Generation of geometric models for numerical simulation with UDEC for risk-assessment of the in-situ consolidation

Conservation works

Approaches to generate geometric models for simulation

1. three approaches
2. comparison effort and results
3. applicability for other stone types

Statistic assignment of properties

- sample size: 10x 3 cm
- left: image - measured result and zoning
- right: image - assigned at 25% porosity (magenta)
- assignment is randomly in i.e. each 1/2 the distribution at different phases
- very last generation of the model but it reproduces the reality in statistic manner

Importing grey values from microimages

Images show the very basic principle: The drawn red raster doesn’t correspond exactly with the real coordinates/grey values (image size 1.3 x 0.97 mm with 238,700 grey values)

Generation of clumps, representing the grain shapes and size

- randomly generated clumps (200 combinations with 7 balls)
- image analysis (see right)
- comparison with real data
- selection of clumps, reproducing grain pattern
- definitions of clump library for specific stones and their varieties
- diagram shows the coverage of the clumps exemplarily within one ellipse group
- at the moment not completely satisfactory time-consuming compared to the other approaches
- [SHIFTF - thin section]

Definition and assignment of properties:
- black = porosity, grey = quartz
- assignment of properties to components and grain boundaries
- boundaries are here important since grains have always the same properties

Image Analysis with ImageJ

1. Analysis of grain shapes and porosity
2. Comparison real grain shapes and shapes of generated clumps
3. Greyscale images are a prerequisite to generate geometric models which mostly correspond to the real fabric

Generation of a binary image to measure width of images = 1.3 mm

Comparison real grain shapes and shapes of generated clumps

Analysis of grain shapes and porosity

- ΔA = CH Area - A with CH Area ≥ A
- ΔP = P - CH Perim with CH Perim ≤ P
- CH Area = area convex hull
- CH Perim = perimeter convex hull
- Solidity = area/convex area

Axial Ratio

- Major = 90°
- Minor = 0°

Exampleary shapes depicting the importance of different shape parameter for classification:
- ellipticity/axial ratio is only valid for elliptic shapes but are misleading for irregular shapes
- axial ratio = 1 for grains 8 to 18 and = 0.9 for grains 19 to 27, ignoring completely the irregular shapes

Approach:
1. measurement of aforementioned shape parameter
2. calculation of delP and deltA and subsequent classification
3. In case of clumps: second classification in accordance to ellipticity

Presentation of the clump library (shape and size) for simulation

Fit Ellipse

Solidity

CH Area

CH Perim

ΔP

ΔA

abP = \frac{ΔP}{P} 100\% 
\frac{ΔA}{A} 100\%

Prepared microimages for image analysis: black parts = porosity in different portions, white parts = mica flakes, grains = quartz

Exported and calculated parameter:
- Area, Perimeter
- Circularity = 4π area/perimeter²
- Axial Ratio = minor axis/longer axis
- Solidity = area/convex area
- CH Perim = perimeter convex hull
- CH Area = area convex hull
- ΔP = P - CH Perim
- ΔA = CH Area - A

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Comparison real fabric with data of the in-situ consolidation

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