

BRIDGE DECK REPAIR TECHNIQUES

FINAL REPORT

by

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DIVISION OF PLANNING AND PROGRAMMING
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PREFACE

Premature deterioration of concrete bridge decks due to corrosion of reinforcing steel is a serious problem in many parts of the U.S. resulting in very high maintenance costs if decks are to be kept in a safe and serviceable condition. Reinforcing steel embedded in concrete normally has a high resistance to corrosion due to the high pH of concrete, but when salts are used for deicing bridge decks, the resulting brine can leach into the concrete, lowering the pH and thus initiating corrosion of the steel. When the reinforcing steel corrodes, it expands, creating large stresses which eventually spall and crack the concrete at the deck surface. This corrosion process, once started, is difficult to halt.

A number of approaches have been developed with regard to this corrosion problem. One tactic is to find a suitable substitute for the deicing salts presently used. Among the protective methods available, studies have indicated that cathodic protection may be the most promising approach to stop active corrosion, short of removal of all contaminated concrete. Information from recent studies also suggests that waterproofing membranes or impermeable overlays, which are relatively inexpensive, could offer protection to existing bridge decks. Since there is a lack of data to support the effectiveness and cost benefits for any of these approaches and because there are a number of bridge decks in Alaska needing repair as evidenced by spalling concrete caused by corroding reinforcing steel, the Research Section began to study various alternatives and collect information to make the recommendations on techniques to be used for the design, construction, and maintenance of bridge decks.

A project was initiated to study the possible application of Calcium Magnesium Acetate (CMA) as a replacement for deicing salts (see Report No. AK-RD-83-16, "Preliminary Design and Feasibility Study for a Calcium-Magnesium Acetate Unit"). Another study is collecting data on bridge deck corrosion throughout the state, and a third project as described in this report was created to analyze four bridge decks in the Fairbanks area that required repairs due to corrosion. The Illinois Street, Minnie Street, and Wendell Street bridges were repaired during the 1982 construction season, and the Cushman Street bridge will be refurbished this summer.

Two repair techniques are utilized for these bridge decks. The Illinois Street, Minnie Street, and Cushman Street bridges are being overlaid with a latex-modified concrete. The Wendell Street deck is also overlaid with latex-modified concrete, and in addition, a cathodic protection system is being installed. Both methods require the removal of all delaminated concrete, and the corroded reinforcing steel must either be cleaned or replaced. The latex-modified concrete overlay will then act as a membrane that should reduce further intrusion of chloride from deicing salts and water, thereby slowing down the corrosion process. The cathodic protection system being used in conjunction with the latex-modified concrete overlay is designed to halt corrosion. The system functions by supplying direct current in the proper direction so that the corroding anodes on the steel are prevented from discharging ions and thus stopping corrosion. These bridge decks are being monitored by the Research Section, and the merits of each technique are evaluated with regard to cost effectiveness and ability to halt corrosion.

This report was also prepared as an aid in the design and construction of future deck repair projects.

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1.0 INTRODUCTION

BRIDGE DECK REPAIR TECHNIQUES

1.1 INTRODUCTION

This report addresses the subject of bridge deck repair using latex-modified concrete and cathodic protection.

Most of the material contained herein concerns the Fairbanks Bridge Deck Repair project (X20143) since the coauthors were involved with that project. Clyde Tilman was the construction Project Engineer and Steve Powers was the Assistant Project Engineer and Inspector. This report contains the sequence of work that was followed during the project with notes on items that require special attention during the construction phase. From the experience gained during construction, some suggestions are presented to help in the design and construction of future projects. The actual costs of the repairs have been tabulated to assist in making an economic evaluation of the repair techniques and for estimating future project costs.

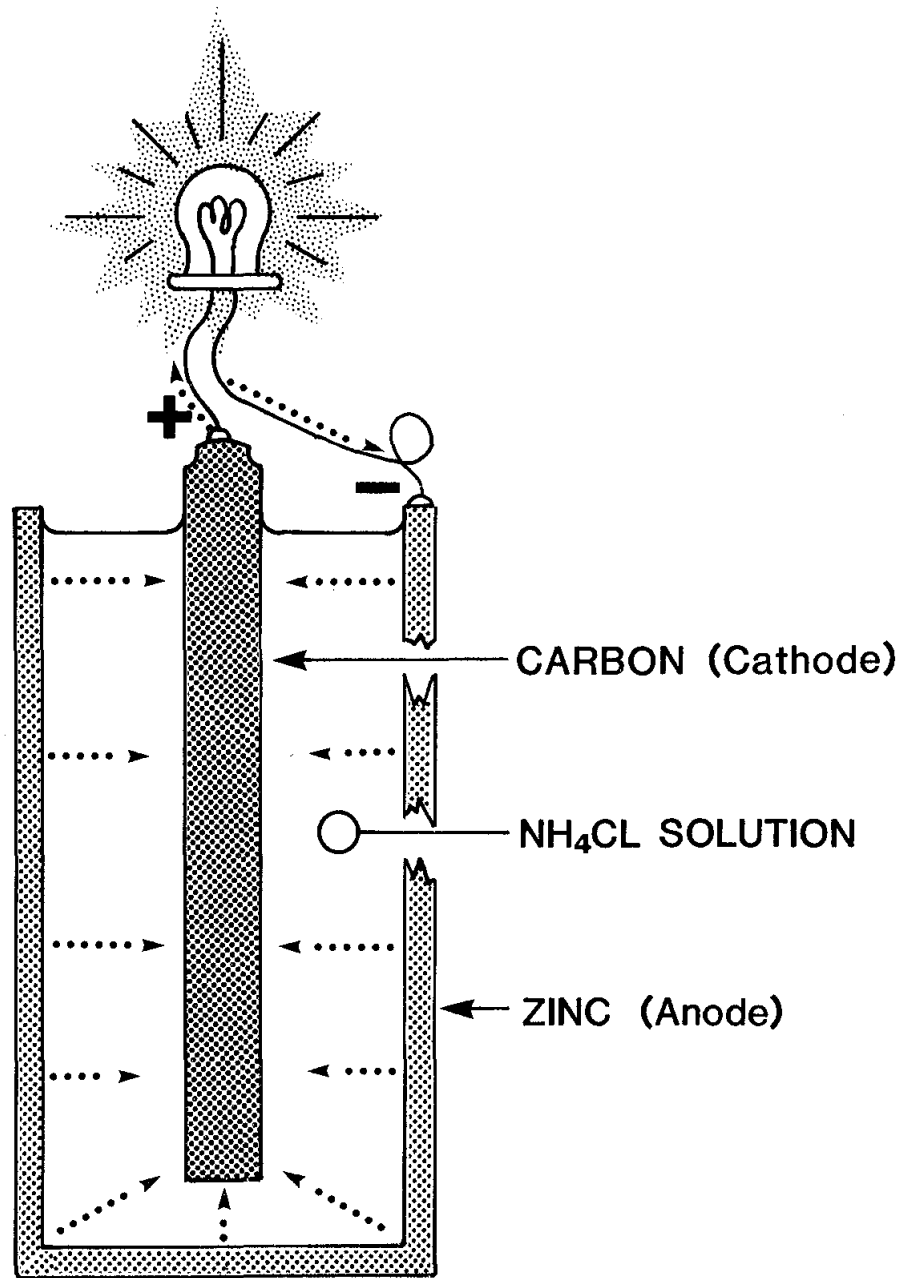
There were four bridges located in the Fairbanks area involved in this project: Minnie, Illinois, Wendell, and Cushman Street bridges built in 1951, 1952, 1951 and 1959 respectively. The initial corrosion survey of these bridge decks was accomplished by the Department of Transportation and Public Facilities Research Section in the summer of 1980. Peratrovich and Nottingham, Inc. engineering consultants prepared a report evaluating the condition of these bridge decks in the fall of 1980. The final design was done by Peratrovich and Nottingham, Inc. and construction began on the project in the spring of 1982. The Minnie, Illinois, and Wendell Street bridges were completed during that season and the Cushman Street bridge will be completed during the 1983 construction season.

The bridges needed repair due to the delaminated and spalling concrete on the bridge decks that was caused by galvanic corrosion of the reinforcing steel embedded in the concrete decks. The easiest way to understand the corrosion reaction in bridge decks is to examine a simple application of the corrosion process, a dry cell battery (galvanic cell).

Basically the battery consists of three essential parts: an anode, a cathode, and an electrolyte (Figure 1). The container, usually a zinc casing, is the anode, the carbon rod in the center is the cathode, and the electrolyte is the compound consisting of ammonium chloride and moisture encased around the carbon. When connected, an electric current will flow from the anode (zinc) through the electrolyte to the cathode (carbon rod). Corrosion will occur where the current enters the electrolyte from the anode, and no corrosion will occur at the cathode.

This current flow is caused by the difference in electrical potential between the two dissimilar metals; zinc is more electronegative (less noble) than carbon. Similarly, current can be generated by coupling any two dissimilar metals within an electrolyte. In fact, differences in electric potential resulting in corrosion (galvanic) cells can occur on metal surfaces simply because of environmental or physical variations. These include variations in ion concentration, oxygen differential, variances in stress, impurities in the metal, and other factors.

In the case of the bridge decks, various chloride salts (sodium and calcium) are placed on the deck for deicing, and then the chlorides penetrate down into the concrete to the reinforcing steel (rebars) as part of the brine solution formed from the ice melting. Normally reinforcing steel embedded in concrete has a high resistance to corrosion due to the high pH of concrete, but when the salt brine leaches into the deck the pH is lowered, thus initiating the corrosion process. In other words, the chloride turns the concrete into an electrolyte by lowering the pH and attracting moisture. Oxygen is also a necessary element for corrosion to take place. Cathodic and anodic areas are created along the surface of the reinforcing steel because of the non-homogeneity of the metal as well as from differences in the electrolyte. This is illustrated in Figure 2. The corrosion products build up at the anodic areas of the rebars, and since they occupy a greater volume than the original steel, pressure is exerted on the concrete which eventually cracks. The freezing and thawing of water in these cracks can then extend the cracking and separate the cover layer of concrete from the rest of the deck. This delaminated concrete can eventually spall off, creating cavities in the deck exposing additional reinforcing steel to corrosion and also producing a rough deck surface and



DRY CELL BATTERY

Figure 1

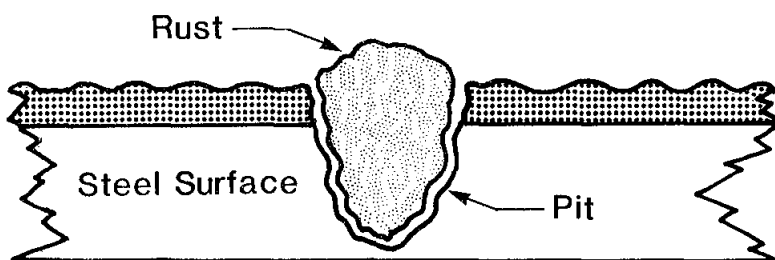
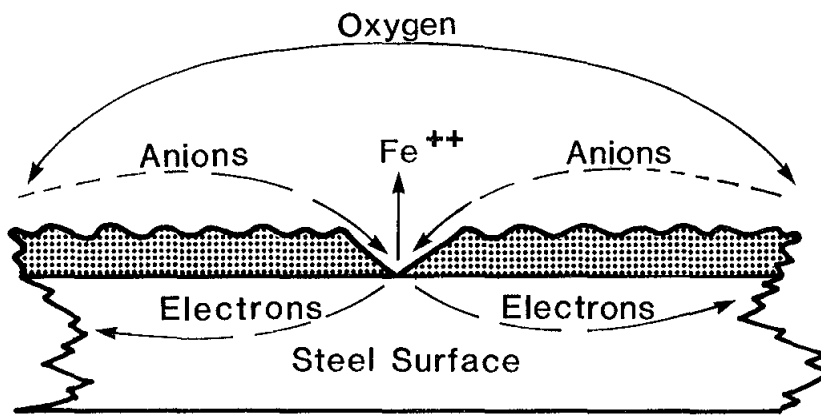
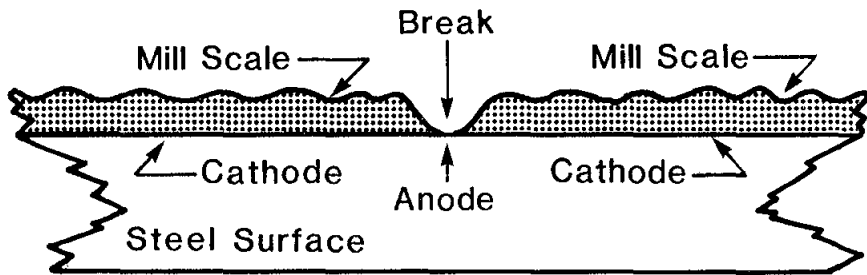


Figure 2 – Cause, effect, and result of the corrosion process on a metal sample exposed to conditions favoring galvanic attack (oxygen, non-homogeneity, moist atmosphere).

a bumpy ride. If the corrosion is allowed to continue, it will lead to structural damage and the eventual failure of the bridge. This corrosion process, once started, is difficult to halt.

Two repair techniques were used on the Fairbanks Bridge Deck Repair project to deal with the corrosion problem. One method utilized a latex-modified concrete overlay of the deck to reduce water and salt penetration so that the concrete (electrolyte) is less conducive for corrosion to occur. The other method made all of the reinforcing steel (anode-cathode) cathodic to an external anode. This process is called "cathodic protection." The following is an introductory description of both methods.

1.2 LATEX-MODIFIED CONCRETE

On the Illinois and Minnie Street bridges latex-modified concrete was used to repair the decks during the 1982 construction season. (Cushman will be repaired similarly in the summer of 1983.) Latex-modified concrete is conventional portland cement concrete with the addition of approximately 15% rubber solids by weight of the cement. A latex emulsion admixture is used, which in the case of the Dylex latex 1186 used on this project, is 46-50% styrene-butadiene rubber in water. The rubber in the concrete renders it more resistant to salt and water penetration and thereby inhibits the corrosion process. Increased adhesion, compression strength, and flexural strength are other significant advantages gained by using a latex-modified concrete. Latex-modified concrete will be discussed in more detail in the construction section of this report.

To completely stop corrosion in a chloride-contaminated deck by using a latex-modified concrete, all of the contaminated concrete would have to be removed and replaced with the latex-modified material. Obviously this would be very expensive and might even require replacement of the entire deck. On the Fairbanks Bridge Deck Repair project only the unsound (delaminated) concrete and the concrete where corrosion was evident were removed, and then the entire deck was overlaid with 1 1/4 inches (nominal) of latex-modified concrete. This is a relatively inexpensive repair method that will slow down the deterioration of the bridge deck. However, the question remains whether this will be as economical in the long run as halting the corrosion completely would be.

1.3 CATHODIC PROTECTION

For chloride-contaminated bridge decks, the only known method to completely halt corrosion is cathodic protection. As mentioned earlier, corrosion takes place at the anode (where current leaves the metal surface and enters the electrolyte) and no corrosion occurs at the cathode (where current is received by the metallic surface from the electrolyte). Therefore, if an entire metallic surface can be "forced" to become cathodic, it will not corrode. This is the principle of cathodic protection. Anodes are installed in the bridge deck that send current to the reinforcing steel which becomes cathodic and no corrosion occurs on the steel.

There are two basic methods of applying cathodic protection: galvanic systems and impressed current systems. The galvanic systems produce a protective current by the same electrochemical reaction that occurs in the dry cell battery. A metal which is less noble (more electronegative) than the metal to be protected is selected as the sacrificial anode and is electrically connected to the cathode. The current flows from the external anode (zinc or magnesium) into the electrolyte (concrete) to the cathode (steel) and back to the anode via the electrical connection. Thus the zinc or magnesium corrodes while the steel is protected from corrosion until it must eventually be replaced. Since the anodes are placed in the concrete when using this type of system for repairing bridge decks, replacing them would be difficult and expensive.

The impressed current system uses the same basic principal except that the anodes are energized by an external energy source. A rectifier is used to convert alternating current (AC) to direct current (DC) and then DC is introduced into the concrete (electrolyte) by anodes having a negligible corrosion rate. The impressed current system is the practical choice for use in bridge decks because the anodes do not have to be replaced. Also another advantage of an impressed current system is that the electrical resistance of a concrete bridge deck can be more easily overcome by adjusting the applied voltage.

An impressed current cathodic protection system was installed on the Wendell Street Bridge in 1982. A test section using an impressed current system was also installed in the upper ramp of the Anchorage International

Airport in 1981. The anodes in both systems are made of wire placed in slots sawed into the deck and backfilled with a conductive grout. References to cathodic protection systems in the report all refer to this anode-in-slot type.

2.0 CONSTRUCTION PRACTICES

2.1 CONTROL OF THE WORK

The main reason for having State personnel assigned to the Fairbanks Bridge Deck Repair project order to assure quality control by close and detailed inspection of the contract work. It was essential that the manufacturers' and suppliers' recommendations be strictly adhered to for the products and materials used. The high cost of some contract items and the increase in the bridge deck dead-load weight require a very close control of yields. The project personnel should work with the supplier/manufacturer representative of the cathodic protection system to assure themselves that adequate supervision is provided. The following items are a checklist including numerous examples for State personnel assigned to a deck repair project of this type:

READ ALL EXTRA WORK ORDERS (EWO'S), CHANGE ORDERS, AND WORK ORDERS.

The contractor shall notify in writing, with a copy to the Project Engineer, Bus, Police, Fire Departments, and the City Engineer five (5) days in advance of bridge closure. See Example 1.

The contractor shall place "BRIDGE CLOSURE" notices in the newspapers to be published each of the two days before closure. See Example 2. The radio and television stations should also be notified.

Install signs and traffic control devices. (Keep covered until required.)

Close bridge.

Clean deck so control can be painted.

Establish stationing (10 feet) on vertical face of curb.

Grid deck (10 foot grid + CL and gutterlines).

Make 10 foot wood grid template with a 1 foot grid using string. (Used for recording and reestablishing repair areas.) See Example 25.

Profile deck grid. See Note 2 and Example 3.

Chain drag deck and paint delaminated areas. (Use grid to record locations.) See Example 4.

Remove 1/4 inch of concrete from deck surface with roto-mill, scabber, etc. See Note 1 for the scarified and/or excavated surfaces. Check and record daily progress. See Example 9.

Repaint original delaminated areas.

Rechain complete deck with special attention to the original areas.

Paint location to be excavated. This may include exposing reinforcing steel to check for corrosion and depth. (Use color coding.)

Excavate the following areas: See Notes 1 and 17.

- A. Delaminated areas.
- B. Damaged, worn or corroded reinforcing steel. See Note 9.
- C. Gutter "Key" if required. See Example 18 and EWO #3 (Appendix A).
- D. Tapers at ends of deck and expansion joint where required.
- E. Around drains.
- F. Around delaminated (de-bonded) reinforcing steel.

Rechain excavated areas and remove all unsound concrete, also test with hammer. Record completed areas daily. See Example 11.

Replace reinforcing steel as required. See EWO #1 (Appendix A) and Note 12.

Record exposed reinforcing steel. See Example 10.

Modify expansion joints prior to final overlay. See Example 17 and EWO #2 (Appendix A).

Sandblast reinforcing steel (check bottom surface of bars) and complete deck. See Note 1. Cover deck if overlay is not to be poured within 36 hours.

Measure patch material volume to be poured monolithically with overlay. See Note 3.

Core-drill holes in deck for Cathodic System. (To reduce spalling under deck.) See Note 10 and Example 33.

Cut recess routes for reference cells, corrosion probes, and grounding lead-in cables. See Note 10 and Example 33.

Install corrosion probes, reference cells, lead-in cables, flex conduits and grounding as required. (Plug holes in deck with duckseal.) See Note 10 and Example 33.

Electrically bond drain castings to reinforcing steel. (This may be done after final sandblasting.) See Note 10 and Example 33.

Profile finishing machine rails and adjust as required. See Example 12.

Check finishing machine template (crossrails). See Example 14.

Check finishing machine against deck surface and adjust as required. See Note 4.

Calibrate mixer truck. See Examples 20 through 24.

Pour first layer (3/4 inch) when two layers are used, with fine concrete sand and #8 AASHTO Coarse Aggregate. See Notes 5 through 8 and Notes 13 through 16.

Keep overlay material back from drains, construction, and expansion joints as required to allow tapers on second layer when two layers are used. See Example 19 and EWO #4 (Appendix A).

Use informational cylinders to determine when the overlay has obtained 2,000 PSI prior to allowing cutting of anode slots.

Saw cut anode slots and header cable slots. Saw shall be capable of maintaining 1/2 inch anode slot depth. See Notes 1, 10, 11 and Example 33.

Install anode wires and header cables. See Examples 26 through 30. See Note 10 and Example 33.

Install conductive grout. (Remove excess after cured.) See Example 16 and Note 10.

Install conduit, conductors, test station load center, rectifier, and complete all required splicing. See Note 10 and Example 33.

Sandblast first layer (complete deck) and cover if overlay is not to be placed within 36 hours. See Note 1.

Check finishing machine against deck and adjust as required. See Note 4.

Make templates for drains and straightedges for tapers at construction joints and expansion joints.

Re-calibrate mixer truck. See Examples 20 through 24.

Pour second layer (1 inch), or first layer when only one layer required, with fine concrete sand and No. 7 AASHTO Coarse Aggregate. See Notes 5 through 8 and Notes 13 through 16. Also see Note 3 when only a single layer is to be placed.

Use spud vibrator adjacent to construction joints, expansion joints, and other locations as required.

Work material in around drains and other excavated areas to force out remaining standing water.

Broom (rake) surface and use 6 inch wide edging tool in gutter.

Do not weigh down covering until material has sufficient set to avoid imprints.

See Notes 7 and 8.

Install joint filler sealant. (Clean out all overlay material and prime vertical surfaces.)

Clean up as required from construction activities.

Have State forces paint traffic markings.

Open to traffic when informational cylinder reaches 3,000 PSI.

Remove all signs and traffic control devices.

Notify Police, Fire and Bus Departments when open.

Obtain certification and warranty for the Cathodic Protection System.

Turn on cathodic protection system after minimum 28 days curing. Deicing chemicals should only be used after 30 days of curing.

NOTES

1. Deck surface shall be clean at the end of each workday.
 - A. The surface may be blown clean if dry.
 - B. The surface may be cleaned with high pressure water (minimum 2,000 PSI) if wet.
 - C. The cleaned surface may be covered to avoid daily cleaning of entire area that has been scarified, excavated, sandblasted, or saw cut.
2. Plot deck profile both by profile and cross-section. Establish new gutter profile (finishing machine rail grades). Establish new template (finishing machine cross-rails). It may be necessary to redo this work after deck has been scarified if roto-mill type equipment has been used. See Examples 5 through 8.
3. Patch material can be measured using a container of known volume (1CF) and using it to fill the patch excavations with sand, recording the units and partial units used. This should be done just prior to the cleanup required from the sandblasting operation to avoid additional cleanup. Patching quantities should be agreed to by the contractor prior to pour.
4. Record final measurements using grid system and calculate the quantity. Use this accumulative quantity to adjust for yield prior to pour and to check yield during pour. See Examples 13 and 15.
5. Wet down deck a minimum of one (1) hour prior to pour and keep damp. Cover deck where mixer truck will be routed. Keep standing water blown or broomed out of low and excavated areas. Protect exposed reinforcing steel when mixer truck is to be routed over them. Keep mixer truck grounded. Check yield with 1/4 C.Y. yield box (rodded) at the beginning of each load poured and keep continuous yield on all components. Make minimum of three project cylinders and three informational cylinders. Due to vibrations, do not do

slump tests on the bridge. Slump tests should be measured 4 to 5 minutes after discharged of the material from mixer. See Example 32.

6. Broom in material just ahead of finishing machine, remove and dispose of coarse aggregate remaining from this operation. Do not deduct quantity. Finish gutterline by hand to template or slightly lower. Finish surface with pan and burlap drag.
7. Cover overlay as soon as possible with wet burlap and plastic to avoid shrinkage cracks. Remove covering after 24 hours and allow to air cure. Repair any defects and shrinkage cracks; paint gutter immediately after area has been uncovered. See Examples 18 and 31.
8. Measure waste and overbatch by recording height in wheelborrow/load and measuring its volume by the same method as Note 3 and have total agreed to by contractor.
9. Reinforcing steel should be excavated 3 to 4 inches each side of the known corroded area to decrease the chance of missing corrosion.
10. All Cathodic Protection System components shall be installed in strict accordance with manufacturer's recommendations and under direct supervision of an authorized manufacturer's representative.
11. If during the sawing of the anode slots there is spalling on the edges, the saw blades should be checked for wear and replaced if necessary.
12. Bridge deck repair literature printed by Dow Chemical, manufacturers of latex Modifier A, recommends that bars that have lost 1/4 or more of their original diameter should be replaced.
13. The manufacturer recommends that latex-modified concrete is not to be placed at temperatures below 45°F. It can be placed at 45°F and rising, preferably if the air temperature will be above 45°F for 8 hours. At temperatures above 85°F the placement should be done at night or early morning.
14. Existing expansion joints and dams shall be formed through the overlayment. Casting full across the joints and later sawing will not be allowed.
15. A construction dam shall be installed in case of major delays (1 hour or more) of the placement operation. During minor delays the end of the placement may be protected from drying with several layers of wet burlap. Adequate precautions should be taken to protect freshly placed modified materials from sudden or unexpected rain. All placing operations should stop when it starts to rain. Material damaged by rainfall shall be removed.

16. At temperatures below 55°F a longer curing period will be needed. Dow Chemical suggests that any day during which the curing temperature falls below 50°F shall not be counted as a curing day. If at any time during the curing period the curing temperature falls below 35°F, the work may be considered as unsatisfactory and rejected. The informational cylinders should be cured under the same conditions as the overlay.
17. It is to both the project's and contractor's benefit to keep the chisel bits relatively sharp. A higher production rate is achieved and cleaner cuts are made.

2.2 EXAMPLES

TUCKPOINTING
CAULKING
BUILDING CLEANING
WATERPROOFING
SPECIAL COATING

Pioneer

MASONRY RESTORATION CO.

Waterproofing Contractors and Consultants

P.O. Box 70110, BALLARD STATION

1100 N.W. 54TH ST.

SEATTLE, WASH. 98107

(206) 782-4331
(206) 782-1540



EXAMPLE 1

THIS IS TO NOTIFY YOU THAT THE CUSHMAN STREET
BRIDGE WILL BE CLOSED EXCEPT FOR EMERGENCY
TRAFFIC BEGINNING _____

MACS

Signature _____ Title _____ Date _____

CITY
ENGR.

Signature _____ Title _____ Date _____

POLICE
DEPT.

Signature _____ Title _____ Date _____

FIRE
DEPT.

Signature _____ Title _____ Date _____

BRIDGE CLOSURE
ILLINOIS STREET BRIDGE
Closed JULY 1 til Finished

Pioneer Masonry Restoration will be performing maintenance work on the Illinois Street Bridge beginning July 1st until finished. Bridge will be closed to all traffic.

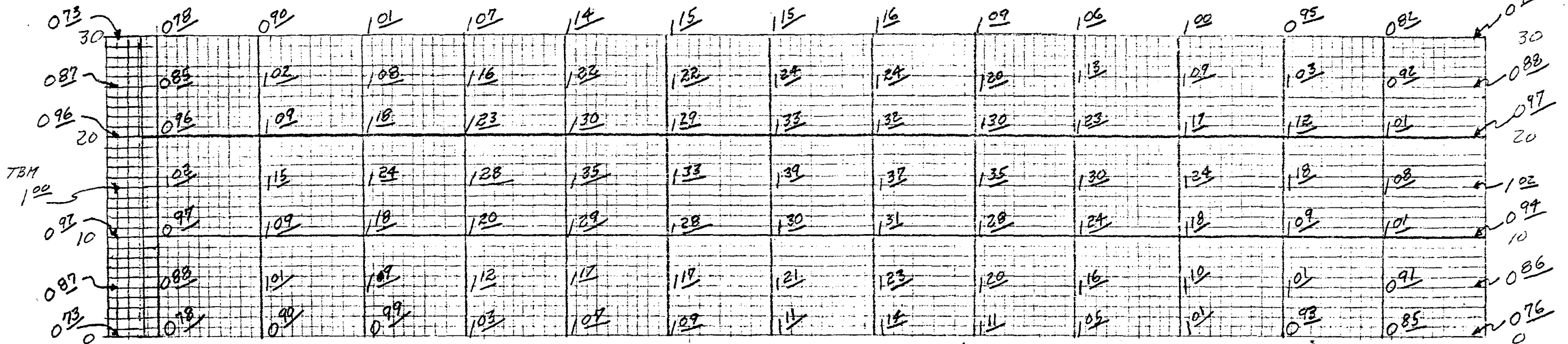
Bus patrons please inquire at MACS about any rescheduling of Bus Routes that are affected by the Bridge Closure. *June 30/82*

Minnie St Bridge

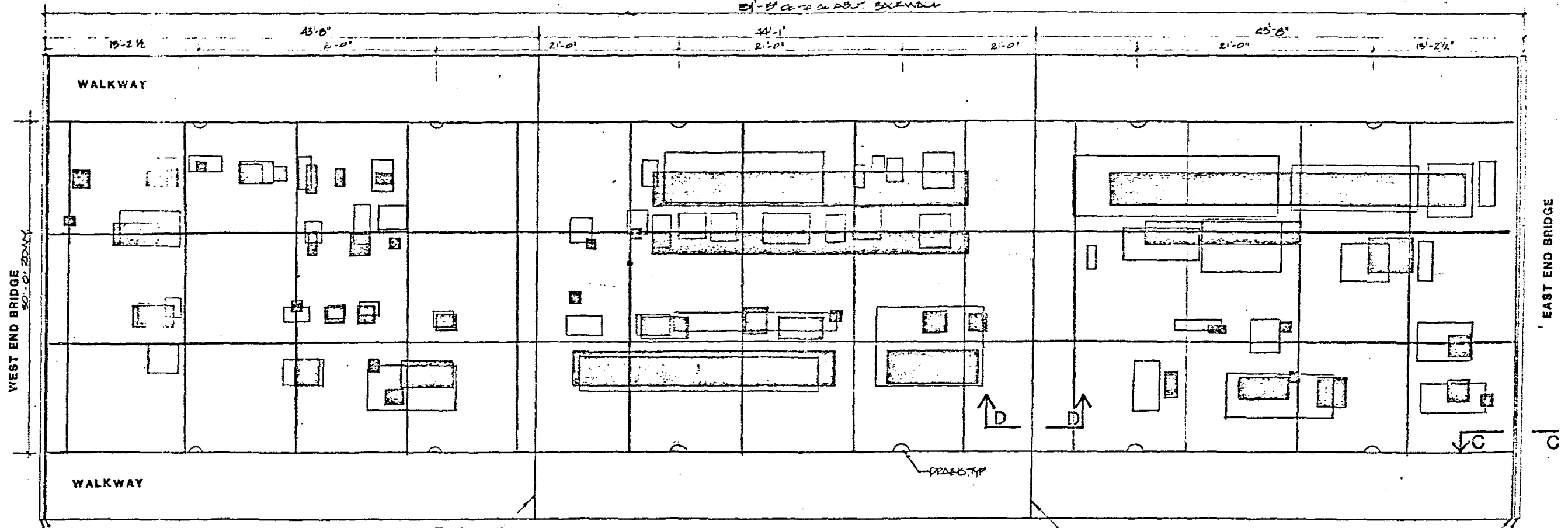
Tilman 6-10-82
Steve Powers
 EXAMPLE 3
Copy Given Bob Olson 6-14-82 Tilman

Existing Bridge Deck Elevations

TBM Top of Expansion plate @ $\frac{1}{2}$ (West End) Assumed Elev = 100



← 135' Out to Out of Back Wall →



20435' TOTAL DECK AREA
 APPROX. AREA DELAMINATION

Const. JOINT DELIMITED EXTERNAL

BY Tilman DATE 6-8-82
CHKD. BY _____ DATE _____

SUBJECT Delamination Areas
and Rebar Repair

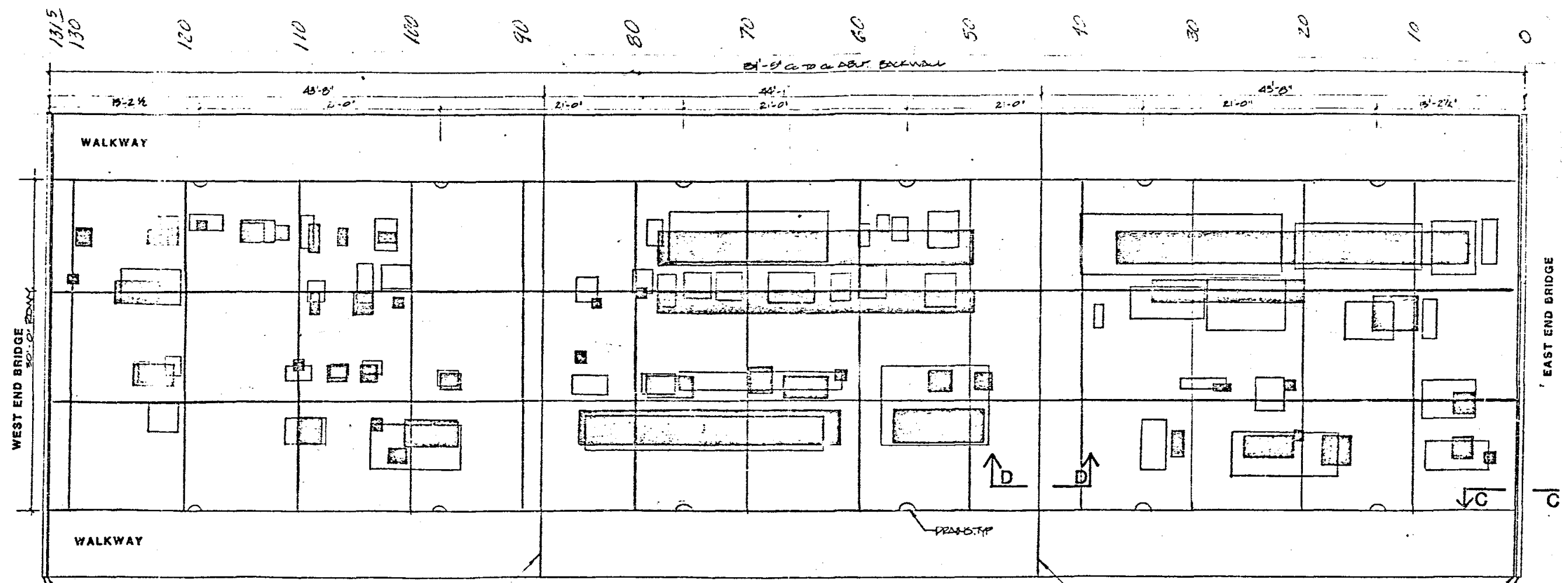
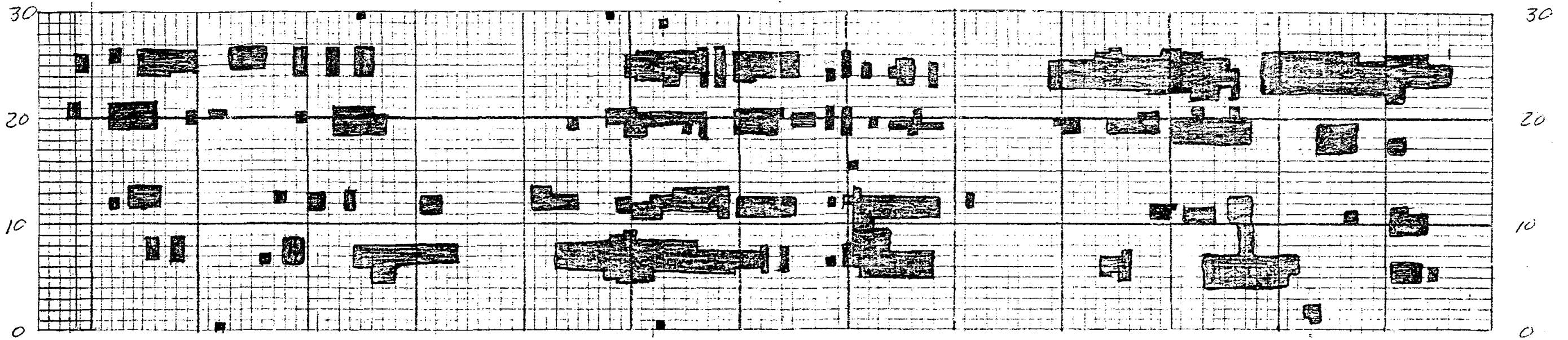
SHEET NO. _____ OF _____
JOB NO. X-20143
Forbridge Bridge Deck Repair

Minnie St Bridge

Tilman 6-11-82
Powers

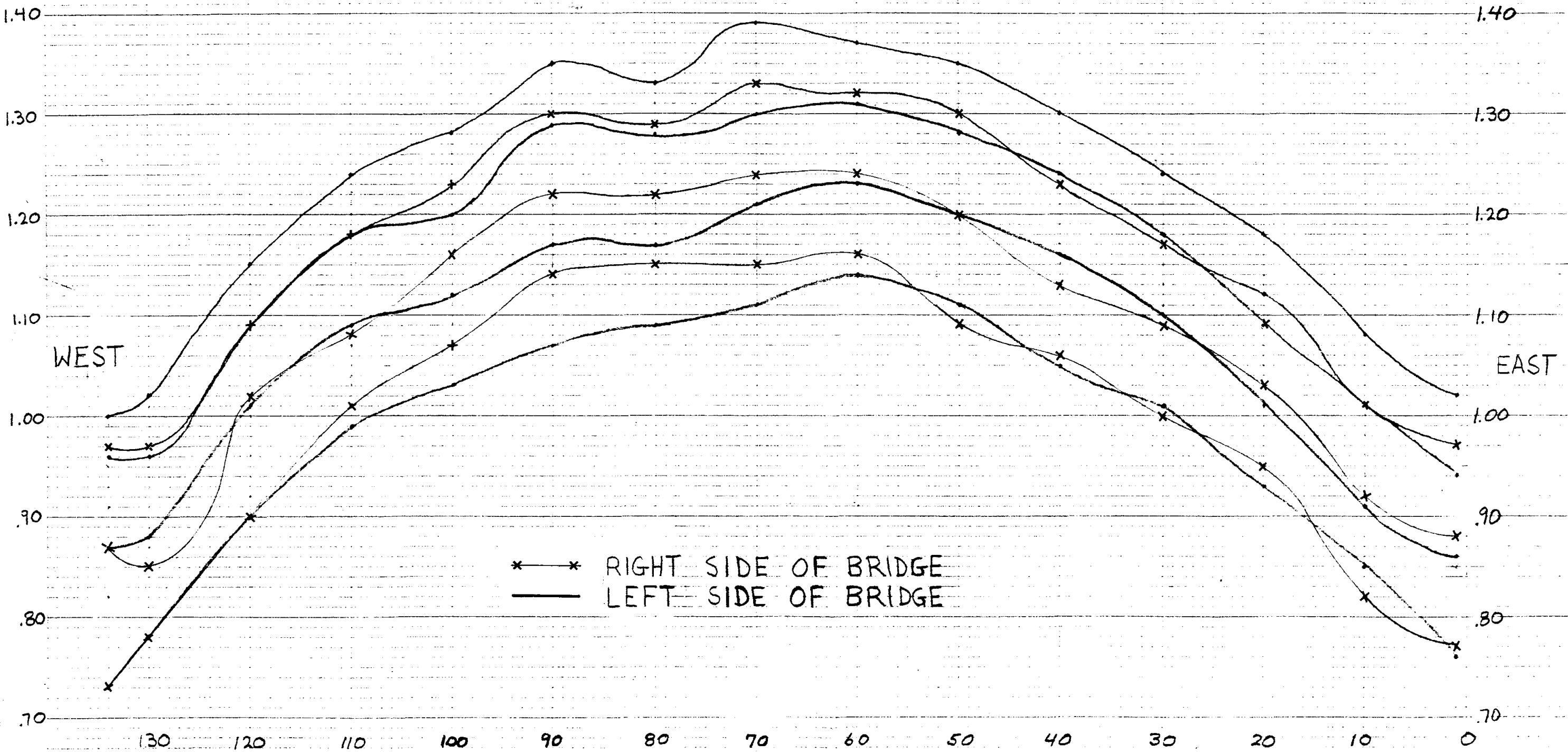
Chain Dragging of Original Surface

EXAMPLE 4

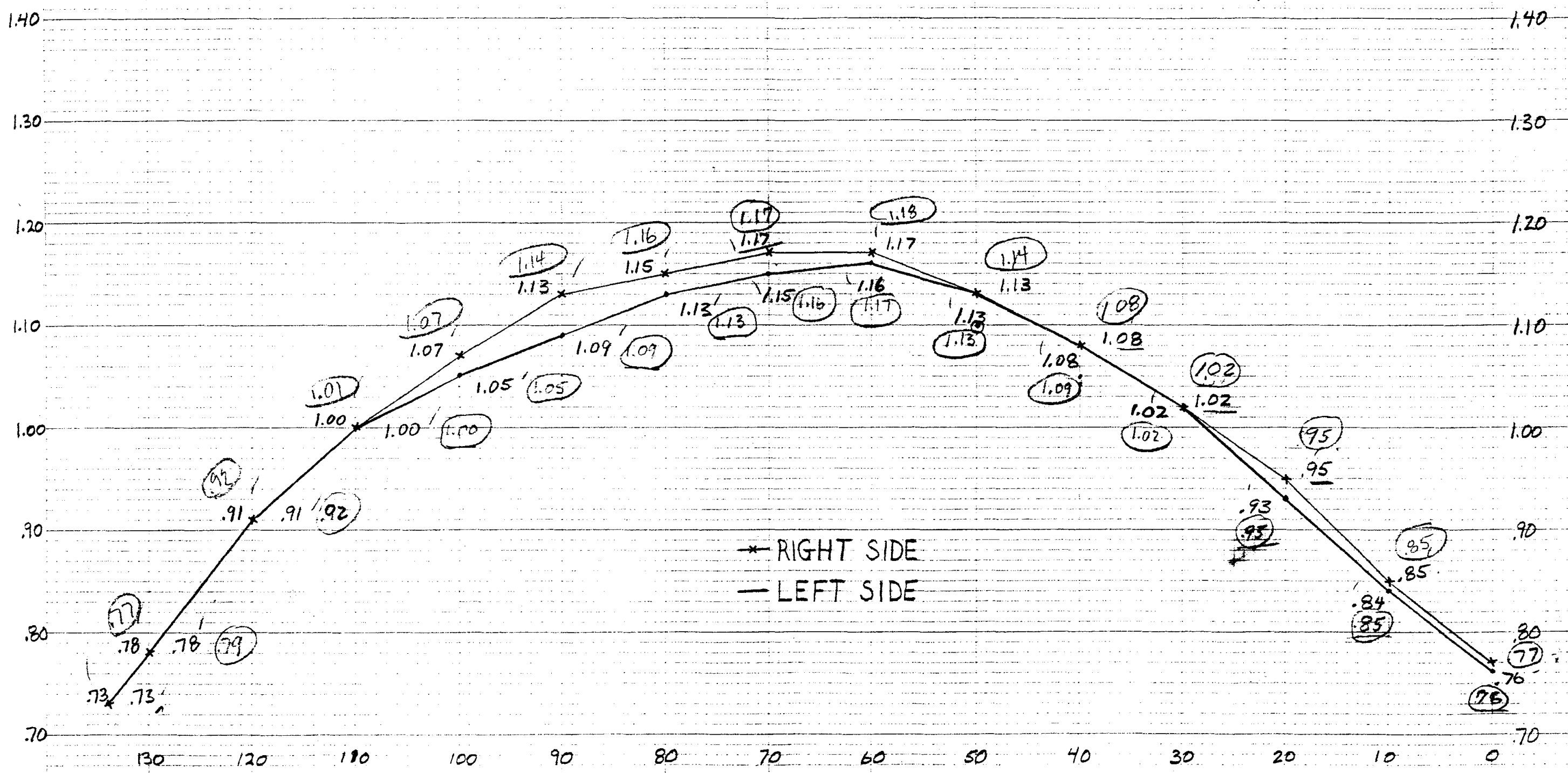


50430' TOTAL DECK AREA
10000' APPROX. AREA DELAMINATION

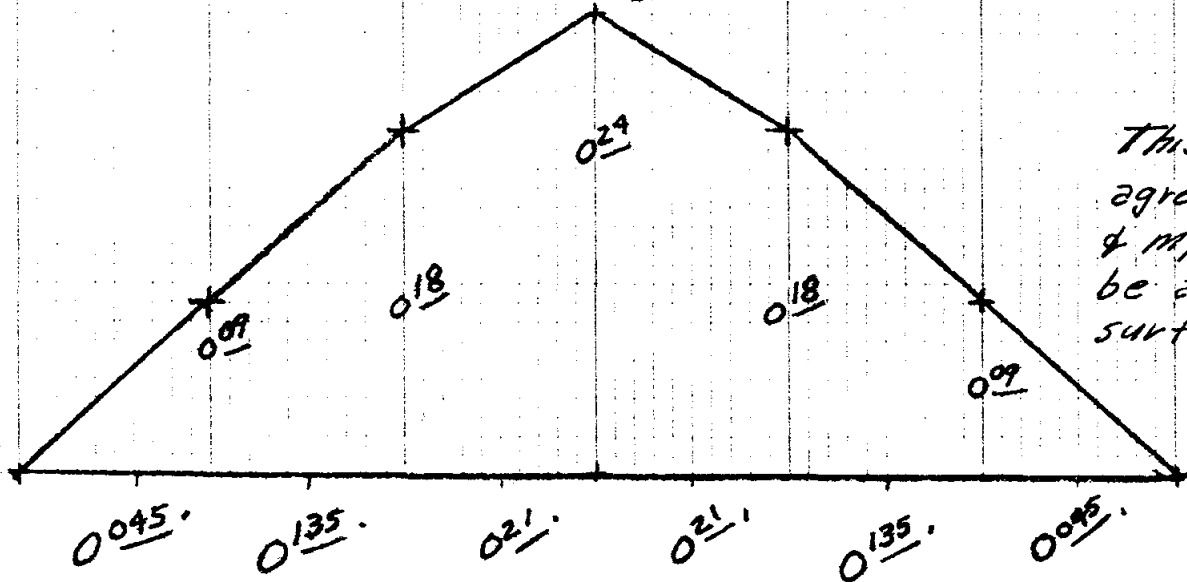
Const
CONSTRUCTION JOINT
DELAMINATION



O = Rail Check
 Tilman & Powers 6-26-82



Minnie St Bridge Deck Template



Tilman 6-17-82
Power 6-18-82

This Template was
agreed on by Contractor
& myself and will
be adjusted to deck
surface as required

Ch. Tilman

Copy Given
Contractor
6-18-82

BY Tilman DATE 6-8-82
CHKD. BY _____ DATE _____

SUBJECT Delamination Areas
and Rebar Repair

SHEET NO. _____ OF _____
JOB NO. X-20143
Fairbanks Bridge Deck Repair

Minnie St Bridge

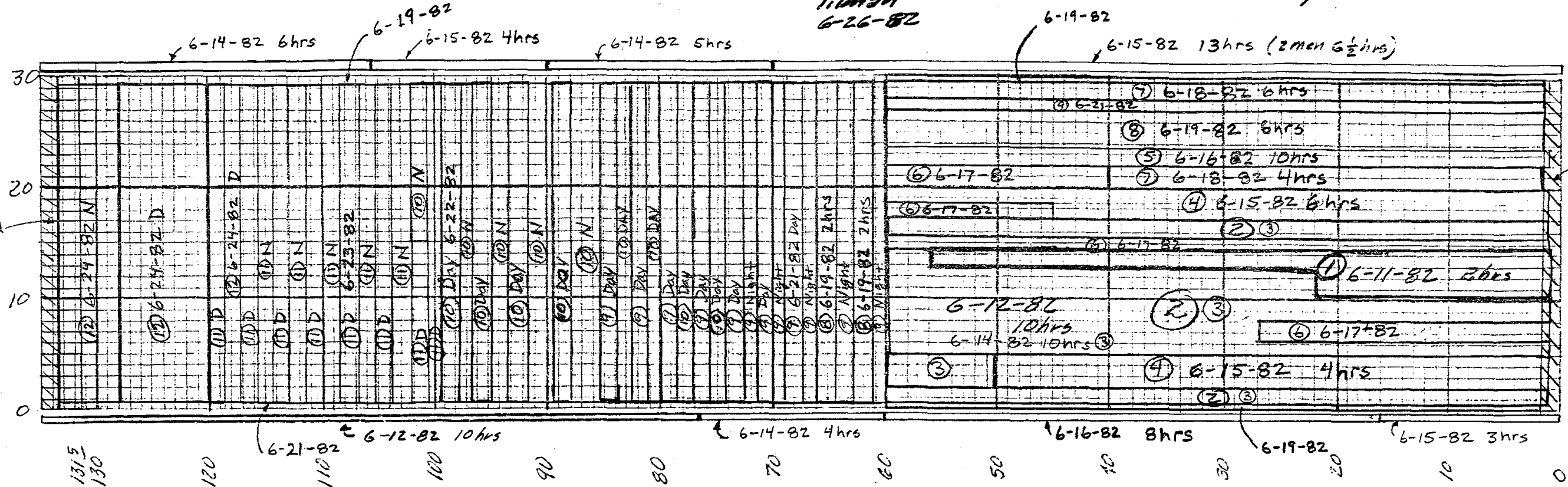
Tilman & Powers

EXAMPLE 9

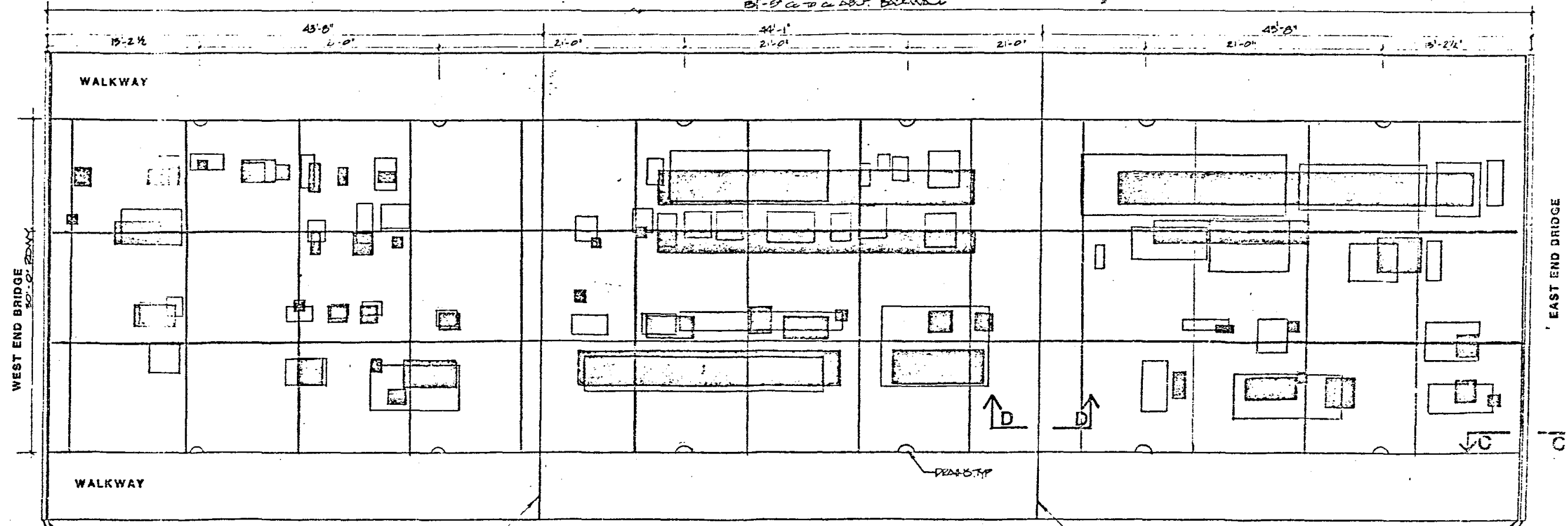
Note: All Drains Excavated
Tilman
6-26-82

Scarified Deck Area by Date

6-19-82
6-15-82 13hrs (2 men 6 1/2 hrs)



Excavated 30 Curb Face
1/2" Excavated 20 9-18-82
Excavated Curb Face



43435' TOTAL DECK AREA
7500'² APPROX. AREA DELAMINATION

BY Tilman DATE 6-8-82
CHKD. BY _____ DATE _____

SUBJECT Delamination Areas
and Rebar Repair

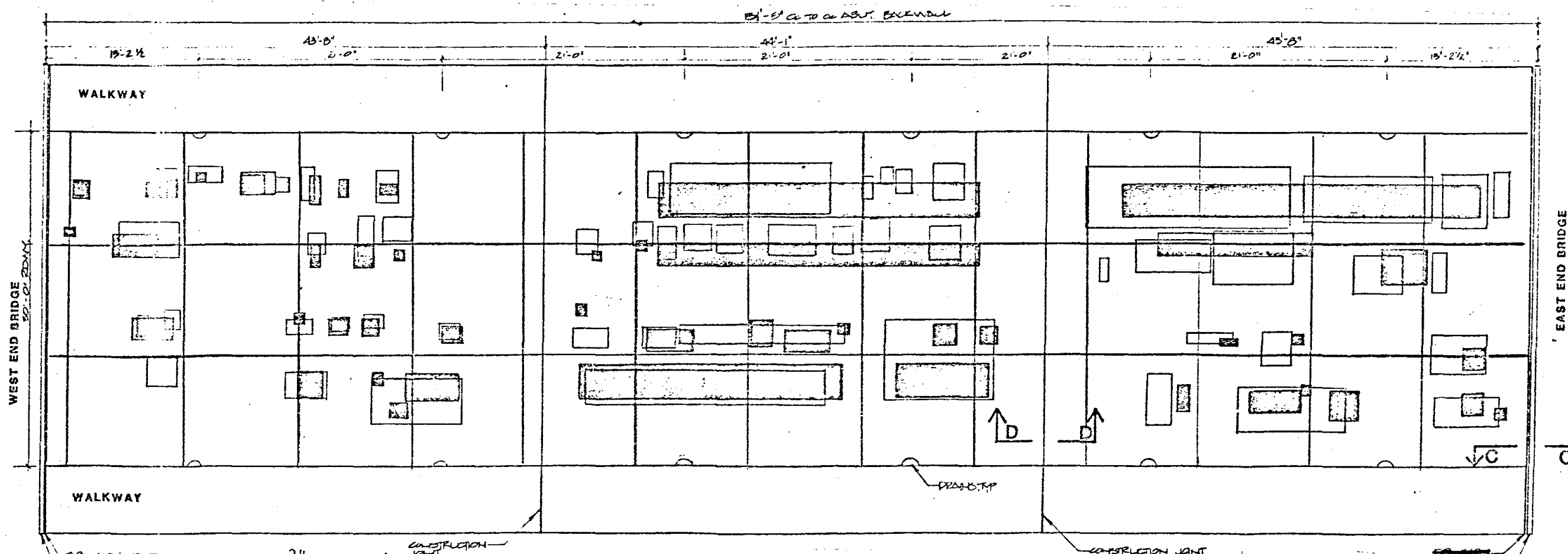
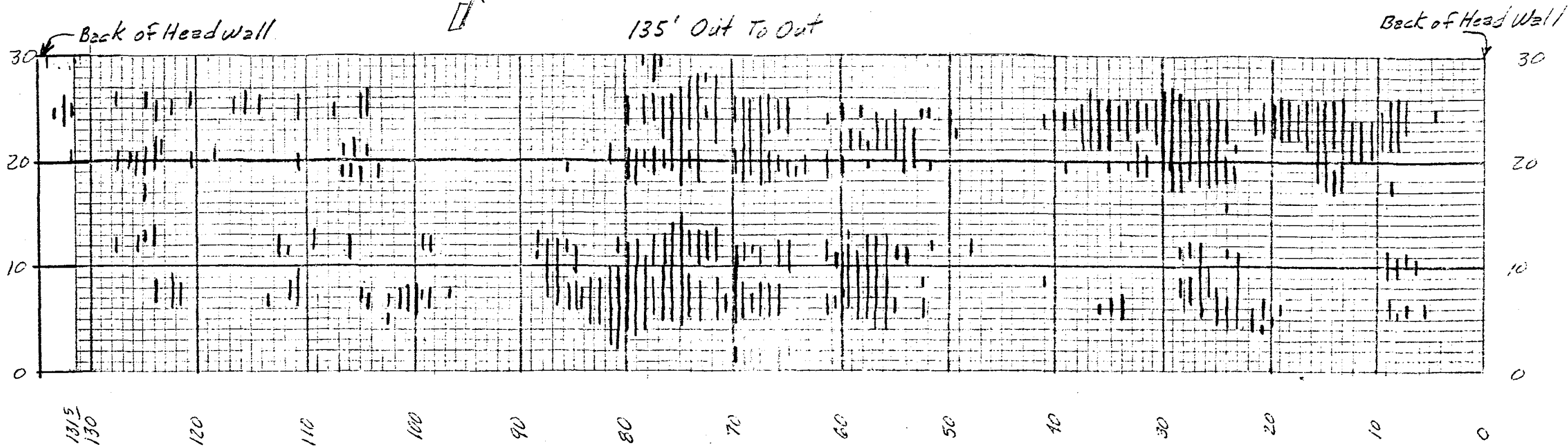
SHEET NO. _____ OF _____
JOB NO. X-20143
Fairbairns Bridge Deck Repair

Minnie St Bridge

Powers & Tilman

EXAMPLE 10

Exposed Rebar prior to overlay



39435 TOTAL DECK AREA
12522 APPROX. AREA DELAMINATION

Const
CONSTRUCTION JOINT
REINFORCEMENT
REBAR

BY Tilman DATE 6-8-82
 CHKD. BY _____ DATE _____

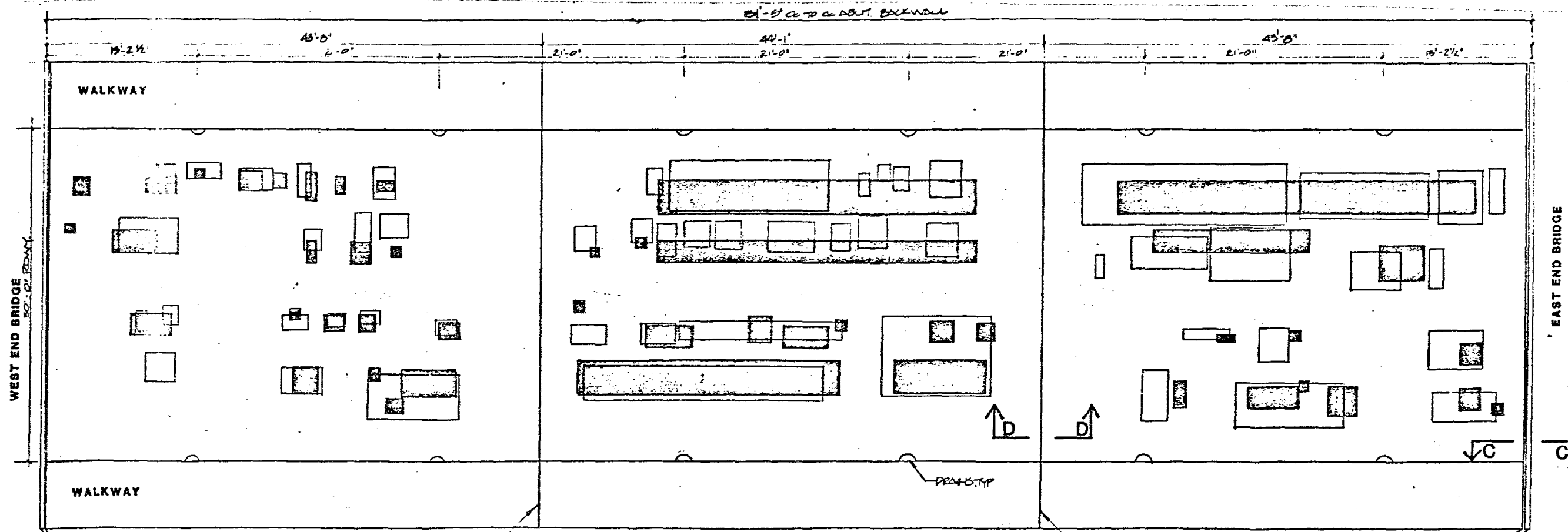
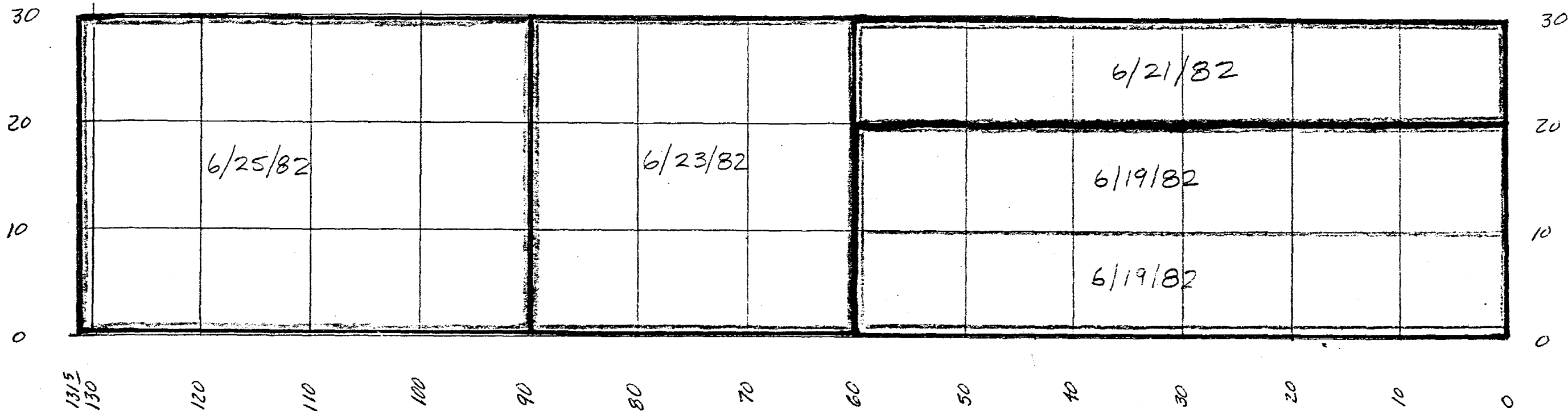
SUBJECT Delamination Areas
and Rebar Repair

SHEET NO. _____ OF _____
 JOB NO. X-20143
Fairbanks Bridge Deck Repair

Minnie St Bridge

EXAMPLE 11

— Checked for corroded Rebar
 — Final Check of Repair Area (Chaining)
 ‡ Date Completed & Accepted

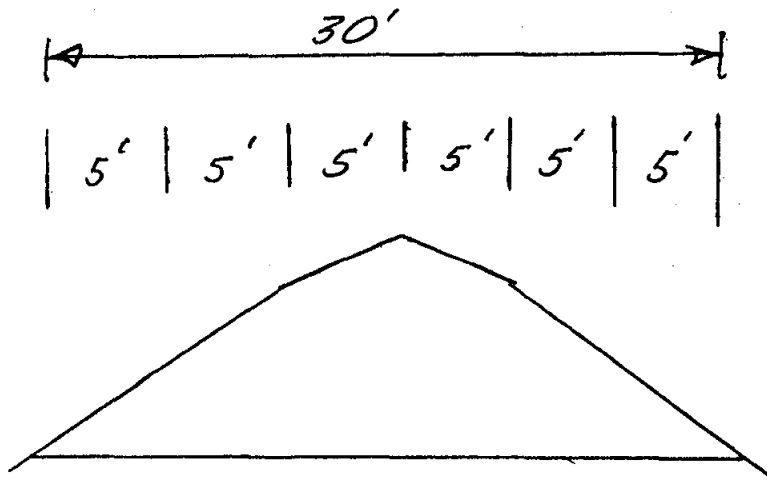


3043 SF TOTAL DECK AREA
 1500 SF[±] APPROX. AREA DELAMINATION

Check OF Cross-bars / Template on Finishing Machine

EXAMPLE 14

Tilman
6-23-82 AM



Proposed

0 0⁰⁹ 0¹⁸ 0²⁴ 0¹⁸ 0⁰⁹ 0

Front Bar

0⁰⁰ 0⁰⁸ 0¹⁷ 0²³ 0¹⁷ 0⁰⁸ 0⁰⁰

Rear Bar

0⁰⁰ 0⁰⁸ 0¹⁷ 0²³ 0¹⁸ 0⁰⁸ 0⁰⁰

Estimated Overlay Quantities
Minnie St Bridge

Tilman 6-27-82
Powers 6-27-82
* = Average SF
EXAMPLE 15
CF = 1728 CY = 46,656

Thickness in 0⁰⁰ / Ft

Stn	0	5	10	15	20	25	30	Total	Aver	Sq 0 ⁰⁰	Cu Ft	Cu Yd	Acccy	Cement Count
1+34	10	10	10	10	10	10	10	70	10.0	300	—	—	—	—
										*3.02	12.1	0.45	—	—
1+30	12	9	8	10	8	12	12	71	10.1	303	—	—	0.45	214
										*3.21	32.1	1.19	—	—
1+20	12	12	11	13	10	10	11	79	11.3	339	—	—	1.64	781
										*3.39	33.9	1.26	—	—
1+10	14	10	12	10	11	10	12	79	11.3	339	—	—	2.90	1380
										*3.36	33.6	1.24	—	—
1+00	14	10	12	12	10	10	10	78	11.1	333	—	—	4.14	1971
										*3.53	35.3	1.31	—	—
0+90	15	14	14	12	9	12	11	87	12.4	372	—	—	5.45	2594
										*3.86	38.6	1.43	—	—
0+80	17	12	12	15	11	12	14	93	13.3	399	—	—	6.88	3275
										*3.84	38.4	1.42	—	—
0+70	15	13	12	12	10	12	12	86	12.3	369	—	—	8.30	3951
										*3.78	37.8	1.40	—	—
0+60	14	12	14	14	12	12	12	90	12.9	387	—	—	9.70	4617
										*3.84	38.4	1.42	—	—
0+50	13	13	13	13	10	13	14	89	12.7	381	—	—	11.12	5293
										*3.95	39.5	1.46	—	—
0+40	16	12	14	14	12	13	14	95	13.6	408	—	—	12.58	5988
										*3.84	38.4	1.42	—	—
0+30	12	13	12	12	12	11	12	84	12.0	360	—	—	14.00	6664
										*3.50	35.0	1.30	—	—
0+20	12	11	11	11	10	12	12	79	11.3	339	—	—	15.30	7283
										*3.51	35.1	1.30	—	—
0+10	10	11	12	13	13	12	14	85	13.1	363	—	—	16.60	7902
										*3.32	29.9	1.11	—	—
0+1	10	10	10	10	10	10	10	70	10	300	—	—	17.71	8430

Count = 68 / 500K X 7 = 476 / CY

Plan quantity 12.2 CY EWO #1 (+) 5 CY = 17.2 CY

8430 = 17.71

DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

CHANGE ORDER NO. "D"
WORK

Interior District

Sheet 1 of 1

Project No. X-20143

Contractor Pioneer Masonry Restoration Co., Inc.

Project Name Fairbanks Bridge Deck Repair

Address PO Box 70110, Ballard Station
Seattle, WA 98107

The following change(s) in the above Contract are hereby ordered, in accordance with the terms of the Contract, and under the terms and conditions stated hereon.

Receipt Acknowledged:

Pioneer Masonry Restoration Co., Inc.

Contractor *[Signature]*
Contractor Representative *[Signature]* Title *Super*

Date 8-30-82

Recommended:

[Signature]
Clyde Tilman, Project Engineer

Issued: *[Signature]*

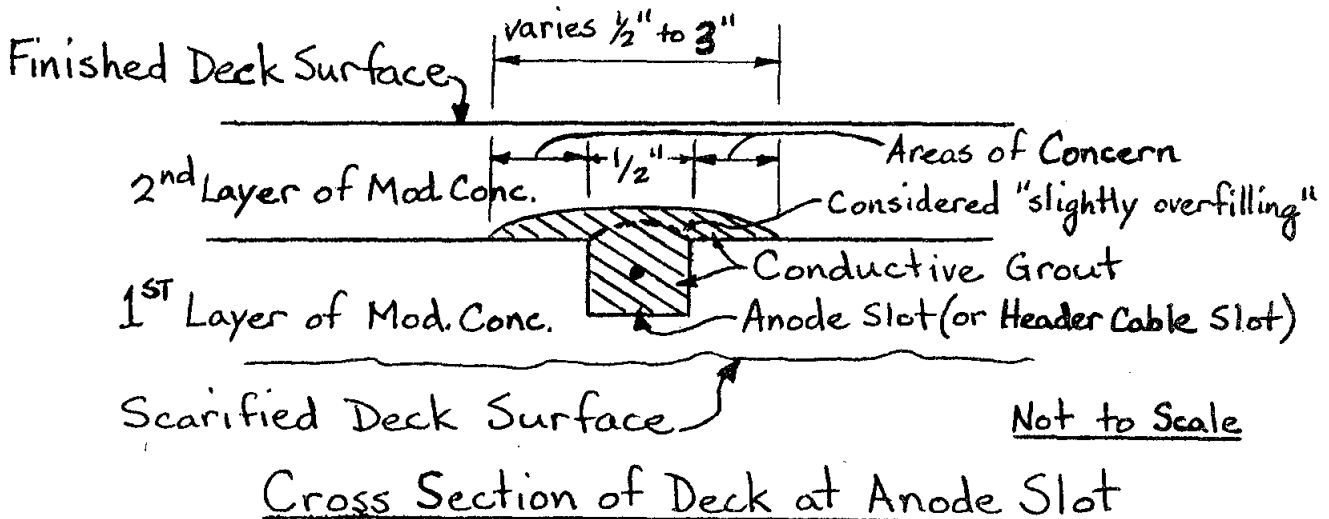
Date 8-30-82

DESCRIPTION

This work order is to notify you in writing of our concern with the bonding properties of the conductive grout interfering with the bonding of the two layers of modified concrete. This grout has been placed on the surface of the deck at the edges of the anode slots for a total width, including the slot width, varying from 1/2" to 3". The grout material has not been placed as detailed on the plans or described in the manufacturer's (of the cathodic system) written installation instructions.

You are directed to remove excess grout material that extends over 1/8" from the edges of the anode and header cable slots unless we receive adequate written assurances that our concerns are without merit.

This work order puts into writing our concern that has been expressed verbally in several conversations with Bob Olson and Jack Tinnea.



Details For I, sm 694-0 Expansion Joint Modification

Attachment For

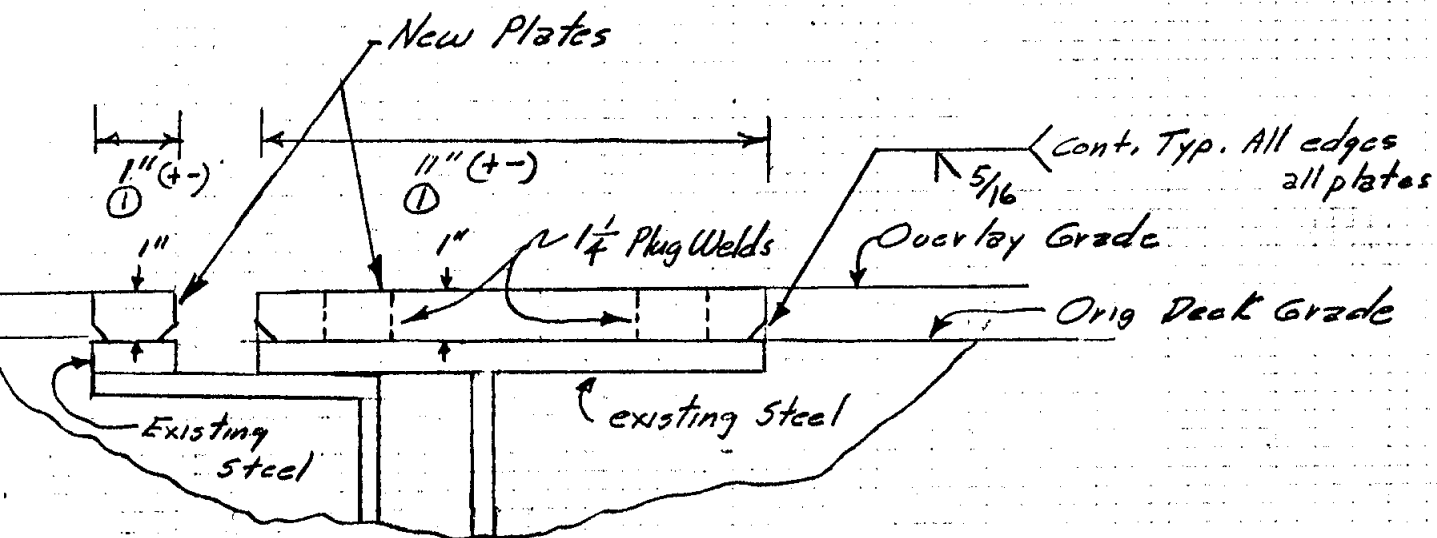
Extra Work Order No. 2

Project X-20143

Fairbanks Bridge Deck Repair

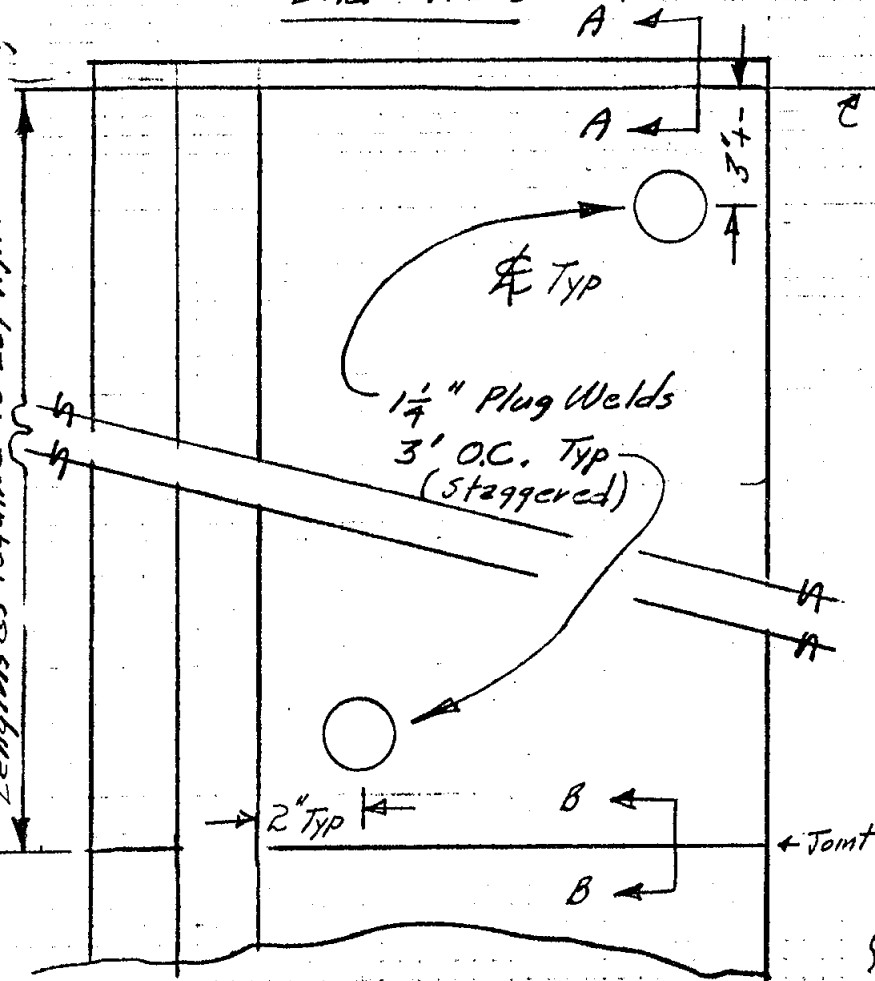
EXAMPLE 17

Not to Scale



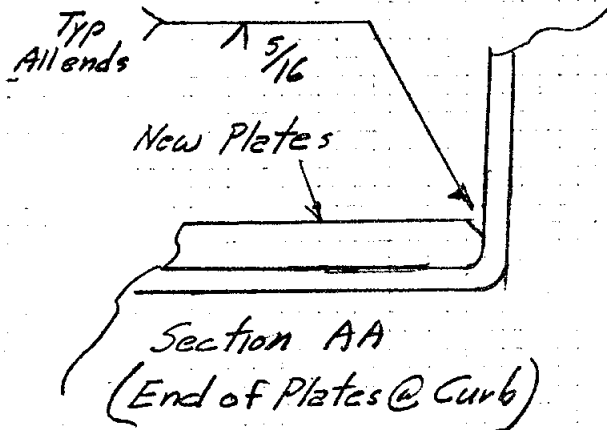
End View

① Width of plates shall be the same as existing

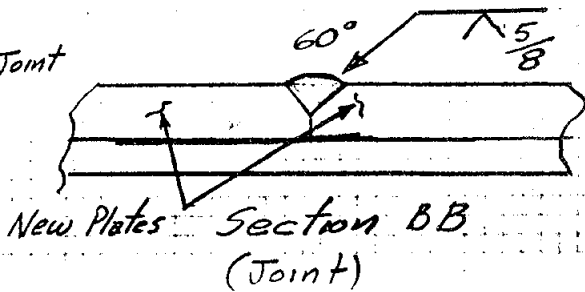


Plan View

Face of Curb



Section AA
(End of Plates @ Curb)



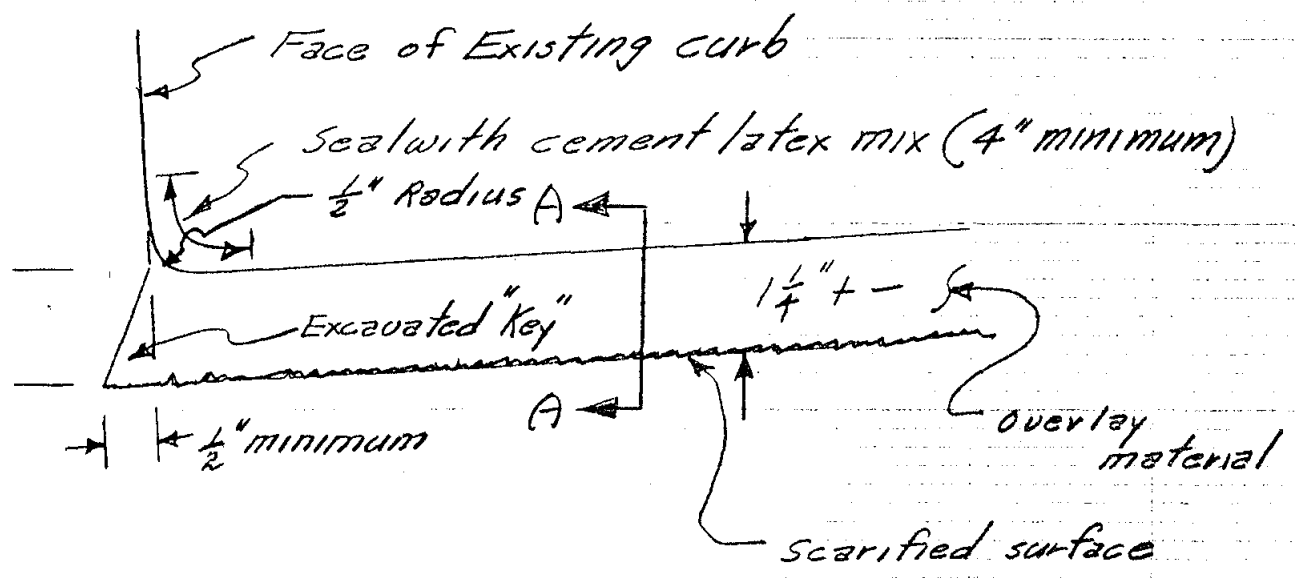
Section BB
(Joint)

X-20143 Fairbanks Bridge Deck Repair
 Attachment for EWO No 3

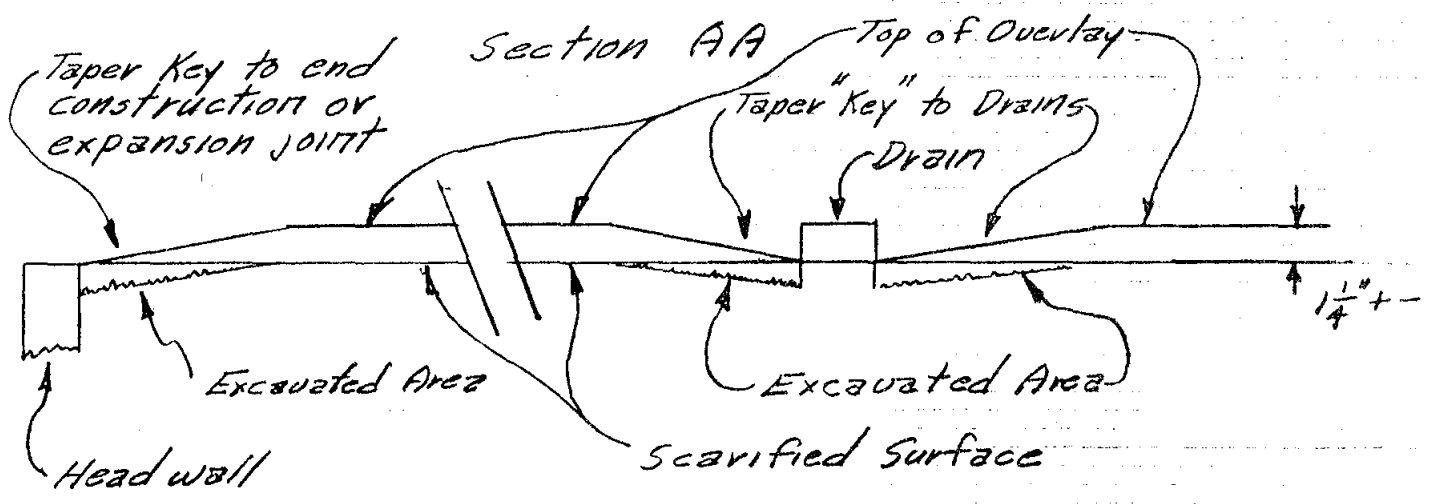
EXAMPLE 18

Revised Excavation Detail @ Curb
 (For Wendell & Cushman St Bridges)

Not to Scale



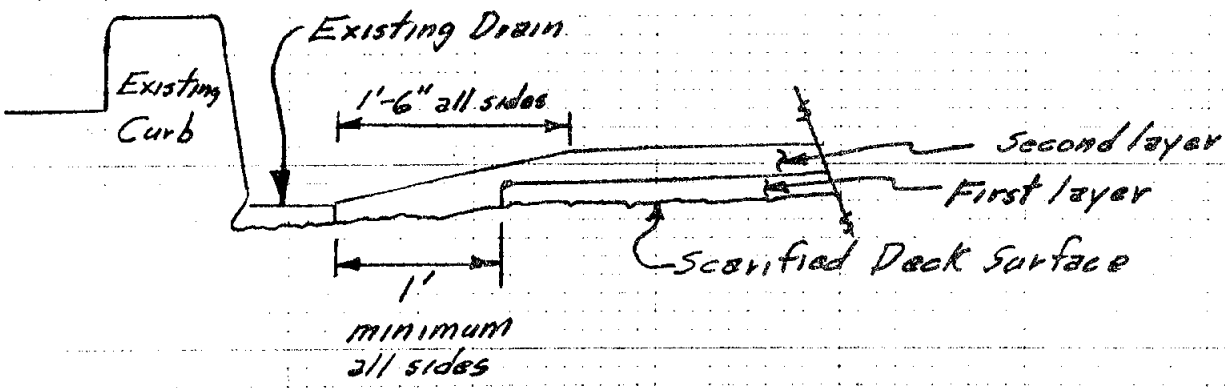
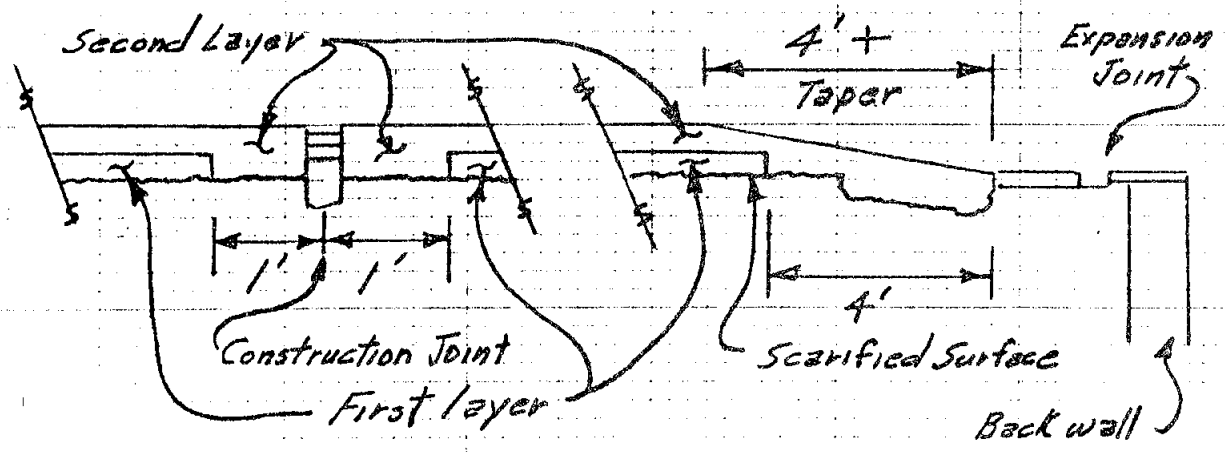
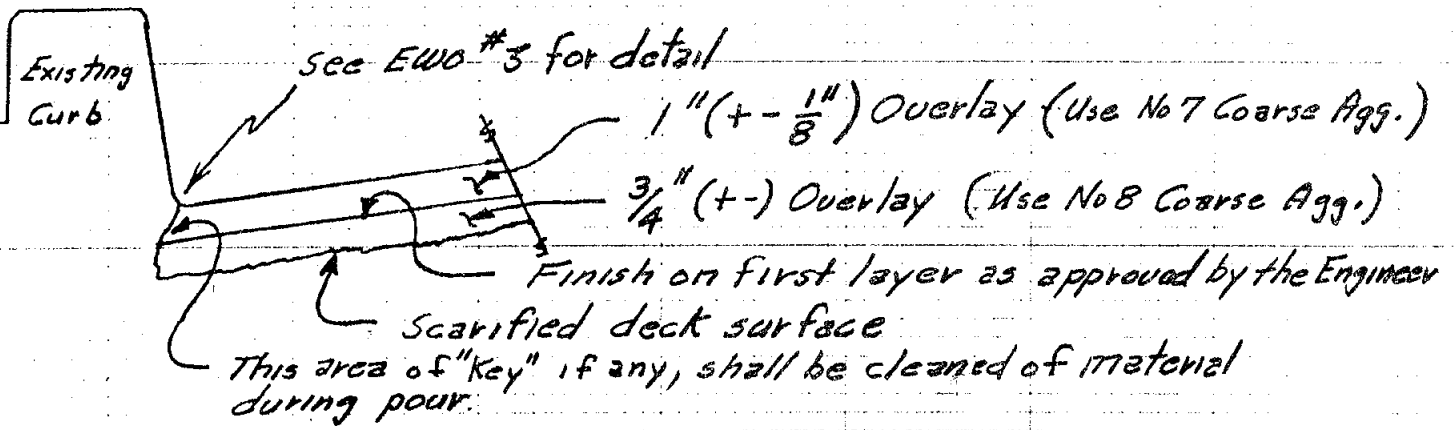
The below information not part of EWO No 3



Details for two-layer overlay of Polymer Modified Concrete

EXAMPLE 19

Not to Scale



Note: The actual thickness of Overlay Material at any location shall be as Directed by the Engineer. The Second layer shall not exceed 1" nominal

Calibration for Minnie St Bridge

TEX-CRETE INC

EXAMPLE 20
S. Powers
6/25/82

CONCRETE MOBILE CALIBRATION DATA SHEET

TO PRODUCE POLYMER MODIFIED CONCRETE

Tilman
6-26-82

PROJECT X-20143 Fairbanks Bridge Deck Repair COUNTY North Star Borough
 CONTRACTOR Pioneer Masonry Restoration DATE 6/25/82
 TRUCK NO. 1304P SERIAL NO & CAPACITY 10TM1304P/108F 10 cu. yd.
 TRUCK R.P.M. 1250 CALIBRATED BY Steve Powers

CALCULATING CEMENT METER REGISTER COUNT

NOTE: ACCORDING TO THE MANUFACTURER'S PLATE, THE CEMENT FEEDER METER COUNT TO DISCHARGE A 94 LB. UNIT OF CEMENT HAS BEEN DETERMINED. ENTER THIS COUNT IN THE BOX.

PLATE COUNT 71.3

CEMENT

Container Wt. <u>6.016</u>		
LBS.	COUNT	SECS.
90 ⁸	64 ⁵	25 ¹
91 ¹	64 ⁵	25 ⁰
90 ⁴	65 ⁰	25 ²
89 ³	63 ⁵	24 ⁶
89 ⁰	63 ⁵	24 ⁵
450 ⁶	321 ⁰	124 ⁴

TOTAL COUNTS	TOTAL WEIGHT	FACTOR (TO 4 DECIMALS)
321 ⁰	450 ⁶	.7124

FACTOR	NEW CEMENT METER COUNT
.7124	94 = 66.96

NOTE: RECORD YOUR ANSWER TO ONE DECIMAL AS THE NEW, RE-CALIBRATED CEMENT METER COUNT (FOR ONE 94 LB. UNIT OF CEMENT)

* see attachment
68*

CALCULATING TIME (IN SECONDS) TO DISCHARGE ONE 94 LB. UNIT CEMENT

TOTAL SECONDS	TOTAL WEIGHT	FACTOR (TO 4 DECIMALS)
124 ⁴	450 ⁶	.2761

FACTOR	NEW TIME
.2761	94 = 25.95

We decided to run a larger quantity to check this. See attached sheet

NOTE: RECORD YOUR ANSWER TO ONE DECIMAL AS THE NEW, RE-CALIBRATED TIME IN SECONDS TO DISCHARGE ONE 94 LB. UNIT OF CEMENT. ENTER THIS FIGURE IN THE BOX

NEW TIME 26.7*

SAND GATE Sec. for Calibration 26.7 Container Wt. 6⁰ Lb Moisture Content 4.3% * see attachment

	1	2	3	4	5		
Dial Setting	49	49	49	49	49	New Setting	49
Lbs. of Sand	234 ³	234 ⁹	232 ⁶	237 ⁵	236 ³	Required Lbs.	234 ⁷

STONE GATE Sec for Calibration 26.7 Container Wt. 6⁰ Lb Moisture Content 1.1%

	1	2	3	4	5		
Dial Setting	38	37 ⁵	37 ⁵	37 ⁵	37 ⁵	New Setting	37 ⁵
Lbs. of Stone	201 ⁹	199 ³	201 ¹	198 ³	199 ⁵	Required Lbs.	200 ¹

LATEX Sec for Calibration 26.7

	1	2	3	4	5		
Setting ^{1/4} valve	9.2-9.3 GPM 122	8.8 GPM 115	8.8 GPM 115	8.8 GPM 115	8.8 GPM 115	New Setting	8.8 115
Lbs.	33 ³	32 ¹	32 ²	32 ²	32 ¹	Required Lbs.	29 ⁴

TER Sec for Calibration _____ Container Wt. _____

	1	2	3	4	5		
Setting	<i>See Attached Sheet</i>					New Setting	
Lbs.	<i>See Attached Sheet</i>					Required Gal.	

STATE OF ALASKA
Department of Transportation
and Public Facilities

Page 1 of 2Date: 6/25/82Project No. X-20143& Name Fairbanks Bridge Deck RepairCalc. by: S. PowersChecked by: T. Man 6-26-82

Computations

for:

We decided to check the count for 3 bags of cement.

Weight-tare	Count	time
283 ²	202	79 ² sec

$$202 \div 283^2 = .7133 \quad .7133 \times 94 = 67.05$$

It was agreed to go to a count of 68

$$\frac{79^2 \text{ sec}}{202 \text{ count}} = .3921 \frac{\text{sec}}{\text{count}} \times 68 \text{ counts} = 26.66$$

Use 26⁷ sec.
for calibration

Computations

for:

Date: 6/25/82

Project No. X-20143

& Name Fairbanks Bridge Deck Repair

Calc. by: S. Powers

Checked by: Tilman 6-26-82

Checking the Buffalo Water Meter

Water was run through the meter until
it register 10 gallons then the water was weighed

#1

$$\frac{88^2 \text{ lb}}{6^2 \text{ tare}} - 82^0 \text{ lb} = 9.84 \text{ gals.}$$
$$\frac{82^0 \text{ lb}}{83^3 \text{ lb/gal}}$$

#2

$$\frac{89^6 \text{ lb}}{6^2 \text{ tare}} - 83^1 \text{ lb} = 10.01 \text{ gals.}$$
$$\frac{83^4}{83^3 \text{ lb/gal}}$$

#3

$$\frac{89^3 \text{ lb}}{6^2 \text{ tare}} - 83^1 \text{ lb} = 9.97 \text{ gal}$$
$$\frac{83^1 \text{ lb}}{83.33 \text{ lb/gal}}$$

Note: The unit weight of the water was checked using
a 1 ft.³ bucket and it came out to be 62³ lb/ft.³
or 8.33 lb/gal

AASHTO M241-811

582

SPECIFICATIONS FOR MATERIALS

M241

5.3.1.1 Requirements for compressive strength as determined on samples taken from the mixer at the point of discharge and evaluated in accordance with Section 10. The purchaser shall specify the requirements in terms of the compressive strength of standard specimens cured under standard laboratory conditions for moist curing. Unless otherwise specified, the age at test shall be 28 days.

5.3.2 At the request of the purchaser, the manufacturer shall, prior to the actual delivery of the concrete, furnish a statement to the purchaser, giving the dry weights of cement and saturated surface-dry weights of fine and coarse aggregate and quantities, type, and name of admixtures (if any) and of water per cubic yard or cubic meter of concrete that will be used in the manufacture of each class of concrete ordered by the purchaser. He shall also furnish evidence satisfactory to the purchaser that the materials to be used and proportions selected will produce concrete of the quality specified.

5.4 *Alternative no. 3:*

5.4.1 When the purchaser requires the manufacturer to assume responsibility for the selection of the proportions for the concrete mixture with the minimum allowable cement content specified, the purchaser shall also specify the following in addition to the requirements of 5.1.1 through 5.1.4:

5.4.1.1 Required compressive strength as determined on samples taken from the mixer at the point of discharge and evaluated in accordance with Section 10. The purchaser shall specify the requirements for strength in terms of tests of standard specimens cured under standard laboratory conditions for moist curing. Unless otherwise specified the age at test shall be 28 days.

5.4.1.2 Minimum cement content in pounds per cubic yard or kilograms per cubic meter of concrete (Note 5), and

5.4.1.3 If admixtures are required, the type, name, and dosage range to be used. The cement content shall not be reduced when admixtures are used.

5.4.2 At the request of the purchaser, the manufacturer shall, prior to the actual delivery of the concrete, furnish a statement to the purchaser, giving the dry weights of cement and saturated surface-dry weights of fine and coarse aggregate and quantities, type, and name of admixture (if any) and of water per cubic yard or cubic meter of concrete that will be used in the manufacture of each class of concrete ordered by the purchaser. He shall also furnish evidence satisfactory to the purchaser that the materials to be used and proportions selected will produce concrete of the quality specified. Whatever strengths are attained the quantity of cement used shall not be less than the minimum specified.

NOTE 5—Alternative No. 3 can be distinctive and useful only if the designated minimum cement content is at about the same level that would ordinarily be required for the strength, aggregate size, and slump specified. At the same time, it must be an amount that will be sufficient to assure durability under expected surface texture and density, in the event specified strength is attained with it. Attention is directed to ACI Recommended Practices 211.1 and 211.2 for additional information on mixture proportions.

5.5 The proportions arrived at by Alternatives 1, 2, or 3 for each class of concrete and which are approved for use in a project shall be assigned a designation (7CV.PK7, etc.) to facilitate identification of each concrete mixture delivered to the project. This is the designation required in 14.1.7 and supplies information on concrete proportions when they are not given separately on each delivery ticket as outlined in 14.2. However, each delivery of concrete shall be covered by a delivery ticket showing enough information to establish that the mix conforms to the mix designs previously approved for the work.

→ 6. MEASURING MATERIALS

6.1 Cement, fine and coarse aggregates, water, and admixtures may be measured by weight or by volume. If volume proportioning is employed, devices such as counters, calibrated gate openings, or flowmeters must be available for controlling and determining the quantities of the ingredients discharged. In operation, the entire measuring and dispensing mechanism must produce the specified proportions of each ingredient.

NOTE 6—The recommendations of the equipment manufacturer in the operation of the equipment and in calibrating and using the various gages, revolution counters, speed indicators, or other control devices should be followed.

6.2 All indicating devices that bear on the accuracy of proportioning and mixing of concrete shall be in full view and near enough to be read by the operator while concrete is being produced. The operator shall have convenient access to all controls.

6.3 The proportioning and indicating devices shall be individually checked by following the equipment manufacturer's recommendations as related to each individual concrete batching and mixing unit. Adequate standard volume measures, scales, and weights shall be made available for the checking accuracy of the proportioning mechanism. The device for the measurement of the added water shall be capable of delivering to the batch the required quantity within the accuracy of ± 1 percent; the device shall be so arranged that the measurements will not be affected by variable pressures in the water supply line.

6.4 Yield Check—Essentially, the volume of concrete discharged from the mixer is checked by first weighing the amount of concrete discharged during some number of revolutions, or as determined by some other output indicator; this is then followed immediately by a determination of the weight of concrete per cubic foot (or cubic meter). The weight of concrete discharged divided by the weight per cubic foot (or cubic meter) is equal to the number of cubic feet (or cubic meters) mixed and discharged during chosen interval. The accuracy of the output indicator is thus checked by this expedient.

Note 7—It is recommended that about 2.5 to 3.0 ft³ (0.070 to 0.085 m³) be discharged for this purpose; this amount of concrete will weigh from 350 to 500 lb (160 to 225 kg) and can be discharged into and contained in a 35 or 55-gal (130 to 210-dm³) drum or other suitable container which in turn can be placed on weighing scale of adequate capacity. The output of a batcher-mixer unit may be indicated by the number of revolutions, travel of a belt, or changes in gage readings; if so, these figures should be used as a measure of output.

6.5 Proportioning Check—Whenever the sources or characteristics of the ingredients are changed, or the characteristics of the mixture are noted to have changed the purchaser may require a check of the fine aggregate content and the coarse aggregate content by use of the washout test. Essentially, in the washout test, 0.03 m³ (1 ft³) of concrete is washed through a 4.75 mm (No. 4) sieve and through a 0.150 mm (No. 100) sieve; that retained on the 4.75 mm sieve is normally considered coarse aggregate whereas that passing the 4.75 mm and retained on the 0.150 mm sieve is considered fine aggregate. Corrections to the quantity of aggregates (per cubic foot or cubic meter of concrete) can be made if the original sieve analysis of each aggregate is available.

6.6 The rate of water supplied the continuous mixer shall be measured by a calibrated flowmeter coordinated with the cement and aggregate feeding mechanism, and with the mixer. The rate shall be capable of being adjusted in order to control slump at the desired levels and to determine that the water-cement (permitted or required) ratios are being met.

6.7 Liquid admixtures shall be dispensed through a controlled flowmeter.

6.8 Tolerances in proportioning the various ingredients are as follows:

Cement, weight percent	0 to + 4
Fine Aggregate, weight percent	± 2
Coarse Aggregate, weight percent	± 2
Admixtures, weight or volume percent	± 3
Water, weight or volume percent	± 1

The tolerances are based on a volume/weight relationship established by calibration of the measuring devices furnished as an integral part of the whole equipment.

Note 8—It is noted that to meet these tolerances, attention must be given to:

- (1) Degree of compaction of the cement.
- (2) Grading and other physical characteristics of the fine and coarse aggregates.
- (3) Moisture content and bulking factor of the fine aggregate.
- (4) Viscosity of the admixture, and
- (5) Other factors of influence.

7. MIXING MECHANISM

7.1 The continuous mixer shall be an auger-type mixer or any other type suitable for mixing concrete to meet the required consistency and uniformity requirements (see 13.3.3).

7.2 Each batching or mixing unit, or both, shall carry in a prominent place a metal plate or plates on which are plainly marked the gross volume of the unit in terms of mixed concrete, discharge speed, and the weight-calibrated constant of the machine in terms of a revolution counter or other output indicator. The mixer shall produce a thoroughly mixed and uniform concrete.

Note 9—For a quick check of the probable degree of uniformity, slump tests can be taken any time after initial discharge and shall be within the following limits: If the average slump is 4 in. (100 mm) or less, the difference between any two slumps shall not be greater than 1 in. (25 mm); if the average slump is above 4 in. (100 mm) and not greater than 6 in. (150 mm), the difference shall not be greater than 1.5 in. (38 mm).

8. MIXING AND DELIVERY

8.1 The batcher-mixer unit shall contain in separate compartments all the necessary ingredients needed for the manufacture of concrete. The unit shall be equipped with calibrated proportioning devices to vary the mix proportions and it shall produce concrete as required by this specification and those of the project.

Received 8/7/82

S. Powers

from Norton

Corrosion Limited, Inc.

I. ANODE WIRE INSTALLATION

EXAMPLE 26

A. LOOM IDENTIFICATION

The various looms are individually tagged with street name and location. These locations correspond to the markings on the enclosed, annotated construction drawings.

B. SAW CUTTING THE PAVEMENT

1. Rebar cover.

Prior to sawing pavement, the field engineer should verify that the minimum concrete cover over the rebars, as specified in bid document drawings, exists at all locations where saw cuts would be made. If the cover is less than specified, sufficient concrete shall be poured, in compliance with Alaska DOT specifications, to bring the cover to that minimum.

C. MARKING THE PAVEMENT FOR CUTTING.

Prior to sawing pavement, the field engineer shall confirm the "fit" of the prefabricated anode looms. The looms shall be laid out on the deck in such a manner that the anode wires are symmetrical to the center longitudinal axis of the respective bridge deck.

The field engineer shall then mark the transverse header cable cut so as to be in compliance with the enclosed construction drawings. Header cables shall typically run parallel to construction or expansion joints and, excepting the two header cables located approximately mid span on the Wendell Street bridge, be at a distance of not less than three feet (3') nor more than four feet (4') from the respective joint.

The two Wendell Street mid span header cables may be run, at the field engineer's discretion, in a common cut. If reference or negative bonding cables are to be run in the anode header cable transverse saw cut, their inclusion must be taken into account in the determination of that saw cut width.

The field engineer shall mark on the pavement the point where each of the anode wires exit at right angles from the respective header cable. One half inch by one half inch ($\frac{1}{2}$ " x $\frac{1}{2}$ ") saw cuts, symmetrical to these point, will be made. These saw cuts will be parallel to the longitudinal axis of the deck and in accordance with the construction drawings. Where two anode wire runs (saw cuts) approach each other from opposite directions between two header cables, and a construction or expansion joint does not exist between the two anode header cables, the saw cuts shall run continuous from one header cable to the other.

Markings for saw cuts shall be made with pavement parking crayons or chalked string or other devices typically used for marking pavement.

D. CUTTING THE PAVEMENT

The field engineer shall provide sufficient supervision of all cutting by the construction crew to ensure all cuts which are made are made at the proper location.

E. INSTALLING THE ANODES

After the cutting is complete, the anode wire and header grooves shall be blown free of all dust, debris and water which may be present. The anode header cables shall be positioned at their respective locations and butt spliced as required. Butt splices shall be coated with mastic and covered with tightly fitting heat shrinkable insulating tubing or encased in epoxy in such a manner to be water tight and ensure no copper is exposed to the patching concrete, conductive grout or any other electrolyte which may be present.

- The anode wires shall be run out in their respective grooves.
- * Balsa shims may be used to keep the anode wire on the approximate center longitudinal axis of the groove. To facilitate installation, anode wires running in a common groove may be spliced at a point of overlap to provide some tension on the anode wires (not to exceed 20 lbs). If anode wires are spliced the splice shall be covered with mastic and tightly fitting heat shrinkable tubing or encased in epoxy in such a manner as to be water tight and prevent contact between the splice and the conductive grout or concrete overlay.

F. FILLING THE GROOVES

Prior to filling the grooves, they shall be free of dust, debris and standing water. Concrete may, at the field engineer's discretion, be used to fill the anode header cable grooves. If concrete is used, the groove shall be moistened with clean water prior to patching.

For all locations where the FHWA conductive grout is used, (required for all anode wire grooves) the grooves shall be free of all dust, debris, moisture (air dried) and grease or oil.

* See Example 30

NOTE: ALL GROOVES SHALL BE FREE OF DUST, DEBRIS, MOISTURE (AIR DRIED), AND GREASE OR OIL PRIOR TO THE POURING OF THE CONDUCTIVE GROUT.

EXAMPLE 28

PLATINIZED WIRE ANODE INSTALLATION INSTRUCTIONS

II. CONDUCTIVE GROUT

READ MANUFACTURER'S TECHNICAL/PRODUCT SAFETY PUBLICATIONS PRIOR TO MIXING OF FEDERAL HIGHWAY ADMINISTRATION (FHWA) DEVELOPED CONDUCTIVE GROUT.

A. PROTECTIVE CLOTHING

Wear impervious gloves and protective clothing as required to prevent skin contact. Wear chemical goggles to prevent eye contact.

B. MIXING INSTRUCTIONS

1. Component Description

The FHWA conductive grout is provided in three (3) component, two and one-half (2½) gallon kits. Component "A" is a vinyl ester resin which is in one (1) gallon steel "paint" cans. Component "B" is the catalyst and is in 125 ml amber polyethylene bottles. Component "C" is coke breeze and is contained in three (3) gallon white polyethylene pails.

2. Mixing Instructions

- a. Use a mixer with a head diameter of at least two and one half (2½) inch.
- b. Open containers "A", "B" and "C".
- c. Pour the contents of container "B", the catalyst, into container "A", the resin.
- d. Mix components "A" and "B" thoroughly (2 minutes at 450-750 rpm).
- e. Pour the catalyzed resin over the coke breeze, container "C".
- f. Mix in the coke breeze (4 minutes at 450-750 rpm).
NOTE: Scooping into the unmixed coke breeze with the mixing head while stirring will help. The surface of the grout will loose some of its gloss when the resin and coke breeze are well mixed.
- g. Transfer the grout to a suitably sized, clean (excepting preceding grout residue) watering can with the "flower" removed or "tar bucket".

- h. Pour the grout around the anode wire, slightly overfilling the $\frac{1}{2}$ " x $\frac{1}{2}$ " grooves.

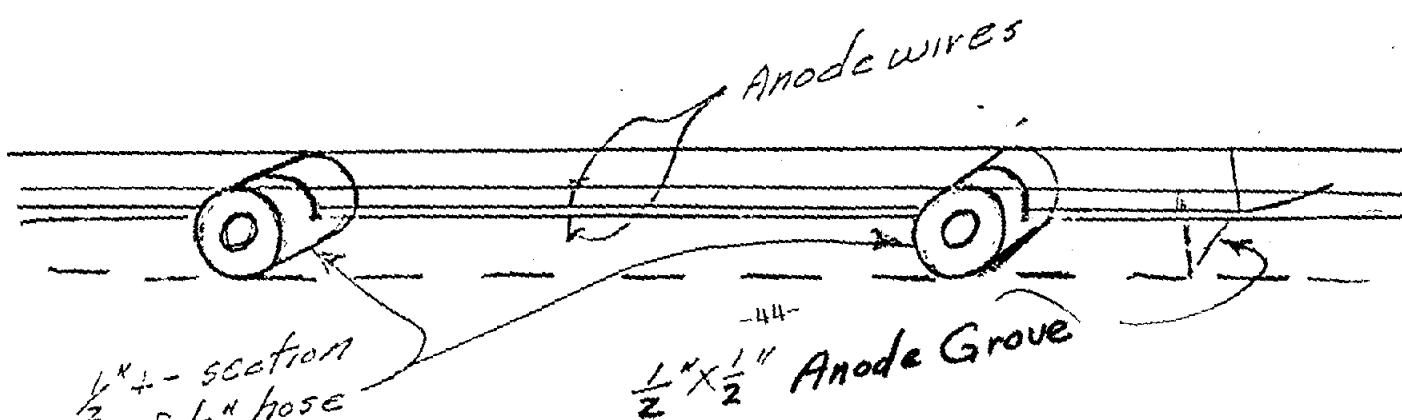
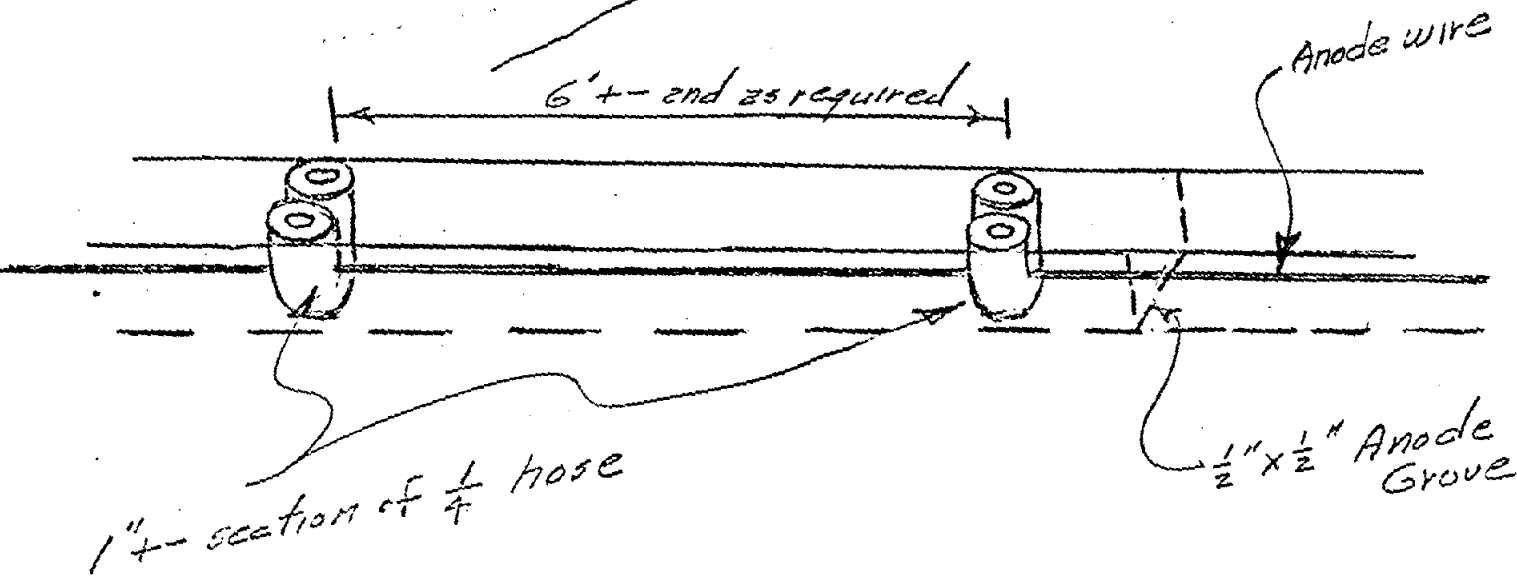
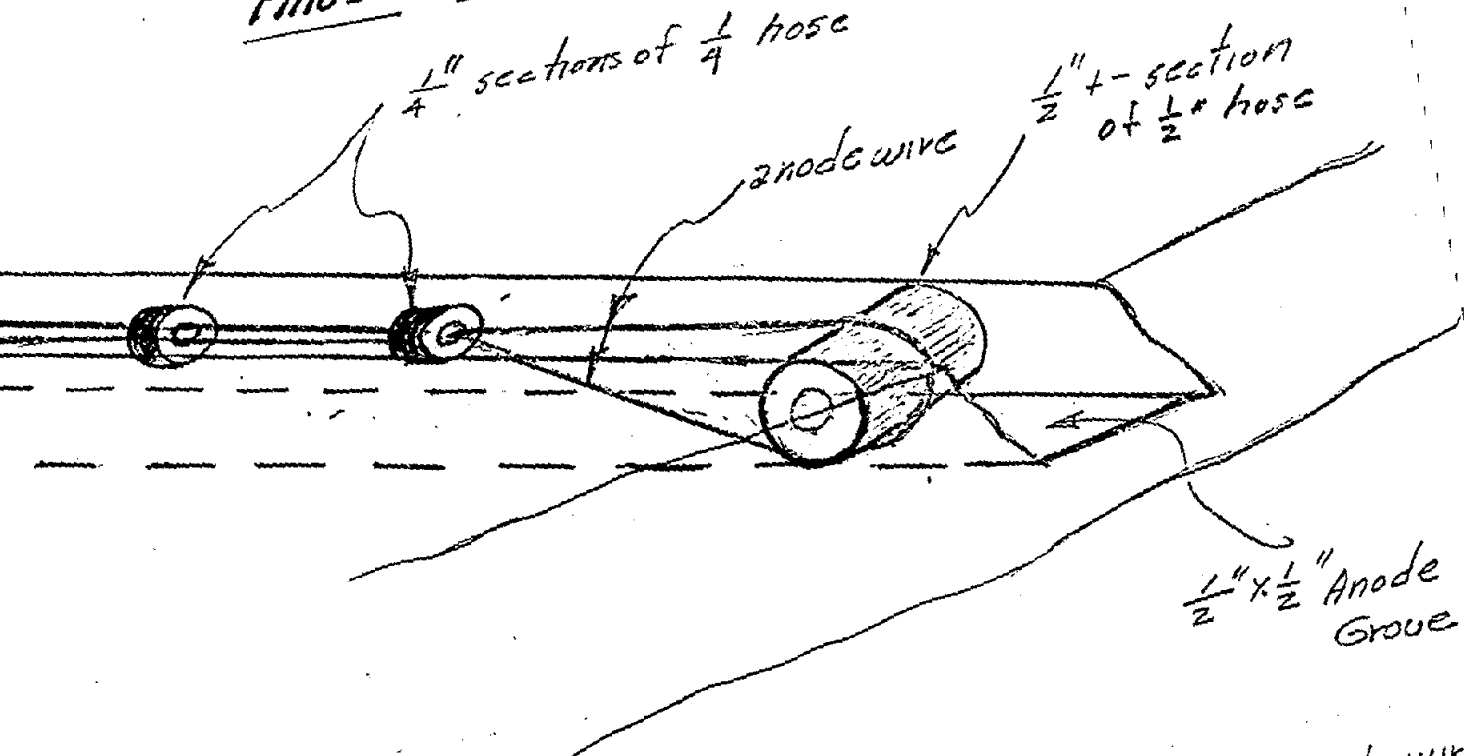
NOTE: At 70^oF, the working time for the grout is 15-20 minutes. Higher temperatures will accelerate the reaction rate and thus reduce the working time. Lower temperatures would have the opposite effect.

Typically, the three components should be stored in a shaded area until ready for use. This would be essential on a warm (air temp. more than 75^oF) day. On a cooler day (air temp. less than 65^oF), however, the sealed containers may be brought into an unshaded area for some gentle warming.

FOR MAXIMUM SHELF LIFE, COMPONENTS "A" AND "B" SHOULD BE STORED AT LESS THAN 100^oF.

Not to Scale

Anode Wire Retainers



Mix for Latex Modified
Concrete Repair Work

1 Part Cement (Type I)

3 Parts Fine Agg or sand

Enough latex to make mixture workable

No Water Required

Paint surface to be repaired with latex material

Mix for sealing Gutter

1 part Cement

Enough latex to obtain a thick paste consistency

Project X-20143 Bridge Wendell Date 9/3/82 Inspector Powers

Begin Pour 9:00 am Finish Pour 6:30 pm Completed Finishing 7:00 pm

As Calibrated?

1/4 Yield

EXAMPLE 32

		9:00				9:15		9:30
mc								
ment Count	68/sack	160		287		868		1657
c Cu Yds	—			.60		1.82		3.48
ter Digital Meter	28.4			17.1		51.5		98.1
x 0.94 =	26.7			16.25		48.9		93.2
al / CY (3.8/sack)	26.6			26.9		26.8		26.8
ter Pressure	38		38			38		38
lue Setting	10 ¹⁰ / ₄		10.0					
ex Flow Meter	8.9 ^{9.1}		9.1			9.1		9.1
ter Flow Meter	2.3		0			0		0
x $\frac{0.7}{2.3}$ (0.21)	0.5							
al / CY	2.0		0			0		0
ter Pressure	75-80							
lue Setting	ON MARK		.					
ter Digital Meter			0			0		0
Temperature			45°F			45°F		
Aggregate								
ine Gate Setting	4.90					4.90		
ourse Gate Setting	3.65					3.65		
Slump				6"				
sch RPM	1250		1250			1250		1250

.93 cu. yd. per 10'

Cement Count = 68 @ 26.7 Sec

Latex = 3.8 Gal @ 26.7 Sec

Water = 7.4 Gal / CY in Agg + 2.0 Added + 12.25 in Latex = 21.65

Coarse Agg 1385 Lbs Dry / CY

Fine Agg 1575 Lb Dry / CY

21.65 = 3.09 Water
7 Cement
ratio
Spact = 4.5 Max

2.3 SOUNDING OF THE BRIDGE DECK

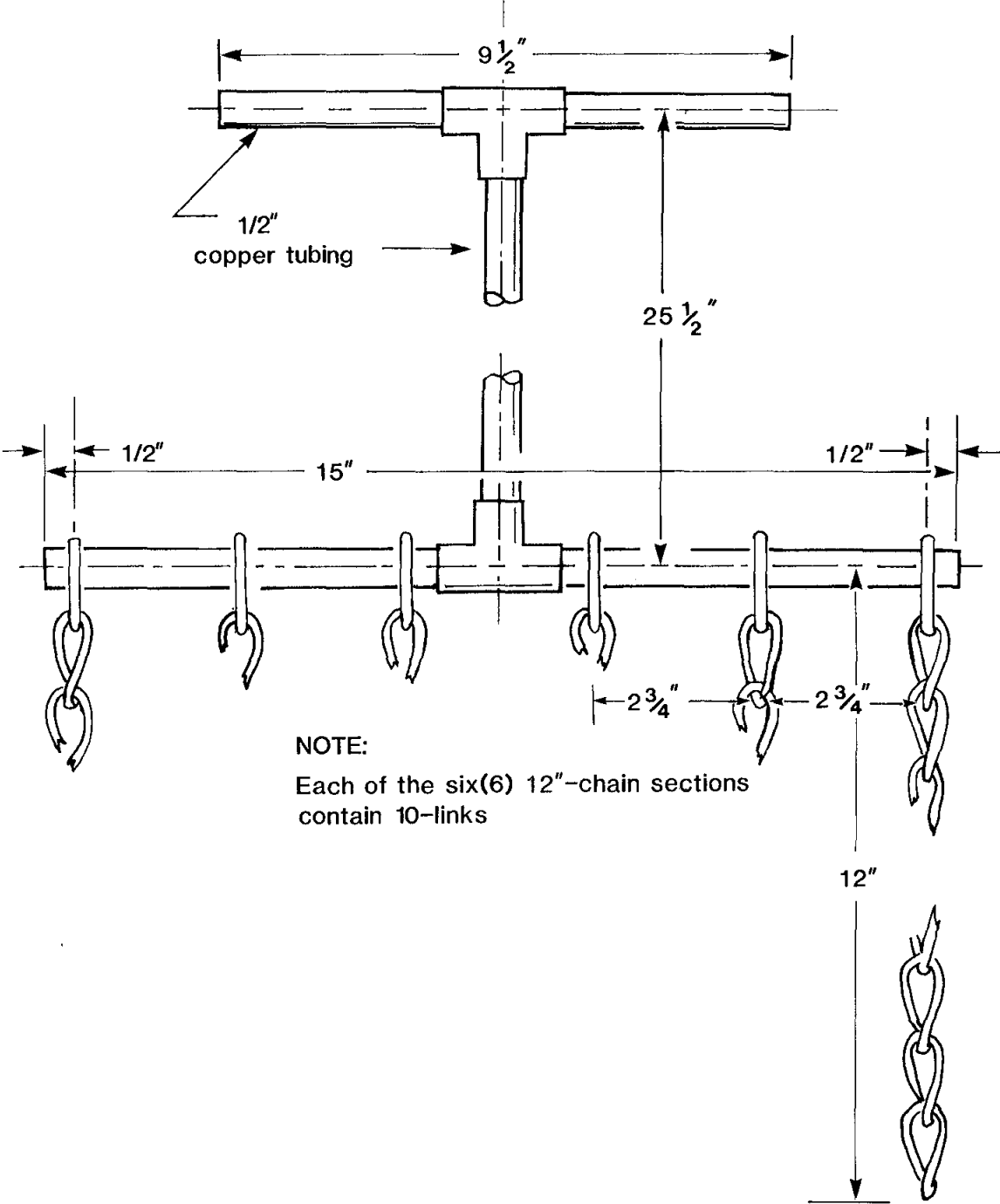
Sounding the bridge deck for areas of delaminated concrete is performed to assure that all rusted rebar is located and a sound bonding surface is obtained. In the sequence of work this was referred to as chain dragging the deck because chains are used to do the sounding. The process is very simple and requires only limited training of personnel. As the chains are dragged along the surface of the deck with structurally sound concrete, the chains will produce a loud and clear noise. However, as the chains pass over areas where the concrete has become delaminated, the noise produced will be dead and hollow sounding. There may not be any surface signs of delamination, but a couple of blows with a hammer will spall out the concrete to reveal a rusted section of reinforcing steel.

To cover a larger area than one set of chains, the device shown in Figure 3 was used. To delineate the delaminated areas, the device could be turned so that all of the lengths of chain follow the same line or it could be tipped up so that only one length of chain drags on the surface. A light duty set of chains produced a more distinct sound differential between firmly bonded concrete and delaminated concrete than did a heavier set of chains. When sounding excavated areas, it was handy to have a rock hammer along to knock out small areas of delamination or single pieces of loose aggregate.

No special training was necessary to chain drag the deck, but this process must be done systematically and conscientiously to insure the integrity of the final repair. The employee performing the chain dragging should also have a good sense of humor to ward off possible comments from the passing public such as "Hey buddy, it's going to take a long time to sweep off the bridge with that funny broom, ha, ha, ha."

BRIDGE DECK CHAIN DRAG

Figure 3



2.4 LATEX-MODIFIED CONCRETE

The American Concrete Institute (ACI) classifies materials which use polymers to form composite concretes in three groups:

- (1) Polymer-impregnated concrete (PIC) is hydrated portland cement concrete that is impregnated with a monomer (a simple unpolymerized compound) and subsequently polymerized (undergoes a chemical reaction in which two or more small molecules continue to form larger molecules) in situ.
- (2) Polymer portland cement concrete (PPCC) is produced by adding either a monomer or polymer to a fresh concrete mixture and subsequently curing and polymerizing in place.
- (3) Polymer concrete (PC) is a composite material formed by polymerizing a monomer and aggregate mixture.

Polymer-modified and/or latex-modified concrete (LMC) falls under group (2). There are polymer latexes and thermosetting polymers which have been added to fresh concrete. According to ACI, latex-modified concretes represent the large majority of commercial applications of PPCC in the United States. The addition of the latex modifier greatly improves shear bond, tensile, and flexural strengths of cements and mortars. There are thermoplastic latexes which include polyvinyl esters, polyacrylics, and polyvinyl chlorides. Elastomeric latexes include acrylonitrile-butadiene and styrene-butadiene.

The latex used on the Fairbanks Bridge Deck Repair project, Polysar Dylex 1186 supplied by TEX-CRETE, Inc., is a styrene-butadiene rubber emulsion and was used with Type 1 portland cement in the mix. According to the 1981 Alaska Department of Transportation and Public Facilities Standard Specifications for Highway Construction, the modified concrete shall have the following proportions:

Minimum Cement Content (Sack/C.Y.)	7.0
Maximum Water-Cement - Ratio (Gals./Sack)	4.50
Slump Range (Inches)	2-4
Entrained Air	6% Max.
Coarse Aggregate (AASHTO Gradation)	No. 7
Fine Aggregate Tolerance of Fineness Modulus	0.2+

The mix design presented by TEX-CRETE's literature agreed with the State specification except for the slump. The slump range was first changed to 3-5 inches on Extra Work Order #1 and then 2-7 inches on Extra Work Order #4. A 4-7 inch slump range was recommended by the manufacturer and was found to be more practical for actual placement of the material. The compressive strength at 28 days for all concrete test cylinders exceeded the 5,000 psi requirement given in the special provisions for this project. The cylinder test strengths are included in Appendix B, page B-1.

The project mix design was provided by TEX-CRETE and is in Appendix B, page B-4. Because of the polymerization process, latex-modified concrete has to be mixed on the bridge deck using a mobile mixer. The standard continuous, mobile mixer has to be modified so that it can add the latex to the mix. The mixer used on the Fairbanks Bridge Deck Repair project would hold enough aggregate, cement, latex, and water to mix 10 cubic yards. Stockpiles were placed at the end of the bridge so that the mixer could be filled without delaying the overlay placement. Examples of the mobile mixer calibration are given in the sequence of work section. AASHTO specification M241-811 was used for this calibration. Since only a small amount of water was being added to the mix, small fluctuations in the aggregate moisture content would affect the slump. Therefore, the amount of water added required adjustment during the pour to keep the mix workable and within the specification slump range; a water flow rate meter that is accurate at low flows is necessary. It was not only practical but necessary in warm weather to stay in the 4-7 inch slump range. A calibrated volumetric water meter is required to monitor the quantity of water used and for checking the water-cement ratio. The maximum water-cement ratio was .35 or 4.0 gallons/sack on the Fairbanks Bridge Deck Repair project.

2.4.1 SHRINKAGE CRACKS

Manufacturers' literature for latex-modified concrete has pointed out that either excessive sunlight exposure to the freshly poured concrete surface prior to placing curing material, the concrete mix being too dry, or excessive heat during the pour may cause rapid hydration resulting in surface cracking. The Minnie Street Bridge was scheduled for concrete placement during hot weather so it was decided to start the pour at 4:00 a.m. to avoid the heat of the day. The pour was completed by 12:00 noon. Both Dow (Dow Chemical manufactures a styrene-butadiene latex modifier with the same composition as Dylex 1186) and Polysar recommend that the latex-modified material not be placed at temperatures greater than 85°F. Prior to the Minnie Street pour, the workers handfinishing the concrete had not worked with a material that set up as quickly as the LMC. By the end of that pour they had fallen behind the finishing machine and in order to finish around the last two drains they had to sprinkle the concrete heavily with water. A few small shrinkage cracks developed in that area. For the pours on the other bridges, the days were cool and cloudy causing no further problems. The finishers also became more familiar with the material, and the amount of effort necessary to finish at the curb was reduced by changing the radius so that they were able to keep up with the mobile mixer. It is hard to put a limit on the finishing time because it depends on the weather and product. Ideally, the surface should be finished and ready for texturing 15 minutes after the material was mixed. Dow and Polysar recommend that a construction dam or bulkhead be installed if there is a delay of the placement operation exceeding 1 hour in duration. During minor delays the manufacturers recommend that the end of the placement be protected from drying with several layers of wet burlap.

The manufacturer of Dylex 1186 recommends that cracks be sealed by using 1 part cement, 2 parts fine graded sand and a 60/40 premix of latex/ water until a creamy slurry is achieved. This slurry should be rubbed into the surface of the cracks until the cracks are not visible but the texturing must not be destroyed. To avoid shrinkage cracking, the finished surface should be covered with a single layer of wet burlap as soon as the surface will support it. Either more layers of wet burlap or a polyethylene film are placed on top of that for the required 24 hours of wet curing.

2.4.2 TEXTURING

A heavy broom finish was the texture chosen for the latex-modified wearing course on the Fairbanks Bridge Deck Repair project. Before a plastic film formed on the concrete surface, a Nelson Rake (wire bristle broom) was used for transverse texturing.

A survey was made on April 20, 1983 to check the wear on the Wendell Street Bridge. After 6 months of service, a wear pattern could be seen on the bridge deck, but the rutting was so slight that it was difficult to measure. It would be safe to say that the wear was generally less than 1/16 inch. The heavy broom finish had not worn off. The Minnie Street bridge was also checked for wear. It was found that there was less overall wear on this deck, but the broom finish had been worn smooth in some areas. There was not as heavy a broom finish put on this deck as on the Wendell Street bridge. (It might be noteworthy that approximately 50-60% of the snow tires sold in the Fairbanks area have studs.⁵)

The Pennsylvania Department of Transportation training manual on latex-modified concrete bridge deck overlays suggests that ideally a metal tine with bristles spaced approximately 1/2 inch apart should be used and the striations should be uniform and 1/16 inch in depth. Also, overlapping strokes and going back over an area should be minimized. It is better to leave small areas untextured than to risk damage to the overlay. The 1/2 inch spacing of the bristles would allow aggregate to remain in the peaks of the texturing and thus minimize initial wear.

3.0 DESIGN CONSIDERATIONS

3.1 SCARIFICATION

The literature from the manufacturer of Dylex 1186 latex additive recommended that a minimum of 1/4 inch of concrete be removed from the existing deck surface for proper bonding. Other literature pointed out that this was necessary because latex will not properly bond to oil, rubber, epoxy, and other contaminants.¹ The scarifying would also produce a rough surface with fractured aggregate surfaces for improved bonding.

As Extra Work Order #1 indicates, the contractor agreed to scarify the deck a minimum of 1/4 inch in exchange for the addition of 1/4 inch to the overlay thickness. He started on Minnie Street bridge using a MacDonald Scabbler Type U11. This is basically a pneumatic tool 19 inches wide with 11 bush type bits mounted on pistons. This machine did a very good job, but the production rate was much slower than anticipated. It took approximately 157 personhours to scarify 83,978 square feet. On the Illinois Street bridge, the contractor used the CMI Autograde Roto-Mill Model 375 that was working on the College Road Pavement Recycling project to scarify the deck. The Roto-Mill was on the bridge deck (3,972 square feet) for 4 1/2 hours, and it scarified the deck with the same teeth used on asphalt pavement. There were some areas that had to be done using the scabbler because of a lack of concrete cover over the reinforcing steel. Because of the 9 foot 5 inch width and instrumentation of the Roto-Mill, a more uniform profile and cross-section was obtained after scarification than with the scabbler. This is part of the reason for the reduced overlay quantity on the Illinois Street deck.

The contractor planned to use the Roto-Mill on the Wendell Street bridge, but it was being used elsewhere and/or it broke down. Therefore, he used the MacDonald Scabbler Type U11 and rented a Type U7. The U7 has only 7 heads and covers an area 15 3/4 inches wide. With these two scabblers it took 474 personhours to scarify the entire deck (11,973 square feet). This was the main reason that the deck repair was completed in 50 days instead of 30 days.

The scabbler is a good reliable piece of equipment for scarifying small areas. However, the production rate is generally not sufficient to scarify 1/4 inch off entire bridge decks. The CMI Autograde Roto-Mill Model 375 has a much higher production rate but is wide and heavy. Be-

cause of its width, the Roto-Mill cannot follow the contour of the deck as closely as might be necessary when rebar cover is a problem. Rebar cover should be checked carefully before a Roto-Mill starts working on a bridge deck because it will severely damage the deck if even one rebar is contacted. Also, the Roto-Mill is a heavy piece of machinery which creates vibration that might cause problems on long spans. For long spans, perhaps a smaller rotary type scarifier would be more suitable for the job.

During the scarifying operation, care should be taken to keep contaminants off the scarified surface. All machinery that might leak oil should be kept off the scarified deck when possible. If machinery, such as a compressor, has to be on the scarified portion of the deck, plastic should be placed under it and extreme care should be taken when refueling. If a spill does occur, it should be wiped up and contaminated concrete must be chipped away immediately. This excavation will not be paid for. The scarified deck shall be kept cleaned on a daily basis.

Relatively accurate project records of the scarifying operation (see Example 9) were kept so that an approximate production rate could be obtained. The three different pieces of machinery used to scarify the deck surfaces are listed below. On all three decks, the 6 inch wide area adjacent to the curb could not be reached by the scarifying equipment and was chipped by hand with the 15 pound pneumatic hammer using chisel and bush bits. One quarter inch was removed from all three decks.

- MacDonald Scabbler Type U11 - 19 inch working width
- MacDonald Scabbler Type U7 - 15 3/4 inch working width
- CMI Autograde Roto-Mill Model - approximately 9'5" working width

<u>Bridge</u>	<u>Scarifying Equipment</u>	<u>Time to Scarify Deck</u>	<u>Production Rate</u>
Minnie Street	MacDonald Scabbler Type U11	157 personhours	26 ft. ² /personhour
	15 pound pneumatic hammer	30 personhours	4.5 ft. ² /personhour

<u>Bridge</u>	<u>Scarifying Equipment</u>	<u>Time to Scarify Deck</u>	<u>Production Rate</u>
Illinois Street	CMI Roto-Mill	4 1/2 hours*	approx. 800 ft. ² / hour
	MacDonald Scabbler Type U11 (used to go over areas Roto-Mill did not complete acceptably)	45 1/2 personhours	
	15 pound pneumatic hammer	34 personhours	4.0 ft. ² / personhour
Wendell Street	MacDonald Scabbler Type U11	290 personhours	25.5 ft. ² / personhours
	MacDonald Scabbler	184	
	personhour	Type U7 15 pound pneumatic hammer	110 personhours

*This does not include approximately 3 hours of set-up time.

3.2 EXPANSION JOINTS

At the preconstruction conference for Project X20143, Fairbanks Bridge Deck Repair, the Maintenance and Operations personnel present expressed concern that the expansion joints in the deck of Cushman Street Bridge were not going to be raised which would produce a 1 inch dip in 6 linear feet (3 foot taper each side of the joint). A letter from Maintenance and Operations goes on to say that this would cause greater traffic impact, and winter maintenance equipment would gouge into the deck on each side of the expansion joints. The expansion joints will be modified as described in Extra Work Order #2, Appendix A. Note that the steel plates will be skip welded so that the concrete will not be heated to excessive temperatures. This modification would produce a smooth riding bridge deck and a full depth overlay at the expansion dams will provide insurance against spalling.

3.3 CURB "KEY"

Because latex-modified concrete flows too much to be worked onto a vertical face, the initially required 2 inch radius was found to be extremely difficult to work into the curb. A great deal of patching was required on the curb of Minnie Street Bridge. The required radius was reduced to 1 inch on Illinois Street Bridge. That was an improvement but still difficult to work with, and the finished product was only marginally acceptable. On Wendell Street Bridge, the detail was changed and a 1/2 inch radius was used. EWO #3 shows the detail used on that deck. This new detail produced a good finished product without much patching.

Since the bonding properties of the latex-modified concrete are very good, the "key" might not be necessary on future projects. Instead, a better result may be produced by scarifying 1/4 inch of the curb surface to be bonded. Also, a small radius must be used with latex-modified concrete. This could also reduce the project cost.

3.4 TWO-LAYER OVERLAY SYSTEM FOR CATHODIC PROTECTION

From the experience on the Fairbanks bridges, it was found that corrosion is concentrated where there is a lack of concrete cover over the rebar. Therefore, if a bridge deck is distressed enough to warrant cathodic protection, there might be a problem making saw cuts in the existing deck without hitting rebar or causing near shorts in the cathodic protection system.

On Wendell Street Bridge, several areas were encountered where the concrete was not delaminated, but it provided only about 1/2 inch of cover over the reinforcing steel. These areas varied in size from 20 feet to only a couple of feet in length along the anode slot lines. Two methods were available to solve this problem: patching or adding an overlay. Trying to patch all of these areas to obtain sufficient cover would have led to additional problems. Since feathering of the patch material is not a good practice, the vertical edges of the patches would have caused a problem during the saw cutting process. The latex suppliers' written recommendations say

that the depth of an overlay layer should be at least twice that of the maximum aggregate size in the mix. Some of the patch areas were located such that in order to meet that requirement and retain a smooth profile, the deck grade for the overlay would have had to be raised, which in turn would have increased the quantities considerably. Therefore, the pachometer survey (this survey determines the depth of the reinforcing steel below the surface of the deck using a pachometer) should be studied prior to determining what method to use. The cathodic protection system subcontractor was satisfied if the bottom of the saw cut was 1/4 inch above all reinforcing steel. In the case of Wendell Street Bridge, it was decided to use a two-layer overlay system since its cost to the state was approximately equal to patching and then overlaying.

First a nominal 3/4 inch layer of latex-modified concrete was placed using a coarse aggregate with a maximum size of 3/8 inch (AASHTO #8). This layer could be easily saw cut leaving at least 1/4 inch of cover over all rebar. After the cathodic protection system was installed, the deck was overlaid with 1 inch of latex-modified concrete that had a maximum coarse aggregate size of 1/2 inch (AASHTO #7). All of this added work was covered by Extra Work Order #4 shown in Appendix A. There is a drawing with that Extra Work Order which shows the details of the two-layer overlay method employed which avoided patching, assured that there will be enough cover for saw cutting, and allowed the engineer better control of the final profile and quantities.

3.5 SAW CUTTING

On the Wendell Street Bridge, sawing of the new overlay was allowed after the concrete reached a compressive strength of 2,000 psi. The cuts were clean, and no raveling at the edges was observed. The latex-modified concrete cut almost like butter at this strength, but as the strength reached 3,000 psi the sawing was much slower. With the Model E-230-PAB Eveready concrete saw the contractor averaged about 12 feet per minute sawing the 1/2 inch X 1/2 inch slots in the 2,000-3,000 psi concrete.

It was apparent that if the anode slots for the cathodic protection system had been cut into the scarified deck surface as originally planned, the Eveready concrete saw would have had to be modified to assure that a uniform specified depth was obtained. The cutting blades are mounted on an arm such that any irregularities in the deck would have caused the blade to rise or dip by a factor of approximately 2 in relation to the irregularity.

3.6 PROFILING THE DECK

On the Wendell Street Bridge, the worst delaminations encountered were located in an area where there was insufficient concrete cover over the reinforcing steel. When profiling the bridge, it was found that there was a dip in this area. According to the original as-built bridge plans, there was supposed to be 1 1/2 inches of cover in this area, but some of the exposed reinforcing steel proved that to be incorrect. It was obvious that the lack of concrete cover was not due to wear but due to poor or inadequate construction methods and inspection. In order to keep a smooth profile and have proper cover over the reinforcing steel, the thickness of new overlay was increased through this area. The point here is that the deck should be profiled and cross-sectioned in the design stage to estimate quantities more accurately than using the bridge as-built. For estimating the quantity of latex-modified concrete needed, the designer should use these profile and cross-sections to make a new profile and cross-section template. This method would give a relatively accurate quantity. The large dip in the Wendell Street Bridge required approximately 18,000 pounds of additional material at a cost of \$8,730.

3.7 "KEYING" OF PATCH AREAS

The recommended 45° angle on the edge of the excavated areas was found to be impractical. Even when using 15 pound pneumatic hammers the lip of the "key" could be easily spalled. Also, the patch material and overlay were poured monolithically, and therefore a separate "key" for the patch was not necessary. The bonding properties of the latex-modified concrete are much better than conventional concrete. If patching is required, perhaps a vertical cut should be made to avoid feathering the patch.

3.8 PAY ITEMS

The items 692(2) Polymer Modified Concrete Patches and 692(3) Polymer Modified Concrete Overlay will represent approximately 65% of the funds for the Fairbanks Bridge Deck Repair project when it is complete. There were many minor details of work that were incidental to these items which naturally led to a high unit price. Any overruns represented a significant increase in the project cost while any underruns would have meant a considerable loss to the contractor. Items such as these should be further separated to protect both the state and the contractor. Having more pay items would help to reduce the cost of this type of project.

The following are suggested pay items intended to aid a designer working on a bridge deck repair project and are not meant to be complete specifications:

3.8.1 Scarifying (Pay unit square yard)

This item would include scarifying the deck a minimum of 1/4 inch by machine and hand chipping in areas that the scarifier cannot reach. This item would include cleaning the deck each day with a high pressure (2,000 psi) water machine and/or compressed air. This item shall be measured by the area of deck scarified. The hand chipping at tapers, drains, and curbs would also be incidental to this item.

3.8.2 Surface Preparation (Square yard)

This item would include sandblasting and cleaning the deck as required. (Sandblast the entire deck surface and exposed rebar for the first overlay and clean with compressed air and/or high pressure water as the sandblasting progresses.) The same would be accomplished for the preparation for the second overlay. This item shall be measured by the area of deck sandblasted, and vertical surfaces of curb shall not be measured but will be considered incidental to this item. Each preparation for overlayment would be measured separately.

3.8.3 Hand Chipping (Cubic foot)

This item would involve excavation with a jackhammer to expose rebar. It would also include any other areas requiring excavation to remove delaminated concrete or any other excavation approved by the Engineer. This item would not include the hand chipping included under scarifying. This item would be measured by using a known volume of sand to fill the excavated areas level with the scarified deck to obtain a volume for these areas. Measurement would be accomplished by State forces in the presence of the contractor. The contractor would supply the sand and labor to remove and dispose of the material after measurement.

3.8.4 Latex-Modified Concrete (Cubic yard)

This item would include furnishing, placing, and finishing the volume of latex-modified concrete required for the bridge deck repairs and would be measured using the calibrated cement meter on the mobile mixer minus any quantity that is wasted or rejected. The wasted or rejected material would be measured by volume for deduction.

4.0 COST

4.1 COST INFORMATION

There are two types of repair techniques used on the Fairbanks Bridge Deck Repair project. As mentioned earlier on the Minnie Street, Illinois Street, and Cushman Street Bridges, the delaminated concrete was removed, rusted rebar sandblasted, and the decks were overlaid with latex-modified concrete. On the Wendell Street Bridge, the above steps were taken plus a cathodic protection system was installed. The actual construction costs are listed in Tables 1 and 2 for the Minnie Street, Illinois Street, and Wendell Street Bridges. (Since Cushman Street Bridge had not been completed at the time this report was written, the costs for that bridge are estimated.) Hopefully this information will be helpful when doing an economic analysis of the two types of repairs and will assist in future design of repair projects.

A few facts about these costs should be noted. The overlay quantities on Minnie Street and Illinois Street Bridges varied due to the lack of cover over the reinforcing steel on the Minnie Street Bridge and because the Roto-Mill, rather than scabblers, was used to scarify the Illinois Street Bridge. The Roto-Mill removed localized high spots which produced a more uniformly scarified deck surface, thereby decreasing the overlay quantity required.

On all of the bridge decks, additional overlay material was required to cover areas of exposed rebar, correct rough profiles, and overcome non-uniform cross-sections. On the Wendell Street Bridge, there was a section where the deck profile dipped abruptly approximately 1 inch for 60 feet. This was in an area of exposed rebar, and to smooth out the profile in this section approximately 18,000 pounds of additional overlay was used at a cost of \$8,730.

The added cost for the cathodic protection system on Wendell Street Bridge includes more than just the cost of the actual system. The bridge deck had to be overlaid twice in order to accommodate the cathodic protection system. In other words, there was not enough cover over the reinforcing steel to saw cut the deck for the anode slots without overlaying the deck first. This work is all spelled out in Extra Work Order #4 (See Appendix A). A detailed pachometer survey was completed after the deck had been scarified to determine how much patching would be required in or-

TABLE 1 - COST FOR CONSTRUCTION ITEMS

Item	Description	Unit	Estimated Total Amount
110(1)	Mobilization	L.S.	\$ 31,622.00
114(1)	Construction Surveying	L.S.	9,699.00
115(1)	Traffic Maintenance	L.S.	5,884.00
115(2)	Construction Signs	L.S.	13,728.00
116(1)	Furnishing Field Office	L.S.	8,324.00
691(1)	Wingwall Modification	L.S.	43,680.00
692(1)	Repair Reinforcing Steel	Lb.	1,466.00
692(2)	Polymer Modified Concrete Patches	Lb.	22,125.00
692(3)	Polymer Modified Concrete Overlay	Lb.	390,218.00
693(1)	Cathodic Protection	L.S.	103,119.00
694(1)	Expansion Joint Modification	L.S.	8,142.00
TOTAL AMOUNT			\$638,007.00

TABLE 2 - COST OF REPAIR PER BRIDGE

			Cushman Street***		Wendell Street*	
Deck Surface Area			11,568 Ft. ²		11,973 Ft. ²	
Approximate Area of Delamination			500 Ft. ²		260 Ft. ²	
Item	Description	Unit	Estimated Quantity	Estimated Final Amount	Quantity	Amount
110(1)	Mobilization	L.S.	All Req'd	\$ 11,651.00	All Req'd	\$ 11,651.00
114(1)	Construction Surveying	L.S.	All Req'd	3,601.00	All Req'd	3,602.00
115(1)	Traffic Maintenance	L.S.	All Req'd	1,984.00	All Req'd	1,984.00
115(2)	Construction Signs	L.S.	All Req'd	4,992.00	All Req'd	4,992.00
116(1)	Furnishing Field Office	L.S.	All Req'd	2,914.00	All Req'd	2,914.00
691(1)	Wingwall Modification	L.S.	All Req'd	43,680.00	All Req'd	----
692(1)	Repair Reinforcing Steel	Lb.	780	1,466.00	0	0
692(2)	Polymer Modified Concrete Patches	Lb.	7,812	9,843.00	5,387.3	6,788.00
692(3)	Polymer Modified Concrete Overlay	Lb.	341,318	165,539.00**	292,666	141,943.00
693(1)	Cathodic Protection	L.S.	All Req'd	51,559.00	All Req'd	51,560.00
694(1)	Expansion Joint Modification	L.S.	All Req'd	8,142.00	----	----
TOTAL AMOUNT				\$305,371.00		\$225,434.00

* Bridge completed/Amounts to nearest \$1.00

**The remaining amount authorized of all Polymer Patch and Overlay except for \$9,843.00.

***Cathodic Protection system deleted in order to reduce time bridge closed for repairs.

TABLE 2 - Continued

	Minnie Street*	Illinois Street*
Deck Surface Area	3,978 Ft. ²	3,972 Ft. ²
Approximate Area of Delamination	750 Ft. ²	350 Ft. ²

Item	Description	Unit	Estimated Quantity	Estimated Final Amount	Quantity	Amount
110(1)	Mobilization	L.S.	All Req'd	\$ 4,160.00	All Req'd	\$ 4,160.00
114(1)	Construction Surveying	L.S.	All Req'd	1,248.00	All Req'd	1,248.00
115(1)	Traffic Maintenance	L.S.	All Req'd	639.00	All Req'd	1,277.00
115(2)	Construction Signs	L.S.	All Req'd	1,872.00	All Req'd	1,872.00
116(1)	Furnishing Field Office	L.S.	All Req'd	1,248.00	All Req'd	1,248.00
691(1)	Wingwall Modification	L.S.	----	----	----	----
692(1)	Repair Reinforcing Steel	Lb.	0	0	0	0
692(2)	Polymer Modified Concrete Patches	Lb.	1,599.2	2,015.00	2,761.2	3,479.00
692(3)	Polymer Modified Concrete Overlay	Lb.	83,061	48,175.00	59,588	34,561.00
693(1)	Cathodic Protection	L.S.	----	----	----	----
694(1)	Expansion Joint Modification	L.S.	----	----	----	----
TOTAL AMOUNT				\$59,357.00		\$47,845.00

*Bridges completed/Amounts to nearest \$1.00

der to assure 3/4 inch minimum of cover over all rebar. Since patch material was \$1.26/lb. and overlay material was \$.485/lb., it was determined that the two-layer overlay method would cost about the same as patching and overlaying. If a cathodic protection system had not been planned for the deck, it would not have been necessary to do the added patching or overlay with the nominal 1/2 inch more latex-modified concrete required to obtain the 3/4 inch minimum cover. Therefore, the cost of the added 1/2 inch should be considered in the cost of the cathodic protection system; that is, 74,800 pounds at \$.485/lb. or \$36,278.00. For Wendell Street Bridge, a reasonable estimated added cost for the cathodic protection system installation would include \$51,559.50 for the cathodic protection system and \$36,278.00 for the additional overlay required for the installation, for a total cost of \$87,837.00.

The cathodic protection system was turned on October 13, 1982. On April 13, 1983 the load center meter read 3,880 kilowatt-hours used. This averages out to 647 kilowatt-hours per month. The rates for a Fairbanks Municipal Utilities System type B1 meter (per month) are as follows:

- \$12.000 minimum (for the first 100 kwh)
- \$ 0.113/kwh for the next 300 kwh (100-400 kwh)
- \$ 0.095/kwh for the next 600 kwh (400-1,000 kwh)
- \$ 0.078/kwh for anything over 1,000 kwh
- \$12.000 connect charge
- \$00.000 no disconnect charge.

For the first 6 months, the system cost \$69.37 per month or \$416.19 total not including the connect charge. It should be pointed out that there is a 720 watt heating element in the rectifier cabinet which was on almost continuously during most of this period. The bridge deck was frozen during most of this time, and the freezing of the bridge deck increases the electrical resistance which slows down the corrosion activity in the bridge deck. In other words, there is not really much need to have the system on during the winters in Fairbanks because the average daily temperatures remain low enough that once the deck gets below about 20°F (approximately 5 months) there is very little corrosion activity. Addi-

tionally, the resistance of the deck becomes so great that higher voltages are needed to move the current for the cathodic protection system through the deck.

To reduce the electrical costs, it is recommended that the cathodic protection system be completely turned off when the deck is frozen enough (below 20°F) so that there will be only insignificant corrosion activity. This could be done automatically by placing a thermal switch in the bridge deck. Norton Corrosion Limited, Inc. and Department personnel are investigating the possibility of installing a thermal switch on Wendell Street Bridge.

5.0 OTHER DESIGN RECOMMENDATIONS

5.1 OTHER DESIGN RECOMMENDATIONS

There are a few additional things that should be considered in the design of bridge deck repair projects. First of all, it would probably be to everyone's best interest to have a licensed Corrosion Engineer in on the ground floor of the design for a cathodic protection system. The corrosion in bridge decks and cathodic protection of bridge decks is not completely understood at this time. Therefore, there is not any one set system that will protect all bridge decks. To get the best guarantee that a system is going to protect the bridge deck properly, a Corrosion Engineer should do the design of the cathodic protection system.

The possibility of incorporating other construction work such as the paving of approaches, repairing of curb and railing, and painting with the deck repair activities should be investigated. A specification is needed so that the bridge closure time can be limited, thereby obtaining liquidated damages from the contractor for failing to perform the work in the designated amount of time. The specifications should be rewritten to require that the scarified and sandblasted surface of the bridge deck be kept clean.

5.2 IMPLEMENTATION

For future bridge deck repair projects, this report will be used as an aid for the designer when the pay item specifications are being developed and utilized as a reference by construction personnel.

Specifically this report will be distributed as a guide to the Department's Highway, Aviation, and Buildings and Harbors Design and Construction personnel who are doing work with bridges, overpasses, docks, ramps, and other concrete structures which may experience corrosion problems associated with the use of salts for deicing. Consultants doing work in the area of corrosion prevention and corrosion damage repair will also receive the report for use at the direction of Department personnel.

6.0 REFERENCES

6.1 REFERENCES

1. Lehmann, Joseph A., P.E., Norton Corrosion Limited, Inc., Cathodic Protection Fundamentals, 1963.
2. Pennsylvania Department of Transportation, Latex Modified Concrete Bridge Deck Overlay Inspector Guidelines, 1981.
3. Peratrovich and Nottingham, Inc., Bridge Deck Evaluation at Fairbanks, Alaska, November, 1980.
4. Polysar Latex, Dylex Latex for Bridge Repaving.
5. Telephone conversations with the Auto Service Company and Tire Warehouse in Fairbanks, Alaska.
6. Dow Chemical, Longer Lasting Bridge Decks with Latex Modified Concrete.
7. Dow Chemical, Modifier A Significantly Improving Concrete's Strength and Durability.

7.0 APPENDICES

DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

EXTRA WORK ORDER NO. 1

Interior _____ Region _____

Sheet 1 of 2

Project No. X-20143

Contractor Pioneer Masonry Restoration Co., Inc.

Project Name Fairbanks Bridge Deck Repair

Address PO Box 70110, Ballard Station

Seattle, WA 98107

The above designated Contract is hereby modified in the manner described below. This order is supplemental to the above Contract, which is, by reference made a part hereof. All terms, conditions and provisions of the Contract, except as specifically modified herein, remain unchanged and in full force and effect.

Acceptance of this Extra Work Order constitutes agreement to the terms, conditions, and prices stated.

ACCEPTED:

Pioneer Masonry Restoration Co., Inc.

Contractor

Stanley S. Johnson Treas.
Contractor Representative Title

Date

6-26-82

Recommended:

R. R. Entoff

for Ron Doner, Regional Construction Engineer

Issued:

Andy Zahara
Andy Zahara, Interior Regional Engr.

Date

6-23-82

DESCRIPTION

In accordance with Section 104-1.02, Alteration of Plans or Work, of the Specifications, the following changes are hereby made:

(1) Subsection 692-2.01 Materials of the Special Provisions.
Change Slump Range (Inches) to read 3-5

(2) Subsection 692-3.01 Construction of the Special Provisions.

3. Repair or Replacement of Reinforcing Steel

Add the following:

When agreed to by the Engineer the existing damaged reinforcing steel may be cleaned and remain in place with the new bar installed and secured parallel to the original bar. The replacement bars shall be of the same length as would be required when damaged bars are removed, including the 12" laps.

4. Polymer- Modified Concrete Patch Repair

Add the following:

When agreed to by the Engineer the Modified Concrete Patch material and the Modified Overlay material may be poured monolithically. This will be allowed only on the bridges without Cathodic protection.

5. Polymer-Modified Concrete Overlay

a. Surface Preparation

Add the following:

The original concrete bridge deck surfaces shall be scarified to a depth of no less than 1/4 " unless authorized otherwise by the Engineer. Care shall be taken to avoid damage or debonding of reinforced steel. Unless directed otherwise, adequate cover shall remain over the bars to allow cutting as required to install the Cathodic Protection Systems without contacting or damaging the reinforcing steel.

Description Continued

(3) Subsection 692-4.01 Method of Measurement of the Special Provisions.

Add the following:

When agreed to by the Engineer the quantity of the polymer-modified patch material may be determined by volume measurements of the excavated areas, not including the scarified depth, and converted to pounds by using the factor of 150 lbs. per cubic foot. The volume of patch material shall be agreed to by the Contractor prior to placement of any concrete. The quantity of patch material shall be deducted from the overlay quantity when the two materials are poured monolithically.

When agreed to by the Engineer the polymer-modified concrete may be measured by a calibrated cement meter and a conversion factor, utilizing the approved mix design weights, to determine the total weight of concrete placed. Waste, and rejected materials shall be deducted from the pay quantity.

(4) 692-5.01 Basis of Payment

Add the following:

There shall be no increase in cost due to this Extra Work Order except as provided for in this document.

(5) Revise Plan Sheets to detail 1 1/4" \pm 1/4" of overlay material on the bridge deck surfaces that have been scarified 1/4".

The actual thickness of any area of a deck shall be as approved by the Engineer.

(6) Pay Items and approximate quantity increases under this Extra Work Order are:

<u>Item No.</u>	<u>Item</u>	<u>Approximate Increase</u>	<u>Unit</u>
692(3)	Polymer Modified Concrete Overlay	100,000	pounds
692(3A)	Polymer Modified Concrete Overlay	20,000	pounds
692(3B)	Polymer Modified Concrete Overlay	20,000	pounds

Payment shall be at the original contract unit prices.

Pay Items not listed in this Extra Work Order are not affected.

The estimated cost increase of work performed under this Extra Work Order is \$73,200.00

Contract time or the 30 day limit on each bridge closure is not affected by this Extra Work Order.

PLEASE INDICATE YOUR AGREEMENT BY SIGNING, DATING, AND RETURNING THE ORIGINAL OF THIS DOCUMENT.

State of Alaska
Department of Transportation
and Public Facilities

Sheet 1 of 2

Backup For: EWO # 1

Project No. X-20143

Project Name Fairbanks Bridge Deck Repair

Contract Amount \$465,905.60

Substantial Change? YES NO *RWF*
Initials

Region Review

Headquarters Review (If Required)

FHWA (If Required)

Verbal Approval Date:

COMPARISON OF COST DUE TO CHANGE

ITEM NO.	FA CODE	ITEM	UNIT	PRICE	QUANTITY (+ or -)	AMOUNT (+ or -)	% CHG. (+ or -)
692(3)		Polymer Modified Concrete Overlay	Lb	0.50	+100,000	+50,000.00	34.2%
692(3A)		Polymer Modified Concrete Overlay	Lb	0.58	+ 20,000	+11,600.00	40.9%
692(3B)		Polymer Modified Concrete Overlay	Lb	0.58	+ 20,000	+11,600.00	40.9%
						NET CHANGE THIS ORDER	+73,200.00 +15.7%
						TOTAL PREVIOUS CHANGES	-0-
						ACCUMULATIVE CHANGE	+73,200.00 +15.7%

Prepared By: *Ch. P. Thman*
Project Engineer

Prior Change Documents:
None

DESCRIPTION AND REASON FOR CHANGE

- (1). The original specifications called for a 2" - 4" slump. The Contractor requested a change to 5" - 6" and the additive manufacturer's recommend a 4" - 7" slump. The compromise of 3" - 5" slump is acceptable to Bridge Design and Regional Materials section. The water cement ratio does not change.
- (2)3. The Contractor has requested that existing rebar be cleaned rather than removed when damaged and the new bar tied to existing bar. Bridge Design has no objection to this method of repair. This option will only be utilized with the approval of the Engineer.
- (2)4. The Contractor has requested the patch and overlay materials be poured monolithically on the bridges that do not have cathodic protection. The additive manufacturer's information agrees with this method of placement.
- (2)5. The Contractor has requested the scarifying as recommended by the additive manufacturer. This work will be at no cost except for the additional 1/4" of Overlay material required to maintain cover over reinforcing steel.

Continuation Sheet for Backup Sheet
Extra Work Order No. 1
Project X-20143
Fairbanks Bridge Deck Repair

Description continued

- (3). This alternate method of measurement will be required to allow the monolithic placement of the two different pay items.
- (4) No explanation required.
- (5) This changes the overlay depth detail on the scarified bridge decks.
- (6) The Increase in these pay quantities are for the 25% increase in overlay thickness, existing bridge deck templates that are not uniform, and material required to obtain minimum cover over reinforcing steel.

DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

EXTRA WORK ORDER NO. 2

Interior _____ Region _____

Sheet 1 of 2

Project No. X-20143 Contractor Pioneer Masonry Restoration Co., Inc.

Project Name Fairbanks Bridge Deck Repair Address PO Box 70110, Ballard Station
Seattle, WA 98107

The above designated Contract is hereby modified in the manner described below. This order is supplemental to the above Contract, which is, by reference made a part hereof. All terms, conditions and provisions of the Contract, except as specifically modified herein, remain unchanged and in full force and effect.

Acceptance of this Extra Work Order constitutes agreement to the terms, conditions, and prices stated.

ACCEPTED:

Pioneer Masonry Restoration Co., Inc.
Contractor

[Signature] Supt
Contractor Representative Title

Date 7-13-82

Recommended:

[Signature]
Sr. Ron Doner, Regional Construction Engineer

Issued: [Signature]
Andy Zahare, Interior Regional Engineer

Date 7-12-82

DESCRIPTION

In accordance with Section 104-1.02, Alteration of Plans or Work, of the Specifications, the following changes are hereby made:

Establish New Item 694(1), Expansion Joint Modification:

Description: This work shall consist of fabrication and installation of one (1") inch thick steel plates, as detailed on attached drawing, at the two expansion joints located on the Cushman Street Bridge.

Materials: The steel plates shall meet the requirements of ASTM A-36 or approved equal. Wire welding rod shall be E70XX or approved equal. The Engineer shall be furnished a copy of the steel certification and welder(s) certification prior to payment.

Construction: The welds on the sides of the plates shall be by a skip method, weld 4" skip 8", until two (2) continuous passes have been completed. The butt and end joints shall be welded with as many passes as required to obtain a flush surface. The plug welds shall be flush when completed. The plates shall be fabricated to lay tight on the existing expansion joint prior to welding. The contractor shall verify lengths, widths, and lengths of sections required to have new plates lay tight on existing steel.

Method of Measurement: Lump Sum Basis. When the basis of payment is lump sum no measurement of quantities will be made.

Basis of Payment: Item 694(1) Expansion Joint Modification shall be paid for at the agreed lump sum price of \$8,141.39 including all work and materials required.

Pay Items not listed in this Extra Work Order are not affected.

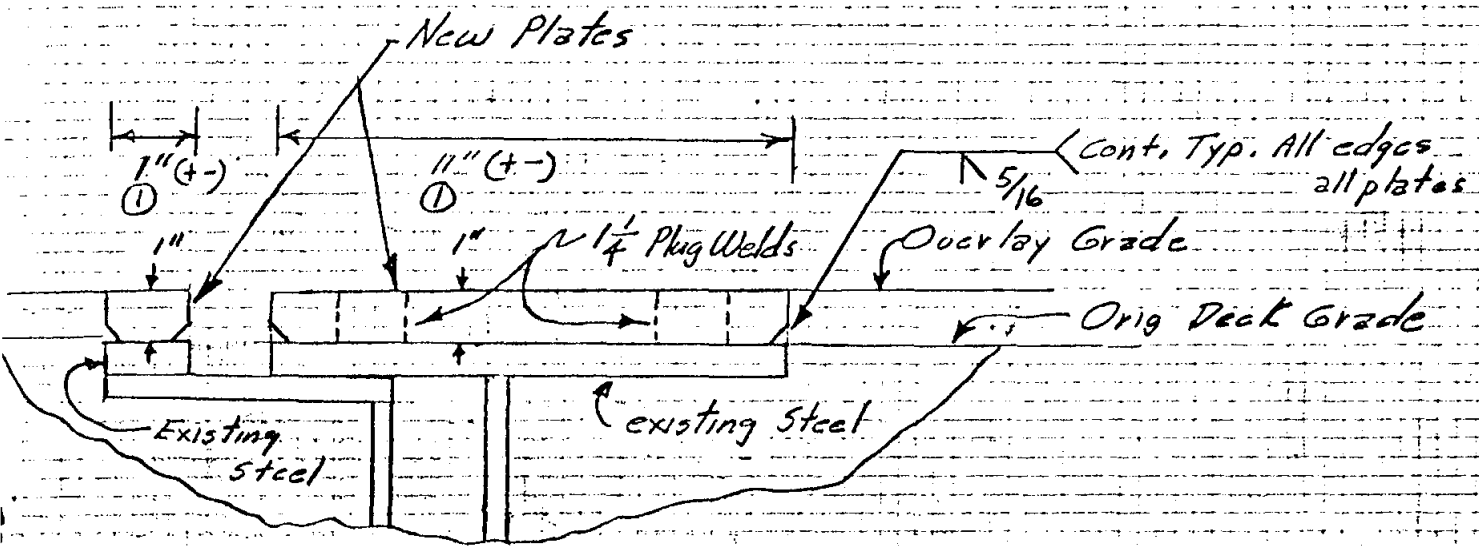
The actual cost increase of work performed under this Extra Work Order is \$8,141.39.

Contract time or the 30 day limit on each bridge closure is not affected by this Extra Work Order.

PLEASE INDICATE YOUR AGREEMENT BY SIGNING, DATING, AND RETURNING THE ORIGINAL DOCUMENT.

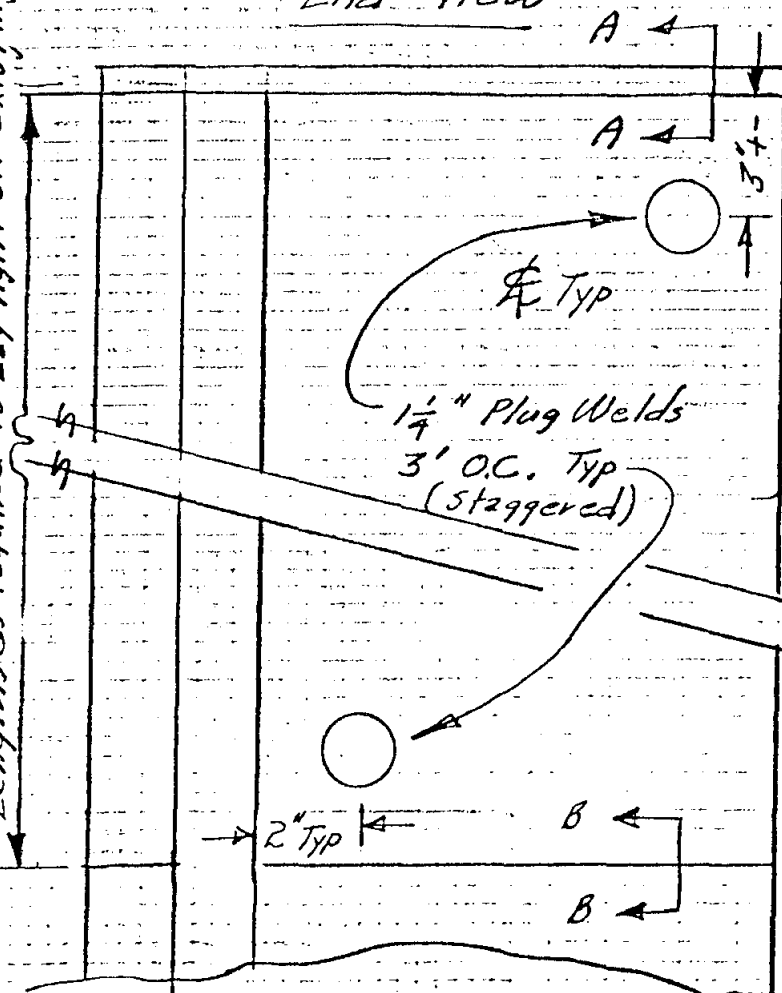
Details for 7.3m (6940) Expansion Joint Modification

Attachment for
 Extra Work Order No. 2
 Project X-20143
 Fairbanks Bridge Deck Repair
 EXAMPLE 17
Not to Scale



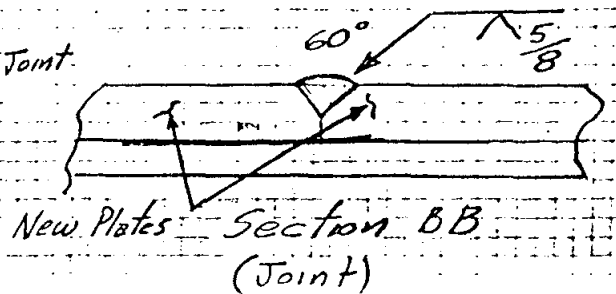
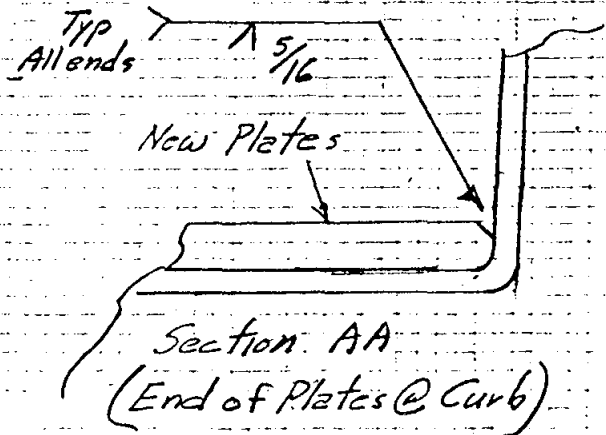
End View

① Width of plates shall be the same as existing



Plan View

Face of Curb



A-6

State of Alaska
Department of Transportation
and Public Facilities

Sheet 1 of 1

Backup For: EWO # 2
 Project No: X-20143
 Project Name: Fairbanks Bridge Deck Repair
 Contract Amount: \$465,905.60
 Substantial Change? YES NO *RWF*
 Initials

Region Review
Robert W. Finnerty
 Headquarters Review (If Required)
 FHWA (If Required)
 Verbal Approval Date:

COMPARISON OF COST DUE TO CHANGE

ITEM NO.	FA CODE	ITEM	UNIT	PRICE	QUANTITY (+ or -)	AMOUNT (+ or -)	% CHG. (+ or -)
694(1)	---	Expansion Joint Modification	L.S.	8,141.39	All req'd	(+)8,141.39	New Item
Prepared By: <i>Chp. Tibman</i> Project Engineer						NET CHANGE THIS ORDER	(+)8,141.39 1.7%
Prior Change Documents: EWO #1						TOTAL PREVIOUS CHANGES	73,200.00 15.7%
						ACCUMULATIVE CHANGE	(+)81,341.39 17.5%

DESCRIPTION AND REASON FOR CHANGE

The original plans detail a 1" taper in 3' at the expansion joints on the Cushman St. bridge. The Contractor, State Maintenance and myself believe that these joints should be raised due to snow removal, impact on overlay, and riding quality problems. See attached correspondence for additional information.

Project personnel contacted a local steel fabricator and with the information obtained and Contractor's submittal the following estimate was made:

Labor: Shop	30 hrs @	\$40.00	=	\$1,200.00
Field	65 hrs @	\$51.50	=	\$3,347.50
Materials: 3920 lb	@	\$ 0.52	=	\$2,038.40
		Total		\$6,585.90
Overhead plus 15%				987.89
		Total		\$7,573.79
Credit for Conc. Excavation not Required				564.00
				<u>\$7,009.79</u>

The contractor's estimate for man hours appears high but is considered acceptable with the information available.

DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

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EXTRA WORK ORDER NO. 3

Interior Region

Sheet 1 of 2

Project No. X-20143

Contractor Pioneer Masonry Restoration Co., Inc.

Project Name Fairbanks Bridge

Address P. O. Box 70110 Ballard Station

Deck Repair

Seattle, Washington 98107

The above designated Contract is hereby modified in the manner described below. This order is supplemental to the above Contract, which is, by reference made a part hereof. All terms, conditions and provisions of the Contract, except as specifically modified herein, remain unchanged and in full force and effect.

Acceptance of this Extra Work Order constitutes agreement to the terms, conditions, and prices stated.

ACCEPTED:

Pioneer Masonry Restoration Co., Inc.

Contractor Robert E. Olsen Supt. 7-30-82

Contractor Representative Robert E. Olsen Title

Date _____

Recommended:

R. J. Dover

For: Ronald J. Dover, Regional Constr. Engineer

Issued: Andy Zahare

Andy Zahare, Interior Regional Engineer

Date 7-29-82

DESCRIPTION

In accordance with Section 104-1.02, Alteration of Plans or Work, of the Specifications, the following changes are hereby made:

Revise details of curb excavation on plan sheets 7 and 11 (Cushman and Wendell St. Bridges) to those shown on the attached drawing.

Reduce the existing unit price of 50 cents per pound for Item 692(3), Polymer Modified Concrete Overlay, by 1.5 cents to a new unit price of 48.5 cents per pound.

Pay items not listed in this Extra Work Order are not affected.

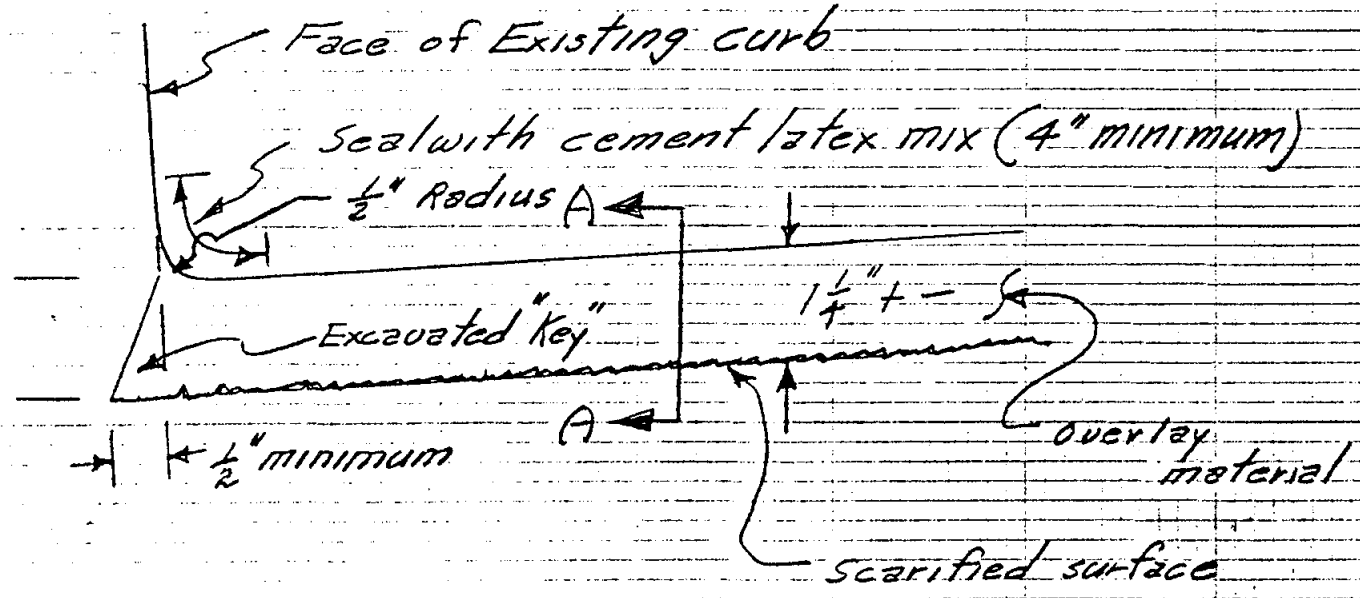
It is estimated that this Extra Work Order will decrease the contract amount by \$5,884.

Contract time or the 30 day limit on each bridge closure are not affected by this Extra Work Order.

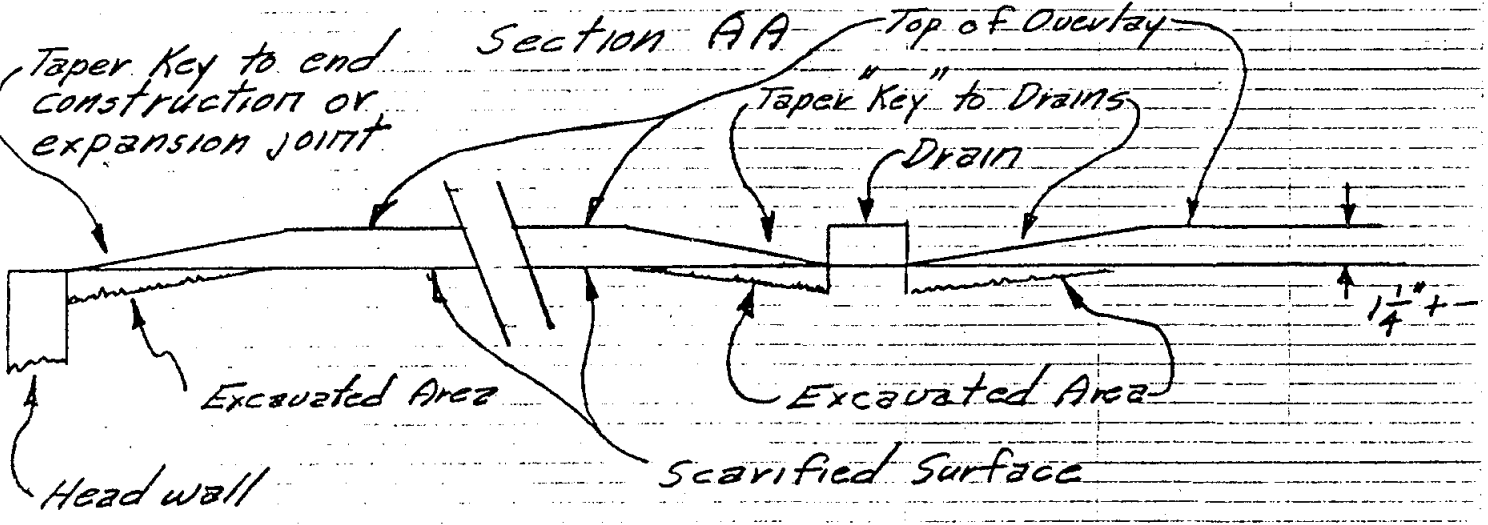
PLEASE INDICATE YOUR AGREEMENT BY SIGNING, DATING AND RETURNING THE ORIGINAL OF THIS DOCUMENT.

X-20143 Fairbanks Bridge Deck Repair
 Attachment for EWO No 3
 Revised Excavation Detail @ Curb
 (For Wendell & Cushman St Bridges)

Not to Scale



The below information not part of EWO No 3



State of Alaska
Department of Transportation
and Public Facilities

Sheet 1 of 4

Backup For: E.W.O. #3
Project No. X-20143
Project Name Fairbanks Bridge Deck Repair
Contract Amount \$465,905.60
Substantial Change? YES NO RUT
Initials

Region Review
Robert W. Fairbank
Headquarters Review (If Required)
FHWA (If Required)
Verbal Approval Date:

COMPARISON OF COST DUE TO CHANGE

ITEM NO.	FA CODE	ITEM	UNIT	PRICE	QUANTITY (+ or -)	AMOUNT (+ or -)	% CHG. (+ or -)
692(3)	NA	Polymer Modified Concrete Overlay	Lb.	0.50	-392,260	-196,130.00	-100
692(3)	NA	Polymer Modified Concrete Overlay	Lb.	0.485	+392,260	+190,246.10	+100
NOTE: THIS IS A REDUCTION IN UNIT PRICE							
Prepared By: <u>Clyde Tilman</u> Project Engineer						NET CHANGE THIS ORDER	-5,883.90 -1.3
Prior Change Documents: E.W.O. #1, #2 W.O. "A", "B", "C"						TOTAL PREVIOUS CHANGES	+81,341.39 +17.5
						ACCUMULATIVE CHANGE	+75,457.49 +16.2

DESCRIPTION AND REASON FOR CHANGE

The contractor has requested this change as noted in his attached letter. I concur with his comments and believe that we can obtain an equal or better product at a reduced cost. See attached calculations for reduced costs due to this modification.

Continuation Sheet for Backup to E.W.O. #3

Project X-20143 Fairbanks Bridge Deck Repair

Estimate of Cost Reduction
For Curb Excavation Modification

(Cushman & Wendell
Approx. 1300 LF
of Curb)

1/2" x 3" Key

Exc. 1 man 15 hrs/100 LF x 35.00 = 525.00

Finishing
Overlay 1 man 1 hr/100 LF x 35.00 = 35.00

560.00

560.00/100 LF Key

1/2" x 1 1/4" Key

Exc. 1 man 5 hrs/100 LF x 35.00 = 175.00

Finishing
Overlay 1 man 1/2 hr/100 LF x 35.00 = 17.50

192.50

192.50/100 LF Key

560.00 Original Key/100 LF
- 192.50 Modified Key/100 LF

367.50 Reduction/100 LF Curb Excavation

367.50 X 1300 LF = 4,777.50* (Cushman & Wendell St. Bridges)

Manhours required for original excavation is from previous
bridge work against manhours checked on sample of modified
excavation.

*This figure should be considered in relation to original
plan quantity.

692-5.01 Construction

5. Polymer - Modified Concrete Overlay
Add the following:

The Polymer - Modified Concrete Overlay on the Wendell Street Bridge shall be placed in two separate layers as shown on attached drawing. The entire surface of the deck shall be sand-blasted and kept clean prior to placement of each lift. There shall be no sand-blasting or cutting of slots for the Cathodic System until the material has cured to 3,000 PSI or as approved by the Engineer. The surface of the first layer shall be finished as approved by the Engineer. All material shall be placed as recommended by the manufacturer/supplier and as approved by the Engineer.

692-4.01 Method of Measurement Add the following:

Polymer Modified Concrete Overlay placed in two layers shall be measured the same as material placed in one layer (per pound).

692-5.01 Basis of Payment. Add the following:

Polymer Modified Concrete Overlay placed in two layers shall be paid at the same unit price as material placed in one layer (48.5 cents per pound). Increase Pay Item 692(3) Polymer Modified Concrete Overlay by 205,740 pounds. The Engineer shall have the option of placing the Polymer Modified Concrete Overlay material on the Cushman Street Bridge deck in the one layer or two layer method (see attached drawing) at the existing contract unit price of 48.5 cents per pound.

Pay items not listed in this Extra Work Order are not affected.

It is estimated that this Extra Work Order will increase the contract amount by \$99,783.90.

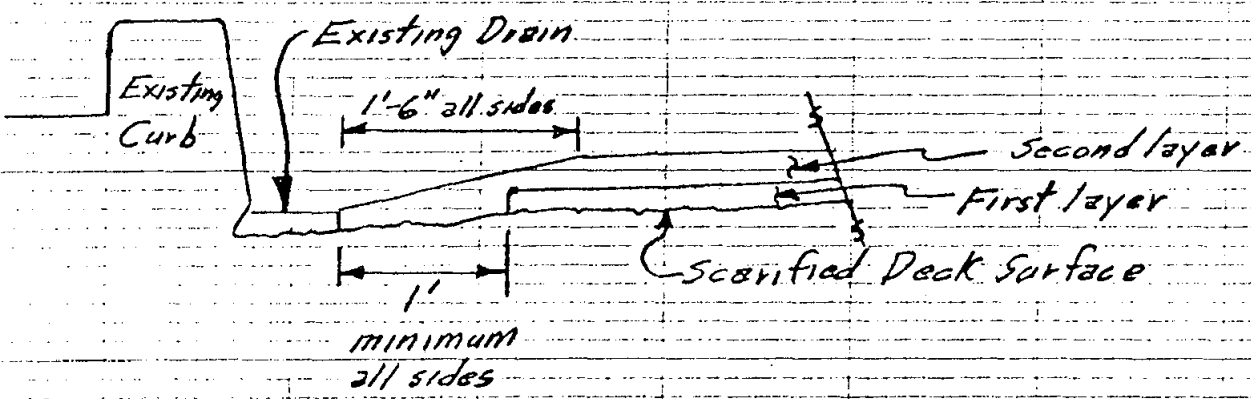
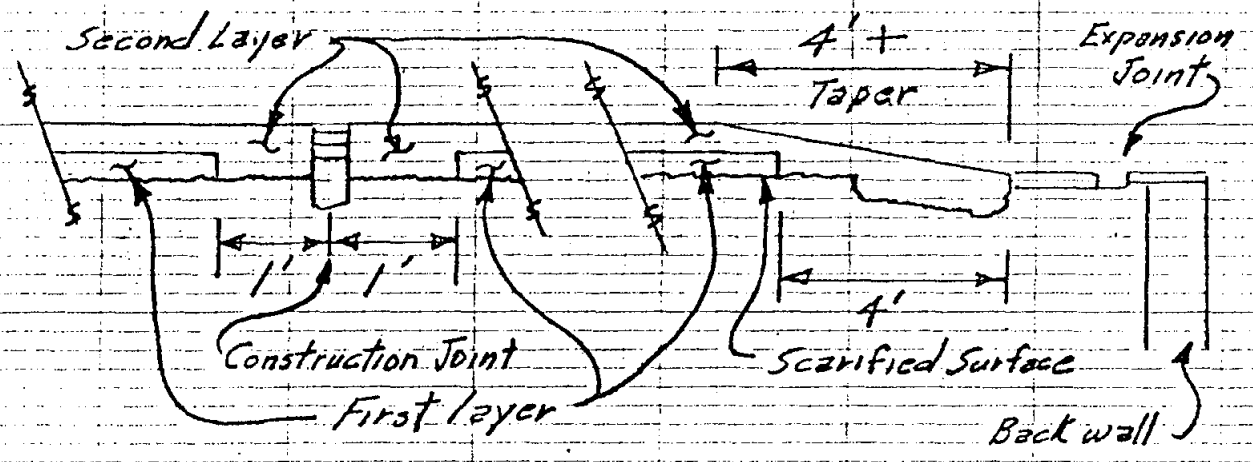
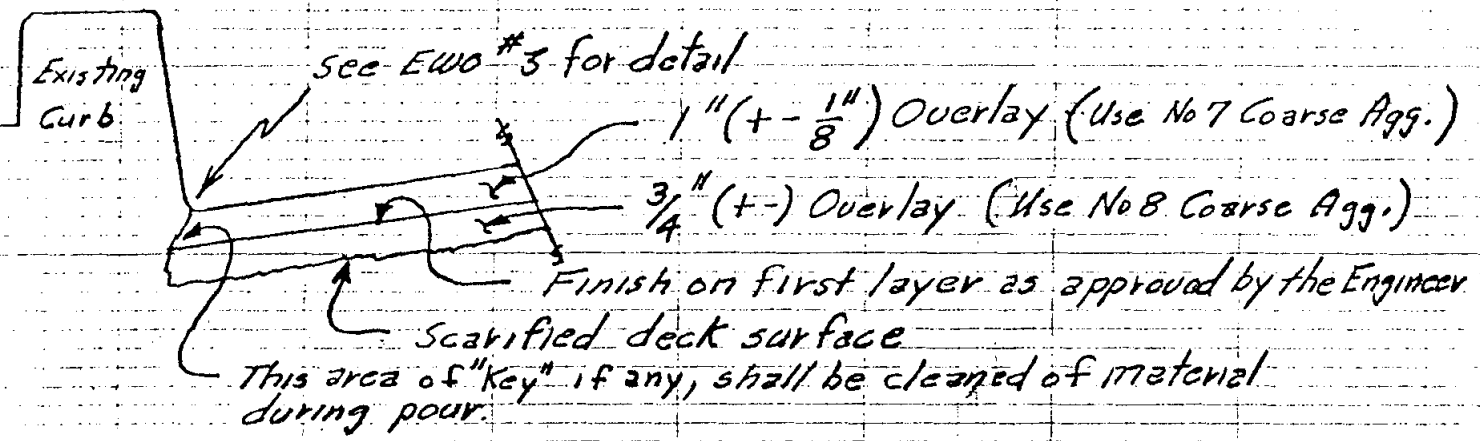
Contract time is not affected by this Extra Work Order. The 30 day limit on the Wendell Street Bridge closure is increased to 45 days.

PLEASE INDICATE YOUR AGREEMENT BY SIGNING, DATING AND RETURNING THE ORIGINAL OF THIS DOCUMENT.

Details for two-layer overlay
 of Polymer Modified Concrete

EXAMPLE 19

Not to Scale



Note: The actual thickness of Overlay Material at any location shall be as Directed by the Engineer. The Second layer shall not exceed 1" nominal

Continuation Sheet for Back-up of E.W.O. #4Project Name & Number X-20143 Fairbanks Bridge Deck Repair

Listed below are the total estimated overlay quantities for Wendell Street Bridge:

1. Original Plan Quantity. 148,000 Lbs.
2. Material to replace scarified deck 37,400 Lbs.
3. Material required to bring the existing varying deck cross-section to a uniform template and profile 56,000 Lbs.
4. Total required prior to E.W.O. #4 241,400 Lbs.
5. Extra material required by E.W.O. #4 (1/2") 74,800 Lbs.
6. Total estimated material required 316,200 Lbs.

This E.W.O. in effect changes 24,000 Lbs. of material from patch (1.26/Lb.) to overlay (0.485/Lb) for a reduction in cost of \$18,600.00 and also increases overlay material required (1/2") by 37,400 Lbs. (0.485/Lb.) or \$18,139.00. The net effect of this Extra Work Order is no increase of the total estimated cost. The increase on the face document actually ^②reflects the estimated additional material not authorized by change document (202,740 Lbs.) required to complete both the Wendell Street and Cushman Street Bridges.

The change in the slump specification is as recommended by the supplier of the latex material and is practical as shown by actual placement of the material.

The change in fine concrete aggregate specifications is as discussed with Regional Materials Section.

① Should read 74,800 Lb

② should read \$36,278

③ should read \$17,678

There was no actual increase in cost
do to being able to control the yield.
See Final Quantities

TJ/mam 4-15-83

14-21E
(2-74)

STATE OF ALASKA
DEPARTMENT OF HIGHWAYS

WORK ORDER NO. "A"

Interior District

Sheet 1 of 1

Project No. X-20143

Contractor Pioneer Masonry Co., Inc.

Project Name Fairbanks Bridge Deck Repair

Address P. O. Box 70110

Seattle, Washington 98107

Performance of the above Contract is hereby ordered as stated hereon.

Receipt Acknowledged:
SEE BELOW

Contractor _____

Contractor Representative _____ Title _____

Date _____

Recommended:
Clyde J. Tilman
Clyde Tilman, Project Engineer

Issued: SAME

Date 6-10-82

DESCRIPTION

This Work Order is to confirm verbal authroization allowing the original bridgedeck concrete surface to be scarified to a depth of 1/4 inch. This work shall be at no additional cost to the State except for the increased quantity of Polymer Modified Concrete Overlay which shall be paid at the original bid unit prices under Item 692(3) Basic Bid, Supplement "A" and Supplement "B".

PLEASE INDICATE YOUR AGREEMENT BY SIGNING AND DATING

Bob Olson
Bob Olson, Superintendent
Pioneer Masonry Restoration Co., Inc.

6-10-82
Date

State of Alaska
Department of Transportation
and Public Facilities

WORK ORDER NO. "B"

Interior

Region

Sheet 1 of 1

Project No. X-20143

Contractor Pioneer Masonry Co., Inc.

Project Name Fairbanks Bridge Deck Repair

Address P. O. Box 70110

Seattle, Washington 98107

Performance of the above Contract is hereby ordered as stated hereon.

Receipt Acknowledged:
Pioneer Masonry Co., Inc.
Contractor
[Signature]
Contractor Representative
Date July 8, 1982

Recommended:
[Signature]
Clyde Tilman, Project Engineer
Issued: Same
Date July 8, 1982

DESCRIPTION

This work order is to confirm verbal approval of the facilities furnished under Item 116(1), Furnishing and Maintaining Field Office, with the agreement that they will be relocated to each bridge site during construction.

STATE OF ALASKA
DEPARTMENT OF HIGHWAYS

WORK ORDER NO. "C"

Interior District

Sheet 1 of 1

Project No. X-20143

Contractor Pioneer Masonry Restoration Co., Inc.

Project Name Fairbanks Bridge Deck Repair

Address PO Box 70110, Ballard Station

Seattle, WA 98107

Performance of the above Contract is hereby ordered as stated hereon.

Receipt Acknowledged:

Pioneer Masonry Restoration Co., Inc.

Contractor [Signature]

Contractor Representative [Signature] Title Superintendent

Date 7-13-82

Recommended:

Clyde Tilman Project Engineer

Issued: [Signature]

Date 7-13-82

DESCRIPTION

The use of AASHTO gradation #67 (1"minus) is approved for class "A" course concrete aggregate deleting the requirement for two stockpiles of course aggregate.

The 6 sacks per cubic yard and (-)1" aggregate shall be noted on the delivery receipt, with a copy to the Engineer.

DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

CHANGE ORDER NO. "D"

WORK

Interior District

Sheet 1 of 1

Project No. X-20143

Contractor Pioneer Masonry Restoration Co., Inc.

Project Name Fairbanks Bridge Deck Repair

Address PO Box 70110, Ballard Station

Seattle, WA 98107

The following change(s) in the above Contract are hereby ordered, in accordance with the terms of the Contract, and under the terms and conditions stated hereon.

Receipt Acknowledged:

Pioneer Masonry Restoration Co., Inc.

Contractor *[Signature]*
Contractor Representative

[Signature]
Title

Date 8-30-82

Recommended:

[Signature]
Clyde Tilman, Project Engineer

Issued: *[Signature]*

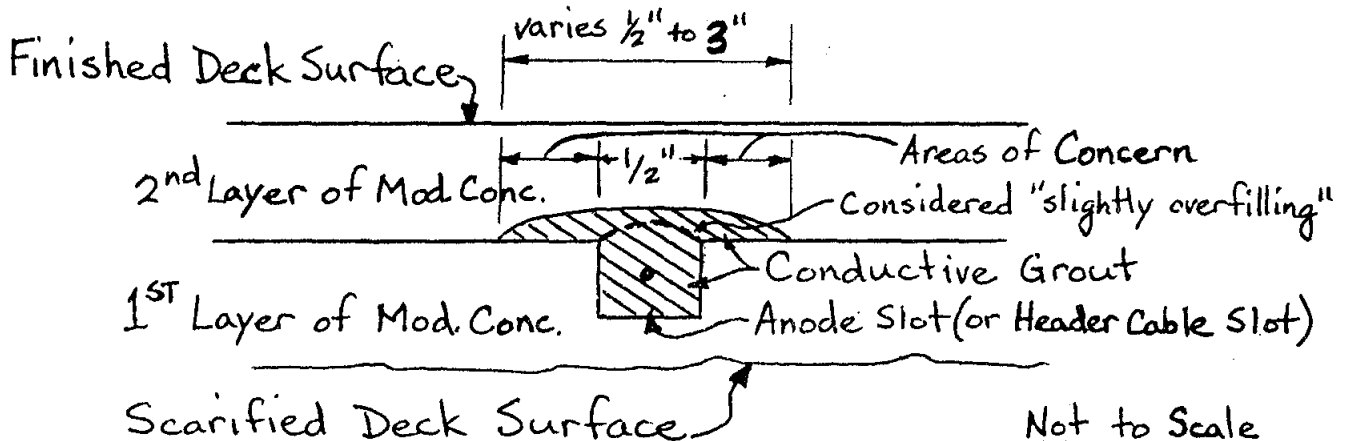
Date 8-30-82

DESCRIPTION

This work order is to notify you in writing of our concern with the bonding properties of the conductive grout interfering with the bonding of the two layers of modified concrete. This grout has been placed on the surface of the deck at the edges of the anode slots for a total width, including the slot width, varying from 1/2" to 3". The grout material has not been placed as detailed on the plans or described in the manufacturer's (of the cathodic system) written installation instructions.

You are directed to remove excess grout material that extends over 1/8" from the edges of the anode and header cable slots unless we receive adequate written assurances that our concerns are without merit.

This work order puts into writing our concern that has been expressed verbally in several conversations with Bob Olson and Jack Tinnea.



Cross Section of Deck at Anode Slot

MATERIALS INSPECTION SUMMARY

Project No. _____

District No. _____

Termini _____

Contractor _____

Date _____

Contract Item	Materials Item	Quantity Used	Source	Number of Tests		Test Report Numbers						
				Required	Run	Bridge	Cyl. No.	Pour	Lab No	Age	PSI	
692(3)	<i>Polymer Modified Concrete Overlay Continued</i>											
(3A) & (3B)	<u><i>Cylinders</i></u>											
	<i>Contractor's Mix Design Project</i>	<i>NA</i>	<i>Contractor</i>	<i>NA</i>	<i>NA</i>	<i>NAC-1</i>	<i>NA</i>	<i>None</i>	<i>3day</i>	<i>3798</i>		
				<i>NA</i>	<i>NA</i>	<i>NA MD 1</i>	<i>NA</i>	<i>82B-0172</i>	<i>5day</i>	<i>3143</i>		
						<i>NA MD 2</i>	<i>NA</i>	<i>"</i>	<i>11day</i>	<i>4289</i>		
						<i>NA MD 3</i>	<i>NA</i>	<i>"</i>	<i>14day</i>	<i>4775</i>		
						<i>NA MD 4</i>	<i>NA</i>	<i>"</i>	<i>31day</i>	<i>5686</i>		
	<i>Informational</i>		<i>Project</i>			<i>Min</i>	<i>4</i>	<i>1</i>	<i>82B-0171</i>	<i>3day</i>	<i>2818</i>	
						<i>"</i>	<i>5</i>	<i>1</i>	<i>"</i>	<i>3day</i>	<i>2975</i>	
						<i>I II</i>	<i>1</i>	<i>2</i>	<i>82B-0233</i>	<i>3day</i>	<i>2839</i>	
						<i>"</i>	<i>2</i>	<i>"</i>	<i>"</i>	<i>3day</i>	<i>2918</i>	
				<i>1st Layer</i>		<i>Wend</i>	<i>1</i>	<i>3</i>	<i>82B-0470</i>	<i>26 1/2 hr</i>	<i>1503</i>	
						<i>"</i>	<i>2</i>	<i>"</i>	<i>"</i>	<i>31 hr</i>	<i>1800</i>	
						<i>"</i>	<i>3</i>	<i>"</i>	<i>"</i>	<i>47 1/2 hr</i>	<i>2388</i>	
						<i>"</i>	<i>4</i>	<i>"</i>	<i>"</i>	<i>55</i>	<i>2652</i>	
				<i>2nd Layer</i>		<i>"</i>	<i>1</i>	<i>4</i>	<i>82B-0628</i>	<i>5day</i>	<i>3033</i>	
						<i>"</i>	<i>2</i>					
						<i>"</i>	<i>3</i>					
	<i>Cush-man</i>	<i>1</i>	<i>5</i>			<i>3day</i>	<i>2546</i>					

B-1

MATERIALS INSPECTION SUMMARY

Project No. _____

District No. _____

Termini _____

Contractor _____

Date _____

Contract Item	Materials Item	Quantity Used	Source	Number of Tests		Test Report Numbers					
				Required	Run	Bridge	Cyl No	Pour	Lab No	Age	PSI
692(3)	Polymer Modified Concrete Overlay Continued										
(3A) 1/3 (3B)	Cylinders Continued										
B-2	<u>Project Acceptance</u>	21.5 CY	Project	3	3	7day	1	1	828-0170	7day	4316
		15.6 CY				14day	2	"	"	14day	4978
						21day	3	"	"	21day	5173
	38.5 CY		28day	1	2	828-0312	28day	5969			
		14day	2	"	"	14day	5279				
		28day	3	"	"	28day	5651				
		1st Layer	7day	1	3	828-0497	7day	4112			
			14day	2	"	"	14day	4996			
			28day	3	"	"	28day	5757			
	7day		4	"	"	7day	4333				
	14day	5	"	"	14day	5111					
	28day	6	"	"	28day	6367					
	36.7 CY	2nd Layer	6	6	7day	1	4	828-0551	7day	4103	
					14day	2	"	"	14day	5465	
					21day	3	"	"	21day	5934	
					28day	4	"	"	28day	5173	
					28day	5	"	"	28day	5421	
					28day	6	"	"	28day	5333	

MATERIALS INSPECTION SUMMARY

Project No. _____

District No. _____

Termini _____

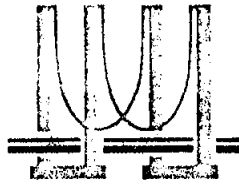
Contractor _____

Date _____

Contract Item	Materials Item	Quantity Used	Source	Number of Tests		Test Report Numbers							
				Required	Run	Bridge	Cyl No	Pour	Lab No	Age	PSI		
692(3)	<i>Polymer Modified Concrete Overlay Continued</i>												
(3A) (3B)	<u>Cylinders Continued</u>	21.5 CY	Project	3	3	Min	A-1	1	82B-0173	28 day	6093		
	"					A-2	"	"	28 day	6190			
	"					A-3	"	"	28 day	6279			
	"					A-2-1	2	82B-0234	7 day	4351			
	"					A-2-2	"	"	14 day	5005			
	"					A-2-3	"	"	28 day	5713			
	<u>Assurance</u>			15.6 CY	1st Layer	3	3	Wend	A-3-1	3	82B-0465	7 day	3811
	"			A-3-2				"	"	14 day	4890		
	"			A-3-3				4	"	28 day	5766		
	"			A-4-1				4	82B-0574	14 day	5244		
	"			A-4-2				"	*	*	*		
	"			A-4-3				"	82B-0574	28 day	6013		
	36.7 CY	2nd Layer	3	3	Cush								

* Saved for 1 yr Break

B-3



TEX-CRETE INC

42289 DELANY ROAD • ZION, ILLINOIS 60099 • (312) 746-9090
 SUPPLIERS OF LATEX CONCRETE MODIFIER

SUGGESTED SPECIFICATIONS FOR NEW DECK OVERLAY AND BRIDGE DECK REPAIR AND OVERLAY WITH LATEX MODIFIED CONCRETE.

DESCRIPTION

This work shall consist of constructing a protective wearing course of latex modified mortar or concrete on the prepared surface of newly constructed concrete bridge decks or pavements before these surfaces have been exposed to traffic or other contaminants detrimental to achieving bond at the time of placement.

MATERIALS

The materials used in producing modified Portland cement mortar or concrete shall meet the requirements of the materials details section of the standard specifications for highway construction or as detailed herein.

Portland cement shall be non-airentraining cement of recent manufacture, free of lumps and conform to the requirements of ASTM C-150 for Type I. (Type II Penn-DOT).

- B. Sand shall be clean and sharp and conform to the requirements of ASTM C-33 for concrete sand.
- C. Coarse aggregate shall be clean, sound crushed stone or crushed gravel meeting the requirements of AASHTO M80. The maximum size particle shall not be larger than $\frac{3}{4}$ " and in no case greater than one half the depth of section to be placed.
- D. Latex emulsion admixture—formulated latex admixture shall be a non-hazardous, film forming, polymeric emulsion in water to which all stabilizers have been added at the point of manufacture and shall be homogeneous and uniform in composition.

The latex shall be styrene-butadiene polymeric emulsion in which the polymer comprises 46-50% of the total emulsion. The polymer shall contain 64% styrene and 36% butadiene. $\pm 2\%$.

POLYMER CEMENT MIXTURE DESIGN:

THE POLYMER CEMENT MORTAR OR CONCRETE SHALL BE DESIGNED BY THE ENGINEER AND MEET THE FOLLOWING REQUIREMENTS.

MATERIAL OR PROPERTY	POLYMER PORTLAND CEMENT MORTAR	POLYMER PORTLAND CEMENT CONCRETE
AVERAGE THICKNESS	LESS THAN 1"	1" AND GREATER
CEMENT CONTENT, SACKS/CYD	8.0	7.0
LATEX EMULSION GAL/SACK	3.5	3.5
*WATER, GAL/SACK	2.5	2.5
AIR CONTENT, % OF PLASTIC MIX ACC. TO AASHTO T-152	4-9	3-6
**SLUMP, INCHES	4-7*	4-7*
PERCENT FINE AGGREGATE AS % OF TOTAL AGG. BY WEIGHT	100	50-55
***WEIGHT RATIO OF CEMENT: SAND: COARSE AGG. DRY BASIS AGG. SPG. = 2.65		1:2.4:2.1

NOTES:

* The net water added shall be adjusted to control the slump within the prescribed limits as defined by slumps vs. water-cement ratios of 0.35 and 0.40 by weight for materials being used.

** The slump shall be measured 4 to 5 minutes after discharge from the mixer. During this waiting period, it shall be deposited on the deck and not be disturbed. Care shall be exercised that

traffic vibrations do not affect the measurement.

*** The dry weight ratios are approximate and should produce accurate yield and good workability but due to gradation changes and/or variable specific gravity may be adjusted within limits by the engineer. A maximum adjustment of 0.2 may be made in aggregate weights.