Aggregates

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Statistical procedures to monitor and regulate the quality of aggregates for highway work have been slow in gaining application. There are several reasons: (a) with the exception of grading, the properties of aggregates significant to their performance are not quantitatively determinable by existing test methods; (b) the required level of a significant characteristic (such as hardness, strength, soundness, or freedom from contaminants) depends on application and exposure in ways that are not at present quantitatively measurable; and (c) a clear-cut delegation of responsibility for aggregate performance among the producer, contractor, and highway department has not been defined.

Ironically, the lack of significant test methods for quality has not completely forestalled the use of statistical bases for acceptance. Studies have been and are being made (1) to establish realistic statistical parameters for the conventional aggregate tests such as absorption, specific gravity, abrasion resistance, and soundness. Eventually these should provide the basis for a more realistic enforcement of the disparate specification limits imposed by individual highway departments even though better statistics will not improve the significance of the tests themselves. In other words, by using realistic sampling plans and allowing properly for sampling and testing variations, as well as actual normal variability of the aggregate in responding to a particular test, it will be possible to arrive at enforceable acceptance criteria for control purposes. Ability to discriminate between good and bad sources will not be improved until tests become available that correlate quantitatively with a significant aspect of performance. On the other hand, statistical monitoring of a particular source may lead to improved uniformity by encouraging the use of mining and processing methods that will minimize test variability and the frequency of failure.

It is in the surveillance of gradation for both control and acceptance purposes that statistical concepts are showing greatest promise. As implied earlier, grading is the only significant aggregate property that can routinely be measured with accuracy. Even so, the reliability of sieve analyses is often in question because of sampling errors, aggravated by segregation that occurs during handling and storage.

Recent researches have shown the way to sampling plans and techniques that, coupled with sound statistical methods of interpretation, provide realistic criteria for enforcement of grading limits (2, 3, 4, 5). It has been shown that variance in sieve analyses can be divided into a batch-to-batch component, which relates significantly to performance of the aggregate, and a within-batch component, which reflects combined errors of sampling, testing, and the inherent variability of particle size distributions within a granular material. A proper specification must stipulate a sampling plan that will measure average grading of each lot of aggregate and also indicate the frequency with which batch-size quantities can be expected to lie outside acceptable limits. With a sound sampling plan and the use of proper sampling and testing techniques, the results provide a basis for decisions on acceptance or assessment of penalties. Details are given in other reports (2, 3, 4), and additional explanation and examples are also given in an earlier report (6).

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The statistical acceptance criteria are aimed primarily at assuring satisfactory performance of aggregates in their end use—concrete, bituminous mixtures, base courses, etc. Acceptability at the point of use depends not only on the gradation and uniformity of the aggregate as produced, but also on the amount and methods of handling and storage between the plant and production site. These latter operations are often handled by persons other than the producer, and he has no control over them. For this reason, many aggregate producers are undertaking statistical quality control monitoring at their plants to ensure that the aggregate as furnished to each customer meets his grading requirement. Depending on circumstances, control measures may range from simple attention to handling and storage to involved systems of size separation and reblending to permit "tailoring" gradings to the needs of individual customers.

In summary, sound statistically based methods are available for use in controlling and evaluating the acceptability of aggregate gradation. Statistical data on aggregate tests other than sieve analysis are being accumulated that should eventually permit establishing acceptance criteria on a sound statistical basis (1). Their application should reduce controversies between producers and purchasers and may lead to improved uniformity within sources. No statistical approach can overcome the inability of existing test methods to measure quantitatively the significant performance characteristics of aggregate.

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