

**BRUGG CABLE MESH
ROCKFALL FENCE**

CONSTRUCTION REPORT

Experimental Features
Project No. OR 90-03

Shellrock Mountain
Columbia River Highway (Interstate 84)
Hood River County
Federal Aid # IR-84-2(31) 052

by

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Project Geologist
Oregon Department of Transportation**

Prepared for

**Oregon Department of Transportation
Salem, Oregon 97310**

and

**Federal Highway Administration
Washington, D.C. 20590**

May 1992

ABSTRACT

The Brugg Cable Mesh Rockfall Fence was installed in 1991 along I-84 from MP 52.1 to 52.7 to prevent large (> 3 foot diameter) rocks from entering the travel lanes. This was one of the first major installations of the Brugg Cable Mesh Rockfall Fence in the United States and it was a FHWA experimental features project. The fence is a patented proprietary item and consists of cable mesh attached to H-beam posts that incorporate a friction brake. The fence was installed in the Columbia River Gorge Scenic Area; to minimize its visual impact, it was painted a dark earth tone.

The bid price of installing the fence was \$27.00 per square foot face. Even though this was the contractor's first installation, both the contractor and the Oregon Department of Transportation (ODOT) inspector considered the constructability very easy.

ACKNOWLEDGEMENTS

Recognition needs to be given to the numerous ODOT personnel involved with the development and construction of this experimental features project, especially Glen Fleming (Location Project Designer), Mary Goldberg (Final Project Design), and Marge West (Assistant Project Manager, Construction). I would also like to thank Rich Watanabe (ODOT Geotechnical Team Leader) and Ron Chassie (FHWA Geotechnical Engineer Region 8) for their time and consideration in reviewing this report.

DISCLAIMER

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This report does not constitute a standard, specification, or regulation.

Brugg Cable Mesh Rockfall Fence

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Brugg Cable Mesh Rockfall Fence

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1.0 INTRODUCTION

On a section of Interstate 84 (I-84), large boulders fall on to the travel lanes creating a significant safety hazard. A Brugg Cable Mesh Rockfall Fence was installed to eliminate this hazard. Since this was one of the first major installations of the Brugg Fence on a United States interstate highway and was also installed in an environmentally sensitive area, the project was designated as a Federal Highway Administration (FHWA) experimental features project. The evaluation of the construction, cost, visual impact, maintenance, and rockfall effectiveness will be documented in this report.

The Brugg Fence consists of cable mesh attached to steel H-beam posts with cables that incorporate a friction brake. This is then draped with gabion mesh to prevent smaller rocks from passing through the fence. The Brugg Cable Mesh Rockfall Fence is a patented proprietary item and all design standards, specifications, and plans for this project were provided by:

Brugg Cable Products, Inc.
R.R. 16 Box 197E 11 East Frontage Road
Santa Fe, New Mexico 87505

The cable mesh fence was installed from MP 52.1 to 52.7 along eastbound I-84, Columbia River Highway (Highway No. 2) as shown in Figure A.1. I-84 travels along the base of Shellrock Mountain in this area. Construction of the fence began at the end of April, 1991 and was completed in October, 1991.

2.0 BACKGROUND

Shellrock Mountain is a volcanic neck of dacite intrusive rock. Around the volcanic neck is a 1,500 foot high talus slope (Figure A.2). Due to natural erosion processes, one to three foot diameter rocks fall from the cliffs above the talus and roll down the talus slope.

A metal bin wall of varying heights was installed in 1964 along the shoulder to act as a rock fallout area (Figure A.3). It was only partially effective and approximately every two to three years one or more large diameter rocks entered the eastbound travel lanes of I-84. These events generally occurred where the existing rock fallout area was less than seven feet high. The Brugg Cable Mesh fence was installed along the top of the existing bin wall in areas where the existing rock fallout width and depth were inadequate.

This project is located in the Columbia Gorge Scenic Area. The Columbia River Gorge Commission must approve all highway designs in this area, therefore, the appearance of the fence was very important. Remnant segments of the Historic Columbia River Highway exist behind the bin wall and it was critical that it was not damaged and future development impeded by the fence installation.

The criteria for selecting the Brugg Cable Mesh Fence over other mitigation options were the following:

1. Prevention of large diameter rocks from entering the I-84 travel lanes.
2. Maintenance and repair had to be low in cost and easily performed by maintenance crews.
3. Cost effective in comparison to other equally effective mitigation measures.
4. Minimal visual impact.
5. Constructable on top of the existing bin walls.
6. Minimal disruption to the existing talus slope environment.
7. No damage to or prevention of future development of the remnant segments of the Historic Columbia River Highway.

This construction report only evaluates items three through seven of these criteria.

3.0 DESIGN AND COSTS

3.1 DESIGN

The design and specifications for this experimental features project were provided by Brugg Cable Products and are given in Appendix B. The special provisions are given in Appendix C. The fence on this project was designed to withstand a rock impact energy of 75 ft.-tons. Achieving a minimum rock fallout area depth of ten feet determined the fence height.

The standard Brugg Cable Mesh Rockfall Fence design includes tieback anchors at each column with a friction brake. The tie-back anchors which are usually located on the up slope side of the fence, were eliminated from the fence at Shellrock Mountain because the tiebacks would have damaged and prevented future development of the remnant segments of the Historic Columbia River Highway. The strength of the fence columns and their brake away elements were increase to compensate for the loss of the tie-backs.

3.2 COSTS

The original total bid price for this project was \$468,882. There were only two contract bid items for this project (Appendix D). All components for fence installation were bid for square foot face of the fence, at \$27/ft². For payment purposes, estimates were made by the contractor for separate components of fence installation. These unit costs and quantities are presented in Table 3.1.

Table 3.1: Payment Estimates for Materials and Installations

ITEM	QUANTITY	UNIT COST	TOTAL COST
Footings	115 ea.	\$600/ea.	\$69,000
Columns	115 ea.	\$750/ea.	\$86,250
Fence	16,615 ft ²	\$17.656/ft ²	\$293,355
TOTAL			\$448,605

The final costs for the materials and installation of the Brugg Cable Mesh Rockfall Fence at Shellrock Mountain including the unanticipated costs are summarized in Table 3.2:

Table 3.2: Final Costs for Brugg Fence Installation			
ITEM	QUANTITY	UNIT COST	TOTAL COST
Entire fence installation	16,615 ft ²	\$27/ft ²	\$448,605
Temporary protection and direction of traffic			\$49,393
Unanticipated costs - Additional excavation required to provide permanent access behind wall and paint gabion mesh			\$4,970
TOTAL			\$502,968

There were two other equally effective mitigation options considered during the preliminary design for this project. These were constructing a ten foot gabion wall on the existing bin wall estimated at \$380,000, and installing two new sections and extending the existing bin wall to a minimum ten foot height estimated at \$570,000. These costs do not include temporary protection and direction of traffic. The visual impact of these options was considered unacceptable by the Columbia River Gorge Commission and therefore, not viable options.

4.0 INSTALLATION

4.1 VISUAL IMPACT

The entire fence was painted with a color selected by a Forest Service Representative for the Columbia River Gorge Commission. All parts of the fence were treated in the factory for corrosion. The mesh was then painted in the Contractor's yard and all remaining parts (columns, bracing rope, etc.) were painted in the field after installation. The contract specified that the gabion mesh not be painted. Once installed, the unpainted gabion mesh dominated the visual appearance of the fence. The gabion mesh was then spray painted in the field the same color as the rest of the fence. This improved the fence's appearance as illustrated in Figure A.4 showing the transition between painted and unpainted gabion mesh. The final fence only minimally affects the visual corridor in this area (Figure A.5).

4.2 CONSTRUCTION

Installing the Brugg Cable Mesh Rockfall Fence on the top of the bin wall created the following design and construction concerns:

1. Installation of the footing into the center of the bins required excavation into coarse granular backfill material.
2. Concern for damage to the face of the bin wall from construction activities.
3. Concern that during a rockfall event, a detached fence component might damage the face of the bin wall.
4. Constructability problems due to the large variations in the profile of the top of the bin wall.

The specified cast in place footing for the fence columns (Appendix B) was replaced prior to construction with 3' x 3' pre-cast footings (see Figure A.6). Due to the type of material excavated, the pre-cast footing allowed an easier installation with no concrete waste. Only one incident of minor damage to the bin wall cap was reported during construction.

The top profile of the bin wall stepped up and down throughout its length (see Figure A.7 for a profile detail of the bin wall). The variations required specially designed posts and mesh sections. There were fourteen different mesh sections details and fourteen different column details because of the profile variations. Due to inaccuracies in the wall profile used for design, it was necessary to redesign most of the rockfall fence after the contract was awarded. Of the 110 mesh sections, it was necessary to change 83 and add four sections and change all necessary columns accordingly. The required changes are shown in Figure A.8.

We learned that an accurate profile of the ground surface exactly where the fence will be constructed is essential to the accuracy of the design.

The construction sequence and time for each activity are given in Table 4.1. Figures A.9 through A.13 illustrate the construction sequence.

The completed fence is shown in Figure A.14. One other construction design change was at the east end of the project where the footings had to be installed in rock instead of in the bin wall. This included a total of one different bracing rope anchor detail (Figure A.15), and two different footings details (Figure A.16). Also, the length and orientation of the bolt on the post (Appendix B, Sheet 2A-11) was reversed because the bolt was too short.

Table 4.1: Construction Sequence and Times

ACTIVITY	DESCRIPTION	WORK DAYS
Pour Precast Footings	Done in the contractor's yard.	9 wk days 4/18/91 - 5/2/91
Excavate and Set Footings (Figures A.9 and A.10)	Excavate with backhoe, make leveling pad, place pre-cast footings, backfill material.	7 wk days 5/6/91 - 5/14/91
Attach Columns to Footings	Attach base plate leveled with grout, anchor factory primed columns and break-away assembly.	9 wk days 5/23/91 - 6/4/91
Paint Columns and Fence	Paint: Spar enamel Miller Paints #2500 series. Spray paint columns at site. Spray paint cable mesh sections in yard to minimize wastage. Spray paint remaining parts of fence painted after they are attached to the fence.	10-14 wk days 6/5/91 - 7/30/91
Attach Wire Bracing and Perimeter Rope (Figure A.11)	Attach 5/8-inch rope, tension with 2 ton come-along, fasten with thimble and 4 cable clips tightened to 3.36 ft-lbs, install friction brakes with torque wrench.	4 wk days 6/3/91 - 6/6/91
Attach Cable Mesh Sections (Figure A.12)	Lace mesh with 5/16-inch seam rope to perimeter rope.	8 wk days 8/6/91 - 8/13/91
Attach Gabion Mesh (Figure A.13)	Hog clip gabion mesh to fence, leave a 5-foot drape at bottom.	5 wk days 8/26/91 - 8/30/91
Paint gabion mesh	Spray paint gabion mesh in field.	2 wk days
Excavate access road	Use a small cat to even out fallout area behind fence to provide access and increase depth of fallout area.	2 wk days

5.0 CONCLUSIONS

This was the first Brugg Cable Mesh Rockfall Fence installation for the contractor. The contractor along with the ODOT inspectors considered its constructability to be very easy. Their only problem was spray painting on site; it was difficult due to the high winds common in this area. To have an accurate fence design for construction, it is critical to have an accurate profile of the ground surface where the fence will be located.

APPENDIX A
FIGURES

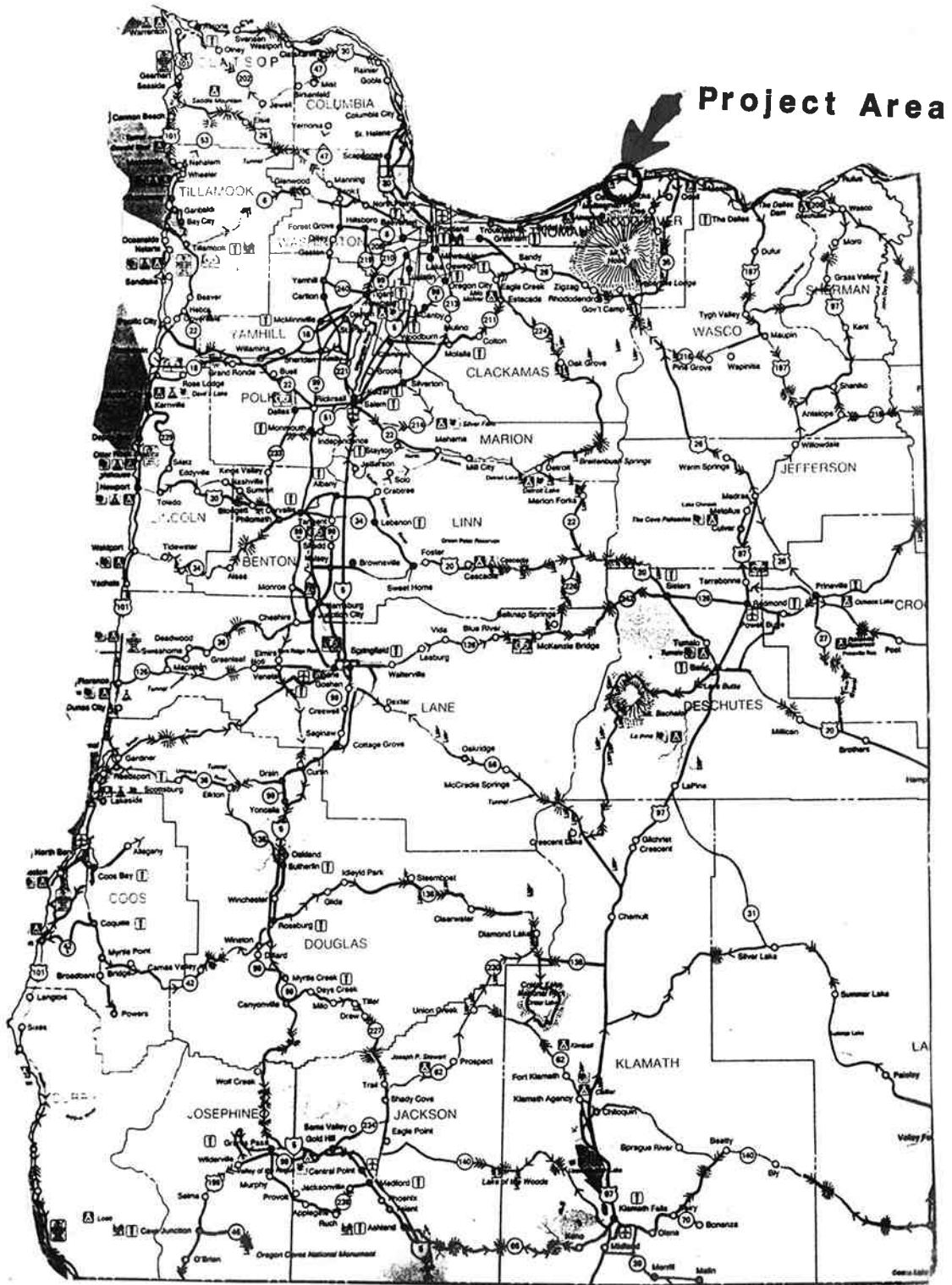
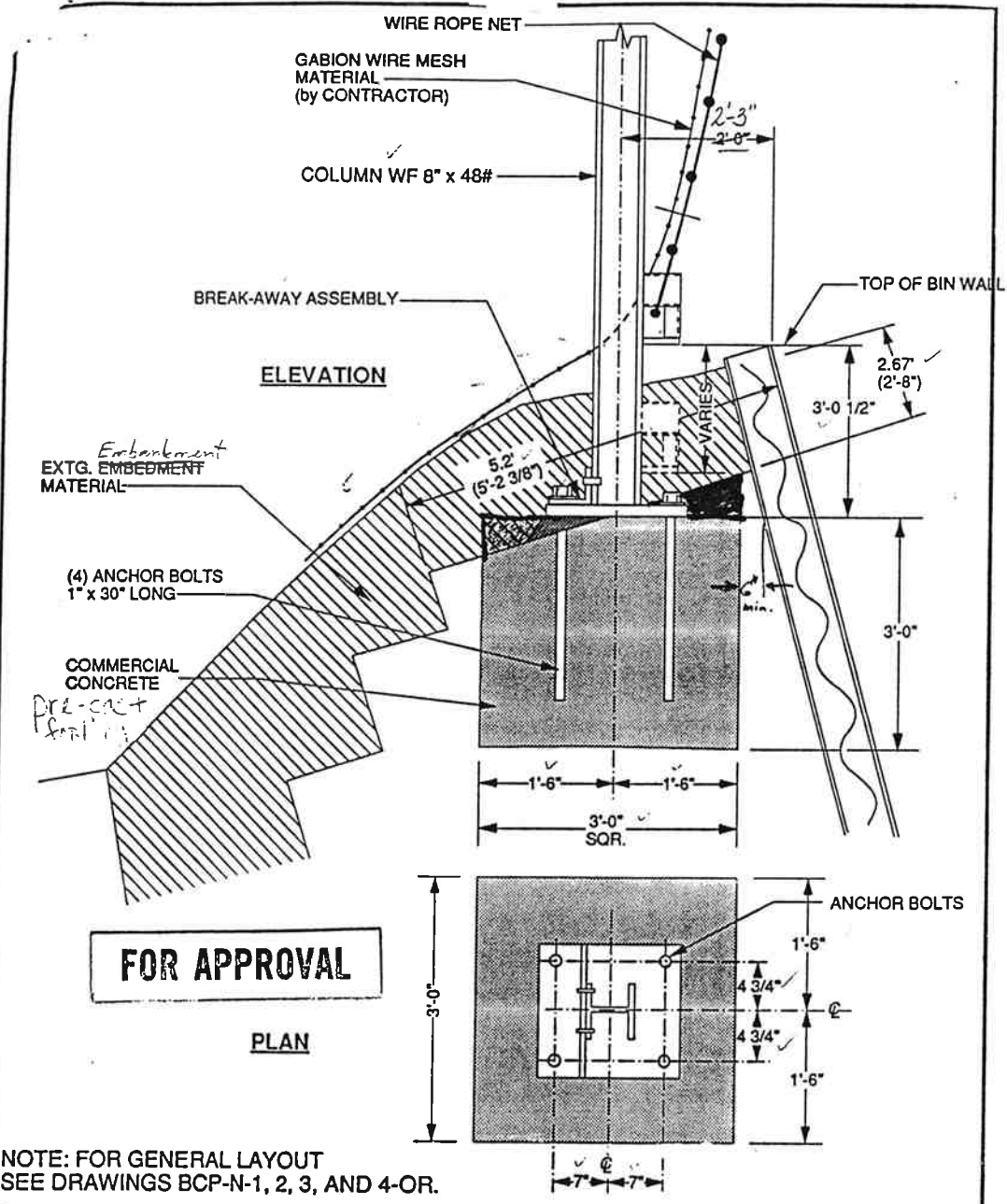


Figure A.1: Project Location



NOTE: FOR GENERAL LAYOUT
SEE DRAWINGS BCP-N-1, 2, 3, AND 4-OR.

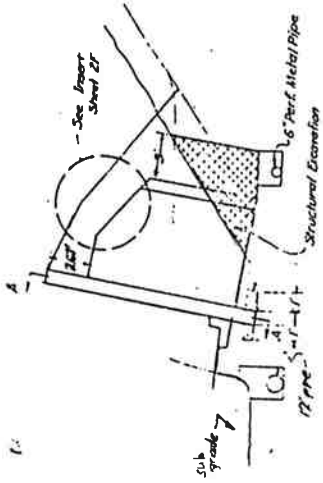
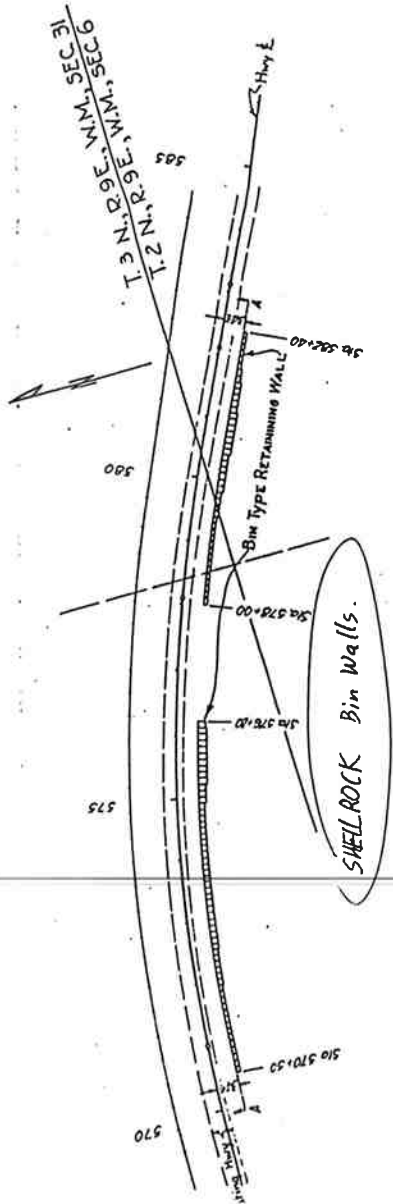
APPROVED WITHOUT CHANGE
 APPROVED AS NOTED
 RETURNED FOR CORRECTION
 CONTRACT NO. C10987
 DATE 4-18-91
 OREGON STATE HIGHWAY COMMISSION
 Subject to Sections 105.01 & 105.52 of the Standard
 Specifications for Highway Construction.
 BY H. H. H. H. H.

BRUGG BRUGG CABLE PRODUCTS, INC. SANTA FE, NEW MEXICO			
PROJECT NO: SHELL ROCK MTN	SCALE: NONE	DRAWN BY: RT	DATE: 3-28-91
CLIENT: OREGON DEPT OF TRANSP		CLIENT APPROVAL:	REV. NO.:
STRUCTURAL COLUMN FOUNDATION DETAIL			DRAWING NO.: BCP-N-8-OR

Figure A.6: Pre-cast footing detail.

CASCADE LOCKS-MITCHELL POINT SEC			
COLUMBIA RIVER HIGHWAY			
HOOD RIVER COUNTY			
PROJECT NO.	STATE	DISTRICT	SECTION
8	OREGON	80N284J	

REVISED AS CONFR
12-20-22 CONTRACT



TYPICAL WALL SECTION
STA 570+00 TO 576+20
STA 573+00 TO 582+40
For Details And Shows See Sheet 2A

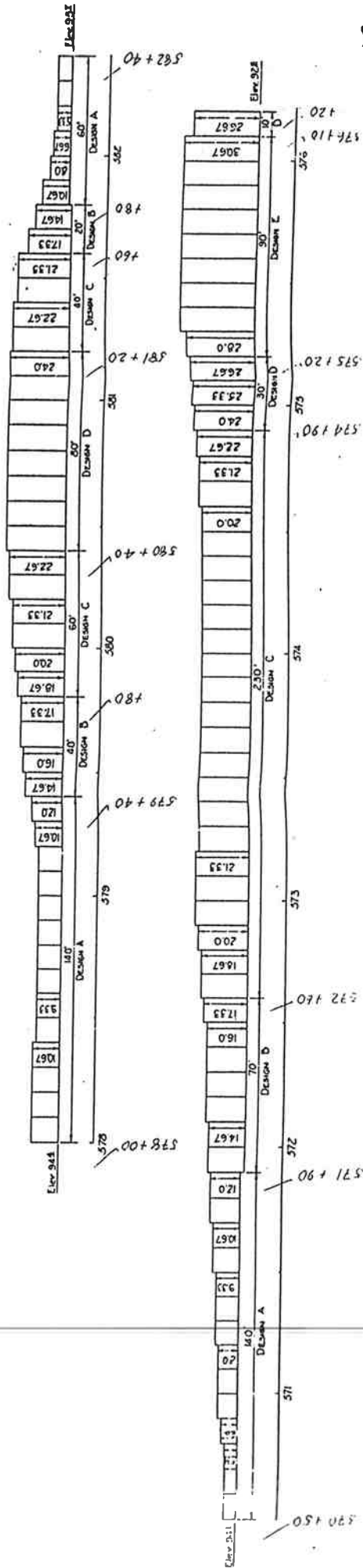


Figure A.7: Existing bin wall profile.

BARRIER LAYOUT DETAIL

23V-86

PROJECT NO.	2
DATE	
DESIGNED BY	
CHECKED BY	
SCALE	
LOCATION	OREGON
PROJECT NAME	
DATE	
SCALE	
LOCATION	
PROJECT NAME	

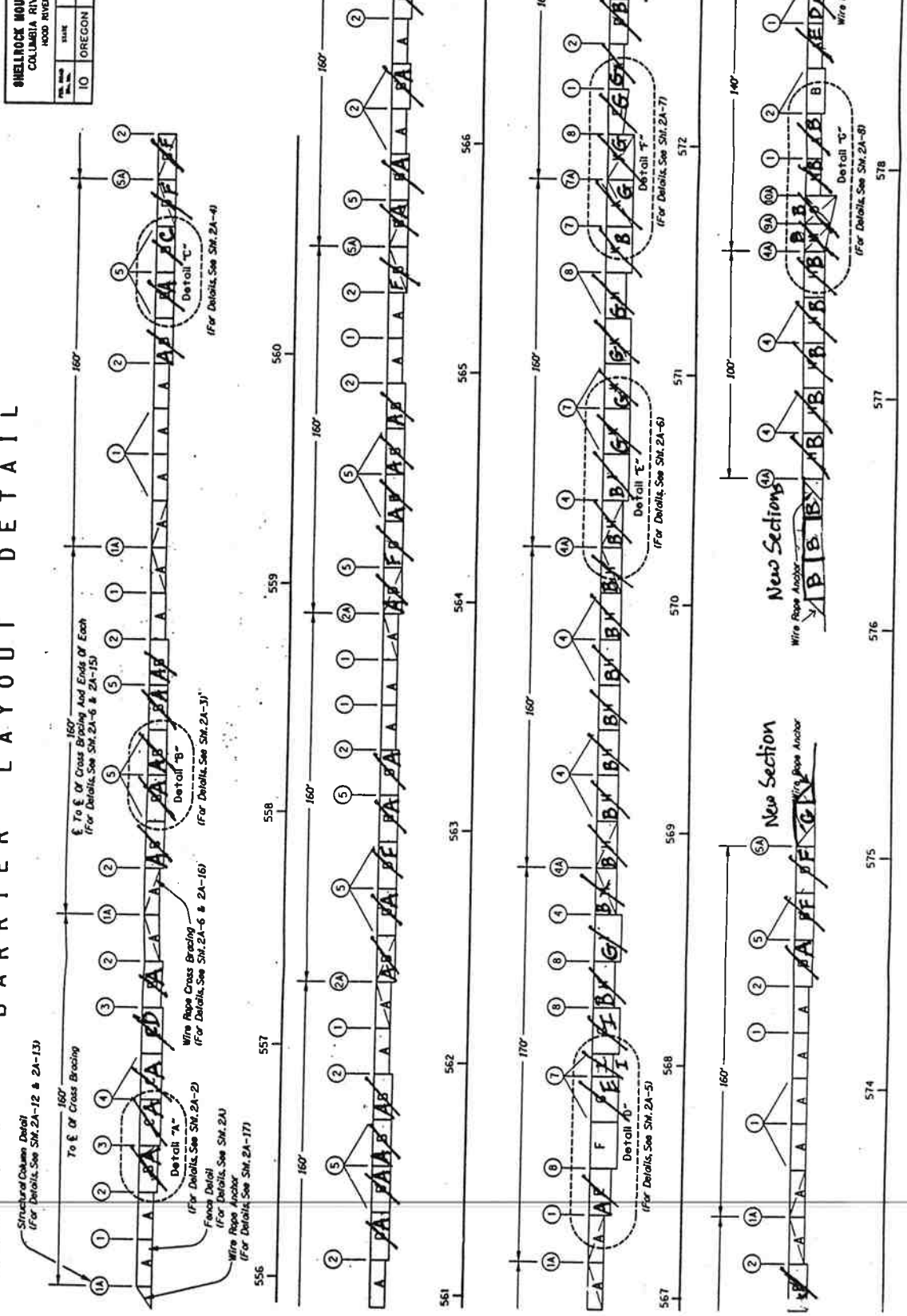


Figure A.8: Detail of mesh section changes.

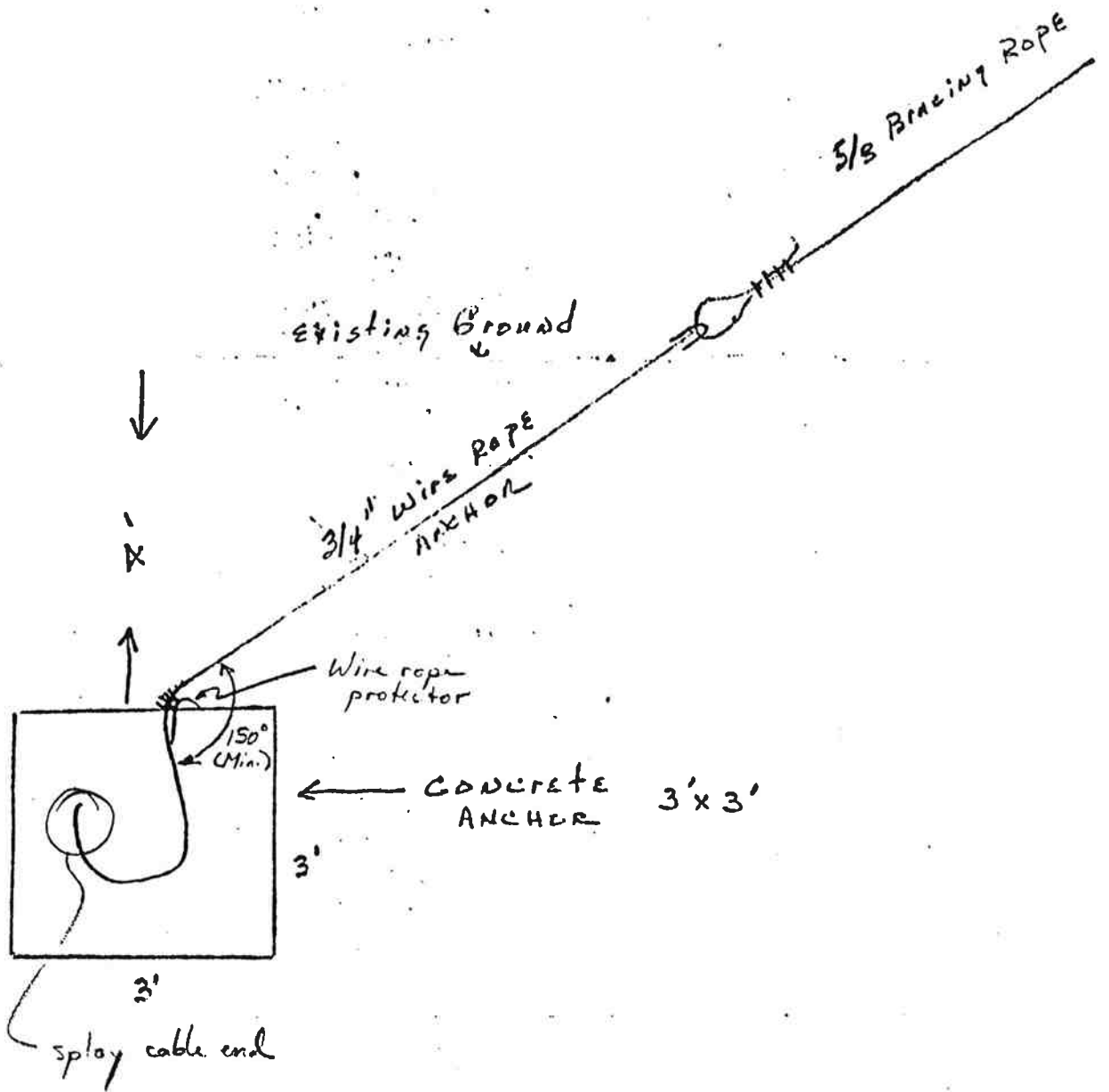


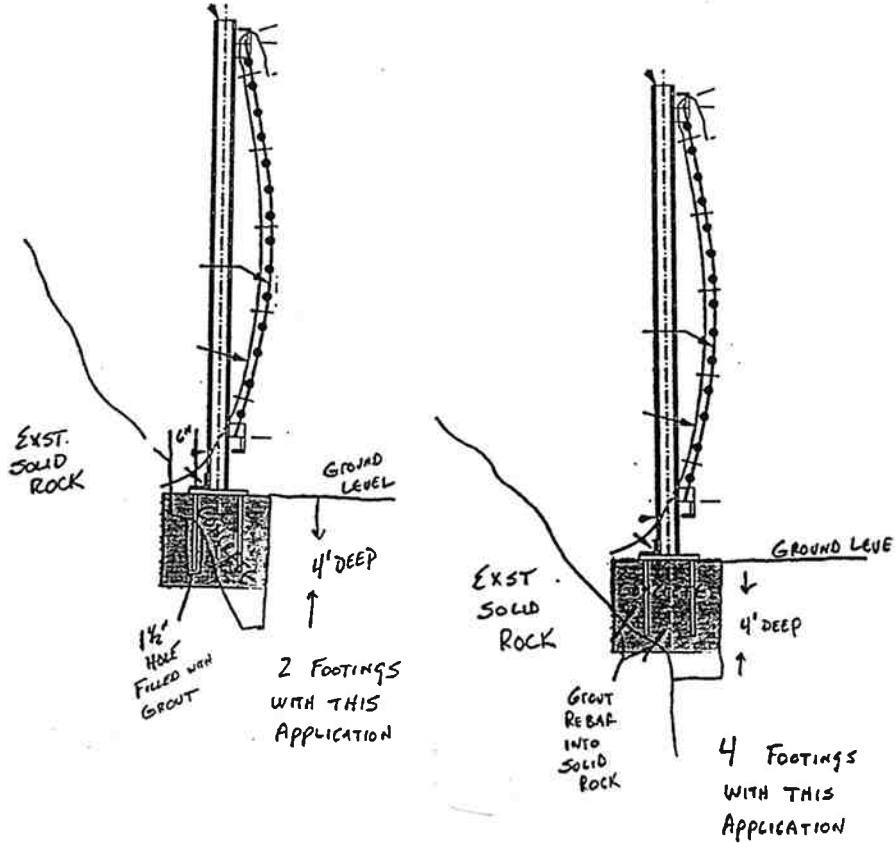
Figure A.15: Alternative anchor detail



Coral Construction Company

SPECIALTY HIGHWAY AND GENERAL CONTRACTORS

P.O. Box 347
Wilsonville, Oregon 97070
Phone (503) 682-2262
Fax (503) 682-0110



APPROVED WITHOUT CHANGE
 APPROVED AS NOTED
 RETURNED FOR CORRECTION
 CONTRACT NO. C10987

DATE _____
 OREGON STATE HIGHWAY COMMISSION
Subject to Section 103.01 & 102.02 of the Standard Specifications for Highway Construction

BY M

Contractor's Licenses: AK AAD4706; AZ 069377-008; 1 332441A; ID 5944-AAA-4; MT 4413A; NV 0017757A; OR 62816; UT 0000394303; WA CORALCC211N2

Figure A.16: Footings in rock

APPENDIX B

PLANS

INDEX OF SHEETS	
SHEET NO.	DESCRIPTION
1	Title Sheet
2, 2A, 2A-2 Thru 2A-17 Incl.	Details
28	Summary
3, 4	Plan



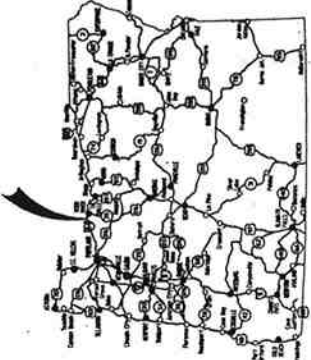
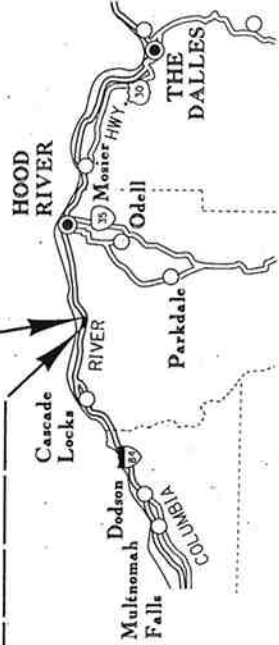
Drawn by: S-1, S-6, S-12, 21286C
 Temporary Protection And Direction Of Traffic

STATE OF OREGON
 DEPARTMENT OF TRANSPORTATION
 STATE HIGHWAY DIVISION

PLANS FOR PROPOSED PROJECT
ROCKFALL PROTECTION FENCE
SHELLROCK MOUNTAIN SECTION
COLUMBIA RIVER HIGHWAY
 HOOD RIVER COUNTY
 OCTOBER, 1990

END OF PROJECT IR-84-2(3)D052
 STA. 579 + 50 (M.P. 52.6)

BEGINNING OF PROJECT IR-84-2(3)D052
 STA. 555 + 50 (M.P. 52.1)



23V-86

SHELLROCK MOUNTAIN SECTION		SHEET	
COLUMBIA RIVER HIGHWAY		1	
HOOD RIVER COUNTY		TOTAL SHEETS	
FILE NO.	STATE	PROJECT NUMBER	SCALE
10	OREGON	IR-84-2(3)D052	1" = 100'

OREGON TRANSPORTATION COMMISSION

Michael P. Hollern
 J. Lynn Whitty
 David F. Bolander
 Cynthia J. Ford
 Roger L. Breezley
 Robert N. Borhman

COMMISSIONER
 VICE COMMISSIONER
 COMMISSIONER
 COMMISSIONER
 COMMISSIONER
 DIRECTOR OF TRANSPORTATION

Duane O. Christensen
 PROJECT DEVELOPMENT ENGINEER

SHEET NO. 2A		TOTAL SHEETS: 10	
SHELL ROCK MOUNTAIN SECTION			
CLATSOP RIVER HIGHWAY			
CLATSOP COUNTY, OREGON			
DATE	PROJECT NUMBER	PROJECT YEAR	SCALE
10	OREGON		

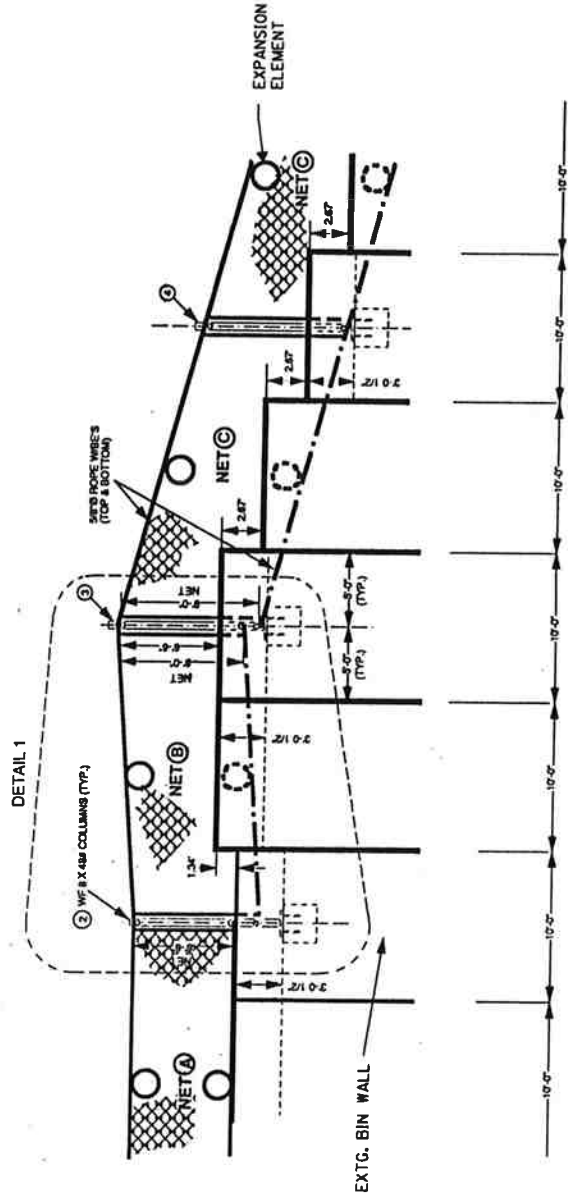
POS.	NET SIZE	QTY.	SO. FT.	TOTAL SO. FT.
(A)		33	130	4290
(B)		29	160	4640
(C)		3	180	540
(D)		11	160	1760
(E)		2	155	310
(F)		1	230	230
(G)		2	230	460
(H)		16	180	2880
(I)		2	205	410
(K)		6	230	1380
(L)		1	90	90
(M)		1	122	122
(N)		1	104	104
(O)		1	150	150

FENCE DETAILS

BRUGG CABLE PRODUCTS, INC.
 SANTA FE, NEW MEXICO
 SHELL ROCK MOUNTAIN SECTION
 CLATSOP COUNTY, OREGON
 HIGH IMPACT WIRE ROPE NETS
 BCP-N-12

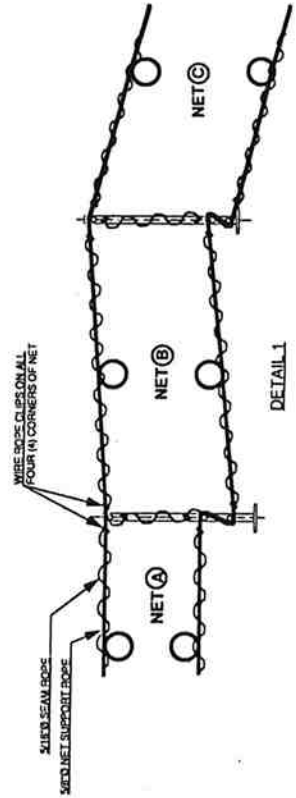
23V-86

SHELL ROCK MOUNTAIN SECTION		2A-2	
COLUMBIA RIVER HIGHWAY		HOOD RIVER COUNTY	
STATE	PROJECT	DATE	SCALE
OR	OREGON		



DETAIL A - (FRONT VIEW)

NOTE:
 FOR CROSS SECTIONS REFER TO DWG'S N°: BCP-N-2 & 2A
 FOR STRUCTURAL COLUMNS FOUNDATION DETAILS SEE DWG N°: BCP-N-10
 FOR TYPICAL WIRE ROPE NET INSTALLATION DETAIL SEE DWG N°: BCP-N-13

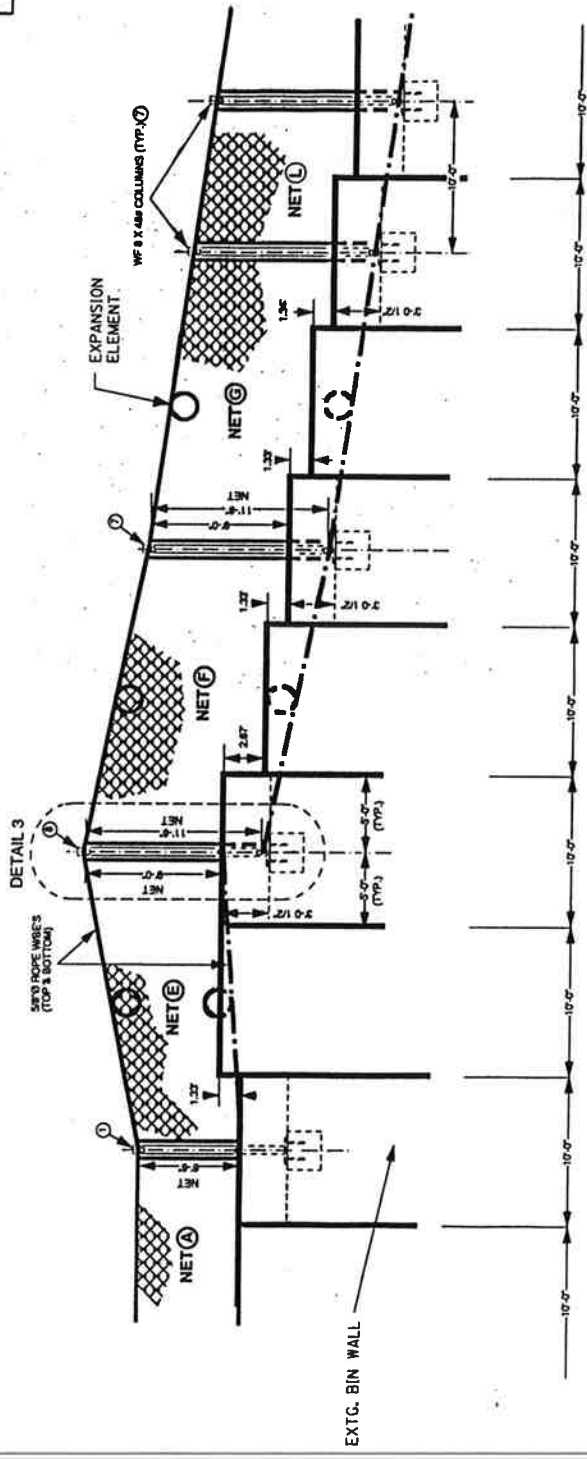


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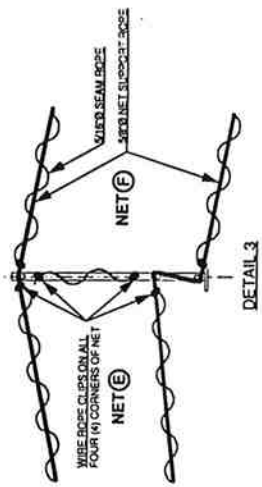
SHELLROCK MOUNTAIN SECTION
COLUMBIA RIVER HIGHWAY
HODD RIVER COUNTY.

2A

FED. ROAD DIST. NO.	STATE	PROJECT NUMBER	FISCAL YEAR	TOTAL SHEETS
10	OREGON			2



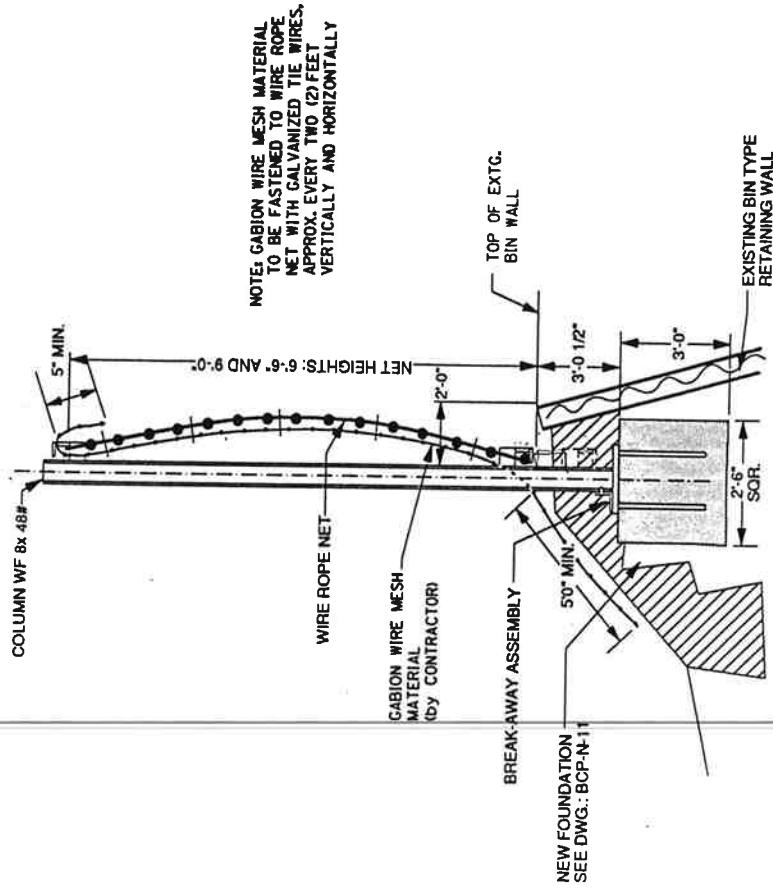
-DETAIL D-
(FRONT VIEW)



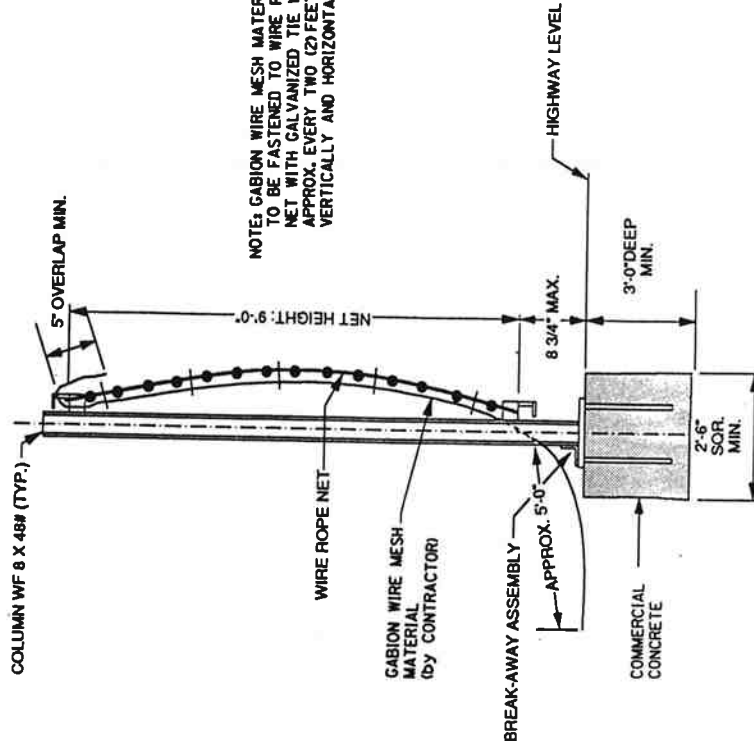
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FOR CROSS SECTIONS REFER TO DWG'S N° BCP-N-2 & 2A
FOR STRUCTURAL COLUMNS FOUNDATION DETAILS SEE DWG N° BCP-N-10
FOR TYPICAL WIRE ROPE NET INSTALLATION DETAIL SEE DWG N° BCP-N-8

23V-86

SHELLROCK MOUNTAIN SECTION		DATE	SCALE	PROJECT NO.	DATE
COLUMBIA RIVER HIGHWAY		2/19			
HOOD RIVER COUNTY					
PROJECT NO.	STATE	FEDERAL PROJECT NO.	FISCAL YEAR	DATE	
10	OREGON				



NOTE: ARRANGEMENTS ONLY FOR NETTING LOCATED ON TOP OF EXTG. BIN WALL

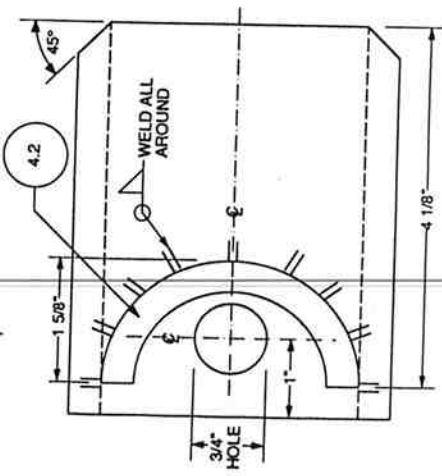
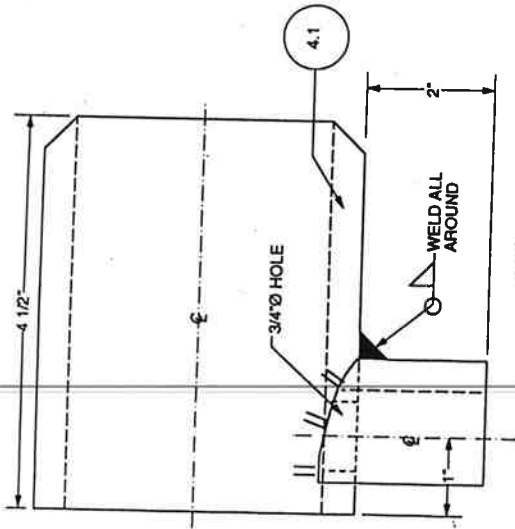
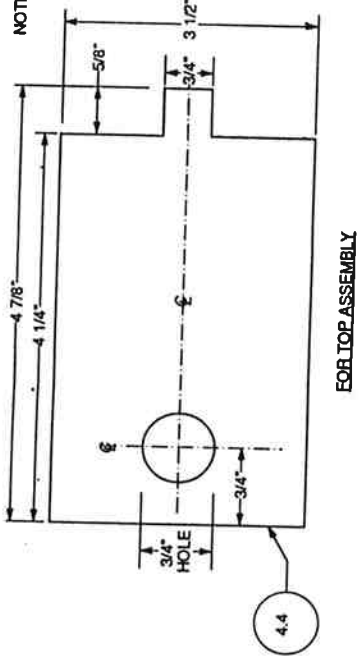
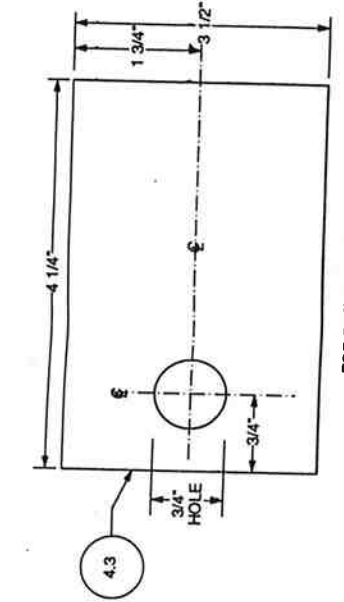


NOTE: THIS ARRANGEMENT ONLY FOR NETTING LOCATED ON HIGHWAY LEVEL.

SHEET No.		2A-10	
SHELLROCK MOUNTAIN SECTION			
COLUMBIA RIVER HIGHWAY			
-000 RIVER COUNTY			
FOR ROAD DIST. NO.	STATE	PROJECT NUMBER	SCALE
10	OREGON		
TOTAL SHEETS		10	

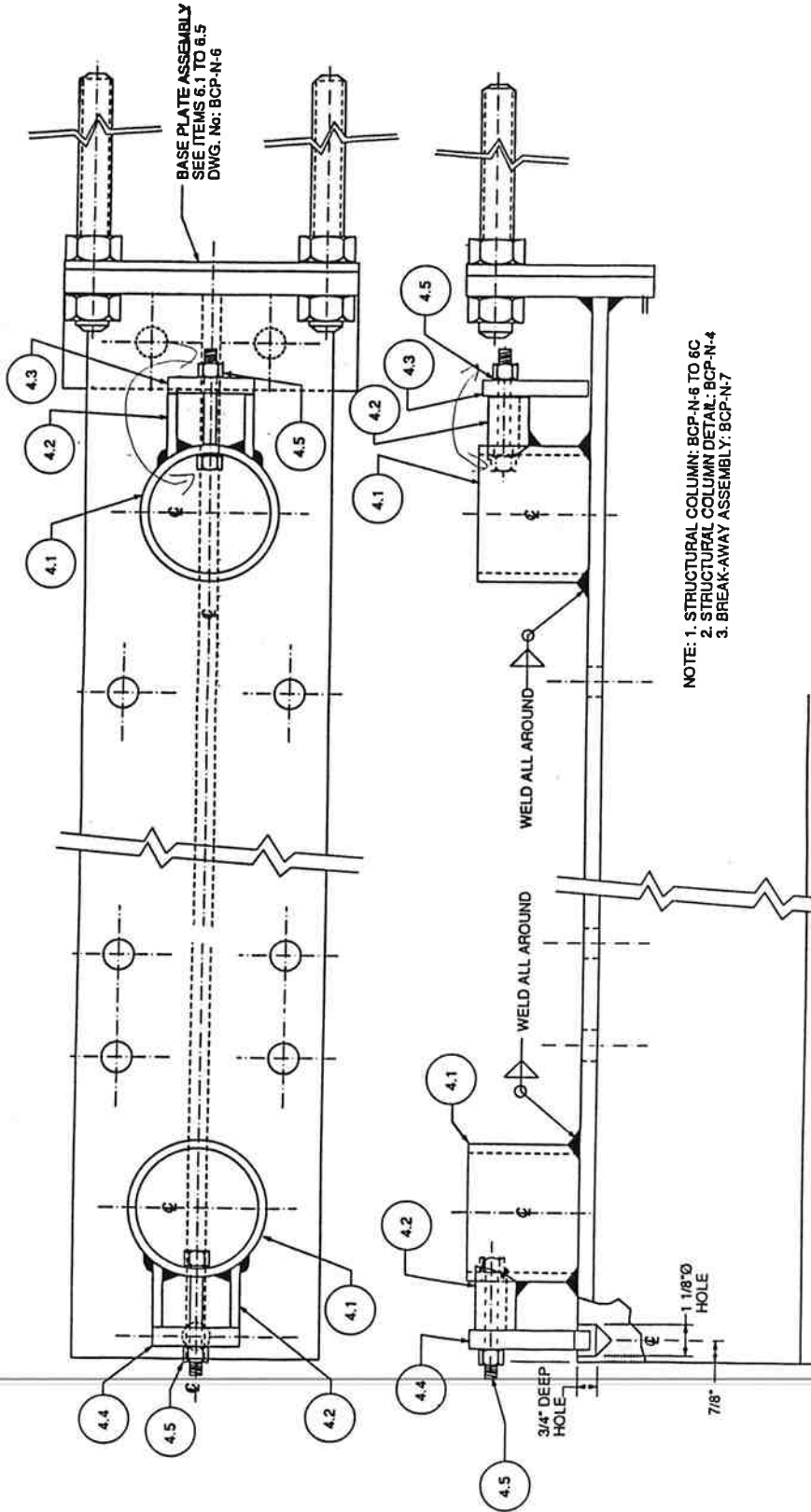
ITEM	QUANTITY	DESCRIPTION
4.1	254	PIPE 4"Ø (NOMINAL) X 14.98# EXTRA STRONG
4.2	254	PIPE 3"Ø (NOMINAL) X 10.25# EXTRA STRONG
4.3	143	PLATE 3/4" THICK X 3 1/2" X 4 1/4"
4.4	111	PLATE 3/4" THICK X 3 1/2" X 4 7/8"

NOTE: 1. STRUCTURAL COLUMNS: BCP-N-6 TO 6C
2. STRUCTURAL ASSEMBLIES: BCP-N-5



BRUGG CABLE PRODUCTS, INC.	
1100 SHELLECK MOUNTAIN	SAVANAH, GEORGIA
TELEPHONE: 404-371-1111	FAX: 404-371-1112
TELETYPE: 404-371-1113	TELEX: 3-84990
STRUCTURAL COLUMN DETAILS	
BCP-N-4	

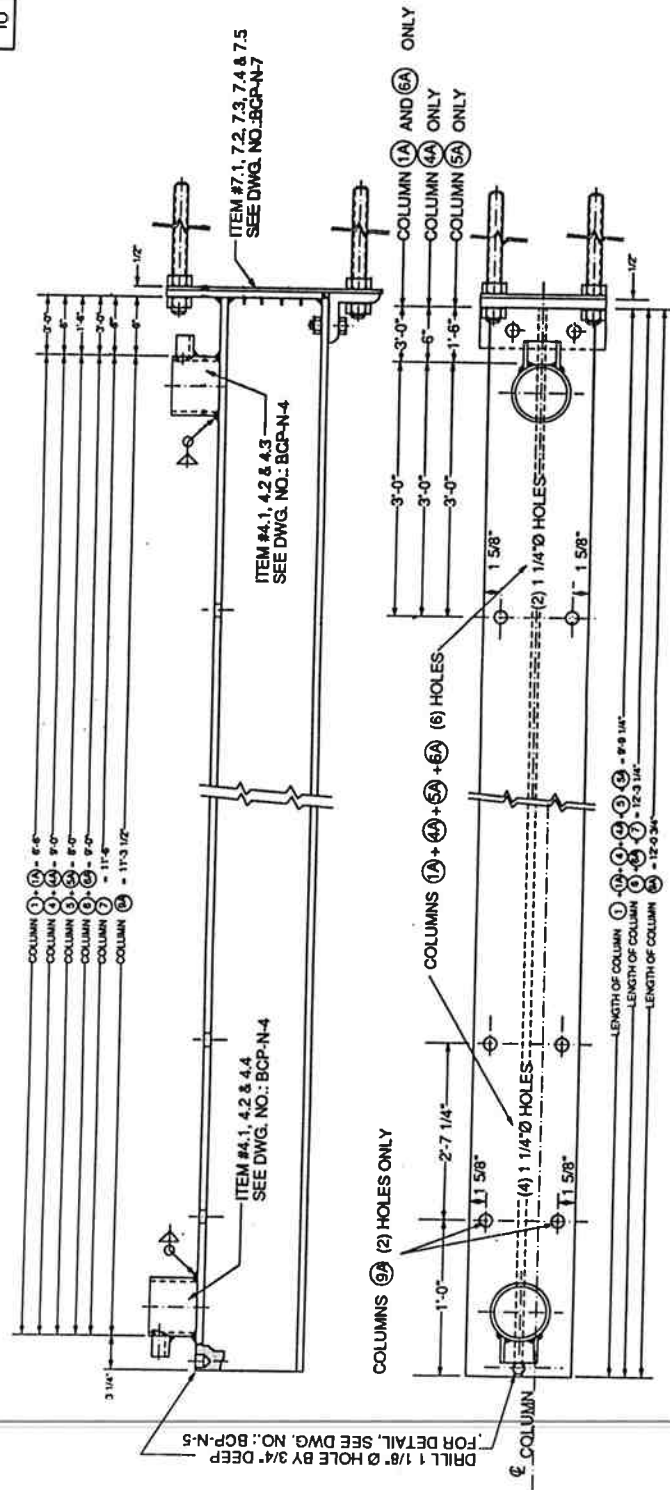
SHELLROCK MOUNTAIN SECTION		2A-111
COLUMBIA RIVER HIGHWAY		
HOOD RIVER COUNTY		
DATE	PROJECT	SCALE
10	OREGON	



ITEM	QUANTITY	DESCRIPTION
4.5	222	5/8" Ø BOLT W/ NUT & WASHERS TO BE FITTED WHEN ASSEMBLING

23V-86

SHEET NO.		2A-12	
SHELLROCK MOUNTAIN SECTION			
COLUMBIA RIVER HIGHWAY			
WASCO, WASHINGTON COUNTY			
ITEM NO.	STATE	PROJECT NUMBER	FOCAL YEAR
10	OREGON		
TOTAL SHEETS		10	

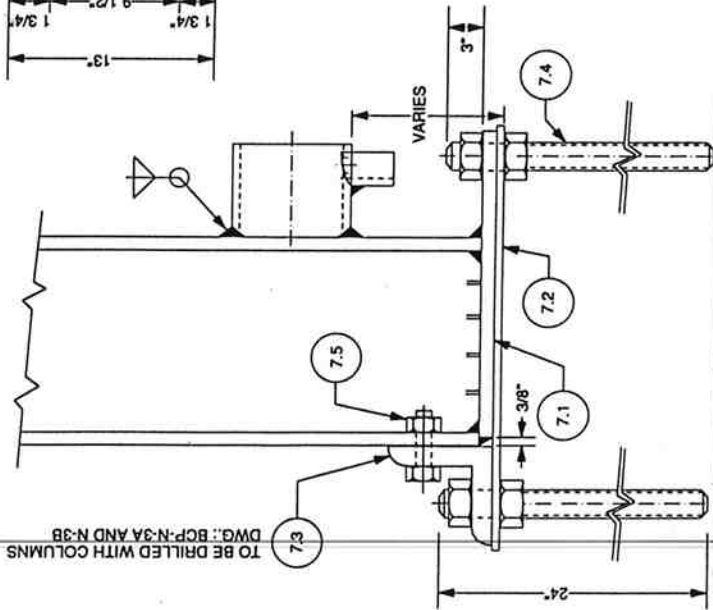
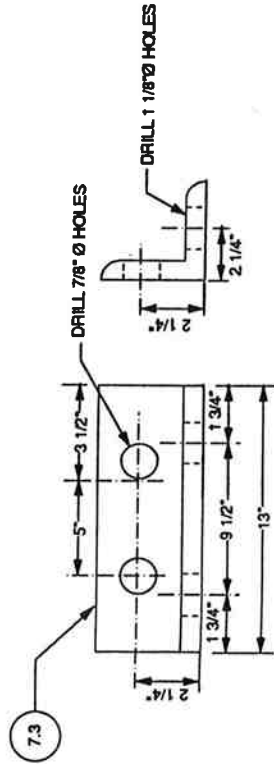
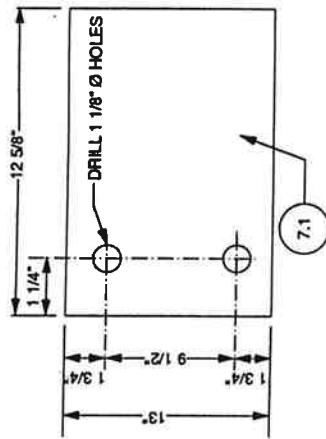
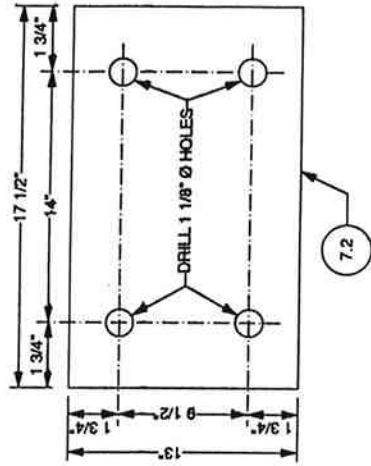


ITEM	QTY	DESCRIPTION	REMARKS
(1)	18	COLUMNS WF 8 X 4.5, 9-9 1/4" LONG	WITHOUT HOLES
(2)	6	COLUMNS WF 8 X 4.5, 9-9 1/4" LONG	WITH (6) 1 1/4" HOLES
(3)	14	COLUMNS WF 8 X 4.5, 9-9 1/4" LONG	WITHOUT HOLES
(4)	4	COLUMNS WF 8 X 4.5, 9-9 1/4" LONG	WITH (4) 1 1/4" HOLES
(5)	25	COLUMNS WF 8 X 4.5, 9-9 1/4" LONG	WITHOUT HOLES
(6)	3	COLUMNS WF 8 X 4.5, 9-9 1/4" LONG	WITH (3) 1 1/4" HOLES
(7)	4	COLUMNS WF 8 X 4.5, 12-3 1/4" LONG	WITHOUT HOLES
(8)	1	COLUMNS WF 8 X 4.5, 12-3 1/4" LONG	WITH (1) 1 1/4" HOLES
(9)	3	COLUMNS WF 8 X 4.5, 12-3 1/4" LONG	WITHOUT HOLES
(10)	1	COLUMNS WF 8 X 4.5, 12-3 1/4" LONG	WITH (1) 1 1/4" HOLES

NOTE: 1) COLUMN DETAILS: BCP-N-4, N-5 & N-7

23V-86

SHELLROCK MOUNTAIN SECTION		2A-14
COLUMBIA RIVER HIGHWAY		
HOOD RIVER COUNTY		
CDL. MAP No.	STATE	PROJECT NUMBER
10	OREGON	
DATE	DESIGNED BY	CHECKED BY
SCALE	APPROVED	DATE



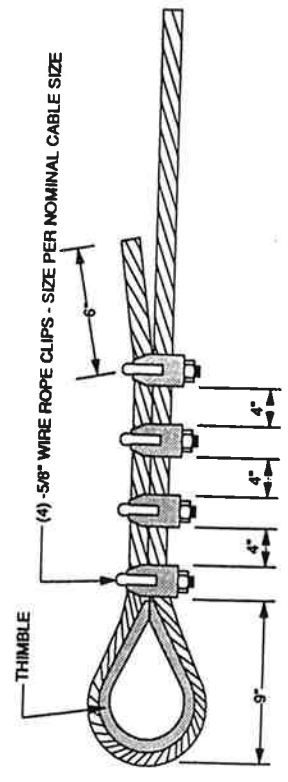
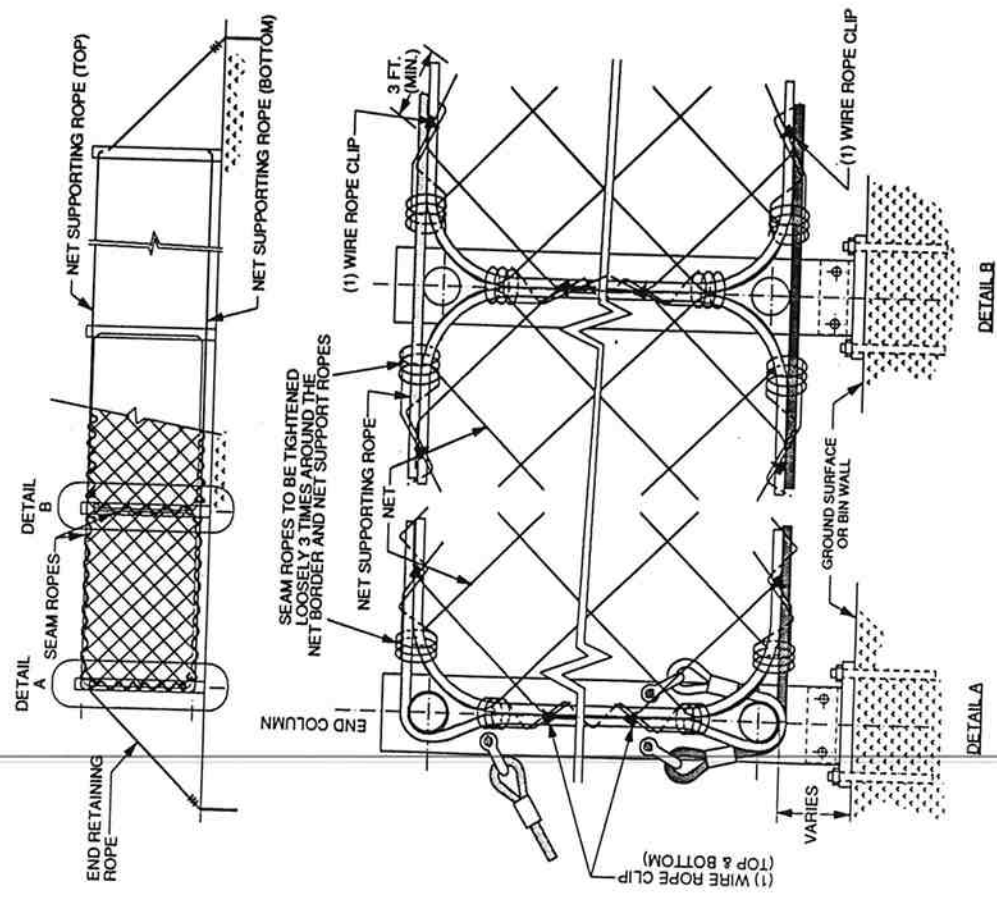
TO BE DRILLED WITH COLUMNS
 DWG.: BCP-N-3A AND N-3B

NOTE: 1) FOR STRUCTURAL COLUMN REFER TO DWG. NO.: BCP-N-5 TO 6C.
 2) BASE PLATE ARRANGMENT TO BE ASSEMBLED IN THE SHOP PRIOR TO SHIPMENT TO THE FIELD.

ITEM	QUANTITY	DESCRIPTION
7.1	111	PLATE 3/8" THK. 13" x 12 5/8"
7.2	111	PLATE 1/8" THK. 13" x 17 1/2"
7.3	111	ANGLES 3 1/2" x 3 1/2" x 11.1# x 13" LONG
7.4	444	ANCHOR BOLTS 10" x 24" LONG W/ NUTS & WASHER
7.5	888	BOLTS 3/4" W/ NUTS (NO WASHERS)

23V-86

SHELL ROCK MOUNTAIN SECTION		DATE	NO. OF SHEETS
COLUMBIA RIVER HIGHWAY		2A-15	
HOOD RIVER COUNTY			
DESIGNED BY	CHECKED BY	DATE	
IO	OREGON		



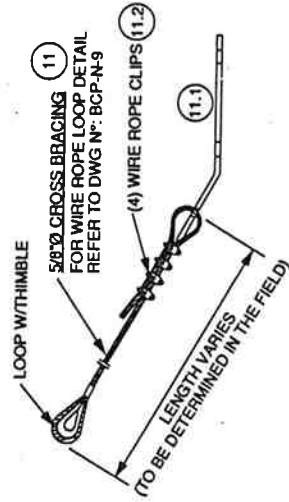
NOTE: 1. Wire Rope Clips To Be Tightened To 3.36 ft-lbs
 2. All Net Support Ropes Shall Be 5/8" In Diameter.

WIRE ROPE LOOP DETAIL
 BCP-N-3

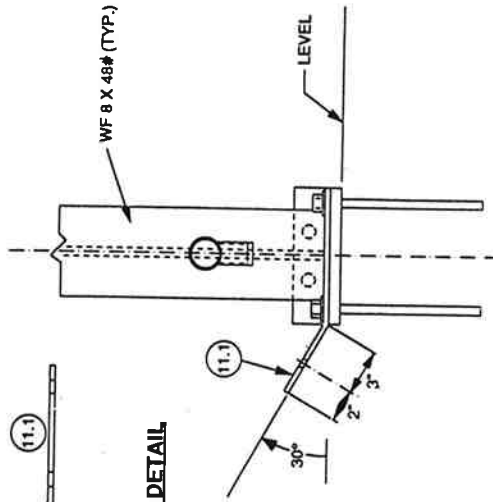
TYPICAL WIRE ROPE NET
 INSTALLATION DETAIL
 BCP-N-8

23V-86

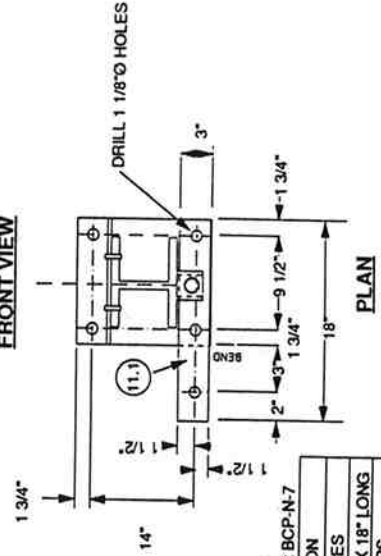
SHELLROCK MOUNTAIN SECTION				DATE	2A-16
COLUMBIA RIVER HIGHWAY				PROJECT	
HOOD RIVER COUNTY				SCALE	
NO.	REV.	DATE	BY	CHKD.	APP.
10					



EASTENING DETAIL



FRONT VIEW

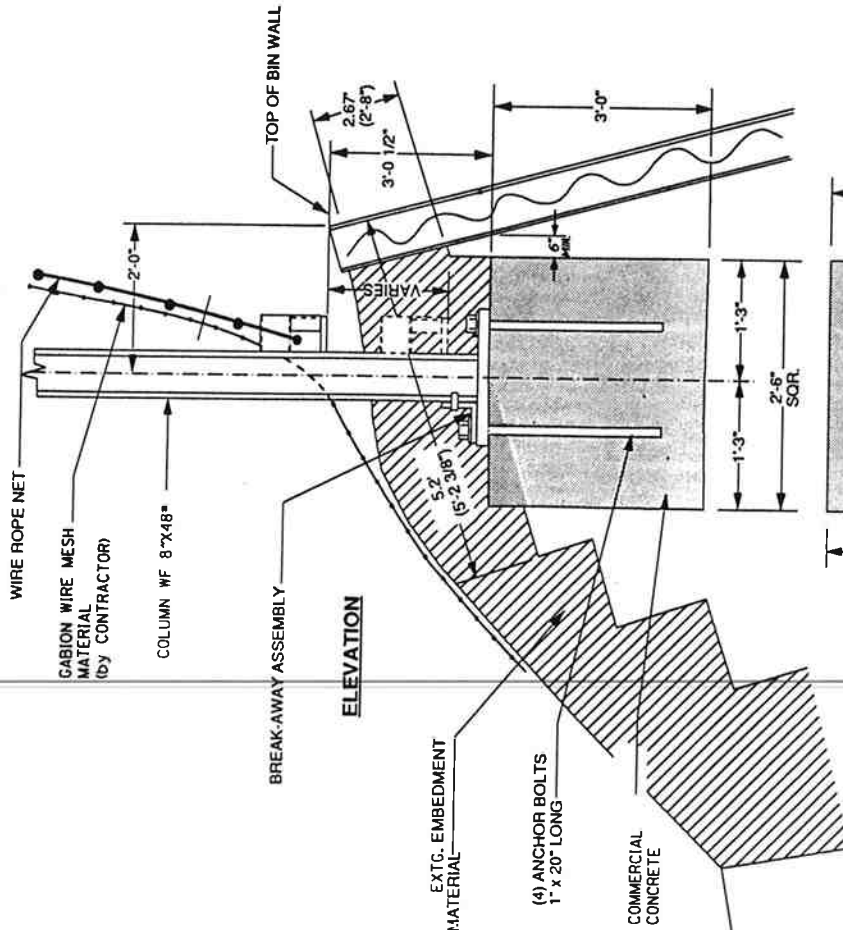


NOTE: FOR STRUCTURAL DETAILS AND ASSEMBLIES, REFER TO DWG N°: BCP-N-7

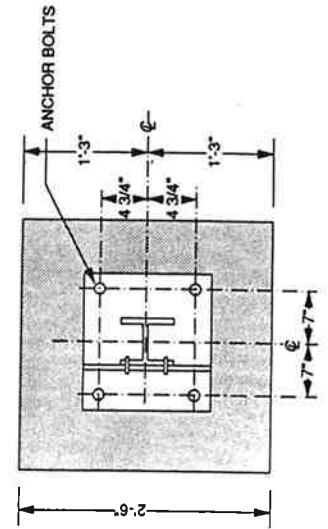
ITEM	QUANTITY	DESCRIPTION
11	26	5/8" Ø BRACING ROPES
11.1	26	PLATE 1/2" THK., 3" X 18" LONG
11.2	104	5/8" WIRE ROPE CLIPS

BRUGG CABLE PRODUCTS, INC.
1100 S. SHELL ROCK AVE. HOOD RIVER, OREGON 97113
PHONE: (503) 325-1100
FAX: (503) 325-1101
WWW.BRUGG.COM

BCP-N-11



ELEVATION

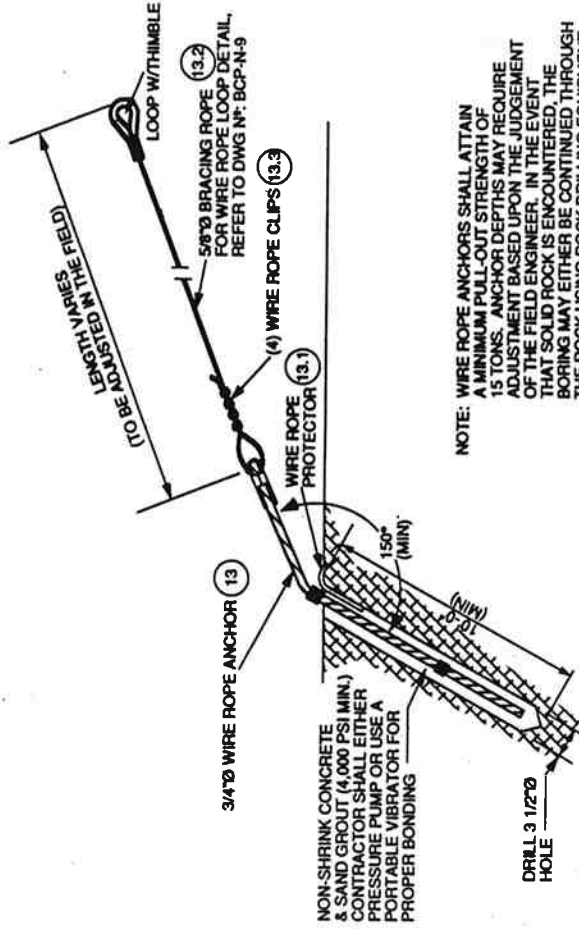


PLAN

STRUCTURAL COLUMN FOUNDATION DETAIL

BCP-N-10

SHELLROCK MOUNTAIN SECTION		SHEET NO. 2	
COLUMBIA RIVER HIGHWAY		TOTAL SHEETS 2	
HOOD RIVER COUNTY		DATE	
FILE NO.	STATE	PROJECT NUMBER	SCALE
10	OREGON		



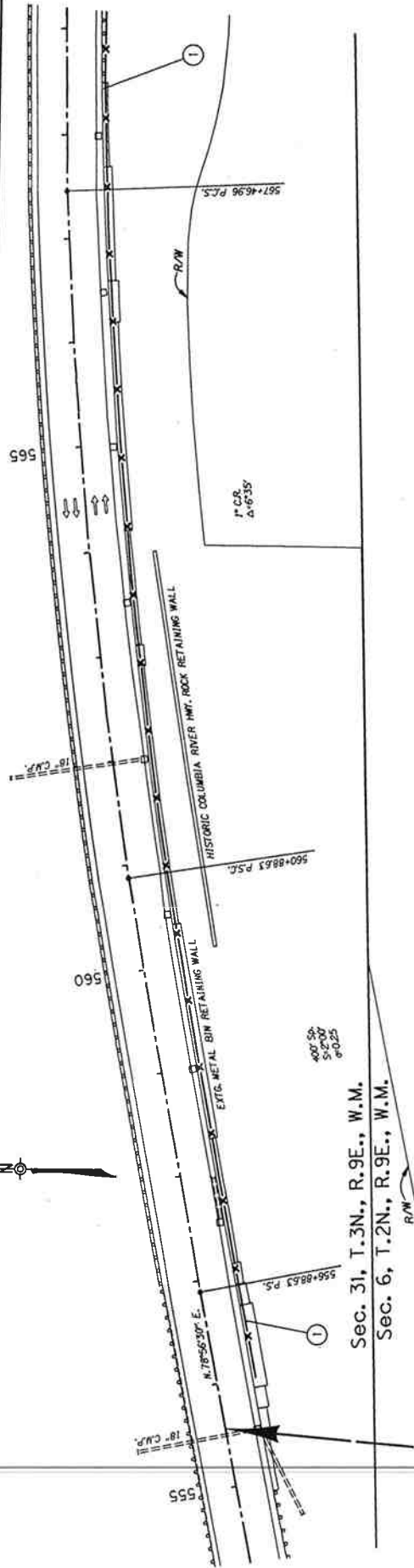
NOTE: WIRE ROPE ANCHORS SHALL ATTAIN A MINIMUM PULL-OUT STRENGTH OF 15 TONS. ANCHOR DEPTHS MAY REQUIRE ADJUSTMENT BASED UPON THE JUDGEMENT OF THE FIELD ENGINEER. IN THE EVENT THAT SOLID ROCK IS ENCOUNTERED, THE BORING MAY EITHER BE CONTINUED THROUGH THE ROCK USING ROCK DRILLING EQUIPMENT, OR RELOCATED 5' AWAY FROM ORIGINAL POSITION.

ITEM	QUANTITY	DESCRIPTION
13	4	3/4" WIRE ROPE ANCHOR
13.1	4	WIRE ROPE PROTECTOR
13.2	4	5/8" BRACING ROPE W/THIMBLE
13.3	16	5/8" WIRE ROPE CLIPS

23V-86

SHELLROCK MOUNTAIN SECTION		SHEET No. 3	
COLUMBIA RIVER HIGHWAY		TOTAL SHEETS	
HOOD RIVER COUNTY		PROJECT NUMBER	
FED. ROAD DIST. NO.	STATE	FISCAL YEAR	DATE
10	OREGON		

① STA. 555+80 To Sta. 575+25
Inst. Wire Rope Fence
(See Sht. Nos. 2A-2 thru 2A-17)



Sec. 31, T. 3N., R. 9E., W.M.
Sec. 6, T. 2N., R. 9E., W.M.

IR-84-2131D52
BEGINNING OF PROJECT
STA. 555+50

