# EVALUATION OF 3/4" CRUSHED STONE FROM CALKINS SAND & GRAVEL CORP. LYNDON, VERMONT FOR USE IN STRUCTURAL CONCRETE

REPORT 93-2
AUGUST 1993

REPORTING ON WORK PLAN 92-C-17

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

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## EXECUTIVE SUMMARY

To produce the optimum structural concrete, aggregate must be tested and evaluated to assure conformance with required specifications.

This report documents results of tests performed on a proposed new source of 3/4" crushed stone for structural concrete. The material tested was a 3/4" crushed stone produced at the Calkins Sand & Gravel Corp. facility in Lyndon, Vermont.

Test results and evaluation confirm this material meets the required specifications as a 3/4" crushed stone, coarse aggregate source for structural concrete.

## INTRODUCTION

To provide an accurate evaluation of an aggregate for use in structural concrete, not only should tests be initiated to assure compliance with required specifications, but a collation of the new aggregate with a previously evaluated reference aggregate should be performed. This procedure compares both aggregates by preparing and testing concrete mixtures under the same conditions.

Mr. Michael Classen, in charge of quality control at Lawrence Sangravco, initially requested an evaluation of 3/4" crushed stone processed at Calkins Sand & Gravel facility, Lyndon, Vermont in May 1992. Following his request, samples of the new material were obtained by Materials and Research Division representatives on June 11, 1992 and evaluated for compliance with the requirements of Section 704.02 of the Standard Specifications for Construction. The Agency of Transportation's Chief Geologist also traveled to the site to obtain samples for petrographic analysis of the material.

One initial sample of 3/4" crushed stone obtained on June 11, 1992 failed to comply with gradation requirements and the manufacturer was informed of the problem. The manufacturer later reported the 3/4" crushed stone to be in compliance with specifications, and subsequent samples of the material were obtained on August 31, 1992. Tests confirmed the manufacturer's claims and materials were obtained for the performance-in-concrete phase of the evaluation which was conducted in the Central Laboratory of the Materials and Research Division.

## PROCEDURES

### PHASE I - SECTION 704.01 AND SECTION 704.02 TESTS

The proposed new aggregate was sampled on June 11, 1992, by representatives of the Materials and Research Division, from a stockpile at the Calkins Sand & Gravel facility in Lyndon, Vermont. Subsequent samples were obtained on August 31, 1992 from stockpiles at the Lyndon facility and from stockpiles at the Lawrence Sangravco, plant in St. Johnsbury, Vermont. The 3/4" crushed stone was examined for Gradation (AASHTO T 27-84), Percent of Wear (AASHTO T 96-83), Thin and Elongated Pieces (VT AOT-MD 22), Fractured Faces (VT AOT-MD 23) and Sodium Sulfate Soundness (AASHTO T104-86).

The fine aggregate and reference coarse aggregate were from the Lawrence Sangravco facility in Guildhall, Vermont. The reference aggregates were sampled from stockpiles at the Lawrence Sangravco ready-mix concrete plant in St. Johnsbury, Vermont. The fine aggregate was examined for Gradation (AASHTO T 27-84) and Organic Impurities (AASHTO T 21-86). The reference 3/4" crushed gravel coarse aggregate was examined for Gradation (AASHTO T 27-84), Thin & Elongated Pieces (VT AOT-MD 22), Fractured Faces (VT AOT-MD 23) and Percent of Wear (AASHTO T 96-83). The fine aggregate and reference coarse aggregate were found to comply respectively with Section 704.01 and Section 704.02 requirements. Fine aggregate test results are shown in Table 1. Coarse aggregate test results are shown in Table 2 and Table 3. Aggregate test results are also shown in Laboratory Report Nos. G9200334, G9200335, G9200983, G9201000, G9201347, G9201348 and A930096, in Appendix B.

The Vermont Agency of Transportation, Chief Geologist traveled to the facility in Lyndon, VT to obtain samples for analysis. Copies of the Chief Geologist's petrographic analysis are shown in Appendix C.

TABLE 1

FINE AGGREGATE TEST DATA (Reference Aggregate)

| | Lawrence Sangravco, Guildhall, VT<br>Date Sampled<br>08-31-92 | VAOT Specification Requirements |
|---|---|---|
| Sieve Size | % Passing | % Passing |
| 3/8" | 100 | 100 |
| #4 | 100 | 95-100 |
| #8 | 89 | - |
| #16 | 65 | 50-80 |
| #30 | 39 | 25-60 |
| #50 | 17 | 10-30 |
| #100 | 6 | 2-10 |
| Fineness Modulus | 2.84 | 2.60-3.10 |
| Organic Impurities, color | <1 | 2 maximum |

TABLE 2

COARSE AGGREGATE TEST DATA (Proposed New Aggregate)

3/4" Crushed Stone
Calkins Sand & Gravel
Lyndon, VT

| | Dates Sampled | | | | | VAOT Specification |
|---|---|---|---|---|---|---|
| | 06-11-92 | 06-11-92 | 08-31-92 | 08-31-92 | 08-31-92 | Requirements |
| Sieve Size | % Passing | % Passing | % Passing | % Passing | % Passing | % Passing |
| 1" | 100 | 100 | 100 | 100 | - | 100 |
| 3/4" | 91 | 100 | 96 | 96 | - | 90-100 |
| 3/8" | 19 | 34 | 34 | 41 | - | 20-55 |
| #4 | 3 | 2 | 6 | 8 | - | 0-10 |
| #8 | 2 | 1 | 4 | 4 | - | 0-5 |
| L.A. Abrasion, % loss | 27.8 | 24.3 | 30.4 | 31.8 | - | 35 maximum |
| Thin and Elongated Pieces, % | 5.6 | 4.2 | 5.8 | 6.6 | - | 10 maximum |
| Fractured Faces, % | 100.0 | 100.0 | 100.0 | 100.0 | - | 50 minimum |
| Soundness, % loss | - | - | - | - | 1.17 | 8 maximum |

TABLE 3

COARSE AGGREGATE TEST DATA (Reference Aggregate)

| | 3/4" Crushed Gravel Lawrence Sangravco, Guildhall, VT<br>Date Sampled 08-31-92 | VAOT Specification Requirements |
|---|---|---|
| Sieve Size | % Passing | % Passing |
| 1" | 100 | 100 |
| 3/4" | 96 | 90-100 |
| 3/8" | 35 | 20-55 |
| #4 | 3 | 0-10 |
| #8 | 2 | 0-5 |
| L. A. Abrasion, % wear | 24.4 | 35 maximum |
| Thin and Elongated Pieces, % | 1.8 | 10 maximum |
| Fractured Faces, % | 86.6 | 50 minimum |
| Soundness, % loss | - | 8 maximum |

## PHASE II PERFORMANCE-IN-CONCRETE TESTS

The performance-in-concrete tests were conducted on concrete prepared in the Central Laboratory. Mixtures were designed by Structural Concrete Subdivision personnel for Class A and Class B concrete, using the following materials:

### Fine Aggregate

A. Reference Aggregate and Proposed New Aggregate

Lawrence Sangravco, Guildhall, VT

### Coarse Aggregate

A. Proposed New Aggregate

Calkins Sand & Gravel Co., Lyndon, VT

B. Reference Aggregate

Lawrence Sangravco, Guildhall, VT

### Cement

Type II
Ciment Quebec Inc., Comte de Portneuf, QC, Canada

### Air Entraining Admixture

Daravair
W. R. Grace Co., Cambridge, MA

### Water Reducing Admixture

WRDA with Hycol
W. R. Grace Co., Cambridge, MA

Aggregate properties used for preparing mix designs are shown in Table 4 and Table 5.

TABLE 4

FINE AGGREGATE PROPERTIES

| | Bulk Specific Gravity | Absorp., Percent | Fineness Modulus |
|---|---|---|---|
| Reference Aggregate Lawrence Sangravco, Guildhall, VT | 2.61 | 1.6 | 2.90 |

TABLE 5

COARSE AGGREGATE PROPERTIES

| | Bulk Specific Gravity | Absorp., Percent | Dry Rodded Unit Weight, $lbs/ft^3$ |
|---|---|---|---|
| Proposed New Aggregate Calkins Sand & Gravel, Lyndon, VT | 2.74 | 0.7 | 101.55 |
| Reference Aggregate Lawrence Sangravco, Guildhall, VT | 2.74 | 1.0 | 104.60 |

The concrete used in this evaluation was mixed in a Sears rotary drum mixer with batch size being 1.8 cubic feet. Aggregates were dried prior to the start of mixing operations.

Two batches each of Class A and Class B concrete containing the new fine aggregate and the new coarse aggregate were prepared as well as two batches each of the Class A and Class B concrete containing the reference aggregates.

The mix proportions used are shown in Table 6 and Table 7.

TABLE 6

NEW AGGREGATE MIX DESIGN
BATCH QUANTITIES PER C.Y.

| | Class A | | Class B | |
|---|---|---|---|---|
| | Batch 7 | Batch 8 | Batch 3 | Batch 4 |
| *Coarse Aggregate, lbs. | 1685 | 1685 | 1685 | 1685 |
| *New Fine Aggregate, lbs. | 1255 | 1255 | 1316 | 1316 |
| Cement, lbs. | 660 | 660 | 611 | 611 |
| Air Entraining Admixture, oz. | 4 | 4 | 2 | 2 |
| Water Reducing Admixture, oz. | 19.8 | 19.8 | 18.3 | 18.3 |
| Net Water, gal. | 33.0 | 32.5 | 32.6 | 30.9 |

*Weights converted to saturated surface-dry condition

TABLE 7

REFERENCE AGGREGATE MIX DESIGN
BATCH QUANTITIES PER C.Y.

| | Class A | | Class B | |
|---|---|---|---|---|
| | Batch 5 | Batch 6 | Batch 1 | Batch 2 |
| *Coarse Aggregate, lbs. | 1740 | 1740 | 1740 | 1740 |
| *Fine Aggregate, lbs. | 1229 | 1229 | 1350 | 1350 |
| Cement, lbs. | 660 | 660 | 611 | 611 |
| Air Entraining Admixture, oz. | 4 | 4 | 2.1 | 2.1 |
| Water Reducing Admixture, oz. | 19.8 | 19.8 | 18.3 | 18.3 |
| Net Water, gal. | 33.1 | 33.5 | 31.3 | 31.2 |

*Weights converted to saturated surface-dry condition

Tests were performed on the fresh concrete to determine Slump (AASHTO T 119-86), Air Content (AASHTO T 152-86) and Unit Weight (AASHTO T 121-86). Six test cylinders (6" x 12") and two 3"w x 3"d x 16"l freeze-thaw specimens were cast from each batch. The cylinders were tested for compressive strength (AASHTO T 22-86), two each at ages 7, 14 and 28 days. The freeze-thaw specimens were moist cured for 14 days, after which they were subjected to freezing and thawing (AASHTO T 161-86) in 3% NaCl solution.

## RESULTS

Results of tests on the fresh concrete and compressive strength test results are shown in Table 8 and Table 9.

TABLE 8

PERFORMANCE TEST RESULTS
NEW AGGREGATE

| | Class A | | Class B | |
|---|---|---|---|---|
| | Batch 7 | Batch 8 | Batch 3 | Batch 4 |
| Slump, inches | 2 | 2 3/4 | 3 1/4 | 2 3/4 |
| Air Content, percent | 5.0 | 5.8 | 5.4 | 4.7 |
| Unit Weight, lbs/ft$^3$ | 147.99 | 145.63 | 144.75 | 145.79 |
| Compressive Strength, psi | | | | |
| 7 days | 3957 | 3986 | 3745 | 3908 |
| 14 days | 4319 | 4371 | 4335 | 4439 |
| 28 days | 4909 | 4884 | 4655 | 4917 |
| (Design Compressive Strength, psi) | (4000) | | (3500) | |

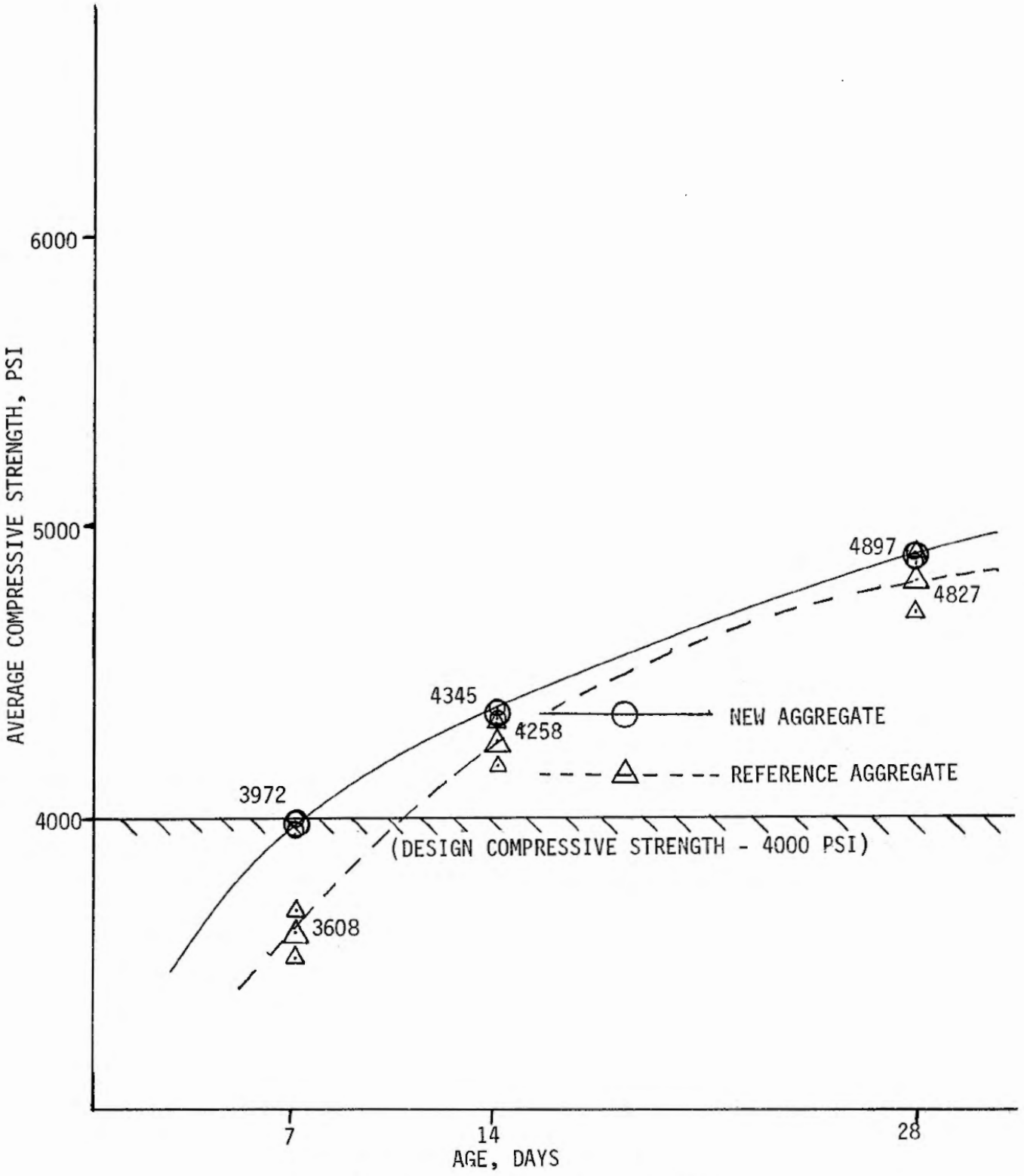
TABLE 9

PERFORMANCE TEST RESULTS
REFERENCE AGGREGATE

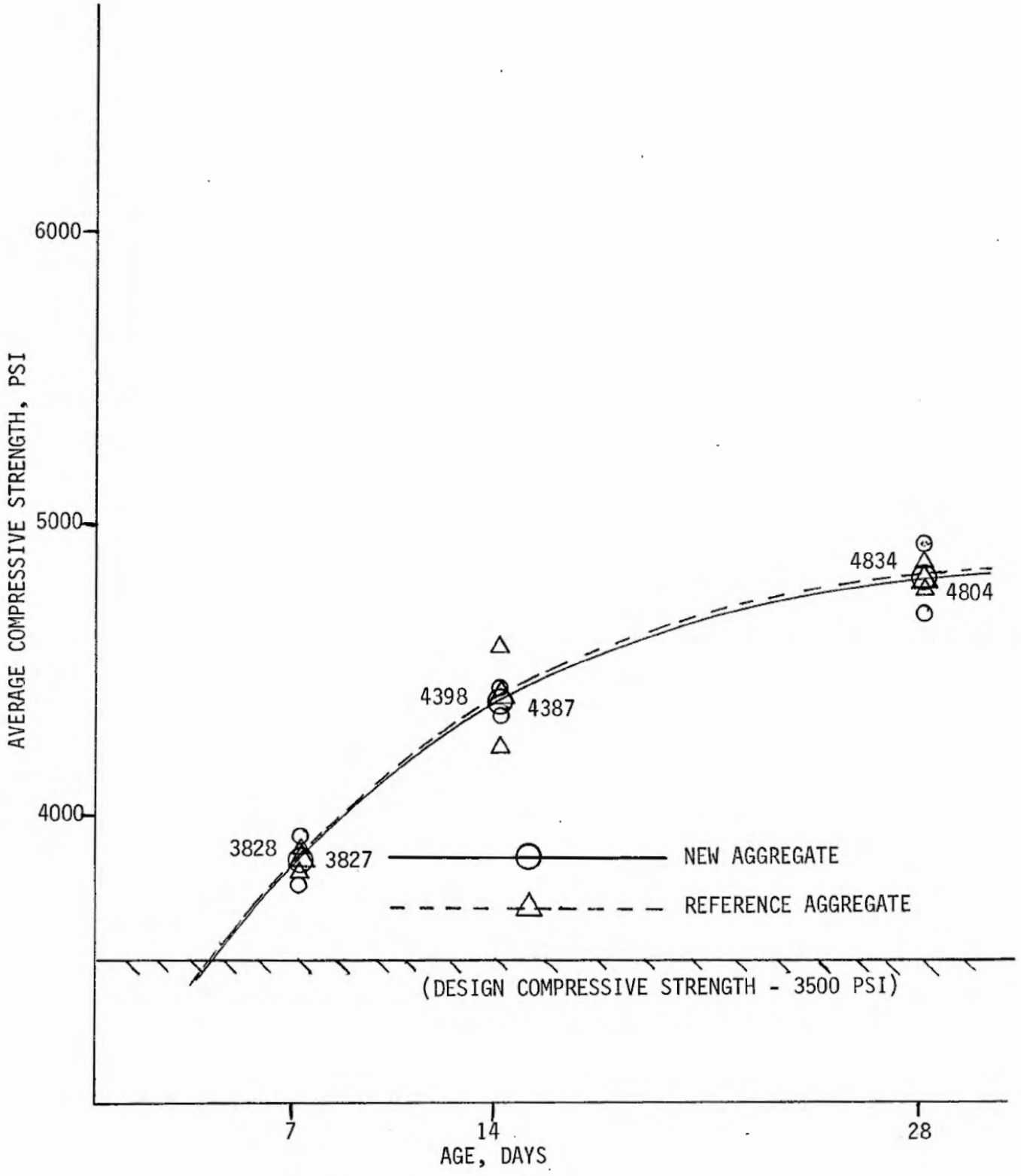
| | Class A | | Class B | |
|---|---|---|---|---|
| | Batch 5 | Batch 6 | Batch 1 | Batch 2 |
| Slump, inches | 2 1/2 | 2 1/2 | 3 1/4 | 2 3/4 |
| Air Content, percent | 6.2 | 6.9 | 5.2 | 5.4 |
| Unit Weight, lbs/ft$^3$ | 145.95 | 144.75 | 145.67 | 146.03 |
| Compressive Strength, psi | | | | |
| 7 days | 3694 | 3525 | 3784 | 3871 |
| 14 days | 4328 | 4188 | 4225 | 4570 |
| 28 days | 4932 | 4722 | 4861 | 4806 |
| (Design Compressive Strength, psi) | (4000) | | (3500) | |

The results of compressive strength tests are also shown on Laboratory Report Nos. C930016 through C930023 in Appendix D. Strength vs. age plots illustrating average compressive strengths in psi over time in days are shown in Figure I and Figure II.

The results of dynamic testing of freeze-thaw specimens are shown in Table 10. The percent weight change resulting from freezing and thawing of specimens is shown in Table 11. Freeze-thaw test results are also summarized in Figure III and Figure IV. These figures show a comparison of results obtained with the reference aggregate and the new aggregate after 300 cycles of freezing and thawing.




AVERAGE COMPRESSIVE STRENGTH VS AGE
CLASS A
FIGURE I




AVERAGE COMPRESSIVE STRENGTH VS AGE
CLASS B
FIGURE II

TABLE 10

FREEZE-THAW TEST RESULTS - DURABILITY FACTOR

| | New Aggregate | | | | Reference Aggregate | | | |
|---|---|---|---|---|---|---|---|---|
| | Class A | | Class B | | Class A | | Class B | |
| No. of Cycles | Batch 7 | Batch 8 | Batch 3 | Batch 4 | Batch 5 | Batch 6 | Batch 1 | Batch 2 |
| | *Average Durability Factor | | | | | | | |
| 50 | 98.4 | 99.3 | 95.4 | 92.8 | 100.9 | 100.6 | 99.9 | 101.4 |
| 100 | 100.3 | 99.9 | 94.0 | 90.8 | 97.5 | 100.3 | 103.6 | 99.3 |
| 150 | 95.0 | 95.8 | 91.6 | 92.4 | 94.5 | 97.0 | 102.1 | 95.4 |
| 200 | 98.3 | 100.0 | 90.7 | 86.5 | 100.8 | 98.6 | 105.4 | 95.4 |
| 250 | 98.5 | 99.4 | 93.1 | 87.2 | 94.5 | 98.8 | 107.1 | 92.8 |
| 300 | 97.1 | 99.4 | 96.5 | 83.7 | 96.0 | 98.2 | 108.1 | 96.3 |

*Values shown are the average results from two specimens.

TABLE 11

FREEZE-THAW TEST RESULTS - PERCENT WEIGHT CHANGE

| | New Aggregate | | | | Reference Aggregate | | | |
|---|---|---|---|---|---|---|---|---|
| | Class A | | Class B | | Class A | | Class B | |
| No. of Cycles | Batch 7 | Batch 8 | Batch 3 | Batch 4 | Batch 5 | Batch 6 | Batch 1 | Batch 2 |
| | *Average Percent Of Weight Change | | | | | | | |
| 50 | -0.8 | -0.2 | -3.6 | -4.8 | -0.3 | -0.4 | -2.8 | -5.2 |
| 100 | -2.8 | -0.8 | -7.8 | -8.7 | -0.9 | -1.3 | -5.7 | -9.2 |
| 150 | -4.6 | -1.7 | -11.0 | -11.8 | -1.6 | -2.4 | -7.5 | -11.2 |
| 200 | -6.4 | -2.6 | -13.8 | -15.1 | -2.2 | -3.2 | -8.6 | -12.7 |
| 250 | -7.8 | -3.6 | -16.2 | -17.8 | -2.9 | -4.4 | -10.0 | -14.3 |
| 300 | -9.1 | -4.7 | -18.4 | -20.5 | -3.5 | -5.4 | -10.2 | -15.6 |

*Values shown are the average results from two specimens.

| Batch Number | No. Cycles | Weight Lbs. | Percent Weight Loss | Fundamental Transverse Frequency "N" | "N"$^2$ | Individual Durability Factor DF | Average DF | Relative Durability Factor RDF |
|---|---|---|---|---|---|---|---|---|
| Reference Aggregate | | | | | | | | |
| 5A | 0 | 12.50 | | 1615 | 2608225 | | | |
| | | | 3.3 | | | 101.2 | | |
| 5A | 300 | 12.09 | | 1625 | 2640625 | | | |
| 5B | 0 | 12.61 | | 1664 | 2768896 | | | |
| | | | 3.7 | | | 90.7 | | |
| 5B | 300 | 12.14 | | 1585 | 2512225 | | | |
| | | | | | | | 97.1 | |
| 6A | 0 | 12.43 | | 1600 | 2560000 | | | |
| | | | 5.1 | | | 97.6 | | |
| 6A | 300 | 11.80 | | 1581 | 2499561 | | | |
| 6B | 0 | 12.56 | | 1602 | 2566404 | | | |
| | | | 5.6 | | | 98.8 | | |
| 6B | 300 | 11.86 | | 1592 | 2534464 | | | |
| | | | | | | | | 101.2 |
| New Aggregate | | | | | | | | |
| 7A | 0 | 12.76 | | 1625 | 2640625 | | | |
| | | | 9.0 | | | 97.0 | | |
| 7A | 300 | 11.61 | | 1600 | 2560000 | | | |
| 7B | 0 | 12.80 | | 1617 | 2614689 | | | |
| | | | 9.1 | | | 97.2 | | |
| 7B | 300 | 11.63 | | 1594 | 2540836 | | | |
| | | | | | | | 98.3 | |
| 8A | 0 | 12.58 | | 1612 | 2598544 | | | |
| | | | 4.5 | | | 100.5 | | |
| 8A | 300 | 12.02 | | 1616 | 2611456 | | | |
| 8B | 0 | 12.56 | | 1604 | 2572816 | | | |
| | | | 4.8 | | | 98.3 | | |
| 8B | 300 | 11.96 | | 1590 | 2528100 | | | |

SUMMARY OF FREEZE-THAW TEST RESULTS
CLASS A
FIGURE III

| Batch Number | No. Cycles | Weight Lbs. | Percent Weight Loss | Fundamental Transverse Frequency "N" | "N"$^2$ | Individual Durability Factor DF | Average DF | Relative Durability Factor RDF |
|---|---|---|---|---|---|---|---|---|
| Reference Aggregate | | | | | | | | |
| 1A | 0 | 12.89 | | 1664 | 2768896 | | | |
| | | | 10.2 | | | 110.4 | | |
| 1A | 300 | 11.57 | | 1748 | 3055504 | | | |
| 1B | 0 | 12.92 | | 1688 | 2849344 | | | |
| | | | 10.1 | | | 105.7 | | |
| 1B | 300 | 11.61 | | 1735 | 3010225 | | | |
| | | | | | | | 102.2 | |
| 2A | 0 | 12.75 | | 1630 | 2656900 | | | |
| | | | 16.3 | | | 94.2 | | |
| 2A | 300 | 10.67 | | 1582 | 2502724 | | | |
| 2B | 0 | 12.71 | | 1635 | 2673225 | | | |
| | | | 14.9 | | | 98.3 | | |
| 2B | 300 | 10.81 | | 1621 | 2627641 | | | |
| | | | | | | | | 88.2 |
| New Aggregate | | | | | | | | |
| 3A | 0 | 12.83 | | 1680 | 2822400 | | | |
| | | | 18.0 | | | 103.0 | | |
| 3A | 300 | 10.52 | | 1705 | 2907025 | | | |
| 3B | 0 | 12.77 | | 1673 | 2798929 | | | |
| | | | 18.7 | | | 89.9 | | |
| 3B | 300 | 10.38 | | 1586 | 2515396 | | | |
| | | | | | | | 90.1 | |
| 4A | 0 | 12.87 | | 1690 | 2856100 | | | |
| | | | 22.0 | | | 92.2 | | |
| 4A | 300 | 10.04 | | 1623 | 2634129 | | | |
| 4B | 0 | 12.78 | | 1680 | 2822400 | | | |
| | | | 19.0 | | | 75.1 | | |
| 4B | 300 | 10.35 | | 1456 | 2119936 | | | |

SUMMARY OF FREEZE-THAW TEST RESULTS
CLASS B
FIGURE IV

## SUMMARY AND CONCLUSIONS

1. An initial sample of the proposed new coarse aggregate from the Calkins Sand & Gravel Corporation facility in Lyndon, VT failed to comply with gradation requirements. Subsequent samples of the proposed new coarse aggregate obtained from the same facility were found to be in compliance with the requirements of Section 704.02 when tested in conjunction with this evaluation.

2. The average 28 day compressive strengths of concrete containing the Calkins Sand & Gravel 3/4" crushed stone coarse aggregate were approximately equal to the strengths of concrete containing the reference aggregate. The Class A concrete containing the proposed new aggregate from Calkins Lyndon quarry had an average compressive strength of 4827 psi at 28 days, while the Class A concrete containing the reference aggregates yielded an average compressive strength of 4897 psi. The Class B concrete containing the new 3/4" crushed stone aggregate from Calkins quarry in Lyndon, VT had an average compressive strength of 4834 psi at 28 days, while the Class B concrete containing the reference aggregate had an average compressive strength of 4786 psi.

3. Results of freezing and thawing tests showed overall reduced performance for concrete containing the new aggregate, when compared with concrete containing the reference aggregate. The average durability factor for Class A concrete with the new aggregate was 98.3 while Class A concrete with the reference aggregate had an average durability factor of 97.1. The Class A concrete containing the new

aggregates, however, showed greater average weight loss (6.9%) than the Class A concrete containing the reference aggregate (4.4%). Class B concrete containing the new aggregate performed poorly in sonic testing when compared with Class B concrete containing the reference aggregate. The average durability factor was 90.1 for Class B concrete with the new aggregate and 102.2 for Class B concrete with the reference aggregate. Class B concrete containing the new aggregate also showed greater average weight loss (19.4%) than Class B concrete with the reference aggregate (12.9%).

4. Mix design tables, shown on page 9, indicate Class A and Class B mixtures containing the new aggregate required comparable quantities of mixing water to develop air contents and slumps equal to the mixes containing the reference aggregates.

## RECOMMENDATIONS

1. It is recommended that the present Calkins Sand & Gravel Corp. facility in Lyndon, VT be approved as a source of coarse aggregate for use in structural concrete.

2. During the initial uses of concrete containing this aggregate on Agency projects, Materials and Research Division representatives shall conduct tests necessary to determine the performance of this aggregate in concrete under field conditions. Due to the range of results obtained in freeze-thaw tests, it is recommended that subsequent testing include fabrication of freeze-thaw specimens to permit further examination of this concrete property.

3. Performance of additional petrographic evaluations of the new coarse aggregate is also recommended annually, as a minimum, to permit monitoring of any changes in the mineralogy of the material. Should examination reveal significant increases in the quantity of Phyllite present in the stone, the Materials and Research Division reserves the right to order use of the material discontinued.

APPENDICES A - E

Prepared By: W. Meyer WFM


STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

# VERMONT PROCEDURE FOR EVALUATING A NEW SOURCE OF STRUCTURAL CONCRETE AGGREGATE

VT-AOT-MRD 9-82

## 1. SCOPE

A procedure for evaluating new structural concrete aggregate sources by testing proposed new aggregates for compliance with Section 700 requirements and by comparing results of tests performed on concrete using the new aggregate with results obtained from concrete containing a reference aggregate.

## 2. PROCEDURE

### General

The evaluation of a new structural concrete aggregate source (i.e., one on which the Materials and 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.

All requests for evaluation of new structural concrete aggregate sources shall be made, in writing, to the Materials and Research Engineer. Requests shall describe the type of material proposed for use as well as the location and quantity of available stockpiles.

Materials and Research Division personnel shall perform all work necessary for both the Phase I and Phase II sections of this evaluation process. The work will be performed in an expeditious manner consistent with availability of manpower. Evaluations may require 60 calendar days or more from the date the aggregate is available for testing (controlled by the availability of personnel to perform testing). Delays beyond the control of the Materials and Research Division shall be documented and notification given of the consequent extension of time required to complete the evaluation.

Test results shall be the basis for determining acceptance, further testing, or rejection of the proposed new material. Failure of the material to comply with all applicable requirements, during any phase of testing, may necessitate rescheduling or termination of the evaluation.

The cost of materials necessary to complete the evaluation will be borne by the requesting party.

A report shall be prepared documenting the Materials and Research Division's involvement in the evaluation. A copy of the report shall be forwarded with a cover letter, informing the requesting party of the acceptability or nonacceptability of the aggregate.

Phase I

1. Following receipt of the written request, the Structural Concrete Engineer will schedule a field petrographic examination of the proposed new aggregate source by the Vermont A.O.T. Chief Geologist.

2. The Structural Concrete Engineer or his representative will visit the site and determine:

   (a) Does a stockpile of at least 50 cubic yards 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 necessary arrangements for obtaining samples from the designated stockpile.

4. The material shall be tested at the Central Laboratory using the Structural Concrete Subdivision Annual Aggregate Testing Program procedure.

5. Report the results (as an Evaluation Sample) on the Standard Materials and Research Division forms.

Phase II

1. The performance-in-concrete tests shall be performed on concrete prepared at the Central Laboratory. The proposed new aggregate will be evaluated by comparing results of tests performed on concrete using the new aggregate with results obtained from concrete containing a reference aggregate. Cement, admixtures, and aggregates, other than the proposed new aggregate, will be selected by the Structural Concrete Engineer. Normally, these materials will be the same as the materials currently in use at the Ready-mix plant where the proposed new aggregate will be used.

2. Mix proportions for each class of concrete required shall be designed or approved by the Materials and Research Division and shall conform to Table 501.03A of the Vermont Standard Specifications for Highway and Bridge Construction, current edition.

3. Test cylinders shall be fabricated and cured in accordance with AASHTO T23. They shall be tested for compressive strength at ages 7, 14, and 28 days in accordance with AASHTO T22.

4. Tests of Slump, Air Content, and Unit Weight shall be in accordance with AASHTO T119, AASHTO T152, and AASHTO T121, respectively.

TA 419 Rev. 2.5 M 1-92

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

## REPORT ON SAMPLE OF STRUCTURAL CONCRETE AGGREGATE

G9200334

Laboratory Number [illegible] Pay Item 501
Project Name Calkins Quarry - Lyndonville VT. Project Number
Sampled By A. McBean Date Sampled June 11 1992 Examined For 704.02
Sampled From Stockpile Plant At Calkins Quarry Lyndonville - upper level
Source of Material Calkins Lyndonville
Quantity Represented ____ Sample Type Preliminary
Sample Comparison No Cross Reference Number
(ledge)
MATERIAL TESTED 3/4" Crushed Stone for Concrete

| SIEVE SIZE | WEIGHT INDIV. | % RETAINED IND'V. | % RETAINED CUMUL. | % PASSING CUMUL. |
|---|---|---|---|---|
| RET ____ | | | | |
| RET ____ | | | | |
| RET 1 | ✓ | ✓ | | 100 |
| RET 3/4 | 2.61 | 9.5 | | 90.5 |
| RET 1/2 | 14.61 | 53.1 | | 37.4 |
| RET 3/8 | 5.22 | 18.9 | | 18.5 |
| RET 4 | 4.37 | 15.9 | | 2.6 |
| RET 8 | .22 | 0.8 | | 1.8 |
| PAN | .50 | 1.8 | | |
| TOTAL | 27.53 | 100.0 | | |

**AGGREGATE MOISTURE CONTENT**

WET WEIGHT ____
DRY WEIGHT ____
MOISTURE CONTENT % ____

1 NOTE: MOISTURE CONTENT (%) =

$$\frac{W_W - W_D}{W_D} \times 100$$

$W_W$ = WET WEIGHT
$W_D$ = DRY WEIGHT

Fineness Modulus
Cumul. Total Retained/100 ____

Organic Impurities: Color ____

T&E / Total Weight = ____ = 5.6 % Thin & Elongated Pieces
Fractures / Total Weight = ____ = 100 % Fractured Faces

| | |
|---|---|
| 3/4" Sieve | 1.3% |
| 1/2" Sieve | 4.8 |
| 3/8" Sieve | 8.2 |
| #4 Sieve | 7.9 |

Original Weight 5000
Final Weight 3612
1388

Grading "B"
Percent Wear 27.8 AASHTO T96

( ) Test results are in compliance with specifications.

(✓) Test results are outside specifications.

Comments: This material tested for evaluation purposes.

Tested By R. Hoyt
Date Completed 6/15/92

Reviewed By John H. Weaver, P.E. JHW
Date 6/17/92
Initials

TA 419 Rev. 2.5 M 1-92

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

## REPORT ON SAMPLE OF STRUCTURAL CONCRETE AGGREGATE

Laboratory Number 6920305 Pay Item 501
Project Name Calkins Quarry-Lyndonville Project Number
Sampled By R. McBean Date Sampled June 11 1992 Examined For 704.02
Sampled From Stockpile Plant At Calkins Pit Lyndonville - lower level
Source of Material Calkins Lyndonville
Quantity Represented Sample Type Preliminary
Sample Comparison No Cross Reference Number

**MATERIAL TESTED** 3/4" Crushed Stone (Ledge) for Concrete

| SIEVE SIZE | WEIGHT INDIV. | % RETAINED IND'V. | % RETAINED CUMUL. | % PASSING CUMUL. |
|---|---|---|---|---|
| RET | | | | |
| RET | | | | |
| RET 1 | — | — | | 100 |
| RET 3/4 | — | — | | 100 |
| RET 1/2 | 5.70 | 22.2 | | 77.8 |
| RET 3/8 | 11.21 | 43.7 | | 34.1 |
| RET 4 | 8.34 | 32.5 | | 1.6 |
| RET 8 | 0.12 | 0.5 | | 1.1 |
| PAN | 0.29 | 1.1 | | |
| TOTAL | 25.66 | | | |

**AGGREGATE MOISTURE CONTENT**

WET WEIGHT
DRY WEIGHT
MOISTURE CONTENT %

1 NOTE: MOISTURE CONTENT (%) =

$$\frac{W_W - W_D}{W_D} \times 100$$

$W_W$ = WET WEIGHT
$W_D$ = DRY WEIGHT

Fineness Modulus
Cumul. Total Retained/100

Organic Impurities: Color

T&E / Total Weight = / Total Sample = 4.2 % Thin & Elongated Pieces

Fractures / Total Weight = / = 100 % Fractured Faces

- 1/2" Sieve 19/683 = 2.8%
- 3/8" Sieve 23/514 = 4.5%
- #4 Sieve 15/319 = 4.7%

Original Weight 5000
Final Weight 3786
1214

Grading B
Percent Wear 24.3 AASHTO T96

(✓) Test results are in compliance with specifications.

( ) Test results are outside specifications.

Comments: This material is being tested for evaluation purposes only.

Tested By E. Putnam & R. Holt Reviewed By John H. Weaver, P.E. JHW
Date Completed June 15, 1992 Date 6/17/92 Initials

R. Holt
C.F

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

## REPORT ON SAMPLE OF STRUCTURAL CONCRETE AGGREGATE

Laboratory Number G9200983 Pay Item 501
Project Name POSSIBLE FUTURE USE Project Number WORK PLAN 92-C-17
Sampled By J. KELLY, S. ARNSTOUT Date Sampled 08/31/92 Examined For 704.02
Sampled From STOCKPILE Plant CALKINS - LYNDONVILLE
Source of Material CALKINS QUARRY, LYNDONVILLE, VT
Quantity Represented 0 CY Sample Type PRELIMINARY
Sample Comparison NO Cross Reference Number N/A

MATERIAL TESTED 3/4" LEDGE ROCK FOR CONCRETE

| SIEVE SIZE | WEIGHT INDIV. | % RETAINED INDIV. | % RETAINED CUMUL. | % PASSING CUMUL. |
|---|---|---|---|---|
| RET ____ | | | | |
| RET ____ | | | | |
| RET 1" | — | | | 100 |
| RET 3/4" | 520.5 | 4 | | 96 |
| RET 1/2" | 3941.1 | 31 | | 65 |
| RET 3/8" | 3044.6 | 24 | | 41 |
| RET 4 | 4191.3 | 33 | | 8 |
| RET 8 | 507.5 | 4 | | 4 |
| PAN | 569.5 | 4 | | |
| TOTAL | 12774.5 | 100 | | |

AGGREGATE MOISTURE CONTENT

WET WEIGHT ____
DRY WEIGHT ____
MOISTURE CONTENT % ____

NOTE: MOISTURE CONTENT (%) =

$$\frac{W_W - W_D}{W_D} \times 100$$

$W_W$ = WET WEIGHT
$W_D$ = DRY WEIGHT

Fineness Modulus
Cumul. Total Retained/100 ____

Organic Impurities: Color ____

T&E / Total Weight = 47.8 / 719.5 = 6.6 % Thin & Elongated Pieces
Fractures / Total Weight = 719.5 / 719.5 = 100 % Fractured Faces

RECEIVED
SEP - 2 1992
MATERIALS & RESEARCH DIVISION

Original Weight 5000g
Final Weight 3419.79g
Grading "B"
Percent Wear 31.8% AASHTO T96

(✓) Test results are in compliance with specifications.

( ) Test results are outside specifications.

Comments: ____

Tested By Chad A. Allen
Date Completed 09/02/92
Reviewed By ~~John H. Weaver, P.E.~~ R. Holt
Date 9/2/92
Initials RHH

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STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

R. Holt
C.F.

## REPORT ON SAMPLE OF STRUCTURAL CONCRETE AGGREGATE

Laboratory Number G9201000 Pay Item 501.
Project Name Possible Future USE Project Number Work Plan 92-C-17
Sampled By J. Kelly & S. Armstrong Date Sampled 08/31/92 Examined For 704.02
Sampled From Stockpile Plant Lawrence, St. Johnsbury
Source of Material Calkins Quarry, Lyndonville VT.
Quantity Represented — Sample Type Preliminary
Sample Comparison No Cross Reference Number

**MATERIAL TESTED** 3/4" Crushed ledge rock for concrete

| SIEVE SIZE | WEIGHT INDIV. | % RETAINED INDIV. | % RETAINED CUMUL. | % PASSING CUMUL. |
|---|---|---|---|---|
| RET ——— | | | | |
| RET ——— | | | | |
| RET 1 | — | — | | 100 |
| RET 3/4 | 455 | 4 | | 96 |
| RET 1/2 | 4346 | 39 | | 57 |
| RET 3/8 | 2573 | 23 | | 34 |
| RET 4 | 3188 | 28 | | 6 |
| RET 8 | 271 | 2 | | 4 |
| PAN | 430 | 4 | | |
| TOTAL | 11263 | 100 | | |

**AGGREGATE MOISTURE CONTENT**

WET WEIGHT ———
DRY WEIGHT ———
MOISTURE CONTENT % ———

NOTE: MOISTURE CONTENT (%) =

$$\frac{W_W - W_D}{W_D} \times 100$$

$W_W$ = WET WEIGHT
$W_D$ = DRY WEIGHT

Fineness Modulus
Cumul. Total Retained/100 ———

Organic Impurities: Color ———

T&E / Total Weight = 32 / 556 = 5.8 % Thin & Elongated Pieces
Fractures / Total Weight = 556 / 556 = 100% Fractured Faces

RECEIVED
SEP - 2 1992
MATERIALS & RESEARCH DIVISION

Original Weight 5000
Final Weight 3478
1522

Grading "B"
Percent Wear 30.4 AASHTO T96

(✓) Test results are in compliance with specifications.

( ) Test results are outside specifications.

Comments: ———

Tested By R. Holt
Date Completed 9/2/92

Reviewed By ~~John H. Weaver, P.E.~~ J. KELLY
Date 09/04/92

Initials

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STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

## REPORT ON SAMPLE OF STRUCTURAL CONCRETE AGGREGATE

Laboratory Number G9201[illegible]7 Pay Item 501
Project Name WORK PLAN 92-C-17 Project Number
Sampled By KELLEY-ARMSTRONG Date Sampled 8/31/92 Examined For 704.01
Sampled From STOCKPILE Plant LAWRENCE - ST. JOHNSBURY
Source of Material GUILDHALL
Quantity Represented Sample Type ACCEPTANCE
Sample Comparison NO Cross Reference Number

**MATERIAL TESTED** FINE AGG FOR CONCRETE

| SIEVE SIZE | WEIGHT INDIV. | % RETAINED IND'V. | % RETAINED CUMUL. | % PASSING CUMUL. |
|---|---|---|---|---|
| RET | | | | |
| RET 3/8 | — | | | 100 |
| RET 4 | — | | | 100 |
| RET 8 | 54.1 | 11 | 11 | 89 |
| RET 16 | 123.1 | 24 | 35 | 65 |
| RET 30 | 136.1 | 26 | 61 | 39 |
| RET 50 | 111.8 | 22 | 83 | 17 |
| RET 100 | 56.4 | 11 | 94 | 6 |
| PAN | 32.4 | 6 | | |
| TOTAL | 513.9 | | 284 | |

**AGGREGATE MOISTURE CONTENT**

WET WEIGHT
DRY WEIGHT
MOISTURE CONTENT %

1 NOTE: MOISTURE CONTENT (%) =

$$\frac{W_W - W_D}{W_D} \times 100$$

$W_W$ = WET WEIGHT
$W_D$ = DRY WEIGHT

Fineness Modulus
Cumul. Total Retained/100 2.84

Organic Impurities: Color

T&E / Total Weight = ____ = ____ % Thin & Elongated Pieces

Fractures / Total Weight = ____ = ____ % Fractured Faces

Original Weight
Final Weight
Grading
Percent Wear AASHTO T96

( ✓ ) Test results are in compliance with specifications.

( ) Test results are outside specifications.

Comments:

Tested By Curt G Weaver
Date Completed 11/5/92

Reviewed By ~~John H. Weaver, P.E.~~ D.F. HALE DFH Initials
Date 11/5/92

TA 419 Rev. 2.5 M 1-92

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

## REPORT ON SAMPLE OF STRUCTURAL CONCRETE AGGREGATE

Laboratory Number G3202.18 Pay Item 501
Project Name WORK PLAN 92-C-17 Project Number
Sampled By ELLIS-ARMSTRONG Date Sampled 8/31/92 Examined For 704.02
Sampled From STOCKPILE Plant LAWRENCE-ST. JOHNSBURY
Source of Material GUILDHALL
Quantity Represented Sample Type ACCEPTANCE
Sample Comparison NO Cross Reference Number

**MATERIAL TESTED** 3/4" GRAVEL FOR CONCRETE

| SIEVE SIZE | WEIGHT INDIV. | % RETAINED IND'V. | % RETAINED CUMUL. | % PASSING CUMUL. |
|---|---|---|---|---|
| RET | | | | |
| RET | | | | |
| RET 1 | - | | | 100 |
| RET 3/4 | 360.0 | 4 | | 96 |
| RET 1/2 | 3101.6 | 31 | | 65 |
| RET 3/8 | 2989.4 | 30 | | 35 |
| RET 4 | 3226.0 | 32 | | 3 |
| RET 8 | 114.0 | 1 | | 2 |
| PAN | 241.7 | 2 | | |
| TOTAL | 10032.7 | | | |

**AGGREGATE MOISTURE CONTENT**

WET WEIGHT
DRY WEIGHT
MOISTURE CONTENT %

1 NOTE: MOISTURE CONTENT (%) =

$$\frac{W_W - W_D}{W_D} \times 100$$

$W_W$ = WET WEIGHT
$W_D$ = DRY WEIGHT

Fineness Modulus
Cumul. Total Retained/100

Organic Impurities: Color

T&E / Total Weight = 7.8 / 441 = 1.8 % Thin & Elongated Pieces
Fractures / Total Weight = 381.9 / 441 = 86.6 % Fractured Faces

Original Weight 5000 g Grading B
Final Weight 3780 g Percent Wear 24.4% AASHTO T96

( ✓ ) Test results are in compliance with specifications.

( ) Test results are outside specifications.

Comments:

Tested By Curt G Weaver
Date Completed 11/5/92

Reviewed By ~~John H. Weaver, P.E.~~ D. F. HALE DFH
Date 11/5/92
Initials

EMABRR11

VERMONT AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

REPORT ON SAMPLE OF AGGREGATE
Preliminary Sample

Distribution List
Central Files
Hale
Geologist

Lab No: A930096

Report Date: 04/26/93

Project: Possible future use

Sampled By: Kelly

Pay Item: CONCRETE, CLASS B 501.25

Date Sampled: 08/31/92

Material Name: Gradation Requirements for 3/4" Stone

Sampled From: Stockpile

Material Spec. No: 704.02B

Date Received: 08/31/92

Sample Source: CALKINS SAND & GRAVEL LYNDONVILLE VT

Tested By: D.Felch

Material Source: CALKINS SAND & GRAVEL LYNDONVILLE VT

Tests Complete: 04/23/93

Quantity Rep:

X-Ref No: CS:

Comment:

TEST RESULTS

| SIEVE | TOTAL SAMPLE PASSING | OUTSIDE SPECS |
|---|---|---|
| 1-1/2" | | |
| 1" | | |
| 3-1/2" | | |
| 3" | | |
| 2-1/2" | | |
| 2" | | |
| 1-3/4" | | |
| 1-1/2" | | |
| 1" | | |
| 3/4" | | |
| 5/8" | | |
| 1/2" | | |
| 3/8" | | |
| No. 4(P) | | |
| No. 4 | | |
| No. 8 | | |
| No. 16 | | |
| No. 30 | | |
| No. 40 | | |
| No. 50 | | |
| No. 100 | | |
| No. 200 | | |

FINENESS MODULUS

% COARSER THAN

| | |
|---|---|
| No. 4 | |
| No. 8 | |
| No. 16 | |
| No. 30 | |
| No. 40 | |
| No. 50 | |
| No. 100 | |

| | | OUTSIDE SPECS |
|---|---|---|
| Fineness | - | |
| Color | - | |
| Grading | - | |
| Percent of Wear | | |
| AASHTO T96 | - | |
| Frac Faces | - | |
| Thin/Elong | - | |
| Soundness | - 1.17 | |

Remarks: Results of tests performed are in compliance with specifications.

Comments:

Reviewed By: R.J.O'Brien Chemist Testing Lab. Supervisor RJO

For: P.E.Cauley Materials & Research Engineer

APPENDIX C

AGENCY OF TRANSPORTATION OFFICE MEMORANDUM

TO: John H. Weaver, Structural Concrete Engineer

FROM: Alan J. McBean, Transportation Geologist

DATE: June 17, 1992

SUBJECT: Petrographic Analysis of Aggregate From Calkins Quarry Lyndon, Vermont

On June 11, 1992 Reginald Holt and I visited the Calkins Quarry in Lyndon, Vermont and inspected two stockpiles of material, which had been manufactured from ledge exposed in the gravel pit currently being operated on the site.

The exposed ledge consists of interbedded limestone and phyllite of the Waits River Formation. A petrographic analysis was conducted on samples from each stockpile to determine the percentages of each rock type present. Tables 1 and 2 summarize the results.

TABLE 1
Upper Stockpile

| | Percent Retained | | | | |
|---|---|---|---|---|---|
| Lithology/Mineral | 3/4 | 1/2 | 3/8 | No. 4 | No. 8 |
| Quartz | 4.1 | 7.0 | 4.9 | 5.9 | 7.5 |
| Phyllite | 44.3 | 45.6 | 42.2 | 42.8 | 46.5 |
| Limestone | 51.5 | 47.4 | 52.9 | 51.3 | 46.1 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.1 |

TABLE 2
Lower Stockpile

| | Percent Retained | | | |
|---|---|---|---|---|
| Lithology/Mineral | 1/2 | 3/8 | No. 4 | No. 8 |
| Quartz | 11.2 | 10.4 | 8.8 | 15.8 |
| Phyllite | 36.6 | 49.4 | 52.6 | 50.6 |
| Limestone | 52.2 | 39.3 | 38.6 | 32.8 |
| Gravel | | 0.8 | | |
| Pyrite | | | | 0.2 |
| Calcite | | | | 0.6 |
| Total | 100.0 | 99.9 | 100.0 | 100.0 |

Of the rock types observed, phyllite is the material which has the potential to behave poorly in concrete. Due to the thinly layered, fine grained texture of the rock, freeze-thaw cycling could result in premature failure of the aggregate. This material also tends to produce thin and/or elongated particle shapes. Further testing is needed to determine the freeze-thaw characteristics and overall performance of this material in concrete.

AJM/slv

cc: Lab File
Central Files
Reading
AJM

LABRPT

Vermont Agency of Transportation
Materials and Research Division

Distribution List
Central Files
R. HALE

Report on Concrete Test Beam
Preliminary Sample

Lab No: C930016

Report Date: 02/05/93

Project: WORK PLAN 92-C-17

Date Sampled: 11/09/92

Pay Item: Concrete, Class A 501.22

Time Sampled: 10:30

Material Name/Type: Concrete Class A 501.03A

Sampled From: LAB MIX BATCH 7

Resident:

Field Test By: CONCRETE DIV

Quantity Represented: 1.8 CF

Lab Tested By: CONCRETE DIV

Material Source: MATERIALS & RESRARCH LAB

Location Used: PERFORMANCE IN CONCRETE EVALUATION

X-Ref No: CS:

Coarse Agg : CALKINS SAND & GRAVE LYNDONVILLE VT
Fine Agg : LAWRENCE SANGRAVCO GUILDHALL VT — Total Agg. Dry Wgt: 2908
Cement Brand: GLENS FALLS GLENS FALLS NY — Type: 2 Lbs: 660

A/E Admix: DARAVAIR — Dosage: 4.0 OZ/CY
Admixture: WRDA / HYCOL — Dosage: 3 OZ/CWT
Admixture: — Dosage:

Comments:

| Test | | Specs Min | Specs Max | Indicates if Outside of Specs |
|---|---|---|---|---|
| Unit Wgt of Fresh Concrete,pcf | 148. | | | |
| Air Content, Percent | 5. | 5. | 7. | |
| Slump, Inches | 2. | 2. | 4. | |
| Total Water, Gal/cy | 33. | | 35.1 | |
| W/C Ratio | 0.42 | | 0.44 | |
| Concrete Temperature, Deg F. | 64 | 50 | 80 | |
| Ambient Temperature, Deg F. | 62 | 10 | 85 | |

| Specm. No. | Cyl Wgt | Date Received | Date Broken | Des Age | Age Brk | Hour Break | F/S | Brk PSI | Avg PSI | 28 Day Spec | Indic. if Out. Specs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TA1 | 151 | 11/09/92 | 11/16/92 | 7 | 7 | | S | 3985 | 3957 | 4000 | |
| TA2 | 151 | 11/09/92 | 11/16/92 | 7 | 7 | | S | 3929 | 3957 | 4000 | |
| TA3 | 150 | 11/09/92 | 11/23/92 | 14 | 14 | | S | 4146 | 4319 | 4000 | |
| TA4 | 150 | 11/09/92 | 11/23/92 | 14 | 14 | | S | 4492 | 4319 | 4000 | |
| TA5 | | 11/09/92 | 12/07/92 | 28 | 28 | | S | 4980 | 4909 | 4000 | |
| TA6 | | 11/09/92 | 12/07/92 | 28 | 28 | | S | 4838 | 4909 | 4000 | |

Remarks: Results of tests performed are in compliance with Specifications.
Comments:

Flexural Strength Tests Conducted in accordance with AASHTO T97

Reviewed By: Robert J. O'Brien, Supervisor of Testing Labs
For: Robert F. Cauley, Materials and Research Engineer

LABRPT

Vermont Agency of Transportation
Materials and Research Division

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R. HALE

# Report on Concrete Cylinder
## Preliminary Sample

Lab No: C930017

Report Date: 02/05/93

Project: WORK PLAN 92-C-17

Date Sampled: 11/09/92

Pay Item: Concrete, Class A 501.22

Time Sampled: 11:15

Material Name/Type: Concrete Class A 501.03A

Sampled From: LAB MIX BATCH 8

Resident:

Field Test By: CONCERTE DIV

Quantity Represented: 1.8 CF

Lab Tested By: CONCRETE DIV

Material Source: MATERIALS & RESEARCH LAB

Location Used: PERFORMANCE IN CONCRETE EVALUATION

X-Ref No: CS:

Coarse Agg : CALKINS SAND & GRAVE LYNDONVILLE VT
Fine Agg : LAWRENCE SANGRAVCO GUILDHALL VT — Total Agg. Dry Wgt: 2908
Cement Brand: CIMENT QUEBEC INC QUEBEC CANADA — Type: 2 Lbs: 660

A/E Admix: DARAVAIR — Dosage: 4 OZ/CY
Admixture: WRDA / HYCOL — Dosage: 3 OZ/CWT
Admixture: — Dosage:

Comments:

| Test | | Specs Min | Specs Max | Indicates if Outside of Specs |
|---|---|---|---|---|
| Unit Wgt of Fresh Concrete,pcf | 146. | | | |
| Air Content, Percent | 5.8 | 5. | 7. | |
| Slump, Inches | 2.75 | 2. | 4. | |
| Total Water, Gal/cy | 32.5 | | 35.1 | |
| W/C Ratio | 0.41 | | 0.44 | |
| Concrete Temperature, Deg F. | 64 | 50 | 80 | |
| Ambient Temperature, Deg F. | 62 | 10 | 85 | |

| Specm. No. | Cyl Wgt | Date Received | Date Broken | Des Age | Age Brk | Hour Break | F/S | Brk PSI | Avg PSI | 28 Day Spec | Indic. if Out. Specs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TA07 | 149 | 11/09/92 | 11/16/92 | 7 | 7 | | S | 4040 | 3987 | 4000 | |
| TA08 | 149 | 11/09/92 | 11/16/92 | 7 | 7 | | S | 3933 | 3987 | 4000 | |
| TA09 | 148 | 11/09/92 | 11/23/92 | 14 | 14 | | S | 4331 | 4371 | 4000 | |
| TA10 | 148 | 11/09/92 | 11/23/92 | 14 | 14 | | S | 4411 | 4371 | 4000 | |
| TA11 | | 11/09/92 | 12/07/92 | 28 | 28 | | S | 4870 | 4884 | 4000 | |
| TA12 | | 11/09/92 | 12/07/92 | 28 | 28 | | S | 4898 | 4884 | 4000 | |

Remarks: Results of tests performed are in compliance with Specifications.
Comments:

Compressive Strength Tests Conducted in accordance with AASHTO T22

Reviewed By: Robert J. O'Brien, Supervisor of Testing Labs
For: Robert F. Cauley, Materials and Research Engineer

LABRPT

Vermont Agency of Transportation
Materials and Research Division

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R. HALE

Report on Concrete Test Beam
Preliminary Sample

Lab No: C930018

Report Date: 04/20/93

Project: WORK PLAN 92-C-17

Date Sampled: 11/09/92

Pay Item: Concrete, Class A 501.22

Time Sampled: 8:45

Material Name/Type: Concrete Class A 501.03A

Sampled From: LAB MIX BATCH 5

Resident:

Field Test By: CONCRETE DIV

Quantity Represented: 1.8 CF

Lab Tested By: CONCRETE DIV

Material Source: MATERIALS & RESEARCH LAB

Location Used: PREFORMANCE IN CONCRETE EVALUATION

X-Ref No: CS:

Coarse Agg : LAWRENCE SANGRAVCO GUILDHALL VT
Fine Agg : LAWRENCE SANGRAVCO GUILDHALL VT — Total Agg. Dry Wgt: 2933
Cement Brand: CIMENT QUEBEC INC QUEBEC CANADA — Type: 2 Lbs: 660

A/E Admix: DARAVAIR — Dosage: 4 OZ/CY
Admixture: WRDA / HYCOL — Dosage: 3 OZ/CWT
Admixture: — Dosage:

Comments:

| Test | | Specs Min | Specs Max | Indicates if Outside of Specs |
|---|---|---|---|---|
| Unit Wgt of Fresh Concrete,pcf | 146. | | | |
| Air Content, Percent | 6.2 | 5. | 7. | |
| Slump, Inches | 2.5 | 2. | 4. | |
| Total Water, Gal/cy | 33.1 | | 35.1 | |
| W/C Ratio | 0.42 | | 0.44 | |
| Concrete Temperature, Deg F. | 62 | 50 | 80 | |
| Ambient Temperature, Deg F. | 65 | 10 | 85 | |

| Specm. No. | Cyl Wgt | Date Received | Date Broken | Des Age | Age Brk | Hour Break | F/S | Brk PSI | Avg PSI | 28 Day Spec | Indic. if Out. Specs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RA1 | 148 | 11/09/92 | 11/16/92 | 7 | 7 | | S | 3645 | 3694 | 4000 | |
| RA2 | 148 | 11/09/92 | 11/16/92 | 7 | 7 | | S | 3743 | 3694 | 4000 | |
| RA3 | 149 | 11/09/92 | 11/23/92 | 14 | 14 | | S | 4296 | 4328 | 4000 | |
| RA4 | 149 | 11/09/92 | 11/23/92 | 14 | 14 | | S | 4359 | 4328 | 4000 | |
| RA5 | | 11/09/92 | 12/07/92 | 28 | 28 | | S | 4948 | 4932 | 4000 | |
| RA6 | | 11/09/92 | 12/07/92 | 28 | 28 | | S | 4916 | 4932 | 4000 | |

Remarks: Results of tests performed are in compliance with Specifications.
Comments:

Flexural Strength Tests Conducted in accordance with AASHTO T97

Reviewed By: Robert J. O'Brien, Supervisor of Testing Labs
For: Robert F. Cauley, Materials and Research Engineer

LABRPT

Vermont Agency of Transportation
Materials and Research Division

Distribution List
Central Files
R. HALE

# Report on Concrete Cylinder
## Preliminary Sample

Lab No: C930019

Report Date: 02/05/93

Project: WORK PLAN 92-C-17

Date Sampled: 11/09/92

Pay Item: Concrete, Class A 501.22

Time Sampled: 9:30

Material Name/Type: Concrete Class A 501.03A

Sampled From: LAB MIX BATCH 6

Resident:

Field Test By: CONCRETE DIV

Quantity Represented: 1.8 CF

Lab Tested By: CONCRETE DIV

Material Source: MATERIALS & RESEARCH LAB

Location Used: PERFORMANCE IN CONCRETE EVALUATION

X-Ref No: CS:

Coarse Agg : LAWRENCE SANGRAVCO GUILDHALL VT
Fine Agg : LAWRENCE SANGRAVCO GUILDHALL VT — Total Agg. Dry Wgt: 2933
Cement Brand: CIMENT QUEBEC INC QUEBEC CANADA — Type: 2 Lbs: 660

A/E Admix: DARAVAIR — Dosage: 4 OZ/CY
Admixture: WRDA / HYCOL — Dosage: 3 OZ/CWT
Admixture: — Dosage:

Comments:

| Test | Specs Min | Specs Max | Indicates if Outside of Specs |
|---|---|---|---|
| Unit Wgt of Fresh Concrete,pcf | 145. | | |
| Air Content, Percent | 6.9 | 5. 7. | |
| Slump, Inches | 2.5 | 2. 4. | |
| Total Water, Gal/cy | 33.5 | 35.1 | |
| W/C Ratio | 0.42 | 0.44 | |
| Concrete Temperature, Deg F. | 65 | 50 80 | |
| Ambient Temperature, Deg F. | 65 | 10 85 | |

| Specm. No. | Cyl Wgt | Date Received | Date Broken | Des Age | Age Brk | Hour Break | F/S | Brk PSI | Avg PSI | 28 Day Spec | Indic. if Out. Specs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RA07 | 148 | 11/09/92 | 11/16/92 | 7 | 7 | | S | 3508 | 3521 | 4000 | |
| RA08 | 148 | 11/09/92 | 11/16/92 | 7 | 7 | | S | 3533 | 3521 | 4000 | |
| RA09 | 148 | 11/09/92 | 11/23/92 | 14 | 14 | | S | 4163 | 4188 | 4000 | |
| RA10 | 148 | 11/09/92 | 11/23/92 | 14 | 14 | | S | 4212 | 4188 | 4000 | |
| RA11 | | 11/09/92 | 12/07/92 | 28 | 28 | | S | 4722 | 4722 | 4000 | |
| RA12 | | 11/09/92 | 12/07/92 | 28 | 28 | | S | 4722 | 4722 | 4000 | |

Remarks: Results of tests performed are in compliance with Specifications.
Comments:

Compressive Strength Tests Conducted in accordance with AASHTO T22

Reviewed By: Robert J. O'Brien, Supervisor of Testing Labs
For: Robert F. Cauley, Materials and Research Engineer

LABRPT

Vermont Agency of Transportation
Materials and Research Division

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Report on Concrete Cylinder
Preliminary Sample

Lab No: C930020

Report Date: 02/05/93

Project: WORK PLAN 92-C-17

Date Sampled: 11/16/92

Pay Item: Concrete, Class B 501.25

Time Sampled: 9:00

Material Name/Type: Concrete Class B 501.03A

Sampled From: LAB MIX BATCH 3

Resident:

Field Test By: CONCRETE DIV

Quantity Represented: 1.8 CF

Lab Tested By: CONCRETE DIV

Material Source: MATERIALS & RESEARCH LAB

Location Used: PERFORMANCE IN CONCRETE EVALUATION

X-Ref No: CS:

Coarse Agg : CALKINS SAND & GRAVE LYNDONVILLE VT
Fine Agg : LAWRENCE SANGRAVCO GUILDHALL VT — Total Agg. Dry Wgt: 2968
Cement Brand: CIMENT QUEBEC INC QUEBEC CANADA — Type: 2 Lbs: 611

A/E Admix: DARAVAIR — Dosage: 2 OZ/CY
Admixture: WRDA / HYCOL — Dosage: 3 OZ/CWT
Admixture: — Dosage:

Comments:

| Test | | Specs Min | Specs Max | Indicates if Outside of Specs |
|---|---|---|---|---|
| Unit Wgt of Fresh Concrete,pcf | 145. | | | |
| Air Content, Percent | 5.4 | 4. | 6. | |
| Slump, Inches | 3.25 | 2. | 4. | |
| Total Water, Gal/cy | 32.6 | | 35.75 | |
| W/C Ratio | 0.45 | | 0.49 | |
| Concrete Temperature, Deg F. | 64 | 50 | 80 | |
| Ambient Temperature, Deg F. | 69 | 10 | 85 | |

| Specm. No. | Cyl Wgt | Date Received | Date Broken | Des Age | Age Brk | Hour Break | F/S | Brk PSI | Avg PSI | 28 Day Spec | Indic. if Out. Specs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TB1 | 150 | 11/16/92 | 11/23/92 | 7 | 7 | | S | 3683 | 3745 | 3500 | |
| TB2 | 150 | 11/16/92 | 11/23/92 | 7 | 7 | | S | 3806 | 3745 | 3500 | |
| TB3 | 150 | 11/16/92 | 11/30/92 | 14 | 14 | | S | 4322 | 4335 | 3500 | |
| TB4 | 150 | 11/16/92 | 11/30/92 | 14 | 14 | | S | 4347 | 4335 | 3500 | |
| TB5 | | 11/16/92 | 12/14/92 | 28 | 28 | | S | 4726 | 4691 | 3500 | |
| TB6 | | 11/16/92 | 12/14/92 | 28 | 28 | | S | 4655 | 4691 | 3500 | |

Remarks: Results of tests performed are in compliance with Specifications.
Comments:

Compressive Strength Tests Conducted in accordance with AASHTO T22

Reviewed By: Robert J. O'Brien, Supervisor of Testing Labs
For: Robert F. Cauley, Materials and Research Engineer

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Report on Concrete Cylinder
Preliminary Sample

Lab No: C930021

Report Date: 02/05/93

Project: WORK PLAN 92-C-17

Date Sampled: 11/16/92

Pay Item: Concrete, Class B 501.25

Time Sampled: 11:30

Material Name/Type: Concrete Class B 501.03A

Sampled From: LAB MIX BATCH 4

Resident:

Field Test By: CONCERTE DIV

Quantity Represented: 1.8 CF

Lab Tested By: CONCRETE DIV

Material Source: MATERIALS & RESEARCH LAB

Location Used: PERFORMANCE IN CONCRETE EVALUATION

X-Ref No: CS:

Coarse Agg : CALKINS SAND & GRAVE LYNDONVILLE VT
Fine Agg : LAWRENCE SANGRAVCO GUILDHALL VT — Total Agg. Dry Wgt: 2968
Cement Brand: CIMENT QUEBEC INC QUEBEC CANADA — Type: 2 Lbs: 611

A/E Admix: DARAVAIR — Dosage: 2 OZ/CY
Admixture: WRDA / HYCOL — Dosage: 3 OZ/CWT
Admixture: — Dosage:

Comments:

| Test | | Specs Min | Specs Max | Indicates if Outside of Specs |
|---|---|---|---|---|
| Unit Wgt of Fresh Concrete,pcf | 145.5 | | | |
| Air Content, Percent | 4.7 | 4. | 6. | |
| Slump, Inches | 2.75 | 2. | 4. | |
| Total Water, Gal/cy | 30.9 | | 35.75 | |
| W/C Ratio | 0.42 | | 0.49 | |
| Concrete Temperature, Deg F. | 66 | 50 | 80 | |
| Ambient Temperature, Deg F. | 69 | 10 | 85 | |

| Specm. No. | Cyl Wgt | Date Received | Date Broken | Des Age | Age Brk | Hour Break | F/S | Brk PSI | Avg PSI | 28 Day Spec | Indic. if Out. Specs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TB07 | 152 | 11/16/92 | 11/23/92 | 7 | 7 | | S | 3929 | 3908 | 3500 | |
| TB08 | 152 | 11/16/92 | 11/23/92 | 7 | 7 | | S | 3887 | 3908 | 3500 | |
| TB09 | 152 | 11/16/92 | 11/30/92 | 14 | 14 | | S | 4435 | 4439 | 3500 | |
| TB10 | 152 | 11/16/92 | 11/30/92 | 14 | 14 | | S | 4442 | 4439 | 3500 | |
| TB11 | | 11/16/92 | 12/14/92 | 28 | 28 | | S | 5023 | 4917 | 3500 | |
| TB12 | | 11/16/92 | 12/14/92 | 28 | 28 | | S | 4811 | 4917 | 3500 | |

Remarks: Results of tests performed are in compliance with Specifications.
Comments:

Compressive Strength Tests Conducted in accordance with AASHTO T22

Reviewed By: Robert J. O'Brien, Supervisor of Testing Labs
For: Robert F. Cauley, Materials and Research Engineer

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# Report on Concrete Cylinder
## Preliminary Sample

Lab No: C930022

Report Date: 02/05/93

Project: WORK PLAN 92-C-17

Date Sampled: 11/16/92

Pay Item: Concrete, Class B 501.25

Time Sampled: 10:00

Material Name/Type: Concrete Class B 501.03A

Sampled From: LAB MIX BATCH 1

Resident:

Field Test By: CONCRETE DIV

Quantity Represented: 1.8 CF

Lab Tested By: CONCRETE DIV

Material Source: MATERIALS & RESEARCH LAB

Location Used: PERFORMANCE IN CONCRETE EVALUATION

X-Ref No: CS:

Coarse Agg : LAWRENCE SANGRAVCO GUILDHALL VT
Fine Agg : LAWRENCE SANGRAVCO GUILDHALL VT — Total Agg. Dry Wgt: 3052
Cement Brand: CIMENT QUEBEC INC QUEBEC CANADA — Type: 2 Lbs: 611

A/E Admix: DARAVAIR — Dosage: 2.1 OZ/CY
Admixture: WRDA / HYCOL — Dosage: 3 OZ/CWT
Admixture: — Dosage:

Comments:

| Test | | Specs Min | Specs Max | Indicates if Outside of Specs |
|---|---|---|---|---|
| Unit Wgt of Fresh Concrete,pcf | 146. | | | |
| Air Content, Percent | 5.2 | 4. | 6. | |
| Slump, Inches | 3.25 | 2. | 4. | |
| Total Water, Gal/cy | 31.3 | | 35.75 | |
| W/C Ratio | 0.43 | | 0.49 | |
| Concrete Temperature, Deg F. | 66 | 50 | 80 | |
| Ambient Temperature, Deg F. | 69 | 10 | 85 | |

| Specm. No. | Cyl Wgt | Date Received | Date Broken | Des Age | Age Brk | Hour Break | F/S | Brk PSI | Avg PSI | 28 Day Spec | Indic. if Out. Specs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RB1 | 152 | 11/16/92 | 11/23/92 | 7 | 7 | | S | 3768 | 3784 | 3500 | |
| RB2 | 152 | 11/16/92 | 11/23/92 | 7 | 7 | | S | 3799 | 3784 | 3500 | |
| RB3 | 152 | 11/16/92 | 11/30/92 | 14 | 14 | | S | 4241 | 4225 | 3500 | |
| RB4 | 152 | 11/16/92 | 11/30/92 | 14 | 14 | | S | 4209 | 4225 | 3500 | |
| RB5 | | 11/16/92 | 12/14/92 | 28 | 28 | 3:00 | S | 4786 | 4861 | 3500 | |
| RB6 | | 11/16/92 | 12/14/92 | 28 | 28 | 3:00 | S | 4935 | 4861 | 3500 | |

Remarks: Results of tests performed are in compliance with Specifications.
Comments:

Compressive Strength Tests Conducted in accordance with AASHTO T22

Reviewed By: Robert J. O'Brien, Supervisor of Testing Labs
For: Robert F. Cauley, Materials and Research Engineer

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Report on Concrete Cylinder
Preliminary Sample

Lab No: C930023

Report Date: 02/05/93

Project: WORK PLAN 92-C-17

Date Sampled: 11/16/92

Pay Item: Concrete, Class B 501.25

Time Sampled: 11:00

Material Name/Type: Concrete Class B 501.03A

Sampled From: LAB MIX BATCH 2

Resident:

Field Test By: CONCERTE DIV

Quantity Represented: 1.8 CF

Lab Tested By: CONCRETE DIV

Material Source: MATERIALS & RESEARCH LAB

Location Used: PERFORMANCE IN CONCRETE EVALUATION

X-Ref No: CS:

Coarse Agg : LAWRENCE SANGRAVCO GUILDHALL VT
Fine Agg : LAWRENCE SANGRAVCO GUILDHALL VT — Total Agg. Dry Wgt: 3052
Cement Brand: CIMENT QUEBEC INC QUEBEC CANADA — Type: 2 Lbs: 611

A/E Admix: DARAVAIR — Dosage: 2.1 OZ/CY
Admixture: WRDA / HYCOL — Dosage: 3 OZ/CWT
Admixture: — Dosage:

Comments:

| Test | | Specs Min | Specs Max | Indicates if Outside of Specs |
|---|---|---|---|---|
| Unit Wgt of Fresh Concrete,pcf | 146. | | | |
| Air Content, Percent | 5.4 | 4. | 6. | |
| Slump, Inches | 2.75 | 2. | 4. | |
| Total Water, Gal/cy | 31.2 | | 35.75 | |
| W/C Ratio | 0.43 | | 0.49 | |
| Concrete Temperature, Deg F. | 66 | 50 | 80 | |
| Ambient Temperature, Deg F. | 69 | 10 | 85 | |

| Specm. No. | Cyl Wgt | Date Received | Date Broken | Des Age | Age Brk | Hour Break | F/S | Brk PSI | Avg PSI | 28 Day Spec | Indic. if Out. Specs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RB07 | 152 | 11/16/92 | 11/23/92 | 7 | 7 | | S | 3848 | 3871 | 3500 | |
| RB08 | 152 | 11/16/92 | 11/23/92 | 7 | 7 | | S | 3894 | 3871 | 3500 | |
| RB09 | 151 | 11/16/92 | 11/30/92 | 14 | 14 | | S | 4559 | 4570 | 3500 | |
| RB10 | 151 | 11/16/92 | 11/30/92 | 14 | 14 | | S | 4580 | 4570 | 3500 | |
| RB11 | | 11/16/92 | 12/14/92 | 28 | 28 | 3:00 | S | 4839 | 4806 | 3500 | |
| RB12 | | 11/16/92 | 12/14/92 | 28 | 28 | 3:00 | S | 4772 | 4806 | 3500 | |

Remarks: Results of tests performed are in compliance with Specifications.
Comments:

Compressive Strength Tests Conducted in accordance with AASHTO T22

Reviewed By: Robert J. O'Brien, Supervisor of Testing Labs
For: Robert F. Cauley, Materials and Research Engineer

APPENDIX E

TA 565 Rev. 4/79

Prepared By: R.J. Holt
Date: 6/17/92
Sheet 1 of 1

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

RESEARCH INVESTIGATION

Work Plan No. 92-C-17

Subject Evaluation of Crushed Stone Coarse Aggregate, Lawrence Sandgravco St.Johnsbury, Vermont

Investigation Requested By Michael Classen Date Received 5/12/1992

Date Information Required ASAP

Purpose of Investigation To evaluate a crushed stone coarse aggregate from the Calkins Quarry, proposed for use as a structural concrete aggregate. Quarry is located in Lyndon, Vermont.

Proposed Tests or Evaluation Procedure See Vermont Procedure For Evaluating a New Source of Structural Concrete Aggregate VT-AOT-MRD 9-82.

1. Performance-in-concrete tests will be performed using two batches each of Class A and Class B concrete containing the proposed new aggregate and two batches each of Class A and Class B concrete containing a reference aggregate.
2. Prepare specimens from each batch of concrete to determine resistance to freezing and thawing.

Proposal Discussed With John Weaver JTW Projected Manpower Requirements 25 man days

Investigation To Be Conducted By Structural Concrete Subdivision

Proposed Starting Date 06/22/92 Estimated Completion Date 08/28/92

Approval/~~Disapproval~~ by Materials & Research Engineer Robert J. Crowley

Comments by Materials & Research Engineer

Materials & Research Division
Agency of Transportation
Date Typed: