

LABORATORY EVALUATION
OF TYPE I CEMENT

REPORT 84-3
APRIL 1984

REPORTING ON WORK PLAN 83-C-11

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

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Materials & Research Engineer

Date: 04-10-'84

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ABSTRACT

Several ready-mix concrete producers in the State of Vermont use Type I cement for non-Agency projects. Recently, one producer has requested the option of using Type I on Agency projects. The Vermont Agency of Transportation specifications require the use of Type II cement for all Agency projects.

This report documents the results of comparison testing of Type I and Type II cement. Compressive strength, freeze-thaw durability and heat of hydration were studied. From the test results, the conclusion has been drawn that we continue with the requirement that only Type II cement be used on Agency projects.

INTRODUCTION

Prior to March 1, 1977, the choice of using either Type I or Type II cement on Agency of Transportation projects was generally left to individual ready-mixed concrete producers. Only on projects involving large box culverts was cement use restricted to Type II.

Frequent problems, encountered when Type I cement was used, led to its deletion from specifications in the General Special Provisions For All Projects dated March 1, 1977. Concrete containing Type I cement displayed rapid strength development at early ages with little or no strength gain between 14 days and 28 days. This often produced 28 day results below anticipated or required strengths.

Many ready-mix concrete producers serving Vermont have multiple cement storage facilities at their plants. This allows them to offer customers some variety in the brands or types of cement which they may use. Producers with single cement storage capability must provide only one brand of Type II cement if they are to supply concrete to Agency projects.

This investigation was initiated at the request of William E. Dailey, Inc., Shaftsbury, Vermont. Dailey's indicated they used mostly Type I cement in their business and would like the Agency of Transportation to consider using this material.

Trial mixes were prepared using locally obtained materials, and laboratory tests conducted to compare the performance of Type I cement with the performance of Type II cement. Compressive strength, freeze-thaw durability, and heat of hydration were studied.

MATERIALS

The materials used in this investigation are as follows:

Cement:

Type I and Type II, Glens Falls Portland Cement Company, Inc.
Glens Falls, New York

Aggregates:

- (a) Coarse Aggregate,
3/4" Crushed Igneous Stone, Cooley Asphalt Paving Corporation
Websterville, Vermont
- (b) Fine Aggregate,
Albert S. Nadeau, Johnson, Vermont

Admixtures:

- (a) Air Entraining Admixture,
Darex AEA, W. R. Grace & Co., Cambridge, Massachusetts
- (b) Water Reducing Admixture
WRDA with Hycol, W. R. Grace & Co., Cambridge, Massachusetts

PROCEDURES

Concrete used in this investigation was prepared in the laboratory in a Sears 1½ cu. ft. mixer, following procedures outlined in AASHTO T 126-76. Two batches each of Class A and Class B concrete were prepared, using the Type I cement and two batches of each class of concrete were prepared, using the Type II cement.

Tests were performed on the plastic concrete to determine Slump (AASHTO T 119-82), Air Content (AASHTO T 152-82) and Unit Weight (AASHTO T 121-82). Six test cylinders (6" x 12") and one 3" w x 3" d x 16" 1 freeze-thaw specimen were cast from each batch. The cylinders were tested for compressive strength, two each, at ages 7, 14 and 28 days, in accordance with AASHTO T 22-82. The freeze-thaw specimens were moist cured for 14 days, after which they were subjected to 500 cycles of freezing and thawing in a 3% NaCl solution, in accordance with AASHTO T 161-82.

An additional 1 cu. ft. batch of Class A concrete containing Type I cement and an additional 1 cu. ft. batch of Class A concrete containing Type II cement were prepared to compare heat of hydration. The batches were placed in plastic containers, and then stored in separate covered enclosures. Thermometers embedded in the concrete were monitored periodically during the early curing period.

RESULTS

Results of physical tests of the Type I and Type II cement are shown on Laboratory Reports Nos. C83 0023 and C83 0028 in Appendix A.

Aggregate test results are shown on Laboratory Reports Nos. G83 0018 and G83 0019 in Appendix B.

The results of tests on the fresh and hardened concrete are shown in Table 1 and Table 2.

TABLE 1
CLASS A CONCRETE TEST RESULTS

	Type I Cement		Type II Cement	
	Batch 1	Batch 2	Batch 3	Batch 4
Slump, inches	3	2 3/4	4 1/4	2 1/4
Air Content, percent	3.9	4.1	5.4	3.5
Unit Weight, lbs/ft ³	145.87	145.87	144.96	148.22
Concrete Temperature, °F	76	73	72	70
Compressive Strength, psi				
7 days	4633	4465	4558	5111
14 days	5133	4890	5477	5823
*28 days	5332	5202	6062	6521
Freeze-Thaw Durability				
Weight Loss, percent				
@250 cycles	7.0	7.0	2.8	7.7
@500 cycles	11.1	13.1	3.9	25.2
Durability Factor				
@500 cycles	87.8	74.5	97.9	52.2

*Design Compressive Strength 4000 psi

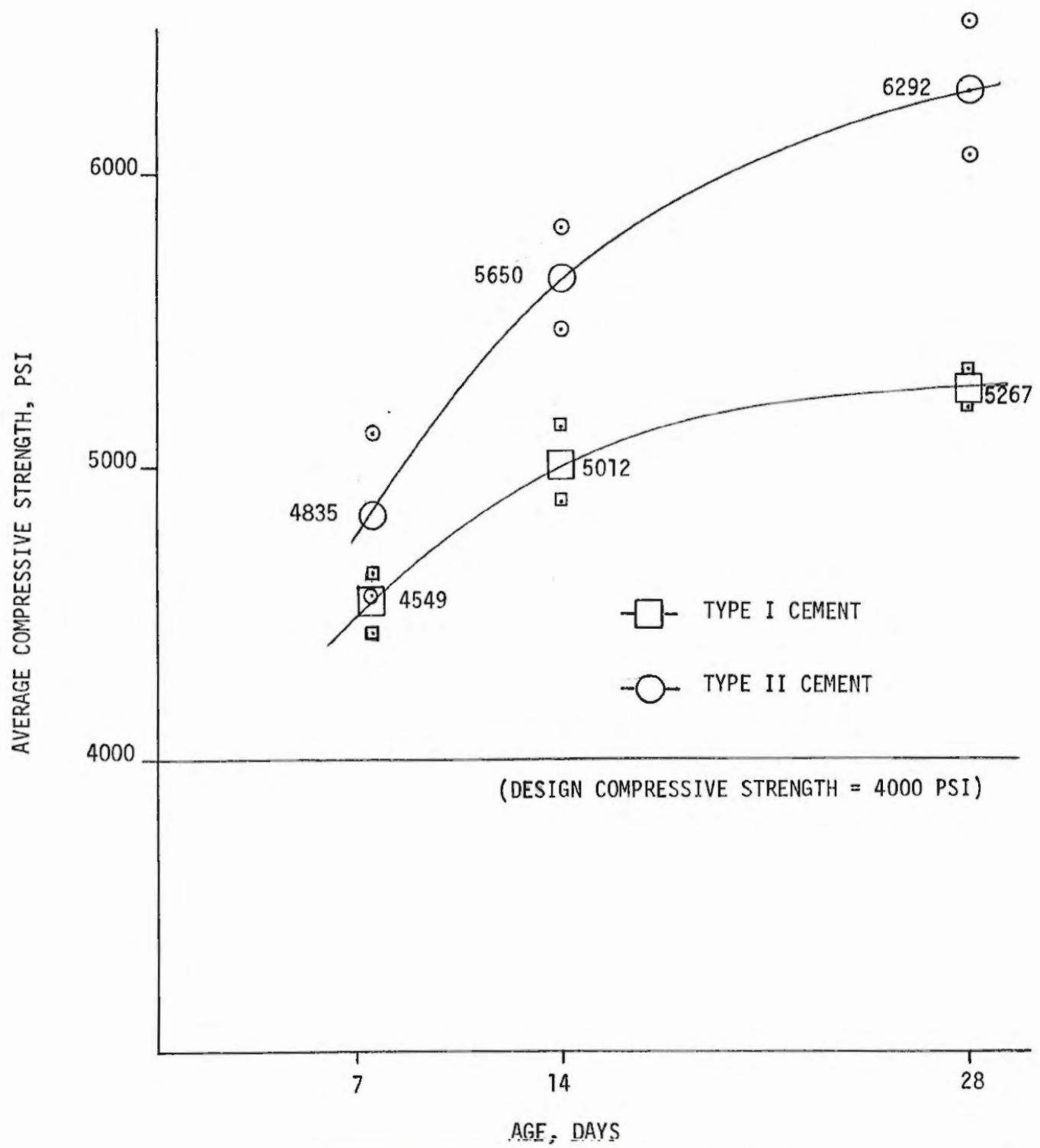
TABLE 2
CLASS B CONCRETE TEST RESULTS

	Type I Cement Batch 5	Type II Cement Batch 6	Type II Cement Batch 7	Type II Cement Batch 8
Slump, inches	2 1/2	3 1/2	3 1/2	3 1/4
Air Content, percent	4.3	5.5	7.3	4.5
Unit Weight, lbs/ft ³	145.82	143.76	141.41	145.78
Concrete Temperature, °F	72	72	70	71
Compressive Strength, psi				
7 days	4302	4226	3501	4143
14 days	4549	4461	4129	5067
*28 days	5098	4912	5001	5752
Freeze-Thaw Durability				
Weight Loss, percent				
@250 cycles	4.5	5.0	1.9	4.2
@500 cycles	6.0	7.4	1.6	7.0
Durability Factor				
@500 cycles	95.8	87.8	101.4	54.9

*Design Compressive Strength 3500 psi

The results of compressive strength tests are also shown on Laboratory Reports Nos. C83 0037 through C83 0044 in Appendix C. Strength age plots illustrating average compressive strengths are shown in Figure I and Figure II.

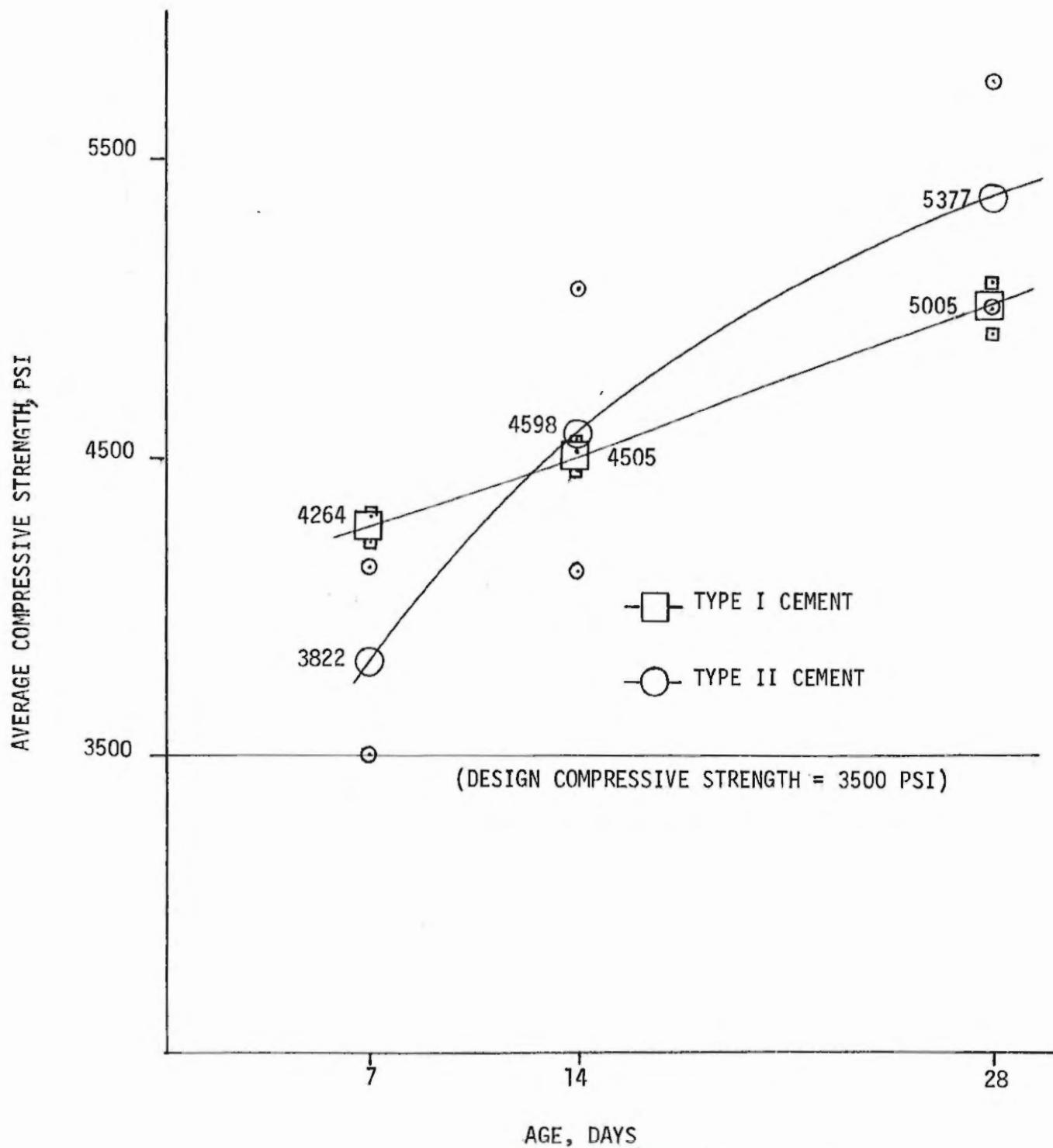
A temperature age graph shown in Figure III indicates differences in the heat of hydration of the two cements.



AVERAGE COMPRESSIVE STRENGTH VS AGE

CLASS A

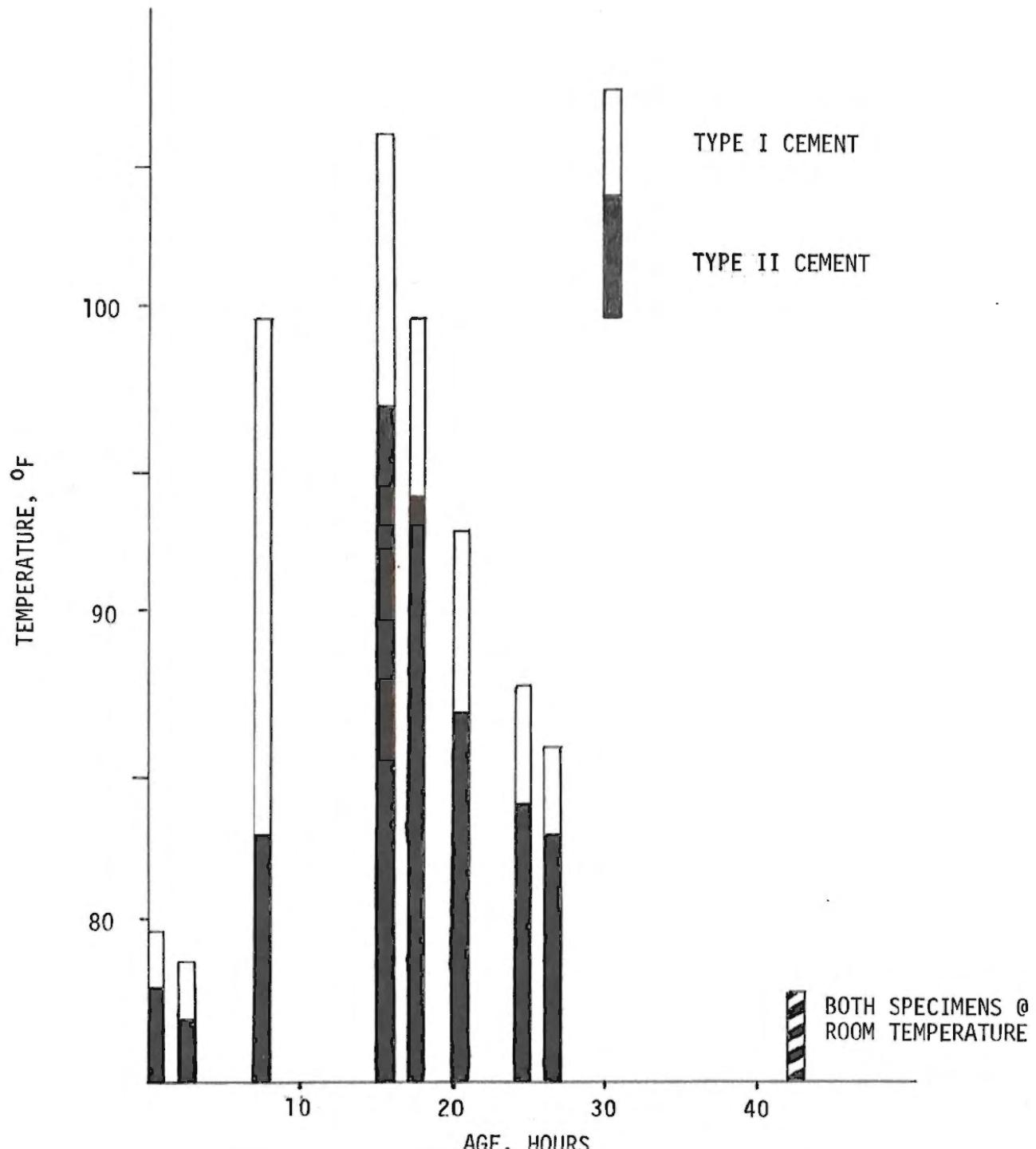
FIGURE I



AVERAGE COMPRESSIVE STRENGTH VS AGE

CLASS B

FIGURE II



TEMPERATURE VS TIME, CLASS A CONCRETE

TYPE I CEMENT & TYPE II CEMENT

FIGURE III

SUMMARY & CONCLUSIONS

1. While compressive strengths were approximately equal for both types of cement at 7 days, the Type II cement produced generally much higher strengths at 14 days and 28 days. One exception, Batch No. 7 Class B concrete containing Type II cement, had an air content of 7.3%, which apparently caused the lower strengths in that batch.
2. The heat of hydration study shows that, during the early curing period, Type I cement generates heat at a faster rate and attains a higher temperature than the Type II cement. Some undesirable effects on concrete due to the higher temperatures may be: decreased strength, decreased durability, and increased tendency for drying shrinkage and differential thermal cracking.
3. Testing in this evaluation was conducted at normal laboratory temperature and humidity levels. Conditions of higher summertime temperatures and long haul distances can be expected to aggravate strength and temperature problems shown in 1 and 2 above.
4. Wide variations in freeze-thaw test results, both weight loss and dynamic testing, appear to be caused more by the air content of the concrete than by the type of cement.

RECOMMENDATION

Specifications requiring the use of Type II cement, "unless otherwise indicated on the plans or approved by the Engineer", should be retained as currently written. Requests for using other types of cement should be examined on a project by project basis, with consideration for approval based upon Agency of Transportation needs and priorities.

Project Name

.....WP No. 83-C-11.....
Project NumberMATERIALS AND RESEARCH DIVISION
MONTPELIER, VERMONT 05602APPENDIX A

REPORT ON SAMPLE OF PORTLAND CEMENT

Report 4-8 1983Laboratory No. C83 0023Tested By EatonName Portland Cement Type II Item 501Identification Marks Preliminary SampleSubmitted by Morissette Title PFP Address Sampled 3-23, 1983 Received , 19Sampled From Bag (Lot CIC)Quantity Represented Source of Material Glens Falls Cement Co., Glens Falls, N.Y.Location Used or to be Used Laboratory mixExamined For 701.01TEST RESULTSPHYSICAL TESTSAir Content of mortar, percent by volume 9.7Fineness-Specific Surface, Sq. cm. per gm..... 3987Soundness-Autoclave Expansion, percent.. 0.00Normal Consistency-Vicat Needle..... 25.5

Time of Setting-Gillmore Needle:

Initial 3 Hrs. 00 Mins.
Final 4 Hrs. 40 Mins.CHEMICAL TESTS

Loss on ignition, percent.....

Insoluble residue, percent.....

Sulphuric Amhydride (SO_3), percent.....Magnesia (MgO), percent.....COMPRESSIVE STRENGTH

This material meets requirements for the tests indicated for item 701.01.

3 days

Cube No. 1..... 2825 psi
Cube No. 2..... 2875 psi
Cube No. 3..... 2900 psiAverage: 2870 psi

7 days

Cube No. 4..... 3888 psi
Cube No. 5..... 3800 psi
Cube No. 6..... 3900 psiAverage: 3860 psiACCEPTED

S. J. Gago, P.E., Chief Engineer

R. F. Nicholson /RAT

By:

R. F. Nicholson, P.E., Materials & Research Engineer

Form 108 Rev. 9/70

Date:

STATE OF VERMONT
AGENCY OF TRANSPORTATIONI
Jarvis
C7Work Plan No. 83-C-11
Project NumberMATERIALS AND RESEARCH DIVISION
MONTPELIER, VERMONT 05602APPENDIX A

REPORT ON SAMPLE OF PORTLAND CEMENT

Report 4-21 19 83

Laboratory No. 083 0028

Tested By Eaton

Name Portland Cement, Type I. Item 501

Identification Marks Preliminary Sample

Submitted by Morissette Title PFP Address

Sampled 3-24, 19 83 Received 3-25, 19 83

Sampled From #38 Tanker @ S. T. Griswold, Williston, Vt.

Quantity Represented

Source of Material Glens Falls Cement Co., Glens Falls, N.Y.

Location Used or to be Used Laboratory Mixes

Examined For 701.01

TEST RESULTSPHYSICAL TESTS

Air Content of mortar, percent by volume 11.0
 Fineness-Specific Surface, Sq. cm. per
 µm..... 4176
 Soundness-Autoclave Expansion, percent.. 0.12
 Normal Consistency-Vicat Needle..... 27.0
 Time of Setting-Gillmore Needle:

Initial	2	Hrs.	00	Mins.
Final	3	Hrs.	50	Mins.

COMPRESSIVE STRENGTH

3 days
 Cube No. 1..... 3188 psi
 Cube No. 2..... 3213 psi
 Cube No. 3..... 3175 psi
 Average: 3190 psi

7 days
 Cube No. 4..... 3650 psi
 Cube No. 5..... 3725 psi
 Cube No. 6..... 3850 psi
 Average: 3740 psi

CHEMICAL TESTS

Loss on ignition, percent.....
 Insoluble residue, percent.....
 Sulphuric Anhydride (SO₃), percent.....
 Magnesia (MgO), percent.....

COMMENTS:

This material was examined for comparison to Type II. The results are as indicated.

S. J. G., P.E., Chief Engineer

R. E. Nicholson - 1983
 By: R. E. Nicholson, P.E., Materials & Research Engineer

STATE OF VERMONT
AGENCY OF TRANSPORTATIONMATERIALS & RESEARCH DIVISION
Montpelier, Vermont 05602APPENDIX B

REPORT ON SAMPLE OF AGGREGATE

Report 3-24, 19 83Laboratory No. G83 0018Tested By MorissetteName Fine Aggregate for Concrete, Item 501Identification Marks Preliminary SampleSubmitted by Morissette Title PFP Address _____Sampled 3-17, 1983 Received 3-17, 1983 Testing Completed: 3-17-83Sample from Stockpile @ Hutch, Montpelier Jct., Vt.

Quantity Represented _____

Source of Material Nadeau, Johnson, Vt.Location used or to be used Work Plan No. 83-C-11Examined for Item 704.01

TEST RESULTS

Total Sample Sieve Size	% Passing	Fineness Modulus % Coarser Than	Percent of Wear
4 1/2"		No. 100	90
4"		No. 50	77
3 1/2"		No. 30	59
3"		No. 16	39
2 1/2"		No. 8	21
2"		No. 4	2
1 3/4"			Fractured Faces, %
1 1/2"			Thin & Elongated Pieces, %
1"			
3/4"			Soundness, % Loss
5/8"			
1/2"			
3/8"	100	Fineness Modulus = <u>2.88</u>	
No. 4	98	Color = -1	
No. 8	79	Comments:	
No. 10		This material meets requirements for the tests indicated for item 704.01.	
No. 16	61	Sand Portion	
No. 30	41		ACCEPTED
No. 50	23		S. J. Gage, P.E., Chief Engineer
No. 100	10		<i>R. F. Nicholson</i> 10/17
No. 200 dry	2.5		By: _____ R. F. Nicholson, P.E., Materials & Research Engineer

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JarvisMATERIALS & RESEARCH DIVISION
Montpelier, Vermont 05602APPENDIX B

REPORT ON SAMPLE OF AGGREGATE

Report 3-24, 19 83Laboratory No. G83 0019Tested By MorissetteName Coarse Aggregate for Concrete, Item 501Identification Marks Preliminary Sample, 3/4" Crushed Igneous StoneSubmitted by Morissette Title PFP Address _____Sampled 3-17, 19 83 Received 3-17, 19 83 Testing Completed: 3-17-83Sample from Stockpile @ Hutch, Montpelier Jct., Vt.

Quantity Represented _____

Source of Material Cooley, Websterville, Vt.Location used or to be used Work Plan No. 83-C-11Examined for 704.02

TEST RESULTS

Total Sample	Fineness Modulus	Percent of Wear
Sieve Size	% Coarser Than	
4 1/2"	No. 100	AASHTO T3 _____
4"	No. 50	AASHTO T4 _____
3 1/2"	No. 30	AASHTO T96 <u>36</u>
3"	No. 16	B Grading
2 1/2"	No. 8	Fractured Faces, % _____
2"	No. 4	
1 3/4"		Thin & Elongated
1 1/2"		Pieces, % <u>1</u>
1"	100	
3/4"	99	Soundness, % Loss _____
5/8"		
1/2"		
3/8"	25	This material meets the requirements for the tests indicated
No. 4	4	for 704.02.
No. 8	3	
No. 10		
No. 16		
No. 30		
No. 50		
No. 100		
No. 200		

Sand
Portion

ACCEPTED

S. J. Gagn, P.E., Chief Engineer

By: R.F. Nicholson / R.F.N.
R. F. Nicholson, P.E., Materials & Research Engineer

Project Name

STATE OF VERMONT
AGENCY OF TRANSPORTATION

2
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CF

W.P. 83-C-11

Project Number

MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C83 0041 (28) Report of 7, 14, 28 Day Breaks Date typed 4-27-83Pay Item 501.20, Class A Type of Sample InvestigatorySubmitted by Morissette Title PFP Address Source of Material Materials & Research Lab Quantity Represented 1 1/2 cfCoarse Aggregate Cooley - Websterville Fine Aggregate Nadeau, JohnsonCement Brand Glens Falls Type I Lbs. 660Air Entraining Admixture Darex AEA Dosage 5 1/2 oz/cy Admixture WRDA Hycol Dosage 3 oz/cwtMaximum allowable water content, Gal/Cy Total Aggregate, Dry Wgt. 2830Field Tested by Morissette Lab. Tested by EatonSampled from 1 1/2 cf Sears Mixer Date Sampled: 3-30-83Location Used or to be Used Laboratory evaluation of Type I cement Batch 1Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

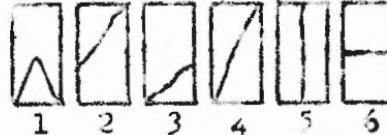
Unit Weight Fresh Concrete 145.37 Air: Pressure 3.9% Chace Total Water, Gal/Cy Used 33.3 Slump 3 Temperature, Concrete 76° F Ambient

Specimen No.	Cyl. Unit Wgt. P.C.F.	Date Rec'd	Date Broken	Desired age at break	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break 1	Break 2
IA1 1	146		4-6	1	7	S	4615	4651	4633		
IA1 2	146										
IA1 3	147										
IA1 4	147		4-13	14	14	S	5173	5093	5133		
IA1 5	145										
IA1 6	147		4-27	28	28	S	5349	5314	5332		

*S = Standard Cured; F = Field Cured

Types of Breaks:

mlm

Comments:
TA 13th Rev.
2M 1/81

S. J. Gage, P.E., Chief Engineer

By: *R.H. Richardson* 10/17
R. H. Richardson, Civil Engineer & Project Manager

Project Name

STATE OF VERMONT
AGENCY OF TRANSPORTATION

W.P. 83-C-11

Project Number

MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 056022
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CF

APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. 083 0042 (28) Report of 7, 14, 28 Day Breaks Date typed 4-27-83

Pay Item 501.20 Class A Type of Sample Investigatory

Submitted by Morissette Title PFP Address

Source of Material Materials & Research Lab Quantity Represented 1 1/2 cf

Coarse Aggregate Cooley - Websterville Fine Aggregate Nadeau - Johnson

Cement Brand Glens Falls Type I Lbs. 660

Air Entraining Admixture Darez AEA Dosage 9 oz/cy Admixture WRDA Hycol Dosage 3 oz/cwt

Maximum allowable water content, Gal/Cy Total Aggregate, Dry Wgt. 2839

Field Tested by Morissette Lab. Tested by Eaton

Sampled from 1 1/2 cf Sears mixer Date Sampled: 3-30-83

Location Used or to be Used Laboratory evaluation of Type I cement Batch 2

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

Unit Weight Fresh Concrete 145.87 Air: Pressure 4.1 Chace

Total Water, Gal/Cy Used 35.2 Slump 2 3/4 Temperature, Concrete 73°F Ambient

Specimen No.	Cyl. Unit Wgt. P.C.F.	Date Rec'd	Date Broken	Desired age at break	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break Type 1	Break Type 2
1A2 1	145										
2	146		4-6	7	7	S	4368	4562	4465		
3	146										
4	145		4-13	14	14	S	4925	4854	4890		
5	146										
6	146		4-27	28	28	S	5305	5199	5202		

*S = Standard Cured; F = Field Cured

Types of Breaks:



mlm

Comments:
TA 183H Rev.
2M 4/81

S. J. Gage, P.E., Chief Engineer

R. F. Nicholson /RAF
By: _____
R. F. Nicholson, P.E., Materials & Research Engineer

Project Name

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AGENCY OF TRANSPORTATION2
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W.P. 83-C-11

PROJECT NUMBER
MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

Report on Concrete Test Beam or Cylinders

APPENDIX C

Laboratory No. 083 0043 (28) Report of 7, 14, 28 Day Breaks Date typed 4-27-83

Pay Item 501.20 Class A Type of Sample Investigatory

Submitted by Morissette Title PFP Address

Source of Material Materials & Research Lab Quantity Represented 1 1/2 cf

Coarse Aggregate Cooley - Websterville Fine Aggregate Nadeau - Johnson

Cement Brand Glens Falls Type II Lbs. 660

Air Entraining Admixture Darex AEA Dosage 6 oz/cy Admixture WRDA Hycol Dosage 3 oz/cwt

Maximum allowable water content, Gal/Cy Total Aggregate, Dry Wgt. 2839

Field Tested by Morissette Lab. Tested by Eaton

Sampled from 1 1/2 cf Sears Mixer Date Sampled: 3-30-83

Location Used or to be Used Laboratory evaluation of Type I cement Batch 3

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

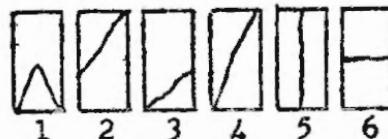
Unit Weight Fresh Concrete 144.96 Air: Pressure 5.4% Chace

Total Water, Gal/Cy Used 33.5 Slump 4 1/4" Temperature, Concrete 72°F Ambient

Specimen No.	Cyl. Unit Wgt. P.C.F.	Date Rec'd	Date Broken	Desired age at break	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break Type 1	Break Type 2
IIA1 1	145		4-6	7	7	S	4615	4501	4558		
IIA1 2	147										
3	146		4-13	14	14	S	5499	5455	5477		
4	146										
5	147		4-27	28	28	S	6234	5889	6062		
6	146										

*S = Standard Cured; F = Field Cured

Types of Breaks:



S. J. Gage, P.E., Chief Engineer

R.J. Nicholson, P.E.
Materials & Research Engineer

Comments:
TA 183H Rev.
2M 4/91

Project Name

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W.P. 83-C-11

MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C83 0044 (28) Report of 7, 14, 28 Day Breaks Date typed 4-27-83Pay Item 501.20 Class A Type of Sample InvestigatorySubmitted by Morissette Title PFP Address Source of Material Materials & Research Lab Quantity Represented 1 1/2 cfCoarse Aggregate Cooley - Websterville Fine Aggregate Nadeau - JohnsonCement Brand Glens Falls Type II Lbs. 660Air Entraining Admixture Darex AEA Dosage 6 oz/cy Admixture WRDA Hycoll Dosage 3 oz.cwtMaximum allowable water content, Gal/Cy Total Aggregate, Dry Wgt. 2839Field Tested by Morissette Lab. Tested by EatonSampled from 1 1/2 CF Sears Mixer Date Sampled: 3-30-83Location Used or to be Used Laboratory evaluation of Type I cement Batch 4Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

Unit Weight Fresh Concrete 148.22 Air: Pressure 3.5% Chace Total Water, Gal/Cy Used 31.4 Slump 2 1/4 Temperature, Concrete 70° F Ambient

Specimen No.	Cyl. Unit Wgt. P.C.F.	Date Rec'd	Date Broken	Desired age at break	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break Type 1	Break Type 2
IIA2 1	150		4-16	7	7	S	5022	5199	5111		
2	149										
3	150		4-13	14	14	S	5845	5800	5823		
4	150										
5	149		4-27	28	28	S	6552	6490	6521		
6	150										

*S = Standard Cured; F = Field Cured

Types of Breaks:



mm

S. J. Gage, P.E., Chief Engineer

R.H. Nicholson RAFFComments:
TA 183H Rev.
23-4/81

R. F. [Signature] Materials & Research Engineer

Project Name

STATE OF VERMONT
AGENCY OF TRANSPORTATION

W.P. 83-C-11

2
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Project Number

MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C83 0037 (28) Report of 7 14, 88 Day Breaks Date typed 4-26-83

Pay Item 501.25 Class B Type of Sample Investigatory

Submitted by Morissette Title PFP Address

Source of Material Materials & Research Lab Quantity Represented 1 1/2 cf

Coarse Aggregate Cooley - Websterbille Fine Aggregate Nadeau - Johnson

Cement Brand Glens Falls Type I Lbs. 611

Air Entraining Admixture Darex AEA Dosage 4 oz/cy Admixture WRDA Hycol Dosage 3 oz/cwt

Maximum allowable water content, Gal/Cy Total Aggregate, Dry Wgt. 2981

Field Tested by Morissette Lab. Tested by Eaton

Sampled from 1/2 cf Sears Mixer Date Sampled: 3-29-83

Location Used or to be Used Laboratory Evaluation of Type I Cement Batch 5

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

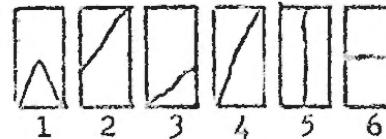
Unit Weight Fresh Concrete 145.82 Air: Pressure 4.3% Chace

Total Water, Gal/Cy Used 33.7 Slump 2 1/2 Temperature, Concrete 72°F Ambient

Specimen No.	Cyl. Unit Wgt. P.C.F.	Date Rec'd	Date Broken	Desired age at break	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break Type 1	Break Type 2
I81 1	145										
2	145		4-5	7	7	S	4297	4306	4302		
3	146										
4	145		4-12	14	14	S	4527	4571	4549		
5	147										
6	145		4-26	28	28	S	5102	5093	5098		

*S = Standard Cured; F = Field Cured

Types of Breaks:



mlm

Comments:
by 13TH Rev.
4-1/21

S. J. Gregg, P.E., Chief Engineer

R. J. Johnson

R. J. Johnson, P.E., Materials & Research Engineer

Project Name

STATE OF VERMONT
AGENCY OF TRANSPORTATION

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W P 83-C-11

Project Number

MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C83 0038 (28) Report of 7, 14, 28 Day Breaks Date typed 4-26-83Pay Item 501.25 Class B Type of Sample InvestigatorySubmitted by Morissette Title PFP Address _____Source of Material Materials & Research Lab Quantity Represented 1 1/2 cfCoarse Aggregate Cooley - Websterville Fine Aggregate Nadeau - JohnsonCement Brand Glens Falls Type I Lbs. 611Air Entraining Admixture Darex AEA Dosage 4 1/4 oz/cy Admixture WRDA Hycol Dosage 3 oz/cwtMaximum allowable water content, Gal/Cy _____ Total Aggregate, Dry Wgt. 2981Field Tested by Morissette Lab. Tested by EatonSampled from 1/2 cf Sears Mixer Date Sampled: 3-29-83Location Used or to be Used Laboratory evaluation of Type I cement Batch 6Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

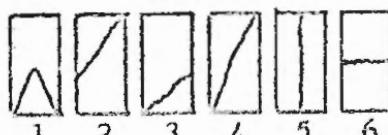
Unit Weight Fresh Concrete 143.76 Air: Pressure 5.5% Chace _____Total Water, Gal/Cy Used 34.5 Slump 3 1/2 Temperature, Concrete 72° F Ambient _____

Specimen No.	Cyl. Unit Wgt. P.C.F.	Date Rec'd	Date Broken	Desired age at break	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break Type 1	Break Type 2
IB2 1	144		4-5	7	7	S	*3254	4226	4226		
IB2 2	144										
3	144		4-12	14	14	S	4465	4456	4451		
4	144										
5	145		4-26	28	28	S	4934	4890	4912		
6	145										

*S = Standard Cured; F = Field Cured

*3254 not used in average

Types of Breaks:



mm

Comments:
1. 183H Rev.
264/31

S. J. Gagné, P.E., Chief Engineer

S. J. Gagné 1/29/83

J. C. MacLean, P.E., Materials & Research Engineer

Project Name

STATE OF VERMONT
AGENCY OF TRANSPORTATION2
Jarvis
CF

WP 83-C-11

Project Number

MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C83 0039 (28) Report of 7, 14, 28 Day Breaks Date typed 4-26-83Pay Item 501.25 Class B Type of Sample InvestigatorySubmitted by Morissette Title PFP Address _____Source of Material Materials & Research Lab Quantity Represented 1 1/2 cfCoarse Aggregate Cooley - Websterville Fine Aggregate Nadeau - JohnsonCement Brand Glens Falls Type II Lbs. 611Air Entraining Admixture Darex AEA Dosage 4 1/2 oz/cy Admixture NRDA Hycold Dosage 3 oz/cwtMaximum allowable water content, Gal/Cy _____ Total Aggregate, Dry Wgt. 2981Field Tested by Morissette Lab. Tested by EatonSampled from 1 1/2 cf Sears Mixer Date Sampled: 3-29-83Location Used or to be Used Laboratory evaluation of Type I cement - Batch 7Examined for Mod. of Rupture Compressive Strength

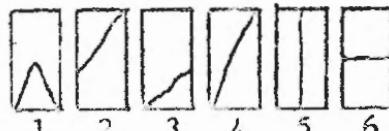
TEST RESULTS

Unit Weight Fresh Concrete 141.41 Air: Pressure 7.3% Chace _____Total Water, Gal/Cy Used 33.4 Slump 3 1/2 Temperature, Concrete 70°F Ambient _____

Specimen No.	Cyl. Unit Wgt. P.C.F.	Date Rec'd	Date Broken	Desired age at break	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break Type 1	Break Type 2
IIB1	1 141			7	7	S	3501	3554	3528		
	2 142		4-5								
	3 141										
	4 143		4-12	14	14	S	4279	3979	4129		
	5 142										
	6 142		4-26	28	28	S	4943	5058	5001		

*S = Standard Cured; F = Field Cured

Types of Breaks:



S. J. Gage, P.E., Chief Engineer

By _____
R. P. Nicholson, P.E., Materials & Research EngineerComments:
AASHTO Rev.
4/1/81

Project Name

WP 83-C-11

STATE OF VERMONT
AGENCY OF TRANSPORTATION

Project Number

MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 056022
Jarvis
cfAPPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C83 0040 (28) Report of 7, 14, 28 Day Breaks Date typed 4-26-83Pay Item 501.25 Class B Type of Sample InvestigatorySubmitted by Morissette Title PFP Address Source of Material Materials & Research Lab Quantity Represented 1 1/2 cfCoarse Aggregate Cooley - Websterville Fine Aggregate Nadeau - JohnsonCement Brand Glens Falls Type II Lbs. 611Air Entraining Admixture D'Arex AEA Dosage 3 oz/cy Admixture WRDA Hycol Dosage 3 oz/cwtMaximum allowable water content, Gal/Cy Total Aggregate, Dry Wgt. 2981Field Tested by Morissette Lab. Tested by EatonSampled from 1 1/2 cf SEars Mixer Date Sampled: 3-29-83Location Used or to be Used Laboratory evaluation of Type I cement Batch 8Examined for Mod. of Rupture Compressive Strength

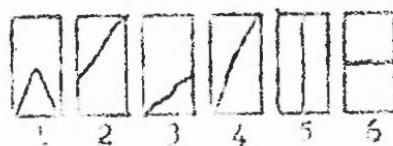
TEST RESULTS

Unit Weight Fresh Concrete 145.78 Air: Pressure 4.5% Chace Total Water, Gal/Cy Used 33.3 Slump 3 1/4" Temperature, Concrete 71°F Ambient

Specimen No.	Cyl. Unit Wgt. P.C.F.	Date Rec'd	Date Broken	Desired age at break	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break Type 1	Break Type 2
I	148										
II82	2 149		4-5	7	7	S	4067	4218	4143		
	3 146										
	4 147		4-12	14	14	S	4969	5164	5067		
	5 148										
	6 146		4-26	28	28	S	5774	5730	5752		

*S = Standard Cured; F = Field Cured

Types of Breaks:



S. J. Gaze, P.E., Chief Engineer

4-26-83

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STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISIONAPPENDIX DRESEARCH INVESTIGATIONWork Plan No. 83-C-11Subject Laboratory Evaluation of Type I CementInvestigation Requested By William E. Dailey, III Date September 14, 1982Date Information Required As soon as possiblePurpose of Investigation To evaluate Type I cement in the laboratory to determine if it should be considered for use on future Agency projects.

Proposed Tests or Evaluation Procedure

Prepare two batches each of Class A and Class B concrete containing Type I cement and two batches each of Class A and Class B concrete containing Type II cement.

Perform tests to determine slump, air content, unit weight, freeze-thaw resistance, and 7, 14 and 28 day compressive strengths.

D. BrownProposal Discussed With R. Frascoia Projected Manpower Requirements 20 man daysInvestigation To Be Conducted By Structural Concrete SubdivisionProposed Starting Date March 21, 1983 Estimated Completion Date June 15, 1983Approval/Disapproval by Materials Engineer R.F. Nichols 3-24-83Comments by Materials Engineer Heat of hydration needs to be investigated.