Core Analysis of
Portland Cement Concrete
Slip Formed Barriers

Final Report
for
MLR-98-4

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## ABSTRACT

Premature deterioration of slip formed Portland cement concrete (PCC) barriers is an ongoing problem in the Iowa Primary and Interstate highway system. The requirement to have a concrete mix which can be sufficiently pliable to be readily molded into the barrier shape and yet be sufficiently stiff to maintain a true shape and height immediately after molding is difficult to meet. A concrete mix which is stiff enough to maintain its shape immediately after molding is usually difficult to work with. It often contains open or hidden tears and large voids. One way to minimize the molding resistance is by additional vibration. If intensive vibration is applied, the entrapped air voids and tears in the concrete can usually be eliminated, however, in that process, the essential entrained air content can also be lost. In the evaluation of slip formed PCC barriers, it is common to find large voids, tears and a low entrained air content, all contributing to premature deterioration.

A study was initiated to evaluate core samples taken from good and from bad appearing areas of various median barriers. Evaluations were done covering visual appearance, construction information, air content and chloride content.
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# DISCLAIMER

The contents of this report reflect the views of the author and do not necessarily reflect the official views of the Iowa Department of Transportation. This report does not constitute any standard, specification or regulation.
INTRODUCTION

Some PCC median barriers showed signs of having less than desirable qualities in appearance and durability. To achieve the desired molded shape, excessive vibration was often applied to a stiff concrete mix. The finished product was sometimes a barrier with large entrapped air voids, tears and low entrained air content, all contributing to premature deterioration. A Materials Laboratory Research proposal, MLR-98-4 (see Appendix A) was set up to evaluate the problem.

OBJECTIVE

The objective of the research is to evaluate existing PCC median barriers and to find procedures, materials and mix designs which will result in a better appearing, more workable and more durable PCC slip formed median barrier.

PROJECT SITES

The sites for taking median barrier core samples were selected to cover four different construction projects. They were all from Interstate routes in Polk County (see Appendix C). With careful observations in the field, the exact location of the core sampling sites may be visible by the evidence of filled core holes.

CORE DESCRIPTIONS

Cores were taken from the median barrier of I-80 in Polk County, October 1998. The core description, “bad,” means there was significant visual appearance of barrier surface deterioration, i.e., cracking, staining and leachate deposits. The core description, “good,” means there was no visual appearance of deterioration on the barrier surface.

The arrow on the face of each core points to the top position. This position was marked to determine if core voids, cracks or tears show a relevance to direction of paving.

The core sites were selected such that no reinforcing steel should be hit by the coring bit (see Appendix B).

RESULTS

The search for information and construction history for the selected sites gave limited success. The majority of information came from field book notes which often gave minimal details. For project sites, mainly 1 and 3, air content problems were recorded a number of times (see project diary and
daily reports, Appendix C).

The visual appearance of some cores showed major voids or tears within the concrete as a result of construction workability, consolidation or mix design problems (see photos, Appendix E).

The results of coring from some areas of barriers with a bad appearing surface showed no significant “bad” problem deeper into the barrier. Examples are core photos 1A and 1C. In other cases, large voids or tears were exposed during coring which were not detectable from surface visual examinations (see core photos 2A and 2B). The concrete in core 4B was so deteriorated that it could not be prepared for laboratory analysis. The air system for most cores was found to be acceptable except for core 1A (see appendix F).

From the differences in core conditions and surface appearances found, it can be seen that there is a wide range and somewhat unpredictable quality of concrete to be found in the barriers.

CONCLUSION

As a result of the study of median barrier quality problems, a significant amount of work has been done to change the mix design to something which would be more suitable for slip formed barrier applications.

The standard Iowa DOT D-57 mix design has typically been used in slip formed barrier rails. This mix has a high amount of paste and fines, having a cement content of 709 lbs./cu. yd., with 50% coarse aggregate and 50% sand. The typical combined gradation produces a gap-graded aggregate structure and in conjunction with the high paste content it produces a very stiff unworkable mix.

In 1999, slip formed barrier rails were being placed on the dual bridges over the railroad on relocated US 18 in Floyd County, near Rudd. The contractor, Allied Construction, called in with problems concerning entraining air in the D-57 mix. The D-57 mix is typically placed at 3/4 in. slump making it difficult to entrain air. The producer had been using 25 oz./cwt of air entraining agent and was able to achieve only 5.5% plastic air content. It was decided to investigate the use of well-graded aggregates in conjunction with a reduced cement content to facilitate placement and air entraining of the concrete.

The new mix design for the concrete barrier rail (BR) utilized well-graded aggregates through the incorporation of ¼" (6.35 mm) chips and a reduced cement content of 603 lbs./cu. yd. This mix required only 8 oz./cwt of air entraining agent to achieve 7.4 % plastic air content. They were also able to increase the slump to 1 in. and rate of placement was increased.

Since this project, the BR mix was included in the standard specifications. In the fall of 1999, it was used on a median barrier on I-35/80 in Des Moines from Merle Hay Road to the 2nd Avenue interchange. The BR mix design achieved better placement characteristics and air entraining
capacity than the D-57 mix design.

Additional design adjustments may be needed as material and construction conditions vary. From initial applications, the new mix design appears to be a significant improvement over previously used mix designs. The new mix design specification for BR is now being applied (see Appendix G). At this time, no specific recommendations for changes in vibration energy applied or configuration of vibrators will be made.

IMPLEMENTATION

A major effort has already been put into place to develop a new concrete mix especially designed for use in slip formed barriers. Initial use of the new mix occurred in 1999 in bridge barrier rails in Floyd County on US 18 and in median barriers in Polk County on I-35/80.

The new mix design was already found to be easier to work with and will result in a better finished product.

ACKNOWLEDGMENT

Sincere thanks and appreciation goes to the Special Investigation personnel for their support to obtain core samples and to the Cement and Concrete personnel for their support in the core analysis.
APPENDIX A
MLR Proposal
DATE: October 28, 1998

PROJECT: MLR-98-4

TITLE: Core Analysis of Slip Formed Barriers

PRINCIPAL INVESTIGATOR: Todd Hanson and Bob Steffes

OBJECTIVE: The objective of this research is to determine the air content and void system of low slump Portland cement concrete (PCC) slip formed median barriers in search of causes of premature concrete deterioration.

DISCUSSION: In some areas of some slip formed barrier projects, premature deterioration appears to be occurring. Extensive surface cracking and growth of leachate deposits become visible on the barrier surface within a few years after construction. To slipform a barrier, a relatively dry, stiff mix of concrete is required and extensive vibration is used to facilitate concrete consolidation and forming. It is assumed that an inappropriate mix design for the application and/or excessive vibration may be contributing to the premature deterioration.

PURPOSE: The purpose of this study is to determine if adjustments in mix design, vibration for consolidation or construction techniques could be made which would result in an improved appearance and durability of slip formed PCC barriers.

PROCEDURE: Cores will be taken from median barriers from four different paving projects on I-80 and I-80/I-35 in Polk County. Core sites will be selected to include areas with no visible deterioration and sites which show extensive deterioration. The cores will be 4" diameter and approximately 5" long, perpendicular to the barrier face. They will be taken approximately 30" above the roadway surface.
ANALYSIS: The core analysis will include chloride content at various depths, and a detailed determination of the air void system.

The chloride contents will be checked at 0.5", 1", and 2" intervals using the Phillips XRF. Samples will be analyzed for elemental chlorine (Cl) and used to estimate the amount per cubic yard.

Air content will be checked at 0.5" and 1" intervals using the Hitachi low vacuum SEM in conjunction with an image analysis program. The air content (%), specific surface ($\alpha$), and spacing factor (L) will be calculated at each depth.

Records of concrete mixes used and construction logs will be evaluated, if core analysis results are found to be abnormal.

RESPONSIBILITIES: Projects for evaluation will be selected by the Portland Cement Pavement Engineer.

Specific sites for cores will be selected by the Materials Research personnel.

Coring will be done by Special Investigations personnel.

Analysis of cores and summation of results will be done by the Technical Services Engineer.

IMPLEMENTATION: The findings from this study will lead to:

1) Improvements in the concrete mix design, workability, durability and appearance of the barriers.

2) Improved consolidation while still maintaining desired entrained air content.
REPORTING: The final report will be coauthored by Todd Hanson and Bob Steffes.
APPENDIX B
Concrete Median Barrier Standard Plan
GENERAL NOTES

Details shown herein are for construction of a typical concrete barrier. The New Jersey shape barrier shall be cast in place or slipformed. Refer to "Tabulation of Concrete Barrier" and Project Plans for specific details.

Materials and methods of construction shall be in accordance with current Standard and Supplemental Specifications.

Details shown are typical. Alternate design details may be submitted to the Engineer for approval.

Barrier shall be constructed as specified in Section 2513 of the current specifications or by methods approved by the Engineer.

Dowels shall be either installed in supporting surface when placed or installed in drilled holes using epoxy cement or grout approved by the Engineer.

If footings are required, excavation shall be to neat line. The footing may be poured without the use of forms. The Contractor may, as an option, form the footings and backfill around the completed footing.

Price bid for "Barrier, Concrete RE-44A" or "Barrier, Concrete RE-44A and Footing" per linear foot shall be considered full compensation for construction of concrete barrier as detailed herein including reinforcing steel and all necessary excavation and backfill.

1. Type "U" joints are necessary to match existing "U" and "O" joints and the expansion material shall conform to shape of barrier. No sealer is required.
2. Construction joints shall be formed by use of pre-molded fiber, pressed wood, or other approved material shaped to conform to shape of concrete barrier, or by sawing as indicated herein. Where sawing sections are placed in concrete, a butt joint may be used. No sealer is required.
3. For barrier dowel and to panel shoulders, match layout joints. For free standing barrier with integral footings, use 10' minimum, 15' minimum joint spacing.
4. "3'-0" Minimum, 3'-8" Maximum.
5. 4'-0" Typical.
6. 3# deformed bars or 1" diameter smooth deplan sufficient length to ensure 4" minimum embedment in rail and supporting surface.
7. Possible reinforcing spliced such as one length or other unsupported areas of 1' or more, used #3 bars. Length equals unsupported portion plus two feet beyond each way.
8. All exposed corners are to be filled with a 3/4" dressed and beveled strip.
9. Concrete footing required when not placed on concrete slab.
APPENDIX C
Project Sites, Contractors and Field Notes
PROJECT SITES, CONTRACTORS AND FIELD NOTES

Site 1
Site Location:
I-80 East bound lane
MP 139.05, MP 140.06
Paved west to east
Used D-57
1994

Contractor:
Dormark Construction Company
P.O. Box 520
303 S 2nd Street
Grimes, IA 50111
515-986-4270

Field Notes:
See pages 13-22

Site 2
Site Location:
I-35/I-80 West bound lane
MP 132.90
Paved west to east
Used D-57-C20 & D-57-C10
1998

Contractor:
Jensen Road Company
Box 3345
5550 NE 22nd Street
Des Moines, IA 50316
515-266-5173

Field Notes:
See pages 23-31
Site 3

**Site Location:**  
I-35/I-80 West bound lane  
MP 128.25  
Paved west to east  
Used D-57 & D-57-6-C  
1994  

**Contractor:**  
Jensen Road Company  
Box 3345  
5550 NE 22nd Street  
Des Moines, IA 50316  
515-266-5173  

**Field Notes:**  
See pages 32-43  

Site 4

**Site Location:**  
I-35/I-80 South bound lane  
MP 126.50  
Files have been purged  
Paved south to north  

**Contractor:**  
United Contractors Inc.  
P.O. Box 347  
6678 N W 62nd Avenue  
Johnston, IA 50131  
515-276-6162  

**Field Notes:**  
Field notes were purged
DIARY      PROJECT NO.______________________________ CONTRACT___________

DATE      WEATHER/COMMENTS

10-17-94
Monday
RAINING MOST OF THE DAY. NO ONE
WORKING - GETTING BACK WORK CAUGHT UP.

10-18-94
Tuesday
LIGHT RAIN SHOWER THIS A.M. EARLY, PI
WORKING ON GRADE MED. (FORCE ACCOUNT) AND PAVING
MEDIAN, 6'

WILLMORE POURING GTOPS THIS MORNING 8:30 7/6/2000
AND WILL POUR FOR 2 OR 3 MORE IN AFTERNOON

DORMARIE SETTING UP FOR SLIP FORM BARRIER WALL
WILL GET STARTED AFTER NOOK WORKING UNTIL

* ABOUT GOD. SOME PROBLEMS WITH CONCRETE - GETTING
AIR CONTENT UP IN MIX AND KEEPING IT THERE

FINISHED FORCE ACCOUNT ON MEDIAN GRADING.
DIARY PROJECT NO. CONTRACT

DATE WEATHER/COMMENTS

10-19-94 CLEAR

10-20-94

WEATHER/COMMENTS

PET POURING MEDIAN AND REMOVING BOXOUTS.
PET ALSO SEALING MEDIAN PAVEMENT.
WINMOR BUILDING INTAKES WILL POUR THIS
AFTERNOON.
DORMARK SETTING UP MACHINE FOR SLIPFORM
RAIL, STARTED RUNNING 11:00 A.M. FINISHED
LENFEDY WEST OF 292ND ST. 3:30 DONE FOR THE
DAY.
4:30 WINMOR STARTED POURING TOPS FOR INTAKES
17, 18, 19, 20, 21 DONE 6:30

PET FINISHED WITH MEDIAN PAVING AND
WITH REMOVING BOXOUTS - DRILLING DOWELS
DORMARK WORKING ON SLIPFORM WALL AND
FORMWORK ON CAST IN PLACE, STILL HAVING PROBLEMS
WITH AIR (ENTRANCE AIR) IN CONC. RUNNING LOW.
WINMOR WORKING ON INTAKE TOPS.
10-21-94
FRIDAY

MORNING: MORTAR SETTING AND SEALING ON MEDIAN

PAVEMENT THIS MORNING.

WINMORE WORKING ON INTAKE TOPS, WILL POUR IN AFTERNOON.

DORMAN WORKING BARRIER WALL - SLIP FORM ALL DAY, STILL HAVING PROBLEMS WITH ENTRAINED AIR.

10-22-94
SAT

WINMORE FORMING ON INTAKES - NO POOR TODAY

DORMAN HAVING ALL KINDS OF PROBLEMS WITH GNA TRICKS AND MIX - SHUT DOWN 11:30 AM
10.24.94  Monday  High 50 Low 28°

Dormark working again on barrier.

Still fighting air problems.

Met with Peterson Const. about overhead trusses and discussed problems with outside footings.

Winmore working on tops.

Forecast cold enough for covering barrier walls tonight.

10.25.94  Tuesday  High 52 Low 26°

Dormark working on wall again same situation as before.

Winmore working on intake tops.

Met with city of Altoona today to discuss patching haul road section of Adventureland drive.

Really started removal of WIB weigh station.
DIARY

DATE      WEATHER/COMMENTS

10-24-94  High 55 Low 40°

WED

WINMOR FINISHING UP ON INTAKE TOPS (3) AND WILL FINISH GROUTING PIPE IN INTAKES.

DORMOR WORKING WITH AGAIN - SEEMS THAT THEIR HEADER LOCATIONS ARE WRONG IN RELATION TO THE TRANSITION BLOCKS FROM 2-½ WALLS TO FULL RAIL. SOME REMOVAL WILL BE NEEDED.

MEAS. PART OF 6' MEDIAN 1224 TO 1286.

10-27-94  High 60° Low 45°

THURSDAY

WINMOR STRIPPING LAST 3 INTAKES AND GROUTING PIPES THIS MORNING, THEN THEY WILL BE OUT OF HERE!

DORMOR WORKING ON SLIPPED WALL AND FORMING ON ½ WALL AND OVER INTAKES - PLACING JUNCTION BOXES FOR CONDUIT ALSO.
DATE   WEATHER/COMMENTS
10-28-94   very windy
   very windy
   FRIDAY  DORMARK WORKING ON SLIP FORM
   HIGH 69° LOW 48°
   BARRIER WALL, STARTING AT 7:30 THIS AM.
   TALKED TO RON BLOOMQUIST — DIST MAT.
   AFTER HE HAD TALKED WITH MARK TRUEBLOOD
   ABOUT COREING OUR 61 MEDIAN PAVEMENT,
   MARK SAID WITH WALL WE WOULDN'T HAVE TO
   CORE. ALSO HAVE THE GRADE CHECKS FOR VERIFICATION.
   REALLY WORKING ON DIRT CUT (DITCH)
   ON WEIGH STATION. ALREADY HAVE REMOVED
   BARING AND SCALE PIT.

10-29-94   SAT
   DORMARK WORKING ON BARRIER WALL.
   DAVE MEKESL CALLED ME AT HOME TO DISCUSS
   THE TEST RESULTS THEY WERE GETTING AND FINALLY
   THE MATERIAL STARTED GETTING BETTER.
   MITCH PILLON CALLED ME AT HOME TO TALK
   ABOUT POURING OVER UNSEAL SLAB. I TOLD HIM I
   DID NOT GIVE PERMISSION. HE SAID HE WOULD THINK ABOUT IT
   AND TALK TO DORMARK ABOUT IT.
   DECIDED TO LET THEM RACE AND TAPE ENOUGH TO FINISH
   OUT SATURDAY.

   "I "
DIARY  PROJECT NO._________________________  CONTRACT_____________________

DATE  WEATHER/COMMENTS

10-31-94

MONDAY

PET HERE TO CONTINUE WITH SEALING "B" JUNTS.
PET WILL ALSO BE DOING PATCHING ON HIGHWAY ADVENTURE LAND DRIVE, TUESDAY.
DORMANT RUNNING WITH DRAIN DURING WED. AND HALF WALL ON E 29TH ST.
RENNY WORKING DITCH CUT WB WEIGH STATION ALL DAY.

11-1-94

TUES.

PET PATCHING HAUL ROAD TODAY ON OUTSIDE LANES.
DORMANT WORKING ON SLEEPER, WALL, AND HALF WALL ON WEST SIDE OF EAST 29TH ST.
BELOW INCLUDING ONE TRANSITION BLOCK.
RENNY WORKING ON WB WEIGH STATION CLEANING UP.
**DATE** | **WEATHER/COMMENTS**
---|---
11-2-94 | REALLY WORKING ON WEIGHT STATIONS, BOTH EB AND WB.
         | PC WORKING ON SEALING AND PATCHING Haul Road - Adventureland Truex
         | Dermack working on full wall and half wall and sections over inlets.

11-3-94 | PC SEALING AND REELY WORKING ED WITH STATIONS
         | Dermack working on wall again today
         | Started raining around 12:00 shut down for the afternoon.
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<th>Date</th>
<th>Weather/Comments</th>
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<tr>
<td>11-4-94</td>
<td>High 50° Low 40°</td>
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<tr>
<td><strong>Friday</strong></td>
<td>Raining Today - Nothing Productive on Project, working on Pay Voucher and Books Today. Out at 2PM.</td>
</tr>
<tr>
<td>11-5-94</td>
<td>High 46° Low 35°</td>
</tr>
<tr>
<td><strong>Sat</strong></td>
<td>Dark. Working today on both full and half wall. Everything running well. Shut off at plant 9:00 AM, covered and out by 5:30.</td>
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DIARY

PROJECT NO. ____________________________ CONTRACT ____________________________
Site 2

Daily Report

Contract No. 77-0353-069  Date: Wednesday, May 27, 1998  Initials of Inspector: RJE

High Temperature: 80.0  Low Temperature: 65.0
Sunrise 5:46 AM  Sunset 8:38 AM

Weather Comment: Partly sunny, warm and humid

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Remarks:

Wed-Jensen began slipforming the 42" concrete barrier wall RE-44A Today beginning at 11:15 am. The barrier was begun at 831+50 heading east with only about 350 feet being completed today due to minor problems such as inconsistent slump in the mix which caused the wall to have minor sags and repairs required. The superintendant was Randy Friel for Jensen with Norm as the lead foreman on the project. Rod Edwards, Michael Dean and Tom Uppena will handle the inspection on the project. Kevin Merryman, John Rullman, Mitch Dillavou, Mark Trueblood and John Adam all visited the project today from the DOT. Kurt Rasmussen, Dan Timmons and Jeff Rasmussen all visited the project today from Jensen construction co.

KDM - I spoke with Mark Bare today and told him that we need to get as much permanent seeding done on the project as we can. I also told him that we would like to install some more silt fence if possible. The storm water reports for this project will reflect our conversation.
Th-Jensen continued slipping the Permanent barrier wall in the median today. Only 300 feet was poured today because the wall had to be set up on the next section east of the Des Moines river bridge. The headers at the drains need to be set and the dowels need to be installed. The concrete tests all complied today with the only problem being the inconsistency of the Mix slump causing tearing of the barrier which all was repaired with no problems. Mark Bortle visited the project today from the dot. The pouring was completed by 12:30 pm with sawing and prep work being performed in the afternoon.
High Temperature: 72.0  Low Temperature: 56.0

Weather Comment: Rain in a.m., Clear in p.m.

Site  Timecharge
00  0.500

Jensen  Jensen Road Co.

Remarks:

Jensen started slipping wall at 10 a.m. due to rain in early morning. New paver didn't work well, switching back to old paver. Mitch stopped by today. Contractor will be switching mix design tomorrow.
High Temperature: 73.0
Low Temperature: 53.0
Weather Comment: Pt. Cloudy

Site Timecharge
00 1.000

Subcontractor
ID Name Comment
Jensen Jensen Road Co.

Jensen started slipping rail at 11:30 with new machine. Worked until 6:00. New mix seems to work much better. They will continue to use that same mix tomorrow with the new paver.
Daily Report

Contract No. 77-0353-069  Date: Friday, June 12, 1998  Initials of Inspector: TPU

High Temperature: 81.0  Low Temperature: 56.0

Weather Comment: Pt. Cloudy

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<th>Name</th>
<th>Comment</th>
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<tr>
<td>Jensen</td>
<td>Jensen Road Co.</td>
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</table>

Remarks:

Jensen started to slip rail again with the new mix and paver at 8:15am. Things went very smooth and they poured 200+ cubic yards. John Adams, Mark Trueblood, and Mitch came out to the project today. Jensen is going to work tomorrow(Sat.) at 7am.
Checked in C.G.N.A.'s Johnston plant today. Mid morning. C.A. has been increased and F.A. dropped... Fly Ash is C 10% in the mix (P-57-50-10).

Air was tuned in good and all didn't look too bad. Mix was getting drier through.

Larry Wilson on the grade, Charlie H., Stan E., and Rod were in the plant.

Also spoke to Mark Trueblood and on Thursday about 1½ stone in a mix design.

It was approved approved in a 72 mix of some kind. 10,000 sample through.

By: [Signature]

Plant good to go. Running with P-57-50-10... continue to see improvement.

Test will run later this week.

Plant good to go.

By: [Signature]
High Temperature: 81.0
Low Temperature: 62.0

Weather Comment: Sunny

Site Timecharge
00 0

Subcontractor Name Comment
Jensen Jensen Road Co.

Remarks:
Jensen began promptly at 7am. Only poured two sections which was about 107 cubic yards. Finished around noon. Things went very well. Barring any rain, they will start Mon. at 7am.
Daily Report

Contract No. 77-0353-069  Date: Monday, June 15, 1998  Initials of Inspector: TPU

High Temperature: 70.0  Low Temperature: 58.0

Weather Comment: Cloudy

Site  Time Charge  00  1.000

Subcontractor ID  Name  Comment
Jensen  Jensen Road Co.

Remarks:
Jensen slipped rail today from 7am to 4:30pm, finished 4 sections. They will continue to use the new paver until they decide if they want to buy it or not. Rex Kinkade stopped today to run some air tests and take some sample cylinders.
High Temperature: 89.0
Low Temperature: 65.0

Weather Comment: Pt. Cloudy

Subcontractor
ID     Name     Comment
Jensen Jensen Road Co.

Remarks:

Jensen finished up slipping the rail today. Slipped 4.5 sections. They worked from 6:30am to 1:30pm. Jensen will hand pour the box outs Monday.
Daily Report

Contract No. 77-0353-069  Date: Friday, June 19, 1998  Initials of Inspector: TPU

High Temperature: 86.0  Low Temperature: 67.0

Sunrise  Sunset

Weather Comment: Pt. Cloudy

Site Timecharge
00 1.000

Subcontractor ID Name Comment
Jensen  Jensen Road Co.

Remarks:
Jensen slipped 6 sections of rail today. Worked from 7am to 7pm. Only 4.5 sections of rail left, they plan to finish up slipping tomorrow.
DATE

2-1-94

Weather/Comments

Oldy Hamili

Hi 86° 100 68°

Carlson Grading & Cleaning out b. Median section placing 1" Expansive to stay dry.

Winner Building intake tops (4 a day)

Jenson setting string line conduit and steel getting ready to place Barrier Rail.

Tuesday July 5th they said they could place 2000 ft. a day. Should just take 3 to 4 days then instead of 2 weeks which they predicted it would take.

Jenson's told Winner they would pay the extra cost for them to use M-4 to help them out with cure time.

Informed Charlie Davis of Carbons to straighten 4ft temp Barrier Rail on West End of Project for this long weekend because no one will be working.
DATE: 2-2-94
Saturday
Drove through checking on traffic Control
and Storm Water Discharge after last nights
Rain. Talked to Charlie Davis he said
they only poured the 2 Median sections
under 10th st, Bridge and 86th st Bridge because
of the Weather said they Stopped Paving at
9:00 or 9:30 am
Filled out Work Day Report left for
home.

DATE: 2-3-94
Sunday
Clear Sunny Humid
Hi: 89° low 20°
Checked on Traffic Control this AM
also noted that Carlson aren't setting
the Header Steel Bars in the 6' Median Sides.
For the Trusses, very straight will have to
cut them off and Redrill. Also, the
Steel for the 1/2 Section of Barrier Rail
under the two Bridges is not very straight
Not 4" out of Concrete, Not 11" from
the Pier.

ENTERED BY: [Signature]
2-4-94
Monday
Breakfast

2-5-94
Tuesday
Clear in AM. Cold in PM. Hi 89° Low 29°

Jensen Placing Barrier Rail from Stn. 582 to 655. Moving slow in the Beginning but
Acting up As Day Warms

Carlson Crew is cleaning up O'Median
area, setting Median getting ready for Paving
working on Bridge Approach Sections, also Sealing
Joints.

Winner building Dollars Again today
using M-4 at Jensen's Pigneto

Carlson. Reilly & the Date are all that
Attended our Weekly Meeting today

Carlson going to Pave O'Median starting
this Afternoon

Des Moines Asphalt Placing 3° temp paving
at 2:30pm today. Will probably get about 1/4 or 1/2
of it today and maybe finish up tomorrow
weather permitting.
<table>
<thead>
<tr>
<th>DATE</th>
<th>WEATHER/COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-6-94</td>
<td>88°, Clay, Wind, Humida! 11: 90°, Humida 24°</td>
</tr>
<tr>
<td>Wednesday</td>
<td>Carson Batching cars set without running</td>
</tr>
<tr>
<td></td>
<td>Measures this AM because they moved their field lab office to Jasper Co. Project and we have no place to run test.</td>
</tr>
<tr>
<td></td>
<td>Sent their plant men to Jasper Co. to run test. Informed them we weren't going to do this because the Spec. Say we will have job trailer for running test as long as we are working on these items: scales, paving, granular and/or Special Backfill Items.</td>
</tr>
<tr>
<td></td>
<td>Informed them to have their field lab here by tomorrow morning or we wouldn't be paving.</td>
</tr>
<tr>
<td></td>
<td>Their field lab arrived about 12:30.</td>
</tr>
<tr>
<td></td>
<td>Mike Page said at 12:00 they were running their grader.</td>
</tr>
<tr>
<td></td>
<td>Season's started Barrier Wall at 8:30.</td>
</tr>
<tr>
<td></td>
<td>Going slow but smooth to start out.</td>
</tr>
<tr>
<td></td>
<td>By noon they were having problems with their Air running low. They added Air Agent but no water which doesn't do any good.</td>
</tr>
<tr>
<td></td>
<td>Phil Kitchin told me he ran 14 tests on 4 different trucks. This many tests is ridiculous. It should be corrected with 3 tests or reject the job.</td>
</tr>
<tr>
<td></td>
<td>Jensen shut down at 5:20 PM.</td>
</tr>
</tbody>
</table>

**ENTERED BY:** [Signature]
2-7-94  Ally City  Humid  H: 83°  L: 64°  
Thursday  
Winner working on Intake today  
Carlson Paving & Median  
Jansen Placing Median & Carrier Rail. Still having problems with the Air, trying to maintain  

2-8-94  Ally City  Mild  H: 83°  L: 68°  
Friday  
Winner building Intake again today, will try and Pour either 4 or 5 at 3:00 AM  
Carlson's Paving crew should finish up with 6th course by Noon or maybe 10:00 today  
Jensen paving an carrier rail again today  
Still having problems with the Air, up to 80°/hr. This AM sent Sample of Air  
Agent to owner for testing, it came back OK. Materials Eng. will be out Monday to check it out & talk to contractor about what to do.
7-9-94
Saturday
Alv Clear to Clear
Hi 83° low 66°

Seasons working on placing
conduit and tying steel for Barrier
Rail. Also working on Machine (Consider III)

Skip Form Paver. Only work being done
Today filled out Pay Voucher. Working
Day Report left for home. Phil was
working on Reports.

2-11-94
Monday
Alv Clly Humid
Hi 88° low 70°

Seasons placing Barrier Rail this
AM. First truck left Plant air at
6.8%. Test on grade at 5.5%. Informed
Plant of this, they added 5" of air and 2 gal
of water. Said they were going to
keep adding water until we reached a slump
that would be workable.

At 1:00, they switched back to the
original mix to try it again (8:52:46)

Dick Munn and Champ McFadden were present
today to examine the Barrier Rail and the
Process of Placing it to maybe enlighten us
on what we are doing wrong and correct
the Problem!
2-11-94  Larry Shette and Rick Carlson stopped by the Project this PM, asked about the Barrier Rail.

Rick said he would call him Rasmussen tonight and talk to him. Rick said the Barrier Rail is holding us back he wants to switch traffic on 2-21-94 which is only 2 weeks away.

Larry Shette left me their New Progress Report which I will give to Larry Hill or Mitch Delavan.

Their Medicine broke down about 2:15 Herman Brown is supposed to be out to fix it will start again tomorrow morning.

2-12-94  Cloudy Humid Hi 86° low 65°

Tuesday

Jensen's placing Barrier Rail at 6:15 AM
Air tested at 2.8% with a 5/8" slump using a 0.57 Mix this AM, with No Fly Ash. Concrete reached Job Site with a temperature of 92°. Hi 74° No fly ash it appears to be sticking to the fins of the truck more!

But working better through machine.

ENTERED BY: [Signature]
DATE: 7-12-94

WEATHER/COMMENTS:

Held our Weekly meeting this AM (8:00)

Present were: Norm Lucas at Carlson, Chris Reilly, Bob Reilly of Reilly Construction, Shawn Gooden at Tri-State Signing, and a man from All-Towers. Didn't get his name. Mitch Dillon, Terry Hill, Phil Ketchum, Mike Pogol and myself from the D.O.T. The major concern was tension in Barrier Rail Operation. Champ Maratam also attended the meeting. Introduced him as Dick Munroe's replacement in District 92. Tri-State will place their glare screen Monday as Wiser has to extend t.p.r. after Reilly removes remainder of median barrier rail which they intend on doing this fall or tomorrow.

All Iowa says they can paint all of their line in 1 day. But they have to remove all of yellow edgelines and taper sections.
DIARY

DATE

WEATHER/COMMENTS

7-13-94

Wednesday

Jensen Placing Barrier Rail today. Everything working well today as they placed 2300. Then it Rained!

7-14-94

Pity Only Mild Hi: 81° Low 68°

Thursday

Barrier Rail Machine (Grainger IV) Not working today went track straight going forward but works great backing up. Working on Machine didn’t get started very early today!

Started about 10:00 quit about 3:00

got 800 today. Not good at all!

Jensen said they would place the Barrier Rail with M-4 to speed up core time

But were informed No M-4 because it shrinks too much would cause cracking and tar

Reilly’s will start stockpiling their Granular Subbase Material tonight at 100th St. North Side of Interstate

ENTERED BY:

40
Friday 7-15-94

Ply Clay Warm Cloudy 
Hi: 86° Low: 65°

Jensen Placing Barrier Rail this AM
started at 7:30. Not very early. Having trouble
with vibrators again this AM. Had a man from
Concrete Co. here working on them.

Reilly's hauled Granular Subbase
in and Steelpiled last night will run
gradation on it to certify material as
the Engineer doesn't like his Method of
Steel pilling. He is using Reilly Dumps over a
Bridge then removing with Rubber Tired End loader
Driving up the pile contaminating the pile with
Mud also causing segregation of Materials.

Jensen said they will make the 72st
SL Bridge tonight even if it is 10:00!

Ames will not allow MCA to be
placed in Barrier Rail except for the small
gaps over the Intake.
2-16-94
Saturday

Project going to place Barrier Rail to 92nd St. Bridge today as that is all the concrete American has, which is only about 700' long. Shower passing through at 7:00 AM. Contractor on hold till it passes.

Had an accident at 7:30 this AM. A 16 year old boy had been delivering papers, was returning when he dropped off South Edge of Slab, as returning went across both lanes and hit our temp Barrier Rail.

Called 911, Wooddale Police Responded Case No. 94-6799 on 2-16-94

Jensen finished Barrier Rail to 72nd St. Bridge at 12:30 AM then went back and wired under 100th St. Bridge on the East Bound Side of the Barrier Rail.

Said they might form and pour the rest of 100th St. gap tomorrow!
DATE       WEATHER/COMMENTS

2-18-94    Over Clay Warm Hi 82° Low 78°

Monday     A chance of Rain Showers this P.M.

Soren Plans on Finishing Main line
Barrier Rail with Skip form Paver today,
also forming gaps over intakes getting
ready to Pour them

Setting forms under 86th St Bridge
this date also getting ready to Pour East
Bound Section of Barrier Rail

Finished Barrier Rail with Paver at 1:00 am

went to work on Gaps

2-19-94    Over Clay Hot Hi 91° Low 22

Tuesday    Setting forms under 86th St Bridge
again this P.M. after they make a pour at
86. Not much going on today, will have
our 2:00 Meeting with Carlson today.

Also attended the Meeting were Cindy of
Wiser, Dave Merrick of Tri State also Shawn Gendro,
Chris Reilly of Kelly Carrí, Larry Streeker and Norm
Larsen of Carlson, Phil Korffun, Mike Page,
Mitch Villauer and myself at the D.D.T. Larry Hill
is sick.

Major Occure is Sorens Barrier Rail and
switching to Bet this Week End!!
APPENDIX D
Core Descriptions
POLK COUNTY PROJECT SITES  
AND  
CORE DESCRIPTIONS  

Core 1A, I-80, EBL  
MP 139.05, 20 ft. west - BAD  

Core 1B, I-80, EBL  
MP 139.05, 70 ft. west - GOOD  

Core 1C, I-80, EBL  
MP 140.06 - BAD  

Core 2A, I-35, I-80, WBL  
MP 132.9, 4 ft. east of drain panel - GOOD  

Core 2B, I-35, I-80, WBL  
MP 132.9, 54 ft. east of drain panel - GOOD  

Core 2C, I-35, I-80, WBL  
MP 132.9, 4 ft. west of drain panel - GOOD  

Core 2D, I-35, I-80, WBL  
MP 132.9, 24 ft. west of drain panel - GOOD  

Core 3A, I-35, I-80, WBL  
MP 128.25 - GOOD  

Core 4A, I-35, I-80, SBL  
MP 126.5 - GOOD  

Core 4B, I-35, I-80, SBL  
MP 126.5 - BAD
APPENDIX E
Core Photos
Cores 1A, 1B and 1C
Barrier showing sites (dark 4" diameter circle) for core 1A
Barrier showing site (dark 4" diameter circle) for core 1B
Barrier showing site (gray 4\textquotesingle\textquotesingle diameter circle) for core 1C
Cores 2A, 2B, 2C and 2D
Barrier showing site (dark 4” diameter circle) for cores 2A and 2C
Core 3A
Barriers showing site (dark 4" diameter circle) for core 3A
Cores 4A and 4B
Barrier showing site (gray 4" diameter circle) for core 4A
Barrier showing site (dark 4" diameter circle) for core 4B
APPENDIX F
Core Analysis Tables
<table>
<thead>
<tr>
<th>SEQUENCE</th>
<th>CORE NUMBER</th>
<th>TEST DEPTH (IN.)</th>
<th>CHLORIDE (%)</th>
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<td>1A</td>
<td>1</td>
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<tr>
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<td>4</td>
<td>1B</td>
<td>0.5</td>
<td>0.222</td>
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<tr>
<td>5</td>
<td>1B</td>
<td>1</td>
<td>0.061</td>
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<td>8</td>
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<td>26</td>
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## MLR-98-4 - Slipform Barrier Rail Cores I-80 Polk County

<table>
<thead>
<tr>
<th>Core #</th>
<th>MP</th>
<th>Location</th>
<th>Visual Appearance</th>
<th>Core Depth (in.)</th>
<th>Mortar Air, %</th>
<th>Total Air, %</th>
<th>Avg. Dia. (microns)</th>
<th>Specific Surface (mm-1)</th>
<th>Spacing Factor (mm)</th>
</tr>
</thead>
<tbody>
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<td>1A</td>
<td>139.05</td>
<td>20' w., EBL</td>
<td>Map cracking</td>
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<td>23.256</td>
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</table>

**NOTE:** Core 4B was too deteriorated for lab analysis.
APPENDIX G
New Mix Design for Concrete Barrier Rail
Section 2513. Concrete Barrier

ADD the following new sentence to the first paragraph of Article 2513.01, Description:
The provisions of Section 2403 shall apply.

ADD the following new paragraph to the end of Article 2513.01, Description:
The Contractor shall use only F-shape temporary concrete barrier rail on roadways with a posted speed limit greater than 45 mph. On any projects let on or after October 1, 2002 the Contractor shall use the F-shape temporary concrete barrier rail.

REPLACE the first sentence of the first paragraph of Article 2513.03, Concrete, with the following:
Concrete shall be Class D concrete, unless otherwise specified in the contract documents.

REPLACE all of Article 2513.03, Concrete, with the following:

A. Precast

Concrete shall be as specified in Article 2513.03, Paragraph B, or as approved by the Engineer, and in accordance with Section 2403. The concrete shall be proportioned, mixed, placed, and cured in a manner that will produce the minimum compressive strength at the time designated, as specified below:

<table>
<thead>
<tr>
<th>Strength Before Moving From Casting Bed (psi)</th>
<th>Strength At Age 28 Days (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precast</td>
<td>1750</td>
</tr>
</tbody>
</table>

Strength at Age 28 Days shall be reached before storing in multilayers or shipping.

The air content of fresh unvibrated concrete shall be 6.5 percent, as a target value, with a maximum variation of plus or minus 1.0 percent.

B. Cast-in-Place and Slip Form

Section 2403 shall apply, except the concrete shall meet the following mix design requirements:

1. Cement. Cement content shall be 603 pounds per cubic yard.

2. Water. The total mixing water and free moisture in the aggregate shall not exceed the following:

<table>
<thead>
<tr>
<th>Class of Concrete</th>
<th>Pounds of Water Per Pound Of Cementitious Material</th>
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</thead>
<tbody>
<tr>
<td>BR (Slip Form)</td>
<td>0.450</td>
</tr>
<tr>
<td>BR (Cast-in-Place)</td>
<td>0.480</td>
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</table>
3. Aggregates. The combination of aggregates shall be uniformly graded in accordance with Materials I.M. 532, meeting the following gradation limits:

<table>
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<th>Sieve Size</th>
<th>Percent Passing</th>
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<tbody>
<tr>
<td>1 1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>81-93</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>67-79</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>57-69</td>
</tr>
<tr>
<td>No. 4</td>
<td>41-53</td>
</tr>
<tr>
<td>No. 8</td>
<td>29-41</td>
</tr>
<tr>
<td>No. 16</td>
<td>21-33</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-1.5</td>
</tr>
</tbody>
</table>

4. Admixtures. Air entrainment shall be used. The air content of fresh unvibrated concrete shall be 6.5 percent, as a target value, with a maximum variation of plus or minus 1.0 percent. To improve workability and aid in air entrainment, water reducing or retarding admixtures may be used in accordance with Article 2513.02, Paragraph C.

5. Fly Ash. The conditions and allowable rates of fly ash substitution shall be in accordance with Article 2301.04, Paragraph E. Article 2301.04, Paragraph F, shall also apply.

Class D concrete may be substituted and Section 2403 shall apply.

REPLACE all of Article 2513.09, Tolerances, with the following:
A newly fabricated unit of temporary barrier rail shall be free from honeycomb, surface spalling, and surface defects. Corner breaks and bottom spalls after shipping and placement shall not exceed 1 square foot of total surface area, which includes the base.

Other than honeycomb, shallow voids, not exceeding 3/4 inch diameter, which appear on the formed surface after proper consolidation will not be considered as surface defects and need not be filled unless they appear in an abnormal concentration.

A used unit of temporary barrier rail shall not have spalls, corner breaks, and bottom spalls totaling more than 5 square feet of surface area, which includes the base.

Connecting loops on all barriers shall not be deformed and shall be true to dimensions.

Gaps between units shall not exceed the dimensions shown in the contract documents.

DELETE the third paragraph of Article 2513.11, Method of Measurement.

DELETE the second paragraph of Article 2513.12, Basis of Payment.