

# Technology in Practice

## What, Why & How?



### TIP 20 - Understanding Variability of Test Methods—Precision Statements

*This TIP discusses precision statements in test methods and how this information can be used in practice*

#### WHAT is a Precision Statement?

ASTM International requires test methods that produce a test result to include statements of precision and bias. These are also included in standards published by other organizations. Precision estimates for a test method are important, especially when the test result is used in specifications as limits or tolerances from which the acceptance of the material is determined. It provides information on acceptable difference between two tests performed by the same operator or by two different operators. A reliable test method should have a low variation in the results of tests performed on identical specimens (precision). Users of a test method should review the precision statement to evaluate the inherent uncertainty in the results.

In simple terms, precision refers to the closeness of agreement of repeated test determinations on identical test specimens. It is a measure of the variability of these determinations attributed to the test method. It excludes variability associated with sampling error, the material, or its production process.

As defined in ASTM C670 *Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials*, a test determination is a single measurement obtained from a single test specimen. A test result can be a single determination or the average of two or more determinations depending on how the test method is written or how test results are used. For example, three cylindrical specimens are made from a sample of concrete to measure compressive strength. The strength measured on each cylinder is a test determination. The average of the three determinations is the test result that is compared against acceptance criteria. The variability of test determinations is the fundamental measure of precision. If a test result is the average of two or more determinations, the variability of the test results can be estimated.

An ASTM test method must include statements on **single-operator** and **multilaboratory** precision. These include a measure of variability, expressed in terms of **standard deviation** or **coefficient of variation**; and the **difference limit** (explained later) based on that measure of variability. Single-operator precision is sometimes referred to as **repeatability** and multilaboratory precision as **reproducibility**. required.

A test method has a **bias** if the value of the characteristic measured by the test method is on average larger or smaller than the true value, or the reference value. For most test methods used for cement, aggregates, and concrete, bias cannot be determined because there is no suitable reference material representing the true **value**, or the test method is the only way to measure the characteristic. This is commonly what is stated in the **bias** statement of these ASTM test methods.

The following is an example of a precision statement, expressed in terms of standard deviation, from ASTM C670. In this case, the result of the test method is reported as a percentage and only one determination is required for the test result.