STRUCTURAL CONCRETE SUBDIVISION

January 1976

LOW STRENGTH CONCRETE INVESTIGATION

INTRODUCTION

Portland cement concrete batched in Calkins Redimix facilities at Lyndon, Vermont has occasionally failed to comply with Vermont Highway Department strength specifications. This investigation was initiated to determine the probable causes underlying the problem. Component materials are examined to determine if any are adversely affecting the concrete.

MATERIALS

Following are listed the materials used in this investigation and their sources. Each of the materials listed meet current Vermont Highway Department and AASHTO Standard Specifications:

Aggregates: (See Chart I)

Coarse and Fine

Caledonia, Inc.
Waterford, Vermont

Cement:

Type I

Northeast Cement Co., Inc.
Montreal, Quebec

Admixture:

N V X

Hercules Powder Co.
Wilmington, Delaware

PROCEDURE

The procedures used in mixing followed as closely as possible that required by AASHTO T-126 and every effort was made in controlling uniformity of detail.

All batches were mixed in a Lancaster pan-type mixer.

Two series of investigations were made. The first was a program to ascertain if field procedures were responsible in affecting the specimens. Laboratory mixes using typical field proportions and materials were prepared and tested as shown on Chart II.

The second investigation was made to observe the affect of the aggregate upon the mix. Previously, it had been suggested that crusher dust or other deleterious matter was causing loss of bond. (See Appendix A.)

Mixes were made incorporating aggregate from the production stockpile. However, half of the aggregate was further cleaned by washing out the fine particles. Charts III and IV show the mixes and results of this investigation. Note that Mixes 4A, 4B, 6A and 6B incorporate hand washed aggregate.

A comparison was also made between mixes containing 3/4" and 1-1/2" maximum size aggregate. Previously, it had been suggested that the 1-1/2" mix (Class BB) was too coarse (see Appendix B).

RESULTS & COMMENTS

Compressive strength results from both investigations were below expectations at every age of test.

The results of the first part of this investigation, shown on Chart II, illustrate that higher strengths can be expected when using smaller maximum size aggregate. Note that Class A achieved higher strengths than Class BB, even though its water-cement ratio was higher. Also, the addition of one-half bag of cement resulted in a negligible increase in compressive strength as shown when comparing Class B with Class BB Concrete mixtures.

The results of the second part of this investigation are shown on Chart III (Class BB) and Chart IV (Class A). Mixtures containing the hand-washed aggregate required slightly less water with a corresponding increase in strength. The wash water was chemically analyzed for sulfate content and found to be inert. As in part I, the Class A mixtures incorporating smaller aggregate resulted in higher strength concrete.

Generally, the 3, 7 and 14 day tests were extremely high in relation to the 28 day strengths. In fact, several 14 day specimens broke higher than their companion 28 day cylinders. The tests indicated that the concrete gained strength very slowly after about 14 days.

The air-entraining admixture "NVX" was substituted for Grace Chemical's "Darex" which is typically used in the field. No effect on strength was observed when comparing laboratory results with project records.

SUMMARY & RECOMMENDATIONS

Compressive strength of the concrete was lower than normal for the mix design at 28 days.

3/4" maximum size aggregate resulted in higher strengths than 1-1/2" maximum size aggregate when compared in mixes with cement contents of 6-1/2 sacks.

Increasing cement did not increase concrete strength proportionately.

The aggregate, as received from the crusher plant, was found to have little effect on the concrete strength when compared to hand washed aggregate.

Strength gain of the cement appeared abnormally high at early ages for Type I cement.

All materials, including cement, separately met applicable standards of acceptance.

In my opinion, the cement was deficient even though the mill tests showing its chemical composition and our laboratory tests for determining physical characteristics all were acceptable. It is conceivable that the specifications followed by the industry are too broad or do not apply to the current problems. These problems have recently been magnified by environmental restrictions and regulations imposed on the cement manufacturing industry.

I recommend that dependence on standard acceptance tests be continued.

Additional tests should be developed for early determination of concrete strength. Such a test could be ASTM C684-74, "Making, Accelerated Curing, and Testing of Concrete Compression Test Specimens".

Furthermore, I recommend the purchase of the parts needed to rebuild and make operational, the concrete coring machine. It would allow us to monitor the increase in strength that normally occurs with age.

VERMONT DEPARTMENT OF HIGHWAYS

MATERIALS DIVISION

Structural Concrete Aggregate

SOURCE	PREDOMINANT MINERAL COMPOSITION
1-1/2" Stone Caledonia, Inc.-Waterford	Gravel Deposit
3/4" Stone Caledonia, Inc.-Waterford	
Sand Caledonia, Inc.-Waterford, Vt.	

SIEVE SIZE	1-1/2" STONE CUM.% RET'D	% PASSING	SPEC.	3/4" STONE CUM.% RET'D	% PASSING	SPEC.
1-3/4"		100	100			
1-1/2"	2	98	90-100			
1"		53	20- 55		100	100
3/4"	90	10	0- 15	2	98	90-100
3/8"	98	2	0- 5	76	24	20- 55
No. 4				97	3	0- 10
No. 8				98	2	0- 5
F.M.	7.90			6.73		

Specific Gravity	2.91	Specific Gravity	2.91
Absorption, %	0.6	Absorption, %	1.0
Passing #200 Sieve, %	0.8	Passing #200 Sieve, %	1.5
T & E Pieces, %	6	T & E Pieces, %	6
Fractured Faces, %	76	Fractured Faces, %	94
Wear (AASHTO T96), %	25.3	Wear (AASHTO T96), %	25.3
Soundness Loss, %	2.8	Soundness Loss, %	2.8

SIEVE SIZE	SAND CUM.% RET'D	% PASSING	SPEC.	SIEVE SIZE	COMBINED AGGREGATE CUM.% RET.	% PASS.	CUM.% RET.	% PASS.
3/8"			100	1-1/2"	1	99		
#4		100	95-100	3/4"	37	63		99
#8	14	86		3/8"	56	44	48	54
#16	35	65	50- 80	#4	61	39	58	42
#30	57	43	25- 60	#8	67	33	65	35
#50	79	21	10- 30	#16	75	25	74	26
#100	91	9	2- 10	#30	84	16	83	17
F.M.	2.76		2.60-3.10	#50	92	8	92	8
				#100	97	3	96	4
				F.M.	5.70			

Specific Gravity	2.75
Absorption, %	1.4
Organic Color No.	- 1
Passing #200 Sieve, %	5.5
Soundness Loss, %	6.0

BLEND:

38 % Sand	40 % Sand
21 % 3/4" Stone	60 % 3/4" Stone
41 % 1-1/2" Stone	-- % 1-1/2" Stone

Remarks:

6/6/75

VERMONT DEPARTMENT OF HIGHWAYS

MATERIALS DIVISION

Structural Concrete - Mix Proportions and Results

Mix Number	1	2	3		
Mix Design:					
Class of Concrete	A	B*	BB		
Cement - lbs.	611	564	611		
1-1/2" Stone (SSD) - lbs.	--	1395	1400		
3/4" Stone (SSD) - lbs.	1971	702	690		
Sand (SSD) - lbs.	1264	1242	1224		
Net Water - lbs.	306	273	280		
Admixture - oz. NVX	1.7	1.6	1.7		
Admixture - oz.					
Total Batch Weight - lbs.	4152	4176	4205		
Concrete Tests					
Water/Cement Ratio	.50	.48	.46		
Slump - Inches	3	3	3		
Air Content - % (Chace)	6.5	6	5.3		
Air Content - % (Pressure)					
Temperature - Deg. F					
Density - lbs./cu. ft.	148.8	152.1	152.1		
Mix Yield - cu. ft.	27.9	27.4	27.6		
Calc. Cement Content - lbs.	591	555	597		
Compressive Strength - PSI					
7 Days	2476	2299	2440		
	2476	2440	2387		
Average	2476	2370	2414		
14 Days	3130	2829	3086		
	3006	2794	2918		
Average	3068	2812	3002		
28 Days	3431	2927	3201		
	3519	2882	2909		
Average	3475	2905	3055		
_____ Days					
Average					
_____ Days					
Average					

NOTES:

CHART II

7/25/75

VERMONT DEPARTMENT OF HIGHWAYS

MATERIALS DIVISION

Structural Concrete - Mix Proportions and Results

Mix Number	* 4A	* 4B	5A	5B	
Mix Design:					
Class of Concrete	BB	BB	BB	BB	
Cement - lbs.	611	611	611	611	
1-1/2" Stone (SSD) - lbs.	1400	1400	1400	1400	
3/4" Stone (SSD) - lbs.	690	690	690	690	
Sand (SSD) - lbs.	1224	1224	1224	1224	
Net Water - lbs.	269	271	289	285	
Admixture - oz. NVX	1.8	1.8	1.8	1.8	
Admixture - oz.					
Total Batch Weight - lbs.	4194	4196	4214	4210	
Concrete Tests					
Water/Cement Ratio	.44	.44	.47	.47	
Slump - Inches	3-1/4	3-1/4	3-1/2	3	
Air Content - % (Chace)	7	6	6.3	5.3	
Air Content - % (Pressure)	5.4	5.4	5.4	4.5	
Temperature - Deg. F					
Density - lbs./cu. ft.	149.1	150.2	147.7	150.5	
Mix Yield - cu. ft.	28.1	27.9	28.5	28.0	
Calc. Cement Content - lbs.	587	591	578	590	
Compressive Strength - PSI					
3 Days	2175	2299	2087	2210	
Average					
7 Days	2290	2493	2387	2484	
Average					
14 Days	2918	3165	2803	2820	
Average					
28 Days	2989	2829	2383	3006	
	2865	2918	2723	2997	
Average	2927	2874	2553	3002	
60 Days	3448	3369	3298	3298	
Average					

NOTES:

* Laboratory washed aggregates

7/25/75

VERMONT DEPARTMENT OF HIGHWAYS

MATERIALS DIVISION

Structural Concrete - Mix Proportions and Results

Mix Number	* 6A	* 6B	7A	7B	
Mix Design:					
Class of Concrete	A	A	A	A	
Cement - lbs.	611	611	611	611	
1-1/2" Stone (SSD) - lbs.					
3/4" Stone (SSD) - lbs.	1971	1971	1971	1971	
Sand (SSD) - lbs.	1264	1264	1264	1264	
Net Water - lbs.	261	268	288	276	
Admixture - oz. NVX	1.8	1.8	1.8	1.8	
Admixture - oz.					
Total Batch Weight - lbs.	4107	4114	4134	4122	
Concrete Tests					
Water/Cement Ratio	.43	.44	.47	.45	
Slump - Inches	2-3/4	3	2-1/2	3-1/4	
Air Content - % (Chace)	6-3/4	5-1/2	6	6-3/4	
Air Content - % (Pressure)	5.7	5.4	5-1/2	6.8	
Temperature - Deg. F					
Density - lbs./cu. ft.	147.3	146.6	147.2	142.8	
Mix Yield - cu. ft.	27.9	28.1	28.1	28.9	
Calc. Cement Content - lbs.	591	588	587	571	
Compressive Strength - PSI					
3 Days	2405	2440	2255	1945	
Average					
7 Days	1945	2476	2449	2334	
Average					
14 Days	3121	3050	3156	2546	
Average					
28 Days	3192 3156	3519 3537	3263 3183	2759 2873	
Average	3174	3528	3223	2816	
60 Days	3563	3590	3625	3280	
Average					

NOTES:

* Laboratory washed aggregates

APPENDIX A

NORTHEAST CEMENT COMPANY INC.

Russ - RAB 9/4

August 29, 1975

RECEIVED
SEP 3 1975
HIGHWAY
TEST. LAB

Mr. Dave Bartlett, P.E.
Concrete Engineer
Materials Division
Department of Highways
State of Vermont
Montpelier, Vermont

Dear Mr. Bartlett:

Earlier this summer, we agreed to run a series of comparative tests, using a Caladonia 1½" stone with your standard class "BB" mix design.

Enclosed is a copy of my letter to Paul Calkins, discussing the results of our tests.

Please note that your findings do confirm points a, c, and d, but do not confirm point b. As mentioned, over the telephone, I would be very happy to continue looking into this discrepancy, should you so desire. Please contact me should you wish to further discuss this subject.

Yours sincerely,

Ian R. Poole

Ian R. Poole, P.E.
Manager - Technical Services

ff
cc Mr. Paul Calkins
Mr. Hubert Lavigne
Mr. Colin Barnett
Mr. Victor De Benedictis
Mr. F. T. Sendker

RFM

NORTHEAST CEMENT
the state tower building • syracuse n.y. 13202 • telephone: 471-2551

NORTHEAST CEMENT COMPANY INC.

August 29, 1975

Mr. Paul R. Calkins
Owner
Calkins Ready-Mix Concrete
Lyndonville, Vermont 05851

Dear Mr. Calkins:

I have recently received from Francon the test results for both the aggregates used in your class "BB" concrete supplied to the State of Vermont, as well as the compressive strength results of the concrete when used in a class "BB" mix design.

The results with my comments are as follows:

a) The sand and the stone graduations in regard to both fineness modulus and blending are good. (Refer to the enclosed data sheets.)

b) The compressive strengths for 7 days averaged 2725 p.s.i. while the 28-day average was 3945 p.s.i.

The 28-day strengths are between 500-1000 p.s.i. lower than what we would normally expect. (I would like to comment more about the cause of this problem in section (d).)

c) The yield for this mix was found to be 28 cubic feet per yard which is high. As a result of this, the actual class "BB" mix design per yard was:

Cement	-	588 lbs
Sand	-	1154 lbs
Stone 1½"	-	1336 lbs
3/4"	-	652 lbs
Water	-	296 lbs (35.7 gallons)
Total Weight	-	4026 lbs
Unit Weight	-	149.1 lbs/c.f.
Air	-	5.5% (Using 5.7 oz of Darex)
Slump	-	3"

Temperature of Concrete: 76°

.../2

d) According to our Laboratory, "there was not one stone broken in the two 28-day cylinder breaks and the top size aggregate could be removed freely by hand in most cases. The only apparent reason for the low compressive strengths is the very poor bond of the coarse aggregate to the Matrix, especially the large 1" - 1½" size particles".

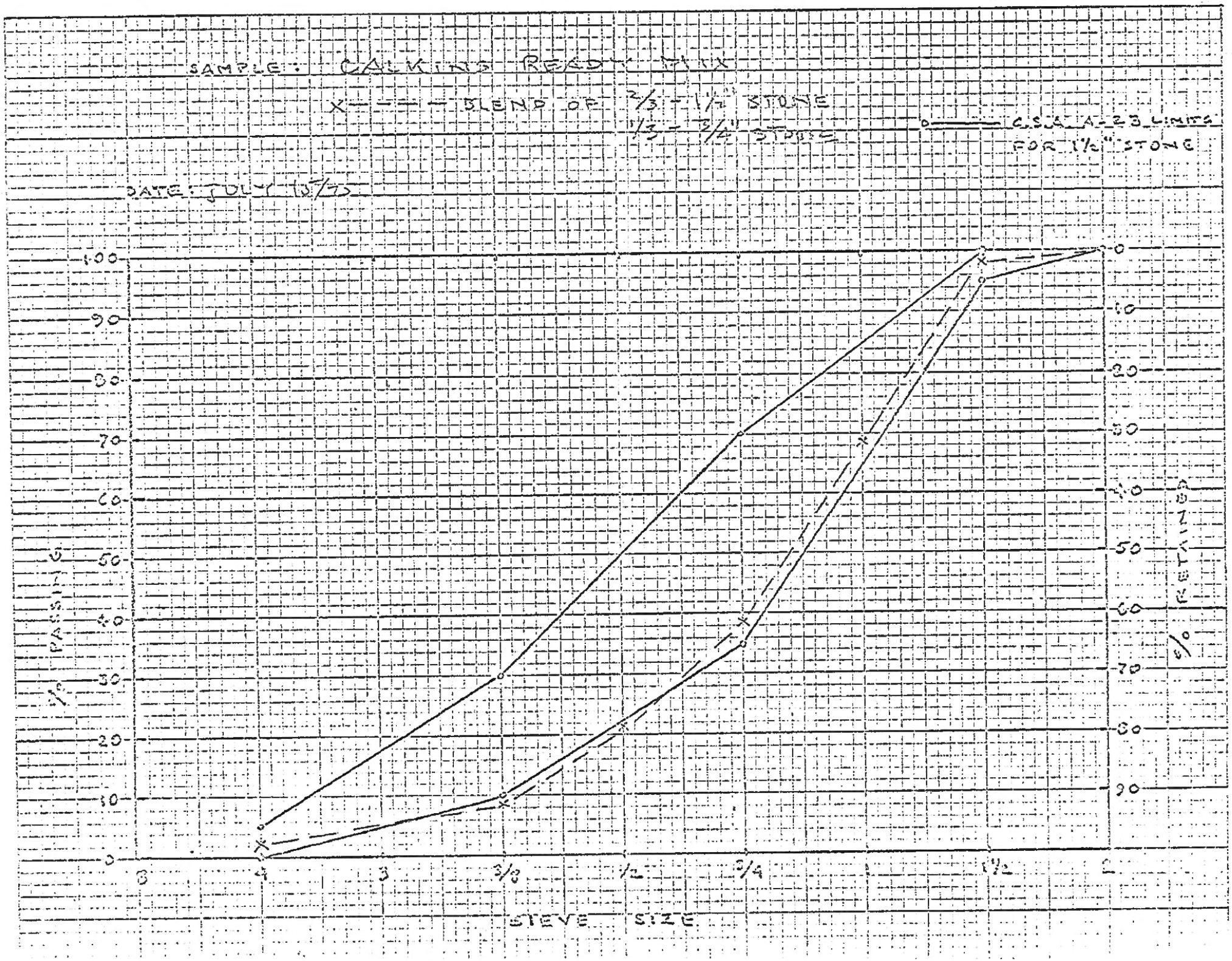
It is the belief of our Laboratory that the dust coating on the coarse aggregate is the cause of your problem and that this would also explain why approximately two gallons more water, was required than normal, to produce a 3" slump concrete. This basically confirms what I mentioned to you during my visit of July 14. It will also explain why you have been getting good results with your own aggregate through tests with Knight Engineering, while you were getting lower results with the Caladonia aggregate.

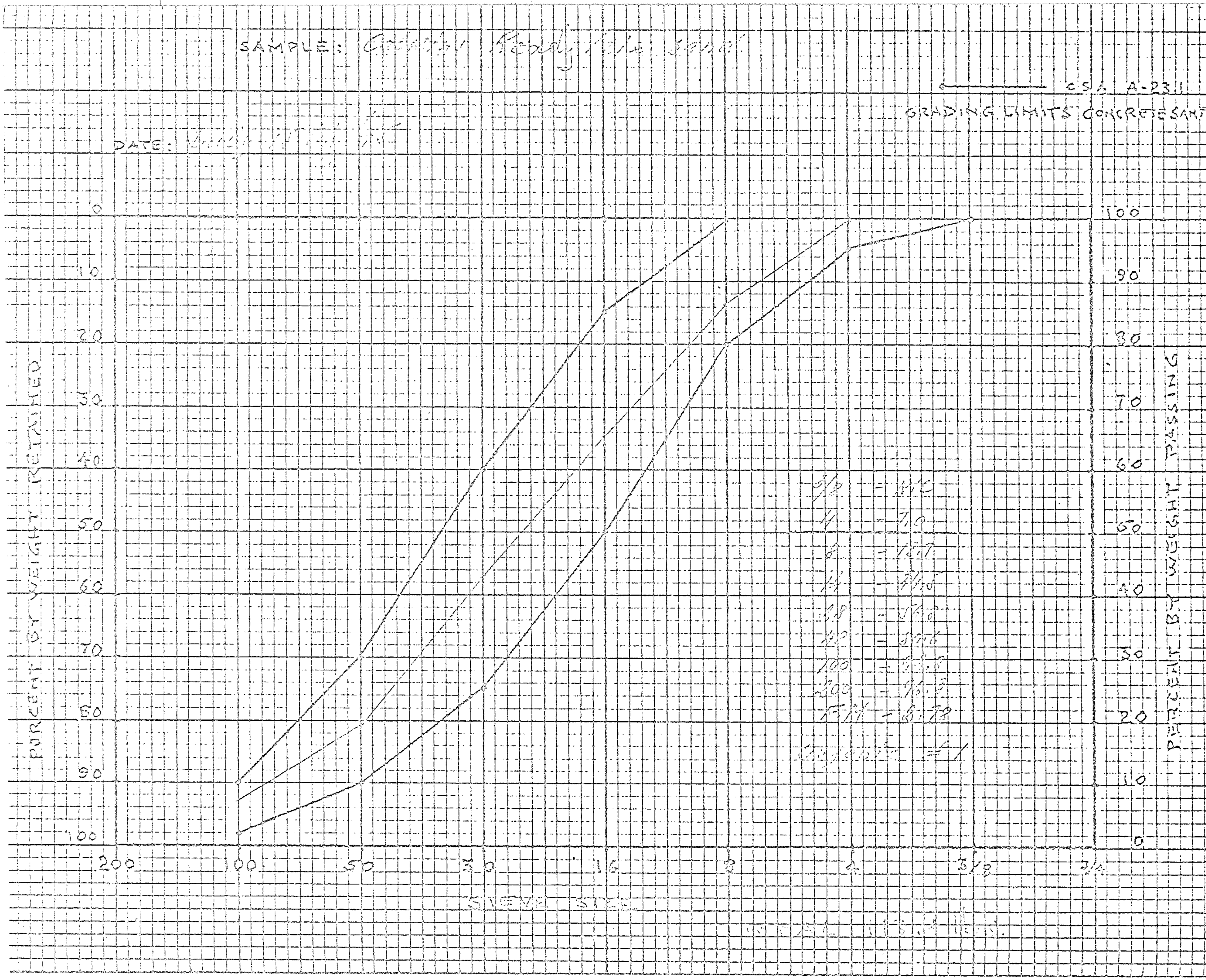
Yours truly,

Ian R. Poole

Ian R. Poole, P.E.
Manager - Technical Services

ff
Enclosures
cc F. T. Sendker
Victor De Benedictis
Hubert Lavigne
Colin Barnett


SAMPLE: CALKINS READY MIX
X - - - - BLEND OF 2/3 - 1 1/2" STONE
1/3 - 3/4" STONE
DATE: JULY 10/75
CSHA A-23 LIMITS
FOR 1/2" STONE
PASSING %
RETAINED %
100
90
80
70
60
50
40
30
20
10
0
3
2
1
3/8
1/2
3/4
1 1/2
2
SIEVE SIZE



SAMPLE:
CSA A-23.1
GRADING LIMITS CONCRETE SAND
DATE:
PERCENT BY WEIGHT RETAINED
PERCENT BY WEIGHT PASSING
0
10
20
30
40
50
60
70
80
90
100
200
100
50
30
16
8
4
3/8
3/4
SIEVE SIZE

FRANCON LIMITEE

AGGREGATE GRADING ANALYSIS REPORT

Sample description: 1½" Stone

Sampling location: Calkins Road, Ont

Date: July 15th 197 V

SIEVE SIZE	WEIGHT gr.-lbs.	INDIVIDUAL %	% PASSING	% RETAINED		SPECIFICATIONS
3"	—	—				
2½	—	—				
2	—	—	100.0			
1½	1.7	2.2	97.8	2.2		
1	34.3	45.0	52.8	47.2		
¾	33.1	43.1	10.7	89.3		
½	4.7	6.2	4.5	95.5		
3/8	0.9	1.2	3.3	96.7		
¼	0.4	0.5	2.8	97.2		
No. 4	0.2	0.3	2.5	97.5		
8						
16						
30						
50						
100						
200						
Pan	1.7	2.5		100.0		
Total	76.6	100.0				

Unit weight, lbs. per cu. ft.: Loose Dry _____ Compacted Dry _____

Moist _____ Moist _____

Finess Modulus: _____

Moisture, %: _____

Remarks: _____

Tested by: _____ Checked by: _____

AGGREGATE GRADING ANALYSIS REPORT

Sample description: 3/4" Stone

Sampling location: Calvin's Ready Mix

Date: July 15th 197 5

SIEVE SIZE	WEIGHT gm.-lbs.	INDIVIDUAL %	% PASSING	% RETAINED		SPECIFICATIONS
3"	—					
2½	—					
2	—					
1½	—					
1	—		100.0			
¾	3.7	5.5	94.5	5.5		
½	26.3	38.3	55.6	44.4		
3/8	24.5	36.3	19.3	80.7		
4	11.3	16.7	2.6	97.4		
No. 4	0.7	1.0	1.6	98.4		
8						
16						
30						
50						
100						
200						
Pan	1.1	1.6		100.0		
Total	67.7	100.0				

Unit weight, lbs. per cu. Ft.: Loose Dry _____ Compacted Dry _____

Moist _____ Moist _____

Finess Modulus: _____

Moisture, %: _____

Remarks: _____

Tested by: _____ Checked by: _____

APPENDIX B

OFFICE OF THE COMMISSIONER

DHB

STATE OF VERMONT
DEPARTMENT OF HIGHWAYS
MONTPELIER
05602

December 4, 1975

Mr. Thomas M. E. Mindock
Chief Chemist
The Flintkote Company
Glen Falls Cement Division
Glen Falls, New York 12801

Dear Tom:

Several months ago you sent me a copy of a letter that you received from the Portland Cement Association, dated May 22, 1975, which analyzed and commented on a mix design from Lawrence Sandgravco. The author, Mr. Mike Pistilli, Research Chemist, noted that the combined FM was high - 6.77 and suggested that for aggregate of 1½" top size, an FM of approximately 6.0 would be more ideal.

In reviewing this data, we have been unable to duplicate these figures. In fact, we have researched in NRMCA pamphlets, as well as several text books, to ascertain that our methods were correct. In every instance, using aggregate sources from throughout the State, we have found the combined FM to be less than 6.0.

We appreciate the opportunity to study your report and have adjusted some of our mix proportions as a result. However, we are puzzled as to the method and result of the combined FM and would welcome any further information in this regard.

Thanks again for forwarding a copy of the Portland Cement Association's comments.

Sincerely,

R. F. Nicholson
Materials Engineer

By: Donald Bartlett
D. H. Bartlett
Structural Concrete Engineer

RFN/DHB/msd
cc: RFN/Lab File
Central Files

No further information received as of 3/15/76 DHB

PORTLAND CEMENT ASSOCIATION
Old Orchard Road, Skokie, Illinois 60076 / Area Code 312 / 966-6200

Research and Development
Construction Technology Laboratories

May 22, 1975

Mr. Thomas M. E. Mindock
Chief Chemist
The Flintkote Company
Glen Falls Cement Division
Glen Falls, New York 12801

Dear Tom:

The following are some comments regarding concrete mix designs from Lawrence Sangravco Co., resulting in low concrete compressive strengths. The mix designs were attached to your letter of April 28, 1975 to Mike Meyer. You had previously discussed this with Mike by telephone.

The material finer than the No.200 sieve may be too high in the sand. ASTM allows a maximum of 3-7% dependent upon type of construction, the amount of clays and shales in this fraction, and if the sand is a crushed product. The major problem is with clays and shales, which increase the w/c ratio when dispersed into the paste. If the clays are not cleaned away from the aggregate surface, the paste to aggregate bonding is interferred with. This was evident in mix No.60 compared to mix No.61.

From the cement content of the mixes, I assume the design is for approximately 4000 psi at 28 days.

I also noticed that the combined fineness modulus (including sand and coarse aggregate) is high, 6.77. This would indicate that the mix is harsh. A good combined F.M. would be approximately 6.0 for 1-1/2" top size aggregate. Harsh mixes are coarse in appearance, and very sensitive to w/c for texture. They are also more variable in compressive strength than leaner mixes. The coarse aggregate blend used was 32.3% (3/4") and 67.7% (1-1/2") crushed stone. The mix design used was approximately 37% sand and 63% coarse. The mix may be improved by using 50% (3/4"), 50% (1-1/2") coarse aggregate blend and approximately 40% sand, 60% coarse. (This is provided the mix is not architectural concrete).

This should lower the F.M. of the mix and still meet ASTM specification for gradation of 467 (C-33) coarse aggregate. This may also improve the strength and reduce variation.

Should additional questions arise, please feel free to contact us in regards to them.

Sincerely yours,

Mike Pistilli

Mike Pistilli
Research Chemist

HA1153/4140

Copies to -
W. E. Kunze
E. Hognestad
J. J. Shideler/L. M. Meyer

GLENS FALLS PORTLAND CEMENT COMPANY
DIVISION OF THE FLINTKOTE COMPANY

LAWRENCE SANGRAVCO - CONCRETE AGGREGATES - FEBRUARY 20, 1975

SIEVE SIZE	CONCRETE SAND % RET'D	CONCRETE SAND CUM. % RET'D	CONCRETE SAND % PASSING	3/4" CRUSHED STONE % RET'D	3/4" CRUSHED STONE CUM. % RET'D	3/4" CRUSHED STONE % PASSING
1"				0.0	0.0	100.0
3/4"				6.5	6.5	93.5
5/8"				14.9	21.4	78.6
1/2"				15.5	36.9	63.1
3/8"	0.0	0.0	100.0	27.0	63.9	36.1
No. 4	0.0	0.5	99.5	29.7	93.6	6.4
8	13.4	13.9	86.1			
16	21.1	35.0	65.0			
30	24.0	59.0	41.0			
50	21.3	80.3	19.7			
100	11.5	91.8	8.2	___	___	___
TOTAL	91.8	280.5				

FINENESS MODULUS	2.80	
ORGANIC COLOR NO.	CLEAR	
SPECIFIC GRAVITY	2.77	2.78
ABSORPTION %	0.84	0.92
MATERIAL FINER THAN NO. 200 SIEVE BY WASHING	4.33	1.15

SIEVE SIZE	1-1/2" CRUSHED STONE % RET'D	1-1/2" CRUSHED STONE CUM. % RET'D	1-1/2" CRUSHED STONE % PASSING	BLEND 32.3% 3/4"&67.7% 1-1/2" CR. STONE % RET'D	BLEND 32.3% 3/4"&67.7% 1-1/2" CR. STONE CUM. % RET'D	BLEND 32.3% 3/4"&67.7% 1-1/2" CR. STONE % PASSING
1-1/2"	0.0	0.0	100.0	0.0	0.0	100.0
1"	52.5	52.5	47.5	35.6	35.6	64.4
3/4"	36.3	88.8	11.2	26.6	62.2	37.8
5/8"	6.0	94.8	5.2	8.9	71.1	28.9
1/2"	1.3	96.1	3.9	5.9	77.0	23.0
3/8"	1.1	97.2	2.8	9.4	86.4	13.6
No. 4	0.6	97.8	2.2	10.0	96.4	3.6
TOTAL	97.8	-	-	96.4	-	-

SPECIFIC GRAVITY	2.88	2.85
ABSORPTION - %	0.72	0.78
MATERIAL FINER THAN NO. 200 SIEVE BY WASHING - %	0.89	0.97
DENSITY (DRY RUDDED) LBS.?CU.FT.	-	111

LN
4/18/75

GLENS FALLS PORTLAND CEMENT COMPANY
DIVISION OF THE FLINTKOTE COMPANY

LAWRENCE SANGRAVCO - CONCRETE MIXES FEBRUARY 24, 1975

MIX NO.	43	44
MIX DESIGN:		
(1) Type I Gls. Fls. Cement - lbs.	611	611
(2) Concrete Sand (S.S.D.) - lbs.	1201	1100
(3) 3/4" Crushed Stone (S.S.D.) - lbs.	660	675
(4) 1-1/2" Crushed Stone (S.S.D.) - lbs.	1385	1400
(5) Net Water - lbs.	314	300
(6) Darex - ozs.	9.0	9.0
(7) Total Batch Weight - lbs.	4171	4086
MIX YIELD - cu. ft.	27.9	27.0
Sand - % of total aggregate by volume	37.6	35.3
CONCRETE TESTS:		
(1) Water - lb per lb. cement	0.514	0.491
(2) Net gallons water per sack	5.79	5.53
(3) Slump - inches	2.75	2.5
(4) % Entrained Air - Chace	5.3	5.2
(5) % Entrained Air - Pressure	6.0	5.1
(6) Concrete Density - lbs./cu.ft.	149.5	151.6
(7) Calculated cement content - sacks per cu.yd.	6.29	6.51
COMPRESSIVE STRENGTH - 6" x 12" cyls. - PSI:		
3 Days	2085	-
3 Days	2195	2475
Average 3 Day Strength	2140	-
7 Days	2600	-
7 Days	2650	2865
7 Days	2705	3025
Average 7 Day Strength	2650	2945
14 Days	2900	3200
14 Days	3005	3255
Average 14 Day Strength	2955	3230
28 Days	3110	-
28 Days	3200	3395
28 Days	2990	3500
Average 28 Day Strength	3100	3450

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Sand Stone 40% 32.5 35

50-50

GLENS FALLS PORTLAND CEMENT COMPANY
DIVISION OF THE FLINTKOTE COMPANY

LAWRENCE SANGRAVCO - MORTAR MIXES - MARCH 4, 1975

MIX NO.	53	54
MIX BY WEIGHT	1:3	1:3
MATERIALS FOR 1 - SK BATCH:		
(1) Type I Gls. Fls. Cement - lbs.	94	94
(2) Concrete Sand (S.S.D.) - lbs.	282	282
(3) Net Water - lbs.	51.1	51.6
(4) Darex - lbs.	1.38	-
(5) NVX Powder - gms.	-	4.9
CONCRETE TESTS:		
(1) Water - lbs. per lb. cement	0.543	0.549
(2) Net gallons water per sack	6.12	6.18
(3) Slump - Inches	3.25	2.75
(4) % Entrained Air - Chace	5.1	4.1
(5) Concrete Density - lbs./cu.ft.	134.2	137.3
(6) Calculated Cement Content - Sacks per cu. yd	8.48	8.67
COMPRESSIVE STRENGTH - 3" x 6" cyls. - PSI:		
3 Days	2505	2785
7 Days	2630	3280
7 Days	2730	3425
Average 7 Day Strength	2680	3350
28 Days	3665	4175
28 Days	3935	4300
Average 28 Day Strength	3800	4235

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GLENS FALLS PORTLAND CEMENT COMPANY
DIVISION OF THE FLINTKOTE COMPANY

LAWRENCE SANGRAVCO SAND - MARCH 5, 1975

SIEVE SIZE	% RETAINED	CUMULATIVE % RETAINED	% PASSING
3/8"	0.0	0.0	100.0
No. 4	0.7	0.7	99.3
8	14.2	14.9	85.1
16	21.8	36.7	63.3
30	23.7	60.4	39.6
50	19.6	80.0	20.0
100	10.6	90.6	9.4
TOTALS	90.6	283.3	-

FINENESS MODULUS	2.83
ORGANIC COLOR	CLEAR
MATERIAL FINER THAN NO. 200 SIEVE BY WASHING - %	5.18
MINUS NO. 200 MATERIAL AFTER LAB WASHING - %	0.46

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LENS FALLS PORTLAND CEMENT COMPANY
IVISION OF THE FLINTKOTE COMPANY

LAWRENCE SANGRAVCO - CONCRETE MIXES - MARCH 6, 1975

MIX NO.	55	56	57	58
MIX DESIGNS:				
(1) Type I Gls. Fls. Cement - lbs.	611	611	611	611
(2) Concrete Sand (S.S.D.) - lbs.	1201	1201	1201	1201
(3) 3/4" Crushed Stone (S.S.D.) lbs.	660	660	660	660
(4) 1-1/2" Crushed Stone (S.S.D.) lbs.	1385	1385	1385	1385
(5) Net Water - lbs.	315	315	309	315
(6) Darex - lbs.	9	9	-	-
(7) 25% Vinsol Resin - oz.	-	-	4.9	2.45
(8) Total Batch Weight - lbs.	4172	4172	4166	4172
MIX YIELD - cu. ft.	27.1	27.1	28.3	27.1
SAND - % of total aggr. by vol.	37.6	37.6	37.6	37.6
CONCRETE TESTS:				
(1) Water - lb. per lb. cement	0.515	0.515	0.506	0.515
(2) Net gallons water per sack	5.80	5.80	5.70	5.80
(3) Slump - Inches (approx.)	2.5	2.5	2.5	2.5
(4) % Entrained Air (Chace)	4.4	4.3	6.5	5.0
(5) Concrete Density - lbs./cu.ft.	154.0	153.8	147.1	154.0
(6) Calculated Cement Content Sacks per cu. yd.	6.48	6.47	6.20	6.48
COMPRESSIVE STRENGTH - 4" x 8" cyls. PSI:				
1 Day	1895	1880	1585	-
7 Days	3055	3080	2540	3110
7 Days	3245	3225	2740	3265
		3150		
Average 7 Day Strength	3150		2640	3185
14 Days	3110	3445	2835	3245
14 Days	3470	3455	2960	3725
Average 14 Day Strength	3290	3450	2895	3485
28 Days	3340	3535	3230	3945
28 Days	3945	3630	3350	4035
Average 28 Day Strength	3645	3580	3290	3990

NOTES: (1) In mix No. 55 Darex added following addition of aggregates, cement 1/2 of water and some mixing.
(2) In mix No. 56 Darex added with coarse aggregate and 1/2 of water. Mixer then started and remainder of materials added.

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LAWRENCE SANGRAVCO - CONCRETE MIXES - MARCH 12, 1975

MIX NO.	60	61
AGGREGATE IDENTIFICATION:	Lab Washed	As Received
MIX DESIN:		
(1) Type I Gls. Fls. Cement - lbs.	611	611
(2) Concrete Sand (S.S.D.) - lbs.	1201	1201
(3) 3/4" Crushed Stone - lbs.	660	660
(4) 1-1/2" Crushed Stone - lbs.	1385	1385
(5) Net Water - lbs.	285	310
(6) Darex - ozs.	9	9.75
(7) Total Batch Weight - lbs	4142	4107
MIX YIELD - CU. FT.	26.7	27.3
Sand - % of Total Aggr. By volume	37.6	37.6
CONCRETE TESTS:		
(1) Water - lb. per lb. cement	0.466	0.507
(2) Net gallons water per sack	5.25	5.71
(3) Slump - Inches (Approx.)	2.5	2.5
(4) % Entrained Air (Chace)	4.8	4.6
(5) Concrete Density - lbs./cu. ft.	155.0	152.4
(6) Bleeding	NONE	LIGHT
(7) Calculated cement content - sacks per cu.yd.	6.57	6.42
COMPRESSIVE STRENGTH - 4" x 8" cyls. - PSI:		
1 Day	2030	1765
7 Days	3645	3200
7 Days	3660	3310
Average 7 Day Strength	3650	3255
14 Days	3890	3380
14 Days	4100	3565
Average 14 Day Strength	3995	3475
28 Days	4355	3765
28 Days	4610	3835
Average 28 Day Strength	4480	3800

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