EVALUATION OF THE PIKE/WATERFORD 3/4" CRUSHED STONE FOR USE IN STRUCTURAL CONCRETE

REPORT 81-9 (FINAL)
JULY 1982

REPORTING ON WORK PLAN 81-C-6

(Originally Reported as Initial Report 81-9 December 1981)

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

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

Date: Oct. 21, 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 new source of coarse aggregate for structural concrete. The new material is a 3/4" crushed stone produced by Pike Industries Incorporated at their facility in Waterford, Vermont.

The results indicate that the material performs satisfactorily.

INTRODUCTION

There have been instances in the past, where a source of aggregate for Structural Concrete has conformed to Section 700 requirements, but has subsequently failed to produce concrete of acceptable strength. A procedure called "Procedure For The Evaluation Of New Structural Concrete Aggregate Sources To Determine Compliance With Agency of Transportation Specifications"; (PENCAS), was recently developed to provide, in addition to the existing Section 704.02 tests of physical properties, a basis to determine whether concrete containing a new aggregate, could achieve acceptable strength. (see Appendix A for PENCAS). Pike Industries Incorporated, of Tilton, New Hampshire, requested late in January 1981 that the Agency approve 3/4 inch Crushed Stone being produced at their crushing operation in Waterford, Vermont for possible use in Structural Concrete on the Waterford-St. Johnsbury I 93 projects.

This material was sampled by Materials and Research Division representatives and tested for compliance with Section 704.02 of the Standard Specifications. The PENCAS procedure was then used to compare concrete mixtures containing this aggregate, with mixtures containing a reference aggregate. Concrete was produced under both laboratory and field conditions. The field concrete was produced at the Lawrence Sangravco Plant in St. Johnsbury, Vermont at the request of Pike Industries, Inc. Laboratory concrete was produced at the Central Laboratory of the Materials and Research Division.

TESTING PROGRAM

PHASE I - SECTION 704.02 TESTS

Pike/Waterford 3/4 inch crushed stone was sampled from an existing stockpile at Pike's quarry in Waterford, Vermont on February 24, 1981. This material was found not to conform to the Gradation requirement, being deficient in the 3/8 inch fraction, and also appeared to be a blend of crushed gravel and crushed stone.

Pike Industries subsequently screen-blended this material with 1/2 inch stone to adjust the 3/8 inch deficiency and created a new stockpile. This new stockpile was sampled on April 17, 1981 and was found to comply with Section 704.02 requirements. The report on Laboratory No. A81-0218 which documents the Section 700 tests is 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 both laboratory and field conditions. Mixtures were designed by Structural Concrete personnel for Class A, Class B, and Class C concrete using the following materials:

Coarse Aggregate:

A. Proposed New Aggregate
   3/4 inch Crushed Rock
   Pike Industries, Inc., Waterford, Vt.

B. Reference Aggregate
   3/4 inch Crushed Gravel
   Lawrence Sangravco, Guildhall, Vt.

Fine Aggregate:

Lawrence Sangravco, Guildhall, Vt.

Cement:

Glens Falls Type II
Glens Falls, New York

Air Entraining Admixtures:

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

Water Reducing Admixture:

WRDA with Hycol
W. R. Grace & Co., Cambridge, Mass.

Aggregate properties used for preparing mix designs are as follows:

Pike Coarse Aggregate:

Bulk Specific Gravity	-	2.94
Absorption, percent	-	0.5
Dry rodded unit weight, lbs./ft^3	-	107.13

Guildhall Coarse Aggregate:

Bulk Specific Gravity	-	2.74
Absorption, percent	-	0.9
Dry rodded unit weight, lbs./ft^3	-	101.80

Guildhall Fine Aggregate:

Bulk Specific Gravity	-	2.64
Absorption, percent	-	1.3
Fineness modulus	-	2.90

FIELD CONCRETE

Ready mixed concrete was produced and tested at the Lawrence Sangravco plant in St. Johnsbury, Vermont during the day of May 15, 1981. Moisture content of the aggregates was determined prior to the start of mixing, and aggregate weights were adjusted. Concrete was mixed in a standard truck

mixer with batch size being one cubic yard. Batches were prepared for each Class A, Class B, and Class C concrete containing the Pike 3/4 inch Crushed Stone, as well as for Class A, Class B, and Class C concrete containing the reference aggregate; Guildhall 3/4 inch Crushed Gravel.

LABORATORY CONCRETE

Laboratory concrete was produced and tested in the Central Laboratory on the day of May 20, 1981. Aggregates were dried prior to mixing, which was carried out in a Lancaster pan mixer. Batch size was approximately 1.75 cubic feet. Batches were prepared for each Class A, Class B, and Class C concrete containing the Pike 3/4 inch Crushed Rock, as well as for Class A, Class B, and Class C concrete containing the reference aggregate. Mix proportions for the Lab-produced concrete are as shown in Tables 1 and 2, and for the Field-produced concrete in Tables 3 and 4.

TABLE 1
REFERENCE AGGREGATE
LAB MIXTURES - BATCH QUANTITIES PER CY.

	Class A	Class B	Class C
*Reference Coarse Aggregate, lbs.	1692	1692	1692
*Fine Aggregate, lbs.	1275	1428	1535
Cement, lbs.	660	611	565
Air Entraining Admixture, oz.	4	3	1 1/2
Water Reducing Admixture, oz.	19.8	18.3	17.0
Net Water, Gals.	33.1	33.3	36.3

*Aggregates batched dry, weights converted to saturated surface-dry condition.

TABLE 2
NEW AGGREGATE
LAB MIXTURES - BATCH QUANTITIES PER CY.

	Class A	Class B	Class C
*New Coarse Aggregate, lbs.	1773	1773	1773
*Fine Aggregate, lbs.	1290	1438	1550
Cement, lbs.	660	611	565
Air Entraining Admixture, oz.	4	3	1 1/2
Water Reducing Admixture, oz.	19.8	18.3	17.0
Net Water, Gals.	34.3	35.0	34.2

*Aggregates batched dry, weights converted to saturated surface-dry condition.

TABLE 3
REFERENCE AGGREGATE
FIELD MIXTURES - BATCH QUANTITIES PER CY.

	Class A	Class B	Class C
*Reference Coarse Aggregate, lbs.	1692	1692	1692
*Fine Aggregate, lbs.	1275	1428	1535
Cement, lbs.	660	611	565
Air Entraining Admixture, oz.	3 1/2	3	1 1/2
Water Reducing Admixture, oz.	19.8	18.3	17.0
Net Water, Gals.	30.1	28.9	25.5

*Weights converted to saturated surface-dry condition.

TABLE 4
NEW AGGREGATE
FIELD MIXTURES - BATCH QUANTITIES PER CY.

	Class A	Class B	Class C
*New Coarse Aggregate, lbs.	1773	1773	1773
*Fine Aggregate, lbs.	1290	1438	1550
Cement, lbs.	660	611	565
Air Entraining Admixture, oz.	3 1/2	3	1 1/2
Water Reducing Admixture, oz.	19.8	18.3	17.0
Net Water, Gals.	29.6	25.5	28.1

*Weights converted to saturated surface-dry condition.

Tests were performed on the fresh concrete to determine; Air Content, Unit Weight, Slump and Yield. Seven standard 6" ø x 12" cylinders were prepared from each batch. Six of the cylinders were tested for compressive strength, two each at ages 7, 14, and 28 days. The remaining cylinder from each batch was moist-cured for 28 days. At age 28 days, three 2 inch cubes were cut from the center section of these cylinders and the cubes subjected to the Agency of Transportation Test Procedure No. 25 for freeze-thaw durability. The results of freeze-thaw durability tests are shown in Table 9. The results of other tests on the fresh and hardened concrete are shown in Tables 5, 6, 7, and 8.

TABLE 5
REFERENCE AGGREGATE
LAB MIXTURES; TEST RESULTS

	Class A	Class B	Class C
Slump, inches	2 3/4	2 1/4	3
Air Content, percent	5.4	4.2	4.8
Unit Weight, lbs/ft^3	148.01	148.97	148.05
Relative yield, percent	97.6	99.7	102.4
Compressive strength, psi			
7 days	3489	3192	3356
14 days	4134	3524	3857
28 days	4696	4390	4271
(Design compressive strength, psi)	(4000)	(3500)	(3000)

TABLE 6
NEW AGGREGATE
LAB MIXTURES; TEST RESULTS

	Class A	Class B	Class C
Slump, inches	2 1/2	2	2
Air Content, percent	5.0	4.9	4.4
Unit Weight, lbs/ft^3	152.03	151.60	152.08
Relative yield, percent	97.7	100.5	102.2
Compressive Strength, psi			
7 days	3616	3214	3365
14 days	4172	3935	3939
28 days	4766	4594	4253
(Design compressive strength, psi)	(4000)	(3500)	(3000)

TABLE 7
REFERENCE AGGREGATE
FIELD MIXTURES; TEST RESULTS

	Class A	Class B	Class C
Slump, inches	3 1/4	3 1/2	3
Air content, percent	3.4	6.2	4.0
Unit weight, lbs/ft^3	149.67	144.95	147.91
Relative yield, percent	95.2	100.6	99.4
Compressive strength, psi			
7 days	4435	3701	3577
14 days	4747	4069	4085
28 days	5292	4819	4505
(Design Compressive Strength, psi)	(4000)	(3500)	(3000)

TABLE 8
NEW AGGREGATE
FIELD MIXTURES; TEST RESULTS

	Class A	Class B	Class C
Slump, inches	3 1/2	3	2 1/2
Air content, percent	3.6	3.7	4.4
Unit weight, lbs/ft^3	151.40	152.12	150.56
Relative yield, percent	96.5	96.0	100.7
Compressive strength, psi			
7 days	4713	4315	3639
14 days	5199	4753	4094
28 days	5655	5186	4643
(Design Compressive Strength, psi)	(4000)	(3500)	(3000)

TABLE 9
FREEZE-THAW DURABILITY

Mixture Type	Class	Percent Weight Loss After 25 Cycles	50 Cycles	75 Cycles	100 Cycles
1. New Aggregate	A	1	4	10	17
	B	6	16	(40)*	-
	C	8	15	(41)*	-
2. Reference Aggregate	A	5	12	21 **	45
	B	9	14	23 **	32
	C	21	40	(86)*	-

* Test terminated at 63 cycles.
** Extrapolated from plot of data.

In Appendix C, the results of compressive strength tests are shown on Laboratory Report Nos. C8100251 to C8100256 for the field produced concrete, and Nos. C8100306 to C8100311 for the lab-produced concrete. Strength-age plots for the field and lab-produced concrete are shown in Figures I, II, and III.

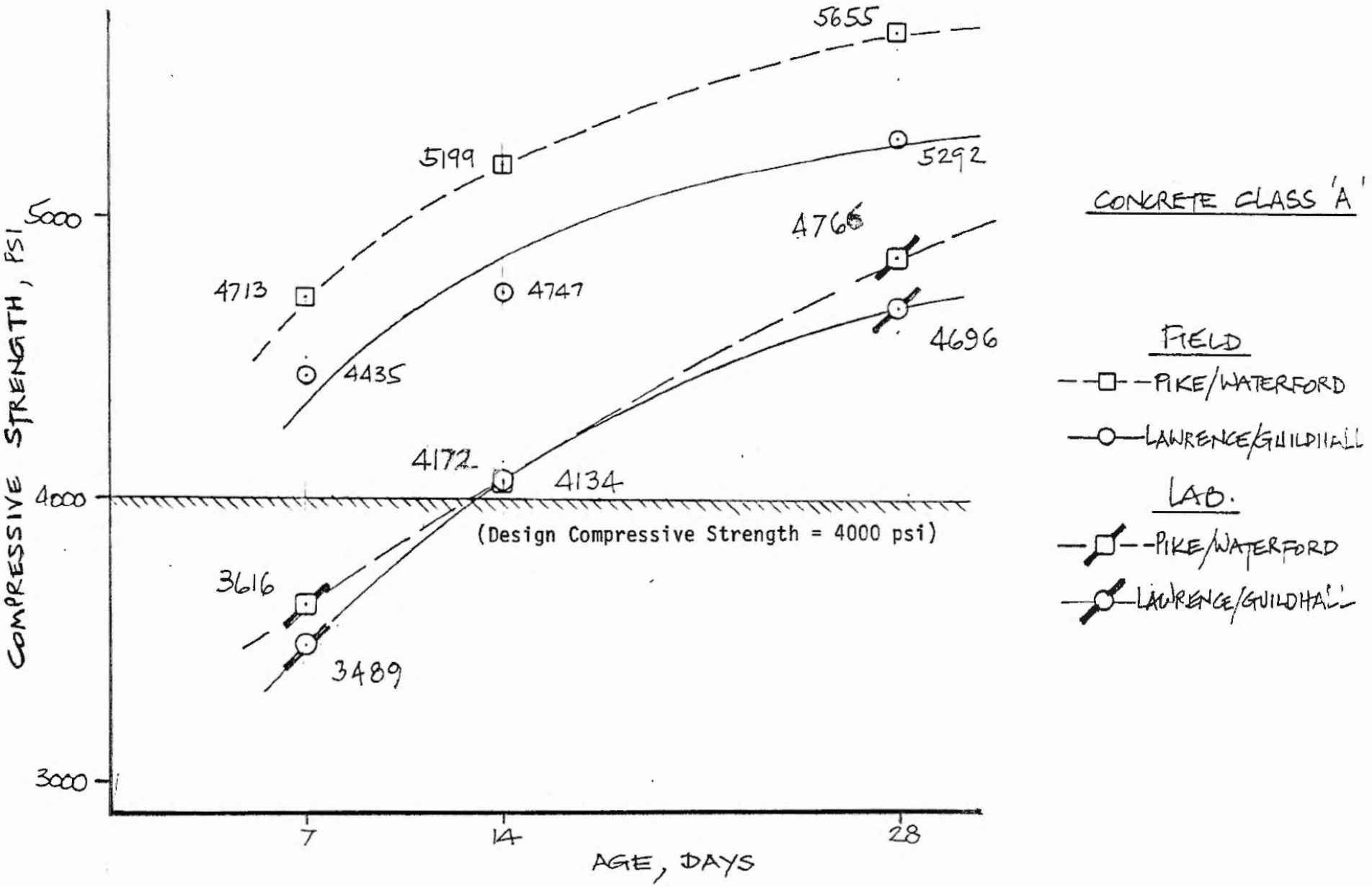
CONCLUSIONS AND RECOMMENDATIONS

1. The 3/4" crushed stone coarse aggregate from Pike Industries, Inc., Waterford, Vermont complied with all requirements of Section 704.02 when tested in conjunction with this evaluation.

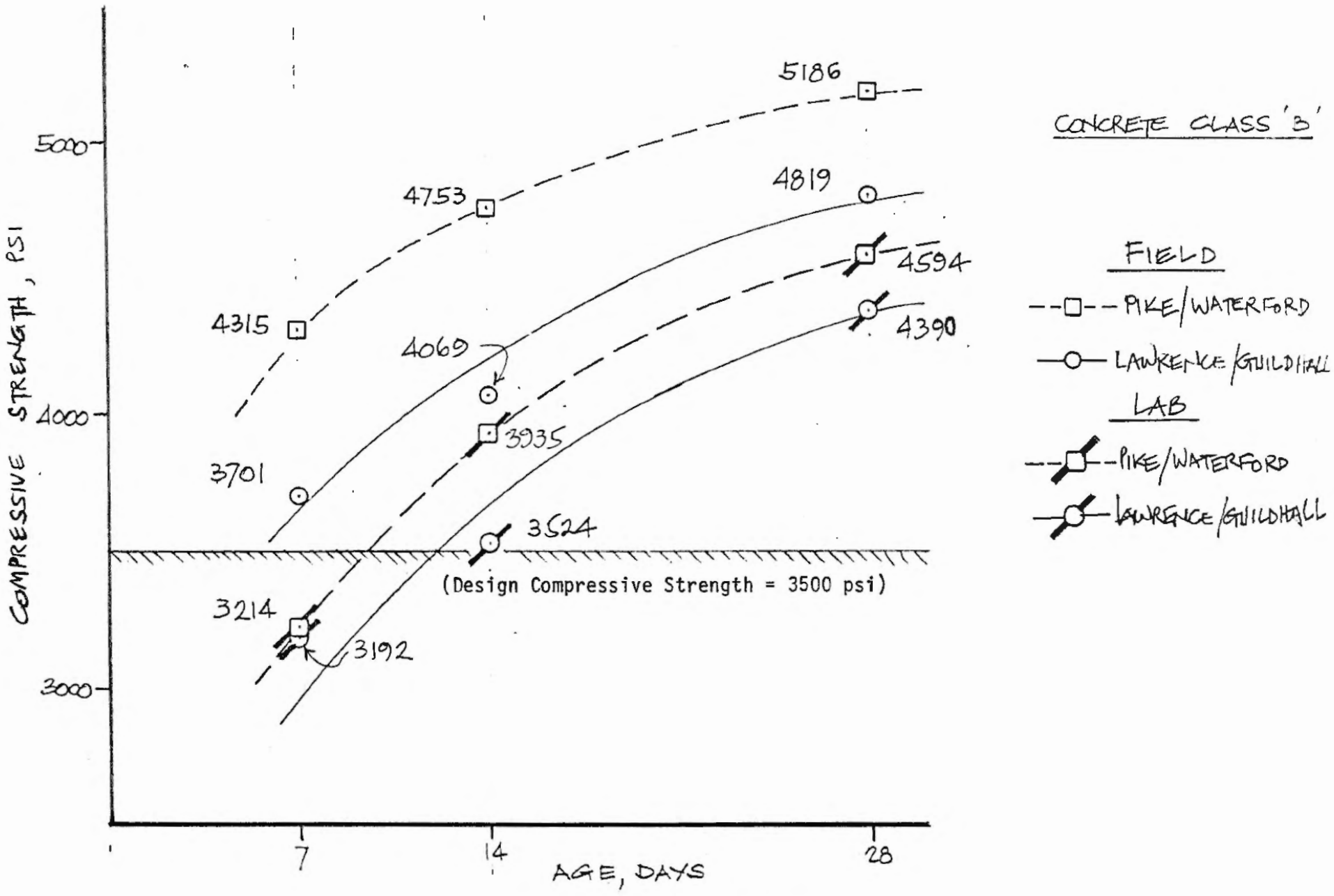
2. For all classes of concrete using Guildhall sand, whether produced in the laboratory or as ready mixed concrete, the mixtures with Pike/Waterford coarse aggregate had strengths equal to or greater than the reference concrete.

3. For Class A and C mixtures using Guildhall sand, the concrete with Pike/Waterford coarse aggregate had greater freeze-thaw durability than the reference concrete.

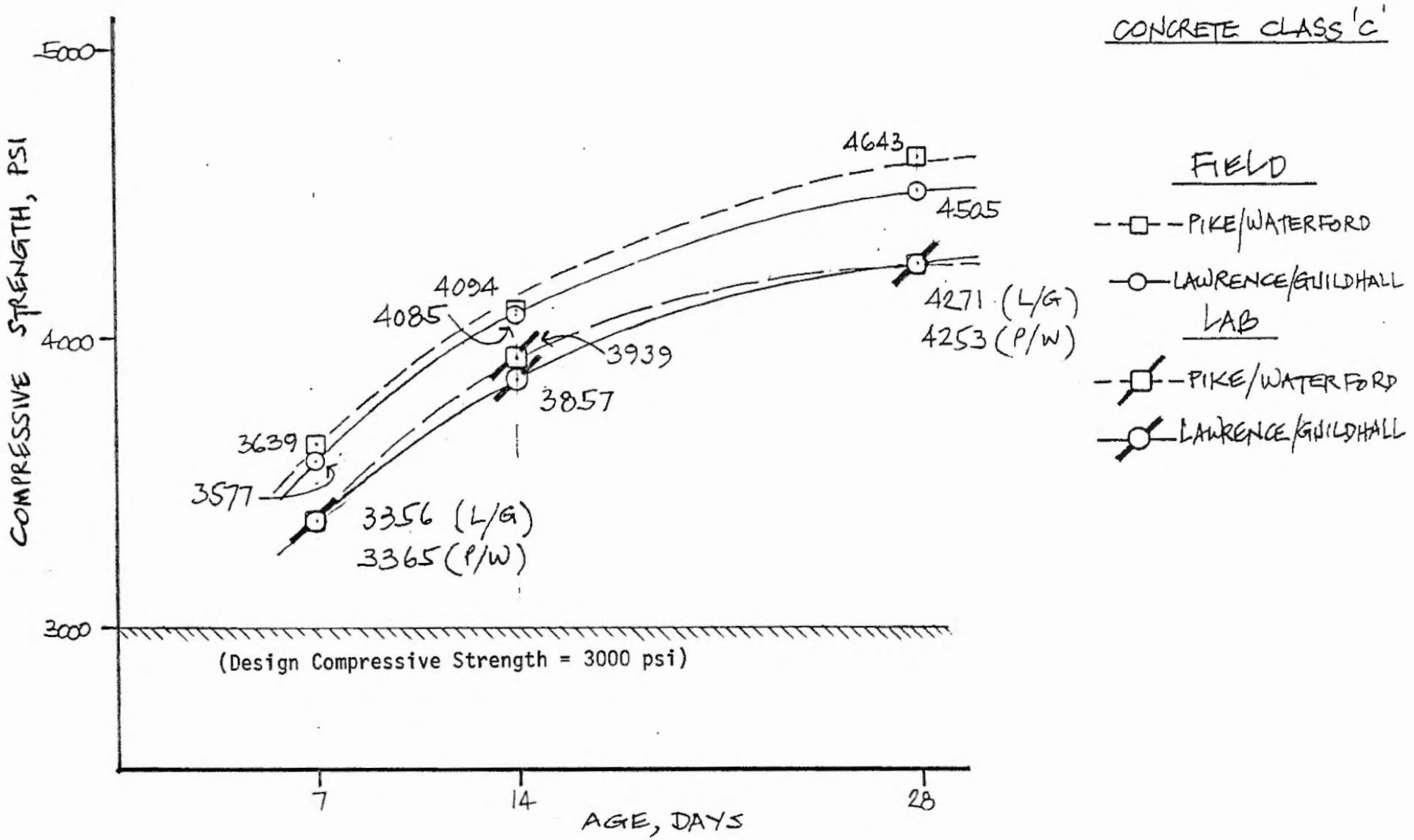
4. It is recommended that 3/4 inch crushed stone from the Pike Industries, Inc. quarry in Waterford, Vermont be approved for use in structural concrete.



COMPRESSIVE STRENGTH VS AGE
CLASS A
FIGURE I



COMPRESSIVE STRENGTH VS AGE
CLASS B
FIGURE II



COMPRESSIVE STRENGTH VS AGE
CLASS C
FIGURE III

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 of the aggregate, when the Phase II tests have been completed.

Prepared By: P.A. Cover
Date: May 5, 1981

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, 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.

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 SAMPLE OF AGGREGATE

Report April 21, 19 81

Laboratory No. A81-0218 Tested By M. Lavin

Name Coarse Aggregate for Concrete 501

Identification Marks Preliminary Sample Crushed Stone

Submitted by M. Morissette Title PFP Address

Sampled 4/17, 19 81 Received 4/20, 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 Item 704.02

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"	100
3/4"	97
5/8"	
1/2"	
3/8"	31
No. 4	8
No. 8	3
No. 10	
No. 16	
No. 30	
No. 50	
No. 100	
No. 200	

Sand Portion

Fineness Modulus
% Coarser Than

No. 100	
No. 50	
No. 30	
No. 16	
No. 8	
No. 4	

Fineness Modulus =

Comments:

Percent of Wear

AASHTO T3
AASHTO T4
AASHTO T96 16.4

Fractured Faces, % 100

Thin & Elongated Pieces, % 9

Soundness, % Loss

This material was examined for gradation, wear, fractured face and T & E. The results are as indicated.

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

By: R. F. Nicholson 1/27

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

Project Name

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

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MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

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APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C8100251 (28) Report of 7, 14, 28 Day Breaks Date typed 6-15-81

Pay Item Performance in Concrete Type of Sample Field

Submitted by M. Morissette Title PFP Address

Source of Material Lawrence - St. Johnsbury Quantity Represented 1 cy

Coarse Aggregate Lawrence, Guildhall Fine Aggregate Lawrence - Guildhall

Cement Brand Glens Falls Type II Lbs. 565

Air Entraining Admixture Darex AEA Dosage 1½ 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 Trk #26 @ plant Date Sampled: 5-15-81

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

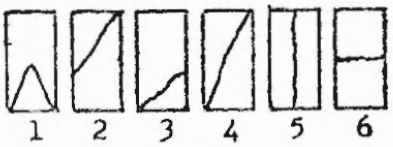
Unit Weight Fresh Concrete 147.91 Air: Pressure 4.0 Chace

Total Water, Gal/Cy Used Slump 3 Temperature, Concrete 71° 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
GC 1	151	5-18	5-22	7	7		3616	3537	3577		
2	151										
3	151	5-18	5-28	13	13		4067	4103	4085		
4	151										
5	151	5-18	6-12	28	28		4527	4483	4505		
6	151										

*S = Standard Cured; F = Field Cured

Types of Breaks:



mlm

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

By: R. F. Nicholson /R17

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

Comments:
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Project Name

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

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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. C8100252(28) Report of 7/14/28 Day Breaks Date typed 6-15-81

Pay Item Performance in Concrete Type of Sample Field

Submitted by M. Morissette Title PFP Address

Source of Material Lawrence - St. Johnsbury Quantity Represented 1 cy

Coarse Aggregate Lawrence - Guildhall Fine Aggregate Lawrence - Guildhall

Cement Brand Glens Falls Type II Lbs. 660

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.

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from Trk . #40 @ plant Date Sampled: 5-15-81

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

Unit Weight Fresh Concrete 149.67 Air: Pressure 3.4 Chace

Total Water, Gal/Cy Used Slump 3 1/4 Temperature, Concrete 72° Ambient 68°

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
GA 1	152	5-18	5-22	7	7		4492	4377	4435		
2	152										
3	152	5-18	5-28	13	13		4860	4633	4747		
4	152										
5	152	5-18	6-12	28	28		5208	5376	5292		
6	152										

*S = Standard Cured; F = Field Cured

Types of Breaks:

mlm

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

By: R. F. Nicholson 10/17

Comments:
TA 183h Rev.
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Project Name

W. P. No. 81-C-6

Project Number

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Montpelier, Vermont 05602

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APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C8100253 (28) Report of 7, 14, 28 Day Breaks Date typed 6-15-81

Pay Item Performance in Concrete Type of Sample Field

Submitted by M. Morissette Title Address

Source of Material Lawrence - St. Johnsbury Quantity Represented 1 cy

Coarse Aggregate Lawrence - Guildhall Fine Aggregate Lawrence - Guildhall

Cement Brand Glens falls Type II Lbs. 611

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

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

Field Tested by M. Morissette Lab. Tested by Eaton..

Sampled from Trk. #39 @ plant Date Sampled: 5-15-81

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

Unit Weight Fresh Concrete 152.12 Air: Pressure 3.7 Chace

Total Water, Gal/Cy Used Slump 3 Temperature, Concrete 71 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
PB 1	155	5-18	5-22	7	7	S	4288	4341	4315		
2	154										
3	155	5-18	5 28	13	13	S	4748	4868	4753		
4	156										
5	156	5-18	6-12	28	28	S	5102	5270	5186		
6	156										

*S = Standard Cured; F = Field Cured

Types of Breaks:

mlm

Comments:
TA 183h Rev.
2M 4/31

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

By: R. E. Nicholson 1/97
R. E. Nicholson, P.E.

Project Name

W.P. No. 81-C-6

Project Number

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MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

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APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C8100254 (28) Report of 7, 14, 28 Day Breaks Date typed 6-15-81

Pay Item Performance in Concrete Type of Sample Field

Submitted by M. Morissette Title PFP Address

Source of Material Lawrence - St. Johnsbury Quantity Represented 1cy

Coarse Aggregate Lawrence - Guildhall Fine Aggregate Lawrence - Guildhall

Cement Brand Glens Falls Type II Lbs. 611

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 Trk #39 @ plant Date Sampled: 5-15-81

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

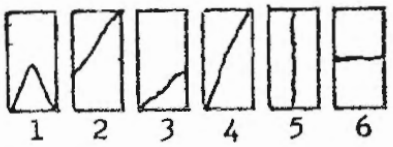
Unit Weight Fresh Concrete 144.95 Air: Pressure 6.2 Chace

Total Water, Gal/Cy Used Slump 3 1/2 Temperature, Concrete 72° 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
1 GB	148	5-18	5-22	7	7	S	3705	3696	3701		
2	148										
3	148	5-18	5-18	13	13	S	4145	3993	4069		
4	148										
5	148	5-18	5-18	28	28	S	4845	4792	4819		
6	148										

*S = Standard Cured; F = Field Cured

Types of Breaks:



mlm

Comments:
183h Rev.
1/81

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

By: R. F. Nicholson 6/17
R. F. Nicholson, P.E., Materials & Research Engineer

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. C8100255 (28) Report of 7, 14, 28 Day Breaks Date typed 6-15-81

Pay Item Performance in Concrete Type of Sample 1 cy

Submitted by M. Morissette Title PFP Address

Source of Material Lawrence Quantity Represented 1 cy

Coarse Aggregate Pike, Waterford Fine Aggregate Lawrence - Guildhall

Cement Brand Glens Falls Type II Lbs. 565

Air Entraining Admixture Darex AEA Dosage 1½ 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 Trk #50 @ plant Date Sampled: May 15, 1981

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

Unit Weight Fresh Concrete 150.56 Air: Pressure 4.4 Chace

Total Water, Gal/Cy Used 2 Slump 2 1/2 Temperature, Concrete 74° 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
1 PC 2	153 153	5-18	5-22	7	7	S	3643	3634	3639		
3 4	153 153	5-18	5-28	13	13	S	4023	4165	4094		
5 6	153 153	5-18	6-12	28	28	S	4669	4616	4643		

*S = Standard Cured; F = Field Cured

Types of Breaks:

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

By: R. F. Nicholson 6/17

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

mlm

Comments:
TA 1331 Rev. 2M 3/31

Project Name

Work Plan 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. C8100256 (28) Report of 7, 14, 28 Day Breaks Date typed 6-15-81

Pay Item Performance in Concrete Type of Sample Field

Submitted by M, Morissette Title PFP Address

Source of Material Lawrence - St. Johnsbury Quantity Represented 1 cy

Coarse Aggregate Pike - Waterford Fine Aggregate Lawrence & Guildhall

Cement Brand Glens Falls Type II Lbs. 660

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.

Field Tested by M. Morissette Lab. Tested by Eaton

Sampled from Trk # 5 @ plant Date Sampled: 5-15-81

Location Used or to be Used

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

Unit Weight Fresh Concrete 151.40 Air: Pressure 3.6 Chace

Total Water, Gal/Cy Used Slump 3 1/2 Temperature, Concrete 72 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
PA 1	155	5-18	5-22	7	7		4633	4792	4713		
PA 2	155										
3	155	5-18	5-28	13	13		5188	5210	5199		
4	155										
5	156	5-18	6-12	-	28		5491	5818	5655		
6	156										

*S = Standard Cured; F = Field Cured

Types of Breaks:

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

By: R. A. Nicholson 1817

mlm

Comments:
TA 183h Rev.
2x 1/31

Project Name

WP 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. C8100306 (28) Report of 7, 14, 28 Day Breaks Date typed 6-18-81

Pay Item Performance in Concrete Type of Sample Lab

Submitted by W. Meyer Title CLP Address

Source of Material Materials & Research, Berlin, Vt. Quantity Represented 1.75 cf

Coarse Aggregate L.M. Pike, Waterford, Vt. Fine Aggregate Lawrence, Guildhall, Vt.

Cement Brand Glens Falls Type II Lbs. 565

Air Entraining Admixture Darex AEA Dosage 1½ oz/cy Admixture WRDA Hycol Dosage 3 oz/cwt

Maximum allowable water content, Gal/Cy Total Aggregate, Dry Wgt. 3294

Field Tested by W. Meyer Lab. Tested by Eaton

Sampled from Lancaster Mixer Date Sampled: 5-20-81

Location Used or to be Used Test Mix

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

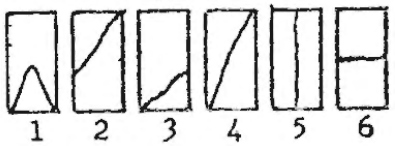
Unit Weight Fresh Concrete 152.08 Air: Pressure 4.4% Chace

Total Water, Gal/Cy Used 37.1 Slump 2" Temperature, Concrete 70° 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
LPC 1	152		5-27	7	7	S	3316	3431	3365		
2	152										
3	152		6-2	13	13	S	3908	3970	3939		
4	152										
5	153		6-17	28	28	S	4279	4226	4253		
6	153										

*S = Standard Cured; F = Field Cured

Types of Breaks:



mlm

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

By: R. F. Nicholson 10/17

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

Project Name

WP 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. C8100307 (28) Report of 7, 14, 28 Day Breaks Date typed 6-18-81

Pay Item Performance in Concrete Type of Sample Lab

Submitted by W. Meyer Title CLP Address

Source of Material Materials & Research Lab, Berlin Quantity Represented 1.75 cf

Coarse Aggregate Lawrence - Guildhall, Vt. Fine Aggregate Lawrence - Guildhall, Vt.

Cement Brand Glens Falls Type II Lbs. 565

Air Entraining Admixture Darex AEA Dosage 1½ oz/cy Admixture WRDA Hycol Dosage 3 oz/cwt

Maximum allowable water content, Gal/Cy Total Aggregate, Dry Wgt. 3193

Field Tested by W. Meyer Lab. Tested by Eaton

Sampled from Lancaster Mixer Date Sampled: 5-20-81

Location Used or to be Used Reference Mix

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

Unit Weight Fresh Concrete 148.05 Air: Pressure 4.8% Chace

Total Water, Gal/Cy Used 36.4 Slump 3" Temperature, Concrete 72° 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
LGC 1	150		5-27	7	7	S	3360	3351	3356		
2	148										
3	149		6-2	13	13	S	3820	3894	3857		
4	150										
5	150		6-17	28	28	S	4262	4279	4271		
6	150										

*S = Standard Cured; F = Field Cured

Types of Breaks:

mlm

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

Comments:
TA 183L Rev.
2M 4/31

Project Name

WP 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. C8100308 (28) Report of 7, 14, 28 Day Breaks Date typed 6-18-81

Pay Item Performance in Concrete Type of Sample Lab

Submitted by W. Meyer Title CLP Address

Source of Material Materials & Research Lab, Berlin Quantity Represented 1.75 cf

Coarse Aggregate Lawrence, Guildhall, Vt. Fine Aggregate Lawrence - Guildhall, Vt.

Cement Brand Glens Falls Type II Lbs. 611

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. 3087

Field Tested by W. Meyer Lab. Tested by Eaton

Sampled from Lancaster Mixer Date Sampled: 5-20-81

Location Used or to be Used Reference Mix

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

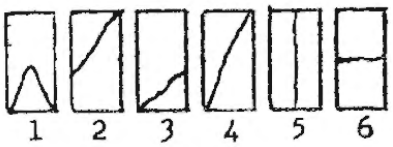
Unit Weight Fresh Concrete 148.97 Air: Pressure 4.2% Chace

Total Water, Gal/Cy Used 33.4 Slump 2¼ Temperature, Concrete 70° 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
LGB	1	150		5-27	7	7	S	3210	3174	3192		
	2	150										
	3	150		6-2	13	13	S	3130	3917	3524		
	4	151										
	5	150		6-17	28	28	S	4209	4571	4390		
	6	150										

*S = Standard Cured; F = Field Cured

Types of Breaks:



mlm

Comments:
TA 193b Rev.
2/4/81

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

By: R. F. Nicholson RFN

R. F. [illegible] Research Engineer

Project Name

WP 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. C8100309 (28) Report of 7, 14, 28 Day Breaks Date typed 6-18-81

Pay Item Performance in Concrete Type of Sample Lab

Submitted by W. Meyer Title CLP Address

Source of Material Materials & Research Lab, Berlin Quantity Represented 1.75 cf

Coarse Aggregate L.M. Pike, Waterford, Vt. Fine Aggregate Lawrence - Guildhall

Cement Brand Glens Falls Type II Lbs. 611

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. 3184

Field Tested by W. Meyer Lab. Tested by Eaton

Sampled from Lancaster Mixer Date Sampled: 5-20-81

Location Used or to be Used Test Mix

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

Unit Weight Fresh Concrete 151.60 Air: Pressure 4.9% Chace

Total Water, Gal/Cy Used 35.0 Slump 2 Temperature, Concrete 72° 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
LPB 1	152		5-27	7	7	S	3227	3201	3214		
LPB 2	152										
3	152		6-2	13	13	S	3846	4023	3935		
4	153										
5	152		6-17	28	28	S	4669	4518	4594		
6	152										

*S = Standard Cured; F = Field Cured

Types of Breaks:

mlm

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

R. F. Nicholson 1917

Comments:

By:

Project Name

WP 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. C8100310 (28) Report of 7, 14, 28 Day Breaks Date typed 6-18-81

Pay Item Performance in Concrete Type of Sample Lab

Submitted by W. Meyer Title CLP Address

Source of Material Materials & Research Lab, Berlin Quantity Represented 1.75 cf

Coarse Aggregate L.M. Pike, Waterford, Vt. Fine Aggregate Lawrence, Guildhall

Cement Brand Glens Falls Type II Lbs. 660

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. 3037

Field Tested by W. MEyer Lab. Tested by Eaton

Sampled from Lancaster Mixer Date Sampled: 5-20-81

Location Used or to be Used test mix

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

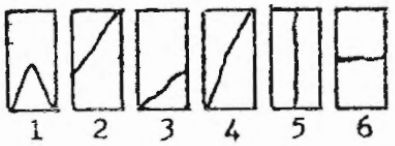
Unit Weight Fresh Concrete 152.03 Air: Pressure 5.0% Chace

Total Water, Gal/Cy Used 34.2 Slump 2½" Temperature, Concrete 70° 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
LPA 1	152		5-27	7	7	S	3563	3669	3616		
2	152										
3	152		6-2	13	13	S	4219	4124	4172		
4	152										
5	152		6-17	28	28	S	4403	5128	4766		
6	152										

*S = Standard Cured; F = Field Cured

Types of Breaks:



mlm

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

R. A. Nicholson 1/27

[illegible], P.E., Materials & Research Engineer

Comments:
TA 183H Rev.
4/81

Project Name

WP 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. C8100311 (28) Report of 7, 14, 28 Day Breaks Date typed 6-18-81

Pay Item Performance in Concrete Type of Sample Lab

Submitted by W. Meyer Title CLP Address

Source of Material Materials & Research Lab, Berlin Quantity Represented 1.75 cf

Coarse Aggregate Lawrence, Guildhall, Vt. Fine Aggregate Lawrence, Guildhall, Vt.

Cement Brand Glens Falls Type II Lbs. 660

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. 3036

Field Tested by W. Meyer Lab. Tested by Eaton

Sampled from Lancaster Mixer Date Sampled: 5-20-81

Location Used or to be Used Reference mix

Examined for Mod. of Rupture Compressive Strength

TEST RESULTS

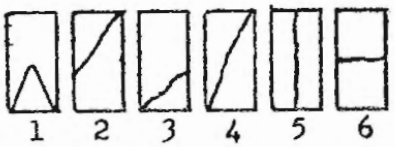
Unit Weight Fresh Concrete 148.01 Air: Pressure 5.4% Chace

Total Water, Gal/Cy Used 33.2 Slump 2 3/4" Temperature, Concrete 70° 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
1	148										
LGA 2	148		5-27	7	7	S	3431	3546	3489		
3	149										
4	148		6-2	13	13	S	4244	4023	4134		
5	148										
6	148		6-17	28	28	S	4722	4669	4696		

*S = Standard Cured; F = Field Cured

Types of Breaks:



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

By: R. F. Nicholson 1/27

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

Comments:
TA 183A Rev.
2/81

TA 565 Rev. 4/79

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

APPENDIX D

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

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 Inc. crushed stone and washed sand from their Waterford quarry as a structural concrete aggregate source.

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

Proposal Discussed With R. I. Fascoia 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. F. Nicholson

Comments by Materials & Research Engineer 5/15/81

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

Prepared By: P.A. Cover
Date: May 5, 1981

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, 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.

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).