EVALUATION OF SWANTON LIMESTONE/SWANTON, VT. 3/4" CRUSHED STONE (BLACK) FOR USE IN STRUCTURAL CONCRETE

REPORT 84-4

MAY 1984

Reporting on Work Plan 83-C-43

STATE OF VERMONT AGENCY OF TRANSPORTATION MATERIALS & RESEARCH DIVISION

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ABSTRACT

As aggregate sources are developed or expanded, tests must be conducted to assure that new materials meet specifications and perform satisfactorily when used in concrete mixtures.

This report documents results of tests performed on a newly developed coarse aggregate from the Swanton Limestone quarry in Swanton, Vermont. The material tested was a 3/4 inch crushed stone designated as "black limestone" by Swanton Limestone President Dennis Demers.

Mr. Demers requested that the new material be tested for approved use in structural concrete and bituminous concrete.

By way of this evaluation, the new material was found to be the black shale of the Iberville formation and as such could produce structural concrete exhibiting poor durability. This report recommends that the new material not be considered acceptable for use in structural concrete for Agency projects.

INTRODUCTION

As aggregate sources, for use in structural concrete, are developed or expanded, new materials must be evaluated not only to determine their compliance with materials specifications, but to examine their performance in concrete mixtures. A procedure has been developed whereby proposed new aggregates are evaluated by comparing results of tests performed on concrete using the new aggregate, with results obtained from concrete containing a reference aggregate. See Appendix A for evaluation procedures.

A request was received from Dennis Demers, President of Swanton Limestone, to evaluate a crushed stone, designated as "black limestone" being produced at their existing quarry in Swanton, Vermont. The new material is in addition to their regular grey limestone coarse aggregate which is produced at the same quarry. Mr. Demers requested that the "black limestone" be evaluated for use in both structural concrete and bituminous concrete.

Samples of the new 3/4 inch crushed stone were obtained by Materials & Research Division representatives and evaluated for compliance with the requirements of Section 704.02 of the Standard Specifications. Materials were obtained and the performance-in-concrete phase of the evaluation was conducted in the Central Laboratory of the Materials & Research Division. Tests were performed cooperatively with the Bituminous Concrete Subdivision and applicable results shared to avoid duplication of effort. The results of the evaluation conducted by the Bituminous Concrete Subdivision are documented in Materials & Research Division Report 84-1.

PROCEDURES

PHASE I - SECTION 704.02 TESTS

The 3/4 inch crushed stone (black) was sampled, by representatives of the Materials and Research Division, from a stockpile at the Swanton Limestone facility in Swanton. The material was examined for gradation, wear, fractured faces, thin and elongated pieces and soundness. It was found to comply with Section 704.02 requirements. Test results are shown on Laboratory Report No. A83 1293 in Appendix B.

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:

Coarse aggregate

A. Proposed New Aggregate (black)

3/4 inch Crushed Stone Swanton Limestone, Swanton, Vermont

B. Reference Aggregate (gray limestone):

3/4 inch Crushed Stone Swanton Limestone, Swanton, Vermont

Fine Aggregate

A. G. Anderson Co., Inc., Highgate, Vermont

Cement

Type II Glens Falls Portland Cement Co., Glens Falls, N.Y.

Air Entraining Admixture:

Darex AEA W. R. Gnace & Co., Cambridge, Massachusetts

Water Reducing Admixture:

WRDA with Hycol W. R. Grace & Co., Cambridge, Massachusetts

Aggregate properties used for preparing mix designs are shown in Table

1 and Table 2.

TABLE 1COARSE AGGREGATE PROPERTIES

	Bulk Specific Gravity		Dry Rodded Unit Weight, lbs/ft
New Aggregate (black) Swanton Limestone, Swanton, Vt.	2.70	0.8	91.11
Reference Aggregate (gray limestone) Swanton Limestone, Swanton, Vt.	2.75	0.5	97.88

TABLE 2 FINE AGGREGATE PROPERTIES

	Bulk Specific Gravity	Absorp. Percent	Fineness Modulus
Reference Aggregate A. G. Anderson Co., Inc., Highgate, Vt.	2.60	1.3	2.74

Initially, the performance-in-concrete evaluation was scheduled to use two batches each of Class A and Class B concrete containing the new aggregate and two batches each of Class A and Class B concrete containing the reference aggregate. However, poor performance of the new aggregate batches in freezethaw testing, prompted testing of an additional batch of Class B concrete.

The mix proportions used in Batches 1-8, the initial part of the evaluation, are shown in Table 3 and Table 4. These batches were mixed in a Sears rotary drum mixer with the batch size being 1.5 cubic feet.

Tests were performed on the fresh concrete to determine slump (AASHTO T 119-82), Air Content (AASHTO T 196-80) and Unit Weight (AASHTO T 121-82). Six test cylinders (6" x 12") and one 3"w x 3"d x 16"l freeze-thaw specimen were cast from each batch. The cylinders were tested for compressive strength (AASHTO T 22-82), 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 161-82) in a 3% NaCl solution.

The second part of the performance-in-concrete evaluation used one batch of Class B concrete containing the new coarse aggregate. This batch of concrete was mixed in a larger capacity Sears rotary drum mixer with the batch size being 2.75 cubic feet.

This concrete was mixed to approximately the same slump and air content as the initial Class B concrete using the new aggregate. The concrete was tested for Slump, Air Content (AASHTO T 152-82) and Unit Weight. Four test cylinders (6" x 12") and four 3"w x 3"d x 16"l freeze thaw specimens were cast. This concrete was identified as Batch 9A.

The remaining concrete was then remixed with additional air entraining admixture and slightly more water. The tests were repeated and the same number of test specimens cast. This concrete was identified as Batch 9B. The mix proportions used in Batch 9A/9B are shown in Table 5.

The cylinders were tested two each, for Batches 9A and 9B, at ages of 7 and 28 days. The freeze-thaw specimens were moist cured for 14 days, after which they were subjected to freezing and thawing, two each per batch in a 3% NaCl solution and two each per batch in water.

At the request of the Structural Concrete Engineer, a field petrographic examination of the new material was conducted by the Vermont Agency of Transportation Chief Geologist. The Chief Geologist examined samples of the crushed stone in the laboratory and traveled to the Swanton quarry for an in-situ examination of the material.

TABLE 3

NEW AGGREGATE MIX DESIGN BATCH QUANTITIES PER C.Y.

	Cla	ass A	Cla	ss B
	Batch 1	Batch 2	Batch 3	Batch 4
*New Coarse Aggregate, 1bs.	1562	1562	1562	1562
*Fine Aggregate, lbs.	1343	1343	1485	1485
Cement, lbs.	660	660	611	611
Air Entraining Admixture, oz.	8.5	10.0	5.0	6.0
Water Reducing Admixture, oz.	19.8	19.8	18.3	18.3
New Water, gal.	33.0	32.1	32.1	31.9

*Weights converted to saturated surface-dry condition.

TABLE 4

REFERENCE AGGREGATE MIX DESIGN BATCH QUANTITIES PER C.Y.

	Cla	ass A	C1	ass B
	Batch 5	Batch 6	Batch 7	Batch 8
*Reference Coarse Aggregate, lbs.	1673	1673	1673	1673
*Fine Aggregate, lbs.	1259	1259	1403	1403
Cement, lbs.	660	660	611	611
Air Entraining Admixture, oz.	7.0	7.0	4.0	5.0
Water Reducing Admixture, oz,	19.8	19.8	18.3	18.3
New Water, gal.	32.3	30.7	30.2	32.2

*Weights converted to saturated surface-dry condition.

TABLE 5

NEW AGGREGATE MIX DESIGN BATCH QUANTITIES PER C.Y.

	Cla	ss B
	Batch 9A	Batch 9B
*New Coarse Aggregate, lbs.	1562	1562
*Fine Aggregate, lbs.	1485	1485
Cement, 1bs.	611	611
Air Entraining Admixture, oz.	6	8
Water Reducing Admixture, oz.	18.3	18.3
New Water, gal.	33.6	34.0

*Weights converted to saturated surface-dry condition.

RESULTS

Results of tests on the fresh concrete and compressive strength test results are shown in Table 6, Table 7, and Table 8.

TABLE 6

PERFORMANCE TEST RESULTS+ NEW AGGREGATE

	C1	ass A	Class B		
	Batch 1	Batch 2	Batch 3	Batch 4	
Slump, inches	3 3/4	3 1/4	3	2 1/2	
Air Content, percent	4.6	4.0	4.0	4.0	
Unit Weight, lbs./ft ³	146.56	147.86	147.90	147.42	
Compressive Strength, psi					
7 days	4050	4086	4112	4200	
14 days	4898	4863	4952	5274	
28 days	4965	5275	4947	5213	

(Design Compressive Strength, psi)

(4000)

(3500)

TABLE 7

PERFORMANCE TEST RESULTS REFERENCE AGGREGATE

	C1	ass A	C1.	ass B
	Batch 5	Batch 6	Batch 7	Batch 8
Slump, inches	4 1/4	3 1/4	. 3	3 3/4
Air Content, percent	6.2	4.0	4.0	5.8
Unit Weight, lbs./ft ³	146.17	149.35	149.01	146.07
Compressive Strength, psi			1	
7 days	4594	4739	4886	4558
14 days	· 5341	5456	5748	5571
28 days	5266	5721	5956	5580

TABLE 8

PERFORMANCE TEST RESULTS

	Clas	s B
	Batch 9A	Batch 9B
Slump, inches	2 1/2	4
Air Content, percent	4.3	7.1
Unit Weight, lbs./ft ³	148.91	144.15
Compressive Strength, psi		
7 days	4209	3988
28 days	5655	5213

(Design Compressive Strength, psi)

(3500)

The results of compressive strength tests are also shown on Laboratory Reports Nos. C84 0001 through C84 0008 and C84 0082 and C84 0083 in Appendix C. Strength age plots illustrating average compressive strengths are shown in Figure I, Figure II and Figure III.

The results of dynamic testing of freeze-thaw specimens are shown in Table 9. The percent weight loss resulting from freezing and thawing of specimens is shown in Table 10.

The report of the field petrographic examination, shown in Appendix D indicates the bedrock is the black shale of the Iberville formation. The report further indicates that the new material is not acceptable in New York State either as structural concrete or bituminous concrete aggregate.

	TABLE 9													
FREEZE-THAW	TEST	RESULTS -	-	RELATIVE	DYNAMIC	MODULUS	0F	ELASTICITY						

		N	lew Aggr	egate		Ref	erence	Aggregat	te		regate			
		Class A Class			ss B	Class	А	Class	s B	Class B				
	E	Batch 1	Batch 2	Batch3	Batch4	Batch 5	Batch6	Batch 7	Batch 8	Batch	9A*	Batch 9	B*	
					3%	NaCl	ŀ.	II		3% NaCl	Water	3% NaC1	Water	
	۰,				Relat	tive Dyna	amic Mo	dulus of	Elastic	ity				
	50	98.6	97.2	92.3	87.6	99.3	94.4	99.3	99.3	98.6	100.4	98.3	100.7	
	100	98.6	95.8	53.1	53.6	97.9	95.8	97.9	97.9	98.6	99.3	97.9	99.3	
	150	97.9	95.8			97.9	94.4	97.2	96.5	98.6	100.0	98.3	99.3	
	200	86.9	92.4			97.9	94.4	93.7	96.5	98.3	99.3	97.2	99.0	
s	250	69.2	60.4			97.9	94.4	90.9	95.8	98.3	99.7	97.9	99.3	
Cycles	300	55.7	52.5			98.6	94.4	86.9	95.8	**98.3	**100.0	**98.2	**99.3	
ofC	350	ס				98.6	94.4	56.3	96.5					
Number	400	D			• .	96.5	85.1		96.5					
Num	450	0				96.5	62.8		96.5					
	50	0				95.8	53.1		95.8					
	55	0				96.5	52.1		96.5				·	
	60	0				**95.8			**96.5					

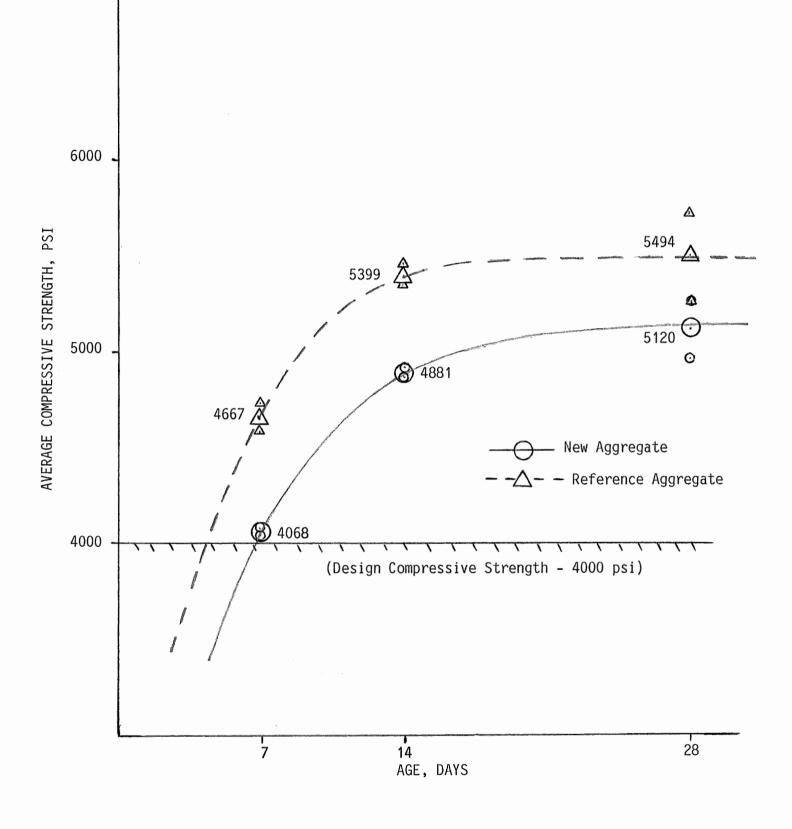
* Results shown are average of two specimens. **Testing terminated prior to complete deterioration of specimens due to time constraints.

TABLE 10

FREEZE-THAW TEST RESULTS - PERCENT WEIGHT LOSS

	:	N	lew Aggr	egate		Re	ference	Aggrega	te	New Aggregate						
		Class	5 A	Clas	ss B	Clas	s A	Class	В		Class B					
		Batch 1	Batch 2	Batch3	Batch: 4	Batch5 Batch6 Batc		Batch7	Batch 8	Batch	9A*	Batch	9B*			
	Ļ		·	!	3%	NaC1				3% NaCl	Water	3% NaC1	Water			
						Per	Percent Weight Loss									
	50	4	3	7	7	2	3	5	3	7	0	4	0			
1	100	6	4	16	25	3	5	7	3	11	0.	7	0			
	150	9	6			4	6	10	4	14	0	9	0			
	200) 13	8			4	• 7	12	5	16	0	10	0			
S	250) 17	12			5	9	17	6	18	1	12	0			
Cycles	300	22	16			5	. 10	20	6	** 20	** 1	**14	**0			
of C	350	0				5	11	23	6							
Number	400	þ				6	13		7							
NUN	45	þ				6	14		7							
	50	q				7	17		8							
	55	d				8	24		9							
	60	q				**8			**9							

*Results shown are average of two specimens. **Testing terminated prior to complete deterioration of specimens due to time constraints.



AVERAGE COMPRESSIVE STRENGTH VS AGE CLASS A Figure I

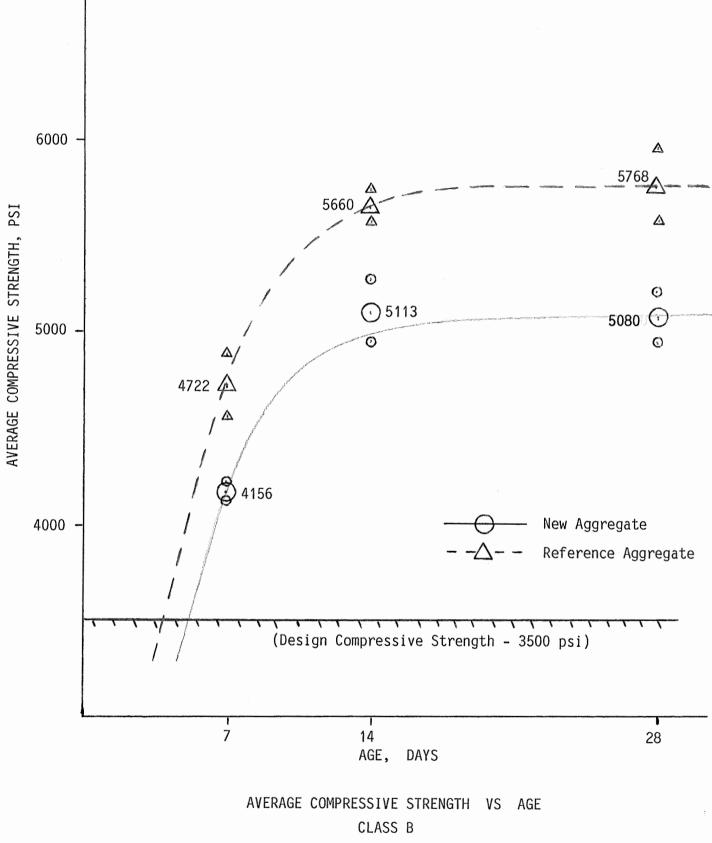
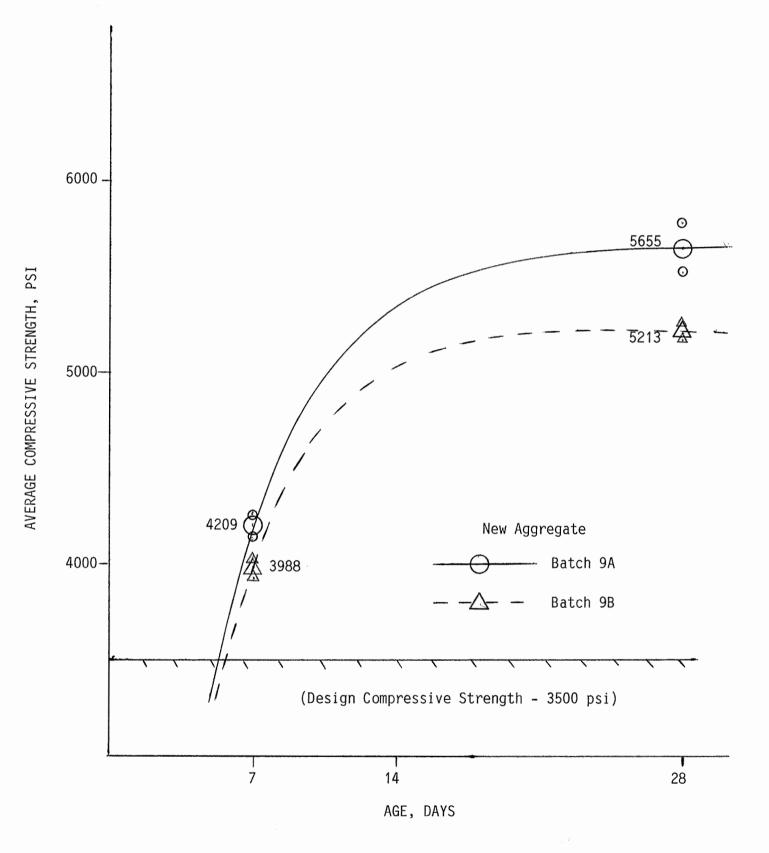


Figure II



AVERAGE COMPRESSIVE STRENGTH VS AGE CLASS B BATCHES 9A & 9B

Figure III

SUMMARY AND CONCLUSIONS

- The 3/4 inch crushed stone coarse aggregate (new material) from the Swanton Limestone quarry in Swanton, Vermont complied with requirements of Section 704.02 for grading, wear, soundness, fractured faces and thin and elongated pieces.
- 2. Comparison of the Net Water (Table 3 and Table 4) and Slump (Table 5 and Table 6) of concrete shows that although the average slump of the new aggregate batches was approximately 1/2 inch less than the reference batches, the new aggregate batches required an average of almost one gallon per cubic yard more mixing water. Visual inspection of the proposed new aggregate indicated a greater portion of thin or platy material in comparison to the reference aggregate. When material of this nature is used in structural concrete, an increased water demand can usually be expected.
- 3. A slightly higher addition rate of air entraining admixture was required in the batches containing the new material than was required in the batches containing the reference aggregate. This can be attributed to the same reasoning given in statement 2.
- 4. The compressive strengths of both classes of concrete containing the reference aggregate were higher than the compressive strengths of the concrete containing the new aggregate.
- 5. Concrete containing the reference aggregate generally performed better in freeze-thaw testing than the concrete containing the new aggregate.

Testing of specimens from Batch 1 and Batch 2, Class A concrete containing the new aggregate, was terminated at 300 cycles due to deterioration of the concrete. Specimens from Batch 5 and Batch 6, Class A concrete containing the reference aggregate were tested through 600 cycles and 550 cycles respectively. Testing was suspended after 600 cycles for Batch 5 with minor deterioration of the specimen while the specimen from Batch 6 showed excessive deterioration at 550 cycles. Specimens from Batch 3 and Batch 4, Class B concrete containing the new aggregate, showed excessive deterioration and testing was terminated after only 100 cycles. Class B concrete containing the reference aggregate showed deterioration severe enough to discontinue testing at 350 cycles for Batch 7, while testing of Batch 8 was suspended at 600 cycles with very little deterioration of the specimen.

Testing of all specimens for Batch 9A/9B, Class B concrete containing the new aggregate, was discontinued at 300 cycles due to time constraints. Although only a slight difference in sonic test results existed between specimens cycled in the NaCl solution and specimens cycled in water, there was a considerable difference in weight loss. The specimens cycled in NaCl showed 20% weight loss at 300 cycles for the concrete with 4.3% air content (Batch 9A) and 14% weight loss at 300 cycles for the concrete with 7.1% air content (Batch 9B). The specimens cycled in water showed only 1% weight loss for Batch 9A and 0% weight loss for Batch 9B.

6. The new material, identified by the owner as "black limestone", was found through examination to be black shale of the Iberville formation. Shales or materials containing shale are generally considered to produce concretes

which have a poor service record. The shale materials exhibit volume change on wetting and drying as well as possible alkali-aggregate reaction. These actions may be further aggrevated by freezing and thawing which results in deterioration of the concrete.¹

RECOMMENDATION

It is recommended by the Structural Concrete Subdivision, that the proposed new material not be considered acceptable for use in structural concrete for Agency projects.

Walker, H.M., "Chemical Reactions of Carbonate Aggregates in Cement Paste", <u>Significance of Tests and Properties of Concrete and Concrete Making Materials</u>, ASTM STP 169B, March 1978, pp. 722 - 743.

Prepared By: W. Meyer@f/M Date: March 26, 1982 Page: 1 of 2

Appendix A

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-inconcrete 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.

Appendix B

TA 182F Rev. 2M 3/82 Rev. 2M 4/83

STATE OF VERMONT AGENCY OF TRANSPORTATION

MATERIALS & RESEARCH DIVISION Montpelier, Vermont 05602

REPORT ON SAMPLE OF ACGREGATE

		Report	1-2	0, 19_84
Laboratory No.	A83 1293	Tested	By Lav	/in
	Coarse Aggregate fo			
Identification Ma	rks Preliminary Sample	Crushed S	tone	
Submitted by	Benda Title	SCE Ad	ldress	· · · · · · · · · · · · · · · · · · ·
Sampled <u>12-2</u> , 1	9 <u>83</u> Received 12-15, 19 8	33 Testing	Completed	1-4, 19 84
Sample from	New Stockpile @ Swa	anton Lime -	Swanton	
Quantity Represen	ted		<u></u>	
Source of Materia	1 Swanton Lime - Swar	nton		
Project Name & Nu	mber <u>W.P. No. 83-C-43</u>			
Examined for	Item 704.02			
	TEST RESUL	LTS		
	e Fineness Mod assing % Coarser 1		Perce	ent of Wear
5/8" 1/2" 3/8" No. 4 No. 8	No. 100 No. 50 No. 30 No. 16 No. 16 No. 4 Fineness Mod Color = 00 Comments: This material was 31 faces, thin and e 2 results are as in	s examined for elongated pied	AASHT B Gra Fract Thin Sound r gradation,	TO T4 TO T96 <u>20.5</u> ding tured Faces, % <u>100</u> & Elongated Pieces, % <u>8</u> dness, % Loss <u>0.85</u> wear, fractured
No. 10 No. 16 No. 30 No. 50 No. 100 No. 200		S. J. Gage, P.Z.	P.E., Chief Er Michos	ngineer

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								Append	dix C		
Project Na	Ime			STATF AGENCY OF	OF VERM				CF Benda		
Project Nu Work	_{mber} Plan No	b. 83-C	MATER -43 M	IALS AND	RESEARCH , Vermon	DIVISI	ON D2				
			Report c	on Concret	e Test E	leam or	Cylinders				
Laboratory	NO. <u>C</u> 8	34 0001		Report	of		Day Break	s Date	typed	1-31-8	4
Pay Item	Perform	nance i	n Concre	<u>te </u> 1	ype of S	Sample	Evalı	uation			
Submitted	ъуМеу	/er	× .	Title	PFP	Address	3				
Source of	Material	Materia	als & Re	search La	b. Berli	NQuanti	Lty Repres	ented	1 1/2 c.	.f	lang data da san di kacamatan da San Bartan
Coarse Agg	regate_S	Swanton	Limesto	ne, Swant	ON Fine	e Aggreg	sate Ande	erson – H	ighgate		paparan an an an Dain Line in 1999.
Cement Bra	ind Gl	lens Fa	lls]	Суре	II	Lbi	B	660	
Air Entrai	ning Adm	ixture_	Darex A	EA Dosa	ge_8½ CZ	/cy	dmixture b	IRDA Hyco	l Dosage	3 oz/	<u>cwt</u>
Maximum al	lowable	water c	ontent,	Gal/Cy		_ Total	Aggregate	, Dry Wgi	28	376	n an
Field Test	ed by St	ructura	al Concr	ete Subdi	vision	Lab. Te	ested by		Steve	ens	
Sampled fr	om Labo	pratory	Mixer				Date Sam	pled:	12/29	9/83	
Location U	lsed or t	o be Us	ed	Test	Mix Bat	ch #1					
Examined f	or Mod.	of Rupt	ure		ti	Con	pressive	Strength			
				TES	T RESULT	S					
Unit Weigh	t Fresh	Concret	.e <u>14</u>	6.56	_Air: Pr	essure_	4.6	_ Chace_			
Total Wate	er, Gal/C	y Used_	33	Slump_3	<u>3/4</u> 1	emperat	ure, Conc	rete73	An	nbient_	
Specimen No.	Cyl. Unit Wgt. P.C.F.	Date Rec'd	Date Broken	Desired age at break	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break 1	Type 2
BA 1 2	149		1-5	7	7	S	4014	4085	4050		
4	149		1-12	14 _	14	S	4916	4880	4898		
5 6	149		1-26	28	28	S	4686	5243	4965		ļ
с. 	-										
4.0		·]·								6	
*S = Stand Types of B		d; F =	Field C	ured	 F		Cara DE	Chiof E	nginoor		
mlm		MK		ШЕ			-			1012	
Comments: TA 183H Re 2M 4/81	ev.		- , •	, 2 V	By R.	/:				<u> </u>	
2M 8/83	$\begin{array}{c c c c c c c c c c c c c c c c c c c $										

rroject la	\$1740°			STAT AGENCY O	E OF VER F TRANSP		1	Аррен	ndix C CF Benda		
Project Nu Work	mber Plan N	0 83-0	MATE	RIALS AND	RESEARC	H DIVIS	ION		Dendu		
		0.000		-			Cylinder	8			
Laboratory	r No. C	84 0002							typed	1-31-8	34
Pay Item											
Submitted											
Source of											
Coarse Age											
Cement Bra			a strange in								
Air Entrai					al and a second	and the second second					cwt
Maximum al											-
Field Test					VISION	Lab. To					
Sampled fr								mpled:	12/2	9/83	
Location U										ini Maria Maria da Como ante	er en Miller de Carente
Examined f	or Mod.	of Rupt	ure			Con	mpressive	Strength			aleta (h. 1997) Aleta a
				TES	ST RESUL	rs .					
Unit Weigh	t Fresh	Concret	e <u>147</u>	.86	_Air: P	cessure_	4.0	_ Chace_			
Total Wate	r, Gal/C	Cy Used_	32.1	Slump_3	3 1/4	Cemperat	ure, Conc	rete 72	A	mbient_	ination International International International International International International International International International International International International International International International International
Specimen	Cyl. Unit	Date	Date	Desired	Age at	Trme*	Break 1	Break 2	Ave.	Break	Turne
No.	Wgt. P.C.F.	Rec'd	Broken	age at break	Break	Type* S - F	P.S.I.	P.S.I.	P.S.I.		2 2
BA 2 2	149 149		1-5	7	7	S	4085	4085	4085		
3 4	149 149		1-12	14	14	S	4934	4792	4863		n frage octor Anna State anna Anna State anna Anna Anna Anna Anna Anna Anna Ann
5 6	149 149		1-26	28	28	S	5155	5394	5275		
•			• 2010	an an an Araban Anna an Araban Anna an Araban						e server en en 1940 - Stand Britte	
			e a se Set de la composition					and the second sec			
										an a	an a
*S = Standa		d; F =	Field C	ured							J
Types of Er	eak s:	FIV	Π			· · ·	are PF	Chief Eng	gineer		
lm			JÅR			5. J. 6		P.Q.		0.1	
Comments: TA 183H Re	v.	± 4			Rv•	Ki	age, P.E., 2.インロン on, P.E., Main		- Il	1 <u>11</u>	
2M 4/81 2M 8/83					R. 1	. Nicholso	on, P.E., Mate	erials & Resi	earch Englin		

								<u>Apper</u>	ndix C		
Project Na	ame			STAT AGENCY O	E OF VER F TRANSP		1		CF Benda		
Project Nu Work	mber Plan N	o. 83-C	MATE -43 1	RIALS AND	RESEARC	H DIVISI nt 0560	I ON 02				
							Cylinder			1	рл ^{с с с}
Laboratory											<mark>74</mark> Statistics
Pay Item	Perfor	mance i	n Concre	<u>te · ·</u> ·	Type of	Samp le_	Eval	uation			
Submitted	by Me	yer		_Title	PFP	_Addres	8 	1993 - 2 1			
Source of	Material	Materi	als & Re	search La	ab. Berl	inQuant:	ity Repres	sented	1 1/2 c	.f.	
Coarse Agg	regate_	Swanton	Limesto	ne, Swant	ton_Fin	e Aggreg	gate And	erson - I	lighgate		
Cement Bra	nd G	lens Fa	11s			Гуре	II	Lb	8	660	
Air Entrai	ning Ada	nixture	Darex A	EA Dos	age 5 (oz/cy_	Admixture	WRDA Hyco	<u>)l</u> Dosage	<u> </u>	<u>'cwt</u>
Maximum al		an an T	- 14			Total	Aggregate	e. Dry Wg	t.	3016	
Field Test			지 않으면 이 가지 않는 것이 같이 많이					. 이번 전문 전문 관람적	의 사람들이 물건하지?		
		1999 - 1997 - 19	a state of the second	$\sum_{i=1}^{n-1} a_{i} = \sum_{i=1}^{n-1} a_{i} $	V1310//		and the second				
Sampled fr							Date Sam				
Location U	sed or t	o be Us	sed]	Test Mix	Bate	ch #3		<u></u>		
Examined f	or Mod.	of Rupt	ure			Con	mpressive	Strength			
				TES	ST RESULT	rs					
Unit Weigh	t Frech	Concret	·a 147	7.90	Δ1+• Ρι		4.0	Chace			
Total Mate										mbient_	
Specimen No.	Cyl. Unit Wgt. P.C.F.	Date Rec'd	Date Broken	Desired age at break	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break 1	Type
BB1 2	149 150		1-5	7	7	S .	4094	4129	4112		
. 3	149 149		1-12	14	14	S	4934	4969	4952		
5	149 149		1-26	28	28	S	4872	5022	4947		
			11980 -							en de la companya de Referencia de la companya de la comp Referencia de la companya de la comp	
										an an San An An Air an Airte An Airte	
· · ·				e.							
\approx S = Stands	ard Cure	d; F =	Field C	ured	1	l Tigan ta	• 	<u> </u>			
Types of Br	eaks:	$\Box \Box$			1	C					
1 1m		$ \Lambda $				승규는 가지 않는 것이 같아.	J. Gage, F				
Commenter		1 2	3 4	5 6		0	P.A.Y	licho	800	-IRAS	2
Comments: TA 193H Re	v.					~ J ·	nolson, P.E.,				
°2:14/81 ⇒.∘ - 2.⊭ 8/83					05			matorialo Q	nescatoli 1	ธ.เเธ ต	
					25			a transmission and the second	ingen en ser	a haran a	

Project 3	AGENCY OF TRANSPORTATION Benda Contract										
									Benda		
Work	Plan N	lo. 83-C	-43 I	Montpelie:	r, Vermo	nt 0560	02				
			Report	on Concre	te Test	Beam or	Cylinder	8			
Laborator	y No. C	84 000 4	1	Report	of		Day Break	ks Date	typed	1-31-8	4
		이번에 에너지 않는 것을 많이 많다.									alay tey ad Tang Malay kasalay
Submitted	ъуМе	yer		_Title	PFP	Addres	B				
Source of	Materia	1 <u>Materi</u>	als & Re	esearch La	ab. Berl	inQuant:	ity Repres	sented	<u>1 1/2 c</u>	.f.	출입다. The
Coarse Ag	gregate_	Swanton	Limesto	one, Swant	ton_Fine	e Aggreg	ga te And	<u>erson - I</u>	lighgate		8
Cement Br	and G	lens Fa	11s	jawa ng langang ng lang Langang ng langang ng la		Гуре	II	Lb	8•	660	
Air Entra	ining Ad	mixture	Darex A	EA Dose	age_60	z/cy	Admixture	WRDA Hyco	Dosage	<u>3 oz/</u>	<u>cwt</u>
Location	Used or	to be Us	sed								landra Na
								Strength			
			•				•				
Unit Weig	ht Fresh	Concret	e 147				4.0	Chace			
								rete 73	A A	mbient	n - Santa Ng Marina Nasih
-		-	nger ^{te} nnen 1997	•		i teatra Estatoria	gi sulikatij Laganti sa	uite de la companya d	adaanaa oo taabhad 1 - Damaa Ahar		
Specimen No.	Unit Wgt. P.C.F.		1	age at				1	1		
	150		1-5	7	7	S	4174	4226	4200		
4	151		1-12	14	14	S	5305	5243	5274		
-			1-26	28	28	S	5270	5155 _.	5213	n an	
1		$\frac{\partial r}{\partial t} = \frac{1}{2} \frac{\partial r}{\partial t} + \frac{1}{2$	an a	na Sevintena Sevintena							
.				and the second sec		en en					
n Letter											
		ed; F =	Field C	ured	- -		•				nii Martin Martin
	LEAND:			/ ⊢-					nee r		
lm seeder.						RA	F. Miel	hobor	-IRA	2	
Comments: TA 183H R	ev.			n a gara San gara	y,		P.E., Materia		ch Enginee r	•	
2M 4/81 2M 8/83					26	- 1 - A					

									Appendix	<u>C</u>	
Project W	3042 -			STAT	e of ver F transp		1		CF Benda		
Project Nu Work	umber Plan N	io. 83-C	MATE -43 1	RIALS AND Montpelie	RESEARCI r, Vermo	H DIVIS) nt 056	I ON D 2				
Laboratory	7 No. <u> </u>	84 000 \$					Cylinder Day Breal		typed	<u>1-31-8</u>	34
Pay Item_	Perfor	mance i	n Concre	ete :	Type of	Sample_	Eval	uation			
Submitted	ъу <u>М</u> е	yer		_Title	PFP	_Addres	B			<u> </u>	
Source of	Materia:	1 Materi	als & Re	search La	ab. Berl	<u>in</u> Quant:	ity Repre	sented	<u>1 1/2 c</u>	.f.	-
Coarse Agg	regate	Swanton	Limesto	ne, Swant	ton Fin	e Aggre	gate And	erson - I	Highgate		
Cement Bra	ind G	lens Fa	11s			Туре	II	Lb	8	660	
Air Entrai					방법 친구에 집을 얻는다.						
Maximum al								이 같이 있는 것이 ^가 같은 것이 있는 것이 ^가	한 바람이 말하지?		
Field Test									an a		
Sampled fr							Date San			~이상하는 요즘 물질을	
Location U											
Examined f								Strength			
			· ·		ST RESUL					•	
Unit Weigh	t Freeh	Concret	e 146				6.2	Chace			
Total Wate				and the second	표정 24 이 영화	ŵa, la T	e generative en entre			mbient	
	[Cyl.		e e gije N			1		1		 	
Specimen No.	Unit Wgt. P.C.F.	Date Rec'd	Date Broken	Desired age at break	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break 1	<u>Туре</u> 2
GA 1 1 2	149 150		1-5	7	7	S	4651	4536	4594		
3	149 149		1-12	14	14	S	5199	5482	5341		
5 6	149 149		1-26	28	28	S	5146	5385	5266		
-		and a second sec									a fixe
											A.A.
*S = Stand		d; F =	Field C	ured				•			
Types of Br mlm	ceaks:	QC	121			s. J. G	iage, P.E., <i>柔.</i> 介に	Chief En Chose	gineer	284	
Comments: TA 183H Re 2M 4/81	2V.		54	, , , ,	By: R. F		n, P.E., Maie			<u>47</u> ee r	
214 8/83					27						

								Appe	<u>endix C</u>		
Project N	ате	STATE OF VERMONT CF AGENCY OF TRANSPORTATION Benda									
Project N Work	umber Plan N	o. 83-C	MATE -43	RIALS AND Montpelie	RESEARC r, Vermo	H DIVISI nt 056	I ON 02				
			Report	on Concre	te Test	Beam or	Cylinder	8			
Tabanotan	- No C	81 000 1	ç				Day Broo	ka Date	typed	1-31-8	34
Laborator			. This can be a star for the	물질 것 것 같은 것 같은 것 같은 것을 가락했다.	방송 방송 위에 가지 않는 것이다.		이 영상적인 것 이 것 같아요.	그는 것 같은 것 같			
Pay Item			한 이상의 위도 또 소리가 관련했다. 상태					2012년 1월 1991년 1월 19		t i servere	
		 Contractions 	Netter Mitheaster							e e e e e e e e e e e e e e e e e e e	
Source of											
Coarse Ag		and the stability			94 (F	en san					
Cement Bra				:::::::::::::::::::::::::::::::::::::	, 승규는 것 같아. 그 가 문		II da di	e na santa an			
Air Entra:	ining Adı	mixture_	<u>Darex A</u>	EA Dost	age 7 02	<u>/cy </u>	Admixture_	WRDA Hyce	<u>Ol Dosage</u>	<u>3 oz/</u>	<u>'cwt</u>
Maximum al	llowable	water c	content,	Gal/Cy		_ Total	Aggregate	e, Dry Wg	t29	08	
Field Test	ted by St	tructur	al Concr	ete Subdi	vision	_Lab. Te	ested by		Stev	ens	
Sampled fi								mpled:		학생님은 물건물건물건	
Location 1											
Examined 1											
		<u>-</u>			T RESULT						
	. Page als	O	- 1/0				4.0	Chase			
Unit Weigh			a the set of a	t de valer -		-			74		
Total Wate	·.	Cy Used_	30.7	Slump	3 1/4 1	lemperat	ure, Conc	rete	<u>74 A</u>	mbient_	
Specimen No.	Cyl. Unit Wgt. P.C.F.	Date Rec'd	Date Broken	Desired age at break	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break 1	Type 2
GA 2 2	151		1-5	7	7	S	4810	4668	4739		
3	151		1-12	14	14	S	5182	5730	5456	-1- ⁻¹	
	<u>150</u> 151		1-26	28	28	S	5562	5880	5721		
6	150									n an	
n an											
	ta sanài balan sa				ngen Selfestigen		ang dalahan				
*S = Stand	ard Cure	d: F =	Field C	ured			a di se se di di di di se d Se se se se se se di se di di se d				
Types of B	医门口 化二氟乙烯酸乙烯酸乙烯										
		MY		´			Gage, P.E	그는 같은 이 없을?			
mlm						F	Z.N	ichob	4000-/	2012	
Comments: TA 183H Re	ev.					y:				<u>147</u>	
2M 4/81 2M 8/83						r. INICIIOI	son, P.E., Ma	alendis & Re	Scalui Liig	MICCI	
		a Sur s Sur s			28						

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hi oʻt					TE OF VI DE TRANSF)1{		CF Benda		
Project Work	Number Plan	No. 83-	MAT C-43	ERIALS AND Montpelie	D RESEAR(er, Vermo	CH DIVIS ont 056	502				
			Report	on Concre	ete Test	Beam or	Cylinder	в			
Laborator	ry No	C84 000	7	Report	of		_Day Brea	ks Date	e typed_	1-31-	84
							Eval			·· .	
Submitted	i by <u>M</u>	eyer			PFP	_Addres	6				-
							ity Repre				
Coarse Ag	gregate_	Swantor	n Limest	one, Swan	ton Fin	e Aggre	gate And	ierson -	Highgate	2	
Cement Br	and (Glens Fa	ills			Туре	II	LŁ		660	
Air Entra	ining Ad	mixture	Darex	AEA Dos	age 4 0	z/cy	Admixture	WRDA Hyc	Ol Dosage	<u>3 oz</u> /	'cwt
Maximum a	llowable	water	content,	Gal/Cy		_ Total	Aggregat	e, Dry Wg	t3050		
Field Tes	ted by S	tructur	al Conci	rete Subdi	ivision	Leb. T	ested by		Stev	ens	
Sampled f							Date Sa				
Location	Used or	to be U	sed	Ref	егепсе М	lix Ba	tch #7				
Examined	for Mod.	of Rup	ture			Cor	mpressive	Strength			
				TES	ST RESUL	TS					
Unit Weigh	nt Fresh	Concret		49.01	_Air: Pr	ressure_	4.0	_ Chace_			
Total Wate	er, Gal/G	Cy Used_	30.2	Slump	3 7	Cemperat	ure, Conc	rete74	1 <u>A</u> 1	mbient_	
Specimen No.	Cyl. Umit Wgt. P.C.F.	Date Rec'd	Date Broken	Desired age at break	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break 1	Type 2
GB 1 2	151 151		1-5	7	7	S	4987	4784	4886		
3 4	150 150		1-12	14	14 -	S	5659	5836	5748		
5 6	151 150	-	1-26	28	28	S ·	5889	6022	5955		
							•				
-											
					Î						
S = Stand ypes of Br lm		$d; F = \int_{1}^{d} \int_{2}^{r}$	Field C		Ву	E	Gage, Р.Е., Д. Лс	chos	~//	Pa7	
A 183H Rev 2M 4/81	V.				R. 1	r. Nicholsi	on, P.E., Mat	eriais & Kesi	earch Engin	eer	

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Project	anc			STAT AGENCY OI	E OF VER	HONT ORTATIO	l	Apper	ndix C CF Benda		
Project N			MATE	RIALS AND Montpelie	RESEARCI	H DIVISI	ON				
WOLK	PIdit N										
				and the second second			Cylinder	 A State 		4 34 0	٨
Laborator										1-31-8	54
Pay Item_	Perfor	mance i	n Concre	ete :	Cype of	Samp le_	Eval	<u>uation</u>	가지가 사람이다 사람이다	eren en Marie en en en	
Submitted	ъуМе	yer		_Title	PFP	_Addres	8				
Source of	Materia	1 Materi	als & Re	esearch La	ıb. Berl	inQuant:	ity Repres	sented	1 1/2 c	.f.	
Coarse Agg											
Cement Bra		1	to a data beta base ta) 너희한 걸는 巖					방소 동작품	
Air Entrai		이 23 ~ 2 ~ 2 ~ 2 ~ 2 ~ 2 ~ 2 ~ 2	이 요즘 옷 변경을 들는 것 같아?					A. P. S. M. L. D. A. P. M.			
			an en al ser res			建設設施設					
Maximum al			1.			1887 1888 1999 199					
Field Test											
Sampled fr	com Lab	oratory	Mixer				Date San	npled:	12/2	9/83	
Location U	Jsed or 1	to be Us	sed	Ref	erence M	lix Ba	tch #8				
Examined f	for Mod.	of Rupt	ure		:	Con	pressive	Strength			
				TES	ST RESULT	rs					
Unit Weigh	nt Fresh	Concret	e 14	6.07	Air: P	ressure	5.8	Chace			
Total Wate			32.2	Slum		- Femnerat	ure, Conc	Tete 74	4 4	mbient	
		Jy USEU_			n - Wigeren _{de} Spinster State strate versionen er			and the second secon			
Specimen	Cyl. Unit	Date	Date	Desired	Age at	Type*	Break 1	Break 2	Ave.	Break	
No.	Wgt. P.C.F.	Rec'd	Broken	age at break	Break	S-F	P.S.I.	P.S.I.	P.S.I.		2
GB 2 2	149 149		1-5	7	7	S	4447	4668	4558		$\frac{(1+1)(1+1)}{(1+1)(1+1)}$
3	149 148		1-12	14	14	S	5641	5500	5571		
5	149	.,	1-26	28	28	S	5668	5491	5580	na an a	1997 - 19 2017 - 19 2017 - 19
6	149		 A state of the sta								
n an	· · · ·		ng track The second se	n settinger versen in som						2019년 1919년 1919년 - 1919년 1919년 - 1919년 - 1919년 - 1919년 - 1919년 1919년 - 1919년 - 1919년 - 1919년 - 1919년 - 1919년 1919년 - 1919년 -	
		e bashi Albana				aliteration and a second			State		
*S = Stand Ypes of Bi		d; F =	Field C	ured	1						
mlm	-			′			Gage, P.E				
		ЦЦ	JYY		l	F	2.A.N	ichos	w~	lan	
Comments: TA 183H Re	ev.						son, P.E., Ma			ince r	

TA 183H Rev. 2M 4/81 2M 8/83

								Append	ix C		
Project Na	me			STATE AGENCY OF	OF VERN						
<u> </u>	No. 83	<u>-C-43</u>		RIALS AND				Bend CF	da		
Project Nu	mber			lontpelier							
			Report c	on Concret	e Test I	leam or	Cylinders	5			
Laboratory	No	<u>C84_00</u>	83	Report	of		Day Break	s Date	typed <u>3-</u>	9-84	
Pay Item F	Performa	<u>nce in</u>	<u>Concrete</u>	<u> </u>	Sype of S	Sample	Evalua	tion			
Submitted	ъу <u>Bend</u>	a		Title	SCE	Address	3				ngalan gungungan an Taribit
Source of	Materia]	. Mat. &	Res. La	ıb, Berlin	<u>ן</u>	_Quanti	lty Repres	sented	2 3/4 C	<u>.</u> F.	t 1920 mar (angula da angula d
Coarse Agg	regate <u>S</u>	wanton	Limestor	ie	Fine	e Aggreg	ate Ander	son - Hig	ghgate		unter an
Cement Bra	nd	·····	<u>Glens</u> F	alls	7	[ype]	I	Lbi	s. <u>611</u>		
Air Entrai	ning Ada	nixture_	Darex AE	A Dosa	ige <u>6 oz</u>	/cy	dmixture_	WRDA/Hyco	<u>]</u> Dosage	3 oz/	<u>cwt</u>
Maximum al	lowab le	water c	ontent,	Gal/Cy	<u></u>	Total	Aggregate	e, Dry Wgi	t. <u> </u>	16	
Field Test	ed by S	tructur	al Concr	rete Subdi	ivision	Lab. Te	ested by				
Sampled fr	om Lab	oratory	Mixer				Date Sam	pled:	2	-9-84	
Location U	sed or t	o be Us	sed	Test Mi	ix Ba	tch #9A	<u></u>				and an operation for a state
Examined f	or Mod.	of Rupt	ure		- 'an ar - 2 az - 1, an -	Con	pressive	Strength	······		
			s	TES	T RESULT	S				•	
Unit Weigh	t Fresh	Concret	.e <u>148.</u> 9	1	_Air: Pr	essure_	4.3%	Chace			
Total Wate	r, Gal/(Cy Used_	33.6	Slump_2	2½"1	emperat	ure, Conc	rete 67	7°F _Ar	nbient	
	Cyl.				<u> </u>			1			
Specimen No.	Unit Wgt.	Date Rec'd	Date Broken	Desired age at	Age at Break	Type* S - F	Break 1 P.S.I.	Break 2 P.S.I.	Ave. P.S.I.	Break 1	Type 2
1	P.C.F. 148		2-16	break 7	7	S	4147	4271	4209		
BB3 2 3	148 149		3-8	28	28	S	5526	5783	5655		
4 ·	149										
			· · ·							•	
. ·							{				
*S = Stand	ard Cure	d; F =	Field C	ured)
Types of Bi					1		Gage, P.E.	Chief Fn	gineer		
mlm		ML		ШĘ]					01	
Comments: TA 183H Re	17	1 2	2 3 4	5 6	Bv	-Ki	Z.Nº		10	1 <u>40</u> 7	
2м 4/81	5∀•				R.	F. Nichols	on, P.E., Ma	cerials & Res	earch Engli	neer	
2M 8/83											

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Project Nam	ne				OF VERM				CF		
W.P	. No. 83	3-C-43		AGENCY OF	TRANSPO	RTATION					
Project Nu	And the owner of the local division of the l		MATER	AIALS AND Contpelier							
			•				Cylinders				
Labora tory											
Pay Item	Perfo	rmance	<u>in Concr</u>	ete 1	Type of S	Sample	Eva	luation			
Submitted 1	by <u>Ben</u> d	da	<u></u>	Title S(E	Address					
Source of 1	Material	Mat.	<u>& Res. L</u>	ab, Berli	n	_Quanti	ty Repres	ented 2	2 3/4 C.I	F	
Coarse Agg											
Cement Bran	ad	Glens	Falls		Ţ	ype	[]	Lb:	S	611	
Air Entrain	ning Adm	nixture_	Darex AE	ADose	ige <u>8 07</u> /	<u>/cy</u> A	dmixture_	WRDA Hyco	Dosage	3 oz/	cwt
Maximum al	lowable	water c	ontent,	Gal/Cy		_ Total	Aggregate	, Dry Wg	t. <u>301</u>	6	
Field Test	ed by <u>S</u>	tructur	al Concr	ete Subdi	vision	Lab. Te	sted by	evens			
Sampled fro	om]	Laborat	ory Mixe	<u>.</u>			Date Sam	pled:	2/9/84		n tana ang dalam giti ta padag
Location U	sed or t	to be Us	ed	Test	Mix Bat	tch #9B		<u></u>		aya <mark>manang kang pang kananda</mark> ka sa kikin sa	
Examined for	or Mod.	of Rupt	ure		4015 var og 1295 startfjorger	Con	pressive	Strength			
			•	TES	ST RESULT	S					
Unit Weight	t Fresh	Concret	e <u>144</u>	.15	_Air: Pr	essure_	7.1%	_ Chace_			
Total Water	r, Gal/C	Cy Used_	34.0	Slump	<u>4</u> 1	Cemperat	ure, Conc	rete 67°	°F Aı	mbient_	
Specimen	Cyl. Unit	Date	Date	Desired	Age at	Type*	Break 1	Break 2	Ave.	Break	Type
No.	Wgt. P.C.F.	Rec'd	Broken	age at break	Break	S - F	P.S.I.	P.S.I.	P.S.I.	1	2
1 BB4 2	147 147		2-16	7	7	S.	4050	3926	3988		
3 3	147 147		3-8	28	28	· S	5164	5261	5213		
-											<u> </u>
*S = Standa Types of Br		ed; F =	Field C	ured	1						
<i></i>				/		S	J. Gage, P	.E., Chief	Enginee	r	
11m				4 5 6	L	-	R.A.Y	Ticho	Som	-101-	7
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AGENCY OF TRANSPORTATION

TO: C. C. Benda, P.E., Structural Concrete Engineer FROM: J. F. J. Lanza, Chief Geologist DATE: March 26, 1984

SUBJECT: Petrographic Field Examination of the "Black Rock" Submitted by Swanton Limestone for Concrete Aggregate

> At the request of the Structural Concrete Engineer, a petrographic examination of the "black rock" submitted by Swanton Limestone was conducted as a supplement to the evaluation of a new aggregate source for use in structural concrete.

The so-called "black rock" is located in the old Swanton Limestone Quarry in Swanton, Vermont. The old quarry rock is a blue gray limestone of the Beldens Formation. Beneath the blue gray limestone, in the floor of the old quarry, is the so-called "black rock". A careful examination of the aggregate pieces in the test cylinders and a follow-up field examination of the "black rock" in the quarry substantiated the bedrock to be the black shale of the Iberville formation.

The Iberville shale is a black non-calcareous shale with interdispersed calcite filled fractures and occasional interbeds of black limestone. This rock type observation was collaborated by a private study and report in 1971 by the Engineering Geologist George L. Marshall to Charles Rich, owner of the Swanton Limestone Quarry at that time.

At a meeting on March 21, 1984 in the Swanton Limestone Office, representatives of New York Department of Transportation, Associate Engineering Geologist George Toung, and William Sherritt of the New York Engineering Geology Division, together with Robert Douglas, Dennis Demers, Chris Benda and myself were informed of the previous study conducted in 1971 by George L. Marshall. Upon further discussion, it was disclosed that this socalled "black rock" (shale) was not acceptable in New York State, either as concrete or bituminous concrete aggregate.

A study of the literature indicates that rocks composed principally of clay minerals are shales and, when present in concrete, will manifest increased volume change on wetting and drying, thus making it undesirable as an aggregate for structural concrete.

FJL:etn

- cc: D. Brown
 - R. Nicholson
 - F. Lanza
 - R. Fraser

TA 565 Rev. 4/79

Prepared By: W. L. Meyer Date: 12/12/83 Sheet 1 of 1

Appendix E

STATE OF VERMONT AGENCY OF TRANSPORTATION MATERIALS & RESEARCH DIVISION

RESEARCH INVESTIGATION

Work Plan No. 83-C-43

Subject Evaluation of Crushed Stone Coarse Aggregate, Swanton Limestone, Swanton, Vt.

Investigation Requested By Dennis Demers Date December 2, 1983

Date Information Required As soon as possible

Purpose of Investigation To evaluate a crushed stone coarse aggregate from

Swanton Limestone, Swanton, Vermont, proposed for use as a structural concrete

aggregate. The proposed new aggregate has been designated by the manufacturer as

a black limestone.

Proposed Tests or Evaluation Procedure <u>See Vermont Procedure For Evaluating a New</u>

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.

Due to the length of time required to conduct freeze-thaw tests, it may be necessary to issue a progress report when compressive strength tests are completed and a final report at the completion of all tests. Testing will be done cooperatively with the Bituminous Concrete Sub-division which is examining the same aggregate for use in bituminous concrete under work plan No. 83-B-44

Proposal Discussed With R. Frascoia Projected Manpower Requirements 25 man days

Investigation To Be Conducted By Structural Concrete Subdivision

2/10/84 Progress Report Proposed Starting Date<u>December 12, 1983</u> Estimated Completion Date<u>3/15/84 Fina</u>l Report

Approval/Disapproval by Materials Engineer 2.7. Nicholm 0/-03-E4 Comments by Materials Engineer <u>Received</u> for approval <u>91-03-E4</u>