New Test Method for Assessing Fine Aggregate

Traditionally, good-quality manufactured sand for use in concrete mixes has been achieved by measuring and chemically treating the deleterious clays within the fines. Leon Bablouzian, Nathan Tregger and Tasha Eagle discuss a new test procedure for quantitatively assessing – and eliminating – clay contamination.

In Australia, as in many other parts of the world, natural sands used in concrete construction are facing rapid depletion. New commercial deposits can be difficult to establish due to multiple environmental and regulatory factors. The reduced availability of natural sand has necessitated greater utilization of fines resulting from the crushing process used to produce coarse aggregate products. These fine materials, often referred to as manufactured sand, are available in abundance and higher utilization is a cornerstone for improving the sustainability of the construction aggregates industry.

Particle size distribution, shape/surface texture and deleterious fines are key features of manufactured sands that control their use in concrete mixes. Recent developments allow a rapid, direct measurement of deleterious clays within the fines, thereby allowing innovative chemical approaches to render them inert. By effectively ‘cleaning up’ manufactured sands through chemical treatment, their use in concrete mixes at significantly elevated levels can be achieved.

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Australian Standards

Fine aggregates in Australia must comply with AS2758.1. In light of this specification, in 2007 Cement Concrete Aggregates Australia (CCAA) made significant efforts to determine the applicability of this standard towards manufactured sands. It recommends several useful tests including sand equivalent and methylene blue value. Sand equivalent (SE) is done by shaking fine aggregate in a clear graduated cylinder containing a flocculant and preservative solution. After shaking, the particles are allowed to settle for 20 minutes and the SE is taken as the ratio of the height of the sand column to the height of the sand and flocculated clay multiplied by 100. Higher percentages indicate ‘cleaner’ sand. SE is widely used in the US, New Zealand and Europe to qualify aggregates for use in concrete and asphalt applications. However, the test can give rise to false negatives, whereby sand with low SE values produces concrete with acceptable performance. Conversely, sand with a high SE value can produce concrete with poor performance. The SE test relies on apparent density.
Quality Control

differences between ‘good’ sand and ‘bad’ clay. Although a flocculant is used to encourage separation of fine clay particles, similar-sized fine sand particles can be impacted by the flocculation process. As a result, the settling behaviours and the difference in SE may not be sufficiently differentiated. For these reasons, the correlation of SE values and concrete performance can be suspect.

Methylene blue value (MBV) is a well-established method to determine the presence of clay minerals in aggregates. It involves reacting deleterious clay fines with a blue dye and measuring dye uptake, as a colour change, to estimate clay contamination. Several variations of the test based on an endpoint titration technique can be found in the literature. This technique commonly requires a laborious sieving procedure to ~75 micron, a slow titration process and visual determination of a blue ‘halo’ on filter paper that is operator-dependent. Despite these shortcomings, the test directly measures clay contamination and the results can be very useful in predicting concrete performance.

Improved MBV test

A recent improvement on the standard MBV test addresses the disadvantages of the titration method. The new method uses a colorimeter, a device that measures the absorption of a given solution at a specific light wavelength.

The colorimeter removes the human interpretation of the blue halo and significantly improves the reproducibility of the results. An additional benefit is that the entire sand sample can be used, not just the 75-micron fraction. The new test takes around 10 minutes to complete, thus providing a quick and reliable MBV test that can easily be measured in the field as well as in the laboratory. The equipment and testing sequence is shown in figures 1a to 1e.

Compared with the standard MBV tests, such as AASHTO T330-07, ISSA 145 or EN 933-9, the improved MBV test provides an excellent correlation. Figure 2 shows an example correlating the new test and EN 933-9 for 26 field-obtained sands from around the world.

From the MBV, a simple conversion can calculate an equivalent clay amount based on a widely known deleterious clay, sodium montmorillonite (Na-Mont). This provides a unit of measure that is applicable to a wide range of clay systems.

Summary

This improved MBV test is increasingly being used in Australia to determine equivalent clay contents of both natural and manufactured sands, providing a rapid and accurate quality-control tool to determine the variability of aggregate contamination.

With knowledge of concrete mix performance, aggregate clay contamination can be an important predictor of concrete behaviour and provides both aggregate and concrete producers with the flexibility to increase fines utilization.

Conversely, the improved MBV test also identifies situations where high levels of clay contamination preclude the increased use of fines. For such situations, Grace have recently developed and launched a new line of chemical solutions designed to limit the negative impact of clay in concrete and further enhance the ability to increase fines use. These products are being sold under the trade name Clarena. For further information visit: www.graceconstruction.com

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REFERENCES


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