RETARDERS - FINAL REPORT

COMPLIANCE TESTING

REPORT R72-9

December 1972

VERMONT DEPARTMENT OF HIGHWAYS

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INTRODUCTION

This series of retarder tests were conducted for the purpose of determining if the effects of various retarding admixtures on locally produced concrete were in conformance with the 1972 Vermont Department of Highways specifications. The admixture brands tested represent those most commonly used by the ready-mix industry in Vermont.

This program was conducted according to modified AASHO specifications and does not necessarily reflect retardation performance under field conditions. The specifications state that retarding admixtures must conform to the requirements of AASHO M194 for 7 day and 28 day compressive and flexural strengths and time of setting. The test results will be compared to the requirements of AASHO M194, Type B, "Retarding Admixtures".

Every effort was made toward following the recommendations set forth in Interim Report No. 1 "Investigation of Retarding Admixtures for Portland Cement Concrete" (Vt. Dept. of Hwys., Research Report 70-3).

It is intended that the results of this investigation will determine the acceptability of the products for their inclusion on a list of approved materials.

ABSTRACT

Tests on six retarding admixtures were conducted to determine if their effects on the concrete's properties were in conformance with the 1972 Vermont Department of Highways specifications. The admixture brands tested represent those most commonly used by the ready-mix industry in Vermont. Test results confirm the manufacturers claims of acceptability although manufacturers suggested dosages will require adjustments in order to insure that retarding requirements are met.

MATERIALS

Class A (6½ sacks/cy) concrete was used throughout this investigation. All batches contained the same quantities of coarse and fine aggregates and cement.

The aggregates used were produced by Lebanon Crushed Stone Inc., West Lebanon, New Hampshire.

The cement used in all batches was Type I as furnished by the Glens Falls Portland Cement Company, Glens Falls, New York.

Hercules Powder Company, Wilmington, Delaware manufactured the NVX (air entraining admixture) which was used in sufficient quantity to obtain the desired air content.

The retarders tested in this program represent three general chemical types: lignosulfonic acids, hydroxylated carboxylic acids, and carbohydrates. Samples were supplied by the manufacturers at the request of the Materials Division. Those companies participating were:

W. R. Grace & Co.	-	Cambridge, Massachusetts
Sika Chemical Co.	-	Passaic, New Jersey
Master Builders	-	Cleveland, Ohio

Following is listed the test number and product name.

Test No. 1. - Plastiment, Sika Chemical Co.

Test No. 2. - MCHC, Master Builders

Test No. 3. - Pozzolith 84, Master Builders

Test No. 4. - Pozzolith 100XR, Master Builders

Test No. 5. - Daratard, W. R. Grace & Co.

Test No. 6. - Daratard HC, W. R. Grace & Co.

The products listed above shall be referred to hereinafter by test number.

PROCEDURES

The procedures used in mixing throughout this investigation followed as closely as possible that which is required by AASHO T-126 and every effort was made in controlling uniformity of detail.

The batches were mixed in a Lancaster mixer after which the following tests were performed; unit weight and yield, slump, air content and penetration resistance. Three compressive strength specimens per batch were cast in 6" x 12" treated paper molds. These specimens were tested at ages 3, 7, and 28 days.

Test beams for flexural strengths were not made.

Three batches of retarded concrete were compared with three batches of reference or non-retarded concrete for each test as required in AASHO M-194, et al.

Two series of tests designated as Part A and Part B, were conducted; each series permitting the investigation of three brands of retarders.

RESULTS

Consistency

All batches of concrete used were within the 2" to 3" slump range required in AASHO specifications.

Air Content

Air content tests were conducted on every batch using a "White" pressure meter. Efforts were made to minimize variations, with all results ranging between 4.8% to 6.0%.

Water Content

The effect of retarding admixtures on the water content is not a requirement of AASHO M-194, Type B. The water contents were measured however, and are included in this report. Only two of the retarders actually reduced the amount of water required while the others increased the quantity of water required for uniform consistancy as much as 2½%. See Figure I.

Retardation (Penetration Resistance)

The retarding admixtures were added in quantities which were expected to produce an increase in setting time of 1 to 3½ hours. Only retarder #5 did not meet this requirement. This retarder did meet strength requirements however, and only minor adjustments in the dosage rate would be necessary to achieve the desired delay in setting time.

The information relative to setting time for each admixture may be seen in Figure 2. The time of set curves (Figures 3A, 3B) are plotted from the results of the penetration resistance tests.

Compressive Strengths

AASHO M-194-Type B, which has been adopted in part by the Vermont Department of Highways, states that concrete containing a retarding admixture must develop a compressive strength of not less than 90 percent of a similar concrete containing no admixture.

Compressive Strengths - cont'd

The admixtures tested met this requirement and in every case their use resulted in an increase in compressive strength which ranged from one to twenty percent. Figures 4A and 4B graphically show the average compressive strengths of retarded concretes when compared with similarly non-retarded concretes while Figure 4C shows the average percentage increase.

SUMMARY & CONCLUSIONS

1. All retarding admixtures tested in this report should be listed as approved. Note that this approval is based on laboratory tests and future field use should be carefully monitored.

   Dosages as encountered under field conditions have been examined in (Vt. Dept. of Hwys., Research Report 72-7) "Retarders - Influence of Variable Quantities".

2. Air content of the plastic concrete was most affected by the lignosulfonate retarders (#3 & #5). Thus, when extended retardation is desired, the use of this chemical should be discouraged.

3. Recommendations set forth in (Vt. Dept. of Hwys., Research Report 70-3) "Investigation of Retarding Admixtures for Portland Cement Concrete" were followed with more conclusive results.

4. In every case, the use of a retarding admixture resulted in an increase in compressive strength.

RECOMMENDATIONS

Further testing of retarding admixtures should be directed toward unfamiliar products or specific problem areas in the field. The testing for other properties such as bleeding, bond, durability, etc. should continue as availability of new equipment allows.

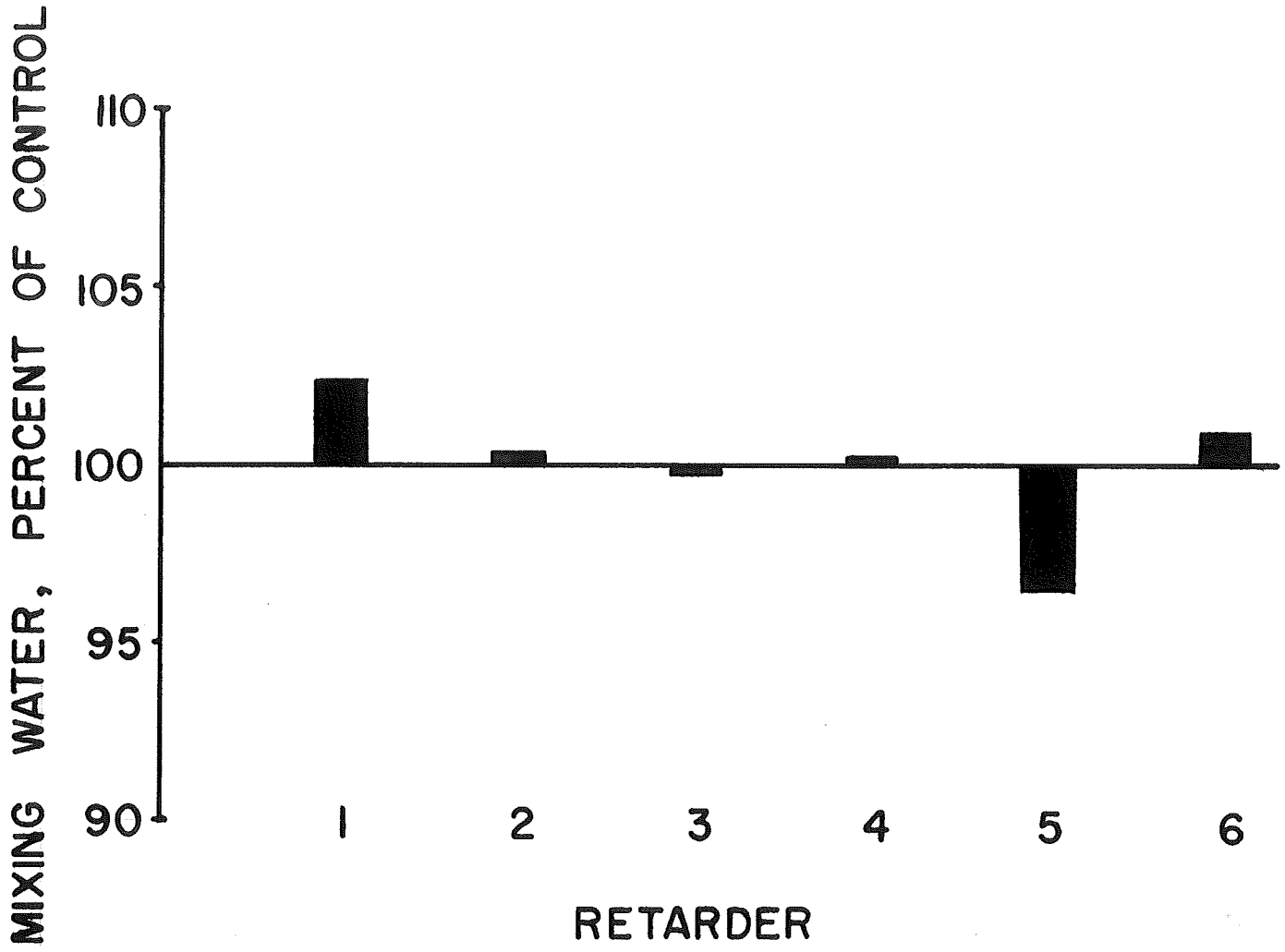

FIGURE 1 WATER CONTENT

AVERAGE PERCENTAGE OF VARIATION DUE TO RETARDER

TEST NUMBER	ADDITION RATE OZ / SK	INITIAL SET 500 PSI		FINAL SET 4000 PSI	
		INCREASE IN HOURS	INCREASE PERCENT	INCREASE IN HOURS	INCREASE PERCENT
1	$2\frac{1}{2}$	1.7	29.8	1.6	19.9
2	$2\frac{1}{2}$	1.0	17.9	0.9	12.1
3	$8\frac{1}{2}$	1.4	12.0	1.0	16.6
4	3	3.0	52.3	3.0	38.4
5	$8\frac{1}{2}$	0.7	12.4	1.9	24.4
6	$2\frac{1}{2}$	1.7	29.4	1.6	20.0

FIGURE 11

INCREASED SETTING TIME OF CONCRETE MIXTURES

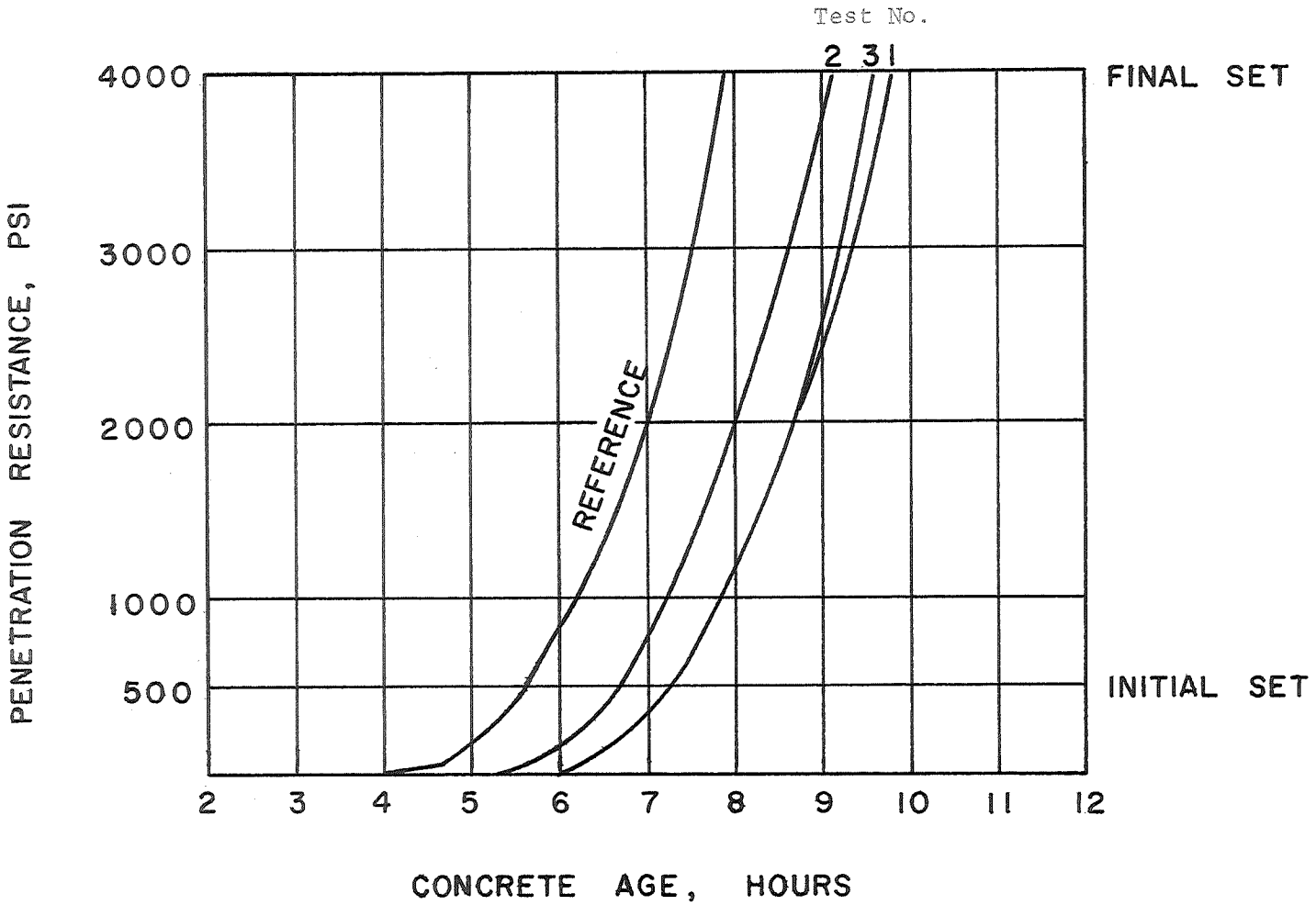

FIGURE III-A TIME OF SET CURVE (PART A)

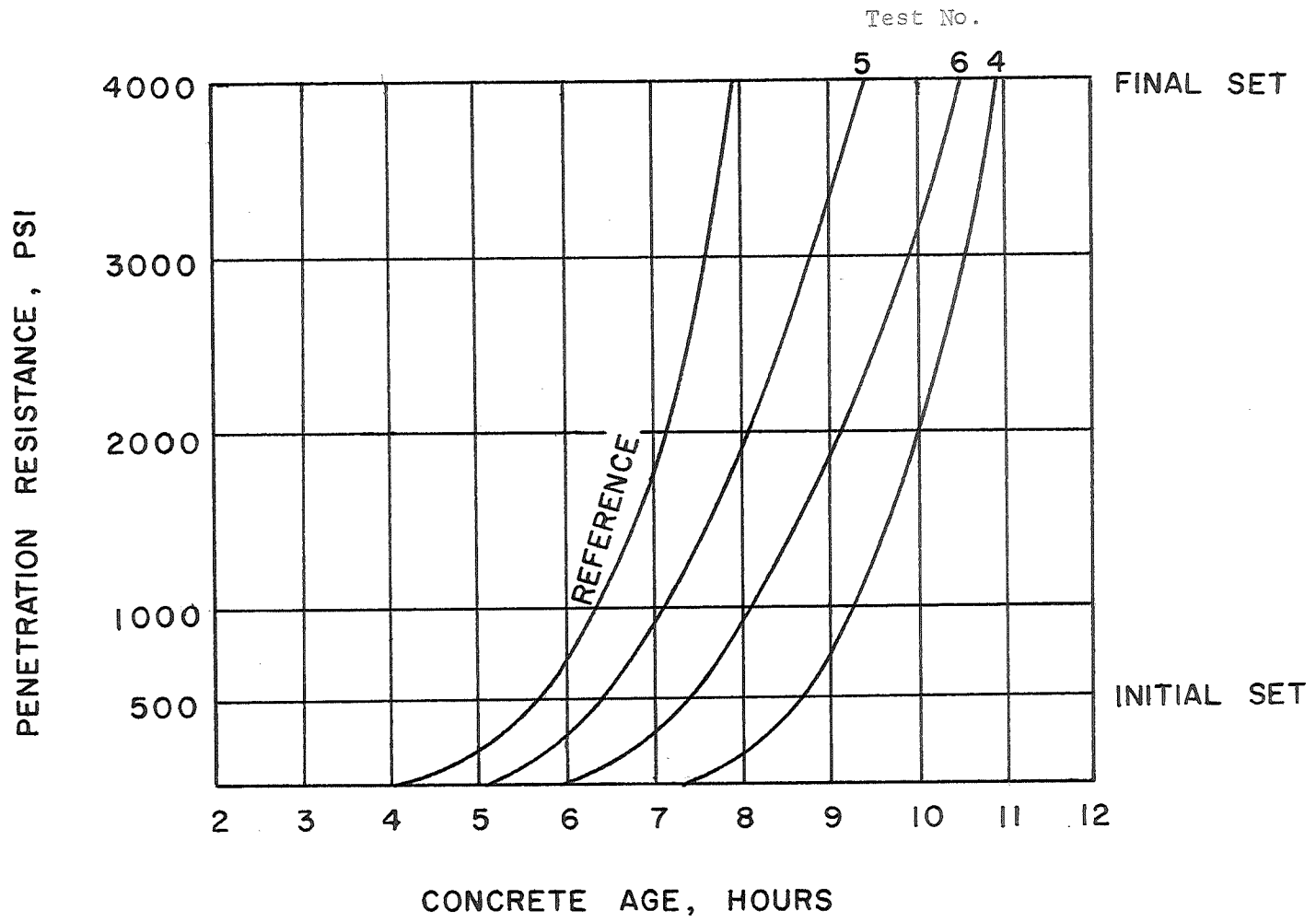

FIGURE III-B TIME OF SET CURVE (PART B)

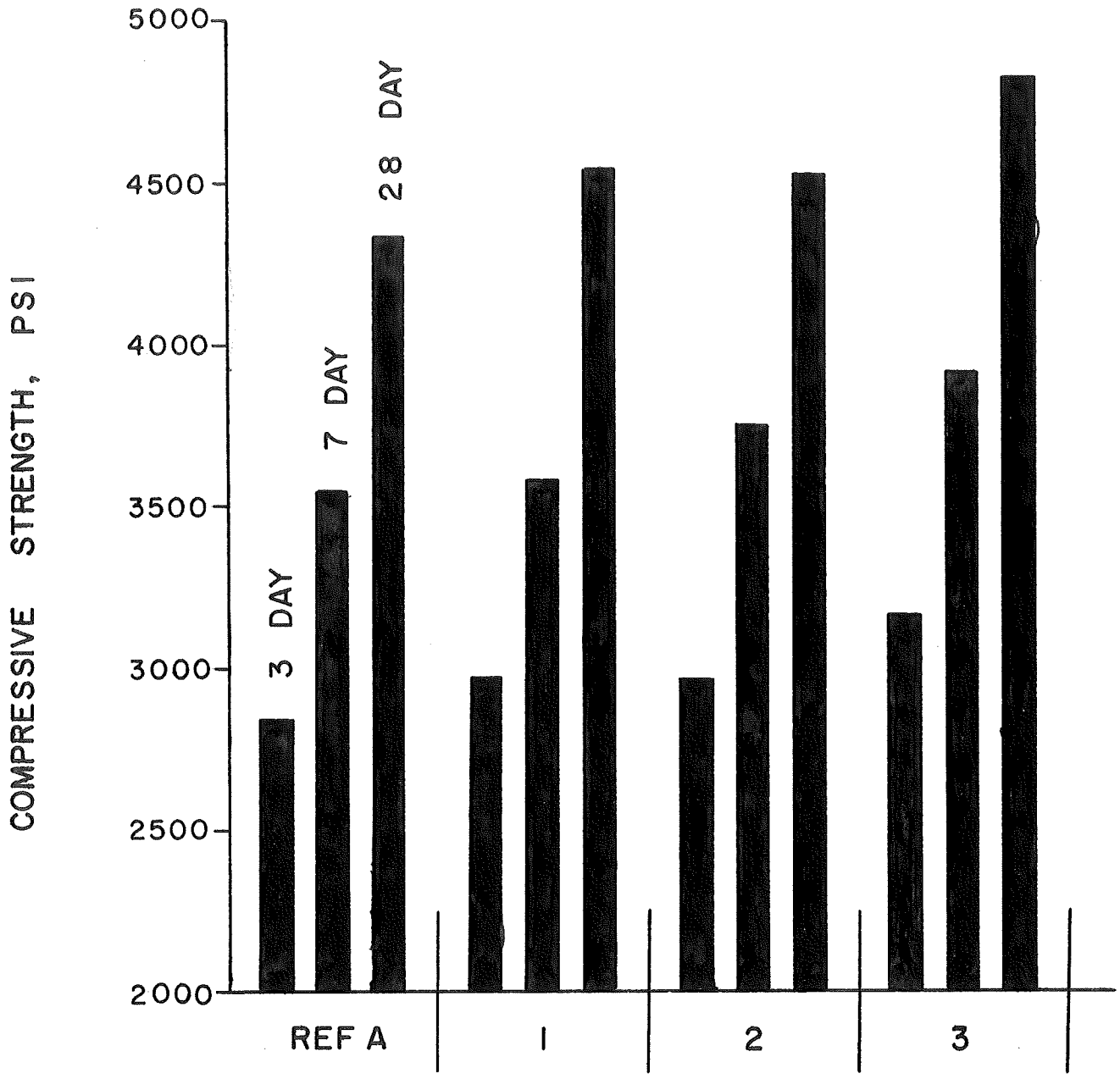

FIGURE IV-A COMPRESSIVE STRENGTH TESTS

PART A

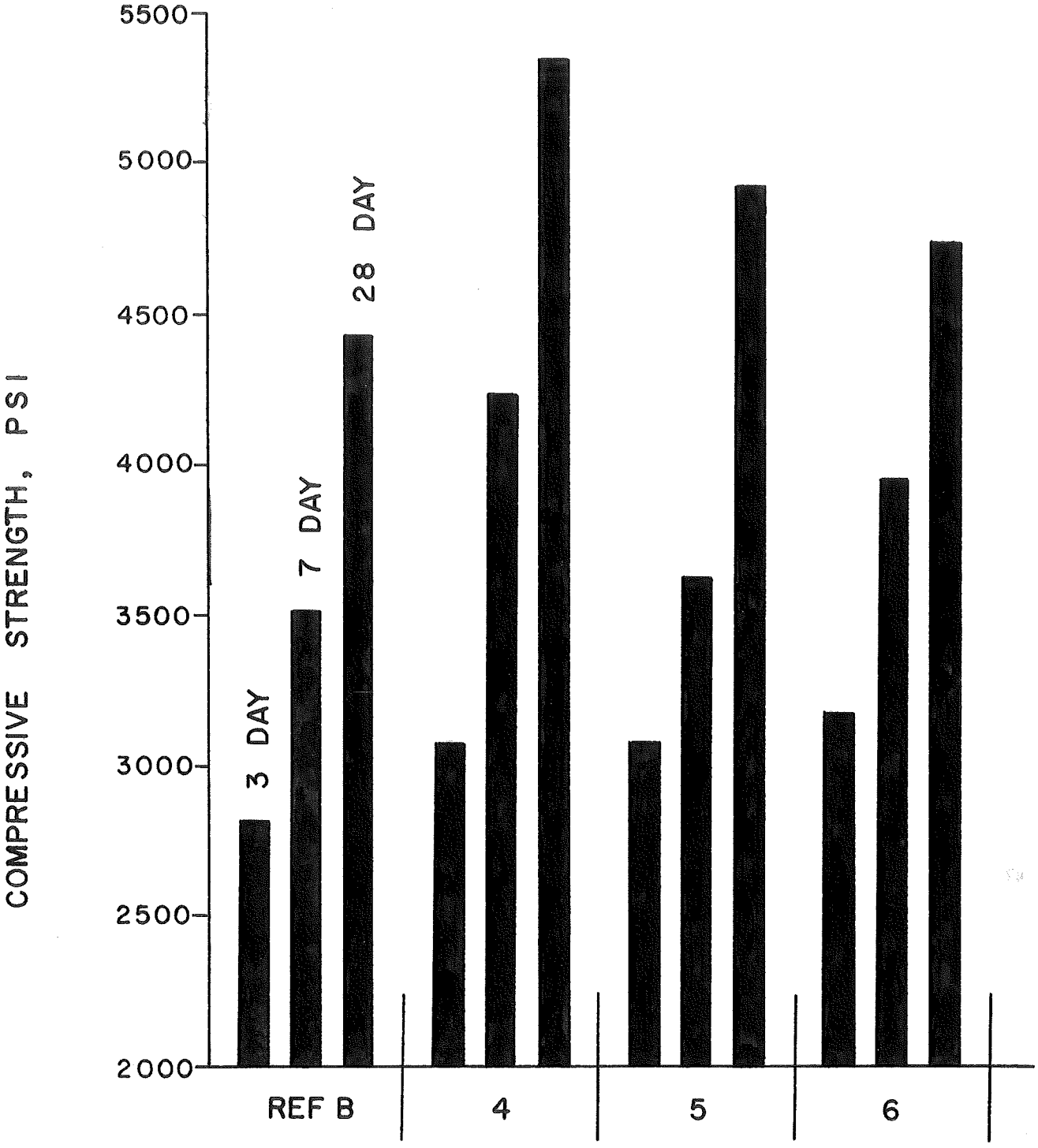

FIGURE IV-B COMPRESSIVE STRENGTH TESTS

PART B

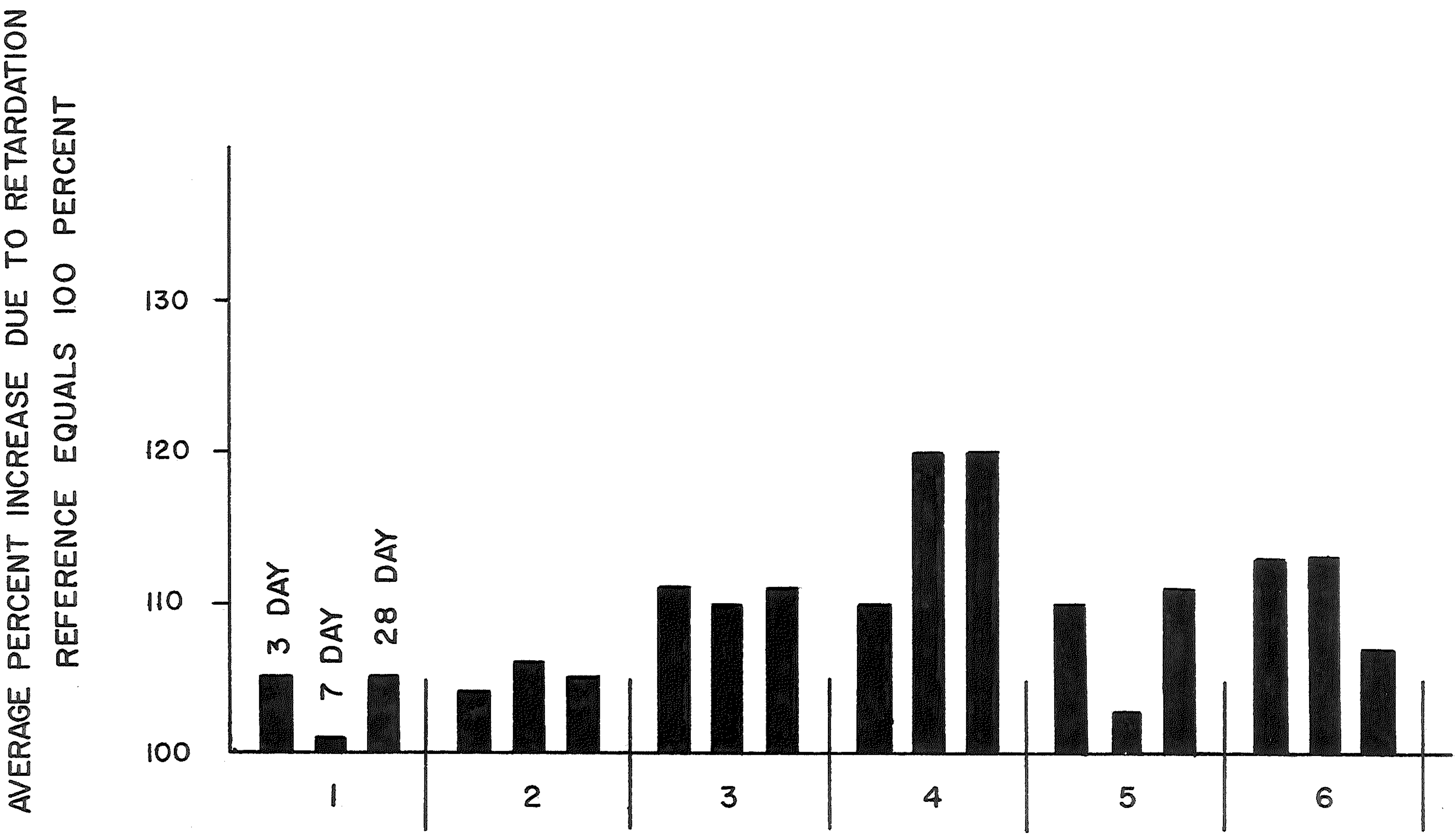

FIGURE IV-C AVERAGE INCREASE IN STRENGTH DUE TO RETARDER

Addendum #1
April, 1976

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Product: Daratard 17 - Retarding Admixture

Manufacturer: Construction Products Division - W. R. Grace & Co.
Cambridge, Massachusetts

Specification: AASHTO M 194-74, Chemical Admixtures for Concrete - Type B

The retarding admixture, Daratard 17, has been tested in accordance with the above specification for time of set and compressive strength. It is recommended for inclusion on the "List of Materials with Advanced Certification" based upon the following results:

Type of Test	Reference	Daratard 17	AASHTO or Vermont Specifications
Slump (inches)	3	2.7	
Air Content (percent)			
Pressure	5.2	5.2	
Chace	5.5	5.1	
Temperature (°F)	75	73	73 ± 3
Density (pcf)	144.27	144.74	---
Mix Yield (cu. ft.)	27.29	27.12	---
Water Content (percent of reference)		95.7	---
Compressive strength (psi)			
3 days	3003	3451	
percent of reference		115	90 min.
7 days	3366	3949	
percent of reference		117	90 min.
28 days	3988	4527	
percent of refrence		114	90 min.
Time of setting (hours)			
Initial	5.31	8.15	
Deviation from reference		+ 2.84	+ 1.00 hr. to + 3.00 hr.
Final	6.78	9.68	
Deviation from reference		+ 2.90	+ 3.50 hr. max.

bas
April 9, 1976

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