



Particle Analysis of Foundry Sand

CAMSIZER 3D

Sample Information

Sample description

Foundry sand (3 samples)

Sample photos

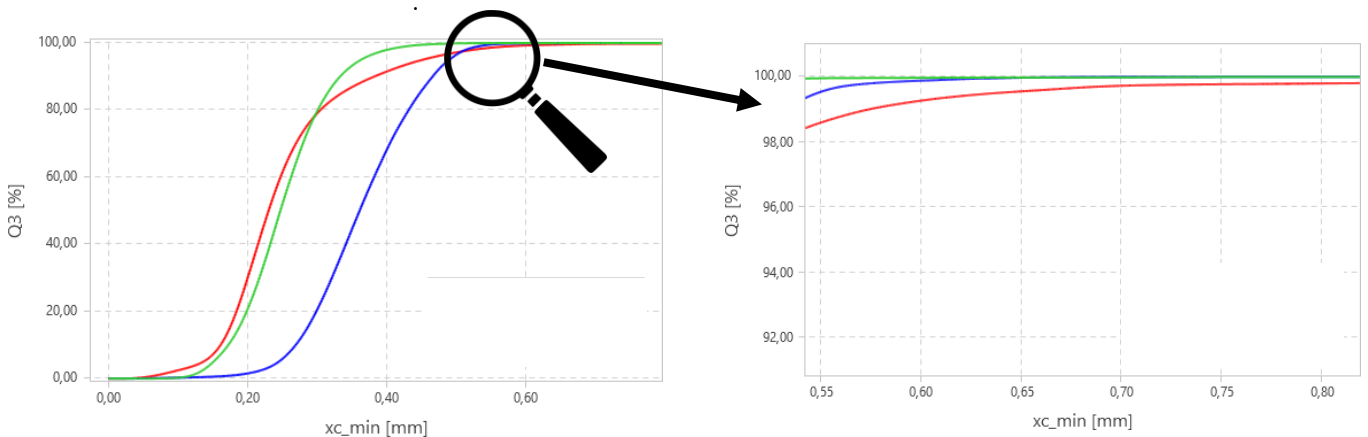


Sample identification

"Sand A" (left)
"200-500" (middle)
"25-5" (right)

General Information

Technology	Dynamic Image Analysis (ISO 13322-2)
Instrument(s)	CAMSIZER 3D
Background	Three sand samples were submitted for analysis. Currently, the materials are characterized with sieve analysis. The aim is to determine which measuring instrument is best suited for analyzing the samples. The results should be comparable with the sieve analysis.
Content	This report provides an analysis of the samples submitted to our laboratory. It contains particle size and shape measurement results obtained by dynamic image analysis and sieve analysis. This report and data can be customized to your specific application or needs. Please contact the laboratory if you have any questions regarding the data or its interpretation.
Summary of results	Since all samples are dry free-flowing bulk materials, the CAMSIZER 3D is suitable for measuring the materials. The analysis time is less than 5 minutes and runs completely automatically after the measurement start. Except for the removal of the sample from the collector box, there is no cleaning effort. The results are very comparable with the sieve analysis and excellently repeatable. The diagram below shows a comparison of the results of the three samples an a cumulative Q3 distribution. The size distributions are between 63 µm and 500 µm. However, sample 25-5 contains some oversize particles up to 1 mm.



Size distribution (left) of all three samples, measured with CAMSIZER 3D. 25-5 (red), 200-500 (blue) and Sand A (green). The right chart shows a magnification of the size range 550 µm –800 µm. it can be seen that sample 25-5 contains oversize particles.

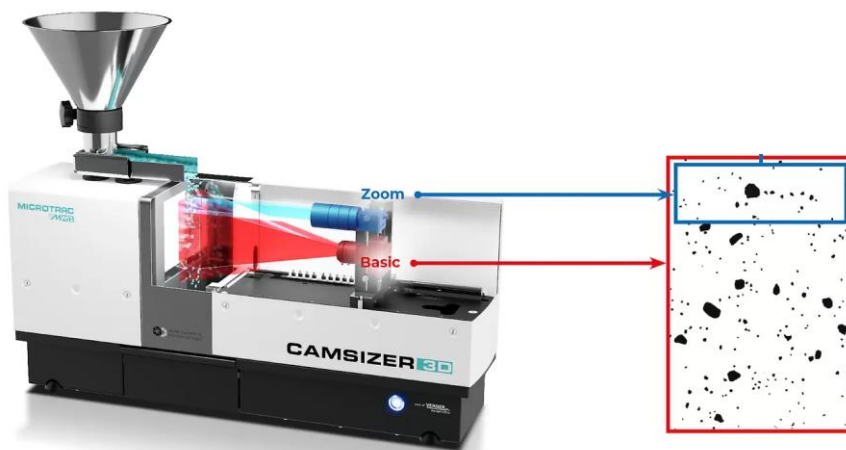
CAMSIZER 3D

The CAMSIZER 3D combines all the advantages of dynamic image analysis (ISO 13322-2) in a completely redesigned measuring system, setting new standards in the characterization of bulk solids.

Unique 3D analysis: thanks to the extended field of view and large droplet spacing, each particle is analyzed up to 20 times and in different orientations, making the actual, three-dimensional particle morphology accessible for analysis. The evaluation of the "3D tracks" also enables a much more meaningful shape analysis than ever before.

Proven 2-camera system: The new ZOOM camera in the CAMSIZER 3D (9 MPx) enables the evaluation of fine particles with high accuracy. In combination with the BASIC camera (5 MPx), this enables a large measuring range from 20 µm to 30 mm. The CAMSIZER 3D is the first choice for the analysis of dry, free-flowing bulk materials in both quality control and research applications.

- Patented 3D analysis with "Particle Tracking"
- Up to 20 images of each particle
- Particle size and shape analysis from 20 µm - 30 mm without hardware adjustment
- Short measurement time of 2-5 minutes
- High sample throughput
- 100% detection of oversize particles
- Excellent compatibility with sieve analysis
- Excellent reproducibility
- Evaluation of > 250 images / s in real time (in 3D mode)
- Powerful, long-life LED light source
- Maintenance free



CAMSIZER 3D with ZOOM camera (blue) and BASIC camera (red).

Sample Preparation and Measurement Conditions

Sample splitting

We used a small riffle divider (lower right on the image) to split the sample volume to 1/2 or 1/4 of the supplied quantity.



Sample preparation

No sample preparation required

Sample quantity

Sand A: approx. 30 g
 200-500: approx. 30 g
 25-5: approx. 60 g
 For sieve analysis, approx. 60 g in all three cases.

Measurement conditions

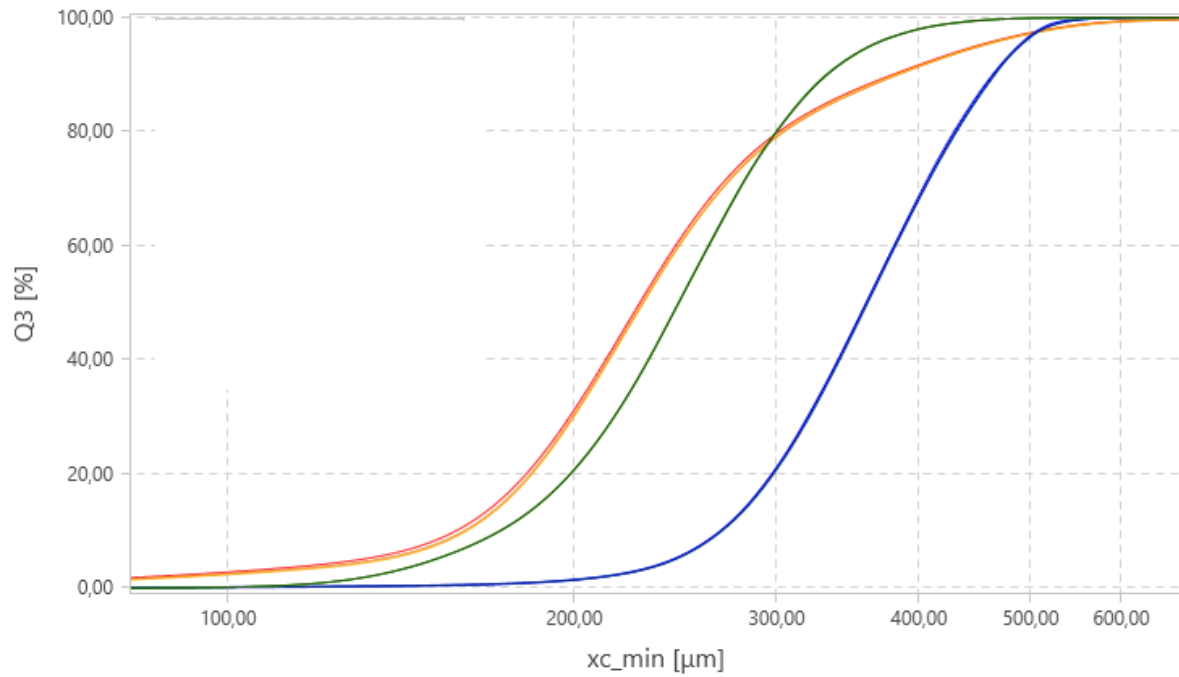
CAMSIZER 3D:

- 60 mm feeder
- No guidance sheet
- Nominal covered area: 0.5 % (samples Sand A and 200-500)
1% (sample 25-5)
- ZOOM camera and BASIC camera
- Measurement in 2D mode. 2D mode is more suitable for sieve correlation than 3D measurement with particle tracking.
- Size definition xc_min (particle width)
- Image acquisition rate: approx. 60 / seconds
- End of measurement: when sample is expired.

Sieve analysis:

- AS200 sieve shaker (Retsch GmbH)
- 10 minutes
- Amplitude 1.3 mm
- 10 s interval
- Sieves [μm]: 63, 90, 125, 180, 250, (280) 355, 500, 710, 1000

Result Overview & Repeatability

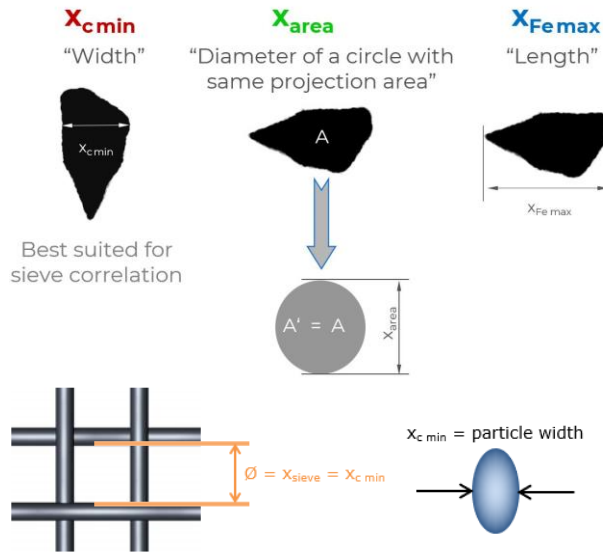


Q3 distributions of all three samples, three consecutive measurements of each sample. The repeatability is excellent. The table below shows the percentiles d10/d50/d90. 25-5 (red colors), 200-500 (blue colors), Sand A (green colors).

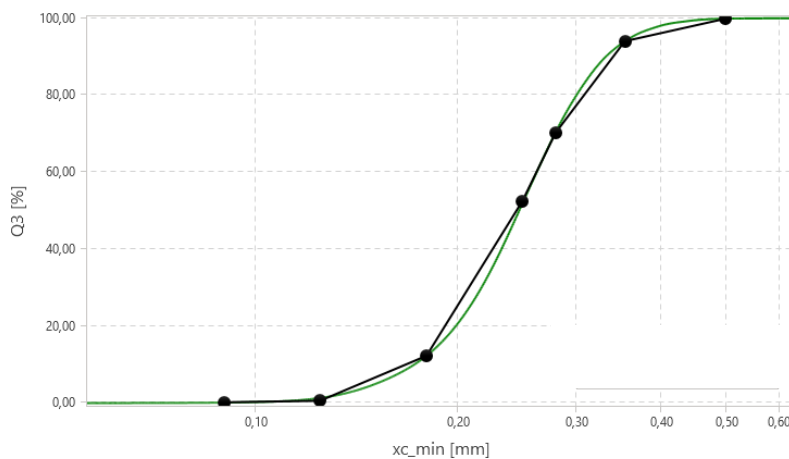
	25-5	25-5	25-5	200-500	200-500	200-500
D10	157.82 µm	160.46 µm	161.23 µm	268.77 µm	268.52 µm	269.45 µm
D50	228.76 µm	229.99 µm	230.36 µm	360.40 µm	360.35 µm	361.47 µm
D90	380.19 µm	384.43 µm	382.62 µm	465.58 µm	464.50 µm	466.69 µm

	Sand A	Sand A	Sand A
D10	172.39 µm	172.58 µm	172.35 µm
D50	247.40 µm	247.21 µm	247.32 µm
D90	333.35 µm	332.71 µm	333.40 µm

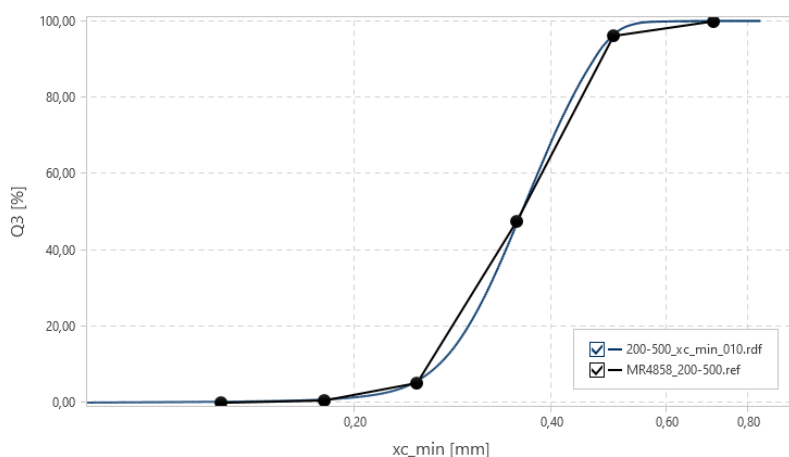
Comparability with Sieve Analysis



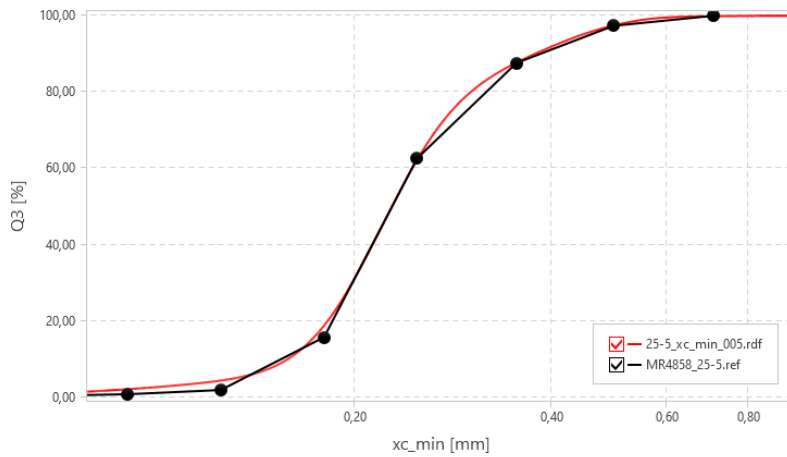
The result of image analysis can be based on particle width (size definition $x_{c\min}$), or particle length (size definition $x_{\text{Fe max}}$), or on the diameter of the area-equivalent circle of the particle projection (x_{area}). $x_{c\min}$ results are comparable with sieve analysis, whereas x_{area} is closer to laser diffraction results. Therefore, both techniques can be matched by CAMSIZER 3D image analysis.



Sand A: CAMSIZER 3D measurement, size definition $x_{c\min}$ (green). with sieve data (black).
 Cumulative distribution Q3



Sample 200-500, CAMSIZER 3D measurement, size definition $x_{c\min}$ (blue). with sieve data (black).
 Cumulative distribution Q3



25-5, CAMSIZER 3D
 measurement, size
 definition xc_min (red).
 with sieve data (black).
 Cumulative distribution Q3

The tables below show a comparison of Q3-values from sieve analysis and CAMSIZER 3D for every sample.

SAND A		
Size	CAMSIZER 3D	Sieve Analysis
63 µm	0.01 %	N/A
90 µm	0.12 %	0.2
125 µm	1.34 %	0.6 %
180 µm	12.35 %	12.3 %
250 µm	51.80 %	52.5 %
280 µm	70.14 %	70.2 %
355 µm	93.90 %	94.0 %
500 µm	99.88 %	99.8 %
710 µm	99.99 %	N/A
1000 µm	100.00 %	N/A

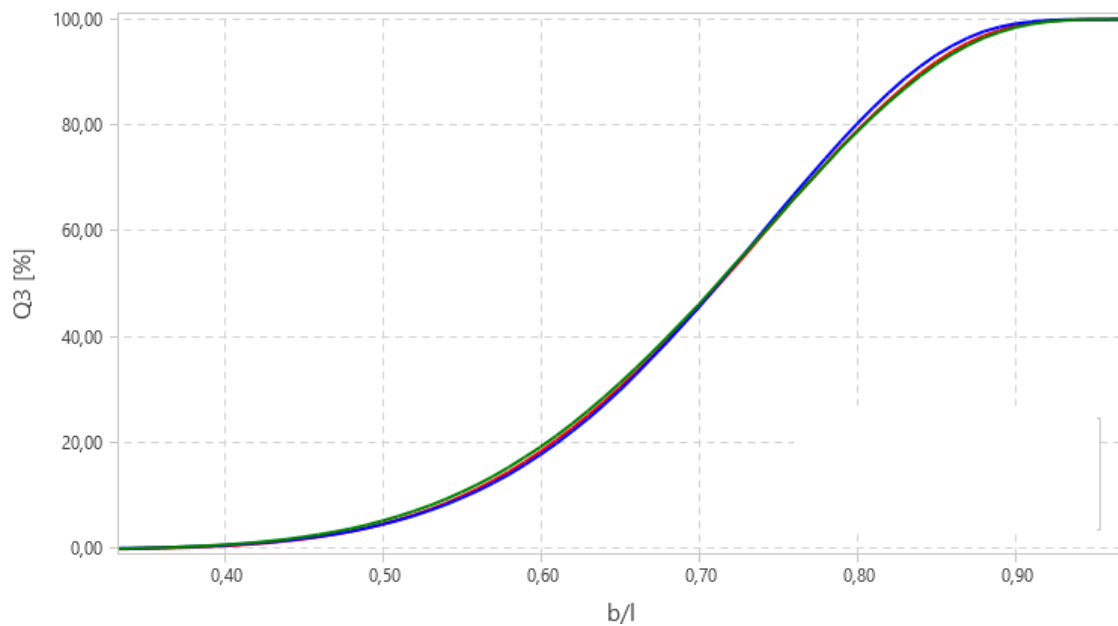
200 - 500		
Size	CAMSIZER 3D	Sieve Analysis
63 µm	0.10 %	N/A
90 µm	0.21 %	N/A
125 µm	0.38 %	0.1 %
180 µm	0.96 %	0.7 %
250 µm	5.81 %	5.3 %
355 µm	46.76 %	47.5 %
500 µm	96.39 %	96.1 %
710 µm	100.00 %	99.9 %
1000 µm	100.00 %	N/A

25-5		
Size	CAMSIZER 3D	Sieve Analysis
63 µm	0.73 %	0.5 %
90 µm	1.94 %	1.0 %
125 µm	3.94 %	2.1 %
180 µm	17.78 %	15.9 %
250 µm	61.29 %	62.6 %
355 µm	87.34 %	87.5 %
500 µm	97.16 %	97.2 %
710 µm	99.74 %	99.8 %
1000 µm	99.87 %	N/A

Shape Analysis

















































































<ul style="list-style-type: none"> Aspect Ratio $\frac{X_{c \min}}{X_{Fe \max}}$	
<ul style="list-style-type: none"> Circularity $\sqrt{\frac{4\pi A}{P^2}}$	<p>P = Perimeter A = Area</p>
<ul style="list-style-type: none"> Symmetry $\frac{1}{2} \left(1 + \min\left(\frac{r_1}{r_2}\right) \right)$	
<ul style="list-style-type: none"> Convexity $\sqrt{\frac{A_{real}}{A_{convex}}}$	
<ul style="list-style-type: none"> Compactness $\frac{\sqrt{\frac{4A}{\pi}}}{X_{Fe \max}}$	

Shape analysis is performed simultaneously with the size measurement. The diagram on the left shows a selection of available shape parameters.

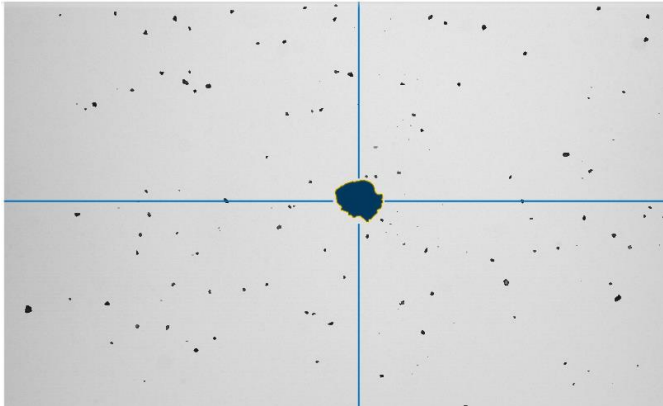


Shape results can be displayed just like size distributions as a cumulative curve. The x-axis shows a shape parameter in this case. Shape characteristics can take values between 0 and 1, where high values always correspond to round, compact, symmetrical or convex particles (e.g. a perfect sphere has sphericity, compactness and aspect ratio of 1). If the cumulative curve runs plots on the left in the diagram, this indicates "irregular particles". The chart below shows a comparison of the aspect ratio for all three samples. The particle shape is very similar for all samples.

Particle Images

 2.61 mm	 1.99 mm	 1.54 mm	 1.52 mm	 1.44 mm	 1.41 mm	 1.36 mm	 1.32 mm	 1.27 mm	 1.24 mm
 1.15 mm	 1.15 mm	 1.11 mm	 1.06 mm	 1.00 mm	 0.99 mm	 0.98 mm	 0.98 mm	 0.96 mm	 0.96 mm
 0.93 mm	 0.93 mm	 0.92 mm	 0.92 mm	 0.92 mm	 0.92 mm	 0.91 mm	 0.91 mm	 0.90 mm	 0.89 mm
 0.89 mm	 0.89 mm	 0.88 mm	 0.88 mm	 0.87 mm	 0.87 mm	 0.87 mm	 0.87 mm	 0.86 mm	 0.86 mm
 0.86 mm	 0.86 mm	 0.86 mm	 0.86 mm	 0.85 mm	 0.85 mm	 0.84 mm	 0.84 mm	 0.84 mm	 0.83 mm
 0.83 mm	 0.83 mm	 0.83 mm	 0.83 mm	 0.83 mm	 0.83 mm	 0.82 mm	 0.82 mm	 0.82 mm	 0.82 mm
 0.82 mm	 0.82 mm	 0.81 mm	 0.81 mm	 0.81 mm	 0.81 mm	 0.81 mm	 0.80 mm	 0.80 mm	 0.80 mm
 0.80 mm	 0.80 mm	 0.80 mm	 0.79 mm	 0.79 mm	 0.79 mm	 0.79 mm	 0.79 mm	 0.79 mm	 0.79 mm

Images may be saved during the measurement for later evaluation. This page shows some images from **sample 25-5**. The size and shape values are displayed next to the particle images. **Sample 25-5** has the oversize particles. The particles are sorted by size in decreasing order. Numbers below images are size (xc_min).



Size characteristics		Shape characteristics	
Parameter	Value 2D	Parameter	Value 2D
x_area	2.84601 mm	b/l	0.78
x_length	2.44323 mm	b/l_rec	0.78
x_length2	2.09052 mm	B/L	0
x_length3	2.60011 mm	B/L_rec	0
x_mesh	3.04353 mm	Circularity (C)	0.68
x_sieve	2.68369 mm	Compactness (Co...	0.65
x_stretch	2.61238 mm	Convexity (Conv_A)	0.97
x_stretch2	2.61238 mm	Ellipse	0.05
xFe_min	2.68369 mm	Sharpness	32.7
xMa_min	2.44323 mm	Sharpness_M	51.0
xMa_min	2.44323 mm	Solidity	0.94
xDP	3.26528 mm	Sphericity	0.77
xEllipse_length	3.22983 mm	Symmetry (Symm)	0.90
xEllipse_width	2.54505 mm	Transparency (Trans)	0.009
xEllipse_thickness	2.54505 mm	Transparency a (Tra...	0
xFe_max	3.34253 mm	Transparency b (Tra...	0.0005
xc_min	2.60811 mm	Particle number	6296796
xc_min	2.60811 mm	Camera	Zoom
xFe_rec	3.28847 mm	Image number	10588
		X position	1.897.0
		Y position	1.055.4

Particles can be found in the images by applying filters. The size and shape data of the highlighted particle are displayed on the right.

CAMSIZER 3D

25.5

General information

Company:
 User: KD
 Result file: 25-5_xc_min_007.rdf
 Task file: MR4858_25-5.afg
 Date/Time: 24.01.23 09:43:25
 Duration: 4 min 55 s
 Material: Sand
 Comments:

Characteristics

x(Q3 = 10.0 %) 0.16123 mm
 x(Q3 = 50.0 %) 0.23036 mm
 x(Q3 = 90.0 %) 0.38262 mm
 Q3(1.00000 mm) 99.87 %
 Q3(2.00000 mm) 99.98 %
 Q3(4.00000 mm) 100.00 %
 SPAN3 0.961
 U3 1.535
 Q3(SPHT = 0,9) 83.30 %
 Q3(Symm = 0,9) 57.44 %
 Q3(b/l = 0,9) 98.77 %
 Mean value SPHT3 0.8336
 Mean value Symm3 0.8831
 Mean value b/l3 0.6975

Measurement parameters

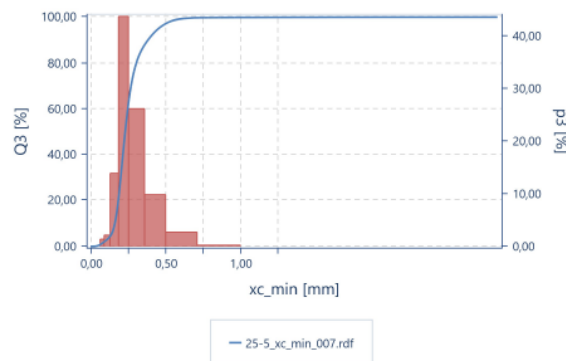
Size definition: xc_min
 Feeder width: 60 mm
 Covered area: 1 %
 Guidance Sheet: No
 Fitting:
 3D Measurement: No

Warnings

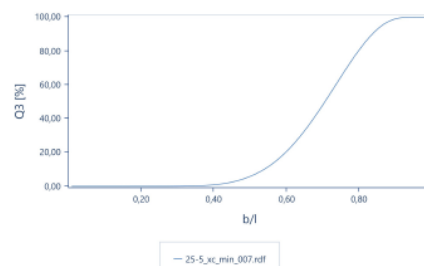
Data Table

Size class		p3 [%]	Q3 [%]	SPHT3	Symm3	b/l3
< 0.063		0.73	0.73	0.817	0.883	0.698
0.063	0.090	1.21	1.94	0.830	0.886	0.716
0.090	0.125	2.00	3.94	0.826	0.889	0.706
0.125	0.180	13.84	17.78	0.832	0.890	0.670
0.180	0.250	43.51	61.29	0.846	0.887	0.716
0.250	0.355	26.05	87.34	0.840	0.879	0.732
0.355	0.500	9.82	97.16	0.840	0.881	0.731
0.500	0.710	2.58	99.74	0.844	0.883	0.753
0.710	1.000	0.13	99.87	0.754	0.843	0.684
> 1.000			100.00	0.767	0.858	0.720

Size chart



Shape chart



System Information

Serial Number: 1222110201EM Software Version: 2.0.1.96

CAMSIZER 3D

200-500

General information

Company:
User: KD
Result file: 200-500_xc_min_010.rdf
Task file: MR4858_200-500.afg
Date/Time: 24.01.23 10:02:53
Duration: 3 min 5 s
Material: Sand
Comments:

Characteristics

x(Q3 = 10.0 %) 0.26945 mm
x(Q3 = 50.0 %) 0.36147 mm
x(Q3 = 90.0 %) 0.46669 mm
Q3(1.00000 mm) 100.00 %
Q3(2.00000 mm) 100.00 %
Q3(4.00000 mm) 100.00 %
SPAN3 0.546
U3 1.419
Q3(SPHT = 0,9) 91.67 %
Q3(Symm = 0,9) 63.86 %
Q3(b/l = 0,9) 99.07 %
Mean value SPHT3 0.8119
Mean value Symm3 0.8773
Mean value b/l3 0.7000

Measurement parameters

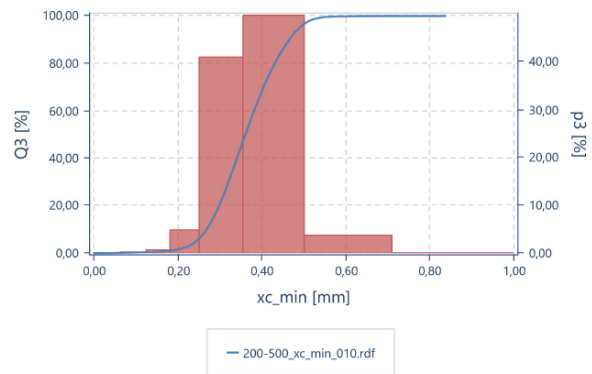
Size definition: xc_min
Feeder width: 60 mm
Covered area: 0,5 %
Guidance Sheet: No
Fitting:
3D Measurement: No

Warnings

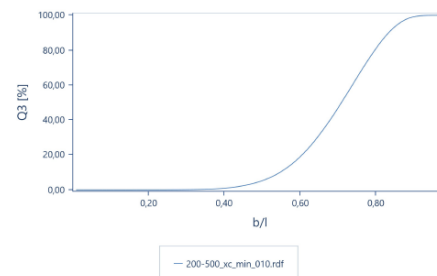
Data Table

Size class		p3 [%]	Q3 [%]	SPHT3	Symm3	b/l3
< 0.063	0.10	0.10	0.10	0.820	0.887	0.721
0.063	0.090	0.11	0.21	0.830	0.889	0.735
0.090	0.125	0.17	0.38	0.816	0.888	0.712
0.125	0.180	0.58	0.96	0.790	0.877	0.642
0.180	0.250	4.85	5.81	0.794	0.876	0.640
0.250	0.355	40.95	46.76	0.820	0.881	0.700
0.355	0.500	49.63	96.39	0.822	0.878	0.734
0.500	0.710	3.61	100.00	0.797	0.861	0.764
0.710	1.000	0	100.00	0.393	0.499	0.842
> 1.000		0	100.00			

Size chart



Shape chart



System Information

Serial Number: 1222110201EM Software Version: 2.0.1.96

CAMSIZER 3D

Sand A

General information

Company:
 User:
 Result file:
 Task file: MR4858.afg
 Date/Time: 24.01.23 09:00:20
 Duration: 3 min 45 s
 Material: Sand
 Comments:

Characteristics

x(Q3 = 10.0 %) 0.17235 mm
 x(Q3 = 50.0 %) 0.24732 mm
 x(Q3 = 90.0 %) 0.33340 mm
 Q3(1.00000 mm) 100.00 %
 Q3(2.00000 mm) 100.00 %
 Q3(4.00000 mm) 100.00 %
 SPAN3 0.651
 U3 1.525
 Q3(SPHT = 0,9) 79.95 %
 Q3(Symm = 0,9) 54.46 %
 Q3(b/l = 0,9) 98.44 %
 Mean value SPHT3 0.8418
 Mean value Symm3 0.8882
 Mean value b/l3 0.7013

Measurement parameters

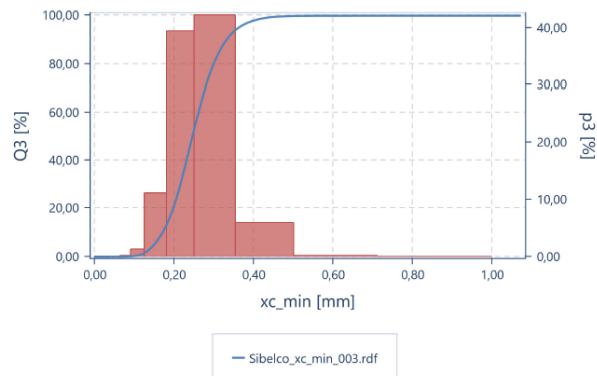
Size definition: xc_min
 Feeder width: 60 mm
 Covered area: 0,5 %
 Guidance Sheet: No
 Fitting:
 3D Measurement: No

Warnings

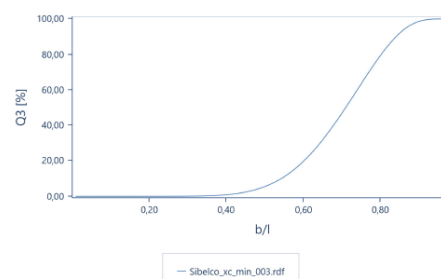
Data Table

Size class	< 0.063	p3 [%]	Q3 [%]	SPHT3	Symm3	b/l3
0.063	0.090	0.11	0.12	0.787	0.876	0.617
0.090	0.125	1.22	1.34	0.780	0.877	0.580
0.125	0.180	11.01	12.35	0.829	0.888	0.664
0.180	0.250	39.45	51.80	0.849	0.891	0.706
0.250	0.355	42.10	93.90	0.856	0.889	0.742
0.355	0.500	5.98	99.88	0.837	0.882	0.765
0.500	0.710	0.11	99.99	0.762	0.875	0.765
0.710	1.000	0.01	100.00	0.618	0.786	0.491
> 1.000		0	100.00			

Size chart



Shape chart



System Information

Serial Number: 1222110201EM

Software Version: 2.0.1.96

Contact Information

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More about CAMSIZER 3D and Dynamic Image Analysis. Click or scan code:



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