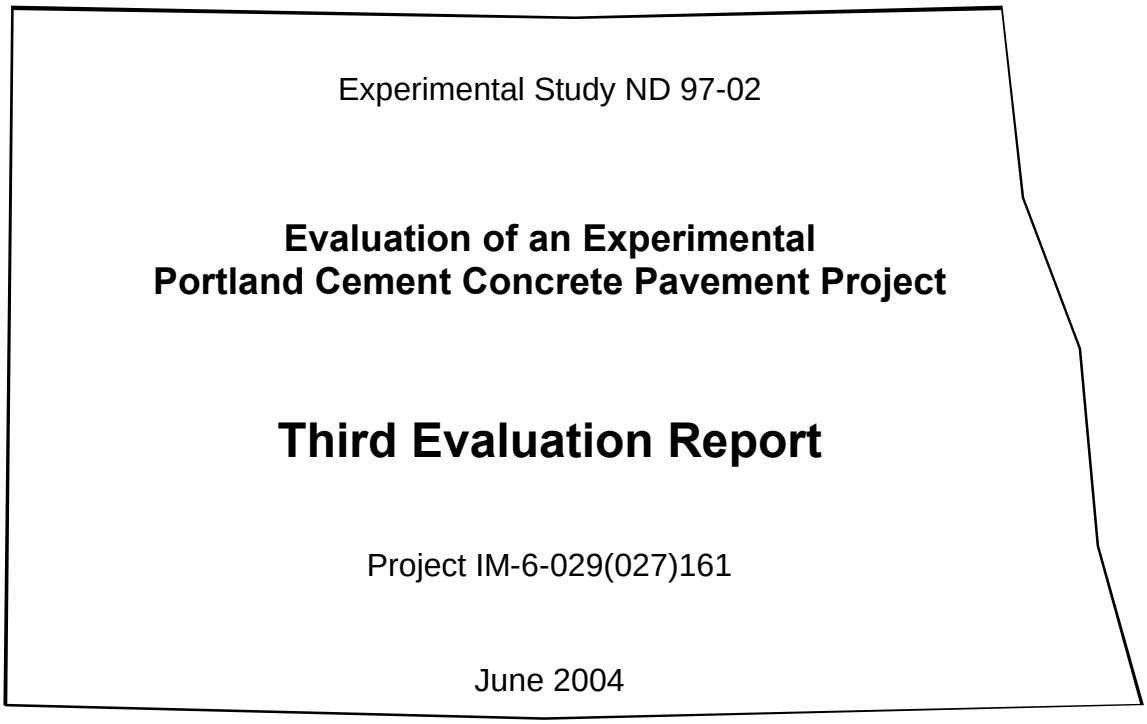
NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH DIVISION



Experimental Study ND 97-02

Evaluation of an Experimental Portland Cement Concrete Pavement Project

Third Evaluation Report

Project IM-6-029(027)161

June 2004

Prepared by

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

EXPERIMENTAL PROJECT REPORT

EXPERIMENTAL PROJECT

EXPERIMENTAL PROJECT NO. (1)
STATE: ND | YEAR: 1997 | NUMBER: 02 | SURF:

CONSTRUCTION PROJ NO (8): IM-6-029(027)161

LOCATION: Walsh (28 Counties)

EVALUATION FUNDING (48)
1 HP&R; 2 X CONSTRUCTION; 3 DEMONSTRATION; 4 IMPLEMENTATION

NEEP NO. (49):

PROPRIETARY FEATURE? (51): Yes / X No

SHORT TITLE

TITLE (52): Evaluation of an Experimental Portland Cement Concrete Pavement Project

THIS FORM

DATE (140): MO. 05 -- YR. 2004

REPORTING: 1 INITIAL; 2 X ANNUAL; 3 FINAL

KEY WORDS

KEY WORD 1 (145): Pavement Concrete
KEY WORD 2 (167): Aggregates
KEY WORD 3 (189): Admixtures
KEY WORD 4 (211): Design
UNIQUE WORD (233): Composite
PROPRIETARY FEATURE NAME (255):

CHRONOLOGY

Date Work Plan Approved (277)	Date Feature Constructed: (281)	Evaluation Scheduled Until: (285)	Evaluation Extended Until: (289)	Date Evaluation Terminated: (293)
04-97	09-97	09-07		

QUANTITY AND COST

QUANTITY OF UNITS (ROUNDED TO WHOLE NUMBERS) (297): 305383

UNITS (305): 1 LIN. FT; 2 X SY; 3 SY-IN; 4 CY; 5 TON; 6 LBS; 7 EACH; 8 LUMP SUM

UNIT COST (*Dollars, Cents*) (306): 7.28

AVAILABLE EVALUATION REPORTS (315)

X CONSTRUCTION | X PERFORMANCE | FINAL

EVALUATION

CONSTRUCTION PROBLEMS (318)
1 NONE; 2 X SLIGHT; 3 MODERATE; 4 SIGNIFICANT; 5 SEVERE

PERFORMANCE (319)
1 EXCELLENT; 2 X GOOD; 3 SATISFACTORY; 4 MARGINAL; 5 UNSATISFACTORY

APPLICATION (320)

1 ADOPTED AS PRIMARY STD.; 2 PERMITTED ALTERNATIVE; 3 ADOPTED CONDITIONALLY; 4 X PENDING; 5 REJECTED; 6 NOT CONSTRUCTED

(Explain in remarks if 3, 4, 5, or 6 is checked)

REMARKS (321)

Results of the third evaluation indicate that all sections are performing well. Minor distresses are noted in all Test Sections. Ride characteristics remain excellent.

700

Form FHWA 1461

Experimental Study ND 97- 02

Evaluation of an Experimental
Portland Cement Concrete Pavement Project

THIRD EVALUATION REPORT

Project IM-6-029(027)161

June 2004

Written by

Curt Dunn /Tom Bold/Bryon Fuchs

Disclaimer

The contents of this report reflect the views of the author or authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not reflect the official views of the North Dakota Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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Evaluation of an Experimental Portland Cement Concrete Pavement Project

Objective

The objective is to move toward an end result specification for concrete paving by moving away from recipe mixes to a mix design philosophy with target properties.

Scope

The scope is to construct an experimental recycled portland cement concrete pavement. The experimental pavement is divided into test sections, each having different design parameters. Individual items to be evaluated over the long term are as follows:

- Distresses in the pavement
- Overall pavement condition
- Ride
- Long term compressive strength

Location

Project IM-6-029(027)161 is located in Walsh County from Jct ND 54 to south of Jct ND 17 in the southbound lane. The location of the individual test sections are as follows:

Test Section 1	MP 169.5 - 175
Test Section 2	MP 164.9 - 169.5
Test Section 3*	MP 162.5 - 163.5
Test Section 4*	MP 163.5 - 164.9

* Shortage of admixture resulted in the reverse order construction of Test Section 3 & 4.

Refer to the next page for the project location.

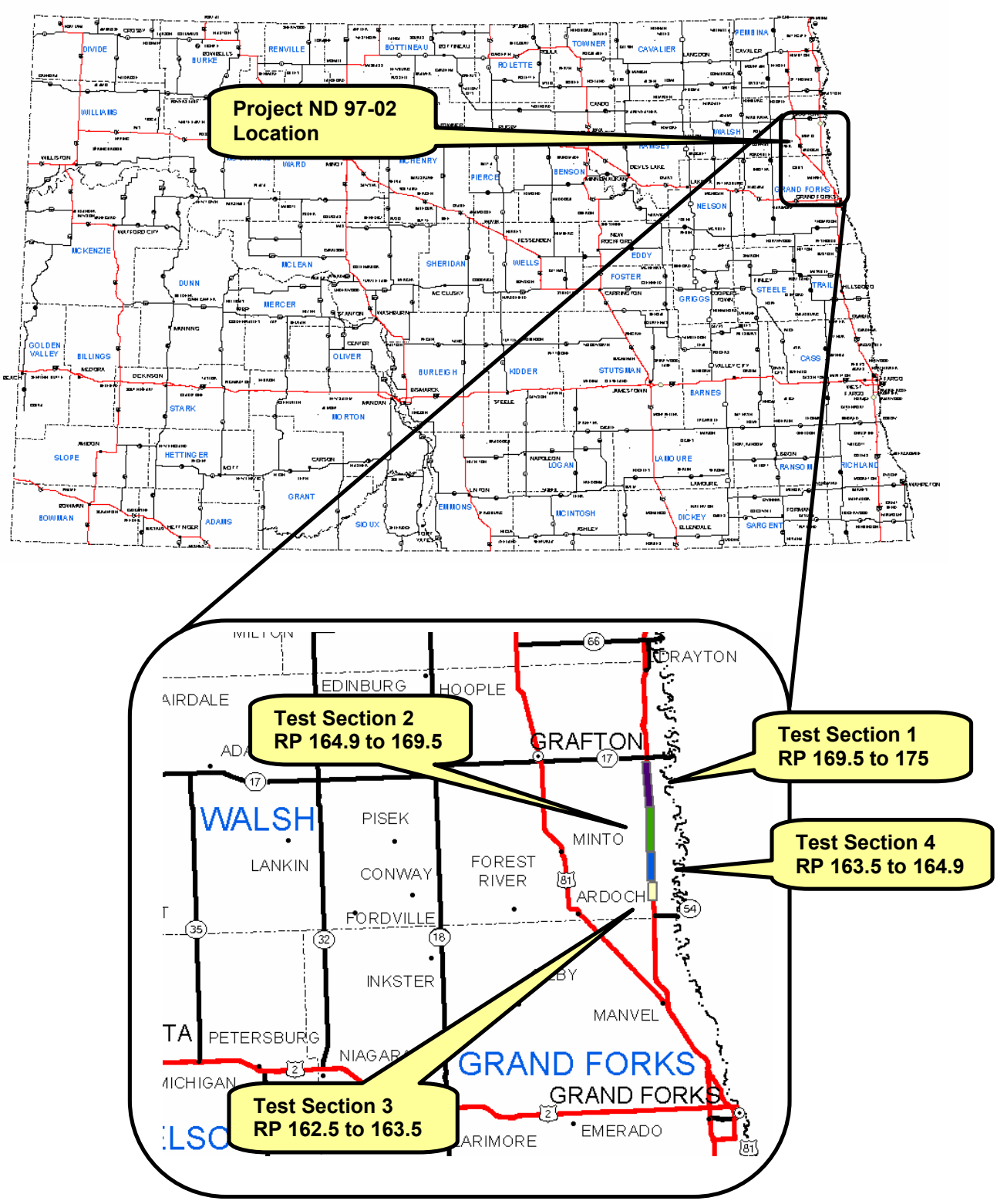

Figure 1 - Project Location.

Traffic

One-way traffic for the above mentioned project is depicted in Table A.

Year	Pass	Trucks	Total	ESALs Rigid
1998	1,700	600	2,300	865
2000	1,647	700	2,347	1,008
2004	2,050	800	2,850	1,105

Table A

Design

The four test sections are as follows in Table B.

Experimental Section	Begin Station to End Station	Length (feet)
1	9234+70.8 - 8945+69.0	28,902
2	8945+69.0 - 8702+28.0	24,341
3	8632+90.0 - 8537+67.7	9,522
4	8702+28.0 - 8632+90.0	6,938

Table B

Table C tabulates the general characteristics of each test section.

Test Section	1	2	3	4
Cement (lb)	480	480	480	480
Fly Ash (lb)	112	112	112	112
Water/Cement Ratio (Max)	0.474	0.474	0.400	0.400
Air Content	6% ± 1%	6% ± 1%	6% ± 1%	6% ± 1%
Water Reducer	No	Yes	Yes	No
Fine & Coarse Aggregates	gap-graded	gap-graded	well-graded	well-graded

Table C

A more detailed account of the design of project IM-6-029(027)161 is included in Special Provision 264 (92) located in Appendix A.

Construction

The work for project IM-6-029(027)161 consisted of removing, crushing, screening and stockpiling the existing portland cement concrete pavement. This recycled material was combined with new materials and used as aggregate for the new PCC pavement.

Construction of experimental project IM-6-029(027)161 went well except for some delays relating to some workability problems in test section 4 and some minor breakdowns. The paving operation was halted for an entire day because of aggregate supply problems. Approximately 1 mile of PCC pavement was produced during one days paving when production was at full swing. The prime contractor was Progressive Contractors, Incorporated (PCI). The project engineer for the North Dakota Department of Transportation was Morris Evens.

Photo 1 – Concrete plant site.

The total length of the project was 13.199 miles. Upon completing test section 2, the contractor's supply of water reducer became low. Test section 3 required the use of a water reducer. Rather than halt construction, the contractor opted to place the concrete mix requirements of test section 4 in the original location of test section 3 since the concrete mix in test section 4 required no water reducer. NDDOT was in favor of

this action. After the placement of test section 4 the contractor then placed test section 3 which was the final section constructed.

The following photos depict some of the steps in constructing the project.

Photo 2 - Placing of the concrete.

Photo 3 - Concrete hopper conveying concrete to the placer.

Photo 4 - Concrete paver.

Photo 5 - Finished PCC pavement prior to carpet drag.

Photo 6 - Carpet dragging finished PCC pavement.

Photo 7 - Tining machine.

Photo 8 - NDDOT testing personnel.

Post Construction Results

During construction of experimental project IM-6-029(027)161 much emphasis was put on sampling and testing of the Portland cement concrete (PCC) as well as the individual materials needed for the PCC mix. Some of the testing frequencies normally used on PCC projects were increased for this experimental project. The data obtained from the various material testing became the basis for achieving the following goals.

Goal #1 Determine the effects of water reducing admixtures as related to performance (strength and durability) and control of water/cement ratio.

Result It has been determined, from the analysis of the data obtained, that the use of a water reducer in the concrete mix has significantly improved the strength characteristics of the concrete. This is evident in both compressive and flexural strengths. Water reducers tend to have significantly greater standard deviations in the concrete. It is recommended that a water reducer be a requirement in NDDOT concrete mix designs or adopt a performance specification where the contractor is induced to use a water reducer that will give good results.

Goal #2 Determine the effects of dense (well) graded aggregates on strength, durability, yield and cost.

Result It has been determined that concrete containing well-graded aggregates resulted in slightly better strength characteristics with less standard deviations than concrete using gap-graded aggregates. Results from durability testing, indicate concrete with well-graded aggregates may be slightly more durable and have higher durability values. However, workability problems still exist in the mix itself. It is recommended that further research be conducted in optimizing mix designs containing well-graded aggregates.

Goal #3 Identify a testing frequency that will be sufficient for a QC/QA specification.

Result It has been determined that the testing frequency implemented on this experimental project is more than sufficient for a QC/QA program. If a QC/QA is implemented, sampling and testing frequencies would be less than what was required in the experimental project. Much of the testing should be part of the contractor's quality control program. Aggregate testing should also be the responsibility of the contractor. Agency testing should be performed for verification purposes. Verification and independent testing should be performed by the agency on a random basis if pay factors are involved. It is also recommend that concrete paving projects be divided into lots and sublots if pay factors are implemented. Pay factors should also be statistically based.

Goal #4 Establish a formal mix design procedure for concrete with admixtures.

Result It is recommended that the NDDOT move toward a more formal mix design procedure with the use of admixtures. If a more formal mix design program is desired perhaps computer mix design programs should be used to aid in optimizing our aggregate gradations on a job-by-job basis.

Goal #5 Establish a relationship between compressive strength and flexural strength and determine a procedure for this relationship on an individual project basis.

Result It has been determined that no significant relationship exists between 28 day compressive strength data and the flexural strength data obtained from this project.

Goal #6 Establish a relationship between w/c ratios calculated from the microwave oven test versus batch tickets for normal concrete and recycled concrete.

Result The conventional batch method and the microwave test method were both used to determine the water/cementitious ratio of the PCC. The results showed that the two methods were very close to one another, however, the average values obtained by the microwave method were slightly lower. It is recommended that the microwave test method be used as a verification tool on future projects.

Goal #7 Determine the relationship between 28-day cylinder strength and core strength and compare the standard deviations of each.

Result It has been determined that no significant relationship exists between 28 day compressive strength data and 28 day core strength data obtained from this project.

Goal #8 Determine the uniformity of the cement and fly ash throughout the project.

Result It has been determined, from the data obtained, that the cement and fly ash material used was uniform.

Goal #9 Establish a relationship between air content (both unconsolidated and consolidated), strength, and durability.

Result It was determined that in some of the test sections where the percent air fell out of specified range, that the strength and durability values decreased slightly. This appeared to be present in the gap-graded sections and not so apparent in the well-graded sections.

Evaluation

Materials and Research conducted the third evaluation of Experimental Project ND 97-02 (IM-6-029(027)161) on September 25, 2003.

Test Section 1 (MP 169.5-175)

Test section 1 was constructed with a concrete mix containing gap-graded aggregates without the use of water reducing admixtures.

Photo 9 - Overall view of Test Section 1.

The first evaluation of test section 1 indicated no detectable distresses, the overall pavement condition was considered to be very good. The ride characteristics were excellent. Random tining depths ranged from 3/32" to 4/32".

The evaluation on October 19, 1999 indicated corner cracking of the pavement panels at Station 8149+80, 9144+30, and 9050+00.

The evaluation on August 30, 2001 noted some minor distresses. The most noticeable distresses were pop-outs and low severity transverse joint spalling. The driving and passing lanes were evaluated. There are approximately 67 transverse joints in 1,000'. The overall condition of the pavement remains very good.

The third evaluation on September 25, 2003 showed very little change in the overall condition of PCC pavement from prior evaluations. There was an increase in

transverse spalling. Ride remains excellent. Refer to Table D for distresses noted in this section.

Date	Station (RP-172)	Long. Cracks	Trans. Cracks	Long. Spalling	Trans. Spalling	Corner Breaks	Other Distresses
8-30-01	9081+68 to 9071+68	0'	0'	None	19.4% of Joints	*0 Panels	Pop-outs
9-25-03		0'	0'	None	34.3% of Joints	*0 Panels	Pop-outs

***Three panels were noted earlier to have corner breaks. The corner breaks were located in section 1, however, they were not located within the segment evaluated. Please note the stationing.**

Table D

Photo 10 - Typical spalled joint and pop-out in Test Section 1.

Test Section 2 (MP 164.9-169.5)

Test section 2 was constructed with a concrete mix containing gap-graded aggregates with water reducing admixtures.

Photo 11 - Overall view of Test Section 2.

The first evaluation of test section 2 indicated the condition of the pavement to be very good. There were no detectable distresses. The ride characteristics were excellent. Random tining depths ranged from 2/32" to 3/32".

The evaluation on October 19, 1999 indicated limited distress of the pavement. Typical distress consists of corner cracking (approximately 12" x 12" at the shoulder), and occasional aggregate pop-outs. Very little of the original tining remains in the area of Station 8930+00; however the condition of the tining improves within the section. Photo 12 provides a view of the condition of the tining at Station 8930+00.

Photo 12 - Tining in Test Section 2 at Station 8930+00

The evaluation on August 30, 2001 noted some minor distresses. As noted in the previous evaluation on October 19, 1999 and again on August 30, 2001, pop-outs are the most noticeable distress in this section. Transverse joint spalling is minimal in test section 2. The driving and passing lanes were evaluated. The overall condition of the pavement remains very good.

The third evaluation on September 25, 2003 showed very little change in the overall condition of PCC pavement from prior evaluations. There was an increase in transverse spalling. Ride remains excellent. Refer to Table E for distresses noted in this section.

Date	Station (RP-167)	Long. Cracks	Trans. Cracks	Long. Spalling	Trans. Spalling	Corner Breaks	Other Distresses
8-30-01	8817+37 to 8807+37	0'	0'	None	4.5% of Joints	0 Panels	Pop-outs
9-25-03		0'	0'	None	10.4% of Joints	0 Panels	Pop-outs

Table E

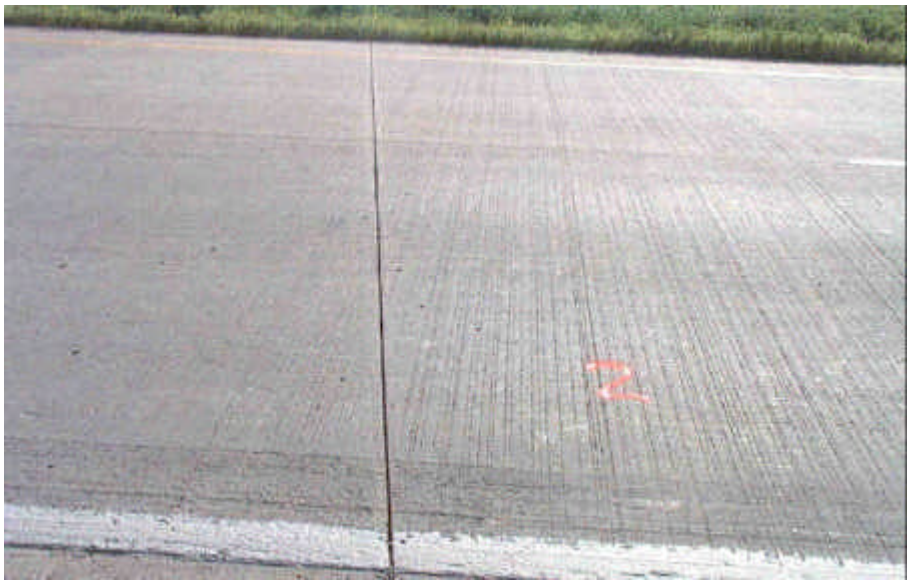

Photo 13 - Typical transverse joint in Test Section 2 and pop-outs.

Test Section 3 (MP 161.9-163.5)

Test section 3 was constructed with a concrete mix containing well-graded aggregates with water reducing admixtures.

Photo 14 - Overall view of Test Section 3.

The first evaluation of test section 3 indicated no detectable distresses. The overall pavement condition was very good. The ride characteristics were excellent. Random tining depths ranged from 1/32" to 2/32".

The evaluation on October 19, 1999 indicated very little distress. The tining in this section is very light.

The evaluation on August 30, 2001 noted some minor distresses. The most noticeable distress observed is pop-outs. The driving and passing lanes were evaluated. The overall condition of the pavement remains very good.

The third evaluation on September 25, 2003 showed very little change in the overall condition of PCC pavement from prior evaluations except one transverse crack that crossed one 12’ lane. There was a slight increase in transverse spalling. Ride remains excellent. Refer to Table F for distresses noted in this section.

Date	Station (RP-162 - 163)	Long. Cracks	Trans. Cracks	Long. Spalling	Trans. Spalling	Corner Breaks	Other Distresses
8-30-01	8590+00 to 8580+00	0'	0'	None	2.9% of Joints	0 Panels	Pop-outs
9-25-03		0’	12’	None	4.5% of Joints	0 Panels	Pop-outs

Table F

Photo 15 - Typical transverse joint and pop-outs in Test Section 3.

Test Section 4 (MP163.5 -164.9)

Test section 4 was constructed with a concrete mix containing well-graded aggregates without the use of water reducing admixtures.

Photo 16 - Overall view of Test Section 4.

The first evaluation indicated no detectable distresses in test section 4. The overall pavement condition was very good. The ride characteristics were excellent. Random tining depths ranged from 1/32" to 2/32".

The evaluation on October 19, 1999 indicated limited distress. Occasional aggregate pop-outs and low severity spalling occurred at transverse joints.

The evaluation on August 30, 2001 noted some minor distresses. The most observed distress in this test section was low severity spalling at transverse joints. Pop-outs appeared to be less frequent than in the other test sections; however, several pop-outs were significantly larger. The driving and passing lanes were evaluated.

A grind area exists within this test section; however, the pavement is in very good condition and the ride remains excellent.

The third evaluation on September 25, 2003 showed very little change in the overall condition of PCC pavement from prior evaluations. There was an increase in transverse spalling. Ride remains excellent. Refer to Table G for distresses noted in this section.

Date	Station (RP-164)	Long. Cracks	Trans. Cracks	Long. Spalling	Trans. Spalling	Corner Breaks	Other Distresses
8-30-01	8659+30 to 8649+30	0'	0'	None	11.9% of Joints	0 Panels	Pop-outs
9-25-03		0’	0’	None	25.4% of Joints	0 Panels	Pop-outs

Table G

Photo 17 - Typical transverse joint spalling and a larger pop-out.

Summary

Provided below in Table H are the results of 28-day compressive strengths, 28-day flexural strengths, w/c ratio, and durability factor.

Test Section	*Durability Factor	W/C Ratio	Average 28-day Compressive Strength (psi)	Average 28-day Flexural Strength (psi)
1 (gap graded w/o water reducer)	83.3	0.413	4,162	650
2 (gap graded with water reducer)	75.6	0.402	4,970	717
3 (well graded with water reducer)	86.5	0.413	5,059	694
4 (well graded w/o water reducer)	92.9	0.442	4,449	663

*Some test sections had only three or four durability beams cast. Results are inconclusive.

Table H

Test sections 1 and 2 are exhibiting some minor corner cracking. All test sections are experiencing some aggregate pop-outs. Test sections 2 and 3 are exhibiting very little distress of any type. Table I provides a summary of the distresses noted in each 1,000 foot segment within a test section.

Test Section	Station	Long. Cracks	Trans. Cracks	Long. Spalling	Trans. Spalling	Corner Breaks	Other Distresses
1	9081+68 to 9071+68	0'	0'	None	34.3% of Joints	0 Panels	Pop-outs
2	8817+37 to 8807+37	0'	0'	None	10.4% of Joints	0 Panels	Pop-outs
3	8590+00 to 8580+00	0'	12'	None	4.5% of Joints	0 Panels	Pop-outs
4	8659+30 to 8649+30	0'	0'	None	25.4% of Joints	0 Panels	Pop-outs

Table I

After the third evaluation, all of the test sections are performing well. The tining, although light in test sections 2 and 3, appears to be performing well. The ride characteristics for all test sections remain excellent.

Appendix A

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

RECYCLED PORTLAND CEMENT CONCRETE PAVEMENT

EXPERIMENTAL MIX DESIGN

WATER CEMENT RATIO / WATER REDUCER / WELL-GRADED AGGREGATE

IM-6-029(027)161

APRIL 18, 1997

DESCRIPTION

This work consists of removing, crushing, screening and stockpiling existing Portland Cement Concrete pavement. The recycled material will be combined with new materials to produce and place a Portland Cement Concrete pavement on a prepared surface. This project will include four test sections as follows:

Test Section	Begin Station to End Station	Length (LF)
1	8537 + 76 to 8761 + 80	22,404
2	8761 + 80 to 8902 + 55	14,075
3	8904 + 65 to 9081 + 60	17,695
4	9081 + 60 to 9234 + 72	15,312

The 10 foot shoulder and ramp tapers shall be paved using the mix design requirements for test section number one. If the Contractor paves full width, the 10 foot shoulder mix design will match the mainline paving. Sections 560 and 802 will be applied in conjunction with this Special Provision.

MATERIALS

Materials shall be as specified in Sections 550 and 802, with the following modifications:

A. **Portland Cement Concrete.** Pavement concrete shall consist of Portland Cement, fly ash, processed salvaged concrete, virgin fine aggregate, virgin coarse aggregate, water, and an air entraining admixture for all test sections as shown in Table A. A water reducing admixture shall be used in test sections 2 and 3 as shown on Table A.

B. **Mix Design.** The Department will design the concrete mixtures. Adjustments to aggregate and water content may be made to produce a mix with the required composition, workability, and consistency. Adjustments to the water content must be limited to maintain the water-cement ratio (w/c). No adjustment in Unit Price will be made because of any increase or decrease in costs which may result from adjustments in air entraining admixture dosage, water content, or aggregate proportions.

TABLE A
MIX DESIGN PROPERTIES BY TEST SECTION

Material	1	2	3	4
Cement (Lb)	480	480	480	480
Fly Ash (Lb)	112	112	112	112
Water/Cement Ratio (Max.)	0.474	0.474	0.40	0.40
Air Content	6% ± 1%	6% ± 1%	6% ± 1%	6% ± 1%
Water Reduction	No	Yes	Yes	No
Virgin Fine Aggregate	816.01	816.01	Well-Graded	Well-Graded
Virgin Coarse Aggregate	816.02-Size 4	816.02-Size 4	Well-Graded	Well-Graded
Recycle Coarse Aggregate	816.02-Size 4	816.02-Size 4	Well-Graded	Well-Graded

1. **Strength.** The target value for compressive strength of the concrete mix will be a minimum of 5500 psi at 28 days.

2. **Cementious materials.** The minimum cement content is 564 pounds. Fly Ash will be allowed as a cement replacement and will be limited to a maximum of 20% fly ash for 15% cement by weight. The resultant weights will be 480 pounds of cement and 112 pounds of fly ash. Fly Ash will be included in the cement content by actual weight, for the determination of w/c ratio.

3. **Water Content.** The concrete mix should be designed and placed with a maximum w/c ratio equal to, or less than the maximum w/c ratio shown above. The water content includes mixing water and free water on the surface of the aggregates, but does not include water absorbed by the aggregates.

4. **Air Content.** The concrete mix shall be designed and placed with an air content of 6.0 ± 1.0 percent by volume of the freshly mixed concrete. The air content shall be continuously adjusted and maintained at 6.0 percent.

5. **Water Reducing Admixture.** A Type A water reducing concrete admixture shall be used in the concrete mix for test sections 2 and 3. The admixture shall not contain calcium chloride or interfere with the proper control of the air content of the concrete. The admixture may require adjustment of the fine material in the concrete mix. Adjustments shall be as recommended by the admixture manufacturer.

6. **Well-Graded Aggregates.** The Contractor shall provide a well-graded composite aggregate for test sections 3 and 4. The composite gradation shall be based on the combined gradation of the virgin fine, virgin coarse and recycled coarse aggregates. The fractional gradations and blend proportions necessary to produce the well-graded aggregate will be determined by the Contractor, and submitted to the Engineer prior to the development of the mix design. The composite aggregate gradations shall meet the following gradation limits:

Composite Gradation Limits

Sieve Size	Percent Passing
1"	100
3/4"	90 - 100
1/2"	80 - 90
3/8"	75 - 85
No. 4	60 - 70
No. 8	45 - 55
No. 16	30 - 40
No. 30	15 - 25
No. 50	5 - 15
No. 100	0 - 10
No. 200	0 - 4

All aggregates shall be blended at the batch plant. The combined gradation may be determined by mathematical computations. The Contractor may submit alternate well-graded composite gradation limits for review and approval by the Engineer.

a. **Virgin Fine Aggregates.** Fine Aggregate is defined as that portion of aggregate that passes the No. 4 sieve. A maximum of 5% of the material may be retained on the No. 4 sieve. Fine aggregates shall meet Section 816.01 A.2.

b. **Virgin Coarse Aggregates.** Coarse Aggregate is defined as that portion of aggregate retained on the No. 4 sieve. A minimum of 95% of the of the material shall be retained on the No. 4 sieve. Virgin coarse aggregate shall meet Section 816.02 A.2.

c. **Recycled Coarse Aggregate.** Coarse Aggregate is defined as that portion of aggregate retained on the No. 8 sieve. Recycled coarse aggregate shall have a maximum aggregate size of 1 inch. Salvaged material passing the No. 8 sieve shall be limited to less than 5 percent. Salvaged fines shall not be used in the new concrete. Recycled coarse aggregate shall be limited to 80 percent of the total coarse aggregate (virgin coarse aggregate plus recycled coarse aggregate). The ratio of virgin coarse to recycle coarse aggregate shall be the same for all test sections.

C. **Submittals.** A minimum of 14 days prior to the beginning of paving operations, the Contractor shall submit the following to the Engineer for review and approval:

1. **Source and Certification.** The sources and certifications for all materials in the concrete mixtures.

1. **Well-Graded Aggregate.** The aggregate gradations, proportions, and sources for all materials in the well-graded aggregate.

2. **Air Entraining Admixture.** The type and brand of air entraining admixture and the Manufacturer's recommended usage of the air entraining admixture.

3. **Water Reducing Admixture.** The type and brand of water reducer admixture and the Manufacturer's recommended usage of the water reducing admixture.

4. **Trial Mix Design.** The Contractor shall provide representative samples of all materials in the concrete mixture for trial mix designs. A sample tag identifying the project number and material shall be attached to the samples. The minimum size samples for the trial mix design are as follows:

Material	Sample
Cement	225 lb.
Fly Ash	50 lb.
Fine Aggregate	500 lb.
Coarse Aggregate	800 lb.
Air Entraining Admixture	1 gal.
Water Reducing Admixture	1 gal.

The sample sizes may require adjustment due to actual conditions and operations.

If aggregates, cement, fly ash, water or other admixtures are utilized from sources other than those initially submitted the Contractor shall notify the Engineer five days before incorporating the material into the work.

CONSTRUCTION REQUIREMENTS

The Project will be constructed according to Section 560 with the following modifications:

B. **Stockpiling.** Delete the second paragraph of Section 560.04 B in its entirety.

E. **Processing Salvaged Concrete.** Add the following after the second pargraph of Section 560.04 E.

Salvaged fines shall not be used in the new concrete.

The salvaged concrete for the well-graded aggregate shall be crushed to such a gradation that when combined with the virgin aggregates it will meet the specified gradation.

F. **Mixing.** Add the following to Section 560.04 F.

1. **Water-Cement (W/C) Ratio.** The determination of the w/c ratio will be based on the following procedures:

   a. **Water Content.** The water content in the concrete mix used for the determination of the w/c ratio shall consist of the water added to the mixer plus the free water carried by the aggregate.

      All water added to the mix shall be recorded by an electronic meter. The moisture contents of the aggregate (fine, virgin coarse, recycled coarse) shall be determined by the Engineer. The batch ticket shall indicate the values for water added, free water, and the total water (water added plus free water).

      For informational purposes, the water content in the mix shall also be determined from samples of the plastic concrete taken at the plant site. The water content will be determined by test procedure: AASHTO TP23-93 "Standard Test Method for Water Content Using Microwave Oven Drying." The Engineer will perform a water content determination each time cylinders and beams are cast and should provide a summary comparison of the water content from the batch tickets and the microwave test.

   b. **Cement Content.** The cement content shall be determined from the batch ticket weight.

      The cement content will be verified by cement cut-offs and recalibration of the cement scales. The Contractor shall perform a minimum of 2 cement cut-offs and recalibrate the cement scales for each three miles of paving, mainline and shoulders.

   c. **Cement Tolerance.** The cement content shall be maintained within a tolerance of ± 1%. The cement content may require adjustments as follows:

      1. If concrete having the required consistency cannot be produced without exceeding the maximum allowable w/c ratio, the cement content shall be increased so the maximum w/c ratio is not exceeded.

      2. If the concrete produced in the field does not meet the strength requirements, the cement content shall be increased until the strength requirements are met.

      The Contractor will be reimbursed for additional cementious materials necessary to meet the requirements of this Special Provision.

   d. **Water-Cement (W/C) Ratio.** The w/c ratio will be determined by dividing the batch ticket weight of the total water by the combined batch ticket weights of cement and fly ash.

METHOD OF MEASUREMENT

The Method of Measurement will be according to Section 560.05 with the following modifications:

Delete the second paragraph of Section 560.05 A in its entirety and replace with the following:

> All virgin P.C.C. pavement aggregate, salvaged concrete, and salvaged bituminous stockpiled at the plant site shall be considered the property of the Contractor. Payment will not be made for salvaged material which is stockpiled and not incorporated into the project.

Add the following to Section 560.06:

G. **Water Reducer - Type A.** This item will be measured by the Gallon. The volume of water reducer will be determined from the actual batch weight used (ounces) minus any waste. The batch weight will be converted to gallons be dividing the batch weight by 128 ounces per gallon.

BASIS OF PAYMENT

The Basis of Payment will be according to Section 560.05 with the following modifications:

Remove the last paragraph of Section 560.06 A and replace with the following:

> Water, Air-Entraining Admixture, Virgin Fine Aggregate , Virgin Coarse Aggregate, and Recycle Coarse Aggregates (including the processing of recycled concrete pavement), will not be measured for payment but will be included in the price bid for "Nonreinforced Recycled Concrete Pavement ."

Add the following pay item to Section 560.06 A:

Pay Item	**Pay Unit**
Water Reducer - Type A	Gallon