

**SPS-2 Construction Report
I-94 Eastbound
West of Fargo, North Dakota
Sections 380213 - 380224**

**Federal Highway Administration
LTPP Division**

North Central Region

Report Prepared By:

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Project DBNX-92-700
June 10, 1996

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*Engineers and Scientists Serving
the Built and Natural Environments®*

June 10, 1996

Mr. Richard Ingberg
Regional Engineer
6875 Washington Avenue South
P.O. Box 39108
Minneapolis, MN 55439-0108

Dear Mr. Ingberg:

Enclosed is the Construction Report for the North Dakota SPS-2 project.

If you have any questions about this report please call Ronald Urbach or Benjamin Worel.

Sincerely,

Ronald R Urbach

Ronald R. Urbach, CET

Benjamin Worel

Benjamin J. Worel, PE

Attachment:
Report

c: Mr. Monte Symons, FHWA
Mr. John Miller, PCS/Law
Mr. Cameron Kruse, Braun Intertec

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1.0 Introduction

1.1 SPS-2 Experimental Design and Research Plan in North Dakota

The experimental design and research plan for Experiment SPS-2 is for the purpose of studying the structural factors for rigid pavements.

The objective of the SPS-2 experiment is to determine the effects of the following specific design features.

- In-pavement drainage systems
- Base type
- Concrete flexible strength
- Pavement thickness
- Lane width

The North Dakota SPS-2 project is designated as an S experiment. The project is a dry-freeze zone, and the subgrade soils are fine-grained (clay).

1.2 Summary of Supplemental Sections

The project consists of 12 SHRP test sections, the North Dakota DOT Control Section, and five supplemental test sections. The control section and five supplemental sections are listed in Table 1.

Table 1. Summary of Supplemental Sections

Test Section	PCC PVMT Thickness (Inches)	PCC PVMT Width (Feet)	14 Day Flexural Strength (psi)	Base Type	Joint Orientation	Transverse Joint Spacing (Feet)	Type of Load Transfer Device
380259	10	24	*	8" SALVE	SKEWED	15	DOWELS
380260	11	38	*	CL 5 AGGR	SKEWED	15	DOWELS
380261	11	24	550	CL 5 AGGR	SKEWED	VARIABLE **	NONE
380262	11	28	550	LCB	SKEWED	VARIABLE	NONE
380263	11	24	550	PASB	SKEWED	VARIABLE	NONE
380264	11	38	*	PASB	SKEWED	15	NONE

Note: 380259 North Dakota DOT control test section.

* Class AE as per NDDOT Specifications.

** Joint spacing varies from 12; 15; 13 and 14 ft.

1.3 Project Location

The project is located on Interstate 94 eastbound driving lane between the Casselton and the Mapleton exits. The test sections start at approximately Milepost 332.8 and end at approximately Milepost 335.2. Attachment A is a map of North Dakota showing the location of the SPS-2 along with the other GPS sites in North Dakota. Attachment B contains a map of Cass County showing the construction.

1.4 Project Location

The original concrete pavement was placed in 1960. It was 24 feet wide and 9 inches thick. There were 3 inches of aggregate base over 6 inches to 9 inches of aggregate subbase. The terrain in this area is very flat and is part of the old glaciated Lake Agassiz.

1.5 Traffic Characteristics

The following traffic information was provided by North Dakota.

Average Daily Traffic (vehicles)	8,310
Percent Trucks	12
Estimated 18k ESAL in Study Lane (year)	900,000
Total Design 18k ESAL Applications in Lane	2,150,000
Design Period (years)	30

1.6 Known Deviations From Guidelines

The first two test sections, which are state supplemental test sections, are on a slight superelevation. These are just after the on-ramp from Casselton. Attachment D is a copy of the SPS deviation report prepared for this project which covers the known deviations.

1.7 Geometry

The remainder of the roadway is relatively straight.

1.8 Underground Structures Within Test Sections

The test section locations were selected to avoid any underground drainage structures.

1.9 Installation of the Weather Station

The automated weather station (AWS) was installed in Fall 1994. This weather station was placed at the maintenance yard located at the northwest corner of Interstate 94 and the Casselton exit (approximately one-half mile from the west end of the project).

1.10 Installation of the WIM

The bending plate weigh-in-motion system was installed at Station 994+00. This is between test sections 380223 and 380263.

1.11 Schedule for Opening to Traffic

Traffic was placed on the test sections in October, 1994.

1.12 General Problems

There were some rain delays because of extremely wet clay soils during construction. Because of these delays, the project opening was delayed approximately four to six weeks.

1.13 Resident Engineer Information

North Dakota Department of Transportation Representatives

Address: 503 38th Street South
Fargo, ND 58103-1198

Mr. Charles Kahl
District Engineer
Phone: (701) 239-7171

Mr. Kent Bartel
Sr. Transportation Manager
Phone: (701) 239-7171

Mr. Duane Carlstrom
Phone: (701) 239-7171

Mr. Steve Pflipsen
Phone: (701) 277-9790

Note: Mr. Carlstrom was replaced by Mr. Steve Pflipsen in July, 1994.

1.14 Material Sampling and Testing

The supervision of the material sampling and testing, conducted by the agency, was supervised by Mr. Duane Carlstrom and Mr. Steve Pflipsen. The overall coordination of the project was handled by Mr. Kent Bartel and Mr. Charles Kahl. Attachment E contains the materials sampling and testing plan.

1.15 Contractor Information

Project Prime Contractor

Progressive Contractors, Inc.
Mr. Steve Gerster
8736 Zachary Lane
Osseo, MN 55369
Phone: (612) 425-4515

Grading Subcontractor

R & G Construction Company
Mr. Greg Mathiowetz
R.R. 1, Box 37A
Marshall, MN 56258
Phone: (507) 537-1473

1.16 Summary of Key Construction Equipment

18-inch Subgrade Preparation

- D9 dozer with a large farm-type plow
- D16 model motor grader
- Disk
- Sheepsfoot vibratory compactor
- CMI Profiler

Edge Drains

- Vermeer Model T 600D Trencher
- Small conveyor mounted on a Case Model 1845C Skid Steer Loader
- BOMAG Vibrating plate compactor Model BP15/49

Dense Graded Aggregate Base

- Motor grader
- 18-ton Pneumatic tired roller
- CMI Profiler

Asphalt Treated Base (ATB)

Permeable Asphalt Treated Base (PATB)

- Mix plant Boeing drum-type
- Barber Greene Model 146 Paver
- 10-ton double-drum vibratory compactor

Lean Concrete Base (LCB)
Portland Cement Concrete (PCC)

- Contractor concrete mix plant
- REX slip form paver model Town and Country
- Curb master spreader
- Internal vibrator screed

2.0 Project Details

After each structural layer was placed, rod and level measurements were performed to document the thicknesses.

Attachment F is a tabulation of base and pavement thickness. This table is a summary of rod and level and cores taken.

Attachment G is a summary of the mix designs.

- Lean concrete base
- 550 psi flexural strength concrete
- 900 psi flexural strength concrete
- North Dakota Type AE-3 concrete

Several trial batches were run and laboratory tests obtained were used to verify the flexural strengths.

The contract specification indicated that the upper 18 inches of the subgrade be reworked and recompacted. This was done to provide a uniform subgrade.

After the existing PCC pavement and base materials were removed, a large farm-type plow was used to loosen up the soils. This plow was mounted on the back of a D9 Dozer. After the soils were loosened, a motor grader was used to remove approximately 12 inches of loose soils. Then sheepsfoot compactors and motor graders were used to work and compact the soils. After the soils were compacted, a CMI profiler was used to trim and shape the subgrade prior to the placement of the base layers.

Soil moisture sensors were placed at two locations on this project. At each of the locations sensors were placed at a joint and mid slab. Sensors were placed to monitor the moisture in salvaged base and in an area where dense graded aggregate base was used. Sensors were placed in the upper and lower portion of the layer. A sensor was also placed in the subgrade.

The equipment that was installed was a model 6050X1 time-domain reflectometry (TDR) moisture analyzer system. The equipment was manufactured by Soilmoisture Equipment Corp., Santa Barbara, California, (805) 964-3525.

The equipment was installed by Fargo Electric. The work was supervised by Mr. Richard White for Soilmoisture Equipment Corp.

3.0 Initial Performance

3.1 Post-Construction Meeting Comments

The meeting was held May 16, 1995, at the District Office in Fargo, North Dakota. The personnel present included Charlie Kahl, Steve Pflipsen, Ann Johnson and Ben Worel.

3.1.1. Construction Problems

1. The Lean Concrete base (LCB) was difficult to place. They had to mix the material stronger than design in order to place it, due to the sides sloughing with the weaker (or as-designed) mix. Too many fines in the design mix caused the placed concrete to collapse on the edges, requiring forms for placement. As the concrete was finished, the water migrated to the outside edge, compounding the problem. During construction the mix was adjusted to correct this problem.
2. Test section 380217 had 8 inches of PCC over 6 inches of LCB. Mr. Pflipsen indicated that some of the transverse cracks that appeared in the LCB that within five days after the 8 inches of PCC pavement was placed reflected throughout the PCC. The crack in the 8-inch PCC were sealed when the transverse joints were sealed.
3. The Permeable Asphalt Treated Base (PATB) was hard to roll. It was very fluid, and once rolled, it lost its form and slope. The material also rolled down too far. Charlie asked if perhaps this material could be placed and left uncompacted (without rolling). They noted that even if the underlying base layers are graded correctly, problems with the PATB deforming can cause ride problems. They also noted that this material was difficult to place in such short sections. The NDDOT typically places PATB beneath all of their concrete interstate pavements, but those are long sections and they do not experience the same problems.

The PATB was rolled at about 200° F.

4. The fabric worked out fine and appears to drain well. They used pearock in the trenches, and experienced no major problems with the placement of the fabric after the contractor got used to working with the material.

5. The contractor did not have problems meeting the high strengths specified for the PCC. This was because they conducted many mix designs and trial batches prior to construction.
6. The drilling and sampling was coordinated by Steve Pflipsen. He wrote an extensive spreadsheet program, which flagged which tests were required each day, based on the actual construction schedule. He also developed a spreadsheet which outlined where the cores and tests were to be taken daily (a copy is attached).

3.1.2. Suggestions

1. Steve Pflipsen suggested that software be purchased for the agencies constructing the SPS projects (he specifically recommended Perform Pro.) The agencies would then create a database, which could be downloaded into the data, sampling and testing forms.
2. The NDDOT felt it worked best to have one person who was ultimately responsible for all aspects of the SPS project construction and documentation. They also recommended that one back-up person be assigned to the project.
3. They recommended sawing the LCB at the same location as the joints in the PCC prior to placement of the PCC.

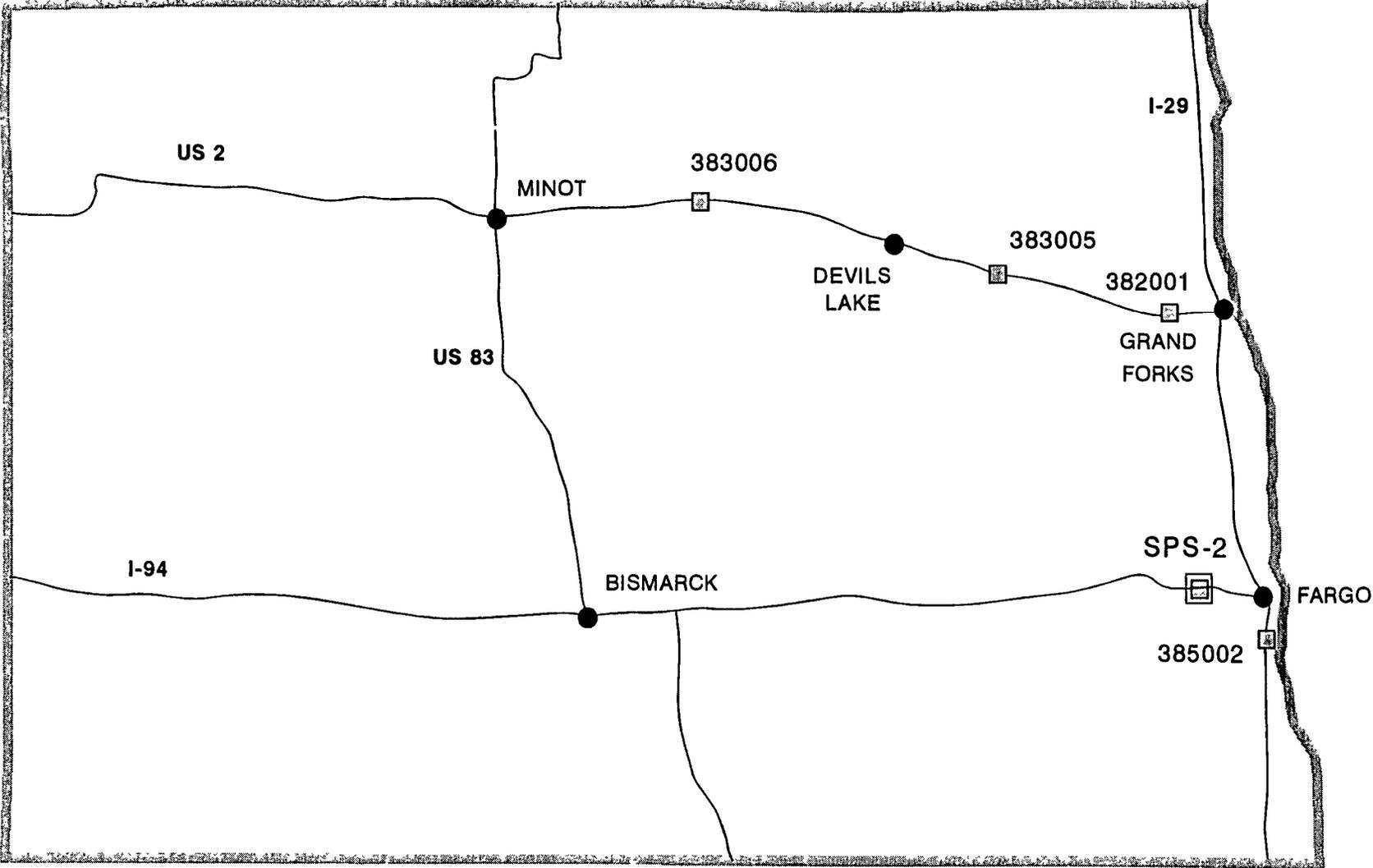
3.1.3 Other Information

1. The project was completed and opened to traffic in mid October, 1994.
2. Due to requirements for uniform subgrade preparation, Section 8 has some bad subgrade material. This caused some heaving in the winter, but has corrected itself. If this section of road was not a SHRP project, they would have subcut at least 2 feet and added some geotextile fabric. The bump was about 1 inch during the winter period.
3. The WIM is operating fine.
4. The AWS is also working fine.

Attachment A

North Dakota LTPP Map

**LTPP TEST SITE LOCATIONS
NORTH DAKOTA
GENERAL PAVEMENT STUDIES**



Attachment B
Project Location Map

DESIGN DATA			
Traffic	Average Daily		Est Max Hr
Current 1994	Pass. 3,455	Trucks 700	Total 4,155 450
Forecast 2014	Pass 5,080	Trucks 1,050	Total 6,130 775
Minimum Sight Dist For:	Design Speed	70 MPH	
Stopping	625 FT		
Full Control of Access			
No Point of Access Other Than at Interchange Ramps			

JOB# _____

FHWA REGION	STATE	PROJECT NO	SHEET NO.
8	ND	IM-8-094(005)331	1

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

IN CASS COUNTY

FEDERAL AID PROJECT IM-8-094(005)331

PCC RECYCLING & SPS-2 EXPERIMENTAL SECTIONS

GOVERNING SPECIFICATIONS:

Standard Specifications adopted by the North Dakota Department of Transportation September 1992; Standard Drawings currently in effect; and other Contract Provisions submitted herein.

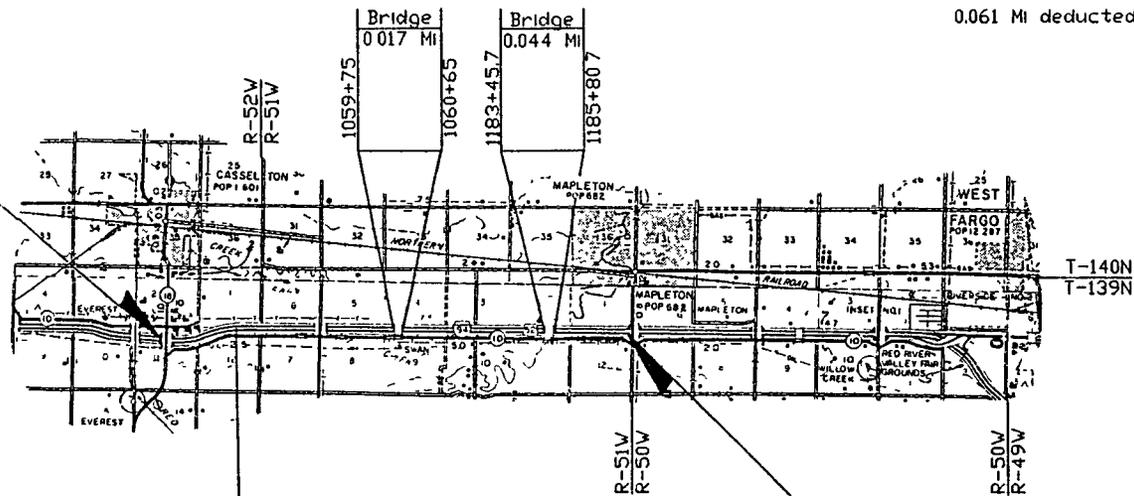
LENGTH OF PROJECT

<u>Miles-Gross</u>	<u>Miles-Net</u>
7.510	7.449

0.061 Mi deducted for bridges



BEGIN Sta 855+48.4
Section 11, Twp 139 N,
Rge 52 W



EQUATION
916+857 Bk=
914+94.4 Ahd

END Sta 1250+11.8
Section 12, Twp 139 N,
Rge 51 W

Attachment B
North Dakota SPS-2
I 94 Eastbound
West of Fargo, North Dakota

Attachment C
Section Layout

380260
888+88 - 893+68
11"PCC, 6"DGAB - 12'LANE

380261
896+66 - 901+66
11"PCC, 6"DGAB - 12'LANE

380215
905+57 - 910+57
11"PCC, 6"DGAB - 12'LANE

380216
914+04 - 917+13
8"PCC, 6"DGAB - 14'LANE

380214
922+15 - 927+15
11"PCC, 6"DGAB - 12'LANE

380213
928+45 - 933+45
8"PCC, 6"DGAB - 14'LANE

380217
934+61 - 939+61
8"PCC, 6"LCB - 14'LANE

380218
940+93 - 945+93
11"PCC, 6"LCB - 12'LANE

380220
950+31 - 955+31
11"PCC, 6"LCB - 14'LANE

380262
958+21 - 963+21
8"PCC, 6"LCB - 14'LANE

380219
965+67 - 970+67
11"PCC, 6"LCB - 12'LANE

380223
974+29 - 979+29
11" PCC, 4" PATB
4" DGAB - 12' LANE

WIM - 994+00

380263
1019+21 - 1024+21
11"PCC, 4"PATB
4"DGAB - 12'LANE

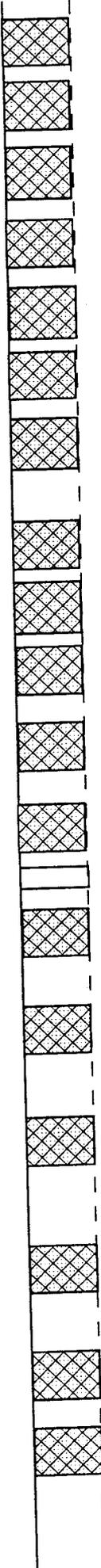
380264
1028+01 - 1033+01
11"PCC, 4"PATB
4"DGAB - 12'LANE

380224
1036+22 - 1041+22
11"PCC, 4"PATB
4"DGAB - 14'LANE

380221
1045+51 - 1050+51
11"PCC, 4"PATB
4"DGAB - 14'LANE

380222
1052+38 - 1057+38
8"PCC, 4"PATB
4"DGAB - 12'LANE

380259
1062+85 - 1067+85
10"PCC, 4"PATB
8"SALV.BASE - 12'LANE



MP 332

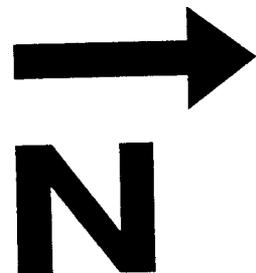
MP 333

MP 334

MP 335

SPS-2
Series "S"
North Dakota
West of Fargo
I-94 EAST BOUND

S:\LTTP\HG\SPS\SPS2_ND.CH3
UPDATED 3/22/96
* EQUATION
916+85.7 BEHIND
=914+99.4 AHEAD



Attachment D
Project Deviation Report

LTPP SPS Project Deviation Report Project Summary Sheet	State Code			<u>3</u>	<u>8</u>
	Project Code	<u>0</u>	<u>2</u>	<u>0</u>	<u>0</u>

Project Classification Information

SPS Experiment Number: 02	State or Province: North Dakota
LTPP Region:	<input type="checkbox"/> North Atlantic <input checked="" type="checkbox"/> North Central <input type="checkbox"/> Southern <input type="checkbox"/> Western
Climate Zone:	<input checked="" type="checkbox"/> Dry-Freeze <input type="checkbox"/> Dry-No Freeze <input type="checkbox"/> Wet-Freeze <input type="checkbox"/> Wet-No Freeze
Subgrade Classification:	<input checked="" type="checkbox"/> Fine Grain <input type="checkbox"/> Coarse Grain <input type="checkbox"/> Active (SPS-8 Only)
Project Experiment Classification Designation (SPS 1, 2 and 8): SPS-2	
Construction Start Date: May 11, 1994	Construction End Date: October, 1994
FHWA Incentive Funds Provided to Agency for this Project: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	

Deviation Summary

Site Location Deviations:	<input checked="" type="checkbox"/> No Deviations <input type="checkbox"/> Minor Deviations <input type="checkbox"/> Significant Deviations
Construction Deviations:	<input type="checkbox"/> No Deviations <input checked="" type="checkbox"/> Minor Deviations <input type="checkbox"/> Significant Deviations

Data Collection and Processing Status Summary

Inventory Data (SPS 5,6,7,9): Not Applicable	<input type="checkbox"/> Complete Submission <input type="checkbox"/> Incomplete <input type="checkbox"/> Data Not Available
Materials Data:	<input checked="" type="checkbox"/> All Scheduled Samples Obtained and Tested <input type="checkbox"/> Incomplete/No Test Data
Construction Data:	<input checked="" type="checkbox"/> All Required Data Obtained <input type="checkbox"/> Incomplete/Missing Data Elements
Historical Traffic Data: Not Applicable	<input type="checkbox"/> All Required Historical Estimates Submitted (SPS 5,6,7,9) <input type="checkbox"/> Required Estimates Not Submitted
Traffic Monitoring Equipment:	<input checked="" type="checkbox"/> WIM Installed On-Site <input type="checkbox"/> AVC Installed On-Site <input type="checkbox"/> ATR Installed On-Site <input type="checkbox"/> No Equipment Installed
Traffic Monitoring:	<input type="checkbox"/> Preferred <input checked="" type="checkbox"/> Continuous <input type="checkbox"/> Minimum <input type="checkbox"/> Below Minimum <input type="checkbox"/> Site Related
Traffic Monitoring Data:	<input checked="" type="checkbox"/> Monitoring Data Submitted <input type="checkbox"/> No Monitoring Data Submitted
FWD Measurements:	<input type="checkbox"/> Preconstruction Tests Performed <input checked="" type="checkbox"/> Construction Tests Performed <input checked="" type="checkbox"/> Post-construction Tests Performed
Profile Measurements:	<input type="checkbox"/> Preconstruction Tests Performed <input checked="" type="checkbox"/> Post-Construction Tests Performed
Distress Measurements:	<input type="checkbox"/> Preconstruction Tests Performed <input checked="" type="checkbox"/> Post-Construction Tests Performed
Maint. & Rehab. Data: Not Applicable	<input type="checkbox"/> Complete Submission <input type="checkbox"/> Incomplete <input type="checkbox"/> Data Not Available
Friction Data:	<input type="checkbox"/> Complete Submission <input checked="" type="checkbox"/> Incomplete <input type="checkbox"/> Data Not Available

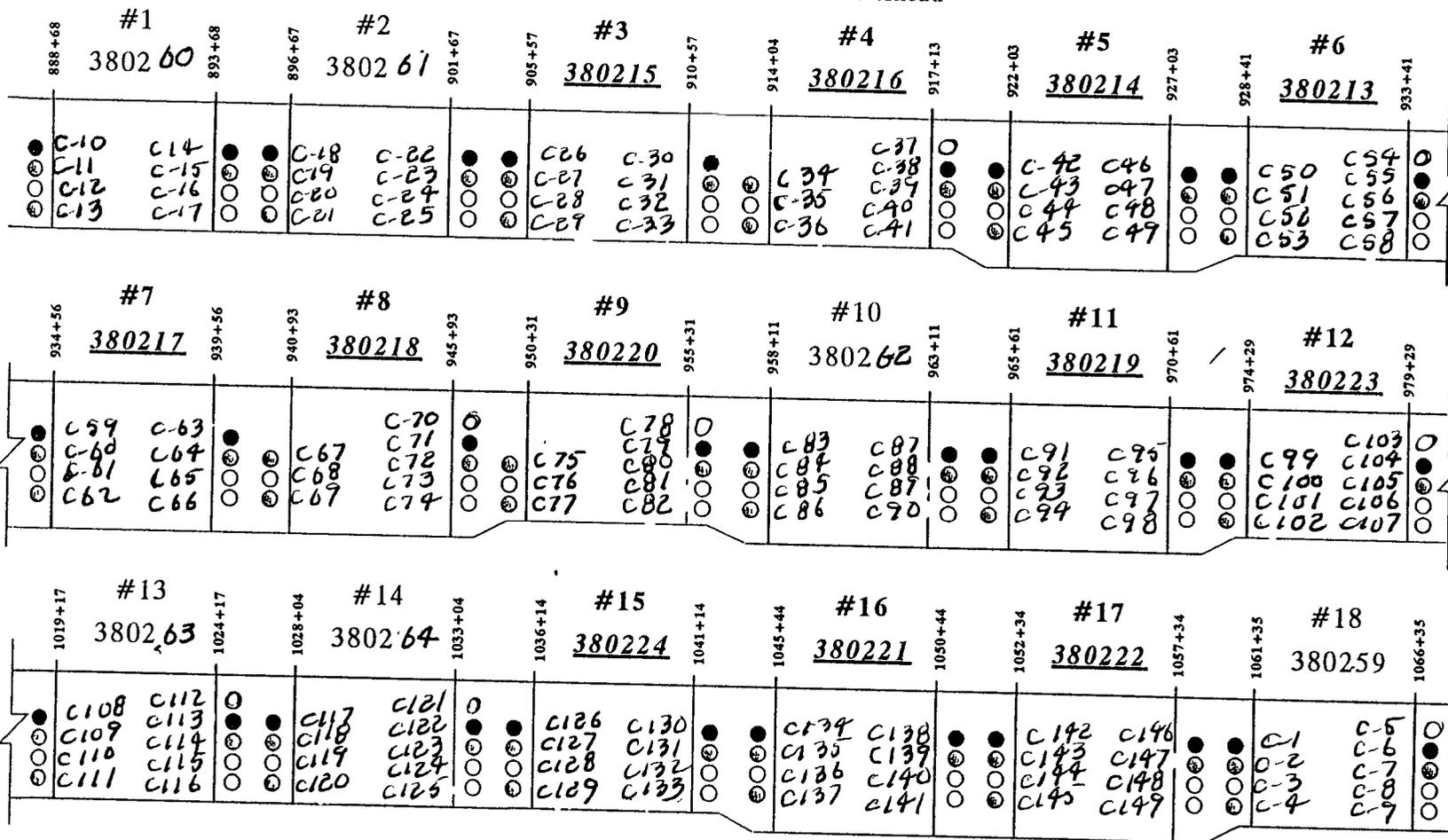
Report Status

Materials Sampling and Test Plan:	<input checked="" type="checkbox"/> Document Prepared <input type="checkbox"/> Final Submitted to FHWA
Construction Report:	<input checked="" type="checkbox"/> Document Prepared <input type="checkbox"/> Final Submitted to FHWA
AWS: (SPS 1, 2, & 8)	<input checked="" type="checkbox"/> AWS Installed <input type="checkbox"/> AWS Installation Report Submitted to FHWA

Attachment E

Materials Sampling and Testing Plan

Equation: 916+85.7 Behind =
914+94.4 Ahead



Direction of Traffic →

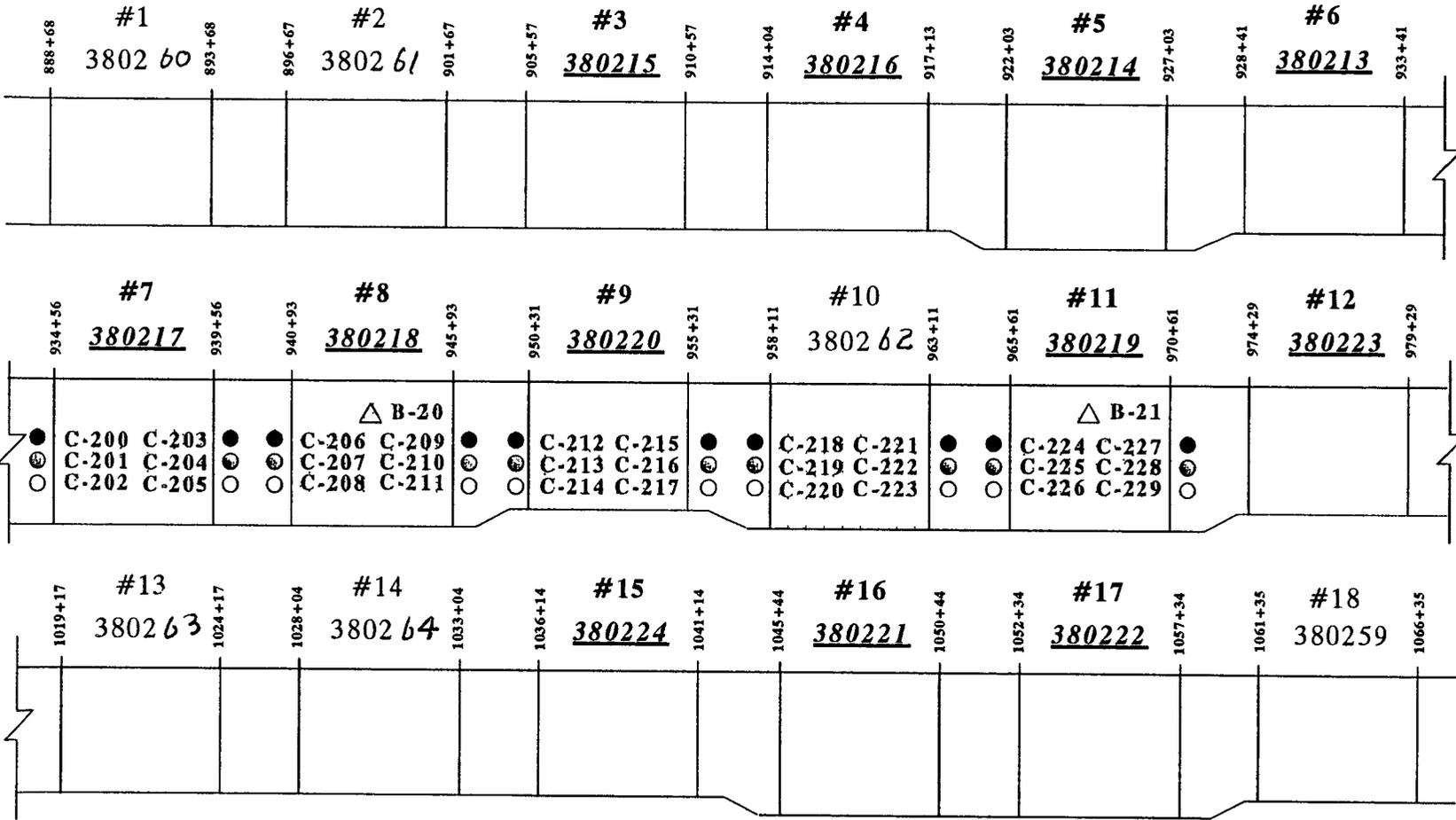
- 102mm (4") OD Core of Finished PCC (14 Day Test)
- ⊙ 102mm (4") OD Core of Finished PCC (28 Day Test)
- 102mm (4") OD Core of Finished PCC (365 Day Test)
- 3802** LTPP Sections

North Dakota SPS-2, I-94 EB Lane
Sampling and Testing Locations for PCC Pavement
Attachment C



Direction of Traffic →

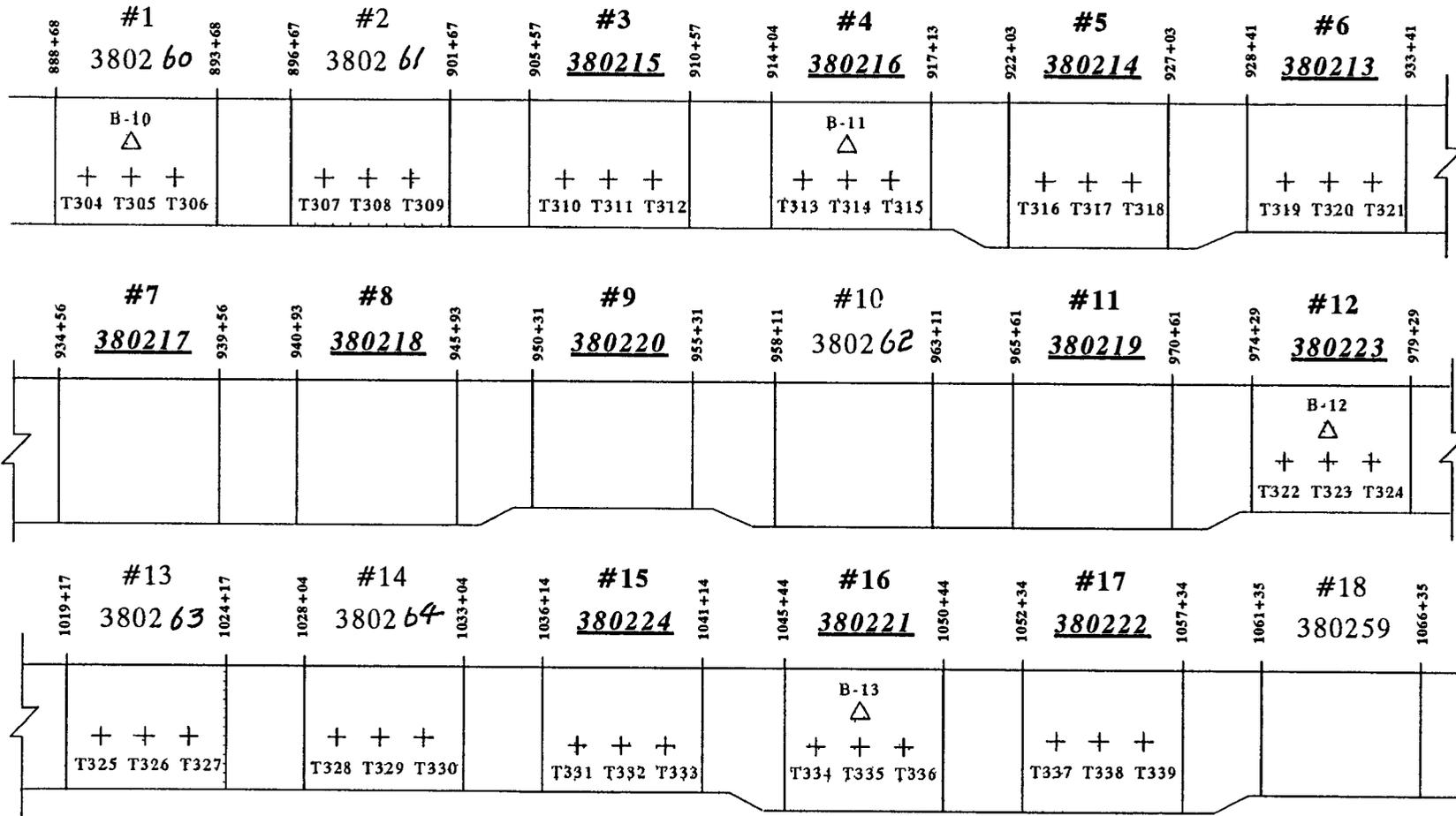
Equation: $916+85.7$ Behind = $914+94.4$ Ahead



- 102mm (4") OD Core of Finished LCB (7 Day Test)
- ⊗ 102mm (4") OD Core of Finished LCB (28 Day Test)
- 102mm (4") OD Core of Finished LCB (365 Day Test)
- △ Sampling of Fresh Lean Concrete Base (LCB)
- Sections with Lean Concrete Base (LCB)
- 3802** LTPP Sections



Equation: 916+85.7 Behind =
914+94.4 Ahead

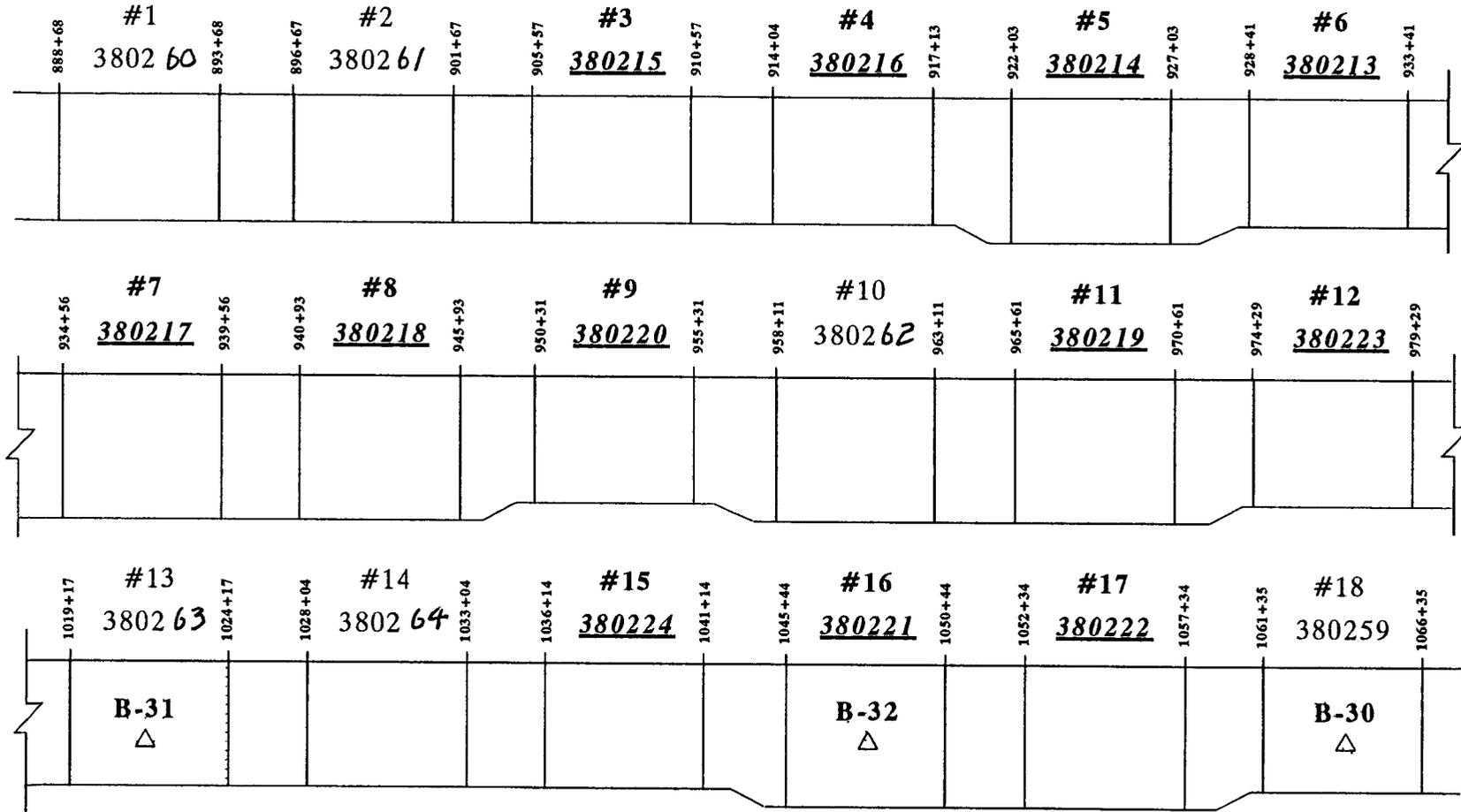


Direction of Traffic →

- + Location of Nuclear Moisture/Density Testing on Compacted Dense Graded Aggregate Base (DGAB)
- Δ Bulk Sampling of Uncompact Dense Graded Aggregate Base (DGAB)
- ▭ Sections with Dense Graded Aggregate Base (DGAB)
- 3802** LTPP Sections



Equation: 916+85.7 Behind =
914+94.4 Ahead



Direction of Traffic →

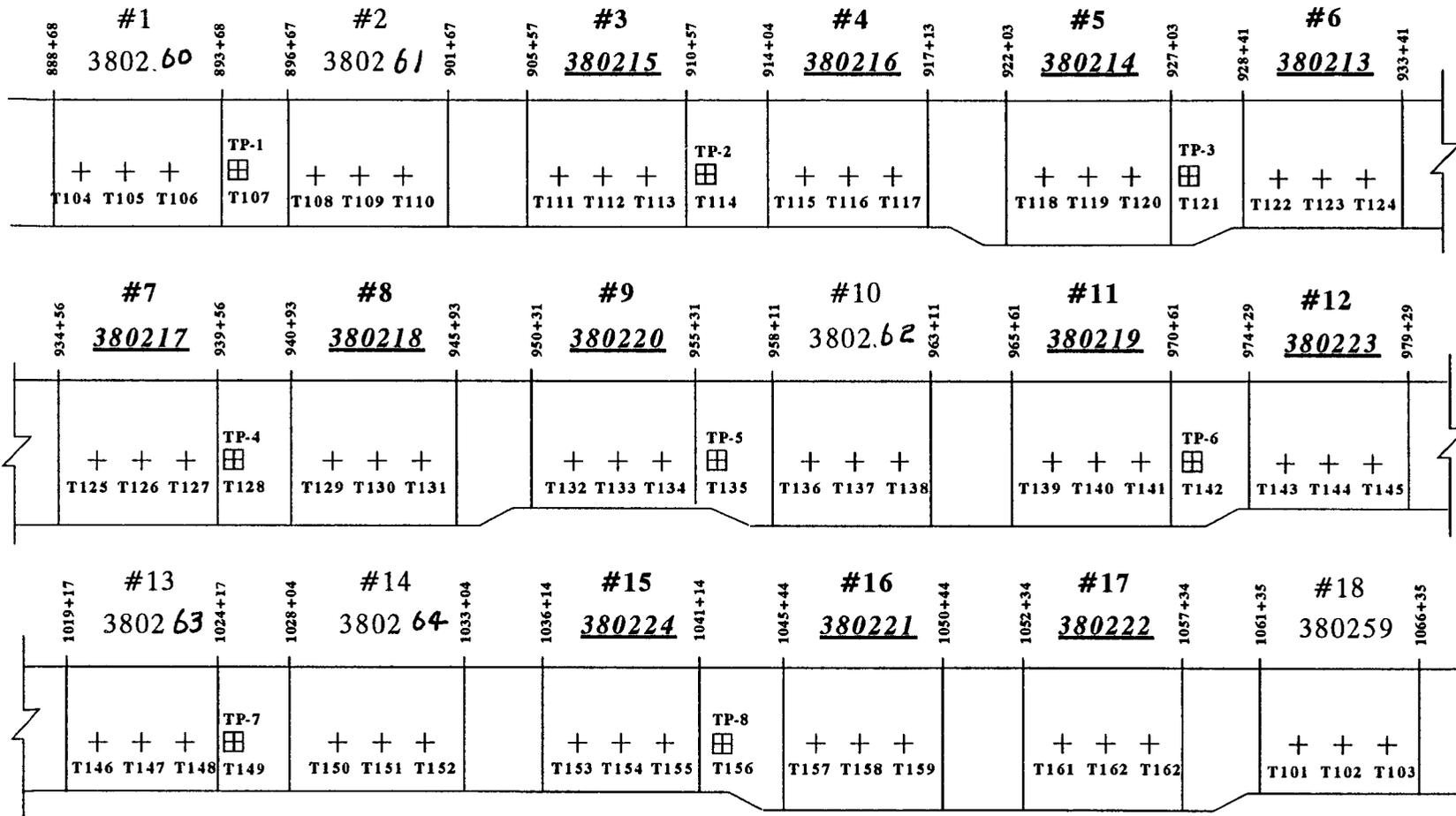
- △ Bulk Sampling of Permeable Asphalt Treated Base (PATB)
- Sections with Permeable Asphalt Treated Base (PATB)
- 3802** LTPP Sections

North Dakota SPS-2, I-94 EB Lane
Sampling and Testing Locations for Permeable Asphalt Treated Base (PATB)

Attachment C



Equation: 916+85.7 Behind =
914+94.4 Ahead

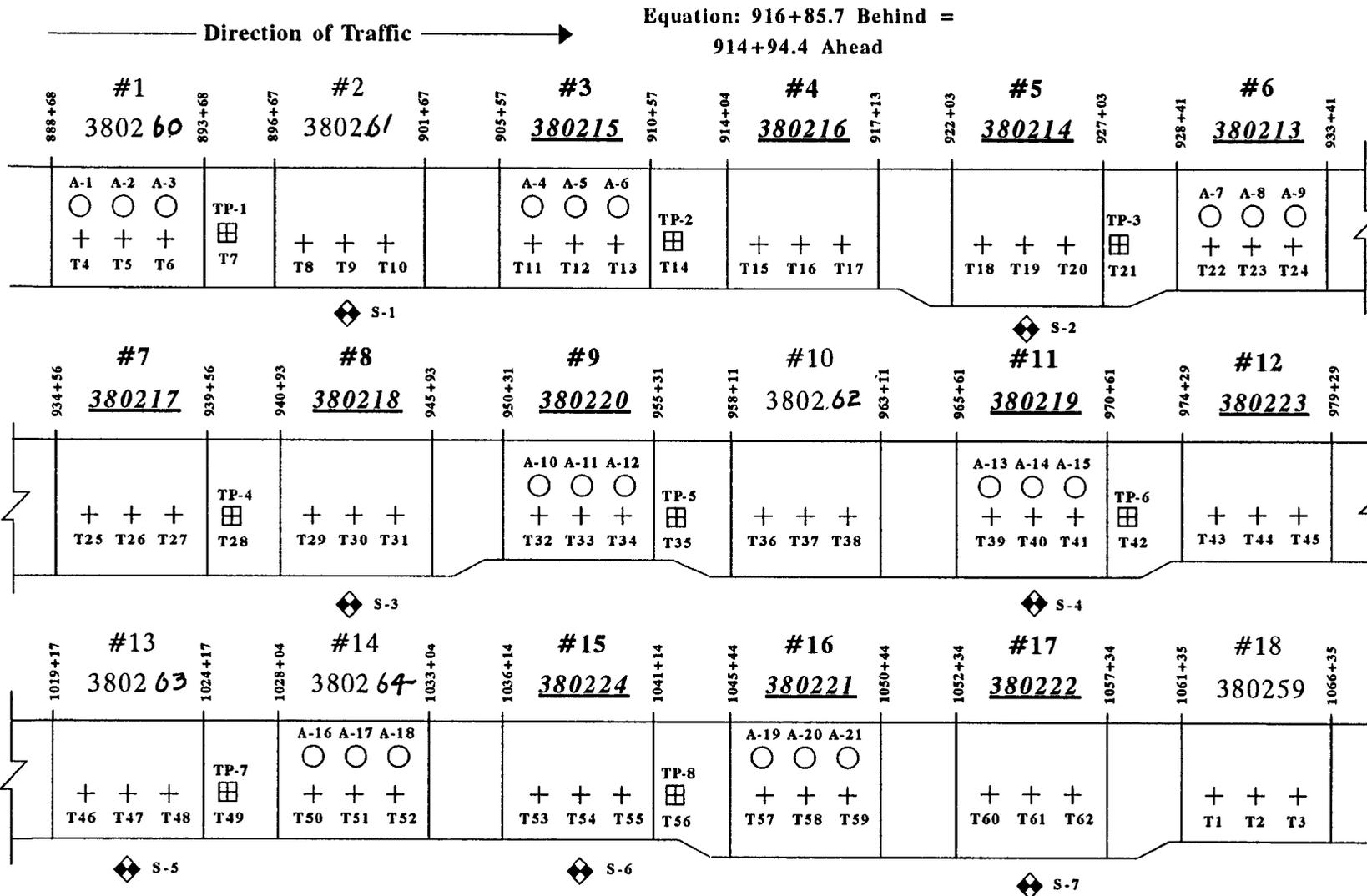


————— Direction of Traffic —————→

- + Location of Nuclear Moisture/Density Testing on Prepared Embankment (T101-T162)
- Test Pit Bulk Sampling of Prepared Embankment (TP1-TP8)
- 3802** LTPP Sections



North Dakota SPS-2, I-94 EB Lane
Sampling and Testing Locations for Prepared Embankment
Attachment C



- + Location of Nuclear Moisture/Density Testing on Subgrade (T1-T62)
- Test Pit Bulk Sampling of Subgrade (TP1-TP8)
- Thin-Wall Tube/Splitspoon Sampling to 1.2m (4ft) Below Top of Subgrade (A1-A21)
- ◆ Shoulder Probe (S1-S7)
- 3802** LTPP Sections

North Dakota SPS-2, I-94 EB Lane
Sampling and Testing Locations for Subgrade
Attachment C



Attachment F

Pavement/Base Thickness Summary

Section Number		Base								PCC Pavement Surface							Cost Per Lane Mile	
SHRP	DOT	Type	Thickness						Width (Feet)	Design	Rod and Level			Core Results				
			Design	Rod and Level			Core Results				High	Low	Average	High	Low	Average		
				High	Low	Average	High	Low										Average
380260	1	DGAB	6"	6.1	5.9	5.8				12	11"	11.2	10.6	10.9	11.3	10.8	11.1	549,000
380261	2	DGAB	6"	6.6	5.6	6.2				12	11"	11.4	10.6	11.0	11.1	10.8	11.0	555,000
380215	3	DGAB	6"	6.6	5.9	6.3				12	11"	11.4	10.4	11.0	10.9	10.9	10.9	555,000
380216	4	DGAB	6"	6.6	5.8	6.2				14	11"	11.5	10.7	11.2	11.3	11.1	11.2	730,000
380214	5	DGAB	6"	6.6	5.6	6.1				12	8"	8.4	7.7	8.1	8.0	7.9	8.0	571,000
380213	6	DGAB	6"	6.4	5.5	5.7				14	8"	8.4	7.7	8.0	8.5	7.9	8.2	454,000
380217	7	LCB	6"	6.9	6.0	6.5	6.3	6.3	6.3	14	8"	8.2	7.6	7.8	8.0	7.9	7.9	527,000
380217	8	LCB	6"	6.9	6.1	6.6	6.8	6.6	6.7	12	8"	8.4	7.7	7.9	7.9	7.8	7.9	644,000
380220	9	LCB	6"	6.9	6.0	6.6	7.0	6.4	6.7	14	11"	11.5	10.6	11.0	11.0	10.8	10.9	802,000
380262	10	LCB	6"	6.9	5.8	6.4	6.7	6.5	6.6	14	11"	11.3	10.7	11.0	11.1	10.9	11.0	628,000
380219	11	LCB	6"	6.8	5.9	6.3	6.9	6.1	6.5	12	11"	11.3	10.6	10.9	11.0	10.8	10.9	628,000
380223	12	PATB	4"	4.3	3.7	4.1				12	11"	11.5	10.8	11.2	11.3	10.9	11.2	634,000
		DGAB	4"	4.4	3.6	4.1												
380263	13	PATB	4"	4.2	3.5	3.8				12	11"	11.4	10.7	11.3	10.9	10.7	10.8	634,000
		DGAB	4"	4.3	3.8	4.0												
380264	14	PATB	4"	4.4	3.6	3.8				12	11"	11.5	11.0	11.3	11.2	10.8	11.0	622,000
		DGAB	4"	4.3	3.8	4.1												
380224	15	PATB	4"	4.4	3.6	4.0				14	11"	11.5	10.6	11.0	10.9	10.7	10.8	809,000
		DGAB	4"	4.4	3.7	4.0												
380221	16	PATB	4"	4.4	3.6	4.1				14	8"	8.3	7.4	7.9	8.2	8.1	8.1	534,000
		DGAB	4"	4.3	3.8	4.1												
380222	17	PATB	4"	4.2	3.7	4.0				12	8"	8.4	7.6	8.0	8.2	8.1	8.2	651,000
		DGAB	4"	4.4	3.6	3.9												
380259	18	PASB	4"	4.4	3.7	4.0				12	10"	10.5	9.8	10.2	10.5	10.3	10.4	488,000
		Salvaged Base	8"	8.3	7.7	8.0												

Highlighted areas = thickness vary more than .04 feet from design.

Attachment G

Concrete Base Mix Designs



MIDWEST TESTING LABORATORY



4102 - 7TH Ave. N. / P.O. Box 3042 / Fargo, North Dakota 58108
Phone (701) 282-9633 / Fax. (701) 282-9635

REPORT OF: TRIAL BATCH MIXES

PROJECT: IM-8-094-(005)331
I-94
Mapleton, North Dakota

DATE: June 29, 1994

REPORTED TO: Attn: Stephen Gerster
Progressive Contractors, Inc.
8736 Zachary Lane
P.O. Box 407
Osseo, MN 55369

COPIES:

PROJECT NO: 7041

LEAD
CONCRETE

SPECIFICATIONS:

Compressive Strength @ 7 Days	500 to 750 psi
Size of Coarse Aggregate	ND/DOT Size #3
Slump (in.)	1-3
Air Content (%)	4-9%

TRIAL BATCH MATERIALS:

Fly Ash	Class "C", NSP Highbridge Plant, furnished by National Minerals Corporation.
Cement	Type 1 Portland meeting ASTM C150, Alpena, furnished by LaFarge Corporation.
Fine Aggregate	#4 down sand furnished by Kost Bros., Inc., Pit #31, Felton, MN.
Coarse Aggregate	1"-#4 gravel (ND Size 3) furnished by Kost Bros., Inc., Pit #31, Felton, MN.
Admixture	Extra Strength Air Entraining meeting ASTM C260 furnished by Construction Materials, Inc.

REMARKS:

The following batch weights are on a saturated surface dry basis and were adjusted based on the amount of moisture in the aggregate at the time of batching.



MIDWEST TESTING LABORATORY

4102 - 7TH Ave. N. / P.O. Box 3042 / Fargo, North Dakota 58108
Phone (701) 282-9633 / Fax. (701) 282-9635



REPORT OF: CONCRETE TRIAL BATCH MIX DESIGNS

PROJECT: IM-8-094-(005)331 DATE: August 11, 1994
 I-94
 Mapleton, North Dakota

REPORTED TO: Attn: Stephen Gerster
 Progressive Contractors, Inc. COPIES:
 8736 Zachary Lane
 P.O. Box 407
 Osseo, MN 55369

PROJECT NO: 7041

SPECIFICATIONS:

Flexural Strength @ 14 Days (psi)	550 to 60
Size of Coarse Aggregate	ND/DOT Size #3
Slump (in.)	2½" Max.
Air Content (%)	5-8% (Assumed)

TRIAL BATCH MATERIALS:

Fly Ash	Class "C", NSP Highbridge Plant, furnished by National Minerals Corporation.
Cement	Type 1 Portland meeting ASTM C150, Alpena, furnished by LaFarge Corporation.
Fine Aggregate	#4 down sand furnished by Kost Bros., Inc., Pit #31, Felton, MN.
Coarse Aggregate	ND/DOT Size #3 furnished by Kost Bros., Inc., Pit #31, Felton, MN.
Admixture	Extra Strength Air Entraining meeting ASTM C260 furnished by Construction Materials, Inc.

REMARKS:

The batch weights as shown on the following trial batch mix designs are on a saturated surface dry basis and were adjusted according to the amount of moisture in the aggregate at the time of batching. Flexural strength specimens of six inch width, six inch depth, and 21 inch length were prepared and tested in accordance with ASTM C78 "Flexural Strength of Concrete" (using simple beam with third point loading), by Midwest Testing Laboratory.

SPS-2 MIX DESIGNS

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

9/29/94

SHRP SECTIONS MIX DESIGN

550 PSI CONCRETE *

Fly Ash 56.4 Lbs.
Cement 319.6 Lbs.
Water 168.6 Lbs.
Sand Aggregate 1399.0 Lbs.
Rock Aggregate 2007.0 Lbs.

Total Weight 3950.6 Lbs.

900 PSI CONCRETE *

Fly Ash 116.0 Lbs.
Cement 660.0 Lbs.
Water 250.0 Lbs.
Sand Aggregate 960.0 Lbs.
Rock Aggregate 2000.0 Lbs.

Total Weight 3986.0 Lbs.

LEAN BASE CONCRETE 500 PSI**

Fly Ash 81.5 Lbs.
Cement 189.5 Lbs.
Water 285.0 Lbs.
Sand Aggregate 2260.0 Lbs.
Rock Aggregate 995.0 Lbs.

Total Weight 3811.0 Lbs.

500 PSI AE-3 CONCRETE**

Fly Ash 112.8 Lbs.
Cement 479.4 Lbs.
Water 262.4 Lbs.
Sand Aggregate 1217.0 Lbs.
Rock Aggregate 1825.5 Lbs.

Total Weight 3897.1 Lbs.

* Flexural Strength (14 Day)

** Compressive Strength (7 Day)

All air based on 6.0

Location: Project File
District File

DIST.

North Dakota Department of Transportation
CONCRETE PROPORTION DESIGN

PROJECT: IM8094005331

CONTRACTOR: PCI

TYPE OF WORK: PCC Paving

DESIGN NO.: 0 DATE: 09/19/94 CLASS OF CONCRETE: AE-3

TYPE & BRAND OF CEMENT: ND Type II

SOURCES: Cement Lafarge ; Sand 32-142-45 ; Rock 32-142-45

SPECIFIC GRAVITIES:

Gc= 3.15 (Cement); Gfa= 2.67 (Flyash); Gs= 2.67 (Sand); Gr= 2.72 (Rock)*
*(Combine if two rock sizes)

PERCENT OF TOTAL AGGREGATE (by weight):

S= 40% Sand; Ra= 60 % Size 3 Rock; Rb= 0 % Size Rock

CALCULATIONS: (for 27 C.F. Batch Size)

PROPORTIONS	LBS/BATCH		C.F.
CEMENT: (94lbs/Sack) x (6.0 Sacks/C.Y.) x (27 /27) adjusted to 5.1 Sacks/C.Y. for Flyash	= 479.40	C=	2.44
FLYASH: 20 % Flyash used	112.80	FA=	0.68
WATER: (5.2 Gal/Sack) x (0.33) x 6.3 Sacks Cement/C.Y. (includes free moisture in aggregates & flyash if any)	= 272.89	W=	4.37
6 % (assumed entrained air in mix)	XXXXXX	A=	1.62

Wt., T= 3014.24 Absolute Volume, V, of Total Aggregate V= 17.89
Combined Specific Gravity of Total Aggregate Gsr= 2.70

D, Dry Wt.	= 1205.69	S=	7.24
ROCK, Size 3, Dry Wt.	= 1808.54	R=	10.66
ROCK, Size , Dry Wt.	= 0		

TOTAL WEIGHT PER BATCH = 3879.33 BATCH SIZE = 27.00

CALCULATED UNIT WEIGHT = 143.67 lbs/C.F.


Engineer

tribution: Project File
District File

North Dakota Department of Transportation
CONCRETE PROPORTION DESIGN

PROJECT: IM8094005331
TYPE OF WORK: PCC Paving

CONTRACTOR: PCI

DESIGN NO.: 0 DATE: 09/19/94 CLASS OF CONCRETE: AE-3

& BRAND OF CEMENT: ND Type II

SOURCES: Cement Lafarge ; Sand 32-142-45 ; Rock 32-142-45

SPECIFIC GRAVITIES:

Gc= 3.15 (Cement); Gfa= 2.67 (Flyash); Gs= 2.67 (Sand); Gr= 2.72 (Rock)*
*(Combine if two rock sizes)

PERCENT OF TOTAL AGGREGATE (by weight):

S= 40% Sand; Ra= 60 % Size 3 Rock; Rb= 0 % Size Rock

CALCULATIONS: (for 27 C.F. Batch Size)

PROPORTIONS		LBS/BATCH		C.F.
CEMENT:	(94lbs/Sack) x (6.0 Sacks/C.Y.) x (27 /27) Adjusted to 5.1 Sacks/C.Y. for Flyash	= 479.40	C=	2.44
FLYASH:	20 % Flyash used	112.80	FA=	0.68
WATER:	(4.7 Gal/Sack) x (8.33) x 6.3 Sacks Cement/C.Y. (includes free moisture in aggregates & flyash if any)	= 246.65	W=	3.95
	6 % (assumed entrained air in mix)	XXXXXX	A=	1.62
Wt., T= 3085.08		Absolute Volume, V, of Total Aggregate		V= 18.31
		Combined Specific Gravity of Total Aggregate		Gsr= 2.70
, Dry Wt.		= 1234.03	S=	7.41
ROCK, Size 3, Dry Wt.		= 1851.05	R=	10.91
ROCK, Size , Dry Wt.		= 0		
TOTAL WEIGHT PER BATCH		= 3923.93	BATCH SIZE =	27.00

CALCULATED UNIT WEIGHT = 145.32 lbs/C.F.


Engineer

Job: Project File
District File

North Dakota Department of Transportation
CONCRETE PROPORTION DESIGN

PROJECT: IM8094005331 CONTRACTOR: PCI
TYPE OF WORK: PCC Paving

DESIGN NO.: 0 DATE: 09/19/94 CLASS OF CONCRETE: AE-3

TYPE & BRAND OF CEMENT: ND Type II

SOURCES: Cement Lafarge ; Sand 32-142-45 ; Rock 32-142-45

SPECIFIC GRAVITIES:
Gc= 3.15 (Cement); Gfa= 2.67 (Flyash); Gs= 2.67 (Sand); Gr= 2.72 (Rock)*
*(Combine if two rock sizes)

PERCENT OF TOTAL AGGREGATE (by weight):
S= 40% Sand; Ra= 60 % Size 3 Rock; Rb= 0 % Size Rock

CALCULATIONS: (for 27 C.F. Batch Size)

PROPORTIONS		LBS/BATCH		C.F.
CEMENT:	(94lbs/Sack) x (6.0 Sacks/C.Y.) x (27 /27) Adjusted to 5.1 Sacks/C.Y. for Flyash	= 479.40	C=	2.44
FLYASH:	20 % Flyash used	112.80	FA=	0.68
WATER:	(5.0 Gal/Sack) x (8.33) x 6.3 Sacks Cement/C.Y. (includes free moisture in aggregates & flyash if any)	= 262.40	W=	4.21
	6 % (assumed entrained air in mix)	XXXXXX	A=	1.62
t., T= 3042.57		Absolute Volume, V, of Total Aggregate		V= 18.06
		Combined Specific Gravity of Total Aggregate		Gsr= 2.70
, Dry Wt.		= 1217.03	S=	7.30
ROCK, Size 3, Dry Wt.		= 1825.54	R=	10.76
Size , Dry Wt.		= 0		
TOTAL WEIGHT PER BATCH		= 3897.17	BATCH SIZE =	27.00

CALCULATED UNIT WEIGHT = 144.33 lbs/C.F.


Engineer