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Committee C09 on Concrete and Concrete Aggregates
Subcommittee C09.61 on Testing for Strength

Research Report C09-1006

Interlaboratory Study to Establish Precision Statements for ASTM C39/C39M-05, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

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MEMO TO: C09.61 and ASTM C 39 File

FROM: R. Gaynor

SUBJECT: Report for ASTM Files to Document the Source of the Data for the Precision Statement in C39, approved July, 1993.

1.0 The information and text for Main Committee C9 (LB 93-1) is attached. It is based on 1 s% for 6 by 12 in. cylinders made in the laboratory and in field tests.

2.0 Laboratory Test Data

The data are from the CCRL Concrete Reference Sample Program where laboratories mix batches of concrete and mold three 6 x 12 in. cylinders from each batch for test at 7 days age. The CCRL does not enter the three individual results in their database, only the average of the three cylinders. Some years ago, Henry Ahari went to NBS and extracted the range of the three tests and the average strength for 10 of the reference samples. See Table 1 or the Lotus 2.3 file C39-CCRL.WK1 for a summary. At this point, there were apparently 43 to 68 labs in the program. At the present time, there are over 200 labs in the program. At the rate of 4 samples per year, this data covers a period of approximately 5 years.

2.1 The range of the three strengths was multiplied by 0.5907 to estimate the within-sample standard deviation. In Table 1, the average and the root mean square standard deviations are given for each sample. (Why the mean square values are smaller than the average is a mystery that I will not try to solve at this point.) The linear regression between standard deviation and average strength is given at the bottom of Table 1. The standard deviation in psi is correlated with average strength with a statistically significant correlation coefficient, M=0.69 and slope of 0.024. When standard deviation is in percent of average strength, the correlation and slope are not significant.

2.2 I don't recall the exact rational for choosing the final value for use in the precision statement, but the values considered would appear to be 1.98 and 2.37 percent. In any case, the difference is small compared to the range of

Harter in C670) will have a very significant effect on the d2s calculated and its proper interpretation. If the distribution of individual values in the 1284 tests represent what one should expect if the lab doing the work is unknown, then the d2s should be approximately 10.7% (9.5%/.8865). On the other hand, if the data is from an "average lab" or a median lab, the expected D2S will be less and closer to the theoretical value given in the precision statement.

3.5 Clearly, this issue could be argued and a more rational explanation developed. Another consideration is that it is generally recognized that compressive strength tests tend to be a log-normal distribution. My experience, without quantitative proof, is that this comes from the tendency for a few relatively gross errors to be made at some point in most strength data sets. With few exceptions, such as reading the testing machine, these errors reduce measured strength. (I rarely make an addition error on my bank account that understates the deposit amount and that could also be true of reading compression machine dials).