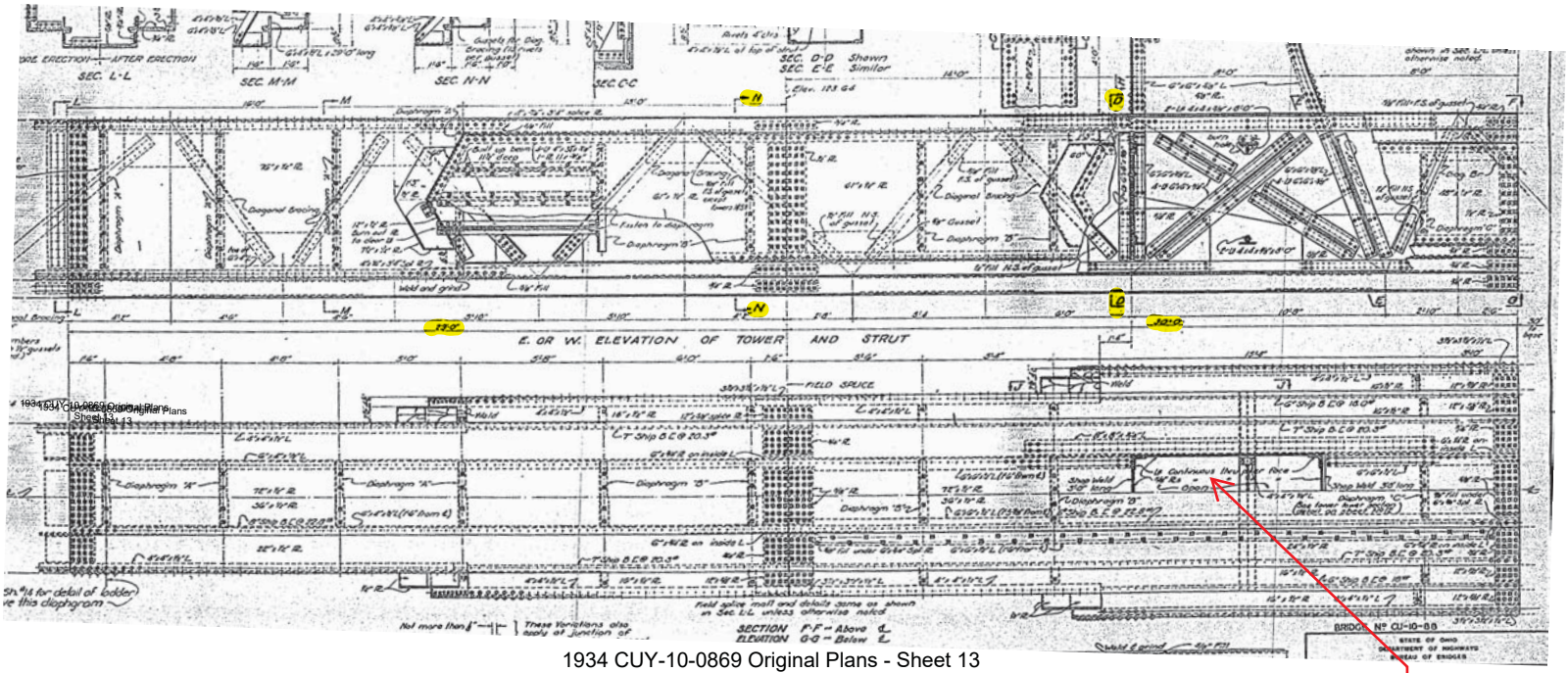
Towers 2-4 Upper Section Exterior Area Calculations

By: KAC

Date: 2/28/2019

Checked: VTD

Date: 3/6/2019



1934 CUY-10-0869 Original Plans - Sheet 13

Notes:

The upper 29' of this section (from the middle field splice to the bottom of the tower girder) is identical to the upper section from the Towers 1&5 exterior calculations (825.93ft^2)

Approximately 15'-6" up this section the cross section tapers from 10ft (section O-O from previous sheet) in width to 8ft (section N-N)

Subtract 24ft^2 to account for the 8' x 3' tower strut opening

Exterior Area Calculation:

Section O-O Perimeter = (2 x 7.125') + (2 x 10') = 34.25'
Section O-O Length = 15.5'
Section N-N Perimeter = (2 x 7.125') + (2 x 8') = 30.25'
Section N-N Length = 30' - 15.5' = 14.5'

Towers 2-4 Upper Section Exterior Area = (34.25' x 15.5') + (30.25' x 14.5') + 825.93ft^2 - 24ft^2
Towers 2-4 Upper Section Exterior Area = 1771.43ft^2

Tower Area Calculations

Tower Interior Area Calculations

By: KAC
Date: 3/4/2019
Checked: VTD
Date: 3/8/2019

Notes:

Each tower has a number of interior elements to be painted including diagonal bracing, ladders, drainage pipes, plates, connections and "Diaphragm A-D" members. It is reasonable to estimate the tower interior area as follows:

Interior Area = Exterior Area x1.10 + Diagonal Bracing Area + "Diaphragm A-D" Area

A 1.10 factor conservatively accounts for extra internal area due to rivets, connections, repair pates, and other miscellaneous interior members that are neither diagonal bracing nor "Diaphragm A-D" members.

Each tower has had its own custom repairs completed in 1986, however after reviewing the repair plans it is reasonable to assume Tower 1&5 have nearly the same interior area and the same for Towers 2-4. Therefore the interior area for Tower 1 will be calculated and used for the interior area for Tower 5, and the interior area for Tower 2 will be calculated and used for the interior area for Towers 3 and 4.

Towers 1&5 Lower Section Interior Area = Lower Section Exterior Area x 1.10
Towers 1&5 Lower Section Interior Area = 947.47ft^2 x 1.10
Towers 1&5 Lower Section Interior Area = 1042.22ft^2

Towers 1&5 Upper Section Interior Area = Upper Section Exterior Area x 1.10
Towers 1&5 Upper Section Interior Area = 825.93ft^2 x 1.10
Towers 1&5 Upper Section Interior Area = 908.52ft^2

Towers 2-4 Lower Section Interior Area = Lower Section Exterior Area x 1.10
Towers 2-4 Lower Section Interior Area = 1027.50ft^2 x 1.10
Towers 2-4 Lower Section Interior Area = 1130.25ft^2

Towers 2-4 Upper Section Interior Area = Upper Section Exterior Area x 1.10
Towers 2-4 Upper Section Interior Area = 1771.43ft^2 x 1.10
Towers 2-4 Upper Section Interior Area = 1948.57ft^2

Tower Area Calculations

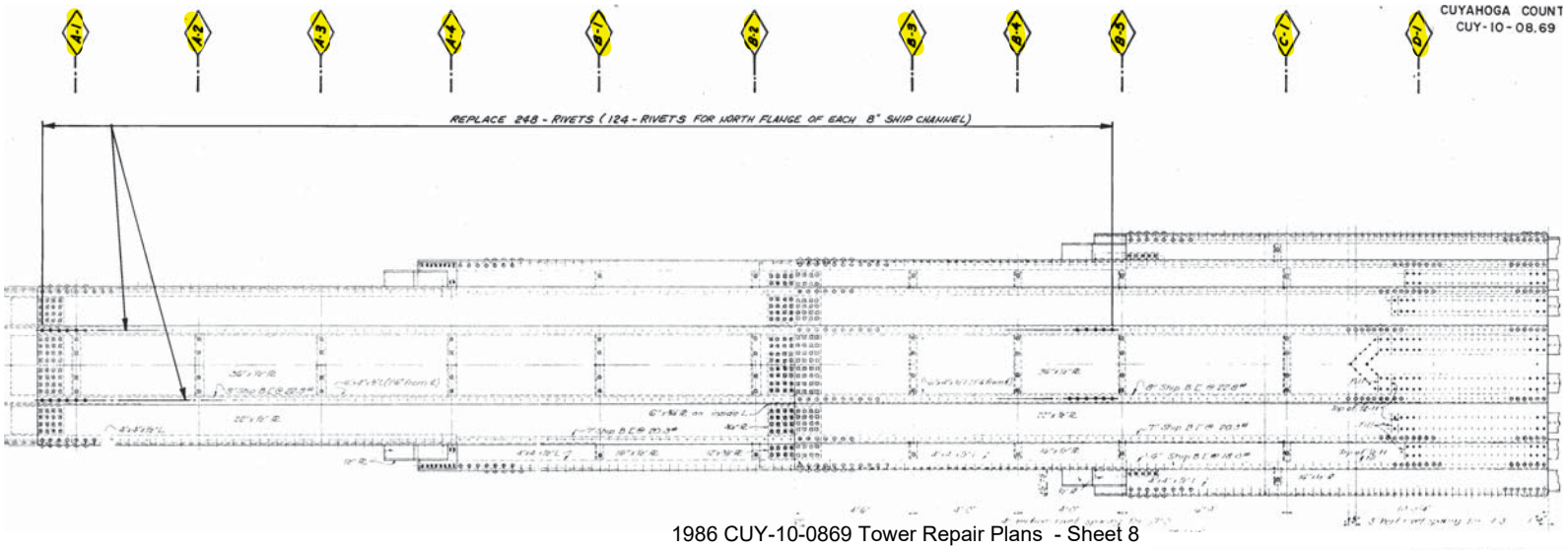
Towers 1&5 Interior Area Calculations

By: KAC

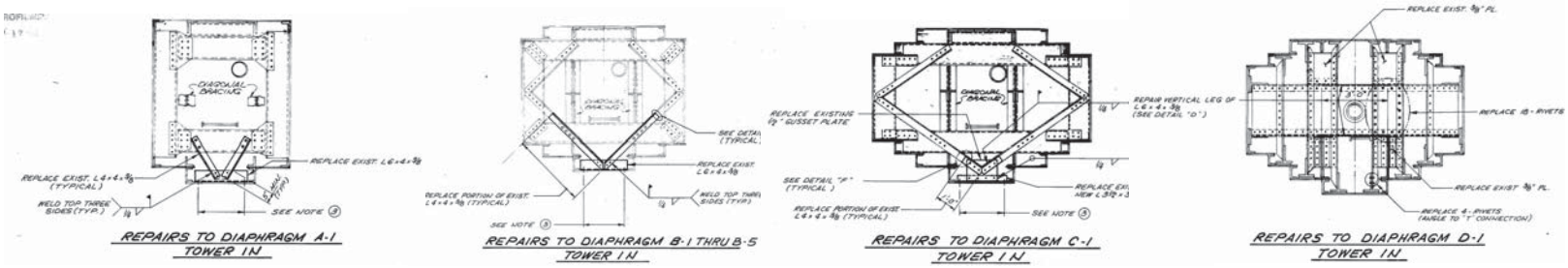
Date: 3/4/2019

Checked: VTD

Date: 3/8/2019



1986 CUY-10-0869 Tower Repair Plans - Sheet 8



1986 CUY-10-0869 Tower Repair Plans - Sheet 7

Notes:

Total Number of "Diaphragm A" Sections = 4

Total Number of "Diaphragm B" Sections = 5

Total Number of "Diaphragm C" Sections = 1

Total Number of "Diaphragm D" Sections = 1

Tower Area Calculations

Towers 1&5 Interior Area Calculations

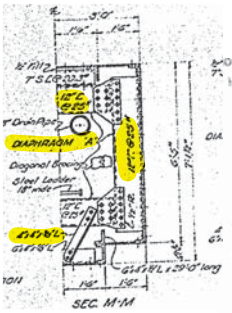
By: KAC

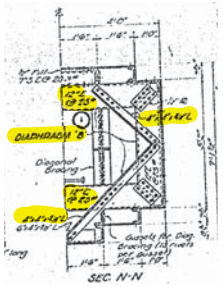
Date: 3/4/2019

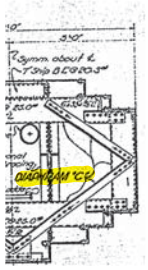
Checked: VTD

Date: 3/8/2019

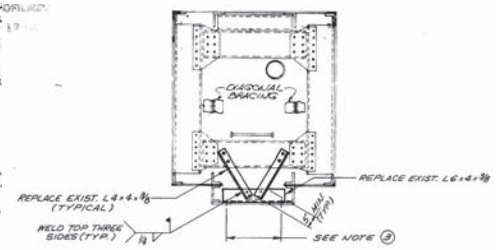
1934 As-Built Details
(From sheets 12 and 13)

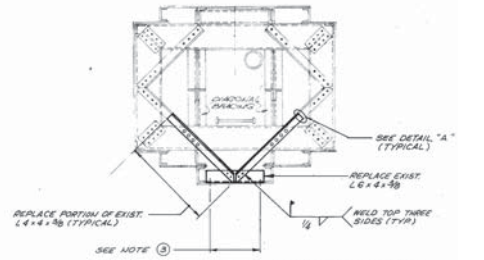


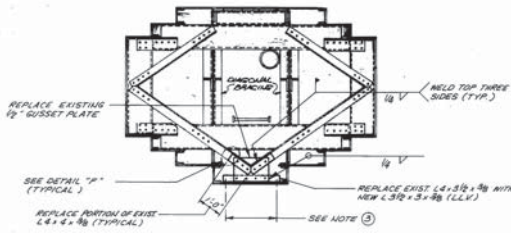


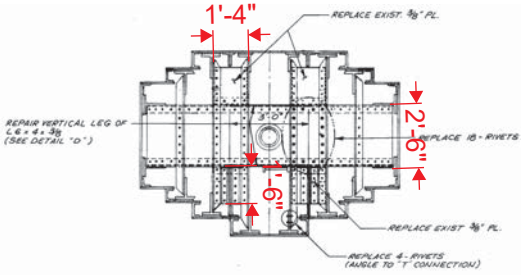


1982 Repairs Details
(From sheet 7)









Notes:
Most of the interior sections are made up of C12x25 and L4x4x3/8 members

C12x25 Perimeter = 2x12" + 2x3" + 2x(3"-3/8") = 35.25" = **2.94'**

To account for one 3" flange against the wall not being painted, use 32.25" or **2.69'** for C sections against the inner wall

L4x4x3/8 Perimeter = 4 x 4" = 16" = **1.33'**

The available plans are unclear about the members making up Diaphragm D, therefore we will increase the calculated Diaphragm D area by 20% to account for uncertainties

Diaphragm A Calculations:
Diaphragm A Area = Channel Area + Angle Area
Diaphragm A Area = 2 x (5.42' x 2.69') + 4 x (1.5' x 2.94') + 2 x (2.17' x 1.33')
Diaphragm A Area = (2 x 14.46ft^2) + (4 x 4.38ft^2) + (2 x 2.88ft^2)
Diaphragm A Area = 52.20ft^2

Diaphragm B Calculations:
Diaphragm B Area = Channel Area + Angle Area
Diaphragm B Area = 2 x (5.17' x 2.69') + 4 x (3' x 2.94') + 2 x ((4.5' + 2'-10") x 1.33')
Diaphragm B Area = (2 x 13.80ft^2) + (4 x 8.75ft^2) + (2 x 9.75ft^2)
Diaphragm B Area = 82.10ft^2

Diaphragm C Calculations:
Diaphragm C Area = Channel Area + Angle Area
Diaphragm C Area = 2 x (4.17' x 2.69') + 4 x (3.83' x 2.94') + 2 x ((5.83' + 4'-0") x 1.33')
Diaphragm C Area = (2 x 11.125ft^2) + (4 x 11.18ft^2) + (2 x 13.08ft^2)
Diaphragm C Area = 93.13ft^2

Diaphragm D Calculations:
Diaphragm D Area = Plate Area x 1.20
Diaphragm D Area = [(2.5' x 10') + 4 x (1.33' x 1.5')] x 2 sides x 1.20
Diaphragm D Area = 80ft^2

Tower Area Calculations

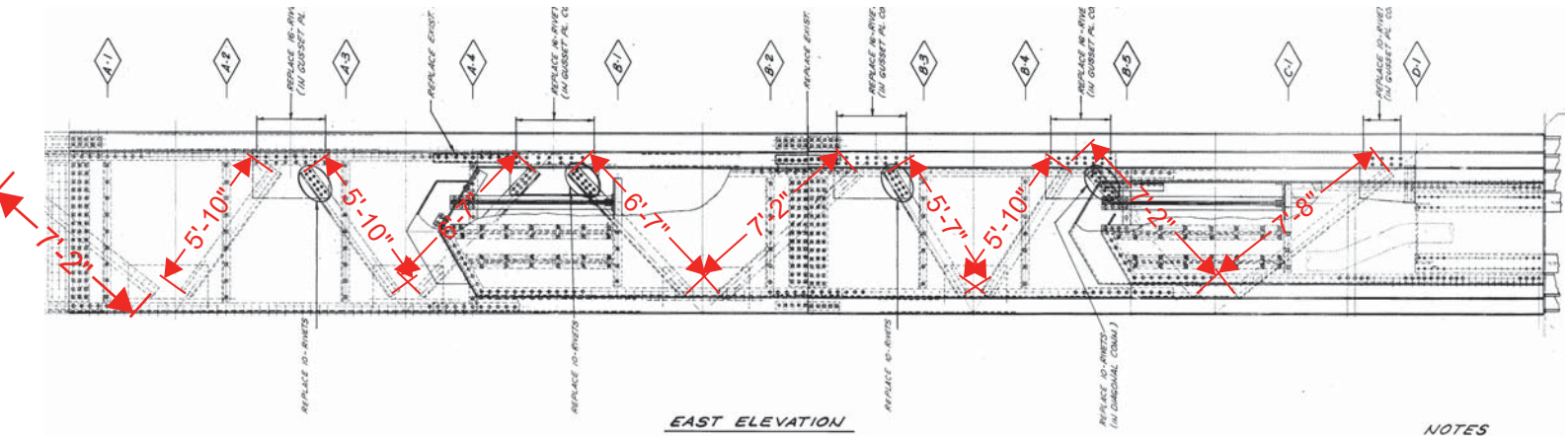
Towers 1&5 Interior Area Calculations

By: KAC

Date: 3/4/2019

Checked: VTD

Date: 3/8/2019



1986 CUY-10-0869 Tower Repair Plans - Sheet 36

Notes:
Tower interiors are braced diagonally by L6x4x3/8 members (one on each side)

Towers 1&5 have 10 angle braces on each side with varying lengths

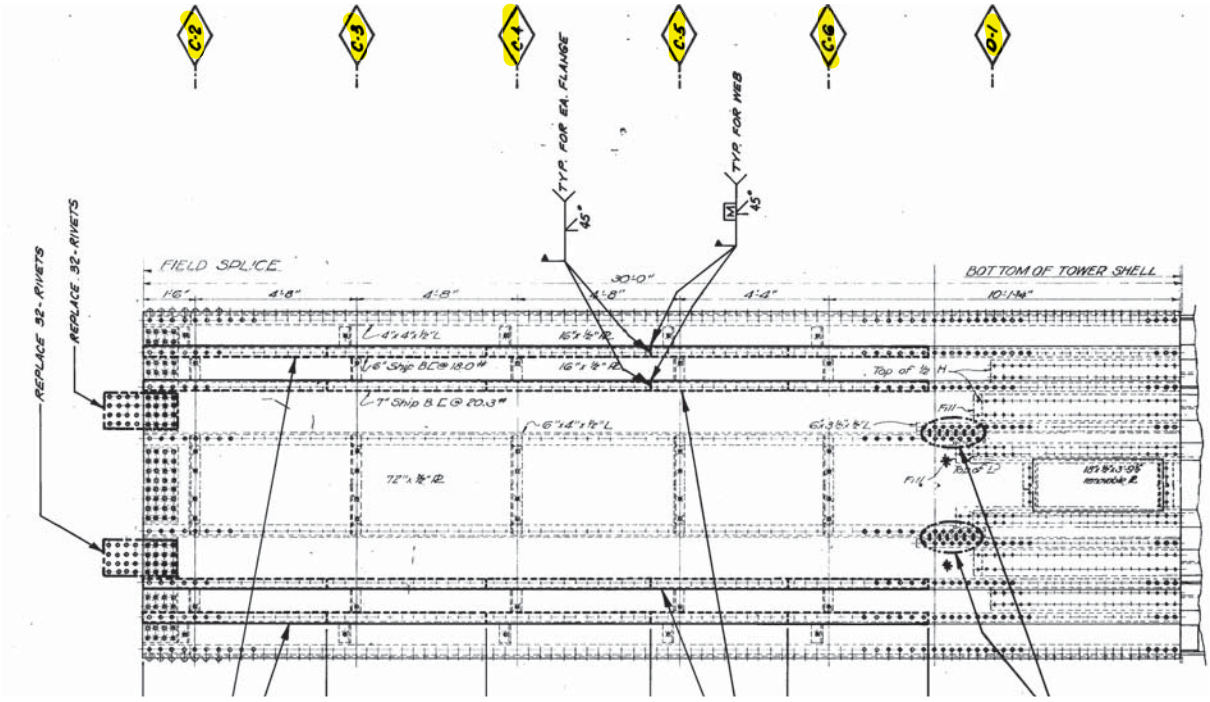
L6x4x3/8 Perimeter = 2 x 6" + 2 x 4" = 20" = **1.67'**

Diagonal Bracing Area Calculations:
Diagonal Bracing Area = Sum of Lengths x 2 x Member Perimeter
Sum of Lengths = (5'-10") x 3 + (7'-2") x 3 + (6'-7") x 2 + (7'-8") + (5'-7")
Sum of Lengths = 17.5' + 21.5' + 13.17' + 7.67' + 5.58' = 65.42'
Diagonal Bracing Area = 65.42' x 2 x 1.67'
Diagonal Bracing Area = 218.50ft^2

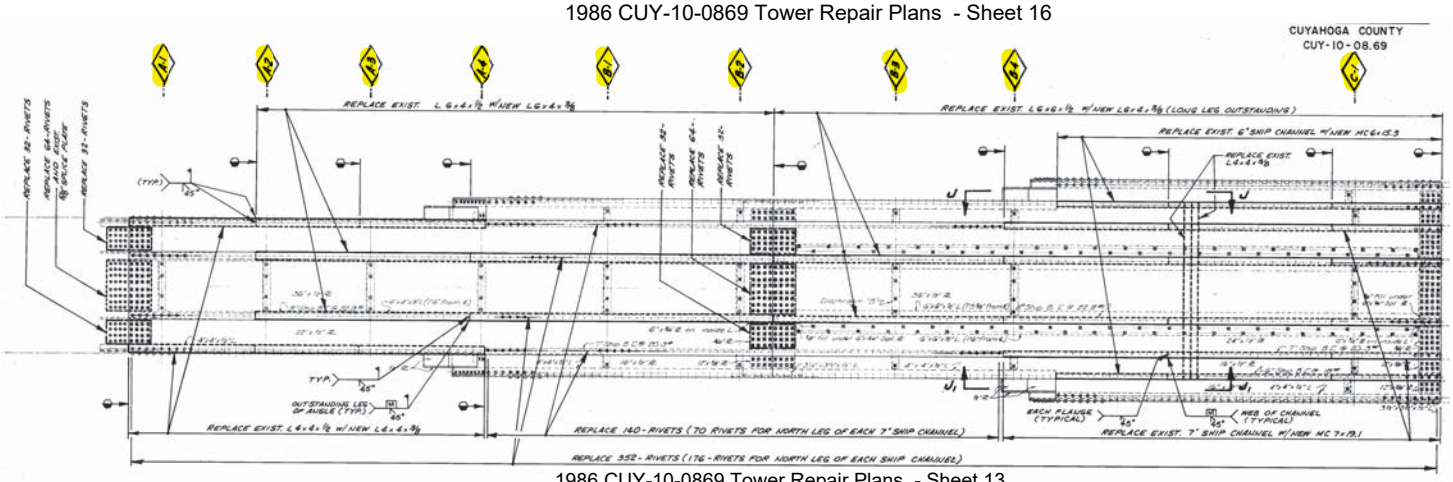
Tower Area Calculations

Towers 2-4 Interior Area Calculations

By: KAC
Date: 3/4/2019
Checked: VTD
Date: 3/8/2019



1986 CUY-10-0869 Tower Repair Plans - Sheet 16



1986 CUY-10-0869 Tower Repair Plans - Sheet 13

Notes:

Total Number of "Diaphragm A" Sections = 4

Total Number of "Diaphragm B" Sections = 4

Total Number of "Diaphragm C" Sections = 6

Total Number of "Diaphragm D" Sections = 1

Tower Area Calculations

Towers 2-4 Interior Area Calculations

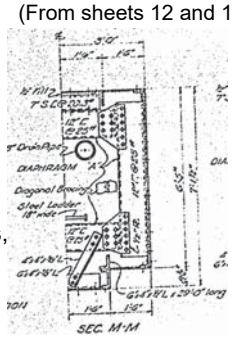
By: KAC

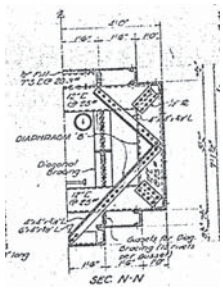
Date: 3/4/2019

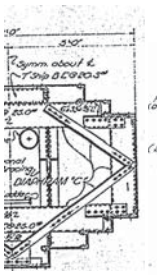
Checked: VTD

Date: 3/8/2019

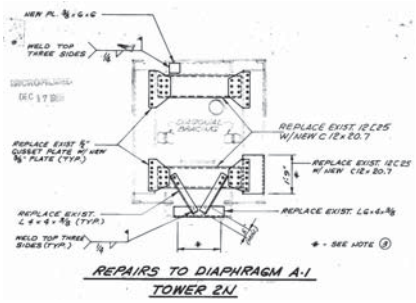
1934 As-Built Details
(From sheets 12 and 13)

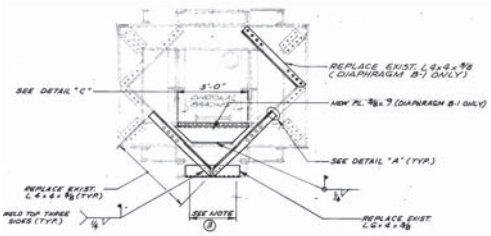


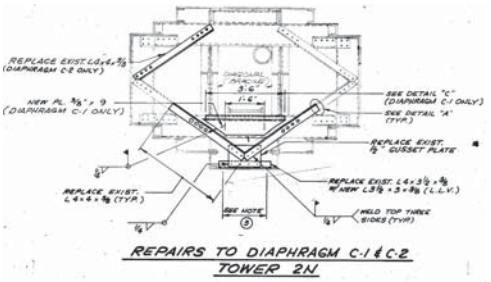




1982 Repairs Details
(From sheet 7)







Notes:
Most of the interior sections are made up of C12x25 and L4x4x3/8 members, and some previous C12x25 members have been replaced with C12x20.7 members, however the perimeter between these members differs by only 0.01' so for practicality we will use the C12x25 perimeter.

By inspection the Diaphragm sections in towers 2-4 have only minor differences from those in towers 1&5, with the channel and angle members being nearly identical. Therefore it is reasonable to estimate that the Diaphragm A-D areas in towers 2-4 are the same as towers 1&5

Diaphragm A Area = 52.20ft^2

Diaphragm B Area = 82.10ft^2

Diaphragm C Area = 93.13ft^2

Diaphragm D Area = 80ft^2

Tower Area Calculations

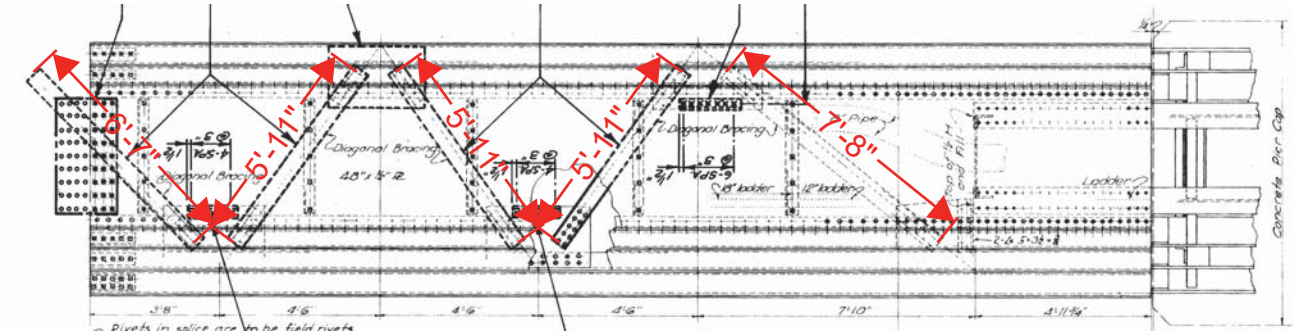
Towers 2-4 Interior Area Calculations

By: KAC

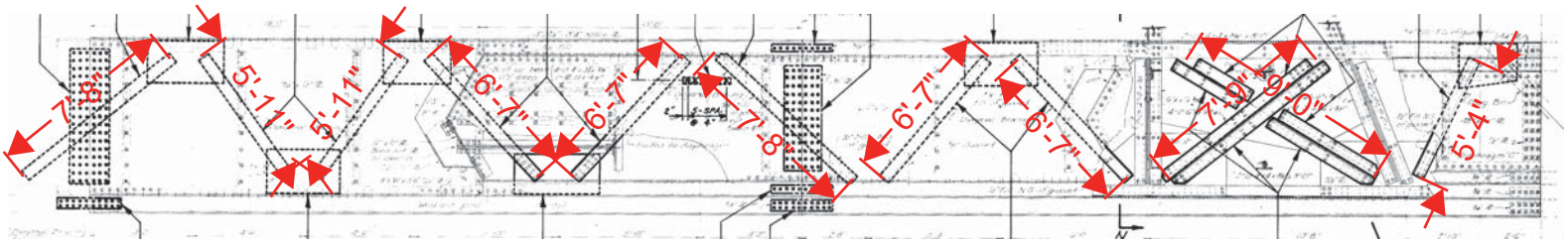
Date: 3/4/2019

Checked: VTD

Date: 3/8/2019



1986 CUY-10-0869 Tower Repair Plans - Sheet 15



1986 CUY-10-0869 Tower Repair Plans - Sheet 12

Notes:
Tower interiors are braced diagonally by L6x4x3/8 members (one on each side), with Towers 2-4 having a 2L6x6x3/8 cross bracing approximately 38' up the section at the location of the Tower Strut.

Towers 2-4 have 14 angle braces on each side with varying lengths with a double angle cross bracing member at the Tower Strut location.

L6x4x3/8 Perimeter = 2 x 6" + 2 x 4" = 20" = **1.67'**

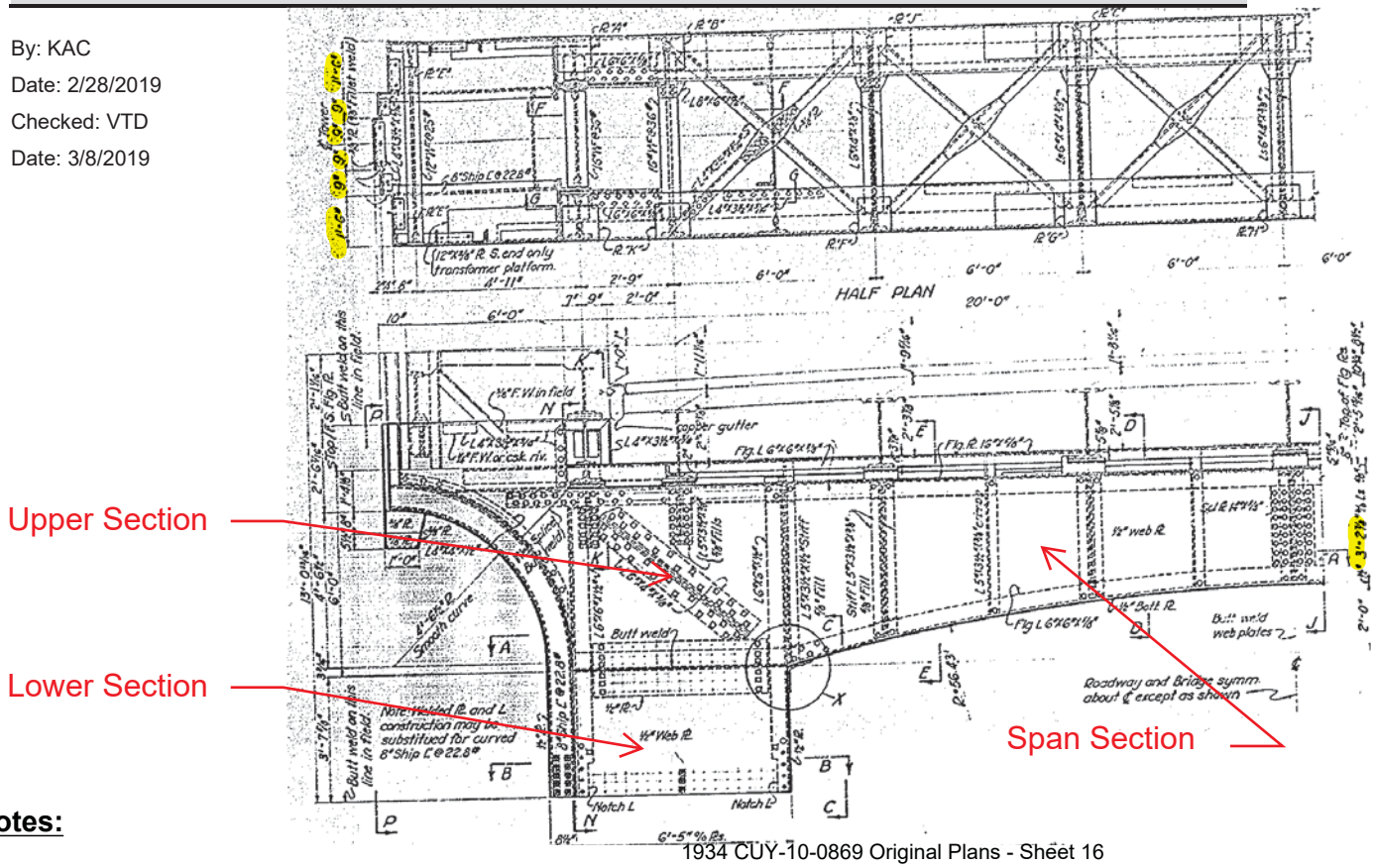
2L6x6x3/8 Perimeter = 2 x 12" + 2 x 6" = 36" = **3'**

Diagonal Bracing Area Calculations:
Diagonal Bracing Area = Sum of Angle Lengths x 2 x Member Perimeter + Cross Bracing Length x Cross Bracing Perimeter
Sum of Angle Lengths = (5'-11") x 5 + (7'-8") x 3 + (6'-7") x 5 + (5'-4")
Sum of Angle Lengths = 29.58' + 23' + 32.92' + 5.33' = 90.83'
Cross Bracing Length = 7'-9" + 9'-0" = 16.75'
Diagonal Bracing Area = (90.83' x 2 x 1.67') + (16.75' x 3')
Diagonal Bracing Area = 353.62ft^2

Tower Area Calculations

Tower Girders 1&5 Calculations

By: KAC
Date: 2/28/2019
Checked: VTD
Date: 3/8/2019



1934 CUY-10-0869 Original Plans - Sheet 16

Notes:

The Tower Girder section is divided between a lower tower section, an upper tower section, and the section where the girder spans between the towers.

Average height of the Span Section = (5.24' + 3.24' + 5.24')/3 = 4.58'

We conservatively estimate the interior area of the tower girders as being equal to the exterior area times 1.10 (10% increase to account for extra interior members)

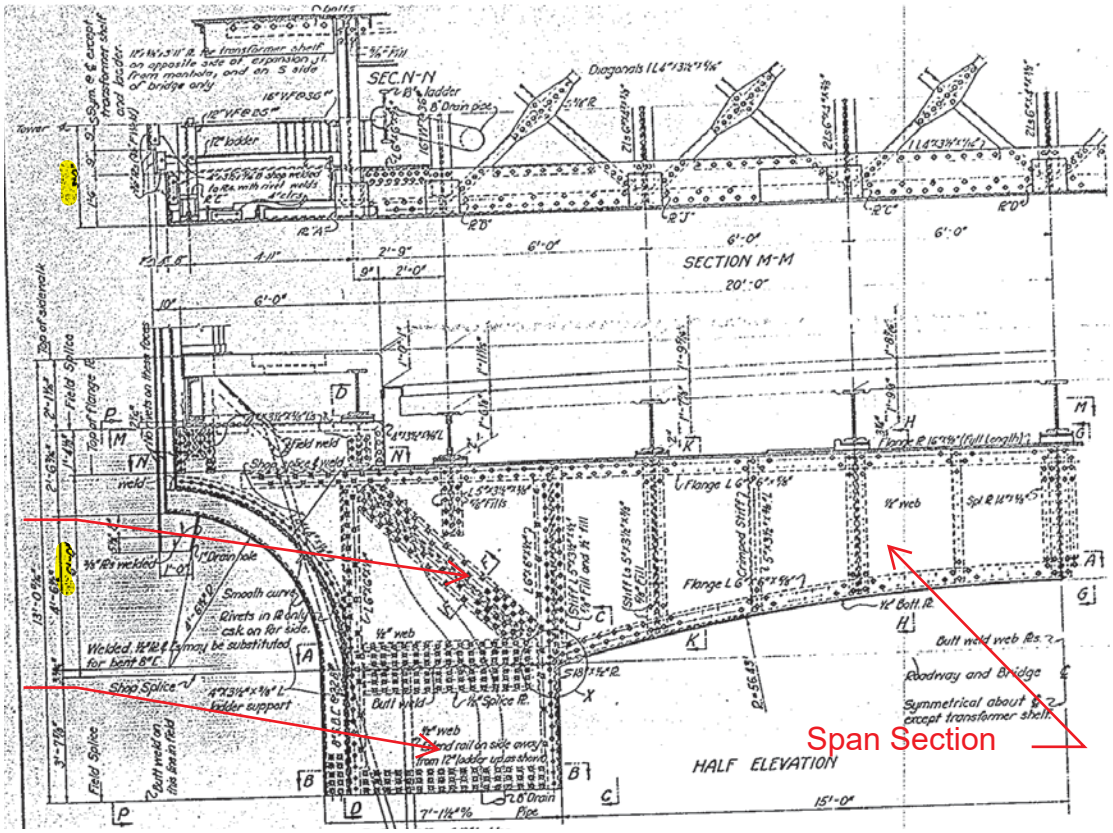
Exterior Area Calculation:
Lower Section Perimeter = (2 x 7.125') + (2 x 6') = 26.25'
Lower Section Length = 3.64'
Upper Section Perimeter = 2 x 7.125' = 14.25'
Upper Section Length = 5.24'
Span Section Perimeter = (2 x 4.58') + (2 x 6') = 21.16'
Span Section Length = 30'
Tower Girders 1&5 Exterior Area = (26.25' x 3.64') + (14.25' x 5.24') + (21.16' x 30')
Tower Girders 1&5 Exterior Area = 805.22ft^2

Interior Area Calculation:
Tower Girders 1&5 Interior Area = Exterior Area x 1.10 = 805.22ft^2 x 1.10
Tower Girders 1&5 Interior Area = 885.75ft^2

Tower Area Calculations

Tower Girders 2-4 Calculations

By: KAC
Date: 2/28/2019
Checked: VTD
Date: 3/8/2019



1934 CUY-10-0869 Original Plans - Sheet 14

Notes:

The Tower Girder section is divided between a lower tower section, an upper tower section, and the section where the girder spans between the towers.

Average height of the Span Section = (6' + 3.91' + 6')/3 = 5.31'

We conservatively estimate the interior area of the tower girders as being equal to the exterior area times 1.10 (10% increase to account for extra interior members)

Exterior Area Calculation:
Lower Section Perimeter = (2 x 7.125') + (2 x 6') = 26.25'
Lower Section Length = 3.64'
Upper Section Perimeter = 2 x 7.125' = 14.25'
Upper Section Length = 6'
Span Section Perimeter = (2 x 5.31') + (2 x 6') = 22.62'
Span Section Length = 30'
Tower Girders 2-4 Exterior Area = (26.25' x 3.64') + (14.25' x 6') + (22.62' x 30')
Tower Girders 2-4 Exterior Area = 859.65ft^2

Interior Area Calculation:
Tower Girders 2-4 Interior Area = Exterior Area x 1.10 = 859.65ft^2 x 1.10
Tower Girders 2-4 Interior Area = 945.62ft^2

Tower Area Calculations

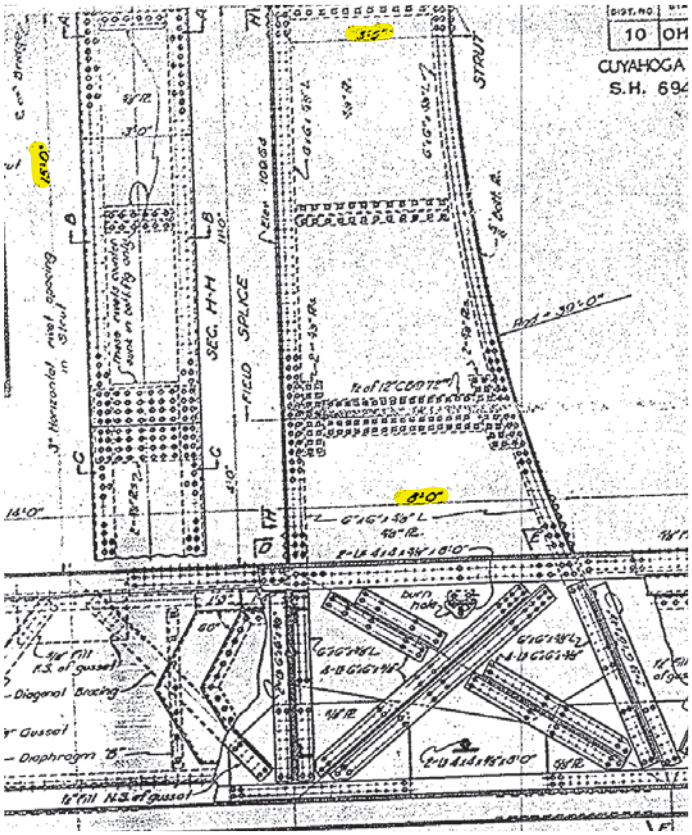
Tower Strut Calculations

By: KAC

Date: 2/28/2019

Checked: VTD

Date: 3/8/2019



1934 CUY-10-0869 Original Plans - Sheet 13

Notes:

Average height of the tower strut = (8'-0" + 5'-0" +8'-0")/3 = 7.0'

Towers 1&5 do not have Tower Struts

We can conservatively estimate the interior area of the tower struts as being equal to the exterior area times 1.05 (5% increase to account for extra interior members)

Exterior Area Calculation:
Tower Strut Perimeter = (2 x 7.0') + (2 x 3') = 20'
Tower Strut Exterior Area = 20' x 30'
Tower Strut Exterior Area = 600ft^2

Interior Area Calculation
Tower Strut Interior Area = Exterior Area x 1.05
Tower Strut Interior Area = 600ft^2 x 1.05
Tower Strut Interior Area = 630ft^2

Tower Area Calculations

Towers 1&5 Total Quantities

By: KAC
Date: 3/4/2019
Checked: VTD
Date: 3/8/2019

Towers 1&5 Total Exterior Area to be Painted (per tower):

Component	Area to be Painted (ft^2)
Lower Section Exterior Area	947.47
Upper Section Exterior Area	825.93
Total Exterior Tower Area (For 1 tower)	**1773.40**
Tower Girder Exterior Area	**805.22**

Towers 1&5 Total Interior Area to be Painted (per tower):

Component	Area (ft^2)	Quantity	Area to be Painted (ft^2)
Lower Section Interior Area	1042.22	1	1042.22
Upper Section Interior Area	908.52	1	908.52
"Diaphragm A" Area	52.20	4	208.80
"Diaphragm B" Area	82.10	5	410.50
"Diaphragm C" Area	93.13	1	93.13
"Diaphragm D" Area	80.00	1	80.00
Diagonal Bracing Area	218.50	1	218.5
Total Interior Tower Area (For 1 tower)			**2961.67**
Tower Girder Interior Area			**885.75**

Tower Area Calculations

Towers 2-4 Total Quantities

By: KAC
Date: 3/4/2019
Checked: VTD
Date: 3/8/2019

Towers 2-4 Total Exterior Area to be Painted (per tower):

Component	Area to be Painted (ft^2)
Lower Section Exterior Area	1027.5
Upper Section Exterior Area	1771.43
Total Exterior Tower Area (For 1 tower)	**2798.93**
Tower Strut Exterior Area	**600.00**
Tower Girder Exterior Area	**859.65**

Towers 2-4 Total Interior Area to be Painted (per tower):

Component	Area (ft^2)	Quantity	Area to be Painted (ft^2)
Lower Section Interior Area	1130.25	1	1130.25
Upper Section Interior Area	1948.57	1	1948.57
"Diaphragm A" Area	52.20	4	208.80
"Diaphragm B" Area	82.10	4	328.40
"Diaphragm C" Area	93.13	6	558.78
"Diaphragm D" Area	80.00	1	80.00
Diagonal Bracing Area	353.62	1	353.62
Total Interior Tower Area (For 1 tower)			**4608.42**
Tower Strut Interior Area			**630.00**
Tower Girder Interior Area			**945.62**