Image Analysis of HMA to Characterize the Aggregate Orientation
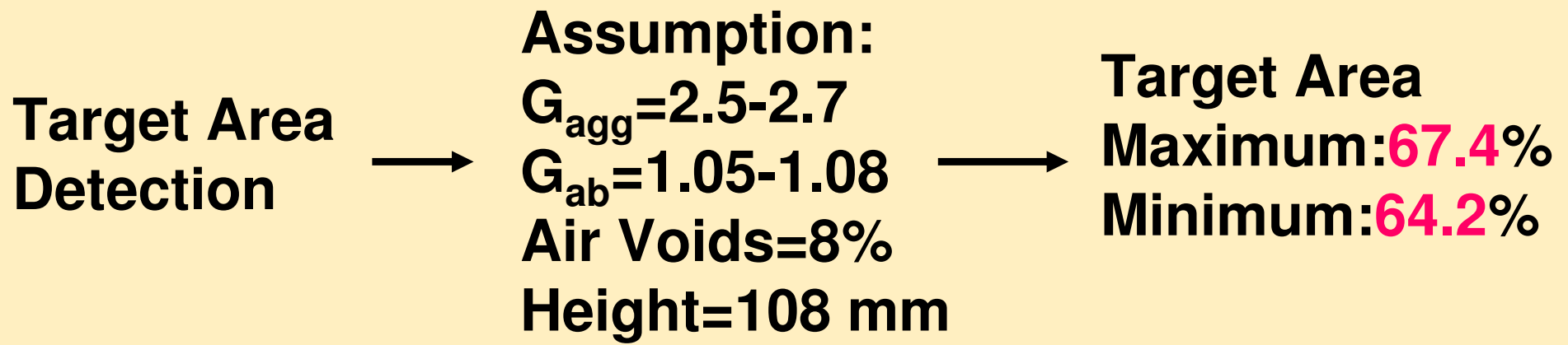
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Program Comparisons

Target Area Detection →

Assumption:
G_{agg}=2.5-2.7
G_{ab}=1.05-1.08
Air Voids=8%
Height=108 mm →
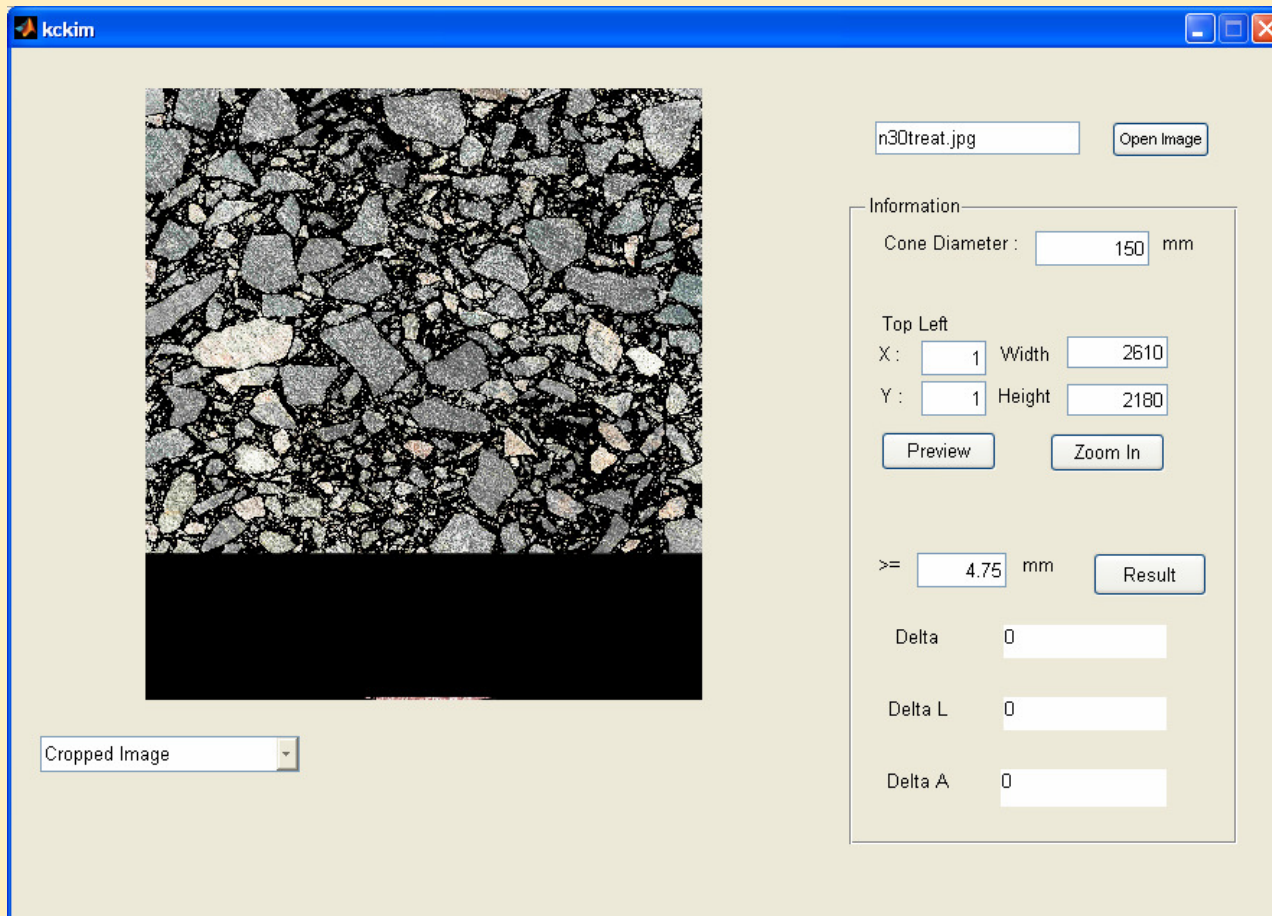
Target Area
Maximum:67.4%
Minimum:64.2%

Aggregates are uniformly distributed
Smaller than 1mm size aggregate can not be detected

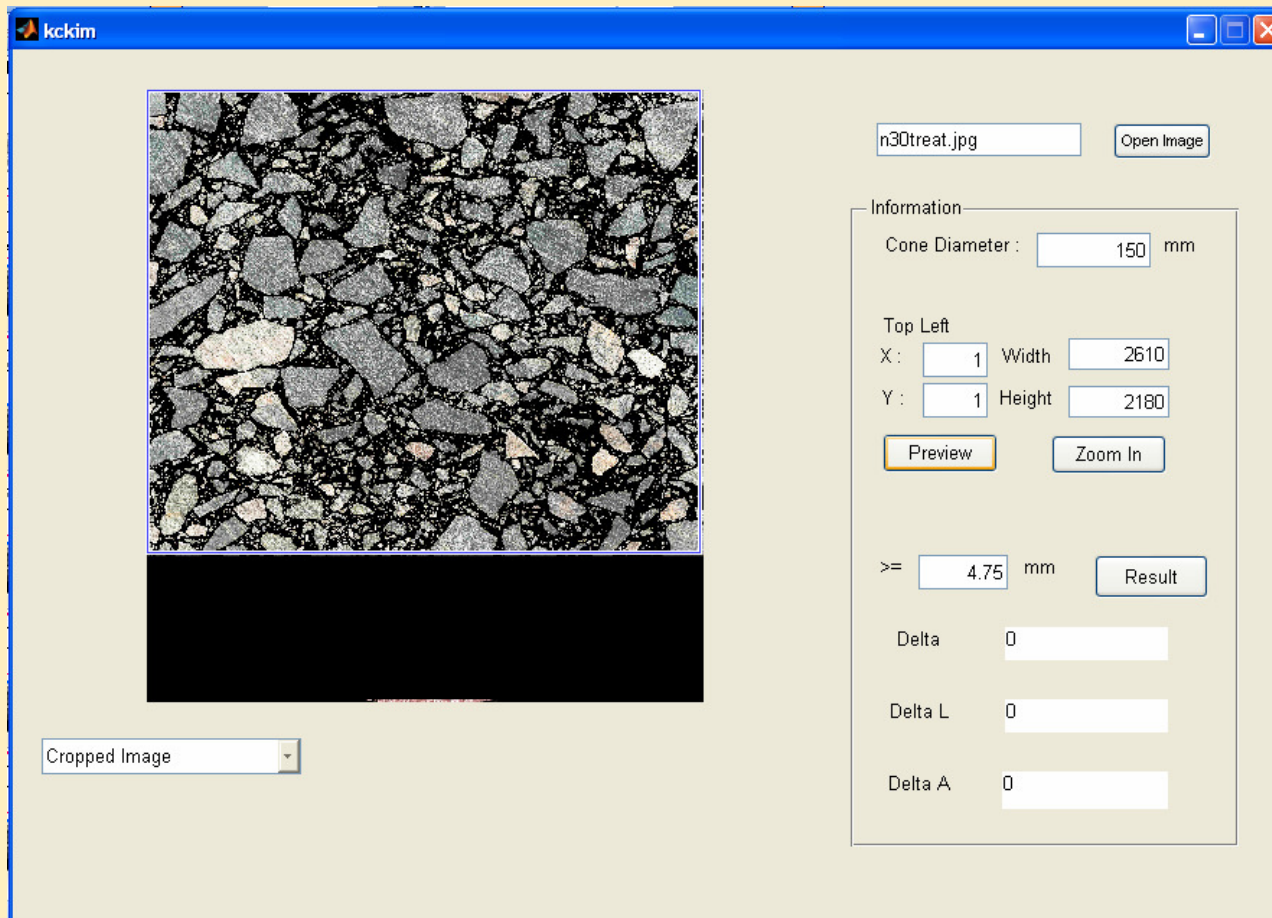# Procedures of KCKIM

(1) Image Loading From Data Folder

Input Image File Name and Click Open Image
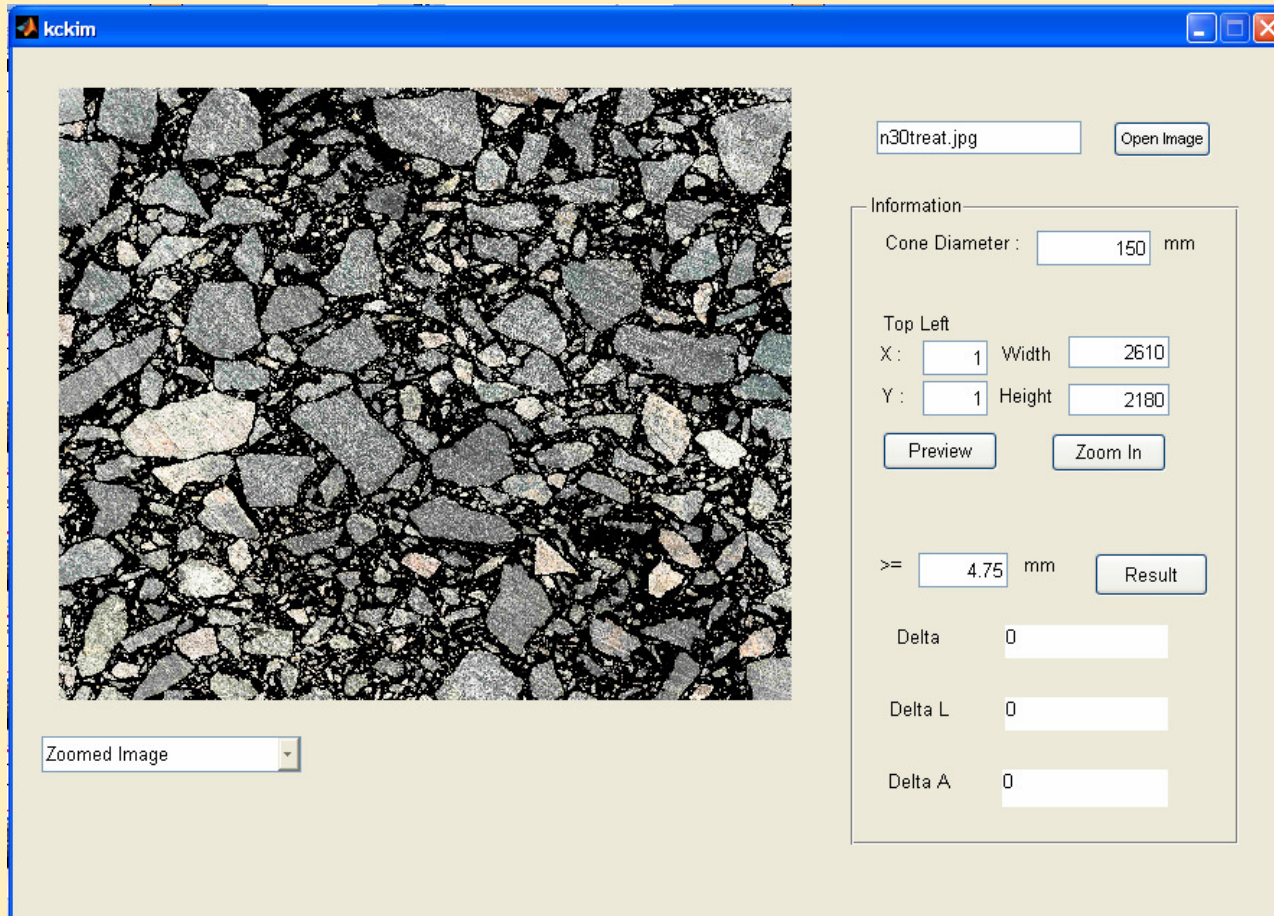An mage for processing must be in data folder

Procedure of KCKIM

(2) Selection of Region of Image for the Processing

Input X and Y, Width and Height for the Interest Region of Image
Click Preview

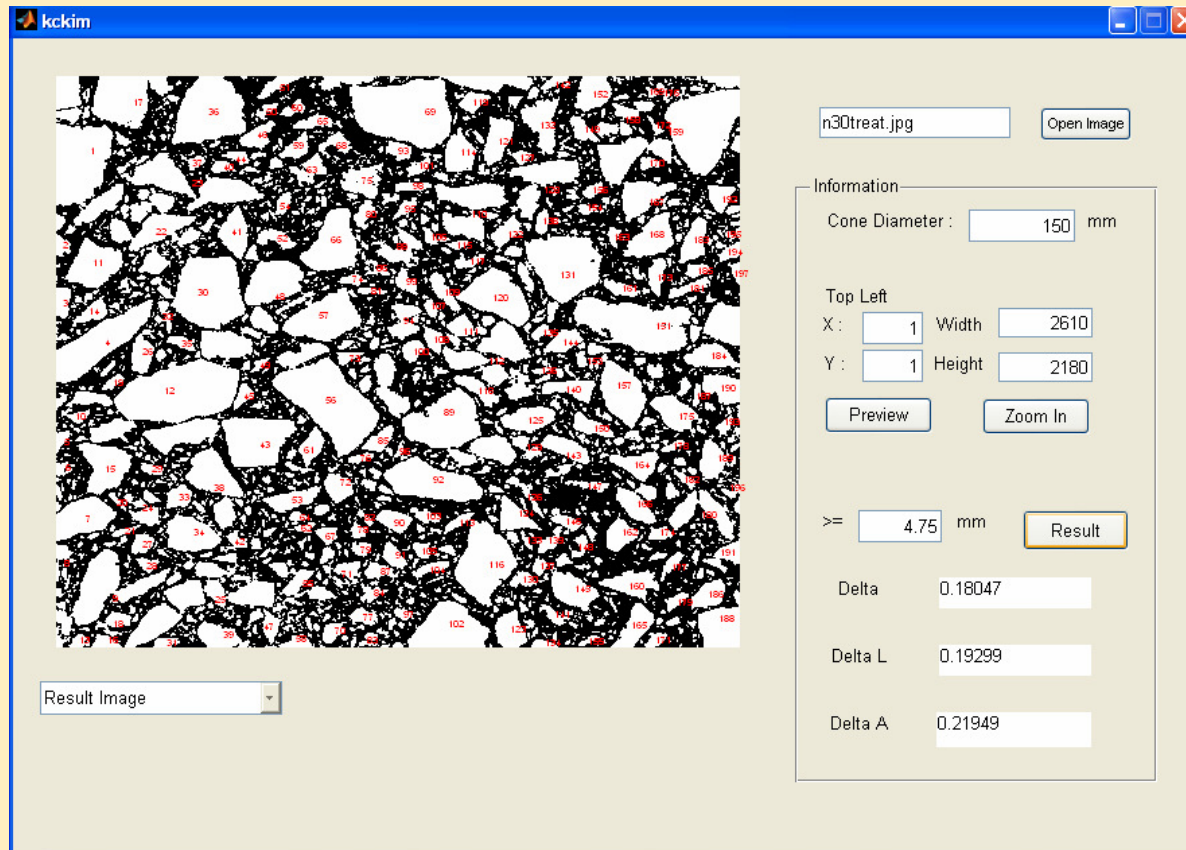# Procedure of KCKIM

(3)Zoom In Selection Region

Click Zoom In
Image applied with Equalization, Stretching, Smoothing, and Filtering

Procedure of KCKIM
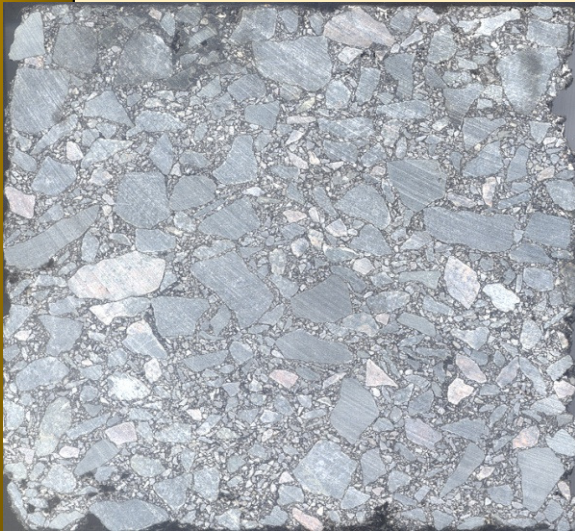
(4)Analysis and Labeling

Processing Techniques

1. Edge Detection,
2. Thresholding
3. Region Growing
4. Erosion and Dilation
5. Opening and Closing
6. Spliting
7. Labeling
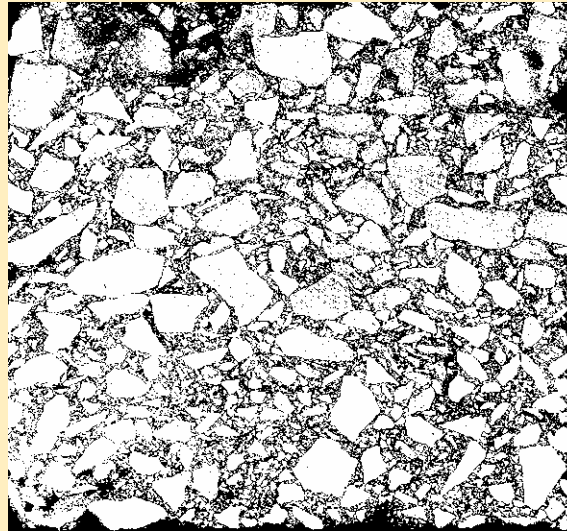8. Data Stored

Input Size of aggregate and Click Result
In the Results Folder,
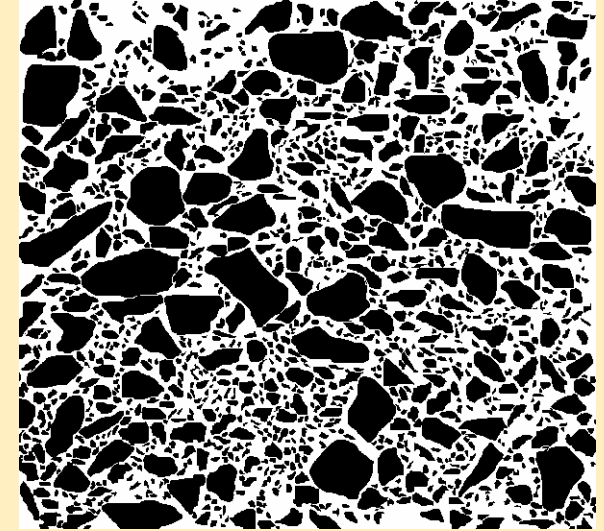Analysis Data (Text File) and Processing Images of Each Step (JPEG File) are Stored

Image Processing from Image Pro

Raw Image

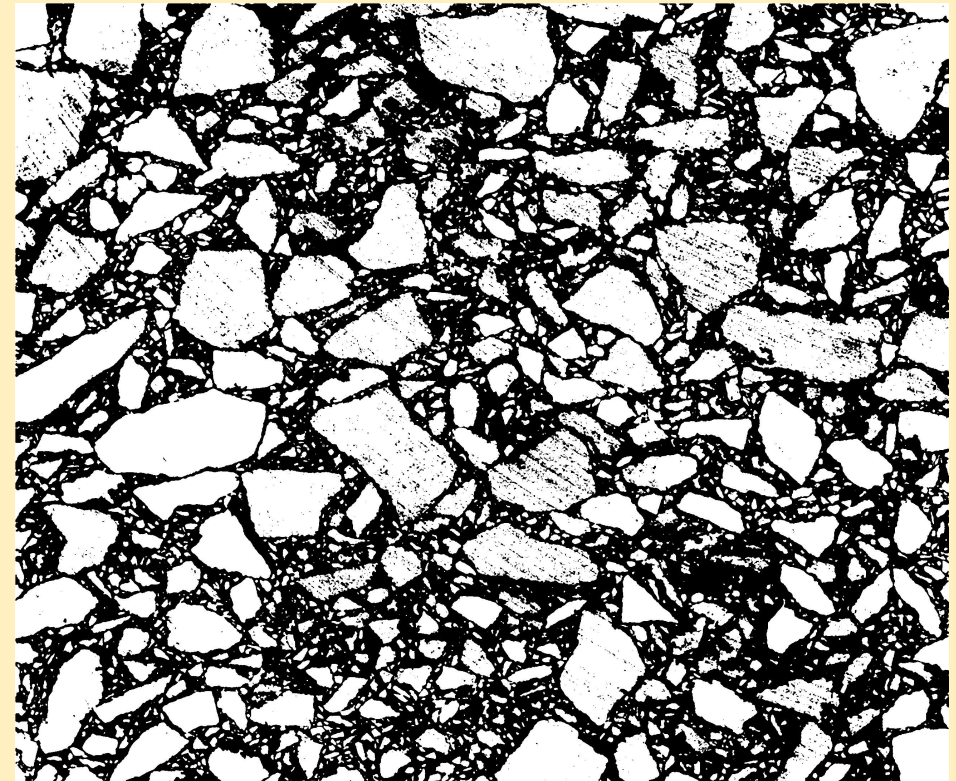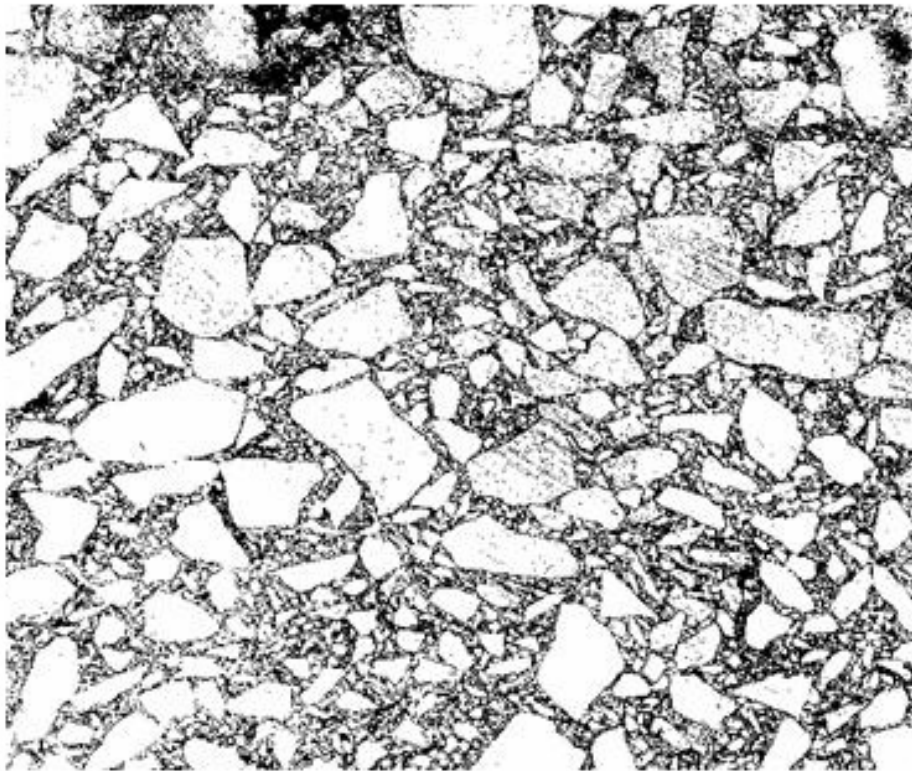Processed with density index
Mastic: ≤164
Aggregate: >164

Fine Image Processing

Using Image-Pro software

(1)Thresholded Image
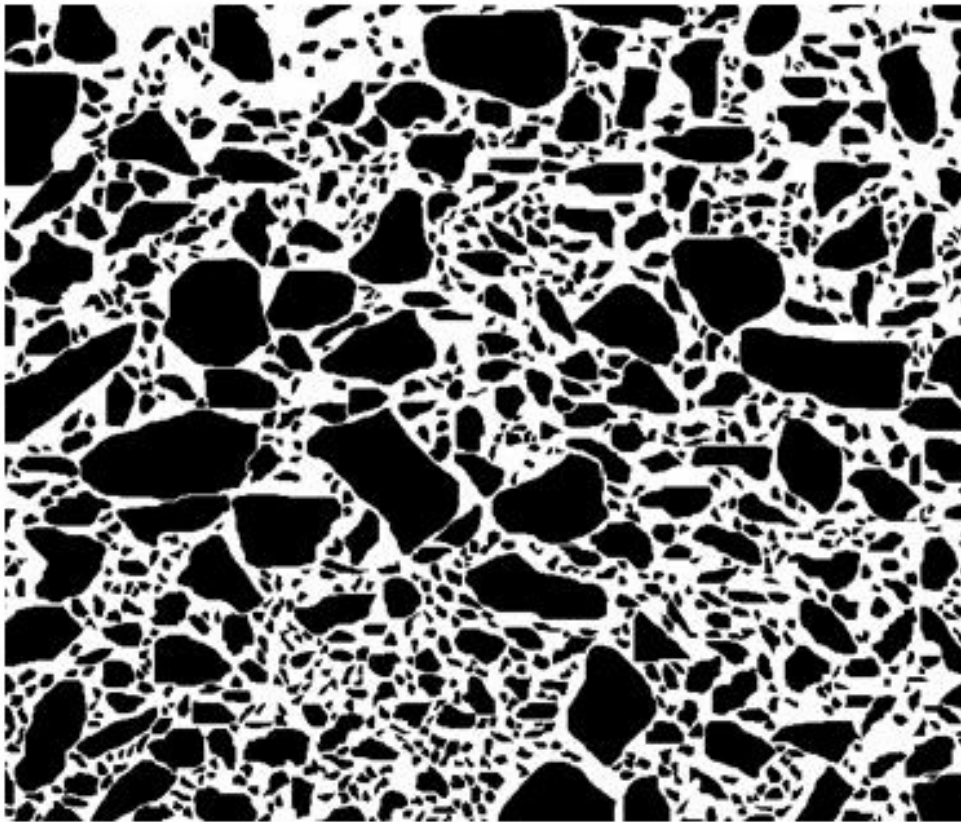
1st Threshold=**0.65** and Region Growing

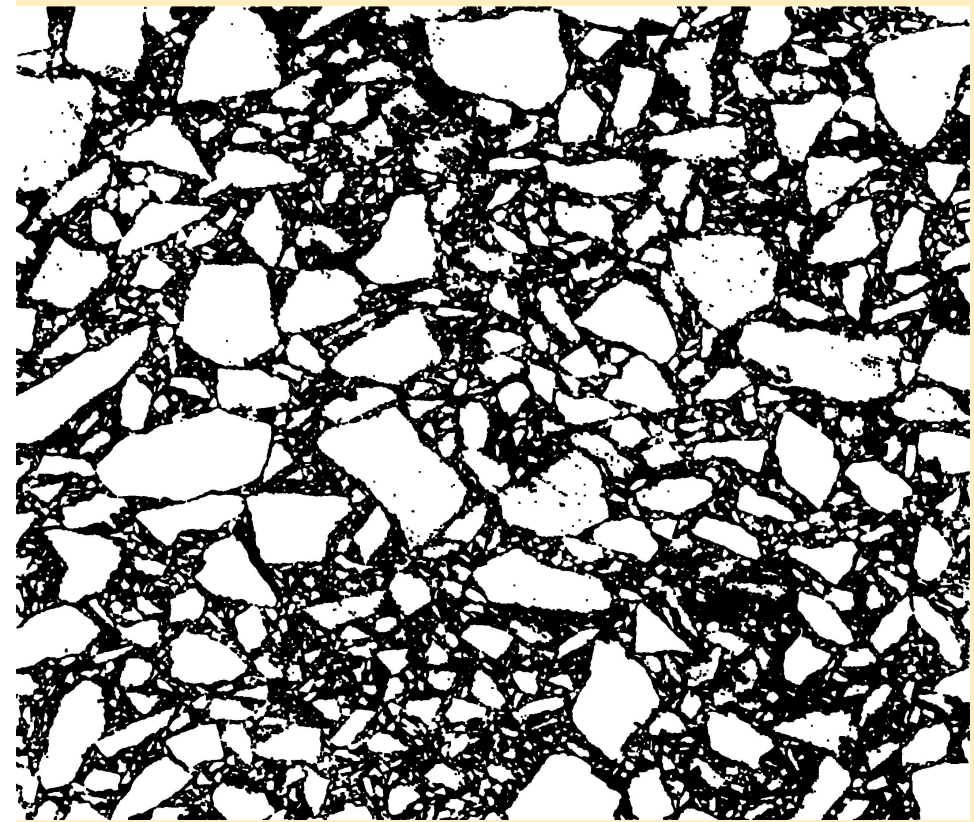Using Image-Pro software   From KCKIM

(2)Final Segmented Image

1st Threshold=0.65 and Region Growing
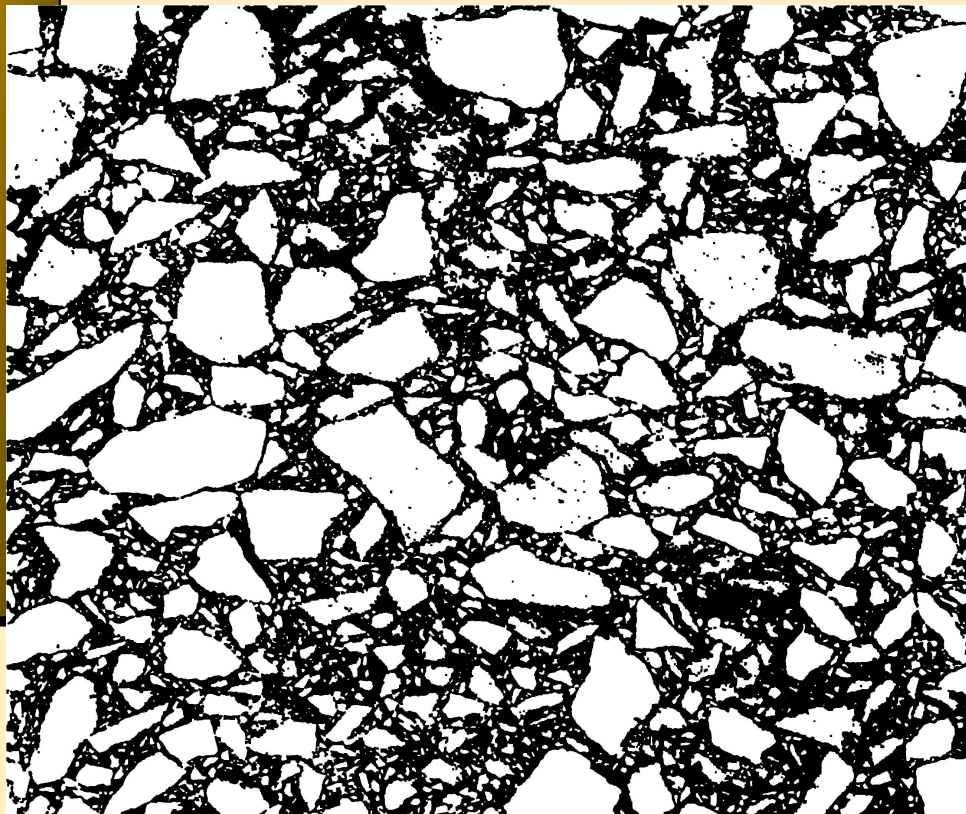

Aggregate Area Detection=**50.38**%

Aggregate Area Detection=**55.28**%

Using Image-Pro software

From KCKIM

(2)Final Segmented Image

1st Threshold=0.70 and Region Growing

1st Threshold=0.75 and Region Growing

Aggregate Area Detection=**56.01**%
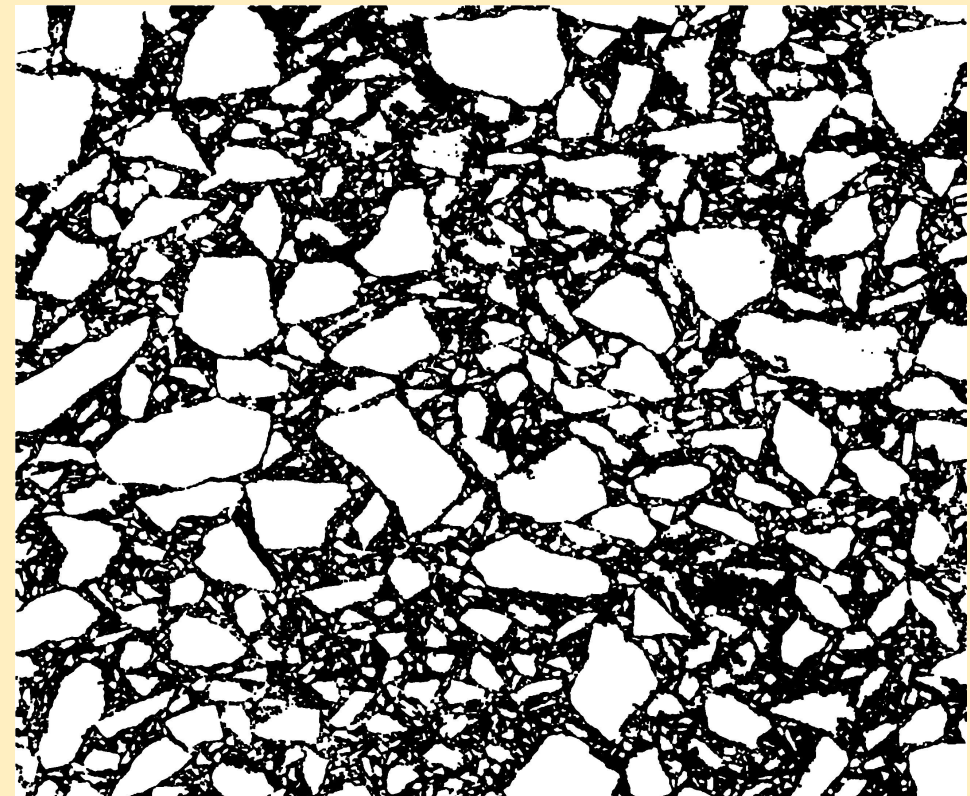
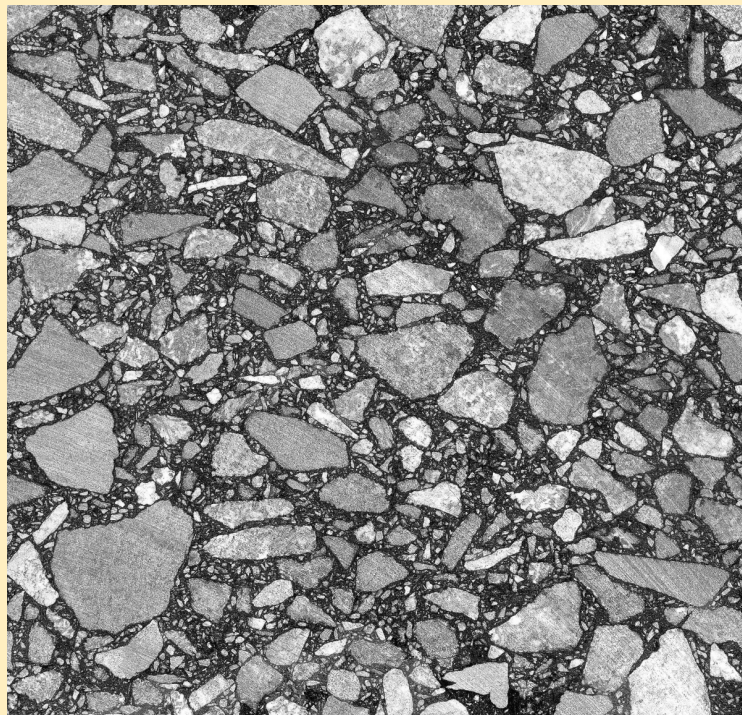Aggregate Area Detection=**57.14**%
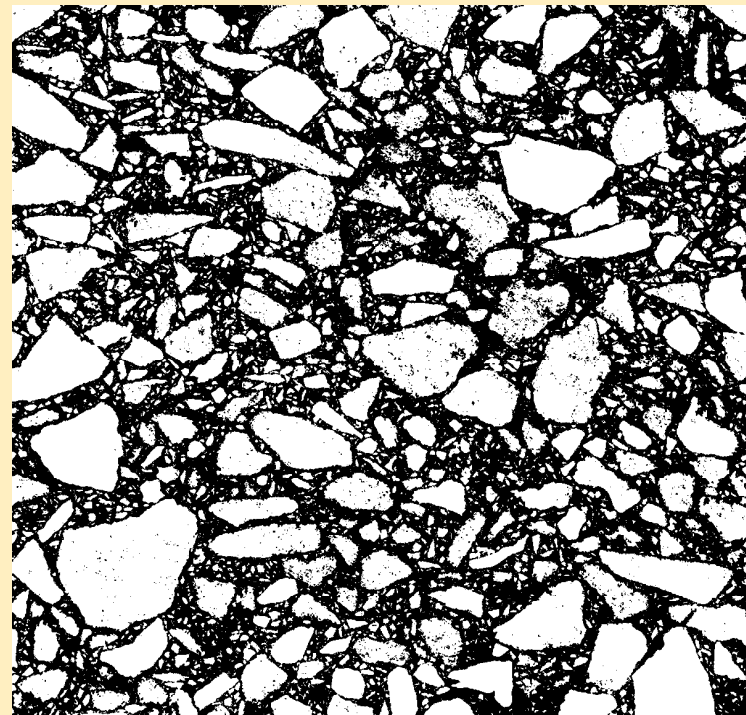
From KCKIM

From KCKIM

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N=200 Mixture

From KCKIM

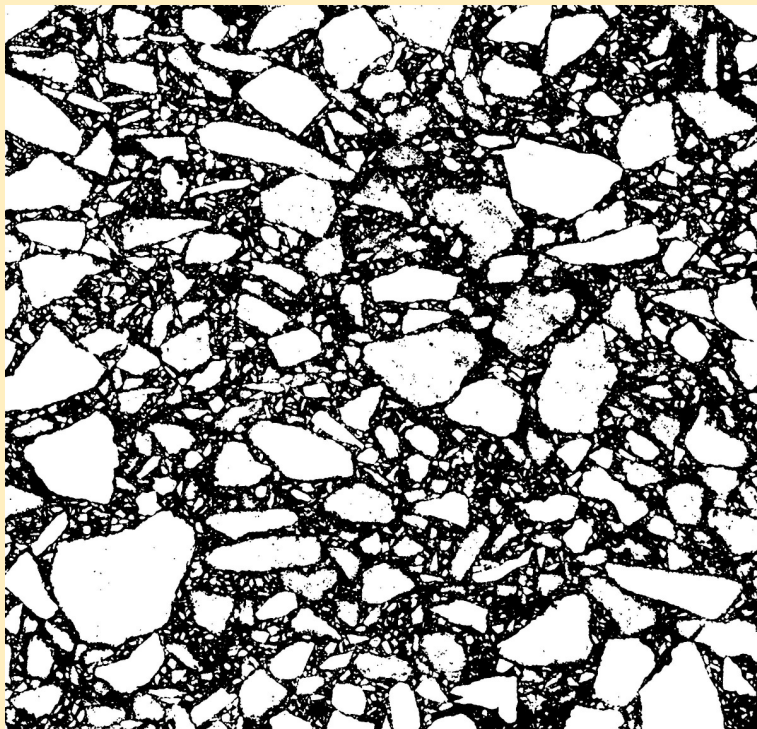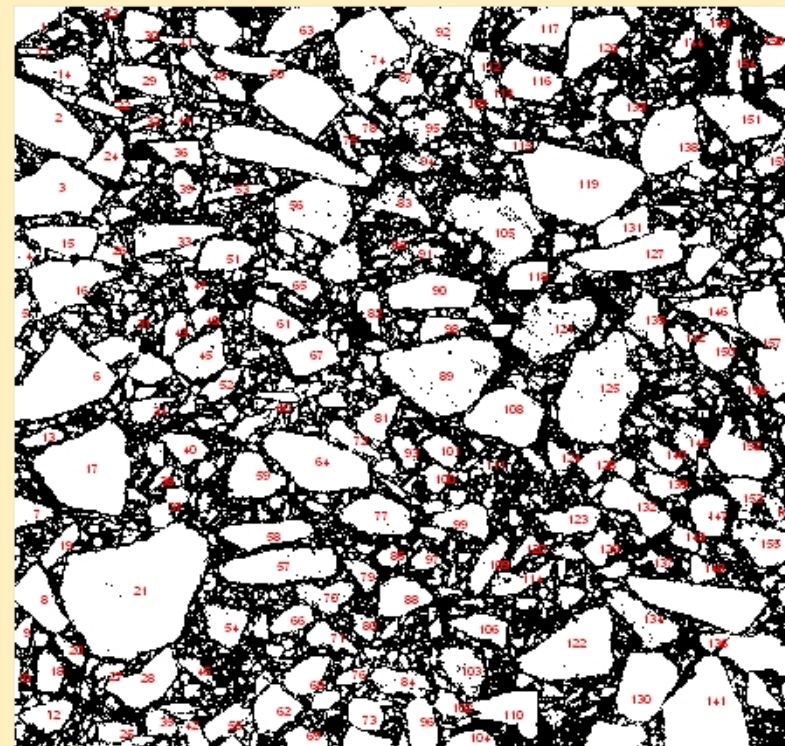Original Image after Equalization   Threshold Image

ARC

N=200 Mixture

ARC

Final Image

Labeling and Analysis

Area Detection=**58.26**%

N=200 Mixture

Aggregate Orientation

From KCKIM

Internal Structure Analysis Using Image Analysis Technique

➤ The direction distribution of aggregate orientation approximated by harmonic series expansion (Masad 1998)

$$n(\theta_i) = n_a(1 + A_2 \cos^2\theta_i + 2B_2 \sin\theta_i \cos\theta_i - A_2 \sin^2\theta_i)$$

➤ Absolute average angle of orientation θ, orientations of aggregates

➤ Vector magnitude Δ, Complete random distribution of the orientation=0%, Exactly the same direction=100%

$$\theta = \frac{\sum|\theta_k|}{N}$$

$$\Delta = \frac{100}{N}\sqrt{(\sum\sin 2\theta_k)^2 + (\sum\cos 2\theta_k)^2}$$

Proposed Internal Structure Interpretation In the Image Processing

$$\theta = \frac{\sum |\theta_k|}{N}$$

$$\Delta_N = \frac{100}{N}\sqrt{(\sum \sin 2\theta_k)^2 + (\sum \cos 2\theta_k)^2}$$

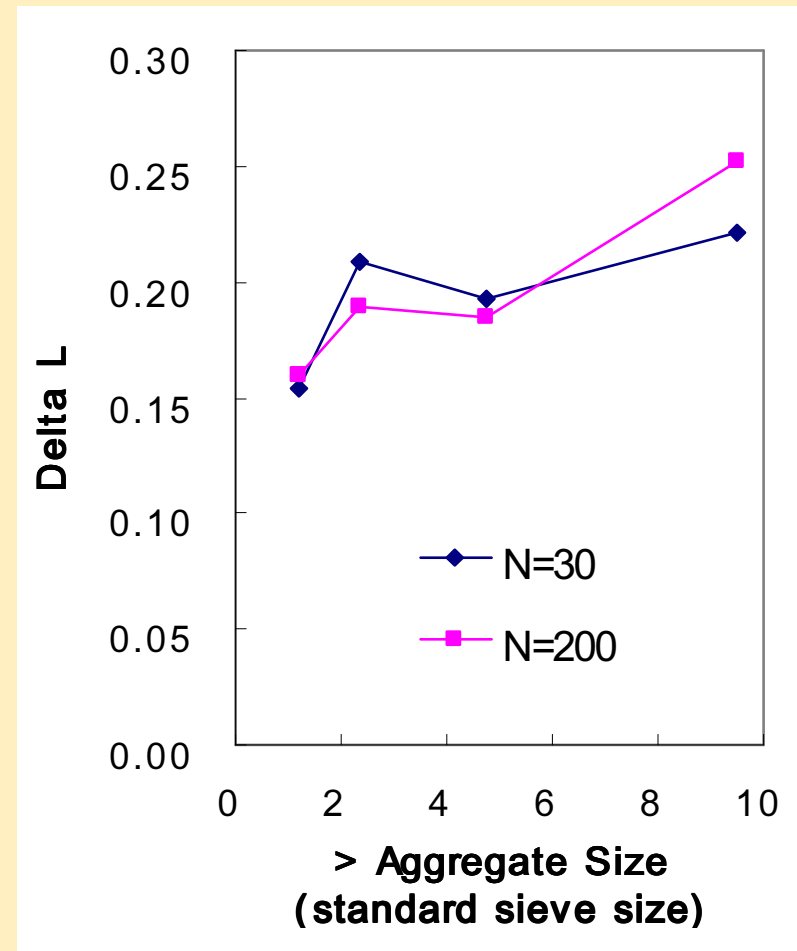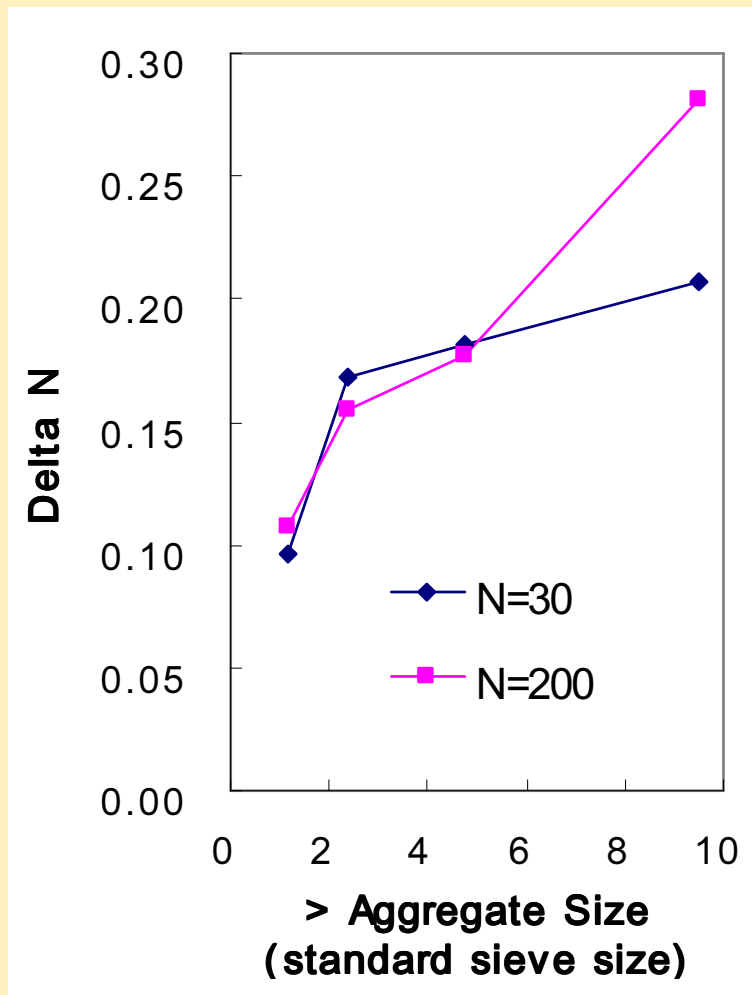$$\Delta_{L, or A} = \frac{\sqrt{(\sum X_K \sin 2\theta_K)^2 + (\sum X_K \cos 2\theta_K)^2}}{\sum X_K}$$

- N is the number of aggregates with a diameter larger than 1.18mm in the image. X_K is either the largest length (L_K) or the area (A_K) of each aggregate object in the image.
- Vector magnitudes, the value of ΔN, ΔL, and ΔA, varies from zero to one. Complete random distribution of the orientation will give a vector magnitude of zero

Comparison of N=30 and N=200

Aggregate Orientation

From KCKIM

Comparison of N=30 and N=200

Aggregate Orientation

From KCKIM