EVALUATION OF PIKE/WATERFORD FINE AGGREGATE FOR USE IN STRUCTURAL CONCRETE

REPORT 82-2
FEBRUARY 1982

REPORTING ON WORK PLAN 81-C-6

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

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Date: Feb. 22, 1982

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ABSTRACT

As aggregate sources are developed, tests must be conducted to assure that the materials meet specifications and perform satisfactorily when used in concrete mixtures.

This report documents results of tests performed on a proposed source of fine aggregate for structural concrete. The material is a washed natural sand produced by Pike Industries, Incorporated at their facility in Waterford, Vermont.

Results indicate the material performed satisfactorily in all classes of concrete when used in combination with coarse aggregate from Calkins Redimix in Coventry, Vermont. The material also performed satisfactorily in Class B and Class C concrete containing coarse aggregate from Pike Industries in Waterford, Vermont, but did not perform satisfactorily in Class A concrete using the Waterford coarse aggregate.

INTRODUCTION

A request from Pike Industries, Incorporated of Tilton, New Hampshire to approve washed natural concrete sand from their Waterford, Vermont quarry was processed by the Materials and Research Division in the same manner as the evaluation of Pike's coarse aggregate reported on in Report No. 81-9. The evaluation procedure used was "Procedure For The Evaluation Of New Structural Concrete Aggregate Sources To Determine Compliance With A.O.T. Specifications" (PENCAS). This procedure was developed early in 1981 by the Materials and Research Division (see Appendix A for PENCAS). The material was sampled by Materials and Research Division representatives and tested for compliance with Section 704.01 of the standard specifications. Then, according to the PENCAS procedure, compressive strengths of concrete mixtures containing this aggregate were compared to strengths of mixtures containing a reference aggregate. Concrete for the evaluation program was produced at Calkins ready mix concrete plant in Coventry, Vermont, at the request of Pike Industries, Incorporated.

TESTING PROGRAM

PHASE I - SECTION 704.01 TESTS:

Pike/Waterford washed sand was sampled from a stockpile at Pike's quarry in Waterford, Vermont on May 13, 1981 by representatives of the Materials and Research Division. This material was found to comply with the specification requirements for Grading, Organic impurities, Compressive strength of mortar and Soundness. Pike Industries was so informed on June 10, 1981. The reports on Laboratory No. C8100332 and A81-0328, which document these tests, are in Appendix B.

PHASE II - PERFORMANCE-IN-CONCRETE TESTS:

As required by PENCAS, after the aggregate had been tested to determine conformance with Section 700 requirements, it was tested in concrete under field conditions. (Concrete was not produced in the laboratory, because it was felt that information gained from testing the ready mix concrete would be sufficient.) Mixtures were designed by Structural Concrete personnel for Class A, Class B, and Class C concrete using the following materials:

Coarse Aggregate:

A. Reference Aggregate

3/4 inch crushed gravel
Calkins, Coventry, VT

B. Reference Aggregate

3/4 inch crushed stone
Pike Industries, Inc., Waterford, VT

Fine Aggregate:

A. Proposed New Aggregate

Washed Sand
Pike Industries, Inc., Waterford, VT

B. Reference Aggregate

Washed Sand
Calkins, Coventry, VT

Cement:

Type II
Independent Cement Corporation
Joliette, Quebec

Air Entraining Admixture:

Darex AEA
W. R. Grace & Co.
Cambridge, MA

Water Reducing Admixture:

WRDA with Hycol
W. R. Grace & Company
Cambridge, MA

Aggregate properties used for preparing mix designs are shown in Table 1 and Table 2.

TABLE 1
COARSE AGGREGATE PROPERTIES

	Bulk Specific Gravity	Absorption, Percent	Dry Rodded Unit Weight, lbs/ft^3
Reference Aggregate - Calkins/Coventry	2.70	1.3	103.68
Reference Aggregate - Pike/Waterford	2.94	0.5	107.13

TABLE 2
FINE AGGREGATE PROPERTIES

	Bulk Specific Gravity	Absorption, Percent	Fineness Modulus
Reference Aggregate - Calkins/Coventry	2.61	1.6	3.07
New Aggregate - Pike/Waterford	2.68	1.3	2.69

Initial testing for this evaluation took place during the day of August 4, 1981. On that date, batches were prepared for Class A, Class B and Class C concretes using Calkins/Coventry sand and stone in the Reference Aggregate mixes and Pike/Waterford sand and stone in the New Aggregate mixes.

When compressive strengths of both the Reference and the New Aggregate mixes were below anticipated strengths, at 7 days, a second round of testing was planned.

On August 18, 1981, batches were prepared for Class A, Class B and Class C concretes using Calkins/Coventry sand and stone in the Reference Aggregate mixes and Pike/Waterford sand with Calkins/Coventry stone in the New Aggregate mixes.

All concrete used in this evaluation was produced and tested at Calkins Redimix in Coventry, Vermont. Concrete was mixed in a standard truck mixer with batch size being one cubic yard. Moisture content of the aggregates was determined prior to the start of mixing, and aggregate weights were adjusted.

The mix proportions used are shown in Tables 3 and 4 for the August 4, 1981 tests and Tables 5 and 6 for the August 18, 1981 tests.

TABLE 3
REFERENCE AGGREGATE MIX DESIGN
AUGUST 4, 1981 - BATCH QUANTITIES PER CY

	Class A	Class B	Class C
*Calkins Coarse Aggregate, lbs.	1671	1671	1671
*Calkins Fine Aggregate, lbs.	1253	1396	1507
Cement, lbs.	660	611	564
Air Entraining Admixture, oz.	7	6	3
Water Reducing Admixture, oz.	19.8	18.3	17.0
Net Water, gal.	40.1	40.3	41.1

*Weights converted to saturated surface-dry condition.

TABLE 4
NEW AGGREGATE MIX DESIGN
AUGUST 4, 1981 - BATCH QUANTITIES PER CY

	Class A	Class B	Class C
*Pike Coarse Aggregate, lbs.	1831	1831	1831
*Pike Fine Aggregate, lbs.	1260	1407	1521
Cement, lbs.	660	611	564
Air Entraining Admixture, oz.	5	3½	2
Water Reducing Admixture, oz.	19.8	18.3	17.0
Net Water, gal.	42.0	42.5	38.0

*Weights converted to saturated surface-dry condition.

TABLE 5
REFERENCE AGGREGATE MIX DESIGN
AUGUST 18, 1981 - BATCH QUANTITIES PER CY

	Class A	Class B	Class C
*Calkins Coarse Aggregate, lbs.	1671	1671	1671
*Calkins Fine Aggregate, lbs.	1253	1396	1507
Cement, lbs.	660	611	564
Air Entraining Admixture, oz.	6	4½	3
Water Reducing Admixture, oz.	19.8	18.3	17.0
Net Water, gal.	31.1	31.3	34.1

*Weights converted to saturated surface-dry condition.

TABLE 6
NEW AGGREGATE MIX DESIGN
AUGUST 18, 1981 - BATCH QUANTITIES PER CY

	Class A	Class B	Class C
*Calkins Coarse Aggregate, lbs.	1785	1785	1785
*Pike Fine Aggregate, lbs.	1168	1316	1429
Cement, lbs.	660	611	564
Air Entraining Admixture, oz.	5	4	2½
Water Reducing Admixture, oz.	19.8	18.3	17.0
Net Water, gal.	33.1	33.1	33.7

*Weights converted to saturated surface-dry condition.

Tests were performed on the fresh concrete to determine; Slump, Air Content, and Unit Weight/Yield. Six standard 6" Ø x 12" cylinders were prepared from each batch. The cylinders were tested for compressive strength, two each at ages 7, 14, and 28 days. Tests for freeze-thaw durability were not conducted.

RESULTS

The results of tests on the fresh and hardened concrete are shown in Tables 7, 8, 9, and 10.

TABLE 7
REFERENCE AGGREGATES
AUGUST 4, 1981 - TEST RESULTS

	Class A	Class B	Class C
Slump, inches	2½	3¼	2¼
Air Content, percent	6.3	6.6	5.0
Unit Weight, lbs/ft^3	145.62	143.54	146.00
Relative Yield, percent	99.7	103.6	103.6
Concrete Temperature, degrees F	80	76	78
Compressive Strength, psi			
7 days	3417	3409	3360
14 days	3997	4041	4081
28 days	4492	4435	4297
(Design Compressive strength, psi)	(4000)	(3500)	(3000)

TABLE 8
NEW AGGREGATE
AUGUST 4, 1981 - TEST RESULTS

	Class A	Class B	Class C
Slump, inches	3 3/4	4 1/2	3 3/4
Air Content, percent	6.4	4.1	4.2
Unit Weight, lbs/ft^3	149.59	151.22	153.76
Relative Yield, percent	101.5	103.0	102.0
Concrete Temperature, degrees F	82	83	81
Compressive Strength, psi			
7 days	2998	2891	2883
14 days	3475	3484	3665
28 days	3926	3904	4103
(Design compressive strength, psi)	(4000)	(3500)	(3000)

TABLE 9
REFERENCE AGGREGATES
AUGUST 18, 1981 - TEST RESULTS

	Class A	Class B	Class C
Slump, inches	2 1/4	2 1/2	3 1/2
Air Content, percent	6.2	6.0	6.6
Unit Weight, lbs/ft^3	145.66	145.61	143.80
Relative Yield, percent	97.8	100.2	103.6
Concrete Temperature, degrees F	76	74	75
Compressive Strength, psi			
7 days	4116	3935	3427
14 days	4474	4532	4045
28 days	4797	4970	4333
(Design compressive strength, psi)	(4000)	(3500)	(3000)

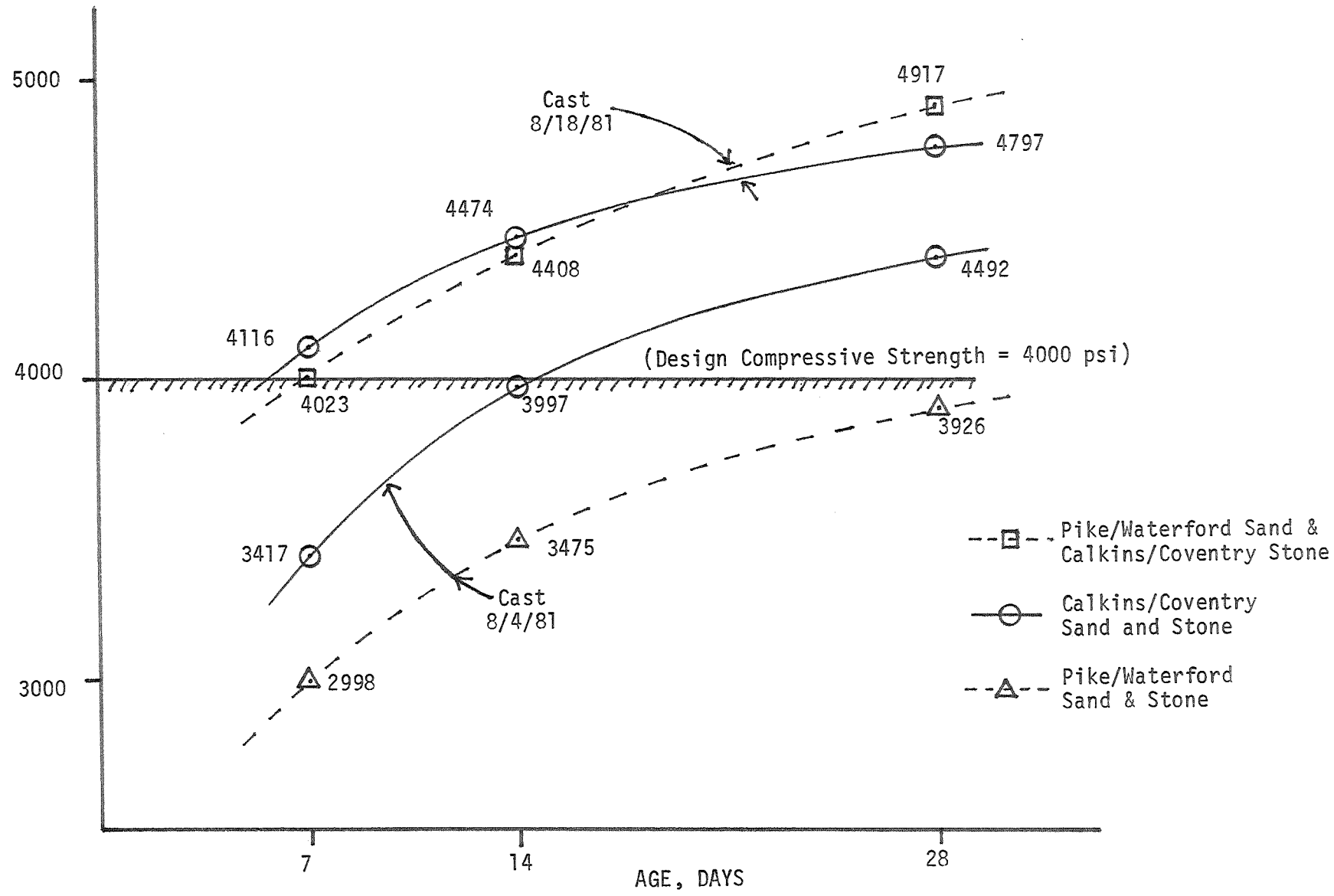
TABLE 10
NEW AGGREGATE
AUGUST 18, 1981 - TEST RESULTS

	Class A	Class B	Class C
Slump, inches	3	3 1/4	2 3/4
Air Content, percent	6.3	5.5	5.0
Unit Weight, lbs/ft^3	145.42	146.66	147.29
Relative Yield, percent	99.0	100.7	102.0
Concrete Temperature, degrees F	70	70	70
Compressive Strength, psi			
7 days	4023	3992	3555
14 days	4408	4505	4218
28 days	4917	4912	4528
(Design compressive strength, psi)	(4000)	(3500)	(3000)

In Appendix C the results of compressive strength tests are shown as follows:

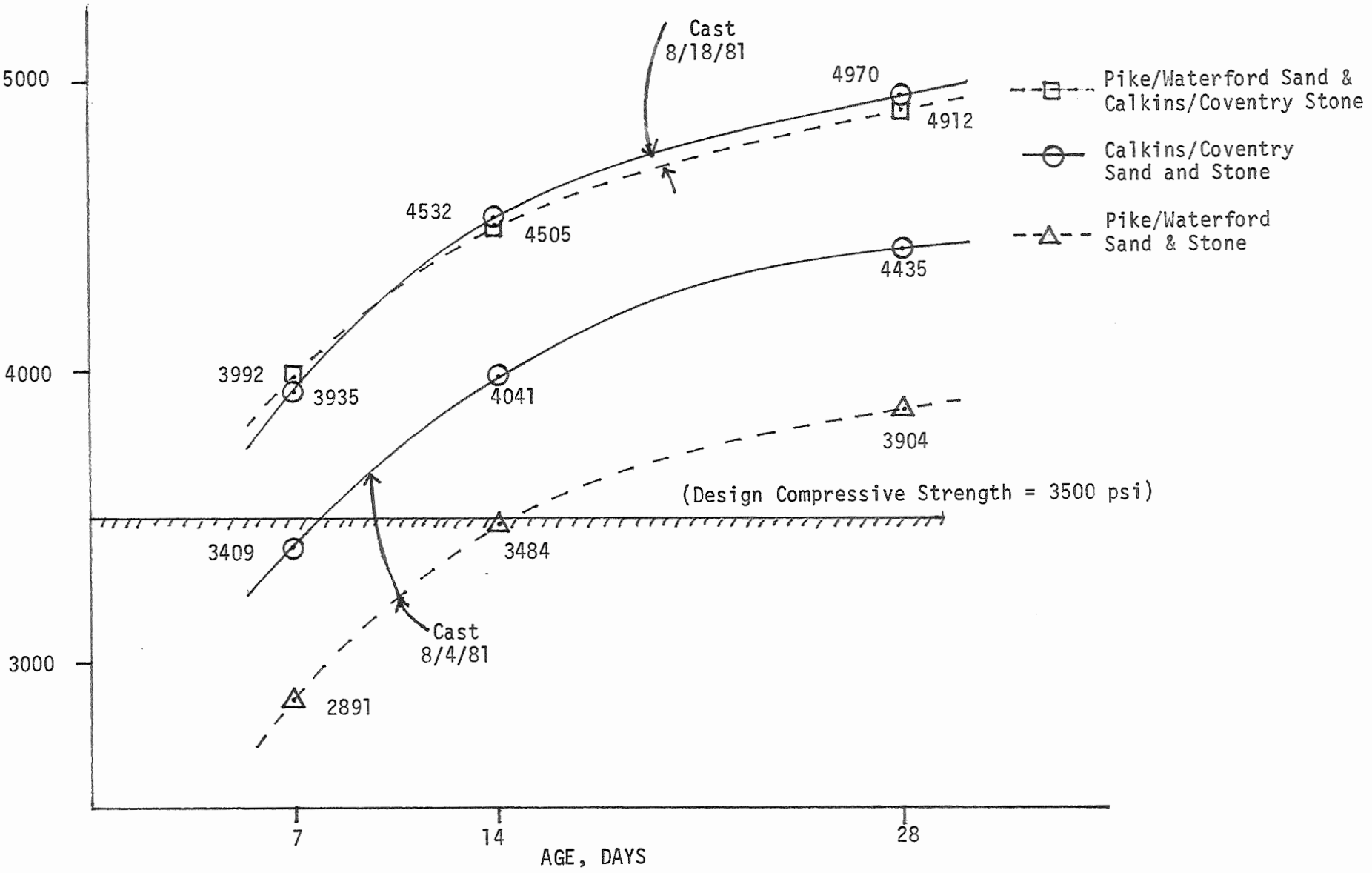
1. Laboratory Report Nos. C8100920 to C8100925 show results of August 4, 1981 tests.
2. Laboratory Report Nos. C8101000 to C8101005 show results of August 18, 1981 tests.

Strength age plots for both test dates are shown in Figures I, II, and III.



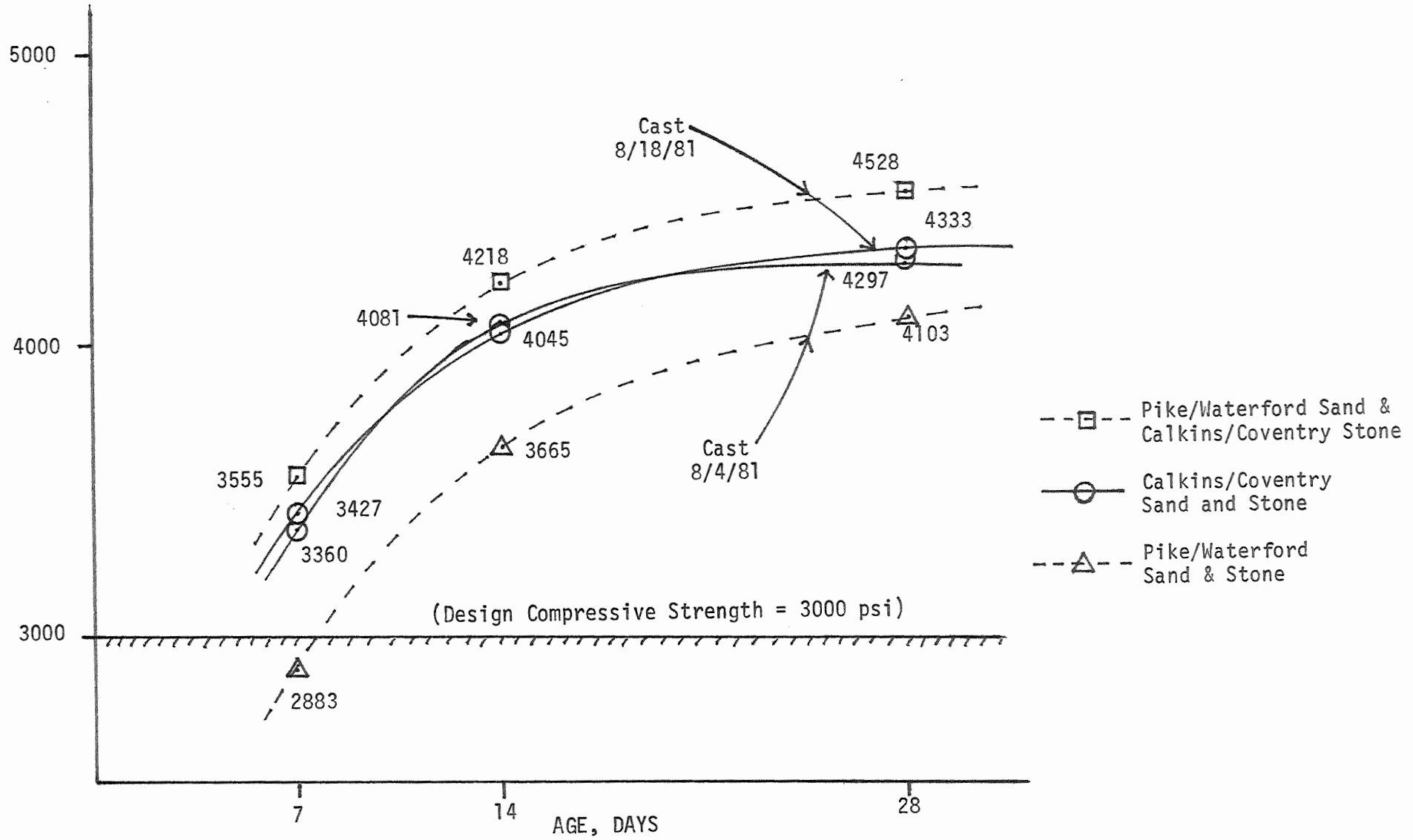
COMPRESSIVE STRENGTH VS AGE
CLASS A

FIGURE I



COMPRESSIVE STRENGTH VS AGE
CLASS B

FIGURE II



COMPRESSIVE STRENGTH VS AGE
CLASS C

FIGURE III

SUMMARY AND CONCLUSIONS

1. For the three classes of concrete examined on August 4, 1981, the mixtures which contained Pike/Waterford sand and stone generally showed between 400 psi and 550 psi less compressive strength at all ages than the control mixtures which contained Calkins/Coventry sand and stone.
2. The Class A mixture containing Pike/Waterford sand and stone did not achieve a satisfactory compressive strength at any age.
3. For the three classes of concrete examined on August 18, 1981, the mixtures which contained Pike/Waterford sand and Calkins/Coventry stone showed strengths comparable to the control mixtures which contained Calkins/Coventry sand and stone.
4. While results indicated that strengths were below anticipated levels for the August 4, 1981 tests, the strengths for the August 18, 1981 tests were at expected levels. Although no apparent reasons exist for the wide fluctuations in strength, the higher temperatures of the freshly mixed concrete, experienced on August 4, 1981 may have been a contributing factor.

RECOMMENDATIONS

It is recommended that fine aggregate from the Pike/Waterford facilities be approved for use in Class A, Class B, and Class C mixtures containing an approved coarse aggregate from sources other than the Pike/Waterford facility.

It is also recommended that fine aggregate from the Pike/Waterford facilities be approved for use in Class B and Class C mixtures containing coarse aggregate from the Pike/Waterford facility. Compressive strength test results of these Class B and Class C mixtures shall be closely monitored.

APPENDIX A

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION - STRUCTURAL CONCRETE SUBDIVISION

PROCEDURE FOR THE EVALUATION OF NEW STRUCTURAL CONCRETE AGGREGATE SOURCES TO DETERMINE COMPLIANCE WITH AOT SPECIFICATIONS

The evaluation of a new structural concrete aggregate source (i.e. one on which the Materials & Research Division has no service-in-concrete data) shall be divided into two sections called:

Phase I Section 700 and related tests; and

Phase II Performance-in-Concrete tests.

The Materials and Research Division shall perform all Phase I and Phase II tests.

Phase I

1. A written request shall be made to the Materials & Research Engineer by the person requesting the evaluation, describing the type of material, quantity available for sampling, and the location of the stockpiles.

2. The Structural Concrete Engineer shall determine from a site visit,

   a) Does a stockpile of at least a day's production of processed material exist?

   b) Can samples be obtained in the standard manner from the stockpiles?

3. If 2(a) and 2(b) are yes, the Structural Concrete Engineer shall make the necessary arrangements and obtain samples from the stockpiles designated by the producer.

4. The material shall be tested at the Materials & Research Division using the Structural Concrete Subdivision Annual Aggregate Testing Program procedure.

5. Report the results (as a Preliminary Sample) on the standard Materials and Research Division forms, and send a copy of the test results to the aggregate producer.

Phase II

1. Aggregates which meet the requirements of the Phase I evaluation will then be tested in concrete. The Structural Concrete Engineer will inform the person requesting the evaluation of the Phase II requirements. The performance-in-concrete tests shall be carried out on Ready Mixed concrete containing the aggregate being evaluated. At the same time concrete with a control aggregate (selected by the Structural Concrete Engineer) will also be processed. Costs for processing the aggregate thru the Ready-Mix plant will be borne by the requesting party. The Phase II tests shall

conform to the Materials & Research Division Performance-in-Concrete Procedure for Evaluating a New Aggregate Source.

2. The Materials and Research Division shall carry out the work necessary for both the Phase I and Phase II sections of this evaluation process in a period of not more than 45 calendar days from the date the aggregate is available for testing. Any delays beyond the control of the Materials & Research Division shall be documented and the person requesting the evaluation shall be notified of the consequent extension of time required to complete the testing. Failure of the aggregate to pass the requirements of the Phase I section would terminate the evaluation.

3. Test results shall be the basis upon which the Structural Concrete Engineer shall recommend acceptance, further testing, or rejection to the Materials and Research Engineer.

4. The Materials and Research Engineer shall inform the person making the request of the acceptability or non-acceptability of the aggregate, when the Phase II tests have been completed.

APPENDIX A

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION - STRUCTURAL CONCRETE SUBDIVISION

PERFORMANCE-IN-CONCRETE

PROCEDURE FOR EVALUATING A NEW AGGREGATE SOURCE

1. Mix proportions shall be submitted for each class of concrete required; or designed by, the Materials and Research Division and shall conform to Table 501.03A.

2. Test shall be run on both Field and Laboratory Concrete.

3. Field Concrete shall be produced at an approved Ready-Mixed Concrete Plant. Cement, sand, water, and admixtures shall all be the same as in current use at the plant, and as approved by the Agency of Transportation.

4. Laboratory Concrete shall be prepared at the Central Laboratory with the same materials used in the Ready Mixed Concrete.

5. An approved aggregate in normal use at the Ready-Mixed Concrete plant shall be used as a control in a separate batch for both Field and Laboratory Concrete.

6. At least one cubic yard of Ready Mixed concrete shall be produced for each class of concrete containing each new and control aggregate being evaluated.

7. Test cylinders shall be fabricated and cured in accordance with AASHTO T23-76.

8. Tests of Slump, Air Content, and Unit Weight and Yield shall be in accordance with AASHTO T119-74, AASHTO T152-80I, and AASHTO T121-79I, respectively.

9. Batching, mixing, field testing, and specimen fabrication using Field Concrete shall be witnessed by a representative of the Materials and Research Division.

10. Cylinder specimens shall be tested at the Materials and Research Laboratory for compressive strength at ages 7, 14, and 28 days in accordance with AASHTO T22-74.

11. The Materials and Research Division's involvement in the evaluation shall be documented in a Materials & Research Division report. The procedure in current use by the Research Subdivision shall be followed (including the drafting and approval of a Work Plan before work has begun).

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Montpelier, Vermont 05602

APPENDIX B

REPORT ON MISCELLANEOUS SAMPLE

Report June 8, 19 81

Laboratory No. C8100332 Tested by Eaton

Name Fine Aggregate for Concrete 501

Identification Marks Preliminary Sample

Submitted by Morissette Title PFP Address

Sampled 5/13, 19 81 Received 5/25, 19 81

Sample from Stockpile - Pike, Waterford

Quantity Represented

Source of Material Pike - Waterford

Location used or to be used Possible Future Use

Examined for 704.01

TEST RESULTS

3 day

	Ottawa Sand	Mortar Sand
Cube #1	2400	3550
#2	2400	3388
#3	2375	3388
Avg.	2390	3400

7 day

Cube #1	2913	4438
#2	2875	4675
#3	2725	4625
Avg.	2840	4580

This material was examined for mortar strengths.
the results are as indicated.

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

By: R. F. Nicholson 6/8/81
R. F. Nicholson, P.E., Materials & Research Engineer

sel

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AGENCY OF TRANSPORTATION

MATERIALS & RESEARCH DIVISION
Montpelier, Vermont 05602

APPENDIX B

REPORT ON SAMPLE OF AGGREGATE

Report June 8, 1981

Laboratory No. A81-0328 Tested By M. Lavin

Name Fine Aggregate for Concrete 501

Identification Marks Preliminary Sample

Submitted by M. Morissette Title PFP Address

Sampled 5/13, 1981 Received 5/14, 1981

Sample from Stockpile @ Pike Waterford

Quantity Represented

Source of Material Pike Waterford

Location used or to be used Possible Future Use

Examined for Item 704.01

TEST RESULTS

Total Sample Sieve Size	% Passing
4 1/2"	
4"	
3 1/2"	
3"	
2 1/2"	
2"	
1 3/4"	
1 1/2"	
1"	
3/4"	
5/8"	
1/2"	
3/8"	100
No. 4	100
No. 8	87
No. 10	
No. 16	68
No. 30	43
No. 50	23
No. 100	10
No. 200	5

Fineness Modulus % Coarser Than	
No. 100	90
No. 50	77
No. 30	57
No. 16	32
No. 8	13
No. 4	

Fineness Modulus = 2.69

Color = 1

Comments:

This material was examined for gradation, color and soundness. The results are as indicated.

Sand Portion

Percent of Wear

AASHTO T3
AASHTO T4
AASHTO T96

Fractured Faces, %

Thin & Elongated Pieces, %

Soundness, % Loss 5.68

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

By: R. F. Nicholson 1847
R. F. Nicholson, P.E., Materials & Research Engineer

sel

Project Name
W.P. No. 81-C-6
Project Number

STATE OF VERMONT
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APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C8100920 (28) Report of 7,14,28 Day Breaks Date typed September 2, 81

Pay Item Performance in concrete Type of Sample Field

Submitted by M. Morissette Title PFP Address

Source of Material Calkins, Coventry Quantity Represented 1 cy

Coarse Aggregate Calkins, Coventry Fine Aggregate Calkins, Coventry

Cement Brand Independent Type II Lbs. 564

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

Maximum allowable water content, Gal/Cy Total Aggregate, Dry Wgt. 3134

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from truck mixer No.34 @ plant Date Sampled: August 4, 1981

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

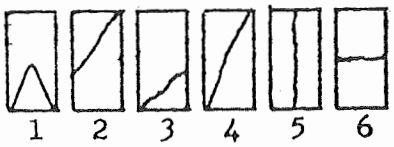
Unit Weight Fresh Concrete 146 Air: Pressure 5.0% Chace

Total Water, Gal/Cy Used Slump 2¼" Temperature, Concrete 78°F Ambient 76°F

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
CC 1-2	149 150	8/6	8/11	7	7	S	3360	3360	3360		
3-4	149 149	8/6	8/18	14	14	S	4173	3988	4081		
5-6	150 150	8/6	9/1	28	28	S	4306	4288	4297		

*S = Standard Cured; F = Field Cured

Types of Breaks:



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

By: R. F. Nicholson 1/8/97
R. F. Nicholson, P.E., Materials & Research Engineer

Comments:
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W.P. No. 81-C-6

Project Number

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APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C8100921 (28) Report of 7,14,28 Day Breaks Date typed September 2, 1981

Pay Item Performance in concrete Type of Sample Field

Submitted by M. Morissette Title PFP Address

Source of Material Calkins, Coventry Quantity Represented 1 cy

Coarse Aggregate Calkins, Coventry Fine Aggregate Calkins, Coventry

Cement Brand Independent Type II Lbs. 660

Air Entraining Admixture Darex AEA Dosage 7oz/cy Admixture WRDA Hycol Dosage 3 oz/cwt

Maximum allowable water content, Gal/Cy Total Aggregate, Dry Wgt. 2884

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from truck mixer No.35 @ plant Date Sampled: August 4, 1981

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

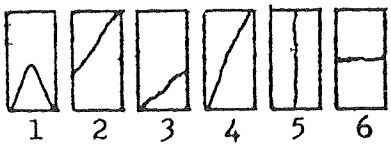
Unit Weight Fresh Concrete 145.62 Air: Pressure 6.3% Chace

Total Water, Gal/Cy Used Slump 2½" Temperature, Concrete 80 Ambient 76

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
CA 1-2	148 148	8/6	8/11	7	7	S	3342	3492	3417		
3-4	148 148	8/6	8/18	14	14	S	3961	4032	3997		
5-6	149 149	8/6	9/1	28	28	S	4501	4483	4492		

*S = Standard Cured; F = Field Cured

Types of Breaks:



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

By: R. F. Nicholson 10/7

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

Comments:
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Project Name

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APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C8100922 (28) Report of 7,14,28 Day Breaks Date typed September 2, 81

Pay Item Performance in concrete Type of Sample Field

Submitted by M. Morissette Title PFP Address

Source of Material Calkins, Coventry Quantity Represented 1 cy

Coarse Aggregate Pike - Waterford Fine Aggregate Pike - Waterford

Cement Brand Independent Type II Lbs. 660

Air Entraining Admixture Darex AEA Dosage 5 oz/cy Admixture WRDA Hycol Dosage 3 oz/cwt

Maximum allowable water content, Gal/Cy Total Aggregate, Dry Wgt. 3066

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from truck mixer No.38 @ plant Date Sampled: August 4, 1981

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

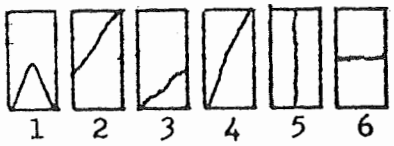
Unit Weight Fresh Concrete 149.59 Air: Pressure 6.4% Chace

Total Water, Gal/Cy Used Slump 3 3/4" Temperature, Concrete 82 Ambient 80

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
PPA 1-2	153 153	8/6	8/11	7	7	S	3077	2918	2998		
3-4	153 153	8/6	8/18	14	14	S	3501	3448	3475		
5-6	152 153	8/6	9/1	28	28	S	3961	3890	3926		

*S = Standard Cured; F = Field Cured

Types of Breaks:



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

By: R. F. Nicholson 1/8/47
R. F. Nicholson, P.E., Materials & Research Engineer

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

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Project Name

W.P. No. 81-C-6

Project Number

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

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APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C8100923 (28) Report of 7,14,28 Day Breaks Date typed September 2, 81

Pay Item Performance in concrete Type of Sample Field

Submitted by M. Morissette Title PFP Address

Source of Material Calkins, Coventry Quantity Represented 1 cy

Coarse Aggregate Pike - Waterford Fine Aggregate Pike - Waterford

Cement Brand Independent Type II Lbs. 611

Air Entraining Admixture Darex AEA Dosage 3½ oz/cy Admixture WRDA Hycol Dosage 3 oz/cwt

Maximum allowable water content, Gal/Cy Total Aggregate, Dry Wgt. 3211

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from truck mixer No. 35 @ plant Date Sampled: August 4, 1981

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

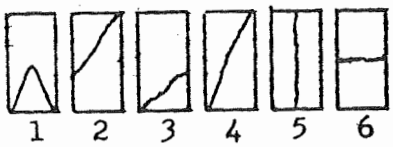
Unit Weight Fresh Concrete 151.22 Air: Pressure 4.1% Chace

Total Water, Gal/Cy Used Slump 4½" Temperature, Concrete 83°F Ambient 80°F

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
PPB 1-2	156 155	8-6	8-11	7	7	S	2900	2882	2891		
3-4	156 155	8-6	8-18	14	14	S	3501	3466	3484		
5-6	155 155	8-6	9-1	28	28	S	3890	3917	3904		

*S = Standard Cured; F = Field Cured

Types of Breaks:



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

By: R. F. Nicholson 10/27
R. F. Nicholson, P.E., Materials & Research Engineer

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

sel

Project Name

W.P. No. 81-C-6

Project Number

STATE OF VERMONT
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MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

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Report on Concrete Test Beam or Cylinders

APPENDIX C

Laboratory No. C8100924 (28) Report of 7,14,28 Day Breaks Date typed September 2, 1981

Pay Item Performance in Concrete Type of Sample

Submitted by M. Morissette Title PFP Address

Source of Material Calkins, Coventry Quantity Represented 1 cy

Coarse Aggregate Pike - Waterford Fine Aggregate Pike - Waterford

Cement Brand Independent Type II Lbs. 564

Air Entraining Admixture Darex AEA Dosage 2 oz/cy Admixture WRDA Hyco Dosage 3 oz/cwt

Maximum allowable water content, Gal/Cy Total Aggregate, Dry Wgt. 3323

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from truck mixer #34 @ plant Date Sampled: August 4, 1981

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

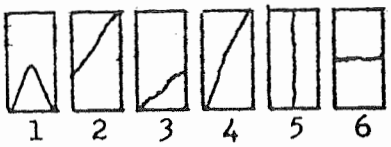
Unit Weight Fresh Concrete 153.76 Air: Pressure 4.2% Chace

Total Water, Gal/Cy Used Slump 3 3/4" Temperature, Concrete 81°F Ambient 78°F

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
PPC 1-2	156 157	8/6	8/11	7	7	S	2830	2936	2883		
3-4	156 157	8/6	8/18	14	14	S	3643	3687	3665		
5-6	156 157	8/6	9/1	28	28	S	4103	4103	4103		

*S = Standard Cured; F = Field Cured

Types of Breaks:



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

By: R. F. Nicholson 10/27
R. F. Nicholson, P.E., Materials & Research Engineer

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

sel

Project Name

W.P. No. 81-C-6
Project Number

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

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APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C8100925 (28) Report of 7,14,28 Day Breaks Date typed September 2, 81

Pay Item Performance in concrete Type of Sample Field

Submitted by M. Morissette Title PFP Address

Source of Material Calkins, Coventry Quantity Represented 1 cy

Coarse Aggregate Calkins, Coventry Fine Aggregate Calkins, Coventry

Cement Brand Independent Type II Lbs. 611

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. 3025

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from truck mixer No. 26 @ plant Date Sampled: August 4, 1981

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

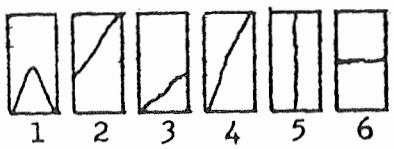
Unit Weight Fresh Concrete 143.54 Air: Pressure 6.6% Chace

Total Water, Gal/Cy Used Slump 3¼" Temperature, Concrete 76° Ambient 70°

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
CB 1-2	147 147	8/6	8/11	7	7	S	3466	3351	3409		
3-4	147 147	8/6	8/18	14	14	S	4050	4032	4041		
5-6	147 147	8/6	9/1	28	28	S	4483	4386	4435		

*S = Standard Cured; F = Field Cured

Types of Breaks:



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

By: R. F. Nicholson 1Ra7
R. F. Nicholson, P.E., Materials & Research Engineer

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

sel

Project Name

W.P. No. 81-C-6
Project Number

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

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Report on Concrete Test Beam or Cylinders APPENDIX C

Laboratory No. C8101000 (28) Report of 7,14,28 Day Breaks Date typed Sept. 16, 1981

Pay Item Performance in concrete Type of Sample Field

Submitted by M. Morissette Title PFP Address

Source of Material Calkins, Coventry Quantity Represented 1 cy

Coarse Aggregate Calkins, Coventry Fine Aggregate Pike, Waterford

Cement Brand Independent Type II Lbs. 564

Air Entraining Admixture Darex AEA Dosage 2½ oz/cy Admixture WRDA Hycol Dosage 3 oz/cwt

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

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from tk. #26 @ plant Date Sampled: Aug 18, 1981

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

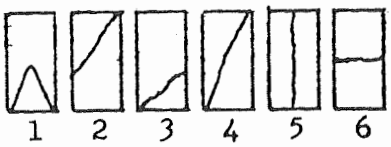
Unit Weight Fresh Concrete 147.29 Air: Pressure 5.0 Chace

Total Water, Gal/Cy Used Slump 2 3/4" Temperature, Concrete 70°F Ambient 68°F

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
PCC 1-2	151 151	8/24	8/25	7	7	S	3546	3563	3555		
3-4	150 151	8/24	9/1	14	14	S	4253	4182	4218		
5-6	151 151	8/24	9/15	28	28	S	4501	4554	4528		

*S = Standard Cured; F = Field Cured

Types of Breaks:



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

By: R. F. Nicholson 10/27

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

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

sel

Project Name

W.P. No. 81-C-6
Project Number

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

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APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C8101001 (28) Report of 7,14,28 Day Breaks Date typed Sept. 16, 1981

Pay Item Performance in Concrete Type of Sample Field

Submitted by M. Morissette Title PFP Address

Source of Material Calkins, Coventry Quantity Represented 1 cy

Coarse Aggregate Calkins, Coventry Fine Aggregate Calkins, Coventry

Cement Brand Independent Type II Lbs. 564

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

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

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from truck #26 @ plant Date Sampled: Aug. 18, 1981

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

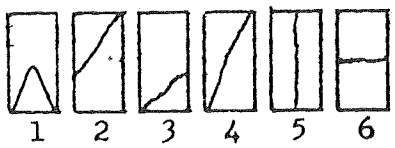
Unit Weight Fresh Concrete 143.80 Air: Pressure 6.6% Chace

Total Water, Gal/Cy Used Slump 3½ Temperature, Concrete 75°F Ambient 74°F

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
CCC 1 - 2	145 146	8/24	8/25	7	7	S	3431	3422	3427		
3 - 4	145 144	8/24	9/1	14	14	S	4032	4058	4045		
5 - 6	144 145	8/24	9/15	28	28	S	4465	4200	4333		

*S = Standard Cured; F = Field Cured

Types of Breaks:



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

By: R. F. Nicholson 1847
R. F. Nicholson, P.E., Materials & Research Engineer

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

sel

Project Name

W.P. No. 81-C-6
Project Number

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

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APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C8101002 (28) Report of 7,14,28 Day Breaks Date typed Sept. 16, 1981

Pay Item Performance in concrete Type of Sample Field

Submitted by Morissette Title PFP Address

Source of Material Calkins, Coventry Quantity Represented 1 cy

Coarse Aggregate Calkins, Coventry Fine Aggregate Pike, Waterford

Cement Brand Independent Type II 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.

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from truck #26 @ Plant Date Sampled: August 18, 1981

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

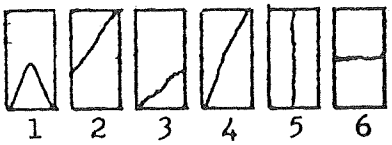
Unit Weight Fresh Concrete 146.66 Air: Pressure 5.5% Chace

Total Water, Gal/Cy Used Slump 3¼ Temperature, Concrete 70°F Ambient 70°F

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
PCB 1-2	149 147	8/24	8/25	7	7	S	4058	3926	3992		
3-4	147 147	8/24	9/1	14	14	S	4465	4545	4505		
5-6	147 147	8/24	9/15	28	28	S	4890	4934	4912		

*S = Standard Cured; F = Field Cured

Types of Breaks:



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

By: R. F. Nicholson 1987

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

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

sel

Project Name

W.P. No. 81-C-6
Project Number

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

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APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C8101003 (28) Report of 7,14,28 Day Breaks Date typed Sept. 16, 1981

Pay Item Performance in Concrete Type of Sample Field

Submitted by M. Morissette Title PFP Address

Source of Material Calkins, Coventry Quantity Represented 1 cy

Coarse Aggregate Calkins, Coventry Fine Aggregate Calkins, Coventry

Cement Brand Independent Type II Lbs. 611

Air Entraining Admixture Darex AEA Dosage 4½ oz/cy Admixture WRDA Hycol Dosage 3 oz/cwt

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

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from Truck #26 @ plant Date Sampled: Aug. 18, 1981

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

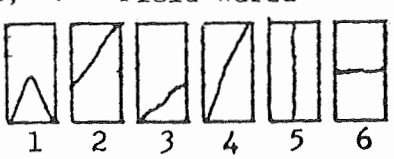
Unit Weight Fresh Concrete 145.61 Air: Pressure 6.0% Chace

Total Water, Gal/Cy Used Slump 2½" Temperature, Concrete 74°F Ambient 74°F

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
CCB 1-2	147 147	8/24	8/25	7	7	S	3970	3899	3935		
3-4	147 147	8/24	9/1	14	14	S	4527	4536	4532		
5-6	147 147	8/24	9/15	28	28	S	4943	4996	4970		

*S = Standard Cured; F = Field Cured

Types of Breaks:



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

By: R. F. Nicholson 10/27

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

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

Project Name

W.P. No. 81-C-6
Project Number

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

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APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C8101004 (28) Report of 7,14,28 Day Breaks Date typed Sept. 16, 1981

Pay Item Performance in Concrete Type of Sample Field

Submitted by M. Morissette Title PFP Address

Source of Material Calkins, Coventry Quantity Represented 1 cy

Coarse Aggregate Calkins, Coventry Fine Aggregate Pike, Waterford

Cement Brand Independent Type II Lbs. 660

Air Entraining Admixture Darex AEA Dosage 5 oz/cy Admixture WRDA Hycol Dosage 3 oz/cwt

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

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from truck #26 @ Plant Date Sampled: August.18, 1981

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

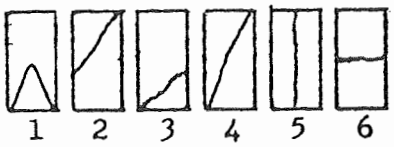
Unit Weight Fresh Concrete 145.42 Air: Pressure 6.3% Chace

Total Water, Gal/Cy Used Slump 3 Temperature, Concrete 70^{o}F Ambient 72^{o}F

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
PCA 1 - 2	147 147	8/24	9/25	7	7	S	4032	4014	4023		
3 - 4	147 147	8/24	9/1	14	14	S	4465	4350	4408		
5 - 6	147 148	8/24	9/15	28	28	S	4837	4996	4917		

*S = Standard Cured; F = Field Cured

Types of Breaks:



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

By: R. F. Nicholson 10/27

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

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

Project Name

W.P. No. 81-C-6
Project Number

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

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APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C8101005 (28) Report of 7,14,28 Day Breaks Date typed Sept. 16, 1981

Pay Item Performance in concrete Type of Sample Field

Submitted by M. Morissette Title PFP Address

Source of Material Calkins, Coventry Quantity Represented 1 cy

Coarse Aggregate Calkins, Coventry Fine Aggregate Calkins, Coventry

Cement Brand Independent 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.

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from truck #26 @ plant Date Sampled: Aug 18, 1981

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

Unit Weight Fresh Concrete 145.66 Air: Pressure 6.2% Chace

Total Water, Gal/Cy Used Slump 2¼" Temperature, Concrete 76°F Ambient 74°F

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
CCA 1-2	148 145	8/24	8/25	7	7	S	4120	4112	4116		
3-4	146 148	8/24	9/1	14	14	S	4456	4492	4474		
5-6	146 145	8/24	9/15	28	28	S	4615	4978	4797		

*S = Standard Cured; F = Field Cured

Types of Breaks:

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

By: R. F. Nicholson /RJ7
R. F. Nicholson, P.E., Materials & Research Engineer

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

sel

TA 565 Rev. 4/79

Prepared By: P. A. Cover
Date: 4-27-81
Sheet 1 of 1

APPENDIX A

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

APPENDIX D

RESEARCH INVESTIGATION

Work Plan No. 81-C-6

Subject Performance evaluation of new coarse aggregate source, Pike Ind., Inc., Waterford, Vt.

Investigation Requested By Pike Industries, Inc. Date April 10, 1981

Date Information Required June 2, 1981

Purpose of Investigation To evaluate the Pike Industries Ind. crushed stone from their Waterford quarry as a structural concrete aggregate source.

Proposed Tests or Evaluation Procedure See Performance in Concrete Procedure for Evaluating a new Aggregate Source (attached.) as prepared by P. A Cover dated May 5, 1981

Proposal Discussed With R. I. Faccoia DF Projected Manpower Requirements 10 man days

Investigation To Be Conducted By STructural Concrete Subdivision

Proposed Starting Date April 29, 1981 Estimated Completion Date June 2, 1981

Approval/Disapproval by Materials & Research Engineer R. J. Nicholson

Comments by Materials & Research Engineer 5/15/81

Materials & Research Division
Agency of Transportation
Date Typed: 4/27/81

APPENDIX D

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION - STRUCTURAL CONCRETE SUBDIVISION

PERFORMANCE-IN-CONCRETE

PROCEDURE FOR EVALUATING A NEW AGGREGATE SOURCE

1. Mix proportions shall be submitted for each class of concrete required; or designed by, the Materials and Research Division and shall conform to Table 501.03A.

2. Test shall be run on both Field and Laboratory Concrete.

3. Field Concrete shall be produced at an approved Ready-Mixed Concrete Plant. Cement, sand, water, and admixtures shall all be the same as in current use at the plant, and as approved by the Agency of Transportation.

4. Laboratory Concrete shall be prepared at the Central Laboratory with the same materials used in the Ready Mixed Concrete.

5. An approved aggregate in normal use at the Ready-Mixed Concrete plant shall be used as a control in a separate batch for both Field and Laboratory Concrete.

6. At least one cubic yard of Ready Mixed concrete shall be produced for each class of concrete containing each new and control aggregate being evaluated.

7. Test cylinders shall be fabricated and cured in accordance with AASHTO T23-76.

8. Tests of Slump, Air Content, and Unit Weight and Yield shall be in accordance with AASHTO T119-74, AASHTO T152-80I, and AASHTO T121-79I, respectively.

9. Batching, mixing, field testing, and specimen fabrication using Field Concrete shall be witnessed by a representative of the Materials and Research Division.

10. Cylinder specimens shall be tested at the Materials and Research Laboratory for compressive strength at ages 7, 14, and 28 days in accordance with AASHTO T22-74.

11. The Materials and Research Division's involvement in the evaluation shall be documented in a Materials & Research Division report. The procedure in current use by the Research Subdivision shall be followed (including the drafting and approval of a Work Plan before work has begun).