HORIBA Scientific

Application Note

Quantifying Building Materials

AN207

Any material used for construction purposes can be called building material. These materials are used in multiple facets of construction including carpentry, roofing, structural reinforcement, insulation, and plumbing. The size and shape of the raw materials used impact the quality and performance of the final product and, therefore, require analysis to quantify these physical properties. This application note describes how the CAMSIZER XT has been successfully implemented to determine the size and shape of several building materials.

Introduction

Building materials range from naturally occurring substances such as rock, clay, sand, and wood to synthetic polymers and multiple combinations of both (composites). Composite materials are made by combining substances such as wood or sand with cement or plastic.

Particle size of the raw materials used is important for many reasons. The particle size distribution has many effects on the processing of building materials such as:

- Powder flow; a wide distribution or too many fines reduces flow ability
- Segregation; a wide distribution will lead to size segregation
- Suspension rheology; fines or irregularly shaped particles increases viscosity

The effect of oversized particles includes:

- Poor quality of the final product (grains sticking out of the plaster, rough surfaces of tiles, inhomogeneous material may break)
- Changes in the “look and feel” of the final product
- Changes in the flow behavior and other process parameters of the final product
- Blockage of filters or sieves in the production
- Required removal from the production process, and recycling (additional costs and effort)

Oversized particles can also indicate problems in the production process such as holes in a production sieve, bad settings or wear in a crusher or mill, or the presence of impurities/contamination.

Undersized particles create another set of problems such as:

- Changes the “look and feel” of the final product
- Dust (pollution) in the work place
- Filter blockage
- Changes the flow behavior and other process parameters of the final product

Figure 1: The CAMSIZER XT

CAMSIZER XT

The CAMSIZER XT, see Figure 1, provides not only the particle size distribution of the material, but also the shape. This shape information can provide insight into changes that can affect end product performance. In addition to the already mentioned affect on rheology and compaction, irregularly shaped particles have a larger surface area and are therefore more difficult to coat - requiring more adhesive or binder.

The CAMSIZER XT is based on the well-proven CAMSIZER dynamic image analysis system, but is optimized for finer samples (from 1 µm to 3 mm). Both improved optical resolution and new options for material feeding allow for an extended application range. A range of sample presentation devices feed the sample to the measurement zone and provide the desired dispersion energy in order to de-agglomerate the sample without breaking individual particles. The CAMSIZER XT offers the flexible X-Change system: the X-Fall module (free fall mode), which is the most gentle method for the material, the X-Jet module with adjustable pressure and variable nozzle geometry, and the X-Flow module in which particles are dispersed in liquids, optionally by ultrasound.

Measurement time is ~ 1 to 3 min depending on the desired measuring statistics. Reported result parameters include smallest diameter, length, mean diameter, aspect ratio, symmetry, sphericity, and convexity. Results can easily and accurately match historic results from other techniques (sieves, microscopy, etc.) with the appropriate selection of result parameters and automated software features.

Experimental

Most sand used in building materials is analyzed by sieves for particle size distribution.

The CAMSIZER XT can replace the older sieve technique with a quicker, easier to use instrument that provides higher resolution particle size results as well as particle shape information. Figure 2 shows two types of sand from different locations, measured with the CAMSIZER XT. This sand is used as a layer in glass reinforced plastic pipes to increase the stiffness. The reported size parameter is xc min (= particle width). The red curve is slightly bimodal. Sand with a wide size distribution can be more closely packed in the core of the pipe which gives the finished product a higher stability.

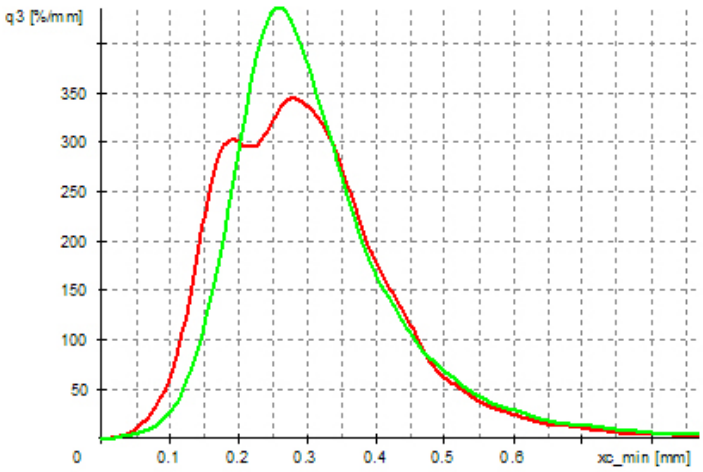

Figure 2: CAMSIZER XT results for sand used in glass reinforced pipes

One sand sample was measured by sieves (black) and by the CAMSIZER XT using two different sampling modules: the X-Fall sampler (green) and the X-Jet sampler (red). The results compare extremely well, proving that CAMSIZER XT can match historic sieve results.

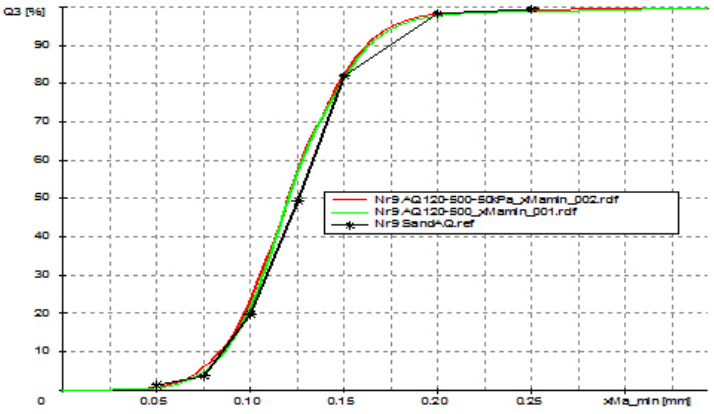

Figure 3: Size results of sand by sieve and CAMSIZER XT free fall and air jet sampler

Limestone is a raw material used in many building products. Figure 4 below shows the particle size distribution as measured on the CAMSIZER XT for a range of limestone grades used in this industry. The X axis shows the Xma min diameter in mm.

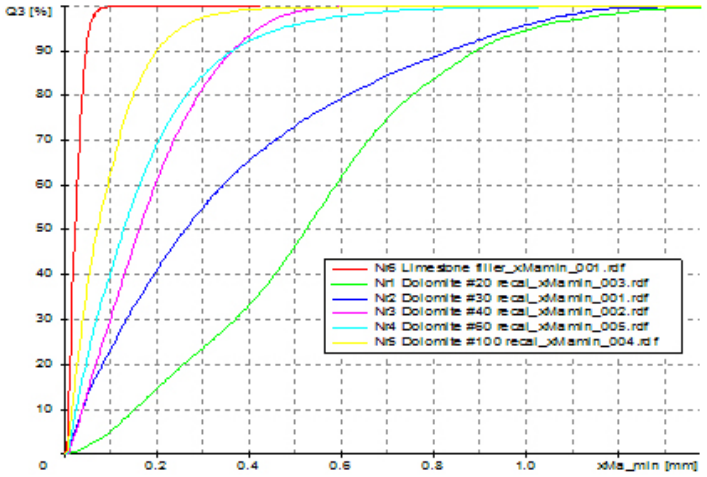

Figure 4: CAMSIZER XT results for six grades of limestone

Figure 5 shows the particle shape distribution results for the same collection of limestone samples. The reported shape parameter is sphericity, defined as:

$$\text{Sphericity} = 4\,p\,A/P2$$

A = Area of the particle projection
P = Perimeter length of the particle projection

The least round sample is Nr6 (red), while the most round sample is Nr4 (light blue).

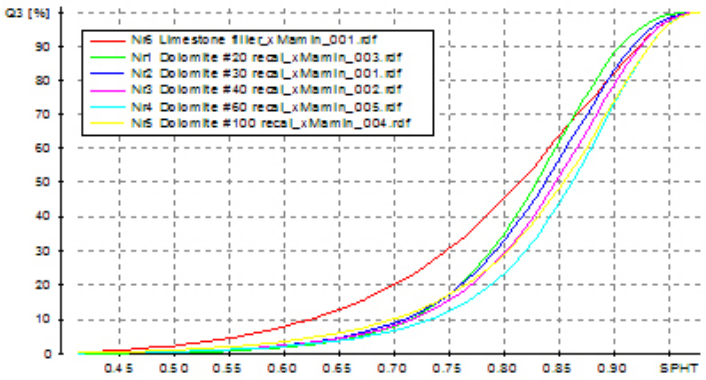

Figure 5 : Sphericity distributions for six grades of limestone

Conclusions

The CAMSIZER XT has been successfully installed at building materials plants around the world. This instrument has replaced sieve analysis providing quick, easy high resolution results while still matching historic sieve data.

Advantages of the CAMSIZER XT include:

- High resolution: more than 3,000 size classes in one measurement
- Faster and more reliable measurements (1 – 3 minutes measuring time)
- Reproducible results, independent from operator
- Wide dynamic range from 1 µm to 3 mm
- Flexible, controlled sample dispersion of both powders and suspensions
- Shape analysis

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