

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS DIVISION

CLASS B CONCRETE
USING GUILDHALL AGGREGATES
GUILDHALL, VERMONT

REPORT 77-5
DECEMBER 1977

REPORTING ON WORK PLAN NO. 77-C-26

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Materials Division
Highway Department
Agency of Transportation
March 31, 1978

Reviewed By:

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Date: April 26, 1978

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ABSTRACT

Difficulties in obtaining a compressive strength of 3500 psi consistently during the summer construction season has been experienced.

In order to achieve the desired strength a mix design must be capable of obtaining the specified strengths under conditions similar to those experienced in the field.

This evaluation is an attempt to obtain a Class B structural concrete mix design that will achieve a compressive strength of 3500 psi under field conditions and during temperatures experienced with summer placement.

The results show that a mix design tested under summer temperatures was developed in the laboratory and will be used in the field for future summer placement of Concrete Class B.

INTRODUCTION

A history of poor structural concrete strength has been experienced during periods of warm weather.

The purpose of this evaluation is to obtain a mix design that will produce concrete meeting the requirements of Item 501.25 Concrete Class B during the warm summer months. Based on the data obtained during the 1976 construction season an average 28 day compressive strength of 4271 psi is required in order for Item 501.25 Concrete Class B to meet the minimum strength requirement of 3500 psi ninety percent of the time. Determination of the 4271 psi average 28 day compressive strength was obtained through the use of the Vermont Department of Highways Concrete Compressive Tests Evaluation and Plot Program No. P609.

In an attempt to produce the proper mix design, knowledge from prior tests was used in selecting two different blends of coarse aggregate, two different cement contents and the use of a water reducing admixture. Comparisons were made between the different mix designs.

MATERIALS

PRODUCT: Item 501.25 Concrete Class B - using Guildhall aggregates

Description of Product:

A portland cement concrete having a minimum of 610 lbs of cement per cubic yard, a maximum of 36.5 gallons of water per cubic yard, a slump range of 2 to 4 inches, an air content of 6.0 \pm 1 percent, and containing coarse aggregate and fine aggregate.

VERMONT DEPARTMENT OF HIGHWAYS SPECIFICATIONS:

Item 501.25 Concrete Class B.

PRODUCER OF PRODUCT:

Lawrence Sangravco Inc., St. Johnsbury, Vermont.

MANUFACTURER OF CONCRETE AGGREGATES:

Product - Item 704.01 - Fine Aggregate for Concrete. Produced in Guildhall, Vermont by Lawrence Sangravco Inc., St. Johnsbury, Vermont.

Product - Item 704.02 Coarse Aggregate for Concrete. Produced in Guildhall, Vermont by Lawrence Sangravco Inc., St. Johnsbury, Vermont.

MANUFACTURER OF PORTLAND CEMENT:

Product - Glens Falls Type II - Manufactured by Glens Falls Portland Cement Co., Glens Falls, N.Y.

MANUFACTURER OF AIR ENTRAINING ADMIXTURE USED:

Product - Darex AEA - Manufactured by W.R. Grace & Co. Cambridge, Massachusetts.

Dosage - 9.7 - 10.8 oz/c.y., as necessary to obtain the desired air content.

MANUFACTURER OF WATER REDUCING ADMIXTURE USED:

Product - Pozzolith 122N - Manufactured by Master Builders, Cleveland, Ohio.

PROCEDURE

All aggregates were tested for compliance to Vermont Department of Highways Specifications (Appendix A). Mix designs were proportioned to ACI procedures (Appendix B).

Cement contents of 610 and 634 lbs. per cubic yard were chosen for these tests.

For each cement content two different blends of 1 1/2 and 3/4 inch coarse aggregate were proportioned for mix designs. These were, by percent of weight of total coarse aggregate, 50% 1 1/2 inch stone to 50% 3/4 inch stone and 33 1/3% 1 1/2 inch stone to 66 2/3% 3/4 inch stone.

Each of the mix designs were proportioned using the water reducing admixture Pozzolith 122N at an addition rate of 5 ounces per hundred weight of cement.

Two methods of curing and two concrete mix temperatures were studied. Trial mixes No. 57, 59, 61 and 63 were prepared and cured as follows: The concrete mix temperatures were raised to 80°F by use of warm water. The purpose of this was to simulate warm weather concrete temperatures in the laboratory. The curing procedures for the cylinders made from these mixes were as follows: These cylinders were placed in a dry curing box for 24 hours prior to removal of their molds. The temperature in the curing box was allowed to rise to 90°F. The heat of hydration was sufficient to create the 90°F temperatures. This procedure was used because it was one way to simulate the worst conditions that should occur in the field during the summer months. At the end of 24 hours, the cylinders were removed from the curing box, stripped of their molds and placed in the moist curing room to receive a standard cure until removal for capping and breaking at 7, 14 and 28 days.

Trial mixes No. 58, 60, 62 and 64 were prepared at a concrete temperature of 70°F and were cured for the first 24 hours in a room at 72°F. The molds were then stripped and the cylinders placed in the moist curing room to receive a standard cure until removal for capping and breaking at 7, 14 and 28 days.

RESULTS

Each of the trial mixes tested obtained a 28 day compressive strength in excess of 3500 lbs. However, only trial mix No. 62, 63 and 64 obtained a compressive strength in excess of 4271 psi, the strength which we feel is necessary in order to assure that ninety percent of the field cylinders will surpass the 3500 psi during the warm summer months.

Test results indicate that the different methods of curing had little effect upon the mixes containing the 610 pounds per cubic yard cement content. A difference is noticed however, when comparing the results of the mixes containing the 634 lbs. per cubic yard cement content. Mixes No. 62, and 64, both cured at 70°F obtained higher 28 day compressive strengths than did mixes No. 61 and 63 cured at 80°F.

The coarse aggregate blend of 33 1/3% 1 1/2" stone and 66 2/3% 3/4" stone gave higher strengths than did the 50% to 50% blend when comparing the mixes containing the 634 pounds per cubic yard cement content.

The air content of each mix tested was controlled properly and did not contribute to any abnormal results.

The water cement ratio of all mixes exceeded that anticipated in our design. This difference is very difficult to measure when dealing with small batches in a laboratory mixer. The yield and the unit weight of our mixes correspond very closely to the slight variations in our percent of air and are within acceptable limits.

CONCLUSIONS AND RECOMMENDATIONS

The mix design used to produce trial mix No. 63 and 64 met the compressive strength requirements desired at temperatures of 70°F and 80°F. This mix design should produce concrete of the quality desired during warm summer temperatures.

The following mix design will be used at Lawrence Sangravco Inc. plants at St. Johnsbury, Vermont and Woodsville, N.H., during the 1977 summer construction season. Results of compressive strengths and field tests will be monitored. Adjustments to this design will be made as conditions indicate.

MIX DESIGN FOR TRIAL MIXES NO. 63 & NO. 64

	<u>Dry Weights</u>
1 1/2" stone	645 lbs.
3/4" stone	1291 lbs.
sand	1100 lbs.
cement	634 lbs.
Pozzolith 122N Darex AEA	5 oz./100 lbs. of cement as required to obtain correct air content

TABLE NO. 1

SUMMARY OF RESULTS OF TRIAL MIXES USING GUILDHALL AGGREGATES

Trial Mix No.	Design cement content lbs./c.y.	Curing temp. first 24 hrs.	Percentage of coarse aggregate blend		Average compressive strength of two cylinders broken at the following			Percent Slump of air in inches		Unit Weight	Yield Cu. Ft.	Water Cement
			1½" - 3/4"	7 Days	14 Days	28 Days	P.	C.				
57	610	80°F	50 - 50	3223	3705	4249	6.2 5.8	3 1/2	146.58	27.25	0.461	
58	610	70°F	50 - 50	3502	3997	4085	6.5 6.0	3	145.69	27.40	0.456	
59	610	80°F	33 1/3-66 2/3	3412	3908	4209	6.1 6.0	2 3/4	145.65	27.39	0.474	
60	610	70°F	33 1/3-66 2/3	3236	4112	4178	6.0 4.6	3 1/4	146.06	27.23	0.452	
61	634	80°F	50 - 50	3281	3864	4187	5.5 5.5	3	148.59	26.86	0.453	
62	634	70°F	50 - 50	3479	4130	4311	6.0 5.1	3	146.54	27.25	0.456	
63	634	80°F	33 1/3-66 2/3	3493	3909	4349	5.6 5.0	3	147.55	27.06	0.454	
64	634	70°F	33 1/3-66 2/3	3493	4165	4607	5.6 4.1	3	147.55	27.04	0.450	

APPENDIX A

GRADATION OF MATERIALS USED

Coarse stone (1 1/2") Crushed Gravel

Source: Lawrence Sangravco Inc., Guildhall, Vermont

<u>Sieve Designation</u>	<u>Percentage by Weight Passing Square Mesh Sieves</u>	<u>Specifications</u>
1 3/4 inches	100	100
1 1/2 inches	93	90 - 100
1 inch	20	20 - 55
3/4 inch	1	0 - 15
3/8 inch	0	0 - 5

Fine stone (3/4") Crushed Gravel

Source: Lawrence Sangravco Inc., Guildhall, Vermont

<u>Sieve Designation</u>	<u>Percentage by Weight Passing Square Mesh Opening</u>	<u>Specifications</u>
1 inch	100	100
3/4 inch	98	90 - 100
3/8 inch	22	20 - 50
No. 4	2	0 - 10
No. 8	1	0 - 5

Fine Aggregate (sand)

Source: Lawrence Sangravco Inc., Guildhall, Vermont

<u>Sieve Designation</u>	<u>Percentage by Weight Passing Square Mesh Sieve</u>	<u>Specifications</u>
3/8 inch	100	100
No. 4	100	95 - 100
No. 16	68	50 - 80
No. 30	37	25 - 60
No. 50	15	10 - 30
No. 100	5	2 - 10
F.M. 2.82		

Ready Mix Supplier: Lawrence Sangravco Trial Mix No. 57 & 58

Aggregate Supplier: <u>Lawrence Guildhall, Vt.</u>	Specific Gravity	Dry Rodded Unit Weight	Absorption
<u>1 1/2" Stone</u> Crushed gravel	2.82	98.06	0.5
<u>3/4" Stone</u> Crushed gravel	2.78	98.52	1.1
Blend: <u>1-1/2" & 3/4" 50 - 50</u>	2.79	101.40	
Sand <u>Lawrence - Guildhall, Vt.</u>	2.64	F.M. 2.82	1.6

Cement 610 Lbs./Cu.Yd.
 Water 32 Gals./Cu.Yd.
 Air 6 Percent

VOLUME OF DRY RODDED COARSE AGGREGATE PER UNIT VOLUME OF CONCRETE

Maximum size Aggregate	Sand F.M.					
	2.60	2.70	2.80	2.90	3.00	3.10
<u>3/4"</u>	0.64	0.63	0.62	0.61	0.60	0.59
<u>1-1/2"</u>	0.73	0.72	0.71	0.70	0.69	0.68

$$\frac{101.40}{\text{(Dry Rodded Unit Weight)}} \times \frac{0.71}{\text{(Unit Volume)}} = \frac{71.994}{\text{}} \times 27 = \frac{1944}{\text{}} \text{ Lbs./CY Coarse Aggregate}$$

-
1. Volume of Water (Gals/CY) $\frac{32}{7.48} = 4.278$ Cu. Ft.
 2. Solid Volume of Cement (Lbs./CY) $\frac{610}{196.56} = 3.103$ Cu. Ft.
 3. Volume of Entrained Air $\frac{.06}{\text{}} \times 27 = 1.620$ Cu. Ft.
 4. Solid Volume of Coarse Aggregate $\frac{\text{(Lbs./CY } 1944 \text{)}}{\text{(SpGr) } 2.79} \times 62.4 = 11.166$ Cu. Ft.
 5. Total Solid Volume of Ingredients Except Sand $\frac{20.167}{\text{}} = 20.167$ Cu. Ft.
 6. Solid Volume of Sand Required $27.00 - 20.167 \text{ Cu.Ft. (Line 5)} = 6.833$ Cu. Ft.
 7. Required Weight of Sand: $\frac{\text{(Solid Volume) } 6.833}{\text{}} \times \text{(SpGr) } 2.64 \times 62.4 = 1126$ Lbs./Cu.Yd.
 8. Ratio of Sand to Total Agg. $\text{Line 6} \div (\text{Line 6} + \text{Line 4}) = 38$ % by Vol.

SUMMARY OF QUANTITIES/CU. YD. (DRY WEIGHTS)

	Trial # 57	Trial # 58	Trial #	
1 <u>1/2" Stone</u>	<u>972</u>	<u>972</u>	<u> </u>	Lbs.
<u>3/4" Stone</u>	<u>972</u>	<u>972</u>	<u> </u>	Lbs.
Sand	<u>1126</u>	<u>1126</u>	<u> </u>	Lbs.
Cement	<u>610</u>	<u>610</u>	<u> </u>	Lbs.
Water	<u>32</u>	<u>32</u>	<u> </u>	Gals.

(See Reverse Side for Results)

RESULTS OF TRIAL BATCHES

Air Admixture used: DAREX AEA

Manufactured by: W. R. Grace Cambridge, Massachusetts

Other Admixtures used: Pozzolith 122N

Manufactured by: Master Builders, Cleveland, Ohio

	TRIAL # 57	TRIAL # 58	TRIAL #
Air Admixture Dosage	<u>10 oz./c.y.</u>	<u>10 oz./c.y.</u>	<u> </u>
Other Admixture Dosage	<u>5 oz./cwt</u>	<u>5 oz./cwt</u>	<u> </u>
% Air	<u>6.2</u>	<u>6.5</u>	<u> </u>
Slump	<u>3 1/2</u>	<u>3</u>	<u> </u>
Unit Weight	<u>146.58</u>	<u>145.69</u>	<u> </u>
Yield	<u>27.25</u>	<u>27.40</u>	<u> </u>
W/C Ratio	<u>.461</u>	<u>.456</u>	<u> </u>

Average
Compressive Strengths - Standard Cured 6" x 12" Cylinders

7 Days	<u>3223</u>	<u>3502</u>	<u> </u>
14 Days	<u>3705</u>	<u>3997</u>	<u> </u>
28 Days	<u>4249</u>	<u>4085</u>	<u> </u>
___ Days	<u> </u>	<u> </u>	<u> </u>

Remarks:

Ready Mix Supplier: Lawrence Sangravco Trial Mix No. 59 & 60

Aggregate Supplier	Specific Gravity	Dry Rodded Unit Weight	Absorption
Lawrence Guildhall, Vt. 1 1/2" Stone Crushed gravel	2.82	98.06	0.5
3/4" Stone Crushed gravel	2.78	98.52	1.1
Blend: 1-1/2" & 3/4" ³³ 1/2-66 ^{2/3}	2.77	100.96	
Sand Lawrence, Guildhall, Vt.	2.64	F.M. 2.82	1.6

Cement 610 Lbs./Cu.Yd.
Water 32 Gals./Cu.Yd.
Air 6 Percent

VOLUME OF DRY RODDED COARSE AGGREGATE PER UNIT VOLUME OF CONCRETE

Maximum size Aggregate	Sand F.M.					
	2.60	2.70	2.80	2.90	3.00	3.10
3/4"	0.64	0.63	0.62	0.61	0.60	0.59
1-1/2"	0.73	0.72	0.71	0.70	0.69	0.68

$$\frac{100.06}{\text{(Dry Rodded Unit Weight)}} \times \frac{0.71}{\text{(Unit Volume)}} = \frac{71.6816}{\text{}} \times 27 = \frac{1936}{\text{}} \text{ Lbs./CY Coarse Aggregate}$$

-
- Volume of Water (Gals/CY) $\frac{32}{7.48} = \frac{4.278}{\text{}} \text{ Cu. Ft.}$
 - Solid Volume of Cement (Lbs./CY) $\frac{610}{196.56} = \frac{3.103}{\text{}} \text{ Cu. Ft.}$
 - Volume of Entrained Air $\frac{.06}{\text{}} \times 27 = \frac{1.620}{\text{}} \text{ Cu. Ft.}$
 - Solid Volume of Coarse Aggregate $\frac{\text{(Lbs./CY 1936)}}{\text{(SpGr) 2.77}} \times 62.4 = \frac{11.201}{\text{}} \text{ Cu. Ft.}$
 - Total Solid Volume of Ingredients Except Sand $\frac{20.202}{\text{}} \text{ Cu. Ft.}$
 - Solid Volume of Sand Required $27.00 - \frac{20.202}{\text{}} \text{ Cu.Ft. (Line 5)} = \frac{6.798}{\text{}} \text{ Cu. Ft.}$
 - Required Weight of Sand: $\frac{\text{(Solid Volume) 6.798}}{\text{}} \times \frac{\text{(SpGr) 2.64}}{\text{}} \times 62.4 = \frac{1120}{\text{}} \text{ Lbs./Cu.Yd.}$
 - Ratio of Sand to Total Agg. $\text{Line 6} \div (\text{Line 6} + \text{Line 4}) = \frac{38}{\text{}} \text{ \% by Vol.}$

SUMMARY OF QUANTITIES/CU. YD. (DRY WEIGHTS)

	Trial # ⁵⁹	Trial # ⁶⁰	Trial #	
1 1/2" Stone	<u>645</u>	<u>645</u>	<u> </u>	Lbs.
3/4" Stone	<u>1291</u>	<u>1291</u>	<u> </u>	Lbs.
Sand	<u>1120</u>	<u>1120</u>	<u> </u>	Lbs.
Cement	<u>610</u>	<u>610</u>	<u> </u>	Lbs.
Water	<u>32</u>	<u>32</u>	<u> </u>	Gals.

(See Reverse Side for Results)

RESULTS OF TRIAL BATCHES

Air Admixture used: DAREX AEA

Manufactured by: W. R. Grace, Cambridge, Massachusetts

Other Admixtures used: Pozzolith 122N

Manufactured by: Master Builders, Cleveland, Ohio

	TRIAL # 59	TRIAL # 60	TRIAL #
Air Admixture Dosage	<u>9 oz./c.y.</u>	<u>9 oz./c.y.</u>	<u> </u>
Other Admixture Dosage	<u>5 oz./cwt</u>	<u>5 oz./cwt</u>	<u> </u>
% Air	<u>6.1</u>	<u>6.0</u>	<u> </u>
Slump	<u>2/3/4</u>	<u>3 1/4</u>	<u> </u>
Unit Weight	<u>145.65</u>	<u>146.06</u>	<u> </u>
Yield	<u>27.39</u>	<u>27.23</u>	<u> </u>
W/C Ratio	<u>0.474</u>	<u>0.452</u>	<u> </u>

Average
Compressive Strengths - Standard Cured 6" x 12" Cylinders

7 Days	<u>3413</u>	<u>3236</u>	<u> </u>
14 Days	<u>3908</u>	<u>4112</u>	<u> </u>
28 Days	<u>4209</u>	<u>4178</u>	<u> </u>
___ Days	<u> </u>	<u> </u>	<u> </u>

Remarks: _____

Ready Mix Supplier: Lawrence Sangravco Trial Mix No. 61 & 62

Aggregate Supplier: <u>Lawrence Guildhall, Vt.</u>	Specific Gravity	Dry Rodded Unit Weight	Absorption
1 1/2" Stone Crushed gravel	2.82	98.06	0.5
3/4" Stone Crushed gravel	2.78	98.52	1.1
Blend: 1-1/2" & 3/4" <u>50 - 50</u>	2.79	101.40	
Sand Lawrence, Guildhall, Vt.	2.64	F.M. 2.82	1.6

Cement 634 Lbs./Cu.Yd.
 Water 32 Gals./Cu.Yd.
 Air 6 Percent

VOLUME OF DRY RODDED COARSE AGGREGATE PER UNIT VOLUME OF CONCRETE

Maximum size Aggregate	Sand F.M.					
	2.60	2.70	2.80	2.90	3.00	3.10
3/4"	0.64	0.63	0.62	0.61	0.60	0.59
1-1/2"	0.73	0.72	0.71	0.70	0.69	0.68

$$\frac{101.4}{\text{(Dry Rodded Unit Weight)}} \times \frac{0.71}{\text{(Unit Volume)}} = \frac{71.994}{\text{}} \times 27 = \frac{1944}{\text{}} \text{ Lbs./CY Coarse Aggregate}$$

-
1. Volume of Water (Gals/CY) 32 = 4.278 Cu. Ft.
 $\frac{7.48}{\text{}} = \frac{4.278}{\text{}}$
 2. Solid Volume of Cement (Lbs./CY) 634 = 3.225 Cu. Ft.
 $\frac{196.56}{\text{}} = \frac{3.225}{\text{}}$
 3. Volume of Entrained Air .06 X 27 = 1.620 Cu. Ft.
 4. Solid Volume of Coarse Aggregate (Lbs./CY) 1944 (SpGr) 2.79 X 62.4 = 11.166 Cu. Ft.
 5. Total Solid Volume of Ingredients Except Sand 20.289 Cu. Ft.
 6. Solid Volume of Sand Required 27.00 - 20.289 Cu.Ft. (Line 5) = 6.711 Cu. Ft.
 7. Required Weight of Sand: (Solid Volume) 6.711 X (SpGr) 2.64 X 62.4 = 1106 Lbs./Cu.Yd.
 8. Ratio of Sand to Total Agg. Line 6 ÷ (Line 6 + Line 4) = 38 % by Vol.

SUMMARY OF QUANTITIES/CU. YD. (DRY WEIGHTS)

	Trial # ⁶¹	Trial # ⁶²	Trial #	
1 1/2" Stone	<u>972</u>	<u>972</u>	<u> </u>	Lbs. -
3/4" Stone	<u>972</u>	<u>972</u>	<u> </u>	Lbs.
Sand	<u>1106</u>	<u>1106</u>	<u> </u>	Lbs.
Cement	<u>634</u>	<u>634</u>	<u> </u>	Lbs.
Water	<u>32</u>	<u>32</u>	<u> </u>	Gals.

(See Reverse Side for Results)

RESULTS OF TRIAL BATCHES

Air Admixture used: DAREX AEA

Manufactured by: W. R. Grace, Cambridge, Massachusetts

Other Admixtures used: Pozzolith 122N

Manufactured by: Master Builders, Cleveland, Ohio

	TRIAL # 61	TRIAL # 62	TRIAL #
Air Admixture Dosage	<u>10 oz./c.y.</u>	<u>10 oz./c.y.</u>	<u> </u>
Other Admixture Dosage	<u>5 oz./cwt</u>	<u>5 oz./cwt</u>	<u> </u>
% Air	<u>5.5</u>	<u>6.0</u>	<u> </u>
Slump	<u>3</u>	<u>3</u>	<u> </u>
Unit Weight	<u>148.59</u>	<u>146.54</u>	<u> </u>
Yield	<u>26.86</u>	<u>27.25</u>	<u> </u>
W/C Ratio	<u>0.453</u>	<u>0.456</u>	<u> </u>

Average
Compressive Strengths - Standard Cured 6" x 12" Cylinders

7 Days	<u>3281</u>	<u>3479</u>	<u> </u>
14 Days	<u>3864</u>	<u>4130</u>	<u> </u>
28 Days	<u>4187</u>	<u>4311</u>	<u> </u>
___ Days	<u> </u>	<u> </u>	<u> </u>

Remarks: _____

Ready Mix Supplier: Lawrence Sangravco, Inc. Trial Mix No. 63 & 64

Aggregate Supplier	Lawrence Guildhall, Vt.	Specific Gravity	Dry Rodded Unit Weight	Absorption
1 1/2" Stone	Crushed gravel	2.82	98.06	0.5
3/4" Stone	Crushed gravel	2.78	98.52	1.1
Blend:	1-1/2" & 3/4"	2.77	100.96	
Sand	Lawrence - Guildhall, Vt.	2.64	F.M. 2.80	1.6

Cement 634 Lbs./Cu.Yd.
 Water 32 Gals./Cu.Yd.
 Air 6 Percent

VOLUME OF DRY RODDED COARSE AGGREGATE PER UNIT VOLUME OF CONCRETE

Maximum size Aggregate	Sand F.M.					
	2.60	2.70	2.80	2.90	3.00	3.10
3/4"	0.64	0.63	0.62	0.61	0.60	0.59
1-1/2"	0.73	0.72	0.71	0.70	0.69	0.68

$$\frac{100.96}{\text{(Dry Rodded Unit Weight)}} \times \frac{0.71}{\text{(Unit Volume)}} = \frac{71.68}{\text{}} \times 27 = \frac{1936}{\text{}} \text{ Lbs./CY Coarse Aggregate}$$

1. Volume of Water (Gals/CY) $\frac{32}{7.48} = \frac{4.278}{\text{}} \text{ Cu. Ft.}$
2. Solid Volume of Cement (Lbs./CY) $\frac{634}{196.56} = \frac{3.225}{\text{}} \text{ Cu. Ft.}$
3. Volume of Entrained Air $\frac{.06}{\text{}} \times 27 = \frac{1.620}{\text{}} \text{ Cu. Ft.}$
4. Solid Volume of Coarse Aggregate $\frac{\text{(Lbs./CY)} \frac{1936}{\text{(SpGr)}}}{2.77} \times 62.4 = \frac{11.201}{\text{}} \text{ Cu. Ft.}$
5. Total Solid Volume of Ingredients Except Sand $\frac{20.324}{\text{}} \text{ Cu. Ft.}$
6. Solid Volume of Sand Required $27.00 - \frac{20.324}{\text{}} \text{ Cu.Ft. (Line 5)} = \frac{6.676}{\text{}} \text{ Cu. Ft.}$
7. Required Weight of Sand: $\frac{\text{(Solid Volume)} \frac{6.676}{\text{}} \times \text{(SpGr)} \frac{2.64}{\text{}}}{\text{}} \times 62.4 = \frac{1100}{\text{}} \text{ Lbs./Cu.Yd.}$
8. Ratio of Sand to Total Agg. $\text{Line 6} \div (\text{Line 6} + \text{Line 4}) = \frac{37}{\text{}} \text{ \% by Vol.}$

SUMMARY OF QUANTITIES/CU. YD. (DRY WEIGHTS)

	Trial # 63	Trial # 64	Trial #	
1 1/2 " Stone	<u>645</u>	<u>645</u>	<u> </u>	Lbs.
3/4 " Stone	<u>1291</u>	<u>1291</u>	<u> </u>	Lbs.
Sand	<u>1100</u>	<u>1100</u>	<u> </u>	Lbs.
Cement	<u>634</u>	<u>634</u>	<u> </u>	Lbs.
Water	<u>32</u>	<u>32</u>	<u> </u>	Gals.

(See Reverse Side for Results)

RESULTS OF TRIAL BATCHES

Air Admixture used: DAREX AEA

Manufactured by: W. R. Grace, Cambridge, Massachusetts

Other Admixtures used: Pozzolith 122N

Manufactured by: Master Builders, Cleveland, Ohio

	TRIAL #63	TRIAL # 64	TRIAL #
Air Admixture Dosage	<u>10 oz./c.y.</u>	<u>10 oz./c.y.</u>	<u> </u>
Other Admixture Dosage	<u>5 oz./cwt</u>	<u>5 oz./cwt</u>	<u> </u>
% Air	<u>5.6</u>	<u>5.6</u>	<u> </u>
Slump	<u>3</u>	<u>3</u>	<u> </u>
Unit Weight	<u>147.55</u>	<u>147.55</u>	<u> </u>
Yield	<u>27.06</u>	<u>27.04</u>	<u> </u>
W/C Ratio	<u>0.454</u>	<u>0.450</u>	<u> </u>

Average
Compressive Strengths - Standard Cured 6" x 12" Cylinders

7 Days	<u>3493</u>	<u>3493</u>	<u> </u>
14 Days	<u>3909</u>	<u>4165</u>	<u> </u>
28 Days	<u>4349</u>	<u>4607</u>	<u> </u>
___ Days	<u> </u>	<u> </u>	<u> </u>

Remarks: _____

Vermont Department of Highways

Materials Division - Structural Concrete Subdivision

PRODUCT EVALUATION WORK PLAN

Number 77-C-26

Product Class B Concrete using Guildhall Aggregates

Manufacturer	<u>Lawrence Sandgravco, Inc.</u>	Distributor or Representative	<u>Lawrence Sandgravco</u>
	<u>St. Johnsbury,</u>		<u>St. Johnsbury,</u>
	<u>Vermont 05819</u>		<u>Vermont 05819</u>

Evaluation Requested By In House Date April 19, 1977

Date Information Required _____

Date Product Data & Application Instructions Received N/A

Date Samples Received March 23, 1977

Sample Quantity N/A Were sufficient samples received yes

Purpose of Evaluation

To develop a mix design that will meet strength requirements, 3500 psi @ 28 days during summer temperatures.

Proposed Tests (Attach extra sheet if necessary)

1. Compressive Strengths 7, 14, 28 days using 6" x 12" cylinders
2. Air Contents - Chace & Pressure
3. Controlled Temperatures
4. Unit Weight & Yield
5. Determine water cement ratios

Proposal Discussed with following Sub-divisions None

Projected Manpower Requirements 15 man days including report

Evaluation to be Conducted by Structural Concrete Subdivision

Proposed Starting Date 3/23/77 Estimated Completion Date July, 1977

Approval/Disapproval by Materials Engineer *R.T. Nicholas* 3/27

Comments by Materials Engineer _____