

## **Effect of Texture on Crushability of Carbonate Sand in Northern Coasts of Persian Gulf**

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### **Extended Abstract**

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### **Introduction**

Carbonate soils are different from silicate soils respect to their origination and engineering behavior. Particles of these soils are mainly residual or debris of sea animals or plants with large amount of calcium carbonate. They also may be chemical sedimentation of calcium carbonate over other soil particles in specific region of seas and oceans. The most important characteristic of these soils is the crushability of their aggregates under loading which is mainly due their shape and also small voids inside of them. Crushability and subsequent volume changes in carbonate soils have caused many engineering problems in some geotechnical structures such as shallow foundations, piles and piers.

### **Material, Apparatus and Procedure**

Soils from different parts of the northern coasts of the Persian Gulf such as Bandar Abbas, Bushehr port, Qeshm, Hormoz and Hengam islands were collected. By preliminary tests, gradation curves, calcium carbonate content, specific gravity and maximum and minimum relative densities, particles shape index and effective size have been determined. Main loading tests were series of 70 one-dimensional compression using Rowe Cell apparatus

(Figure 1). Poorly graded sand samples with big, medium and small size particles (in margins of sand definition) were tested.



**Figure 1. Material and apparatus a) Rowe Cell, b) Sand inside Rowe cell, c and d) Specimen after loading**

#### **Determination of Texture Parameters (shape index & effective size)**

Soil particles were classified in different groups with spherical, platy, needle and blade shapes. For this classification the following equation was used;

*shape i*

In which, L, W and T are longest, middle and shortest dimensions relatively. By this equation, the shape index of a sphere will be equal to 2. However by increasing the difference in particles three measured dimensions, this index will be increased.

Another parameter for sand texture was defined as effective size by following equation;

$$Effective\ size = 0.1 \left( \frac{d_{min} + D_{10}}{2} \right) + 0.2 \left( \frac{D_{10} + D_{30}}{2} \right) + 0.3 \left( \frac{D_{30} + D_{60}}{2} \right) + 0.4 \left( \frac{D_{60} + d_{max}}{2} \right)$$

in which,  $d_{min}$  and  $d_{max}$  are the minimum and maximum particle sizes.

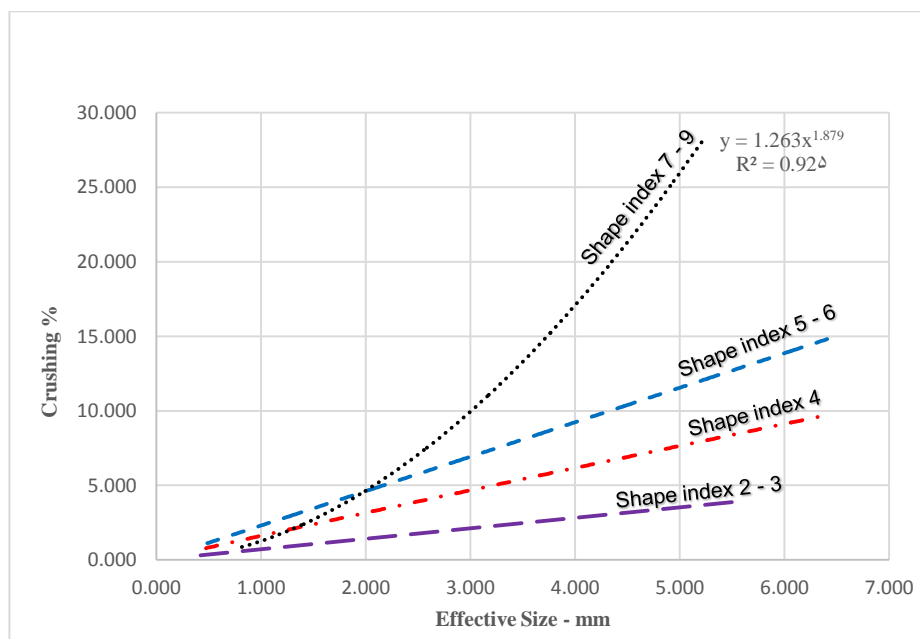
This two defined parameters (shape index and effective size) were used in statistical analysis to find the relation between particle breakage and soil texture.

### Determination of crushing

To determine crushing of aggregates, Hardin (1985) method has been used. Soil gradation test was performed on each specimen before and after compression tests.

### Results

Results of statistical analysis on crushability of sand particles with their different effective sizes and shape indexes is shown in Figure 2.



**Figure 2. Sand particles crushing for different effective sizes and shape indexes of aggregates**

### Conclusion

1. Carbonate soils of the southern coast of Iran are very different in shape of particles.

2. The crushability of carbonate soils grains increases with increasing of their effective size.
3. For sand particles with effective size of less than 1 millimeter with any shape index the crushability is very low, however it is high for particles bigger than 5 millimeters.
4. The crushing of aggregates is intensified by simultaneous increase of the particle effective size and shape index effect.

**Keywords:** Carbonate soils, Sand, Crushing, Effective size, Shape index.

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