LONG CONTINUOUS BRIDGE DECK EVALUATION JOHN DAY RIVER BRIDGE CLATSOP COUNTY Bridge No. 1827B

Final Report

Experimental Features Project OR 88-04

by

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prepared for

FEDERAL HIGHWAY ADMINISTRATION
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16. Abstract

The John Day River Bridge, near Astoria, Oregon was built with a continuous deck length of 1,105 ft. (340 m). The rationale for designing the John Day River Bridge with an unusually long continuous deck is in part based on the site's very mild climate. Overall temperature changes in the deck are in the range of 50°F (28°C). The objective was to monitor and evaluate the impacts which may result from expansion, contraction, or shrinkage of the bridge deck. This bridge has shown no significant signs of distress which may be related to expansion/contraction of the bridge deck. Deck measurements show that the bridge has not expanded or contracted more the anticipated amount.

In the future, if the long continuous bridge deck design is considered, recommendations include:

1) locating the bridge on stable fill,
2) providing for controlled cracking, and
3) providing for expansion, contraction or shrinkage between the bridge ends and the impact panels.

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Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

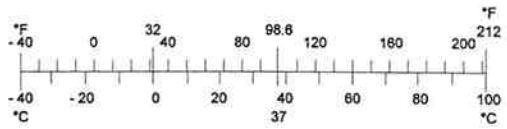
SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8 + 32	Fahrenheit	°F



* SI is the symbol for the International System of Measurement

(4-7-94 jbp)

ACKNOWLEDGEMENTS

The author wishes to thank project manager Tom Falls, his crew and Region 2 Bridge Inspector Jeff Swanstrom for their active role in taking measurements and providing quality inspection reports. Thanks are also extended to Marty Laylor, and Jerry Bellin for reviewing this report.

DISCLAIMER

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Long Continuous Bridge Deck Evaluation

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1.0 INTRODUCTION

1.1 BACKGROUND

The John Day River Bridge, near Astoria, Oregon, was built with a continuous deck length of 1,105 feet (340 m). Oregon's only other long continuous deck is the Nehalem River Bridge on the Oregon Coast Highway. Its continuous length is comparable to that of the John Day River Bridge, and no signs of distress related to expansion/contraction effects have been observed. This study was done because no formal study was performed on the Nehalem River Bridge. In addition, post tensioned box girders were used on the Nehalem Bridge and precast prestressed girders were used on the John Day Bridge.

The rationale for designing the John Day River Bridge with an unusually long continuous deck is in part based on the site's very mild climate. Overall temperature changes in the deck are in the range of 50°F (28°C). Also, thermal and shrinkage forces were not considered a problem because of the flexible foundation material, and the belief that the pile-supported bents would allow enough movement to accomodate the expected creep shortening and thermal length changes.

1.2 OBJECTIVES

The objective is to monitor and evaluate the impact of expansion, contraction, and shrinkage of the superstructure. Information from observations of this structure will provide a basis for future design decisions regarding the allowable continuous length of a bridge.

The following were identified in the workplan to help guide the inspection process:

1) Cracking of the concrete deck

2) Damage to approach fill or pavement

3) Cracking or distress at the piers and the bridge end panels.

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2.0 PROJECT LOCATION

The John Day River Bridge (Bridge No. 1827B) is located on the Columbia River Highway, Hwy. 30 (OR Route No. 2W) in Clatsop County. It is an 8-span prestressed concrete beam superstructure on single column interior bents. The total length of the bridge is 1,105 feet (340 m) with no intermediate deck expansion joints. Figure 2.1 is a vicinity map showing the project location. General bridge design drawings are in Appendix A.

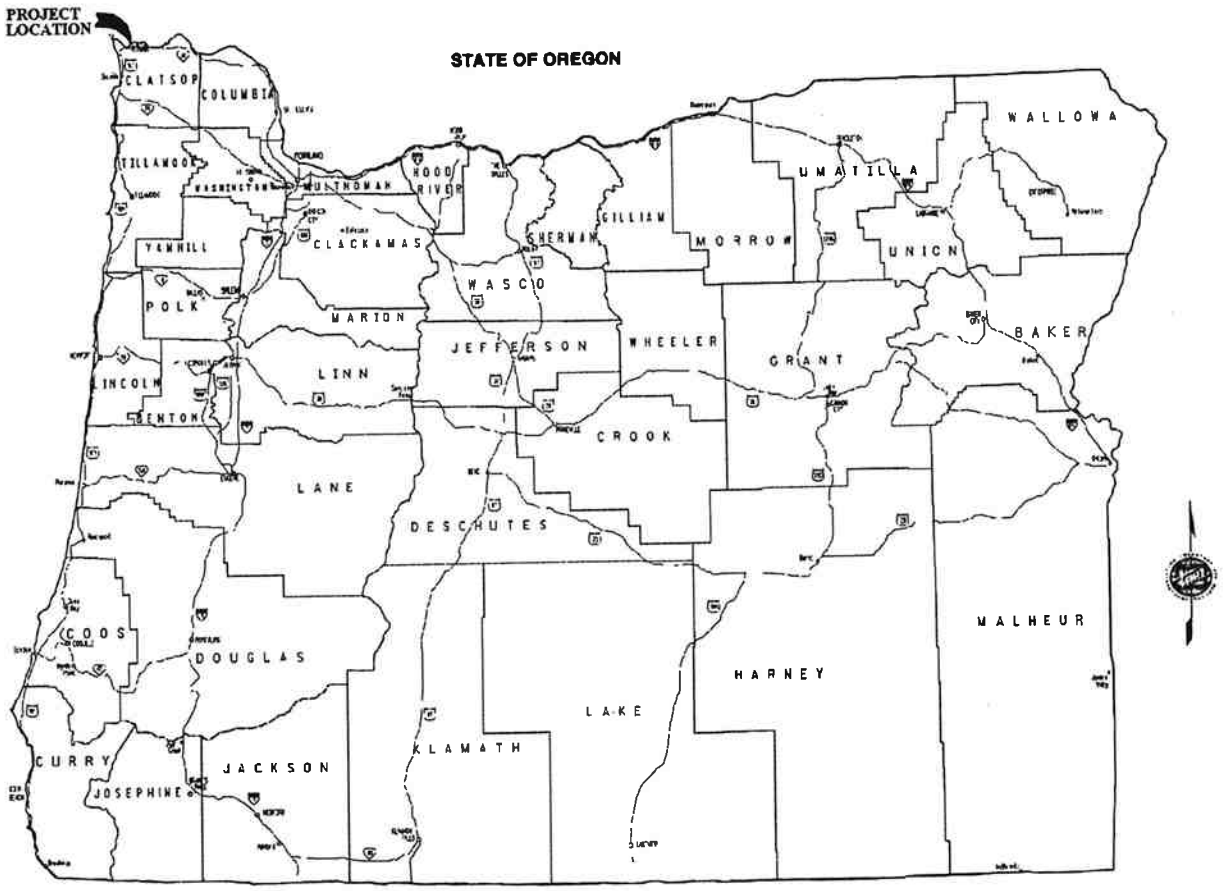

Figure 2.1 Project Location

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3.0 EVALUATION

3.1 CONSTRUCTION

Inspection of the pavement, after construction, at each end of the impact panel showed considerable movement of the structure which caused the pavement to break up and separate from the bridge end panels prior to and after the final wearing course was laid. Also, a considerable amount of settlement of the fill occurred at the east end of the structure.

Cracking was also noticed at each bent. This cracking could have been partly related to the specified construction technique. The deck pour could only be stopped at Bent 1 or 9 or over an intermediate diaphragm beam. The specifications should probably have indicated that the pours should start and end just short of the center of the bents. Then closure pours should have been made. This would have allowed the deck to deflect to its final position before the material over the bents was placed. Thus, possibly, reducing the tendency to bend and crack the material over the bents. The cracks were also a result of live load negative moment resisted unsuccessfully by the deck.

These cracks were sealed using a methacrylate by Revolan® Systems as shown in Figure 3.1. Several applications were made at various times and the cracks seem to have been closed to moisture.

3.2 DECK MEASUREMENTS

Monuments were established to monitor the movement of the structure. The monitor line was established between the southerly fog line and the concrete bridge rail. Two reference monuments were established at each end of the monitor line. The Easterly reference monument is located on the shoulder of the county road 2620.39 feet (798.69 m) from Bent 5. The Westerly monument is located between double power poles 4392.16 feet (1338.73 m) from Bent 5. Measurements were made by measuring the distance in each direction from Bent 5 and running a level circuit over the monuments. The base measurement was taken at the first seasonal extreme following construction. Subsequent measurements were taken at 6 month intervals for approximately three years.

According to FHWA Technical Advisory T 5140.13, movement of 1/2 inch (12.7 mm) per 100 feet (30.5 m) of structure in moderate climate conditions (temperature range of 70°F or 39°C) is a reasonable value. These values assume no effect from shrinkage and long-term creep. The John Day River Bridge initially lengthened 0.11 feet (34 mm), with Bent 9

moving 0.06 feet (18 mm) to the east and Bent 1 moving 0.05 feet (15 mm) to the west. The structure then shortened 0.09 feet (27 mm), with Bent 9 moving 0.08 feet (24 mm) west of the original location and Bent 1 moving 0.01 feet (3 mm) east of its original location. The initial lengthening movement was caused by temperature changes. Creep caused by the prestressed beams makes it difficult to tell whether the shortening that occurred later was caused by temperature changes. By design, Bent 1 is stiffer than Bent 9, which is indicated by noticing that Bent 1's total movement was less than Bent 9's total movement.

Deck elevations varied from 0.04 feet (12 mm) higher to 0.13 feet (40 mm) lower than the base elevations at each bent. More detailed information about the measurements are contained in Appendix B.

Figure 3.1: Sealed Cracks at the North Side of Bent 3

3.3 VISUAL INSPECTIONS

Although, no significant signs of distress in the superstructure were observed during the visual inspections, severe distress was observed at the end panel. Visual inspections were conducted approximately every six months after construction. They consisted of:

1) checking for pavement buckling or other expansion effects at the end of each impact panel,

2) looking for cracking and other signs of distress at the column/superstructure interface, and

3) looking for cracking in the deck.

Differential settlement was discovered between the bridge's east endwall and approach impact panel. This settlement and the movement of the deck due to bridge shortening at Bent 9 caused the impact panel to pull away from the bridge deck, allowing water to enter the fill. The water scoured the sandy soil, leaving a large void under the impact panel. In June of 1993 the impact panel was reconstructed.

Transverse cracks have appeared in the bottom of the deck overhang over each bent cap and continue to the edge of the deck under the bridge railing. The edges of the cracks are reasonably sound. Small cracks are also occurring at midspan were the diaphragm beams are located.

Transverse cracks on the deck surface range from hairline to 1/4 inches (6.4 mm) as shown in Figure 3.2. They are located at each bent and have raveling severity levels from low to moderate. Cracks have not been noticed at the midspans. All bridges of this type have transverse cracks regardless of the total structure length.

The bearing pads on each bent nearest both approaches indicate movement has occurred between the prestressed beams and the substructure. Instead of being vertical, the edges of the pads are displaced in a way such that an obtuse angle exists in the direction of the bridge ends. This pad displacement was expected. It is due to the creep shortening of the superstructure.

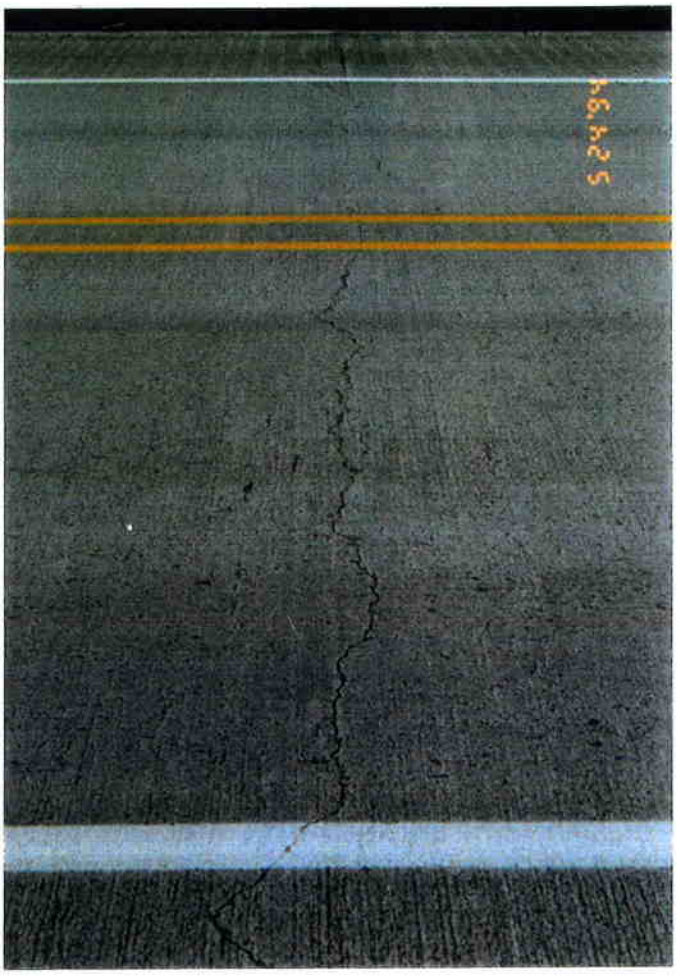


Figure 3.2: Transverse Cracks on Deck Surface at Bent 8

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

The John Day River Bridge has shown no significant signs of distress which may be related to expansion/contraction of the bridge deck. There is distress between the bridge end panels and the impact panels. Deck measurements show that the bridge has not expanded or contracted over the 1/2 inch (13 mm) over 100 feet (31 m) that is considered reasonable. Deck cracking has occurred over the bents, which was expected. Some of the cracking could have possibly been avoided if the contractor had used deck closure pours.

4.2 RECOMMENDATIONS

In the future, if the long continuous bridge deck design is considered, recommendations include:

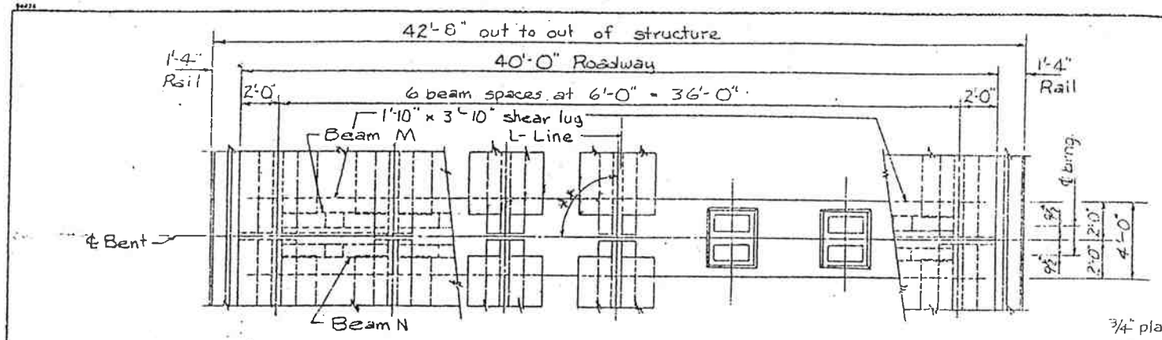
1) locating the bridge approach on stable fill,

2) providing for controlled cracking over the bents, and

3) providing for expansion, contraction or shrinkage between the bridge ends and the impact panels.

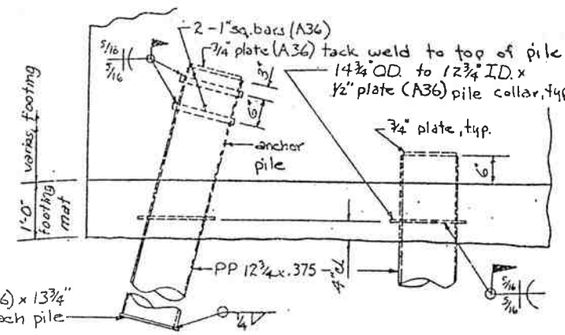
APPENDIX A

Bridge Drawings



PLAN BENT 2 & 8

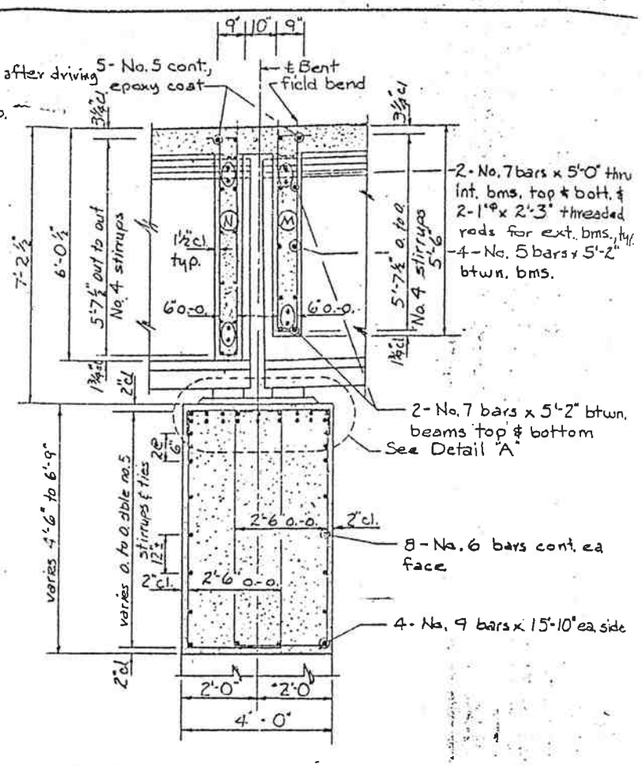
** 90° Bent 2, 89° 18' 17" Bent 8



ANCHOR PILE DETAIL AND PILE COLLAR DETAIL

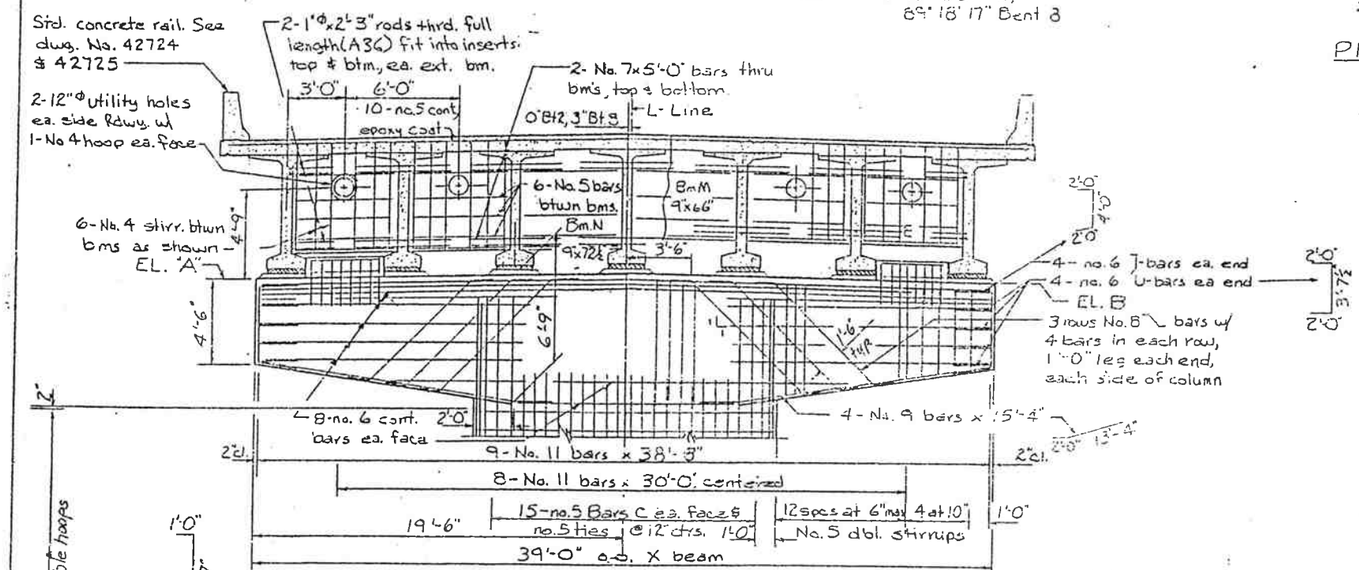
Scale: 3/4" = 1'-0"

(reinforcing steel not shown)



TYPICAL SECTION BENT 2 & 8

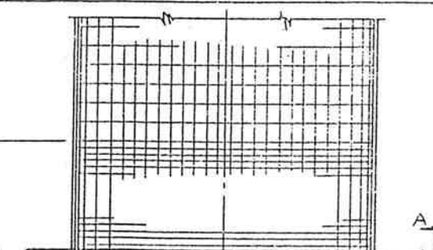
Scale: 1/2" = 1'-0"



TYP. ELEVATION ~ BENTS 2 & 8

Scale: 1/4" = 1'-0"

NOTE: Bent 2, 3, 6, 7 & 8 footings shall be poured on a 1'-0" deep footing mat. Footing mat shall attain 3300 psi design strength before pouring footing.



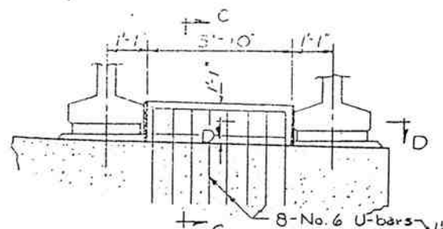
COLUMN STEEL (EA. COL.)

56 - No. 11 vert. col. bars full length with std. 90° hk at bottom. Stop 12" from top of x-bm.
No. 4 dbl. hoops @ 4" & 12" ctrs.
No. 4 ties @ 12" vert. ctrs.
See dwg. No. 43409 for TIE BAR DETAIL.

NOTE: See dwg. No. 43409 for TYP. COLUMN SECTION and dwg. No. 43408 for TYP. FOOTING PLAN

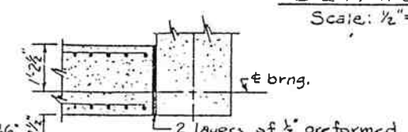
1 - anchor pile each corner (total - 4). See ANCHOR PILE DETAIL.
No. 5 U-bars w/ 12" legs @ 12" ctrs. all around footing. See dwg. No. 43408 for VIEW A-A

BENT ELEVATIONS				
BT.	El. "A"	El. "B"	El. "C"	El. "D"
2	31.75	31.75	5.0	1.5
8	26.41	27.69	6.0	2.5



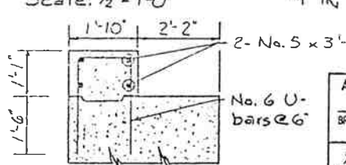
SHEAR LUG DETAIL

Scale: 1/2" = 1'-0"



SECTION D-D

Scale: 1/2" = 1'-0"



SECTION C-C

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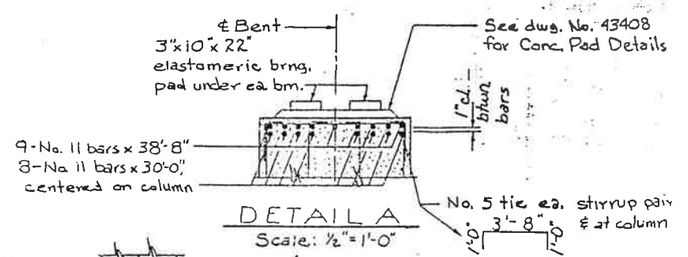


DETAIL A

Scale: 1/2" = 1'-0"

Note: Field bend X-beam stirrups

NOTE
THE SCALE OF THIS PRINT IS 1/2 THAT OF THE ORIGINAL DRWG
FOR EXAMPLE:
INDICATED SCALE 3" = 1'-0"
SHOULD BE READ 1 1/2" = 1'-0"
INDICATED SCALE 1" = 10'-0"
SHOULD BE READ 1/2" = 10'-0"

APPROVED: _____ PE
BRIDGE ENGINEER
PE NO. 3895
DESIGNED
PE NO. 5246
G. BELLIN
DRAWN
P. Rabb
CHECKED
O.M. Parent
REVIEWED
PE NO. _____
J. E. Backstrand
REVIEWED

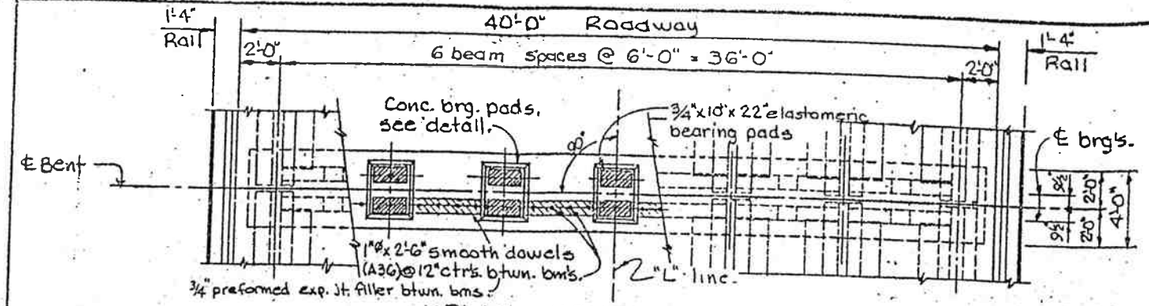
DATE	REVISION	BY

OREGON DEPARTMENT OF TRANSPORTATION
BRIDGE DESIGN SECTION

JOHN DAY RIVER BRIDGE

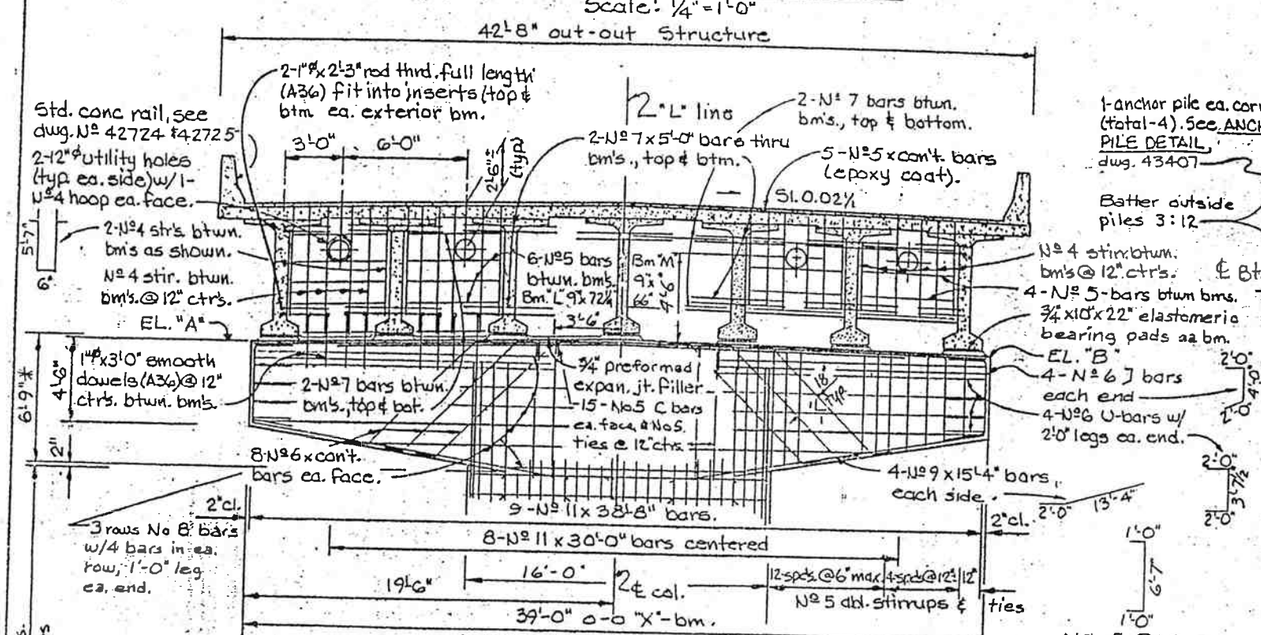
BENT 2 & 8 DETAILS

DATE JULY 1987 CALC. BOOK 23-54 SHEET 12 OF 23
BRIDGE NO. 1827B DRAWING NO. 43407



PLAN ~ BENTS 2, 6 & 8

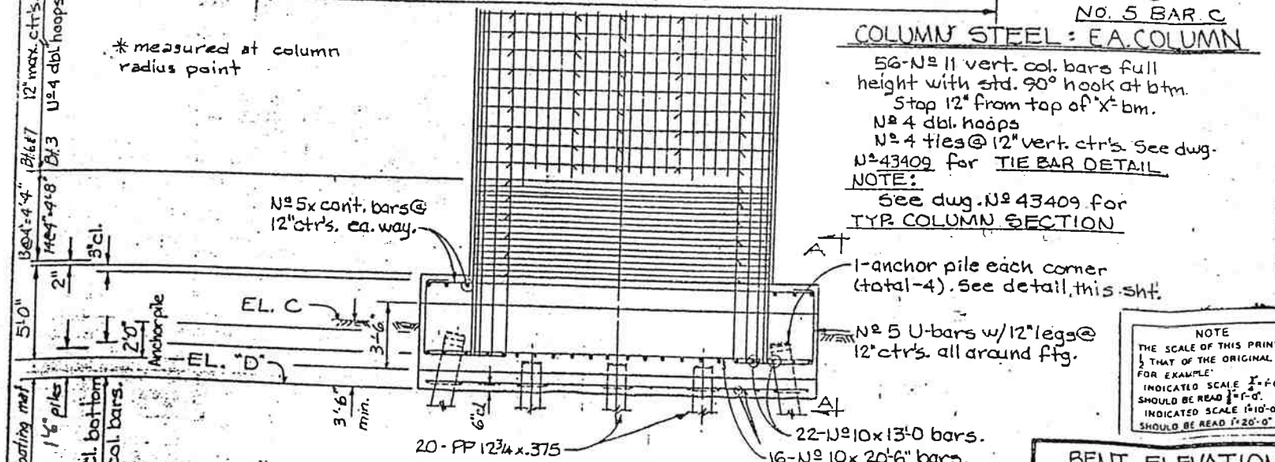
Scale: ¼" = 1'-0"



COLUMN STEEL: EA. COLUMN

56-Nº 11 vert. col. bars full height with std. 90° hook at btm. Stop 12" from top of "X" bm.
Nº 4 dbl. hoops
Nº 4 ties @ 12" vert. ctr's. See dwg. Nº 43409 for TIE BAR DETAIL

NOTE:
See dwg. Nº 43409 for TYP. COLUMN SECTION



TYP. ELEVATION ~ BENTS 3, 6 & 7

Scale: ¼" = 1'-0"

NOTE: See footing note on dwg. no. 43407.

BENT ELEVATIONS				
BT.	EL. "A"	EL. "B"	EL. "C"	EL. "D"
3	34.28	34.28	4.0	0.5
6	33.58	33.58	5.5	2.0
7	30.82	30.89	2.0	-1.5

NOTE
THE SCALE OF THIS PRINT IS ½ THAT OF THE ORIGINAL DRWG.
FOR EXAMPLE:
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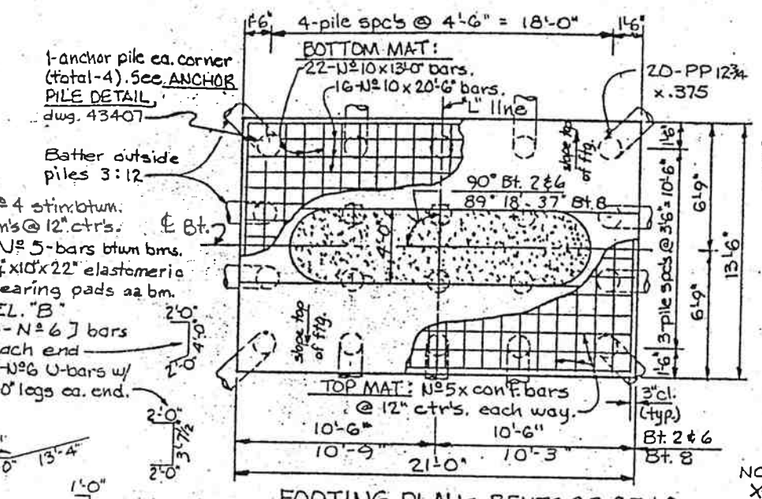
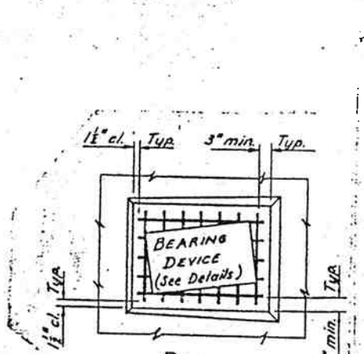
INDICATED SCALE 1"=10'-0" SHOULD BE READ 1"=20'-0"

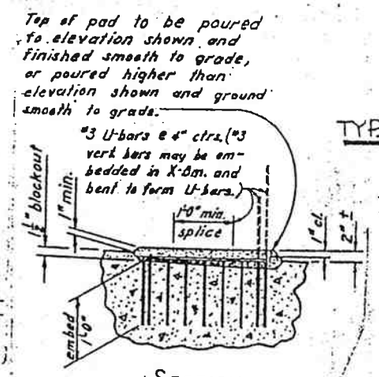


FOOTING PLAN ~ BENTS 2,3,6,7 & 8



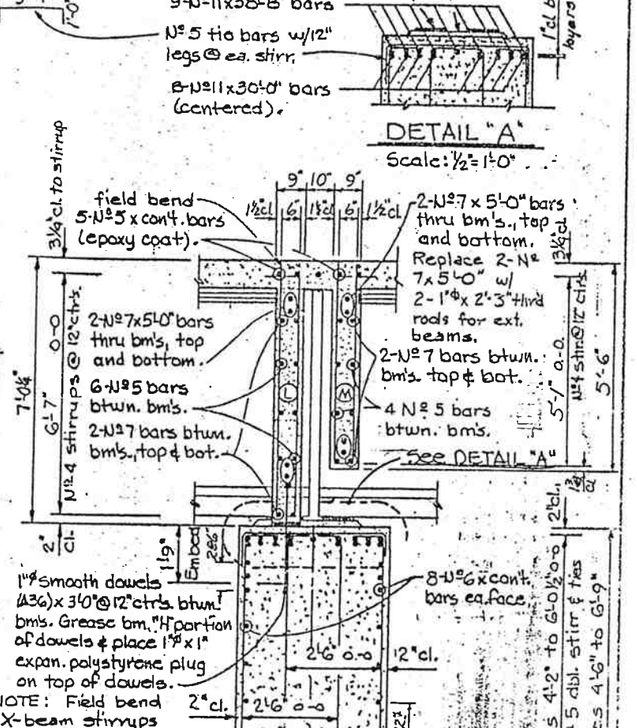
PLAN

Top of pad to be poured to elevation shown and finished smooth to grade, or poured higher than elevation shown and ground smooth to grade.



SECTION

TYPICAL CONCRETE PAD



TYP. "X" BM. SEC. ~ BT'S 3, 6 & 7

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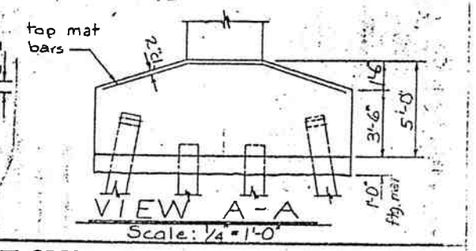

VIEW A-A

Scale: ¼" = 1'-0"

OREGON DEPARTMENT OF TRANSPORTATION
BRIDGE DESIGN SECTION

JOHN DAY RIVER BRIDGE

BENTS 3, 6 & 7 ~ DETAILS

APPROVED
Walter K. Hunt PE
BRIDGE ENGINEER PE NO. 3525
DESIGNED H. A. Bollin PE NO. 5246
T. A. OHREN
DRAWN P. Rabb
CHECKED OM Forest
REVIEWED
REVIEWED J. E. Backstrand

DATE	REVISION	BY

DATE July 1987 CALC. BOOK 2354 SHEET 13 OF 23
BRIDGE NO. 1827B DRAWING NO. 43408

NOTE
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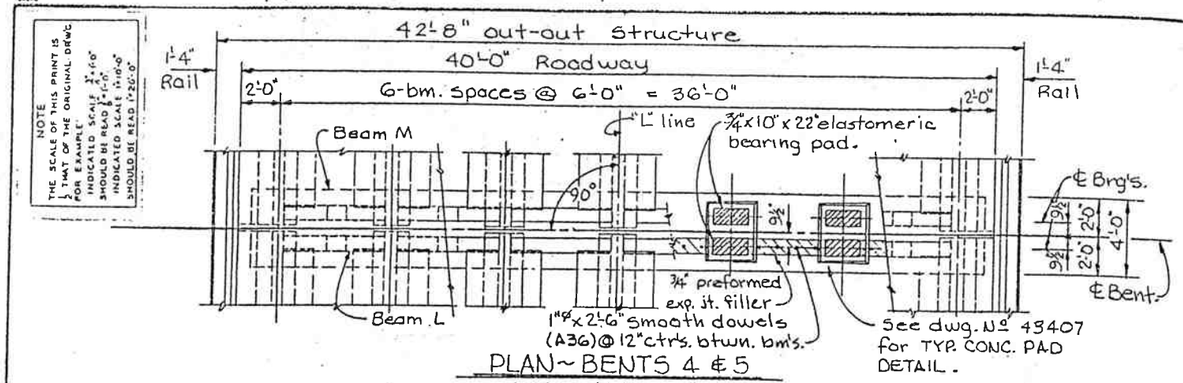
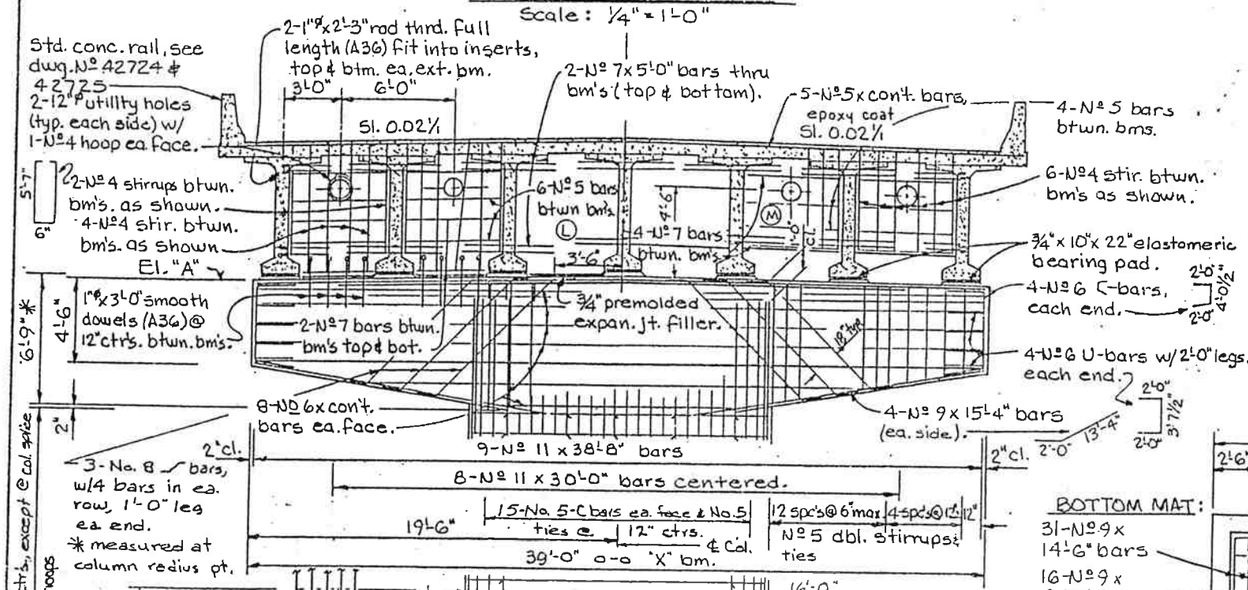
INDICATED SCALE 1"=10'-0" SHOULD BE READ 1/2"=5'-0"



PLAN ~ BENTS 4 & 5
Scale: ¼"=1'-0"



COL. BAR SPLICE DETAIL
Not to Scale

Note:
Seal is designed for a top of water elevation of +6.3

ELEVATION ~ BENTS 4 & 5
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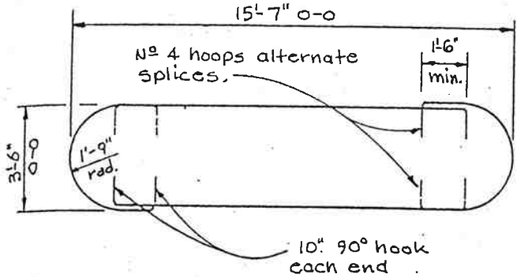
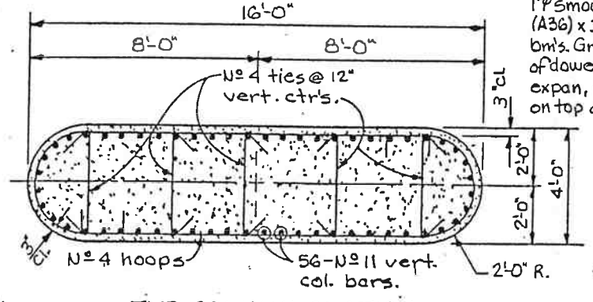


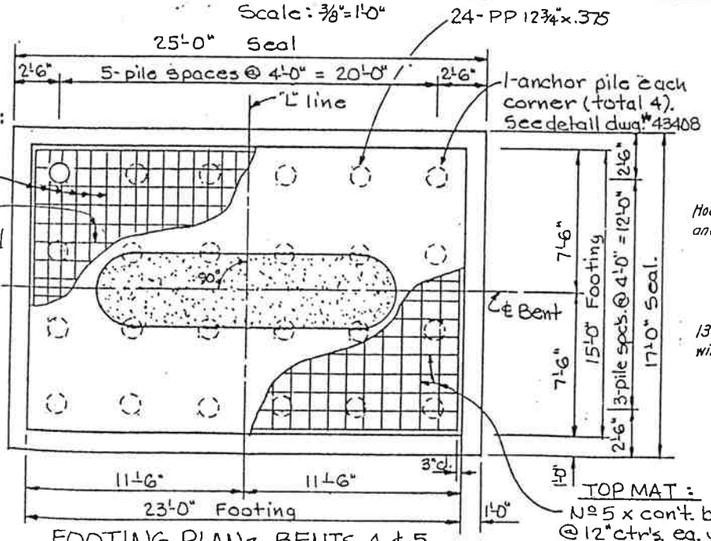
COL. HOOP DETAIL
Scale. ⅜"=1'-0"



TYP. COLUMN SECTION
Scale: ⅜"=1'-0"

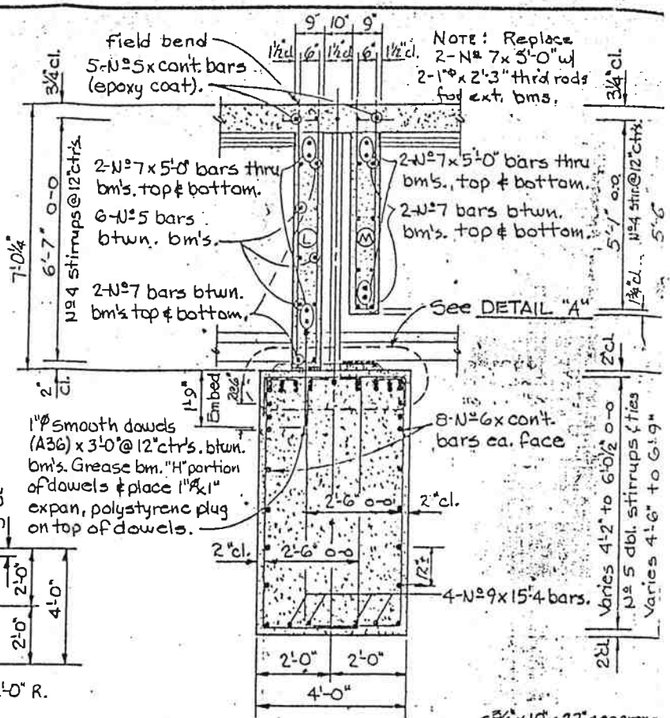
BOTTOM MAT:
31-No 9 x 14'-6" bars
16-No 9 x 22'-6" bars

COLUMN STEEL, EA. COLUMN
56-No 11 vert. col. bars full height with std. 90° hook at b'tm. Stop 12" from top of "X" bm.
No 4 hoops as shown.
Vertical column bars may be spliced (See COL. BAR SPLICE DETAIL). Only ⅓ of the bars may be spliced in any one plane.
No 4 ties @ 12" vert. ctr's.
1-anchor pile each corner (total -4). See detail dwg. #43407.

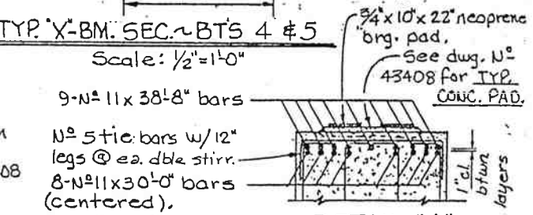


TOP MAT:
No 5 x con't bars @ 12" ctr's. ea. way.

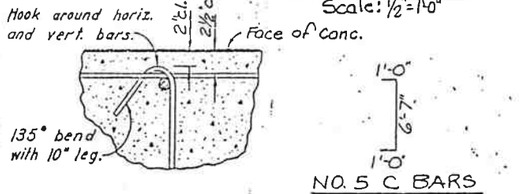
FOOTING PLAN ~ BENTS 4 & 5
Scale: ¼"=1'-0"



TYP. "X"-BM. SEC. ~ BTS 4 & 5
Scale: ½"=1'-0"



DETAIL - "A"
Scale: ½"=1'-0"



NO. 5 C BARS

TIE BAR DETAIL

NOTE: Field bend X-beam stirrups.

BENT ELEVATIONS

BENT	El. "A"	El. "B"	El. "C"
4	35.34	-12.±	-32.
5	35.10	-14.±	-32.

DATE	REVISION	BY

APPROVED
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BRIDGE ENGINEER
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Harold Bollin
DESIGNED
PE NO. 5246
T.A. OHREN
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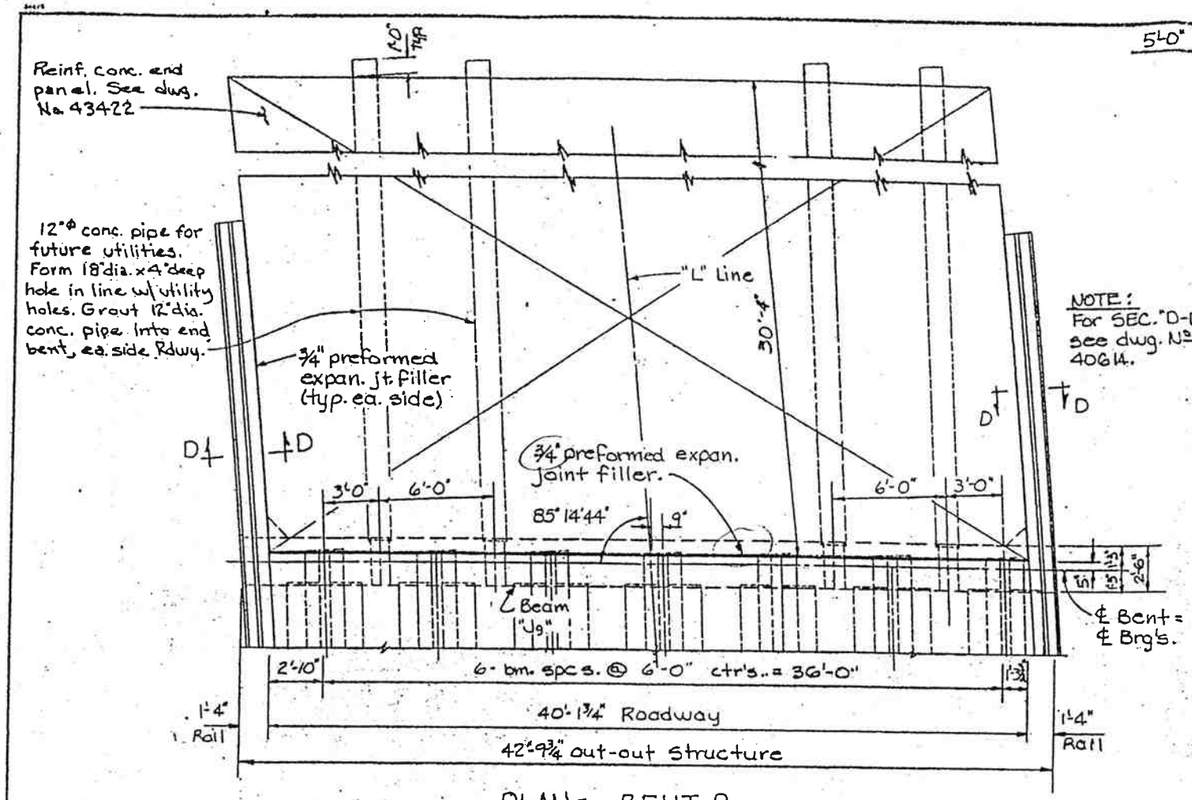
REVISED

OREGON DEPARTMENT OF TRANSPORTATION
BRIDGE DESIGN SECTION

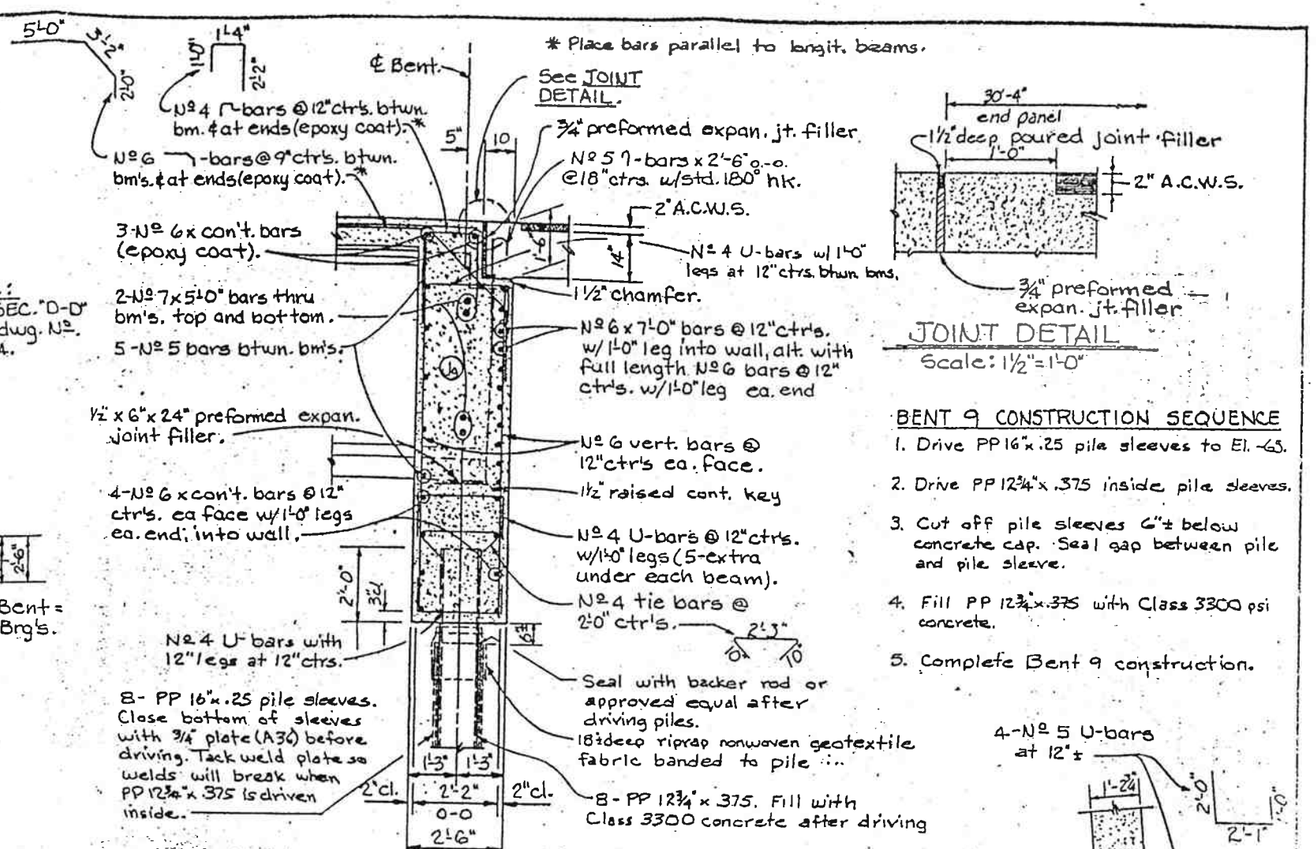
JOHN DAY RIVER BRIDGE

BENTS 4 & 5 ~ DETAILS

DATE July 1987 CALC. BOOK 2354 SHEET 14 OF 23
BRIDGE NO. 1827B DRAWING NO. 43409



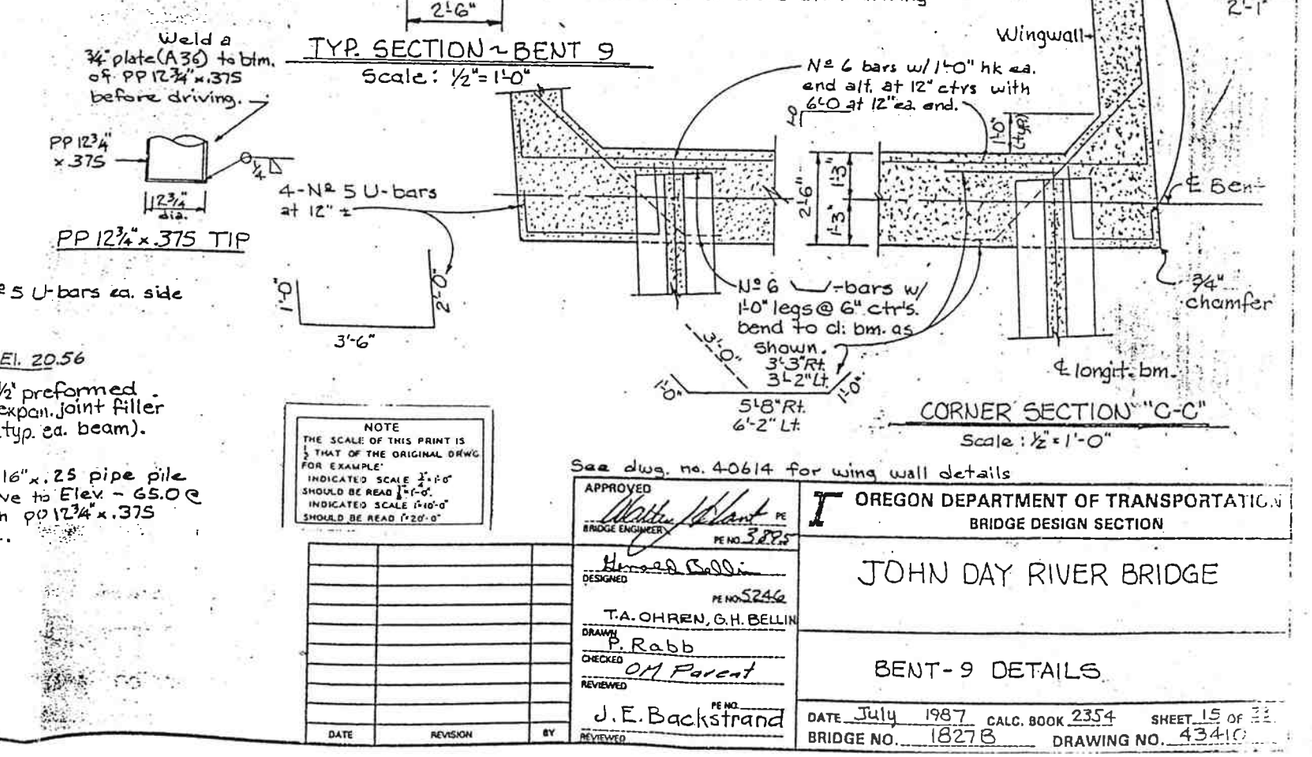
PLAN ~ BENT 9
Scale: 1/4" = 1'-0"



JOINT DETAIL
Scale: 1 1/2" = 1'-0"

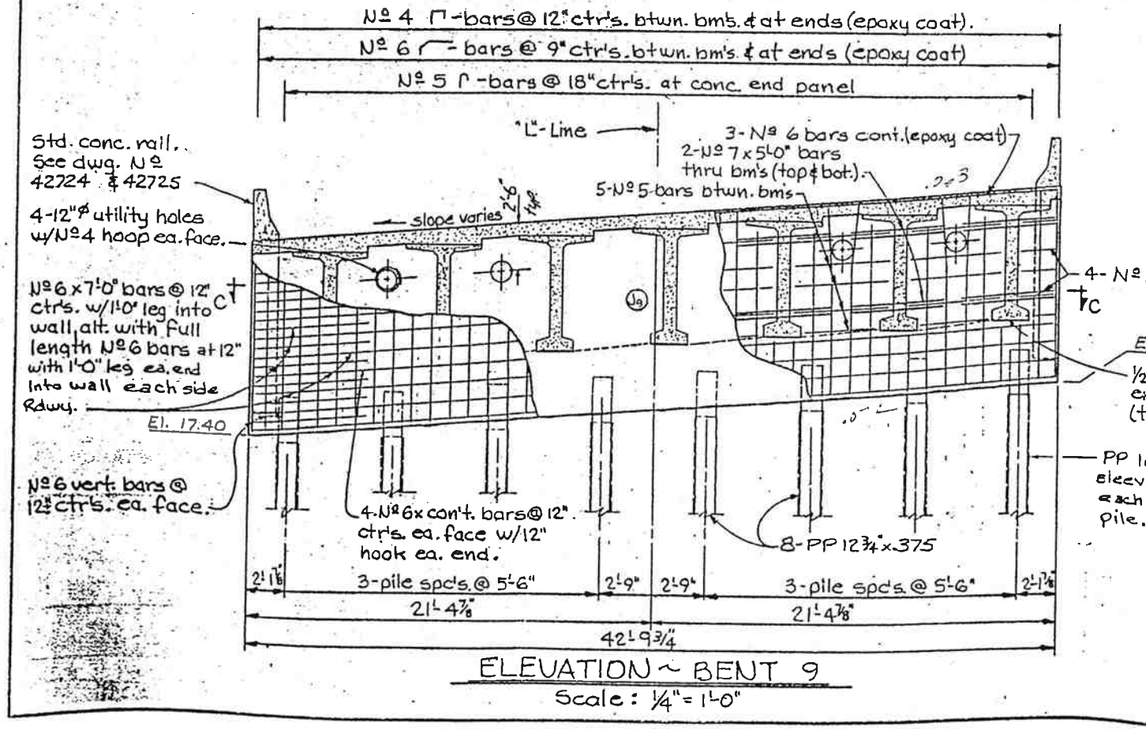
BENT 9 CONSTRUCTION SEQUENCE

1. Drive PP 16" x .25 pile sleeves to El. -65.
2. Drive PP 12 3/4" x .375 inside pile sleeves.
3. Cut off pile sleeves 6" ± below concrete cap. Seal gap between pile and pile sleeve.
4. Fill PP 12 3/4" x .375 with Class 3300 psi concrete.
5. Complete Bent 9 construction.



TYP. SECTION ~ BENT 9
Scale: 1/2" = 1'-0"

CORNER SECTION "C-C"
Scale: 1/2" = 1'-0"



ELEVATION ~ BENT 9
Scale: 1/4" = 1'-0"

NOTE
THE SCALE OF THIS PRINT IS 1/2 THAT OF THE ORIGINAL DRWG.
FOR EXAMPLE:
INDICATED SCALE 1/2" = 1'-0" SHOULD BE READ 1/4" = 1'-0".
INDICATED SCALE 1" = 10'-0" SHOULD BE READ 1" = 20'-0"

See dwg. no. 40614 for wing wall details

DATE	REVISION	BY

APPROVED
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PE NO. 5246
DRAWN: T.A. OHREN, G.H. BELLIN
CHECKED: P. Rabb
REVIEWED: OM Parent
REVIEWED: J.E. Backstrand
PE NO.

OREGON DEPARTMENT OF TRANSPORTATION
BRIDGE DESIGN SECTION

JOHN DAY RIVER BRIDGE

BENT - 9 DETAILS

DATE July 1987 CALC. BOOK 2354 SHEET 15 OF 22
BRIDGE NO. 18278 DRAWING NO. 43410

APPENDIX B

Deck Measurements

TABLE B-1: Length Measurements

	Base	1	2	3	4
Temp.	35˚F	55˚F	62˚F	55˚F	47˚F
Bent 1	549.95	549.99	550.00	549.94	549.94
Bent 5	0	0	0	0	0
Bent 9	555.18	555.22	555.24	555.16	555.10

TABLE B-2: Elevation Difference from Base Measurement

Temp.	67°F	44°F	63°F	62°F	55°F	46°F	47°F
BENT 1	-0.01	0	0	0	0	-0.01	0
	+0.02	+0.02	+0.03		+0.01	+0.01	+0.03
	+0.01	+0.01	+0.04	+0.01	0	-0.01	0
	-0.01	+0.01	+0.01	+0.03	+0.01	0	+0.01
	+0.01	+0.01	0		+0.01	0	0
	-0.01	0	0	+0.02	+0.01	0	0
BENT 5	0	-0.01	-0.01	0	-0.01	-0.02	-0.02
	-0.02	-0.01	+0.01	+0.03	+0.01	-0.02	0
	+0.02	0	+0.01	+0.02	+0.01	-0.02	0
	0	0	+0.02	+0.04	+0.02	0	0
	+0.01	0	0	+0.01	0	-0.02	-0.01
	-0.01	0	+0.01	+0.03	+0.01	0	-0.01
	0	0	-0.01	0	+0.01	-0.01	-0.02
	0	+0.01	+0.02	+0.03	+0.01	-0.02	-0.03
	+0.02	0	0	+0.01	0	-0.03	-0.03
	+0.01	0	+0.02	+0.01	-0.02	-0.06	-0.08
BENT 9	0	0	-0.02	-0.04	-0.06	-0.10	-0.13