WA-RD 87.1

Cathodic Protection For Reinforced Concrete Bridge Decks Woodinville Interchange Bridge 522/30ES

Demonstration Project 34

Post Construction Report April 1986

Washington State Department of Transportation
Planning, Research and Public Transportation Division
In Cooperation With
United States Department of Transportation
Federal Highway Administration

TECHNICAL REPORT STANDARD TITLE PAGE

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WA-RD-87.1		

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Woodinville Interchange Bridge No. 522/30ES

5. Report Date
April, 1986

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7. Author(s)
Tom H. Roper and Edward H. Henley, Jr.

8. Performing Organization Report No.

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Washington State Department of Transportation
Transportation Building
Olympia, WA 98504

10. Work Unit No.

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DTFH71-84-34-WA-10

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U.S. Department of Transportation
Federal Highway Administration
400 - 7th Street SW
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16. Abstract

Under FHWA Demonstration Project No. 34, "Cathodic Protection for Reinforced Concrete Bridge Decks," a slotted cathodic protection system was installed on the ES ramp in the Woodinville Interchange during the summer of 1985. The slotted cathodic protection system involves sawing 3/4" by 3/4" slots longitudinally in the existing deck at one-foot centers. Platinum wire or carbon strand wire is placed in the cut slots first and then conductive polymer is filled in the slots. Electric power from a rectifier supplies current to the wire and conductive polymer. The current then flows to the top mat reinforcing steel, giving the steel protection from further corrosion.

The objective of the demonstration project was to familiarize the Washington State DOT with this new technology. This objective was fulfilled.

Some problem areas with the system were identified during the work:

1. A more positive method of finding grounding locations from the anode to rebar nicks, ties, etc. needs to be developed. Perhaps an instrument can be used to supplement visual inspection.
2. The necessity for having a minimum of 1/2-inch cover from the bottom of the slot to the top of the rebar needs to be resolved.
3. A better method of installing the conductive polymer needs to be developed. Hand-spreading of the material from plastic bags results in sloppy work.
4. Procurement time for the rectifier needs to be shortened.
5. Since the project, once it has started, moves along very rapidly, there is very little time for on-the-job training of workers. Workmen should have prior experience at this work.
6. In remote areas, sources of electrical power may not be available. It will be necessary for sources of power, such as solar panels or long-lasting batteries to be developed for this system.

These problems need to be overcome to obtain a better quality product.

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Unclassified	Unclassified	39	

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HWY FORM 341-004 6/72

Demonstration Project No. 34
Cathodic Protection for Reinforced Concrete Bridge Decks
Woodinville Interchange Bridge No. 522/30ES

BY
Tom H. Roper
Edward H. Henley, Jr.
Bridge and Structures Branch

Post Construction Report
Demonstration Project DTFH 71-84-34-WA-10

Prepared for
Washington State Transportation Commission
Department of Transportation
and in cooperation with
U.S. Department of Transportation
Federal Highway Administration

April, 1986

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SYNOPSIS

Under FHWA Demonstration Project No. 34, "Cathodic Protection for Reinforced Concrete Bridge Decks," a slotted cathodic protection system was installed on the deck of the ES ramp in the Woodinville Interchange during the summer of 1985. The slotted cathodic protection system involves sawing 3/4" by 3/4" slots longitudinally in the existing deck at one-foot centers. Platinum wire or carbon strand wire is placed in the cut slots first and then conductive polymer is filled in the slots. Electric power from a rectifier supplies current to the wire and conductive polymer. The current then flows to the top mat reinforcing steel, giving the steel protection from further corrosion.

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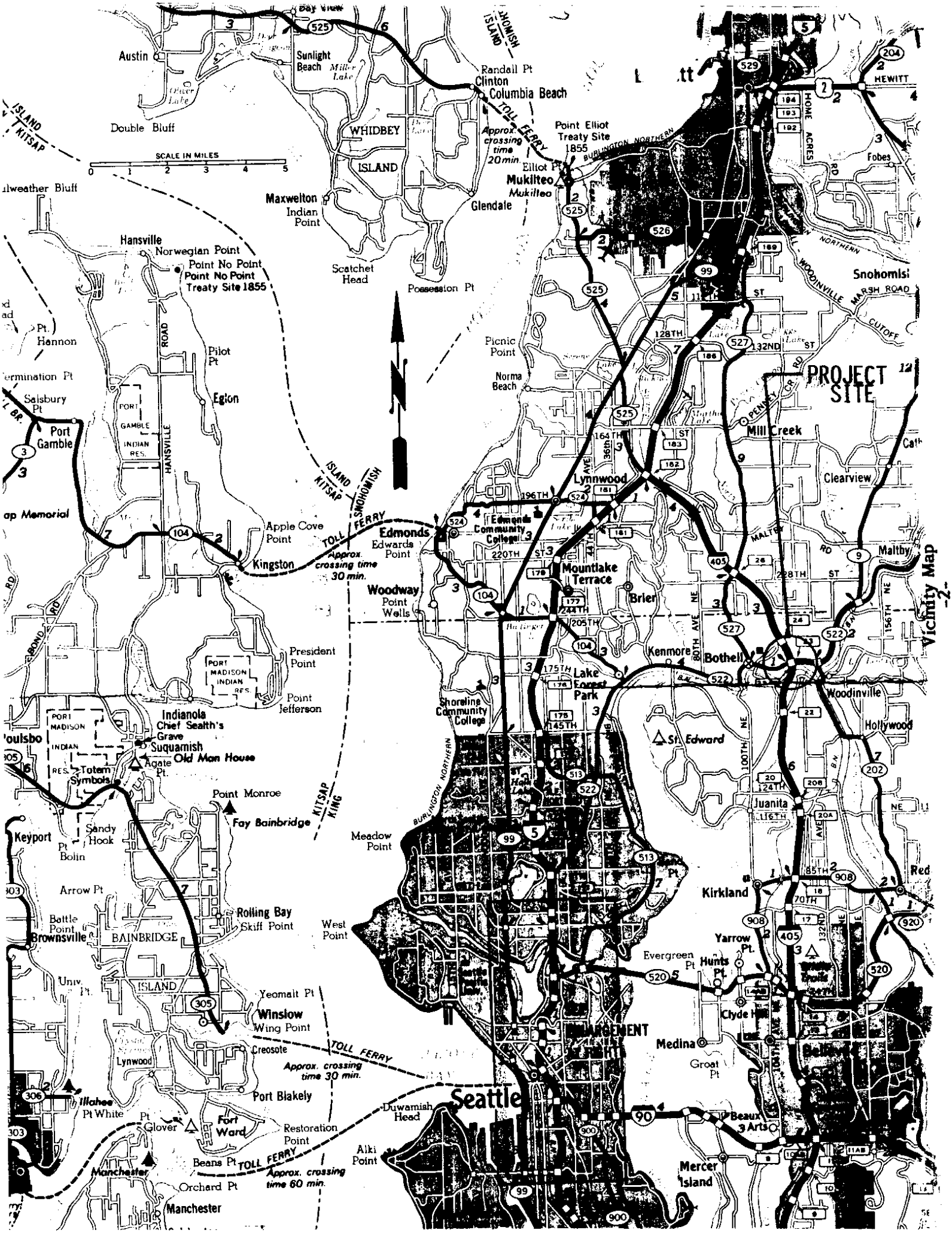
PROJECT SITE
Vicinity Map
-2-
SCALE IN MILES
0 1 2 3 4 5
Austin
Sunlight Beach
Miller Lake
Oliver Lake
Double Bluff
WHIDBEY ISLAND
Randall Pt
Clinton
Columbia Beach
TOLL FERRY
Approx. crossing time 20 min.
Point Elliot Treaty Site 1855
Elliot Pt
Mukilteo
Glendale
Maxwelton
Indian Point
Scatchet Head
Possession Pt
Hansville
Norwegian Point
Point No Point
Point No Point Treaty Site 1855
Pt. Hannon
Pilot Pt
Egion
Salsbury Pt
Port Gamble
PORT GAMBLE INDIAN RES.
HANSVILLE ROAD
Apple Cove Point
Kingston
Edmonds
Edwards Point
Approx. crossing time 30 min.
Woodway
Point Wells
Picnic Point
Norma Beach
Lynnwood
Edmonds Community College
Mountlake Terrace
Brier
Mill Creek
Clearview
Maltby
Kenmore
Bothell
Lake Forest Park
Shoreline Community College
Woodinville
Hollywood
St. Edward
Juanita
Kirkland
Yarrow Pt.
Hunts Pt.
Evergreen Pt
Medina
Groat Pt
Clyde Hill
Bellevue
Beaux Arts
Mercer Island
Seattle
Duwamish Head
Alki Point
Meadow Point
West Point
Fay Bainbridge
Point Monroe
Keyport
Sandy Hook
Pt Bolin
Arrow Pt
Battle Point
Brownsville
BAINBRIDGE ISLAND
Univ. Pt.
Rolling Bay
Skiff Point
Yeomalt Pt
Winslow
Wing Point
Creosote
Lynnwood
Port Blakely
Illahee
Pt White
Glover Pt
Fort Ward
Restoration Point
Beans Pt
Orchard Pt
Manchester
TOLL FERRY
Approx. crossing time 60 min.
PORT MADISON INDIAN RES.
President Point
Point Jefferson
Indianola
Chief Sealth's Grave
Suquamish
Old Man House
Agate Pt.
Totem Symbols
Poulsbo
ISLAND KITSAP
KITSAP KING
SNOHOMISH ISLAND
ISLAND KITSAP SNOHOMISH
BURLINGTON NORTHERN
HEWITT
HOME ACRES RD
Fobes
Snohomish
WOODINVILLE MARSH ROAD CUTOFF
128TH ST
132ND ST
164TH ST
196TH ST
220TH ST
228TH ST
205TH ST
244TH ST
175TH ST
145TH ST
124TH ST
116TH ST
85TH ST
70TH ST
132ND NE
100TH NE
80TH AVE NE
36TH AVE
MALTBY RD
PENNEY CR RD
BOND RD
Ap Memorial

PROJECT PLANNING

Selection of Candidate Structure: Criteria was established for selecting a suitable structure for the demonstration project. A number of structures were reviewed to find an acceptable structure that satisfied the criteria.

The structure needed to have a deck area of approximately 10,000 square feet in order to keep the project costs down. Electric power had to be available in the area to energize the cathodic protection system. It was desirable to have a bridge with two-lane traffic in one direction. Traffic during construction could be narrowed to one lane if necessary. For contract administration, the bridge would have to be included in an upcoming contract in the near future. The bridge deck should be chloride contaminated with active corrosion. It was desirable that deck repairs were not too extensive. Lastly, the top mat rebar needed to be deep enough to accommodate the saw cut slots in the deck.

The Woodinville ramp was selected. A final bridge deck survey was made by the Washington State Department of Transportation to check the existing condition of the deck.

Effect of Slots on Motorcycles: There was concern by the Washington State Department of Transportation on the effects to motorcycles of the 3/4" by 3/4" saw cut slots running longitudinally on the deck at one-foot centers. The saw cut slots would be filled with conductive polymer to grade, and covered with silica sand for skid resistance. However, the slots might have some effects on motorists, particularly motorcycles.

A telephone survey was therefore conducted of states that had installed the slotted system to see if the slots had any effects on motorists. Virginia Department of Transportation, Ohio Department of Transportation, Minnesota Department of Transportation, city of Akron, Ohio and FHWA indicated no problems with the longitudinal slotted system. West Virginia was using a transverse slotted system with no problems from motorists.

PROJECT DESIGN

For this demonstration project, it was considered desirable to contract the work by performance specification rather than detailed plans. This gave the contractor some flexibility in accomplishing the work and made him more responsible for the final product.

The essential components of the cathodic protection system were called out in the contract special provisions. The supplier of the system was limited to either HARCO or Norton, two firms that had done previous cathodic protection work for the Washington State Department of Transportation. Supervision of the work was to be done by a licensed NACE qualified engineer.

Submittals required of the supplier of the system included a project proposal, shop plans, maintenance and operation manuals, and as-built drawings. All submittals were subject to engineer approval.

PROJECT CONSTRUCTION

General Description: The ES ramp in the Woodinville Interchange is the first bridge deck cathodic protection project the Washington State Department of Transportation has constructed under the FHWA Demonstration Project 34. The 10-year-old structure is a box girder bridge 35 feet wide and slightly longer than 300 feet. The structure carries one-way traffic.

A bridge deck survey was conducted to determine the condition of the deck and its suitability for an impressed current cathodic protection system. The deck was found to be contaminated with chlorides. Repairs were not too extensive and the top mat rebar had sufficient cover to accommodate a slotted cathodic protection system.

The contractor began the project by cutting the 3/4" by 3/4" slots in the deck using a concrete saw. The secondary anode slots are spaced at one-foot centers transversely and run longitudinal to the bridge. The primary slots were run perpendicular to the roadway center line and were spaced at 25 feet. Previous testing on this system has indicated good current distribution to the top mat steel using a one-foot slot spacing.

In this instance, the contractor used two cutting blades spaced slightly apart to make his slot cuts. This left a small section in the middle of the cut. This small section in the middle of the cut was then removed manually by breaking and prying it out with a long steel bar. It may have been easier to saw the entire 3/4" by 3/4" section out at one time, as has been accomplished on other projects.

The next operation was to clean out the slots by sandblasting. Very fine debris accumulates in the slots from the cutting operation. Cooling water from the concrete saw mixes with the very fine cuttings to form a very slippery paste on the deck. This paste dries and hardens in the saw slots. Any rebar that was nicked during the cutting operation was coated with a non-conductive polymer. This was necessary to prevent grounding of the current carrying anode system.

Per FHWA recommendation, all of the slots were pachometered to ensure that there was at least 1/2 inch from the bottom of the slot to the top of the rebar. This further ensures that no grounding of the electrical current will occur. Where there was less than 1/2-inch cover, the bottom of the slot was coated with a non-conductive polymer by brush also.

Very fine platinum-niobium-copper wire is used as the primary anode to distribute the current to the deck. The secondary anode strand is made of a conductive carbon. This is used where possible since it is less expensive than the platinum wire. Both platinum wire and carbon strand are placed in the sawed slots and held temporarily by wads of putty. The putty is removed just prior to placing the conductive polymer in the slots.

Control of the electrical current to the various zones of the cathodic protection system is accomplished by the embedment of silver-silver chloride reference cells in the deck of the bridge. These devices measure electrical potential in volts and thus control the current output of the system rectifier. The Goodall Rectifier can be preselected voltage controlled, current controlled, or potential controlled. The Woodinville Project is potential controlled.

The rebar probe is a Number 5 rebar encased in a small concrete block. The block has been spiked with heavy concentrations of chlorides. This device also plays a part in the cathodic protection current control. The concept is that if we provide enough current to protect this heavily chloride contaminated rebar, then we are supplying sufficient current for the deck to protect all other existing rebar. Cutouts are made in the deck to install the reference cells and rebar probes. Holes are drilled through the adjacent curbs for control wiring from the instruments to the outside PVC conduit.

Mixing of the conductive polymer is done on site. The contractor on this project had the luxury of being able to close down the structure totally to traffic. Traffic was detoured to another route. This allowed the contractor total access to the deck at all times. It is recommended this procedure be followed in this type of work if possible. Component A and B of the polymer, gray pigment, and powdered carbon are mixed together in 5-gallon pails. The carbon additive gives the mixture current carrying properties. If the carbon is not present, the polymer is an insulator and is suitable to coat nicked rebar during the slot cutting operation.

The conductive polymer is then poured into plastic bags from the 5-gallon mixing pails. One corner of the plastic bag is snipped off with scissors and then a workman is ready to squeeze the material into the precut deck slots. A lot of skill is required during this operation to get the right amount of polymer into the slots and to do a neat job.

After the conductive polymer is put in the deck slots, silica sand is lightly sprinkled on the surface of the polymer. This gives the surface of the polymer skid resistance. Apparently, no way of mechanizing the installation of the conductive polymer has been developed to date. Samples of the conductive polymer are collected and sent to the Materials Laboratory for testing.

All power and control wiring is run in PVC conduit that is attached to the outside of the concrete parapet. The PVC is gray in color and blends well with the lines of the bridge. PVC C-clamps at NEMA required spacings are used to support the conduit. Stainless steel inserts attach the clamps to the concrete.

Appropriate expansion devices for the PVC conduit should be provided at regular intervals, as PVC has a coefficient of thermal expansion different than concrete. Three pieces of electrical equipment stationed just at the end of the bridge are necessary for power control; the transformer, the rectifier, and the rectifier junction box.

Project Costs: Bid prices for the cathodic protection system ranged from $50,000 to $85,000. The contractor who was awarded the project submitted a bid of $60,000. This amounts to $5.71 per square foot. This figure is comparable with other similar projects of this nature.

Shop Plans: Cathodic protection shop plans submitted by the system supplier needed very few corrections. Most of the changes to the shop plans concerned details involving electrical equipment. All plans were returned approved or approved as noted from the Washington State Department of Transportation.

Change Order Work: During the installation of the system, the project was visited by Don Jackson, FHWA Demonstration Project 34 Manager. Per his suggestion, there needed to be a minimum of 1/2 inch below the bottom of the saw cut slot and

the top of the deck reinforcing. This was necessary, in his opinion, to prevent shorting of the current from the anode to the rebar.

The HARCO system supplier did not agree with this requirement. The Department of Transportation representative elected to implement Mr. Jackson's suggestion.

All of the cut slots were pachometered. Those slots that had less than 1/2-inch cover were coated at the bottom of the slot with a non-conductive polymer. Coating was done by hand with a brush.

Also per Mr. Jackson's suggestion, a splice in the deck between the primary anode and a Number 12 copper wire was eliminated. Splices in the deck are not desirable due to the chance of a faulty connection.

PROBLEM AREAS

Problem areas that need to be addressed for this system:

1. A more positive method of finding grounding locations from the anode to rebar nicks, ties, etc. needs to be developed. Perhaps an instrument can be used to supplement visual inspection.

2. The necessity for having a minimum of 1/2-inch cover from the bottom of the slot to the top of the rebar needs to be resolved.

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CONCLUSIONS

For a new construction system, the installation went relatively smooth. Some areas of concern, as listed in the "PROBLEM AREAS" section, need to be overcome to obtain a better quality product. The demonstration project was a good learning experience for everyone involved.

APPENDIX

APPENDIX A

BRIDGE DECK SURVEY REPORT

Washington State Department of Transportation

INTRA-DEPARTMENTAL COMMUNICATION

DATE: JUN 2 5 1984

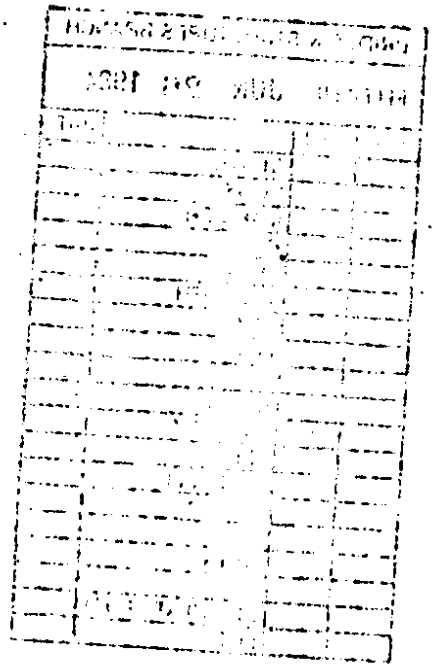
FROM: K. E. Whalen
PHONE: SCAN 443-4258

SUBJECT: SR-522 L-7636
Bridge No: 522/30 E-8

TO: C. S. Gloyd, Bridge Engineer
KF-01

Transmitted are copies of the field data for the following bridge deck evaluation tests as checked:

- X Chloride Sample Locations
- X Chain Drag (Delaminations)
- X Half-Cell
- X Pachometer
- X Wheel Path Wear Measurements
- X Chloride Sample Test Results



KEW:sl
Attach.
cc: Project Engineer
A. J. Peters
D.M.F.

t. of Transportation
erials Laboratory
. Box 167
mpia, WA 98504

District 1
Section
Job No. L-7636 SR 522 C.S.
Date Sampled 5-15-84 Crew Ron Mitchell

BRIDGE DELAMINATIONS

ge E-S Ramp Sammamish R. No. 522/30 E-S
gth 300' Width 35' Skew yes Curve yes Sealed no
tioning measured from North Bridge seat (STA. 74+96.09) Ending (STA. 77+96.09) Along E.S. ℄

STATION	LEFT	RIGHT	LENGTH OR WIDTH	NUMBER OR SQ. FT.	REMARKS
2+31		2' RT	1'4" x 2'3"	1.5'	
2+77		℄	3' x 2'3"	6.75'	Exposed rebar
3+13		18' RT	8" x 9"	0.5'	Exposed Rebar
3+10		8' RT	6" x 21'	10.5'	All Along South Bridge Seat
2+74	2' LT		4'4" x 1'6"	6.45'	Exposed Rebar
2+98	6' LT		6" x 11'	5.5'	All Along South Bridge Seat

COMPUTED BY

DEPARTMENT OF TRANSPORTATION

Hqtrs.
Lab No.

Half Cell Potentiometer Test Results

pt. of Transportation
terials Laboratory
O. Box 167
ympia, WA 98504

District 1
Section
Job No. 7636 SR 522 C.S.
Date Sampled 5-15-84 Crew VFW, BB

idge E.S. Ramp Snoqualmie No. 522/30E.2.
ngth 300' Width 35' Skew ✓ Curve ✓ Sealed
tioning measured from NORTH bridge seat (STA 74+96) ending (STA. 77+96) along E.2.4.

Ground @ 1+50 used for entire bridge
used 3-A half cell and the CPV-H voltmeter

tion						15'	10'	5'	℄	5'	10'	15'						Station Const. Joints
–						.018	.001	.010	.03	.06	.05	.07						
+10						.016	.004	.009	.04	.02	.01	.02						
–						.010	.009	.017	.00	.00	.01	.01						
+20						.004	.017	.025	.00	.01	.00	.00						
–						.010	.004	.025	.01	.00	.00	.01						
+30						.016	.024	.032	.01	.00	.01	.01						
–						.008	.030	.035	.02	.00	.00	.00						FROM ℄ R.T
+40						.041	.036	.051	.01	.00	.01	.00						USED 2C VOLT
–						.022	.034	.050	.02	.01	.02	.01						SCALE, STA 0+00
+50						.034	.034	.048	.00	.01	.02	.00						TO STA. 1+75
–						.047	.021	.045	.02	.00	.01	.00						
1+60						.020	.017	.032	.00	.01	.00	.00						
–						.044	.009	.029	.00	.00	.02	.01						
+70						.036	.023	.030	.03	.00	.01	.00						
–						.038	.014	.011	.02	.01	.01	.00						
1+80						.044	.018	.041	.00	.01	.01	.00						

Bridge 522/30 E.S. L7636 — 5/15/84

Station	15'	10'	5'	℄	5'	10'	15'	
	.028	.010	.018	.00	.02	.01	.01	
0+90	.026	.001	.016	.08	.03	.00	.00	
	.017	.072	.049	.05	.01	.01	.01	
1+00	.040	.018	.125	.03	.03	.01	.02	
	.115	.042	.005	.01	.00	.01	.02	
1+10	.015	.100	.093	.04	.05	.00	.02	
	.004	.028	.008	.03	.02	.01	.01	
1+20	.039	.016	.007	.02	.01	.00	.01	
–	.012	.006	.017	.01	.01	.01	.00	
1+30	.043	.007	.034	.02	.00	.00	.05	
–	.038	.015	.034	.03	.00	.01	.01	
1+40	.033	.023	.046	.00	.01	.02	.00	
–	.004	.025	.047	.01	.01	.01	.01	
1+50	.039	.012	.012	.05	.01	.00	.01	Ground at
	.073	.044	.033	.00	.00	.00	.00	1+50 ℄
1+60	.054	.041	.059	.01	.02	.02	.01	
–	.057	.080	.041	.02	.01	.01	.01	2 digit Readings
1+70	.067	.046	.058	.00	.01	.00	.069	used 30 VOLT scale
–	.051	.040	.040	.01	.00	.00	.016	
1+80	.053	.023	.051	.014	.012	.000	.026	3 digit Readings
–	.035	.014	.047	.016	.003	.024	.021	Used 2.0 VOLT
1+90	.026	.026	.040	.006	.003	.019	.015	scale
–	.045	.034	.047	.014	.011	.021	.009	
2+00	.013	.046	.011	.00	.009	.005	.022	

Bridge No. 522/30 G.S. L7636 Sheet 3 of 3 5/15/84

Station Const. Joints

Station	15'	10'	5'	℄	5'	10'	15'
	.046	.024	.038	.056	.017	.051	.009
2+10	.105	.043	.047	.075	.026	.017	.009
	.031	.017	.034	.058	.041	.047	.026
2+20	.036	.011	.015	.046	.031	.004	.014
	.019	.009	.014	.065	.036	.003	.013
2+30	.026	.004	.006	.067	.025	.019	.014
	.049	.016	.029	.030	.006	.013	.020
2+40	.029	.007	.010	.061	.022	.004	.008
	.033	.022	.024	.102	.046	.005	.003
2+50	.042	.006	.011	.038	.018	.016	.004
	.050	.026	.034	.036	.023	.016	.017
2+60	.047	.013	.032	.010	.016	.029	.020
	.039	.016	.033	.007	.024	.029	.003
2+70	.016	.017	.013	.024	.012	.011	.035
	.043	.008	.013	.075	.002	.011	.031
2+80	.045	.040	.040	.138	.034	.014	.021
	.021	.006	.046	.043	.006	.026	.030
2+90	.010	.023	.026	.025	.034	.023	.003
		.060	.068	.050	.004	.015	.011
3+00				.019	.038	.008	.026
					.004	.016	.013
3+10						.050	.060

DEPARTMENT OF TRANSPORTATION
REBAR COVER IN INCHES

Hdqtrs.
Lab No.

...t. of Transportation
...terials Laboratory
...O. Box 167
...mpia, WA 98504

District 1
Section
Job No L-7636 SR 522 C.S.
Date sampled 5-15-84 Crew
CLAYTON

...dge E-S Ramp Sammamish R. No. 522/30 E-S
...gth 300.0' Width 35.0' Skew L Curve L Span
...tioning measured from North bridge seat STA ~~ENE~~ 74+96 ...ering STA ~~END~~ 77+96 along ℄
...#6 bar @ 6" CTS. James rolling Pachometer

Station & % Section	RT. 15.0'	10.0'	5.0'	℄	5.0'	10.0'	15.0' LT.	Station Const. Joints
–	2"		1 3/4"	1 7/8	1 7/8	1 3/4	3 7/8	
– 0	2"		1 3/4"	1 3/4	1 7/8	1 7/8	2 1/2	
–	2"		2"	1 7/8	1 7/8	1 7/8	2 7/8	
+ 20	2"		2"	2	1 7/8	1 3/4	2 7/8	
–	1 3/4	2 3/8	1 3/4"	2	1 5/8	1 5/8	2 1/4	
+30	2	1 3/4	1 3/4"	1 7/8	1 3/4	1 7/8	2 1/2	
–	2	1 7/8	1 3/4"	1 7/8	1 7/8	1 7/8	2 1/2	
+40	1 7/8	1 7/8	2"	1 7/8	1 7/8	1 7/8	2 7/8	
–	1 3/4	1 7/8	1 3/4"	1 7/8	1 3/4	1 3/4	2 3/4	
+50	2	1 7/8	2"	1 7/8	1 7/8	1 7/8	2 3/4	
	2 1/4	1 7/8	2"	2	2 1/8	2	2	
)+60	2 1/8	2	2"	1 7/8	2 3/4	2	3 1/8	
–	2	2 1/4	2"	2 3/8	2 3/8	2	3 3/8	
)+70	2 1/8	2 1/2	2"	2 1/8	1 7/8	1 7/8	3 1/4	
–	2 1/2	2 1/2	2"	2 1/4	2	1 3/4	2 7/8	
)+80	2 1/2	2 1/2	1 1/8"	2 1/8	1 7/8	2	2 5/8	

Bridge

tion	RT. 15'	10'	5'	℄	5'	10'	15'	LT	Joints
	2 1/4	2 1/8	2 1/8"		2 3/8	1 7/8	1 5/8	2 5/8	
+90	1 7/8	2 5/8	2"		2 1/8	1 3/4	1 7/8	2 3/4	
	2	2 5/8	2"		2	1 7/8	1 7/8	3 3/8	
+00	2 1/4	2	2"		2 1/8	1 7/8	1 7/8	2 1/2	
	2 1/4	2 1/4	2"		2 1/8	1 7/8	2	2	
+10	2	2 5/8	2 1/8"		2	1 7/8	1 3/4	2 3/8	
	1 3/4	2 3/8	2"		1 7/8	1 7/8	1 5/8	2 3/8	
+20	2	2 3/8	1 3/4"		1 5/8	1 7/8	1 5/8	2 1/2	
–	1 3/4	2 1/4	1 3/4"		2	1 7/8	1 3/4	2 1/2	
+30	1 7/8	1 7/8	1 3/4"		1 7/8	1 7/8	1 7/8	2 3/4	
	1 7/8	1 7/8	1 3/4"		1 7/8	1 7/8	1 7/8	2 3/4	
+40	2	1 3/4	2"		1 7/8	1 7/8	1 7/8	3 1/8	
–	2	1 7/8	2 1/4"		2 3/8	1 7/8	1 7/8	2 1/2	
1+50	2 1/4	1 3/4	2 3/4"		1 7/8	2	1 7/8	2 1/2	
	2	2	2 3/4"		2 3/8	2	1 3/4	2 5/8	
1+60	2 1/8	2 1/2	2"		2	2	1 7/8	3	
–	2	2	2"		1 7/8	1 7/8	1 7/8	2 1/2	
1+70	1 7/8	2 1/4	2 1/4"		2 1/4	1 7/8	2	2 5/8	
–	1 7/8	2 1/8	2 1/4"		2	2	1 7/8	2 7/8	
1+80	2	2	1 3/4"		2	1 7/8	1 7/8	2 7/8	
–	1 7/8	1 7/8	2"		1 7/8	2	1 7/8	3 3/8	
1+90	1 7/8	2	2"		1 5/8	1 3/4	1 3/4	2 5/8	
–	1 3/4	2	1 3/4"		1 5/8	1 5/8	1 5/8	2 7/8	
1+100	1 3/4	2	1 3/4		1 5/8	1 5/8	1 1/2	2 1/2	

Station	RT	15'	10	5'	℄	5'	10	15'	LT
		1 3/4	1 7/8	1 3/4"	1 5/8	1 5/8	1 1/2	2	
10		1 7/8	1 5/8	1 3/4"	1 5/8	1 5/8	1 1/2	2 1/8	
		1 3/4	1 3/4	1 3/4"	1 5/8	1 5/8	1 1/2	1 7/8	
20		1 3/8	1 3/4	1 3/4"	1 5/8	1 5/8	1 1/2	1 7/8	
		1 3/8	1 7/8	1 3/4"	1 5/8	1 5/8	1 1/2	2 5/8	
30		1 3/4	1 3/4	1 3/4"	1 5/8	1 5/8	1 1/2	2	
		2 1/8	1 1/2	1 3/4"	1 5/8	1 5/8	1 5/8	2 7/8	
40		2	1 7/8	1 3/4"	1 5/8	1 5/8	1 1/2	2 3/4	
		1 7/8	1 7/8	1 5/8"	1 5/8	1 5/8	1 1/2	2 3/4	
50		2	1 7/8	1 5/8"	1 5/8	1 5/8	1 5/8	2 7/8	
		1 3/4	1 7/8	1 3/4"	1 3/4	1 5/8	1 5/8	3 1/2	
60		1 7/8	1 3/4	2"	1 7/8	1 5/8	1 1/2	2 1/2	
		1 7/8	1 3/4	1 3/4"	1 5/8	1 1/2	1 1/4	1 5/8	
70		1 7/8	1 3/4	1 3/4"	1 1/2	1 1/2	1 3/8	2 3/8	
		2 3/8	1 7/8	1 3/4"	1 1/2	1 1/4	1 5/8	1 5/8	
80		2	1 3/4	1 3/4"	1 1/2	1 5/8	1 5/8	1 5/8	
		2 1/8	2 3/8	2"	1 5/8	1 7/8	1 1/2	2	
90		2	2 7/8	2 1/4"	1 7/8	1 3/4		1 7/8	
		2 1/2	2 1/2	2"	1 7/8	1 7/8			
00		1 3/4	2 1/4	2"	1 7/8				
			1 5/8						
10									

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

Sheet 1 of 1

t. of Transportation
rials Laboratory
. Box 167
mpia, WA 98504

District 1
Section
Job No: L-7636 SR 522 C.S.
Date Sampled 5-15-84 Crew Ron Mitchell

WHEEL RUT MEASUREMENTS

Type E-S Ramp Sammamish R. No. 522/30 E-S
gth 300' Width 35' Skew yes Curve yes Sealed no
tioning measured from North Bridge seat (STA 74+96.09) Ending (STA 77+56.09) Along C.S. ℄

STATION	LT		℄	RT	DEPTHS					
0+25	3/16"	1/16"	0	0						
0+50	1/16"	0	0	0						
0+75	0	0	1/16"	0						
1+00	0	0	0	1/16"						
1+25	0	0	0	0						
1+50	0	0	1/16"	0						
1+75	1/16"	0	1/16"	0						
2+00	0	0	0	0						
2+25	0	0	0	0						
2+50	0	0	0	0						
2+75	1/16"	0	0	0						
3+00	0	0	1/16"	1/16"						
3+25										
3+50										
3+75										
4+00										
4+25										
4+50										
4+75										
5+00										
5+25										

DEPARTMENT OF TRANSPORTATION

LAB NO. CL 1782

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MAY 29 1984
SOILS OFFICE

of Transportation
Soils Laboratory
Box 167
WA

FILE

District 1
Section
Job No. 27636 SR 522 C.S.
Date Sampled 5-15-84 Harris
Ditch

E-S ramp Sammamish R 522/30 E-S
300 35ft yes Curve yes No
E-S E from North pavement Seat
sta 74+96 Ending sta 77+96

PORTLAND CEMENT CONCRETE SAMPLES FOR CHLORIDE CONTENT ANALYSIS

SAMPLE	STATION	OFFSET (Feet)	SAMPLE DEPTH	REBAR DEPTH	CHLORIDE LB/YD3
1	0+05	7'rt	1¼" to 1¾"	1¾"	6.02
2	0+50	7.5'rt	1¼" to 1¾"	1¾"	2.45
3	0+90	11.0'rt	1¼" to 1¾"	1¾"	3.84
4	1+30	14.0'rt	1" to 1½"	1½"	2.21
5	1+70	10.0'rt	1¼" to 1¾"	1¾"	3.47
6	2+10	2.5'rt	¾" to 1¼"	1¼"	6.17
6	2+50	15.0'rt	1" to 1½"	1½"	1.56
7	0+25	12.0'Lt	1" to 1½"	1½"	1.62
8	0+65	7.0'Lt	1½" to 2"	2"	1.17
9	1+05	2.0'Lt	1¼" to 1¾"	1¾"	3.64
10	1+45	17.0'Lt	1¼" to 1¾"	1¾"	0.84
11	1+90	5.0'Lt	1¼" to 1¾"	1¾"	1.98
12	2+30	2.5'Lt	¾" to 1¼"	1¼"	4.86
13	2+75	11.0'Lt	¼" to ¾"	¾"	5.58
14					
			AVG. 3.24 LBS PER YD3		

Remarks:

T2 B2-14
Materials File x
Central File x
Admin. x
Dist. Engr. Whalen x (2)
x

Knier x

R. E. Whalen
District Soils Engineer

Date 5-23-84

A. J. Peters, P.E.
Materials Engineer

By R. E. WHALEN, DIST. MATLS. ENGR.

C. L. Sherrell

APPENDIX B

CONTRACT SPECIAL PROVISIONS

Part 5 Measurement

5.01

A. Measurement for this item of work, excluding the work required for further deck preparation and the subsequent filling of the prepared areas, will be made by the square yard of overlay in place.

Part 6 Payment

6.01

A. Payment for this item of work, excluding the work required for further deck preparation and the subsequent filling of the prepared areas, will be made at the unit contract price per square yard for "Special Concrete Overlay", which price shall be full compensation for all material, labor, tools and equipment necessary to complete the work specified in accordance with the plans, these special provisions and the standard specifications.

All costs involved with furnishing and installing the epoxy-coated welded wire fabric as shown in the Modified Expansion Dam Detail shall be incidental to and included in the unit contract price per square yard for "Special Concrete Overlay".

B. Payment for the work required for further deck preparation and the subsequent filling of the prepared areas will be made by force account in accordance with section 1-09.6 of the standard specifications. For the purpose of providing a common proposal for all bidders, and for that reason only, the State has estimated the cost of the item "Further Deck Preparation" and has arbitrarily entered the amount in the bid proposal to become a part of the total bid by the Contractor.

CATHODIC PROTECTION SYSTEM

The Contractor shall furnish a proposal document by the supplier of an embedded wire non-overlay cathodic protection system to be used on the deck of the E-S Ramp (522/30 E-S) to the Engineer for approval. The total length of the ramp is 300 feet 9 3/4 inches. The width curb to curb is 35 feet. The scope of the work to be covered under this item shall include but not be limited to cutting slots and filling cut slots in the concrete deck for primary and secondary anodes, furnishing all electrical conduit, wiring, rectifiers, connections, and hardware; installing, energizing and adjusting a complete cathodic protection system for the deck area. The conductive polymer poured in the slots shall have a gray color pigment added to match the existing concrete. Silica sand shall be broadcast over the installed

conductive polymer. All slots and conductive polymer shall be installed to clean neat lines.

Electrical power source is available where shown in the plans. The Contractor shall furnish and install all equipment necessary to bring power to the bridge. All electrical work shall comply with the requirements of the National Electrical Code. Conduit where required shall be PVC rigid wall schedule 40. Concrete fasteners shall be stainless steel or other approved corrosion resistant material. This system shall be installed after deck repair is complete as specified in the special provision.

The cathodic protection system shall include a minimum of five permanent reference cells (half-cells), five resistance type corrosion rate probes and five thermocouples installed in the deck for monitoring the system.

The Contractor shall submit to the Engineer for approval all drawings, detail plans and calculations for this sytem. Six sets of prints shall be submitted to the Engineer for approval. Approval of drawings and details shall be understood to be an acceptance rather than a check on the system. No changes shall be made to any drawing after it has been approved, except by the consent or direction of the Engineer in writing. No material shall be purchased or fabricated and no work shall be done on preparation of the deck surface or installation of any part of the system until the plans have been approved by the Engineer and confirmation of such approval has been received in writing by the Contractor.

Prior to the completion of the project, the Contractor or his supplier shall furnish the original drawings of the as-built system to the Engineer. All drawings shall be on sheets conforming in size to the provisions of section 1-05.3 of the standard specifications. In addition, the Contractor shall furnish three complete sets of operating and maintenance instructions to the Engineer.

To aid in assuring proper installation of the cathodic protection system, the Contractor shall have available during installation of the system the services of a qualified full-time field representative in the employ of the system supplier. This representative shall be qualified in the field of cathodic protection of reinforced structures. The representative shall provide instructions and training of State personnel in the operation and maintenance of the system.

To help in having the system properly energized and adjusted for proper operation, the Contractor shall have this work supervised by a Registered Professional Engineer certified by the National Association of Corrosion Engineers as a Corrosion Specialist or other Corrosion Specialist approved by the Engineer.

Testing of this system shall be as recommended by the system supplier. Number and type of tests to be performed shall be approved by the Engineer prior to start of any testing. The results of this testing, the data collected and the findings of the whole study shall be documented and presented to the Engineer for his use.

The Contractor shall also submit to the State a proposal document by the supplier of the cathodic protection system indicating how to maintain, monitor and evaluate the system and prepare periodic performance reports. The proposal document shall cover a period of time of three years after the State has given final acceptance of all work under this contract. Such proposal document shall be furnished to the State before the State shall approve the source of supply for the system. The proposal document shall include an itemized list of activities and costs that describes the labor and materials anticipated to operate and maintain the system in a satisfactory manner. The State shall have the option of entering into an arrangement with the supplier to provide the services contained in the proposal without interference or obligation to the Contractor. Such an arrangement does not relieve the Contractor from providing instruction and training of State personnel in the operation and maintenance of the system before final acceptance of the work as described elsewhere in the contract provisions.

The cathodic protection system supplier shall be one of the following:

1. Norton Corrosion Limited, Inc.
   22327 - 89th Avenue S.E.
   Woodinville, WA 98072
   Tel. (206) 483-1616
   TWX 910 449-2810

2. Harco Corporation
   8305 S.E. Monterey
   #220, Suite A
   Portland, OR 97266
   Tel. (503) 654-5905
   Seattle (206) 282-4880

The Contractor is advised that the State may exclude this item of work from this contract in accordance with section 1-09.5 of the standard specifications.

The lump sum contract price for "Cathodic Protection System" shall be full compensation for all labor, materials, tools and equipment necessary to complete, furnish, install, energize, adjust, evaluate and test the system as specified and as shown in the plans. All concrete patches required for equipment installation, including repairs to damaged areas, if any, and the proposal documents to maintain this system are also included in this item.

APPENDIX C

PROJECT CHANGE ORDERS

ORIGINAL

Sheet 1 of 2
Date 5-2-85

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

CHANGE ORDER

Change Order Number 4

MAY 14 1985

[XXX] Ordered by Engineer under terms of Section 1-04.4 of the Standard Specifications

[ ] Change proposed by Contractor

Endorsed by: Butler-Sealant Co.
Contractor Firm Name

Signature: Patricia A. Stumph Date: 5/5/85

Title: V. Pres.

Consent given by Surety: (when required)

By _____ Attorney-in-fact _____ Date

2814

BUTLER-SEALANT COMPANY
11525 E. MARGINAL WAY S.
SEATTLE, WA. 98168

SR 405
IR-405-3(521)
WOODINVILLE I/C BRIDGE DECKS - RESURFACING

DESCRIPTION OF WORK

You are ordered to perform the following described work upon receipt of an approved copy of this change order:

The contractor shall coat the bottom of the cathodic protection slots to the satisfaction of the engineer with a non-conductive material. The slots shall be coated where the concrete cover at the steel reinforcement bars is less than ½ inch. Care shall be taken that the sides of the slots remain free of the non-conductive material.

Payment for the additional work shall be by Force Account in accordance with Section 1-09.6 of the standard specifications.

All work, materials and measurement to be in accordance with the provisions of the Standard Specifications and Special Provisions for the type of construction involved

[ ] DISTRICT APPROVAL REQUIRED [XXX] HEADQUARTERS APPROVAL REQUIRED	ORIGINAL CONTRACT AMOUNT	CURRENT CONTRACT AMOUNT	ESTIMATED NET CHANGE THIS ORDER	ESTIMATED CONTRACT TOTAL AFTER CHANGE
	$ 1,556,834.15	$ 1,597,004.17	$ + 600.00	$ 1,597,604.17

DISTRICT USE

APPROVAL RECOMMENDED
Stephen J. Miller 5-2-85
Project Engineer Date

[X] APPROVAL RECOMMENDED [ ] APPROVED

DISTRICT ADMINISTRATOR R. E. BOCKSTRUCK, P.E.

By Charles R. Cook Date

HEADQUARTER'S USE

APPROVED
Allen H. Whitley 5/14/85
Highway Construction Engineer Date

DOT FORM 421 003

ORIGINAL

Sheet 1 of 3
Date 5-2-85

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

CHANGE ORDER

Change Order Number 5

MAY 13 1985

[X] Ordered by Engineer under terms of Section 1-04.4 of the Standard Specifications

[ ] Change proposed by Contractor

Endorsed by Butler-Sealant Co.
Contractor Firm Name
Gabriel A. Humphreys
Signature
5/7/85
Date
Title V. Pres.

Consent given by Surety: (when required)

By _____
Attorney-in-fact
Date

2814

BUTLER-SEALANT CO.
11525 E. MARGINAL WAY S.
SEATTLE, WA. 98168

Sign Route SR 405
Federal Aid No. IR-405-3(521)
Project Title WOODINVILLE I/C BRIDGE DECKS - RESURFACING

DESCRIPTION OF WORK

You are ordered to perform the following described work upon receipt of an approved copy of this change order:

Where directed by the Engineer and as shown on Sheet 3 of 3, the Contractor shall incorporate the following modifications into the Cathodic Protection System.

1. Splices shall be removed from the bridge deck and installed in the rail mounted junction boxes.
2. Platinum wire shall be installed from the transverse anodes back to the junction box.
3. A heat shrink sleeve shall cover the platinum wire from the junction box to a point in the slots where there is no overlap with the monitoring system wiring.
4. Conductive grout shall cover the platinum wire to within 6 inches of the bridge rail; Non-Conductive grout shall be used to fill the remainder of the slot and the hole drilled through the bridge rail for a minimum of 4 inches in each end.

Payment shall be at the lump sum price of $3,474.00 and shall be full compensation for furnishing all materials, labor, tools and equipment necessary or incidental to complete the work.

RECEIVED
MAY 17 1985
PROJ. ENGR. MILLER

All work, materials and measurement to be in accordance with the provisions of the Standard Specifications and Special Provisions for the type of construction involved

[ ] DISTRICT APPROVAL REQUIRED [X] HEADQUARTERS APPROVAL REQUIRED	ORIGINAL CONTRACT AMOUNT	CURRENT CONTRACT AMOUNT	ESTIMATED NET CHANGE THIS ORDER	ESTIMATED CONTRACT TOTAL AFTER CHANGE
	$ 1,556,834.15	$ 1,597,604.17	$ + 3,474.00	$ 1,601,078.17

DISTRICT USE

APPROVAL RECOMMENDED
Stephen J. Miller 5-9-85
Project Engineer — Date

[ ] APPROVAL RECOMMENDED [ ] APPROVED

DISTRICT ADMINISTRATOR R. E. BOCKSTRUCK, P.E.
By Charles R. Cook 5/13/85

HEADQUARTER'S USE

APPROVED
Allan L. Kelley 5/14/85
Highway Construction Engineer — Date

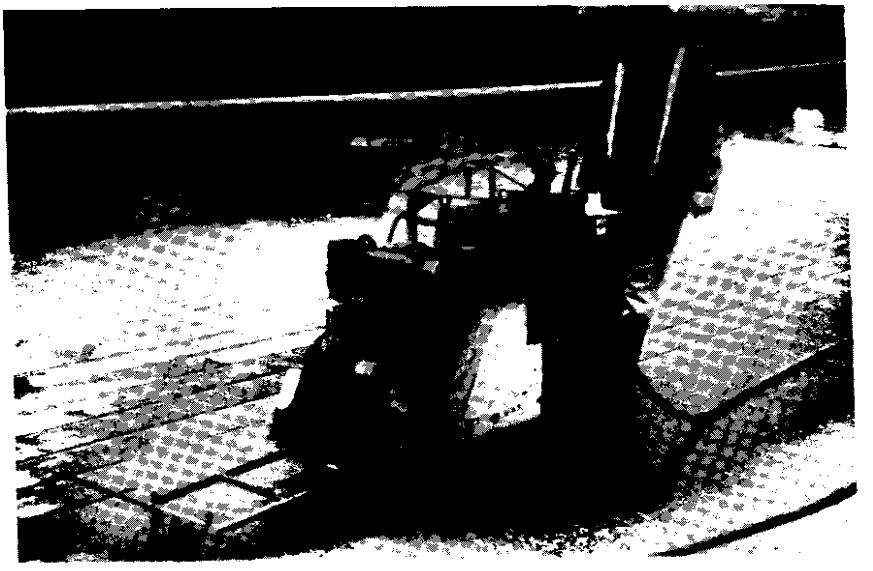
DOT FORM 421 003 REVISED 9 70

APPENDIX D

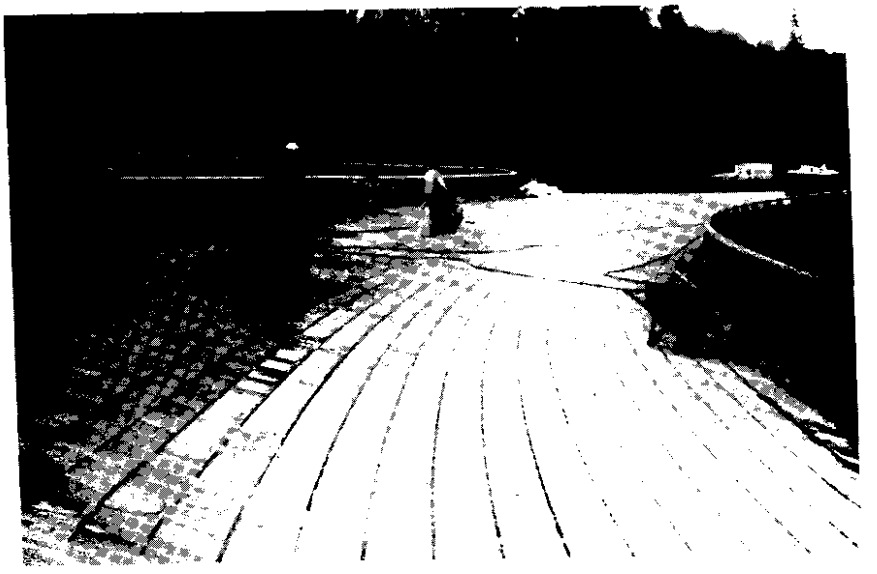
PROJECT PHOTOGRAPHS

Woodinville bridge elevation.

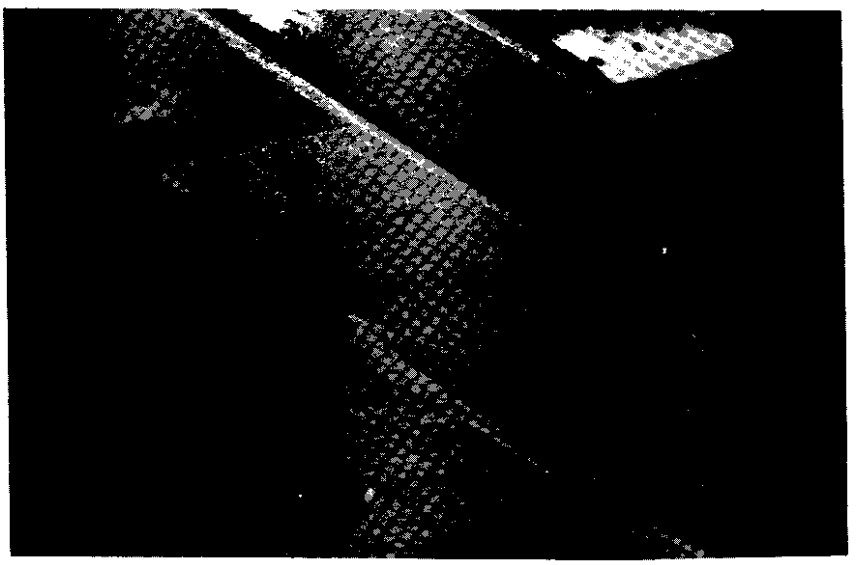
Woodinville bridge deck.



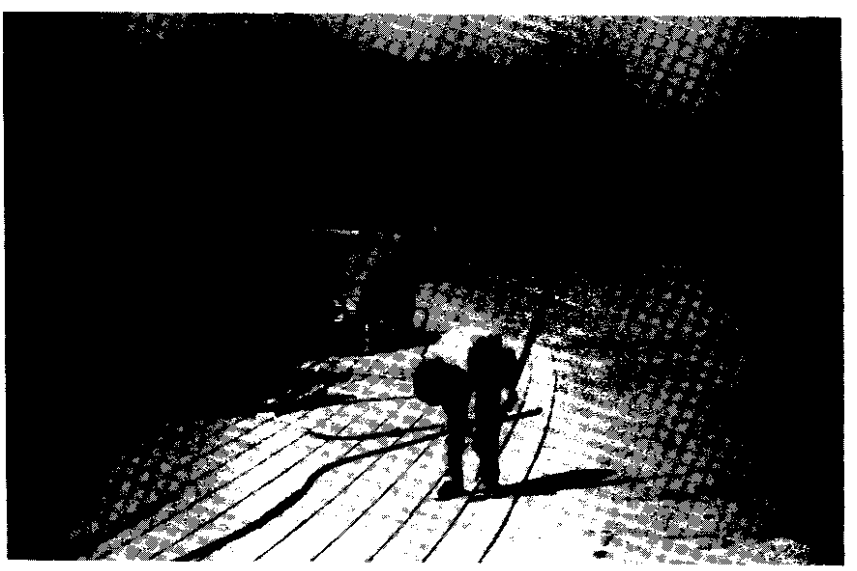
Cutting the 3/4" by 3/4" slots in
the deck using a concrete saw.



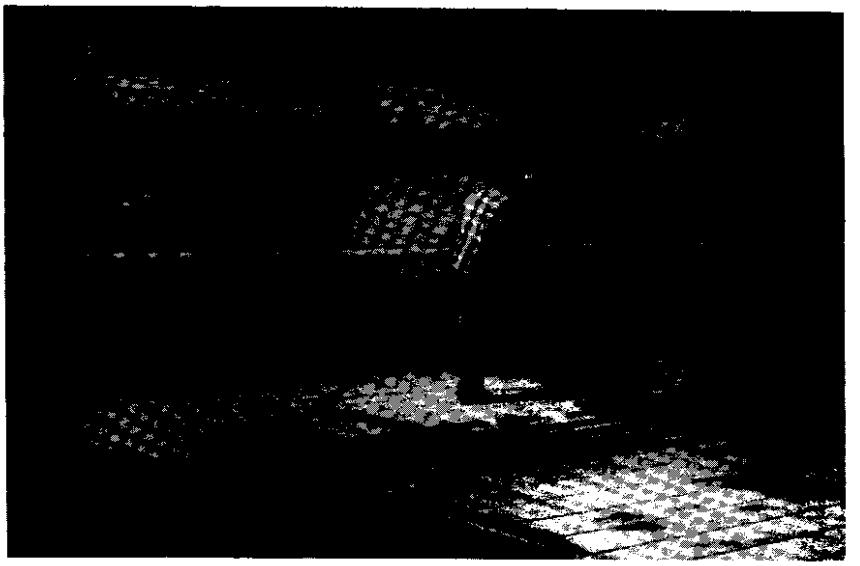
Slots at one foot center running
longitudinal on the deck.



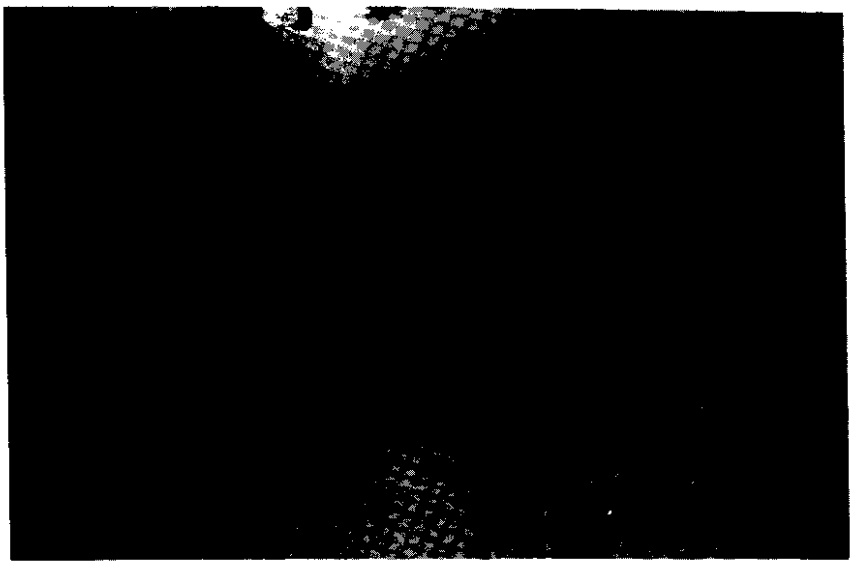
Deck cut slots.



Prying out slot center with
a long steel bar.

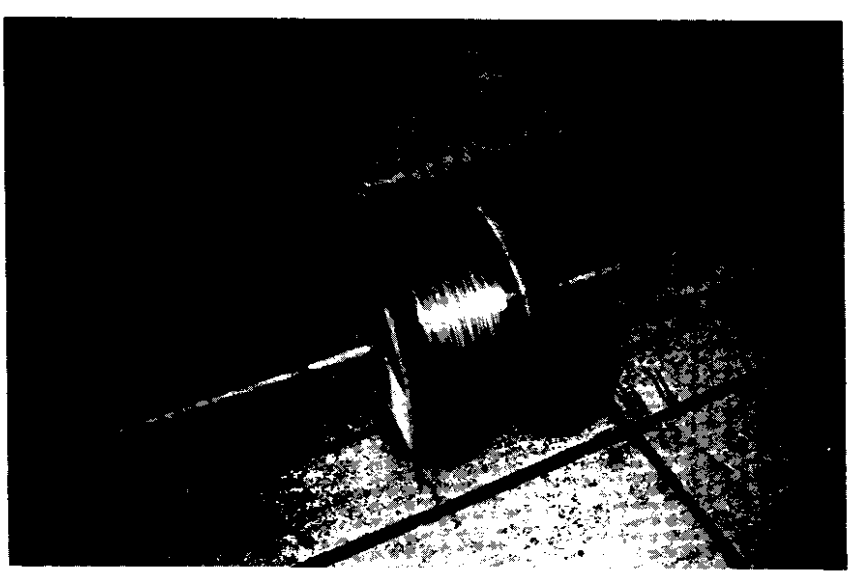


Sandblasting slot and deck debris
from cutting operation.

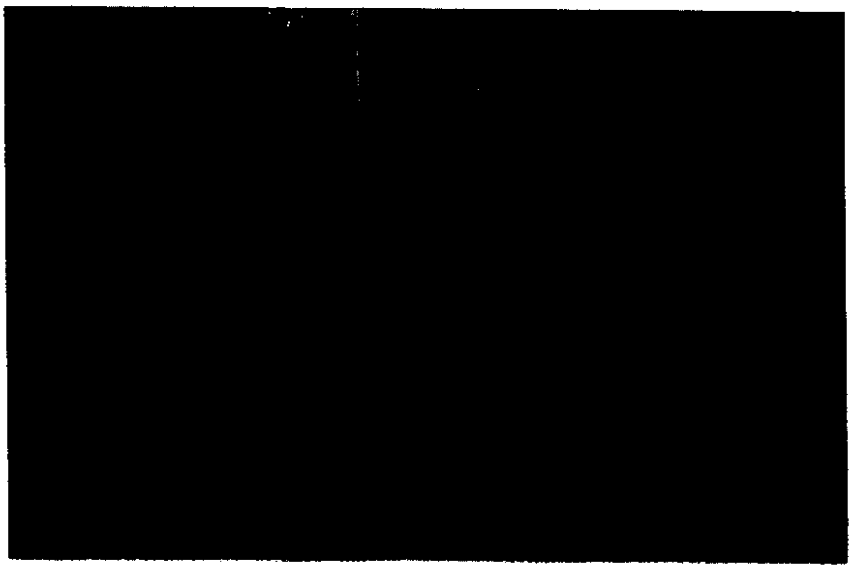


Coating nicked rebar with
a non-conductive polymer.

Pachometering slots to check for 1/2" cover below bottom of slot.



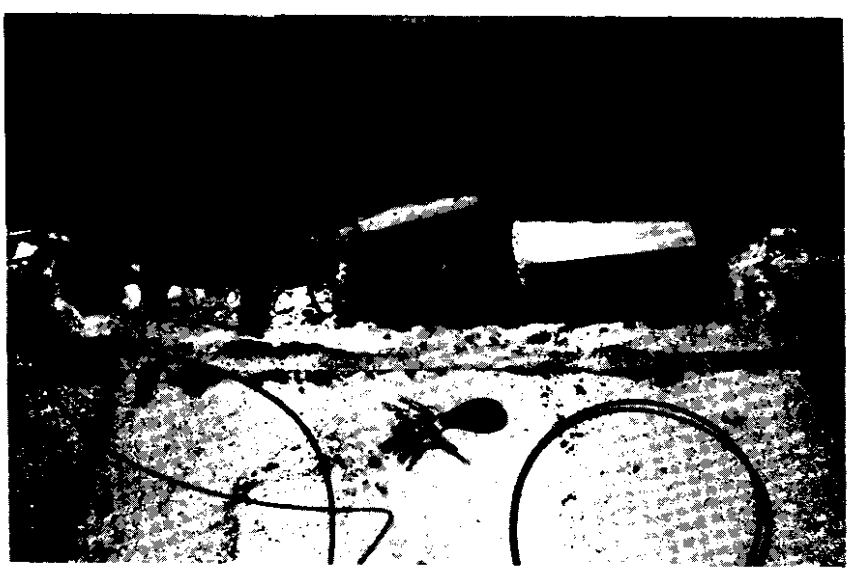
Platinum - niobium - copper wire anode on spool.



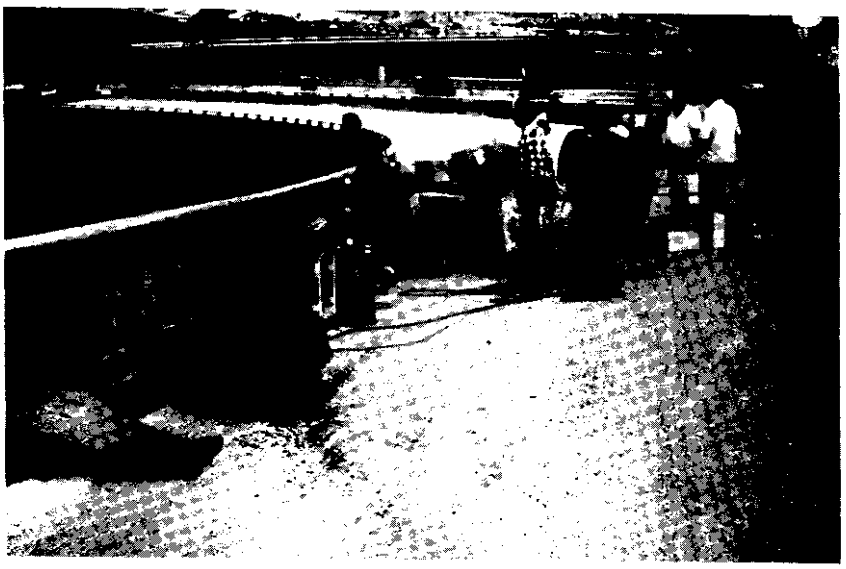
Platinum wire and carbon strand held
in slots by wads of putty.

Reference cell and thermistor
with cloth cover.

Rebar probe laying on deck.



Deck cutouts for installing reference cell, thermistors and rebar probe.



On site mixing of conductive polymer.

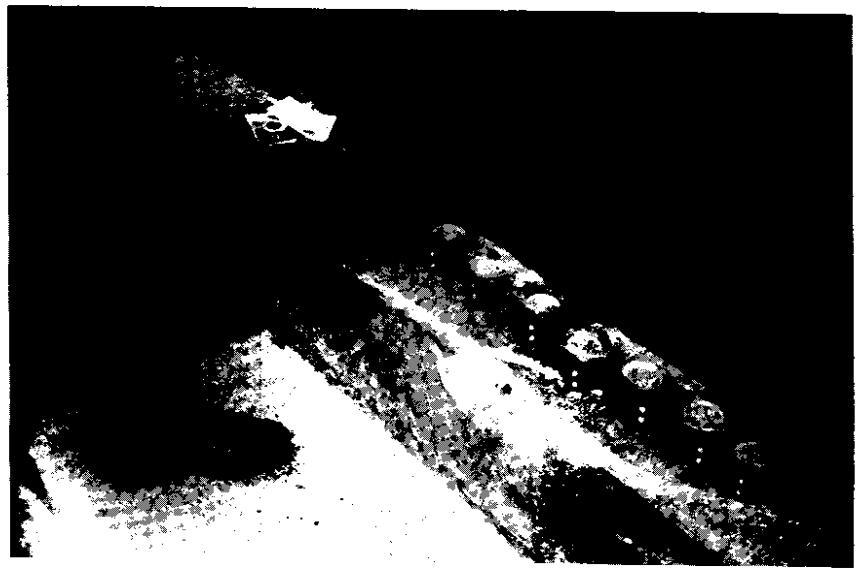
Mixing component A and B, gray pigment,
and powdered carbon in 5 gallon pails.

Pouring conductive polymer into plastic bags.

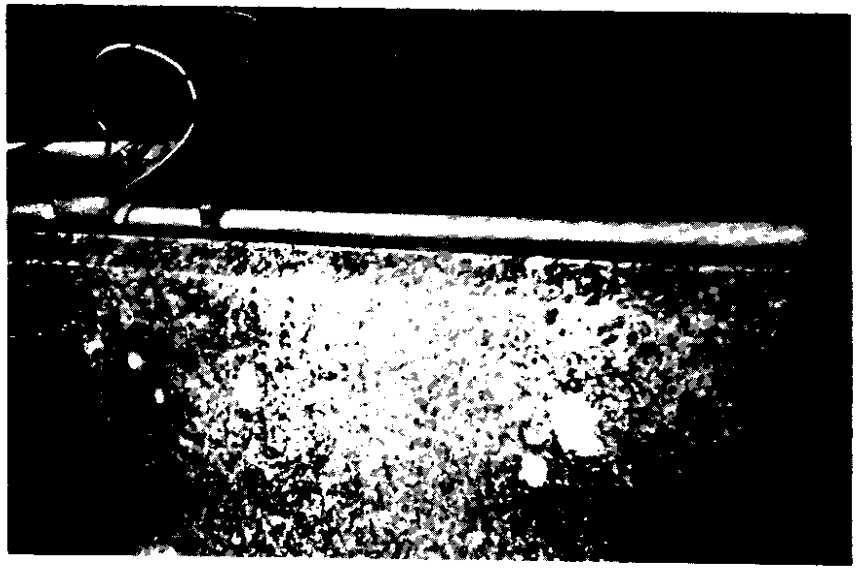
Placing conductive polymer by
hand from plastic bags.

Sprinkling silica sand by hand on the conductive polymer for skid resistance.

Entire crew installing conductive polymer.



Collecting conductive polymer samples
for testing at the Materials Lab.



Longitudinal PVC conduit attached
to outside of bridge parapet.

PVC C-clamps at NEMA spacing
used to support conduit.

PVC conduit expansion devices.