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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Date: Oct. 21, 1982
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</tbody>
</table>
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 I93 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

Water Reducing Admixture:

WRDA with Hycol

Aggregate properties used for preparing mix designs are as follows:

Pike Coarse Aggregate:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk Specific Gravity</td>
<td>2.94</td>
</tr>
<tr>
<td>Absorption, percent</td>
<td>0.5</td>
</tr>
<tr>
<td>Dry rodded unit weight, lbs./ft³</td>
<td>107.13</td>
</tr>
</tbody>
</table>

Guildhall Coarse Aggregate:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk Specific Gravity</td>
<td>2.74</td>
</tr>
<tr>
<td>Absorption, percent</td>
<td>0.9</td>
</tr>
<tr>
<td>Dry rodded unit weight, lbs./ft³</td>
<td>101.80</td>
</tr>
</tbody>
</table>

Guildhall Fine Aggregate:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk Specific Gravity</td>
<td>2.64</td>
</tr>
<tr>
<td>Absorption, percent</td>
<td>1.3</td>
</tr>
<tr>
<td>Fineness modulus</td>
<td>2.90</td>
</tr>
</tbody>
</table>

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
mixture 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.

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

*Aggregates batched dry, weights converted to saturated surface-dry condition.
### TABLE 2
**NEW AGGREGATE**
**LAB MIXTURES - BATCH QUANTITIES PER CY.**

<table>
<thead>
<tr>
<th></th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>New Coarse Aggregate, lbs.</em></td>
<td>1773</td>
<td>1773</td>
<td>1773</td>
</tr>
<tr>
<td><em>Fine Aggregate, lbs.</em></td>
<td>1290</td>
<td>1438</td>
<td>1550</td>
</tr>
<tr>
<td>Cement, lbs.</td>
<td>660</td>
<td>611</td>
<td>565</td>
</tr>
<tr>
<td>Air Entraining Admixture, oz.</td>
<td>4</td>
<td>3</td>
<td>1 1/2</td>
</tr>
<tr>
<td>Water Reducing Admixture, oz.</td>
<td>19.8</td>
<td>18.3</td>
<td>17.0</td>
</tr>
<tr>
<td>Net Water, Gals.</td>
<td>34.3</td>
<td>35.0</td>
<td>34.2</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th></th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Reference Coarse Aggregate, lbs.</em></td>
<td>1692</td>
<td>1692</td>
<td>1692</td>
</tr>
<tr>
<td><em>Fine Aggregate, lbs.</em></td>
<td>1275</td>
<td>1428</td>
<td>1535</td>
</tr>
<tr>
<td>Cement, lbs.</td>
<td>660</td>
<td>611</td>
<td>565</td>
</tr>
<tr>
<td>Air Entraining Admixture, oz.</td>
<td>3 1/2</td>
<td>3</td>
<td>1 1/2</td>
</tr>
<tr>
<td>Water Reducing Admixture, oz.</td>
<td>19.8</td>
<td>18.3</td>
<td>17.0</td>
</tr>
<tr>
<td>Net Water, Gals.</td>
<td>30.1</td>
<td>28.9</td>
<td>25.5</td>
</tr>
</tbody>
</table>

*Weights converted to saturated surface-dry condition.

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

<table>
<thead>
<tr>
<th></th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>New Coarse Aggregate, lbs.</em></td>
<td>1773</td>
<td>1773</td>
<td>1773</td>
</tr>
<tr>
<td><em>Fine Aggregate, lbs.</em></td>
<td>1290</td>
<td>1438</td>
<td>1550</td>
</tr>
<tr>
<td>Cement, lbs.</td>
<td>660</td>
<td>611</td>
<td>565</td>
</tr>
<tr>
<td>Air Entraining Admixture, oz.</td>
<td>3 1/2</td>
<td>3</td>
<td>1 1/2</td>
</tr>
<tr>
<td>Water Reducing Admixture, oz.</td>
<td>19.8</td>
<td>18.3</td>
<td>17.0</td>
</tr>
<tr>
<td>Net Water, Gals.</td>
<td>29.6</td>
<td>25.5</td>
<td>28.1</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Slump, inches</th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Content, percent</td>
<td>2 3/4</td>
<td>2 1/4</td>
<td>3</td>
</tr>
<tr>
<td>Unit Weight, lbs/ft³</td>
<td>148.01</td>
<td>148.97</td>
<td>148.05</td>
</tr>
<tr>
<td>Relative yield, percent</td>
<td>97.6</td>
<td>99.7</td>
<td>102.4</td>
</tr>
<tr>
<td>Compressive strength, psi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 days</td>
<td>3489</td>
<td>3192</td>
<td>3356</td>
</tr>
<tr>
<td>14 days</td>
<td>4134</td>
<td>3524</td>
<td>3857</td>
</tr>
<tr>
<td>28 days</td>
<td>4696</td>
<td>4390</td>
<td>4271</td>
</tr>
<tr>
<td>(Design compressive strength, psi)</td>
<td>(4000)</td>
<td>(3500)</td>
<td>(3000)</td>
</tr>
</tbody>
</table>

### TABLE 6
NEW AGGREGATE
LAB MIXTURES; TEST RESULTS

<table>
<thead>
<tr>
<th>Slump, inches</th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Content, percent</td>
<td>2 1/2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Unit Weight, lbs/ft³</td>
<td>152.03</td>
<td>151.60</td>
<td>152.08</td>
</tr>
<tr>
<td>Relative yield, percent</td>
<td>97.7</td>
<td>100.5</td>
<td>102.2</td>
</tr>
<tr>
<td>Compressive Strength, psi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 days</td>
<td>3616</td>
<td>3214</td>
<td>3365</td>
</tr>
<tr>
<td>14 days</td>
<td>4172</td>
<td>3935</td>
<td>3939</td>
</tr>
<tr>
<td>28 days</td>
<td>4766</td>
<td>4594</td>
<td>4253</td>
</tr>
<tr>
<td>(Design compressive strength, psi)</td>
<td>(4000)</td>
<td>(3500)</td>
<td>(3000)</td>
</tr>
</tbody>
</table>
### TABLE 7
**REFERENCE AGGREGATE**
**FIELD MIXTURES; TEST RESULTS**

<table>
<thead>
<tr>
<th></th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slump, inches</td>
<td>3 1/4</td>
<td>3 1/2</td>
<td>3</td>
</tr>
<tr>
<td>Air content, percent</td>
<td>3.4</td>
<td>6.2</td>
<td>4.0</td>
</tr>
<tr>
<td>Unit weight, lbs/ft(^3)</td>
<td>149.67</td>
<td>144.95</td>
<td>147.91</td>
</tr>
<tr>
<td>Relative yield, percent</td>
<td>95.2</td>
<td>100.6</td>
<td>99.4</td>
</tr>
<tr>
<td>Compressive strength, psi</td>
<td>4435</td>
<td>3701</td>
<td>3577</td>
</tr>
<tr>
<td>7 days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 days</td>
<td>4747</td>
<td>4069</td>
<td>4085</td>
</tr>
<tr>
<td>28 days</td>
<td>5292</td>
<td>4819</td>
<td>4505</td>
</tr>
</tbody>
</table>

(Design Compressive Strength, psi) (4000) (3500) (3000)

### TABLE 8
**NEW AGGREGATE**
**FIELD MIXTURES; TEST RESULTS**

<table>
<thead>
<tr>
<th></th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slump, inches</td>
<td>3 1/2</td>
<td>3</td>
<td>2 1/2</td>
</tr>
<tr>
<td>Air content, percent</td>
<td>3.6</td>
<td>3.7</td>
<td>4.4</td>
</tr>
<tr>
<td>Unit weight, lbs/ft(^3)</td>
<td>151.40</td>
<td>152.12</td>
<td>150.56</td>
</tr>
<tr>
<td>Relative yield, percent</td>
<td>96.5</td>
<td>96.0</td>
<td>100.7</td>
</tr>
<tr>
<td>Compressive strength, psi</td>
<td>4713</td>
<td>4315</td>
<td>3639</td>
</tr>
<tr>
<td>7 days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 days</td>
<td>5199</td>
<td>4753</td>
<td>4094</td>
</tr>
<tr>
<td>28 days</td>
<td>5655</td>
<td>5186</td>
<td>4643</td>
</tr>
</tbody>
</table>

(Design Compressive Strength, psi) (4000) (3500) (3000)
TABLE 9
FREEZE-THAW DURABILITY

<table>
<thead>
<tr>
<th>Mixture Type</th>
<th>Class</th>
<th>25 Cycles</th>
<th>50 Cycles</th>
<th>75 Cycles</th>
<th>100 Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. New Aggregate</td>
<td>A</td>
<td>1</td>
<td>4</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>6</td>
<td>16</td>
<td>(40)*</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>8</td>
<td>15</td>
<td>(41)*</td>
<td>-</td>
</tr>
<tr>
<td>2. Reference</td>
<td>A</td>
<td>5</td>
<td>12</td>
<td>21 **</td>
<td>45</td>
</tr>
<tr>
<td>Aggregate</td>
<td>B</td>
<td>9</td>
<td>14</td>
<td>23 **</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>21</td>
<td>40</td>
<td>(86)*</td>
<td>-</td>
</tr>
</tbody>
</table>

* 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.
CONCRETE CLASS 'A'

FIELD
- - PIKE/WATERFORD
- - LAWRENCE/GUILDFIELD

LAB.
- - PIKE/WATERFORD
- - LAWRENCE/GUILDFIELD

DESIGN COMPRESSIVE STRENGTH = 4000 psi

AGE, DAYS

COMPRESSIVE STRENGTH VS AGE
CLASS A
FIGURE I
COMPRESSION STRENGTH VS AGE
CLASS B
FIGURE II

FIELD
- - - PIKE/WATERFORD
- - O LAURENCE/GUILDHALL
LAB
- - - PIKE/WATERFORD
- - O LAURENCE/GUILDHALL

CONCRETE CLASS' S'

(Design Compressive Strength = 3500 psi)
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-Mix 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.
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).
Laboratory No. A81-0218
Name

Identification Marks
Submitted by M. Morissette

Sampled 4/17, 1981
Sample from

Quantity Represented
Source of Material

Received 4/20, 1981
Stockpile @ Pike Waterford

Location used or to be used

Examined for

<table>
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<tr>
<th>Sieve Size</th>
<th>% Passing</th>
<th>Fineness Modulus % Coarser Than</th>
<th>Percent of Wear</th>
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Comments:

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, P.E., Materials & Research Engineer
**APPENDIX C**

**LABORATORY REPORT**

**Laboratory No.** C8103251 (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**

---

### TEST RESULTS

**Unit Weight Fresh Concrete** 147.91 **Air: Pressure** 4.0 **Chace**

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<th>Specimen No.</th>
<th>Cyl. Unit Wgt. P.C.F.</th>
<th>Date Rec'd</th>
<th>Date Broken</th>
<th>Desired age at break</th>
<th>Age at Break</th>
<th>Type* S - P</th>
<th>Break 1 P.S.I.</th>
<th>Break 2 P.S.I.</th>
<th>Ave. P.S.I.</th>
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*S = Standard Cured; *F = Field Cured

**Types of Breaks:**

![Types of Breaks Diagram]

**Comments:**

---

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

By: R. F. Nicholson, P.E., Materials & P.E.
APPENDIX C

Report on Concrete Test Beam or Cylinders

Laboratory No. C810252 (28) Report of 1/24/25 Day Breaks Date typed 6-15-81

Pay Item Performance in Concrete Type of Sample Field

Submitted by M. Morissette Title PFJ 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°F Ambient 68°F

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<th>Desired Age at Break</th>
<th>Age at Break</th>
<th>Type* S-F</th>
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<th>Break 2 P.S.I.</th>
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</table>

*S = Standard Cured; F = Field Cured

Types of Breaks:

mlm

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

By: 19

Comments:

R.F.M. 1971
## 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

Field

### 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

### Slump

3

### Temperature, Concrete

71

### Ambient

70

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<th>Age at Break</th>
<th>Type*</th>
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*S = Standard Cured;  
F = Field Cured

### Types of Breaks:

- Standard Cured
- Field Cured

### Comments:

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

By: [Signature]  
1987

---

TA 183H Rev.  
24 4/31
# 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°

<table>
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<th>Cyl. Unit Wgt. P.C.F.</th>
<th>Date Rec'd</th>
<th>Date Broken</th>
<th>Desired age at break</th>
<th>Age at Break</th>
<th>Type* S - F</th>
<th>Break 1 P.S.I.</th>
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*S = Standard Cured;  F = Field Cured

### Types of Breaks:

![Diagram of Types of Breaks]

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

By: R. F. Nicholson, P.E., Materials & Research Engineer
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. Morisette 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 1 1/2 oz/cy Admixture WRDA Hycol Dosage 3 oz/cwt

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

Field Tested by M. Morisette 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 Change

Total Water, Gal/Cy Used 2 Slump 2 1/2 Temperature, Concrete 74°F Ambient 70°F

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*S = Standard Cured; F = Field Cured

Types of Breaks:

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

By: R. F. Nicholson, P.E., Materials & Research Engineer
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 3/8 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

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*S = Standard Cured; F = Field Cured

Types of Breaks:

mlm

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

[Signatures]
# 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** Darenx 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°F **Ambient**

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*S = Standard Cured;  F = Field Cured

Types of Breaks:

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

By: [Signature]
# 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 Engraining Admixture** Darex AEA **Dosage** 1.5 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** Slump 3" **Temperature, Concrete** 72° Ambient

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<th>Desired age at break</th>
<th>Age at Break</th>
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*S = Standard Cured; F = Field Cured

**Types of Breaks:**

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

Comments: TA 183: Rev. 27/4/31
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
Sample 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 2½ Temperature, Concrete 70° Ambient

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*S = Standard Cured;  F = Field Cured

Types of Breaks:

mlm

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

By: [Signature]

[Note: The date and initials at the bottom right corner are not legible.]
# 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

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### Submitted by W. Meyer

**Title**: CLP

**Address**: 

### Source of Materials

- **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**
- **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

#### Temperature, Concrete

- **72°**

- **Ambient**

### Total Water, Gal/Cy Used

- **35.0**

### Slump

- **2**

### Break Type

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

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**S. J. Gage, P.E., Chief Engineer**
Project Name
STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
Montpelier, Vermont 05602

WP 81-C-6
Project Number

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

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*S = Standard Cured; F = Field Cured

Types of Breaks:

mlm

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

Comments:

1 2 3 4 5 6

28
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\(^\circ\) Ambient

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<tr>
<th>Specimen No.</th>
<th>Cyl. Unit Wgt.</th>
<th>P.C.F.</th>
<th>Date Rec'd</th>
<th>Date Broken</th>
<th>Desired age at break</th>
<th>Age at Break</th>
<th>Type*</th>
<th>Break 1 P.S.I.</th>
<th>Break 2 P.S.I.</th>
<th>Ave. P.S.I.</th>
<th>Break Type</th>
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<td>S</td>
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*S = Standard Cured; P = Field Cured

Types of Breaks:

- S = Standard Cured
- P = Field Cured

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

By: R. F. Nicholson, P.E., Materials & Research Engineer
Revised 4/79 Prepared by: P. A. Cover

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. J. Fragassa

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


Comments by Materials & Research Engineer: 5/5/81

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, 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).