

# Research Spotlight

## Project Information

**REPORT NAME:** Feasibility of Digital Imaging to Characterize Earth Materials

**START DATE:** October 2010

**REPORT DATE:** June 2012

**RESEARCH REPORT NUMBER:**  
RC-1557

**TOTAL COST:** \$129,707

**COST SHARING:** 20% MDOT, 80% FHWA through the SPR, Part II, Program

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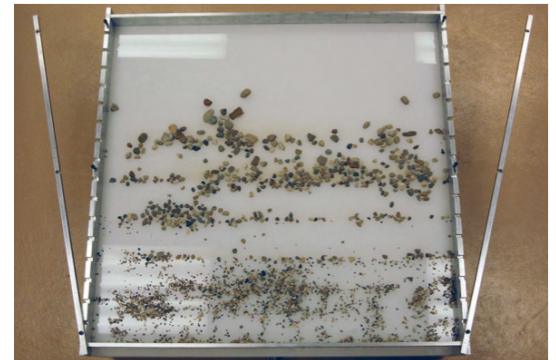
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## Cameras instead of sieves for aggregate characterization

Michigan researchers explored the use of cameras and software that may eventually replace the use of screen sieves in sizing and assessing crushed aggregate for pavement construction. This research explored approaches to imaging aggregate as a way to move on from a dusty, slow, energy-intensive process.



Sedimaging (left) statistically calculates aggregate particle sizes from camera images of samples that have been settled by water. The tilting, backlit Translucent Segregation Table process (right) uses images to calculate the size of each particle on the table.

### Problem

Engineers typically measure the size distribution of aggregate with a sieve test—they sift aggregate samples through a series of screens of increasingly fine mesh to separate aggregate by grain size. The process takes about an hour with a typical sample, generates dust and noise, uses a significant amount of electricity to shake the aggregate and regularly wears out sieves that cost hundreds of dollars to replace.

The method, however, is the industry standard. It provides results that work well in designing pavements.

The accessibility of sophisticated imaging software and increasingly sensitive camera equipment suggests there will soon be faster and more cost-effective ways to characterize aggregate. MDOT wanted to investigate digital imaging of aggregate to keep ahead of the technological curve.

*“The models used to develop correlations between digital imaging methods and sieving need improving so we’re confident the two methods are statistically equivalent. Imaging could be very useful in the future.”*

**Richard Endres, P.E.**  
Project Manager

## Approach

Researchers conducted a literature review and consulted with MDOT on aggregate samples and needs. Investigators then reviewed the available camera equipment and assessed software development capabilities. The group identified potential approaches, appropriate aggregate samples and evaluation procedures.

## Research

Researchers developed software and hardware for two methods of imaging aggregate. One method focused on small aggregates, from fine sand up to 2 mm-size rock (No. 10 sieve). The other method treated particles larger than 2 mm. Both methods used consumer-grade, 16.2-mega-pixel cameras remotely operated by a computer running commercial software and a user-friendly operator interface created by researchers.

Sedimaging, the method for smaller aggregates, uses a 7-foot-tall square tube that segregates the sample with water. The camera then calculates particle size distribution statistically from 5,000 data points, taking 10 minutes to perform (or 15 minutes, if the percentage of fines is required).

The tilting, backlit Translucent Segregation Table (TST) for larger aggregates employs a 3-foot-by-3-foot backlit platform fitted with bars of graduating height above the surface of the table. Operators place a sample on the end of the table with the highest bar, then tilt the table, using gravity to sort aggregate by size. Rapping the table with a rubber-headed hammer spreads aggregate sufficiently to evaluate individual pieces. The TST requires 10 minutes to run an aggregate assessment.

## Results

Initial findings did not achieve accuracy suitable for replacing sieving—for now.

Many samples included aggregates both smaller and larger than 2 mm; for these samples, both methods can be run. Sedimaging showed little deviation from sieving results for fine aggregate, and overall results correlated well with sieving except for “% passing No. 30 sieve.” TST results, however, differed more significantly from sieving results, though researchers believe this was because the TST accounted for only two dimensions of each particle. An unexpected and welcome benefit of the TST was that it determined not just each individual piece’s size, but also its aspect ratio, an important design input now determined by painstaking use of calipers on a very small sample size.

Researchers concluded that aggregate imaging was not quite ready to replace sieving for use in pavement design. It was, however, judged sensitive enough for aggregate producers to use for quality control. Investigators believe imaging problems can be corrected. An algorithm for TST’s third (vertical) dimension will improve results, and MDOT continues to run tests with the imaging hardware at an MDOT laboratory.

## Value

Characterizing aggregate with cameras and software may be an imminent technology

to replace sieving. MDOT has a strong start on the use of two imaging methods: sedimaging for fine aggregates and TST for larger aggregates.

Once these methods are fully refined, MDOT will have an aggregate assessment approach that saves a significant amount of time and money, and that puts MDOT on the cutting edge of aggregate design technology.

## Research Administration

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### This final report is available online at

[www.michigan.gov/mdot/0,4616,7-151-9622\\_11045\\_24249-280828--,00.html](http://www.michigan.gov/mdot/0,4616,7-151-9622_11045_24249-280828--,00.html).

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