

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS DIVISION

J.P. CARRARA & SONS
NORTH CLARENDON, VERMONT
TRIAL MIXES FOR CLASS A & CLASS B CONCRETE

REPORT 78-8
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REPORTING ON WORK PLAN NO. 77-C-32

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Materials Division
Highway Department
Agency of Transportation
March 30, 1978

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ABSTRACT

This report is an evaluation of two concrete trial mix designs. The designs were studied for the possible future use in the production of Class A and Class B concrete by J.P. Carrara & Sons Inc., North Clarendon, Vermont.

The results of this evaluation show that the design proposed for the production of Class A concrete may be, with minor adjustments for yield, adequate to produce concrete of the desired quality. The design proposed for the production of concrete Class B proved to be harsh and lack workability. A revised Class B trial mix design is recommended for laboratory testing.

INTRODUCTION

This study was an evaluation of two trial mix designs, one for Concrete Class A, and one for Concrete Class B as specified in the State of Vermont Department of Highways Standard Specifications for Highway and Bridge Construction March 1976.

The purpose of this study was to evaluate two prepared concrete trial mix designs using materials available to J.P. Carrara & Sons Inc., North Clarendon, Vermont.

In order for a plant to produce quality concrete meeting the requirements of the Class of concrete specified, a design for the concrete mix must be established.

Several trial mix designs may have to be tested before an adequate design can be determined. The results of the tests performed on these trial mixes are being recorded for possible future use or study.

MATERIALS

Coarse Aggregate:

1 1/2" Stone - J.P. Carrara & Sons Inc., North Clarendon, Vermont
3/4" Stone - J.P. Carrara & Sons Inc., North Clarendon, Vermont

Fine Aggregate:

Sand - J.P. Carrara & Sons Inc., North Clarendon, Vermont

Cement:

Type II - Glens Falls Portland Cement Co., Glens Falls, New York

Admixtures:

Air Entraining - Darex AEA - W.R. Grace & Co., Cambridge, Mass.
Retarding - Daratard 17 - W.R. Grace & Co., Cambridge, Mass.

PROCEDURES

Aggregates were obtained from stockpiles at J.P. Carrara & Sons Inc, North Clarendon, Vermont. The aggregates were tested for gradation, specific gravity, absorption and dry rodded unit weight.

Trial mix designs were proportional using the ACI recommended practice for selecting proportions for normal weight concrete.

The Class A Concrete was proportioned to contain 660 lbs/cy of cement, 3/4" stone coarse aggregate, and a retarding admixture. The Class B Concrete was proportioned to contain 610 lbs/cy of cement and a coarse aggregate blend of 50% 1 1/2" stone and 50% 3/4" stone.

All concrete was tested for air content, slump, temperature, unit weight, and yield. Two 6 inch by 12 inch cylinders were made and standard cured for breaking at each of the following ages: 7, 14 and 28 days. The recorded compressive strengths is the average of the two cylinder breaks.

Ready Mix Supplier: J.P. Carrara & Sons Inc., North Clarendon, Vermont

Aggregate Supplier:	Specific Gravity	Dry Rodded Unit Weight	Absorption
<u> </u> " Stone			
<u>3/4"</u> Stone J.P. Carrara & Sons	2.64	100.63	0.9
Blend: <u>1-1/2"</u> & <u>3/4"</u>			
Sand J.P. Carrara & Sons	2.62	F.M. 2.72	1.0

Cement 660 Lbs./Cu.Yd.Water 35 Gals./Cu.Yd.Air 6 PercentVOLUME 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

$$\frac{100.63}{(\text{Dry Rodded Unit Weight})} \times \frac{0.63}{(\text{Unit Volume})} = 63.3969 \times 27 = \underline{1712} \text{ Lbs./CY Coarse Aggregate}$$

1. Volume of Water (Gals./CY) $\frac{35}{7.48} = \underline{4.679}$ Cu. Ft.
2. Solid Volume of Cement (Lbs./CY) $\frac{660}{196.56} = \underline{3.358}$ Cu. Ft.
3. Volume of Entrained Air $\underline{.06} \times 27 = \underline{1.620}$ Cu. Ft.
4. Solid Volume of Coarse Aggregate $\frac{(\text{Lbs./CY}) \ 1712}{(\text{SpGr}) \ 2.64 \times 62.4} = \underline{10.392}$ Cu. Ft.
5. Total Solid Volume of Ingredients Except Sand $\underline{20.049}$ Cu. Ft.
6. Solid Volume of Sand Required $27.00 - \underline{20.049} \text{ Cu.Ft. (Line 5)} = \underline{6.951}$ Cu. Ft.
7. Required Weight of Sand: $(\text{Solid Volume}) \ \underline{6.951} \times (\text{SpGr}) \ \underline{2.62} \times 62.4 = \underline{1136}$ Lbs./Cu.Yd.
8. Ratio of Sand to Total Agg. $\text{Line 6} \div (\text{Line 6} + \text{Line 4}) = \underline{40.1} \% \text{ by Vol.}$

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

	Trial # <u>A₁</u>	Trial # <u>A₂</u>	Trial #	
<u> </u> " Stone				Lbs.
<u>3/4"</u> Stone	<u>1712</u>	<u>1712</u>		Lbs.
Sand	<u>1136</u>	<u>1136</u>		Lbs.
Cement	<u>660</u>	<u>660</u>		Lbs.
Water	<u>35</u>	<u>35</u>		Gals.

MATERIALS DIVISION - STRUCTURAL CONCRETE SUBDIVISION Date 4/26/77MIX DESIGN SHEET - STRUCTURAL CONCRETE ITEM # 501.25 CONCRETE CLASS BReady Mix Supplier: J.A. Carrara & Sons, Inc., North Clarendon, Vermont

Aggregate Supplier:	Specific Gravity	Dry Rodded Unit Weight	Absorption
1 1/2" Stone	2.63		0.7
3/4" Stone	2.64		0.9
Blend: 1-1/2" & 3/4" <u>1/2 - 1/2</u>	2.64	104.01	0.8
Sand	2.62	F.M. 2.72	1.0

Cement 610 Lbs./Cu.Yd.
 Water 32 Gals./Cu.Yd.
 Air 5 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

$$\frac{104.01}{(\text{Dry Rodded Unit Weight})} \times \frac{0.72}{(\text{Unit Volume})} = 74.8872 \times 27 = 2022 \text{ Lbs./CY Coarse Aggregate}$$

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 $.05 \times 27 = 1.350$ Cu. Ft.
4. Solid Volume of Coarse Aggregate $\frac{(\text{Lbs./CY}) 2022}{(\text{SpGr}) 2.64 \times 62.4} = 12.274$ Cu. Ft.
5. Total Solid Volume of Ingredients Except Sand 21.005 Cu. Ft.
6. Solid Volume of Sand Required $27.00 - 21.005$ Cu. Ft. (Line 5) = 5.995 Cu. Ft.
7. Required Weight of Sand:
 (Solid Volume) 5.995 \times (SpGr) 2.62 \times 62.4 = 980 Lbs./Cu.Yd.
8. Ratio of Sand to Total Agg. $\text{Line 6} \div (\text{Line 6} + \text{Line 4}) = 32.8$ % by Vol.

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

	Trial # B ₁	Trial # B ₂	Trial #	
1 1/2" Stone	<u>1011</u>	<u>1011</u>		Lbs.
3/4" Stone	<u>1011</u>	<u>1011</u>		Lbs.
Sand	<u>980</u>	<u>980</u>		Lbs.
Cement	<u>610</u>	<u>610</u>		Lbs.
Water	<u>32</u>	<u>32</u>		Gals.

RESULTS OF AGGREGATE TESTS

Percent Passing	1 1/2" Stone	3/4" Stone	Sand
1 3/4" Sieve	100		
1 1/2" Sieve	96		
1" Sieve	38	100	
3/4" Sieve	3	30	
3/8" Sieve		5	
#4 Sieve		2	100
#8 Sieve			91
#16 Sieve			73
#30 Sieve			45
#50 Sieve			14
#100 Sieve			5 F.M. 2.72
Bulk (Dry) Specific Gravity	2.64	2.64	2.62
Absorption %	0.7	0.9	1.0
Dry Rodded Unit Weight Lbs/Ft ³	104.01	100.63	

RESULTS OF TRIAL BATCHES

Air Admixture used: DAREX AEA

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

Other Admixtures used: Daratar 17

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

	TRIAL # Λ_1	TRIAL # Λ_2	TRIAL #
Air Admixture Dosage	4 oz/cy	4 oz/cy	
Other Admixture Dosage	3 oz/cwt	3 oz/cwt	
% Air	6.0	4.7	
Slump	4 1/4	2 1/4	
Unit Weight	142.07	145.21	
Yield	26.92	26.24	
W/C Ratio			

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

7 Days	3400	3529	
14 Days	3696	4218	
28 Days	4593	5243	
Days			

Remarks: This mix design appears adequate to produce Concrete Class A. The
coarse aggregate and fine aggregate weights should be increased 3 %
to correct the low yield and field tests monitored for results.

RESULTS OF TRIAL BATCHES

Air Admixture used: DAREX AEA

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

Other Admixtures used: None

Manufactured by: _____

	TRIAL # B_1	TRIAL # B_2	TRIAL #
Air Admixture Dosage	<u>4 oz/cy</u>	<u>4 oz/cy</u>	_____
Other Admixture Dosage	<u>-</u>	<u>-</u>	_____
% Air	<u>4.7</u>	<u>4.2</u>	_____
Slump	<u>2 3/4</u>	<u>2 1/4</u>	_____
Unit Weight	<u>145.57</u>	<u>146.14</u>	_____
Yield	<u>26.84</u>	<u>26.69</u>	_____
W/C Ratio	_____	_____	_____

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

7 Days	<u>2697</u>	<u>3068</u>	_____
14 Days	<u>3135</u>	<u>3510</u>	_____
28 Days	<u>3382</u>	<u>3771</u>	_____
___ Days	_____	_____	_____

Remarks: Trial mixes were harsh. Poor workability was obtained.
Suggest eliminating 1 1/2" stone and using a water reducing
admixture and increase cement for additional strength.

SUMMARY OF LABORATORY TEST RESULTS

CLASS OF CONCRETE

	A1	A2	B*1	B*2
1 1/2" Stone (SSD)	-	-	1018	1018
3/4" Stone (SSD)	1727	1727	1020	1020
Sand (SSD)	1147	1147	990	990
Cement	660	660	610	610
Admixtures				
Air Entraining	4 oz/cy	4 oz/cy	4 oz/cy	4 oz/cy
Retarding	3 oz/cwt	3 oz/cwt	-	-
Air Content %	6.0	4.7	4.7	4.2
Slump in.	4 1/4	2 1/4	2 3/4	2 1/4
Temperature °F	73	73	73	74
Unit Weight Lbs/Ft ³	142.07	145.21	145.57	146.14
Yield Ft ³	26.92	26.24	26.84	26.69
Compressive Strength				
7 Days Avg.	3400	3529	2697	3068
14 Days Avg.	3696	4218	3135	3510
28 Days Avg.	4593	5243	3382	3771

*During mixing and testing, it was noted that the plastic Class B Concrete was very harsh and unworkable.

RECOMMENDATIONS

The following Class A mix design is recommended for use in the field. This revised mix design is subject to change based upon the results of future tests and evaluations. The dosage rate of the proposed admixtures will vary depending on the project requirements.

Class A

3/4" Stone (Dry weight)	1763	lbs/cy	S.G. 2.64
Sand (Dry weight)	1170	lbs/cy	S.G. 2.62 F.M. 2.70
Cement	660	lbs/cy	

Air Entrainment - Darex AEA (as required to produce $6 \pm 1\%$ air)

Retarding Admixture - Daratard 17 (3 - 5 oz/cwt depending on project requirements)

The following Class B trial mix design is recommended for laboratory testing. The results of the tests will determine the suggested future mix design.

Class B

3/4" Stone (Dry weight)	1729	lbs/cy
Sand	1249	lbs/cy
Cement	634	lbs/cy

Air Entrainment - Darex AEA (as required to produce $5 \pm 1\%$ air)

Water reducing admixture WRDA Hycol 5 oz/cwt

APPENDIX A

Vermont Department of Highways
Materials Division - Structural Concrete Subdivision

PRODUCT EVALUATION WORK PLAN

Number 77-C-32

Product Trial Mixes - J.P. Carrara & Sons, No. Clarendon, Vt. - Class A & Class B Concrete

Manufacturer J. P. Carrara & Sons, Inc. Distributor or
No. Clarendon Representative
Vermont

Evaluation Requested By In House Date NA

Date Information Required NA

Date Product Data & Application Instructions Received NA

Date Samples Received May 16, 1977

Sample Quantity NA Were sufficient samples received Yes

Purpose of Evaluation

Investigative. To evaluate mix designs for Class A & Class B concretes to determine if
concrete of the desired quality can be produced. Class A - 4875 psi
Class B - 4275 psi

Proposed Tests (Attach extra sheet if necessary)

1. Two batches for each class of concrete
Air content
Slump
Temperature
Unit Weight and Yield
7, 14, & 28 day compressive strength
using 6"x12" cylinders

Aggregate Tested for
Gradation
Specific Gravity and Absorption
Dry Rodded Unit Weight

Proposal Discussed with following Sub-divisions Research & Development, Compliance Testing

Projected Manpower Requirements 11 mandays including report

Evaluation to be Conducted by Structural Concrete Subdivision

Proposed Starting Date May 17, 1977 Estimated Completion Date June 30, 1977

Approval/Disapproval by Materials Engineer [Signature]

Comments by Materials Engineer _____