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Committee C09 on Concrete and Concrete Aggregates
Subcommittee C09.67 on Resistance to the Environment

Research Report RR #C09-1017

Inter-Laboratory Study to Establish Precision Statements for ASTM C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing

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Committee C09 on Concrete and Concrete Aggregates

RR. C09:
INTERLABORATORY TEST STUDY OF THE PRECISION OF THE LENGTH CHANGE TEST USED IN C666 - *RESISTANCE OF CONCRETE TO RAPID FREEZING AND THAWING* , October 1996

INTRODUCTION

This study was conducted by the Michigan Department of Transportation to determine the within-laboratory precision of the length change method of determining freeze-thaw resistance of beams subjected to rapid freezing and thawing. All of the testing was performed at the Materials and Technology Division of the Michigan Department of Transportation.

TEST METHOD

The test procedure used was in general accordance with C666. The actual procedure use is covered in Michigan Test Method 115 which can be found in Appendix A of this report. The only real variation is that the aggregates were vacuum saturated before being incorporated into the concrete.

PARTICIPATING LABORATORIES

This research study was conducted entirely within the facilities of the Michigan Department of Transportation so there are no outside participating laboratories. To produce variation in the mixes used. coarse aggregates from four different sources were used in the concrete. The aggregate represented materials with different levels of durability. The four sources chosen were:

Wallace Stone - Source 32-4	medium durability
Universal #1 - Source 34-78	low durability
Michigan Lime & Chemical - Source 71-3	high durability
Parker Gravel - Source 41-138	medium durability

RESEARCH PROCEDURE

Nine batches of concrete were mixed on different days for each of the four different aggregates. Three freeze-thaw beams were molded from each batch of concrete. for a total of 27 beams for each aggregate type. These beams were moist cured for 14 days before being placed in the freeze-thaw chamber. All freeze-thaw testing was performed on a Webber T1 apparatus.

Length change measurements were made on the beams every cycles. The final reported expansion was based on total expansion when the specimens reached 300 cycles of freezing and thawing or when the total expansion reached 0.100%. The calculations report the result as "percent expansion per 100 cycles ". Complete data on mix designs used in this research and the expansion results are given in Appendix B.

ANALYSIS OF RESULTS

Several different approaches were used in analyzing the expansion results obtained from each aggregate type. It was finally decided that all 27 expansion results obtained from the multiple mixes using each aggregate type would be considered as 27 tests on a single beam. These results have been tabulated in Appendix C. I should be noted that two of the expansion results from aggregate source 41-138 were discarded as outliers in accordance with procedures in E 178. The mean. standard deviation, and coefficient of variation were determined for the set of data representing the mixes for each of the four aggregate sources. The results of this statistical analysis appear in Table 1.

Table 1: Results of Statistical Analysis of Expansion Results

Source	71-3	32-4	41-138	34-78
Mean	.016	.040	.049	.104
Std. Deviation	.009	.006	.015	.031
Coef. of Variation	56.3	15.0	30.6	29.3

DETERMINATION OF WITHIN-LABORATORY PRECISION

Since the standard deviations in Table 1 are different for each different rock type, this statistical parameter cannot be used for the precision statement. The coefficient of variation is similar for two sources (41-138 and 34-78) but differs for the other two. In Table 1 the standard deviation generally increases as the mean increases although the values for 71-3 and 32-4 reverse this trend. However, both are quite low. If they were reversed, the coefficients of variation for all four rock types would be fairly close (see Table 2).