Concrete Curing Materials & Admixtures

Section 725

Testing Program 1970 - 1978

Summary of Results

Report 79-3

May 1979

STATE OF VERMONT AGENCY OF TRANSPORTATION

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ABSTRACT

Standard specifications for highway and bridge construction, March 1976, require that a list of approved materials be developed. In addition to receipt of proper certifications, many products must be tested prior to approval. This report summarizes the results of several testing programs and will recommend, for inclusion on the List of Approved Materials, products covered under Section 725 - Concrete Curing Materials and Admixtures.

INTRODUCTION

Standard Specifications for Highway and Bridge Construction, March 1976, require that a List of Approved Materials be developed. This requirement is based on Sampling and Testing provisions of Division 700 Materials which state; "Upon request, the Department will furnish a list of products that have been previously tested and are considered satisfactory."

Section 725 - Concrete Curing Materials and Admixtures, contains the following subsections which require the materials to be tested prior to being approved:

- 725.04 Liquid Membrane-Forming Compounds
- 725.05 Air-Entraining Admixtures
- 725.06 Retarding Admixtures
- 725.07 Latex Admixture
- 725.08 Silicone Admixture
- 725.09 Water Reducing Admixture
- 725.10 Water Reducing And Retarding Admixture

Several testing programs have been initiated in the Laboratory to determine specification compliance and to examine the performance of the various curing compounds and admixtures. All of the testing programs have not been entirely successful nor have they all resulted in written reports.

Some of these products have been evaluated on construction projects so their performance under actual field conditions could be monitored. Usually the results of these evaluations were reported orally or in a memorandum to a supervisor. Very few of these evaluations were recorded in the form of a formal report.

The purpose of this report is to:

- A. Summarize the test results reported in several research investigations and product evaluations on file in the Structural Concrete Subdivision.
- B. Provide a list of products recommended for inclusion on the List of Approved Materials. Recommendations are to be based on satisfactory field performance, results of laboratory tests, or products having been approved by the F.H.W.A.

DATA

Following are listed the research reports and product evaluations which have been used in compiling information for this report:

Product Evaluation or	Data	m	
Report No.	Date	<u>1</u> .	
	725.05 - Air	Entraining Admin	ktures
76-2	April 1976	Air Entraining	g Admixtures - Compliance Testing
	725.06 - R	etarding Admixtu	ires
70-3	1970	Investigation Portland Cemer	of Retarding Admixtures For nt Concrete
72-7	May 1972	Retarders - In	nfluence of Variable Quantities
R 72-9	December 1972	Retarders - Fi (Includes Adde	inal Report - Compliance Testing endum #1 Date: April 1976)
	725.09 - Wat	er Reducing Admi	lxture
76-3	December 1976	Investigation AASHTO M 194 7	of Water Reducing Admixtures Type A
P 77-4	May 1977	Product Name:	Pozzolith 122 N
P 77-21	December 1977	Product Name:	WRDA
P 77-22	December 1977	Product Name:	WRDA w/Hycol
P 77-23	December 1977	Product Name:	Mighty 150
P 78-10	March 1978	Product Name:	Mighty 150
P 77-24	December 1977	Product Name:	Pozzolith 200 N
P 77-25	December 1977	Product Name:	Sikament
P 78-9	February 1978	Product Name:	Sikament
P 77-26	December 1977	Product Name:	FX 32 D
P 78-15	March 1978	Product Name:	FX 32 D
P 77-27	December 1977	Product Name:	FX 32
P 78-16	March 1978	Product Name:	FX 32

725.10 Water Reducing and Retarding Admixture

See Item 725.06 Retarding Admixtures for applicable report numbers.

The applicable sections of the Standard Specifications for Highway and Bridge Construction-March 1976 and AASHTO Specifications are shown and test results are tabulated for each product.

Air Entraining Admixtures

Standard Specifications for Highway and Bridge Construction, March 1976, state:

"725.05 Air-Entraining Admixtures. Air-entraining admixtures shall conform to the requirements of AASHTO M 154 for 3-day, 7-day, and 28-day compressive strengths and resistance to freezing and thawing."

AASHTO M 154 states:

"6.1.3 Compressive Strength.-The compressive strength at any test age of concrete containing the admixture under test shall be not less than 90 percent of that of similar concrete containing the reference admixture at the same test age.

6.1.5 Resistance to Freezing and Thawing.-The relative durability factor of concrete containing the admixture under test shall be not less than 80. The relative durability factor shall be calculated as follows:

$$DF (or DF_1) = \frac{PN}{300}$$

$$RDF = \frac{DF}{PN} \times 100$$

$$DF_1$$

where:

- DF = durability factor of the concrete containing the admixture
 under test.
- - P = relative dynamic modulus of elasticity in percentage of the dynamic modulus of elasticity at zero cycles (values of P will be 60 or greater).
 - N = number of cycles at which P reaches 60 percent, or 300 if P does not reach 60 percent prior to the end of the test (300 cycles), and

RDF = relative durability factor."

Report 76-2

Compressive Strength (Percent of Reference)

Product Name	3 Days	7 Days	14 Days	28 Days	
Darex AEA	96	93	95	97	
MBAE 10	103	103	102	106	

Tests for resistance to freezing and thawing were not performed. There is no equipment available in the Materials and Research Division to perform these tests, as specified.

Retarding Admixtures and Water Reducing and Retarding Admixtures

Standard Specifications for Highway and Bridge Construction, March 1976, state:

725.06 RETARDING ADMIXTURES. Retarding admixtures shall conform to the requirements of AASHTO M 194, Type B for time of setting and 3 day, 7 day, and 28 day compressive strengths.

725.10 WATER REDUCING AND RETARDING ADMIXTURE. Water reducing and retarding admixtures shall conform to the requirements of AASHTO M 194, Type D, for water content, time of setting and 3 day, 7 day, and 28 day compressive strengths.

	Table	1
Physical	Requi	rementsa

	Type B Retarding	Type D, Water Reducing and Retarding
Water content, max. percent of control Time of setting, allowable deviation from con- trol. hours: minutes		95
Initial: at least	1:00 later	1:00 later
not more than	3:00 later	3:30 later
Final: at least	3:30 later	3:30 later
Compressive strength, min. percent of control:b		
3 days	90	110
7 days	90	110
28 days	90	110
6 months	90	100
1 yr	90	100

^aThe values in the table include allowance for normal variation in test results. The object of the 90 percent compressive strength requirement for a Type B admixture is to require a level of performance comparable to that of the reference concrete.

^bThe compressive and flexural strength of the concrete containing the admixture under test at any test age shall be not less than 90 percent of that attained at any previous test age. The objective of this limit is to require that the compressive or flexural strength of the concrete containing the admixture under test shall not decrease with age.

						P=P F=F	P=Passing F=Failing	
Product Name &	Compressive Strength				Time of Setting De + Indicates La - Indicates Ea	Control ime Time	Type D Water Reducing	
Report No. or Product Evaluation No.	3 days	7 days	28 days	Mixing Water (Percent of Control)	Initial Hrs: Min.	Final Hrs: Min.	Type B Retarding	and Retarding
Daratard								
70-3	126	115	103	90.6	+3:19	+3:50	F	F
	132	125	124	93.1	+2:24	+2:28	Р	Р
	107	110	108	92.9	+3:57	+4:01	F	F
72-7	127	129	120					
R72-9	110	103	111	96.5	+0:42	+1:54	F	F
Daratard HC								
70-3	133	130	125	95.0	+3:04	+3:05	F	Р
72-7	134	135	142					
R72-9	113	113	107	101.0	+1:42	+1:36	Р	F
Daratard 17								
R72-9 Addendum #1	115	117	114	95.7	+2:50	+2:54	P	F
Plastiment								
70-3	127	117	107	95.4	+2:40	+2:59	Р	F
72-7	136	136	128					
R72-9	105	101	105	102.5	+1:42	+1:36	Р	F
1 00		Un	its under	lined are not in compl	iance with specifica	ations.		

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(Con't.)

								P=Pa F=Fa	issing
Product Name & Report No. or Product Evaluati	on No. 3	Compres Percer davs	ssive S nt of Co 7 davs	trength ontrol) 28 days	Mixing Water	Time of Setting De + Indicates La - Indicates Ea Initial Hrs: Min.	ontrol me Time Type B Retarding	Type D Water Reducing and Retarding	
Pozzolith 100 XR									
70-3		107	115	119	100.2	+4:35	+4:41	F	F
R72-9		110	120	120	100.5	+3:00	+3:00	Р	F
MBHC									
70-3		119	115	122	97.6	+3:15	+3:28	F	F
R72-9		104	106	105	100.5	+1:00	+0:54	Р	F
Pozzolith 84	(Rename	d MBL	84)						
R72-9		111	110	111	99.5	+1:24	+1:00	Р	F

Units underlined are not in compliance with specifications.

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Water Reducing Admixtures

Standard Specifications for Highway and Bridge Construction, March, 1976 state:

725.09 WATER REDUCING ADMIXTURE. Water reducing admixture shall conform to the requirements of AASHTO M 194, Type A, for water content, time of setting and 3 day, 7 day, and 28 day compressive strengths.

AASHTO M 194 states:

TABLE 1

Physical Requirements

	Water- Reducing
Water content, max., percent of control Time of setting, allowable deviation from control, Hrs: Min:	95
not more than	1:00 earlier nor 1:30 later
Final: at leastnot more than	1:00 earlier 1:30 later

Compressive strength, min., percent of control:b

3 days	110
7 days	110
28 days	110

^bThe compressive and flexural strength of the concrete containing the admixture under test at any test age shall be not less than 90 percent of that attained at any previous test age. The objective of this limit is to require that the compressive or flexural strength of the concrete containing the admixture under test shall not decrease with age.

Duradurate Nama P	Compressive Strength (Percent of Control) 3 days 7 days 28 days		trength	Time of Setting Deviation from Control + Indicates Later Setting Time - Indicates Earlier Setting Time			
Report No. or Product Evaluation No.			28 days	Mixing Water (Percent of Control)	Initial Final Hrs: Min. Hrs: Min.		P=Passing F=Failing
FX32D							
P77-26	181	179	153	80.9	+2:07	+1:24	F
P-78-15		146	143				
FX32							
P77-27	182	174	159	82.3	+0:06	-0:50	Р
P78-16		137	134				
Sikament							
P77-25	183	182	155	79.4	+0:27	-0:13	Р
P78-9		143	135				
Mighty 150							
P77-23	161	149	144	86.4	-0:18	-0:50	Ρ
P78-10		121	124				

Units underlined are not in compliance with specifications.

Product Name &	Compres	sive St	trength		Time of Setting De + Indicates La - Indicates Ea		
Report No. or Product Evaluation No.	3 days	7 days	28 days	Mixing Water (Percent of Control)	Initial Hrs: Min.	Final Hrs: Min.	P=Passing F=Failing
Pozzolith 122N							
76-3	112	114	113	96.5	+1:07	+0:57	F
P77-4	131	124	121	98.0	+2:32	+2:16	F
Pozzolith 200 N							
76-3	119	120	119	96.5	+1:31	+1:08	F
P77-24	122	115	113	98.5	+1:57	+1:30	F
WRDA/Hycol							
76-3	106	102	104	94.7	+0:54	+1:02	F
P77-22	117	110	109	98.7	+1:01	+0:31	F
WRDA							
P77-21	118	119	106	96.4	+1:52	+1:27	F
Plastocrete 160							
76-3	108	109	104	98.2	+0:34	+0:28	F
FX32RA		β.					
76-3	133	121	115	82.7	+1:22	+1:18	Р
12		Uni	ts underl	ined are not in compli	ance with specificat	cions.	

The following product evaluations:

P78-9 Product Name: Sikament P78-10 Product Name: Mighty 150 P78-15 Product Name: FX32D P78-16 Product Name: FX32

were conducted by the Research & Development Subdivision using Class AA concrete. Test results not previously shown are summarized as follows:

P78-9-Sikament Bond Strength-Good, Sikament increased the bond strength by 8%.

Freeze-Thaw Durability-Poor, durability was very poor when compared to the reference mix.

Chloride Intrusion-Approximately equal to the reference mix.

P78-10-Mighty 150 Bond Strength-Poor, bond strength was decreased by 26%.

Freeze-Thaw Durability-Poor, durability was very poor compared to the reference mix.

Chloride Intrusion-Approximately equal to the reference mix.

P78-15-FX32D

Bond Strength-Fair, although 731 psi, it was 24% lower than the reference mix.

Freeze-Thaw Durability-Poor, durability was very poor when compared to the reference mix.

Chloride Intrusion-Good, allowed less intrusion than reference mix.

P78-16 -FX32

Bond Strength-Fair, bond strength was 13% less than the reference mix.

Freeze-Thaw Durability-Poor, durability was very poor compared to the reference mix.

Chloride Intrusion-Good, allowed less intrusion than reference mix.

Discussion and Recommendations

Item 725.04 - Liquid Membrane Forming Compounds

At the present time no liquid membrane forming compounds are recommended for inclusion on the list of approved materials. Insufficient laboratory tests and a lack of knowledge as to their performance in the field prohibits recommending any products at the present time.

Item 725.05 - Air Entraining Admixtures

Recommended Products

Product Name	Manufacturer
Darex AEA	Construction Products Division
NO 15 10	W. R. Grace & Co., Cambridge, MA
MB-AE IU	Master Builders, Cleveland, OH

The approval of Darex AEA and MB-AE 10 is based upon their conformance with the compressive strength requirements to AASHTO M154. See Report No. 76-2.

Item 725.06 - Retarding Admixtures and

Item 725.10 - Water Reducing and Retarding Admixture

At the present time no product will be recommended for Item 725.10 Water Reducing and Retarding Admixture. None of the products examined met all of the applicable requirements for an AASHTO M194 Type D admixture.

The following products will be recommended for Item 725.06 Retarding Admixtures:

Division
mbridge, MA
Division
mbridge, MA
Division
mbridge, MA
land, OH
land, OH
land, OH
assaic, NJ

In all of the testing programs, the use of a retarding admixture resulted in an increase in the compressive strength of the concrete. These compressive strengths varied considerably as did the mixing water required and time of setting. Although several of the setting times were not in compliance with the specifications only minor adjustments in the addition rates would be necessary to correct the discrepancies. In the summer months, the addition rates for these products in the field is usually higher than that necessary to provide the one to three and one-half hour delay in setting time required in the specifications.

Item 725.07 - Latex Admixtures

Recommended Products

Product Name

Manufacturer

Dow Concrete Modifier "A"	Dow Chemical U.S.A.
(Formerly SM100)	Midland, Michigan
Dylex Latex 1186	Tex-Crete Inc., Gurnee, IL
Thermoflex 8002	Thermoflex, Inc.
	Louisville, Kentucky
Deco-Rez 4776	General Polymers Corp.
	Cincinatti, Ohio

Dow Concrete Modifier "A" is recommended for approval based on several years of satisfactory performance in the field. This product has also been approved by the FHWA.

Dylex Latex 1186, Thermoflex 8002 and Deco-Rez 4776 are approved only for Category II projects. These products must have a certification stating they are of the same formulation as those products previously tested and approved by the Fairbanks Research Testing Laboratories.

Dylex Latex 1186 and Thermoflex 8002 are currently being evaluated, in the laboratory, in Class AA concrete.

Item 725.08 - Silicone Admixture

Recommended Products

Product Name

Manufacturer

Z-6020 Silane (Formerly 777B) Dow Corning Corporation Midland, Michigan

Z-6020 Silane is recommended for approval based on several years of satisfactory performance in the field. This product is currently being evaluated, in the laboratory, in Class AA concrete.

Item 725.09 - Water Reducing Admixture

Recommended Products

Product Name	Manufacturer
WRDA	Construction Products Division W. R. Grace & Co., Cambridge, MA
WRDA w/HYCOL	Construction Products Division W. R. Grace & Co., Cambridge, MA
Pozzolith 200 N	Master Builders, Cleveland, OH

None of the recommended products met all of the specified requirements of an AASHTO M194 Type A admixture. The products did substantially increase the compressive strength of the test mixes at all ages. Two of the products; WRDA and WRDA w/HYCOL have performed satisfactorily, in the field, for one or more construction seasons.

Several of the remaining products; FX32 RA, FX32D, FX32, Sikament, and Mighty 150 are new materials classified as super water reducers, super plastcizers or catalytic agents. The test results obtained in the laboratory with these products greatly exceeded AASHTO requirements for strength and water content. However, the freeze-thaw durability of most of these products was very poor compared to the reference concrete when tested in accordance with VT AOT MD #4 using 2" cubes. Further evaluation of these products is recommended prior to approving them for general use.

Plastocrete 160 is not presently marketed in Vermont and this subdivision has no experience using it in the field. It is recommended the use of this product be permitted on a trial basis, if requested. This would provide the necessary experience and data for determining final acceptance or rejection.

Pozzolith 122N contains calcium chloride, and although it has apparently performed satisfactorily in the field, is not recommended for approval at this time.

Summary

Following is a summary of the products recommended by the Structural Concrete Sub-division for inclusion on the List of Approved Materials.

Item 725.04 - Liquid Membrane Forming Compounds None

Item 725.05 - Air Entraining Admixtures

Product Name

Darex AEA

MBAE 10

Manufacturer

Construction Products Division W.R. Grace & Co., Cambridge, MA Master Builders, Cleveland, OH

Item 725.06 - Retarding Admixtures

Product Name

Daratard

Daratard HC

Daratard 17

Pozzolith 100 XR MBHC MBL 84 Plastiment

Manufacturer

Construction Products Division W.R. Grace & Co., Cambridge, MA Construction Products Division W.R. Grace & Co., Cambridge, MA Construction Products Division W.R. Grace & Co., Cambridge, MA Master Builders, Cleveland, OH Master Builders, Cleveland, OH Master Builders, Cleveland, OH Sika Chemical Corp., Passaic, NJ

Item 725.07 - Latex Admixtures

Product Name

Dow Concrete Modifier "A"

*Dylex Latex 1186 *Thermoflex 8002 *Deco-Rez 4776

Manufacturer

Dow Chemical, U.S.A. Midland, MI Tex-Crete, Inc., Gurnee, IL Thermoflex, Inc., Louisville, KY General Polymers Corp. Cincinatti, OH

*Approved for Category II projects only.

Item 725.08 - Silicone Admixtures

Product Name

Z6020 Silane

Manufacturer

Dow Corning Corp. Midland, MI

Item 725.09 - Water Reducing Admixtures

Product Name	Manufacturer
WRDA	Construction Products Division W. R. Grace & Co., Cambridge, MA
WRDA w/Hycol	Construction Products Division W. R. Grace & Co., Cambridge, MA
Pozzolith 200N	Master Builders, Cleveland, OH

Item 725.10 - Water Reducing and Retarding Admixtures None