

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS DIVISION

Brattleboro Sand & Gravel
Trial Mixes for Class A & Class B Concrete

Report 78-1
March 1978

Reporting on Work Plan No. WP77-C-28

R.E.W. Crisman, Acting Commissioner
S. J. Gage, Chief Engineer
R. F. Nicholson, P.E., Materials Engineer

Prepared By

W. Meyer, Technical C
Structural Concrete Subdivision

"The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. This report does not constitute a standard, specification, or regulation. Anyone, other than the Agency using this report does so with awareness that the Agency does not guarantee the opinions, findings, or conclusions contained therein".

Materials Division
Highway Department
Agency of Transportation
March 15, 1978

Reviewed By:


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

Date: April 28, 1978

TABLE OF CONTENTS

	<u>Page</u>
Plant Location	1
Laboratory Evaluation	1
Materials.	1
Procedures	1
Results.	2
Summary & Conclusions.	3 - 4
Recommendations.	4
Product Evaluation Work Plan Number WP77-C-28.	Appendix A

STATE OF VERMONT
AGENCY OF TRANSPORTATION
Trial Mixes for Class A & Class B Concrete
Report 78-1

PLANT LOCATION:

Brattleboro Sand & Gravel, Brattleboro, Vermont.

LABORATORY EVALUATION:

To test mix designs. To be assured the designs, when used with the available materials, can produce concrete of the desired quality.

MATERIALS:

Coarse Aggregate:

1 1/2" Stone: Cold River Sand & Gravel, North Walpole, New Hampshire

3/4" Stone: Northfield Sand & Gravel, Northfield, Mass.

Fine Aggregate: Northfield Sand & Gravel, Northfield, Mass.

Cement: Type II, Atlantic Cement Co., Ravena, New York

Admixtures:

Air Entraining: Darex AEA, W.R. Grace & Co., Cambridge, Mass.

Water Reducing: WRDA/Hycol, W.R. Grace & Co., Cambridge, Mass.

Retarding: Daratard 17, W.R. Grace & Co., Cambridge, Mass.

PROCEDURES:

Aggregates were tested for gradation, specific gravity and absorption, and dry rodded unit weight.

Three Class A mix designs were evaluated using cement contents of 660, 682 and 705 Lbs/cy. Concrete temperatures ranged from 71°F to 81°F. A Water Reducing or Retarding Admixture was used in all Class A batches.

The Class B concrete was proportioned at three cement contents; 610, 634 and 660 Lbs/cy. Temperatures ranged from 71°F to 82°F for the Class B concrete. A coarse aggregate blend of 50% 1 1/2" stone and 50% 3/4" stone was used in two batches with the remainder of the batches using only 3/4" stone as the coarse aggregate. Water Reducing Admixture was used in several of the batches.

All concrete was tested for air content, slump, temperature, unit weight and yield, and 7, 14 and 28 day compressive strength.

STATE OF VERMONT AOT
 Trial Mixes for Class A & Class B Concrete
 Report 78-1

RESULTS:

Results of all aggregate tests are as follows:

<u>Percent Passing</u>	<u>1 1/2" Stone</u>	<u>3/4" Stone</u>	<u>Sand</u>
1 1/2" Sieve	100		
1" Sieve	54	100	
3/4" Sieve	5	99	
3/8" Sieve	1	34	
#4 Sieve		5	100
#8 Sieve		2	91
#16 Sieve			70
#30 Sieve			43
#50 Sieve			19
#100 Sieve			6 F.M. 2.71
Bulk (Dry) Specific Gravity	2.55	2.65	2.63
Absorption %	0.6	0.9	1.7
Dry Rodded Unit Weight Lbs/Ft ³	104.31	100.61	

Mix designs and results of concrete tests are shown in the following tables:

<u>Class A Concrete</u>					
3/4" Stone (Dry)	1711	1711	1711	1711	1711
Sand (Dry)	1148	1148	1109	1109	1090
Cement	660	660	682	682	705
Air Entraining					
Admixture	8 oz/cy	12 oz/cy	10 oz/cy	8 oz/cy	11 oz/cy
Other Admixtures					
Brand	Daratard 17	Daratard 17	WRDA/Hycol	Daratard 17	Daratard 17
Quantity	3 oz/cwt	3 oz/cwt	3 oz/cwt	5 oz/cwt	5 oz/cwt
Air Content %	4.8	5.5	5.8	4.8	5.2
Slump in.	3	2 1/4	2 3/4	2 1/2	2 3/4
Temperature °F	81	80	72	71	72
Unit Weight					
Lbs/Ft ³	144.52	143.76	142.79	145.21	143.76
Yield Ft ³	26.55	26.65	26.66	26.29	26.62
Compressive Strength					
7 days Avg.	3360	3400	3431	3586	3546
14 days Avg.	4227	3957	3877	4510	4165
28 days Avg.	4797	4412	4527	5040	4828

STATE OF VERMONT AOT
 Trial Mixes for Class A & Class B Concrete
 Report 78-1

Class B Concrete

1 1/2" Stone (Dry)	1014	1014	-	-	-
3/4" Stone (Dry)	1014	1014	1711	1711	1711
Sand (Dry)	985	985	1300	1270	1192
Cement	610	610	610	634	660
Air Entraining					
Admixture	9 oz/cy	9 oz/cy	5 oz/cy	8 oz/cy	8 oz/cy
Other Admixtures					
Brand	-	-	WRDA/Hycol	WRDA/Hycol	WRDA/Hycol
Quantity	-	-	3 oz/cwt	3 oz/cwt	3 oz/cwt
Air Content %	4.4	4.2	5.0	7.0	5.8
Slump in.	2	2 1/4	2 1/2	3	2 1/4
Temperature °F	82	81	71	72	73
Unit Weight					
Lbs/Ft ³	148.15	147.10	144.56	141.38	142.92
Yield Ft ³	26.48	26.67	27.40	27.71	27.22
Compressive Strength					
7 days Avg.	2502	2489	3042	3444	2961
14 days Avg.	2962	2927	4028	3939	3749
28 days Avg.	3670	3577	4395	4195	4236

SUMMARY AND CONCLUSIONS:

The test results obtained for the Class A mix designs having a cement content of 660 Lbs/cy failed by a small margin in obtaining the 4875 psi desired. However, the mix temperatures used in these trail mix are representative of the highest mix temperatures expected during the placement of summer concrete. The test results did surpass the required 4000 psi for Class A concrete by an average of 15%. Based on this data the mix design for a cement content of 660 Lbs/cy will be used in our production of Class A concrete and the early field production monitored for strength. If field results fail to produce strengths of sufficient magnitude to maintain a compressive strength of 4000 psi adjustments to the design will be undertaken. The mix design having a cement content of 682 lbs/cy developed a strength of 5040 psi. The mix design having a cement content of 705 lbs/cy developed a lower strength than did the mix with 682 lbs/cy of cement. These results indicate that the addition of cement did not increase compressive strengths proportionately.

The Class B concrete containing 610 lbs/cy of cement, 3/4" coarse aggregate and a water reducing admixture yielded the highest compressive strength of all Class B mixes tested. This was the only batch which exceeded the desired strength of 4275 psi. Mix designs using cement contents of 634 lbs/cy and 660 lbs/cy did not obtain compressive strengths as expected.

STATE OF VERMONT AOT
 Trial Mixes for Class A & Class B Concrete
 Report 78-1

Based upon the results of these tests strict quality control measures will be necessary in order to produce concrete of the desired quality. These tests demonstrate the variance possible even when tested in the laboratory. Increased cement contents did not produce higher strengths as expected. This may be due to the ability of the particular batch of cement used in our testing.

RECOMMENDATIONS:

The following mix designs are recommended for the production of Class A and Class B concrete. In order for the recommended Class A mix design to produce concrete of the quality desired, plant control of a good to excellent range will be required.

With good to excellent plant and project control a coefficient of variation of about 10 should be maintained. With this degree of control the mix designs recommended for both Class A and Class B will produce concrete of the quality desired.

Review of plant production will be monitored for a broader range of available test data to evaluate our recommended mix designs.

Mix Designs

	Class A	Class B
3/4" Stone (Dry) - Northfield Sand & Gravel, Northfield, Mass.	1728	1711 lbs.
Sand (Dry) - Northfield Sand & Gravel, Northfield, Mass.	1159	1300 lbs.
Cement Type II - Atlantic Cement Co., Ravena, New York	660	610 lbs.
Air Entraining Admixture - Darex AEA - W.R. Grace Cambridge, Mass.	As required	As required

Water Reducing or Retarding admixtures will be used in both classes of concrete. The selection will be determined by project requirements.

Weights of the Class A mix design have been raised 1% over the laboratory trial mix to compensate for the low yield obtained. Field test results may dictate further minor adjustments to obtain the correct percent of air and yield.

Materials Division
 Highway Department
 Agency of Transportation
 March 15, 1978

Vermont Department of Highways

PRODUCT EVALUATION WORK PLANNumber WP 77-C-28Product Trial Mixes - Brattleboro S & G. Class A and Class B ConcreteManufacturer Brattleboro S & GDistributor or NABrattleboro, Vermont

Representative _____

Evaluation Requested By In HouseDate NADate Information Required NADate Product Data & Application Instructions Received NADate Samples Received April 15, 1977Sample Quantity NAWere sufficient samples received Yes

Purpose of Evaluation

To test our mix designs. To be assured our design when used with the available aggregatescan produce concrete of the desired quality.

Class A - 4875 psi

Class B - 4275 psi

Proposed Tests (Attach extra sheet if necessary)

- | | |
|---|-------------------------------|
| 1. Two batches for each class of concrete | Aggregate Tested for |
| Air content | Gradation |
| Slump | Specific Gravity & Absorption |
| Temperature | Dry rodded unit weight |
| Unit Weight and Yield | |
| 7, 14 and 28 day compressive strength | |

Proposal Discussed with following Sub-divisions Research & Development, Compliance TestingProjected Manpower Requirements 11 man days including reportEvaluation to be Conducted by Structural Concrete SubdivisionProposed Starting Date May 3, 1977 Estimated Completion Date June 10, 1977Approval/Disapproval by Materials Engineer R. F. Nicholas 5/9/77

Comments by Materials Engineer _____