Fine Recycled Concrete Aggregates Particle Morphological Parameters and Packing Properties

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INTRODUCTION

In the European Union, concrete accounts for 25% of the construction and demolition waste generated each year. At the same time, many places around Europe the availability of natural rounded aggregates for the production of concrete is becoming a crucial question. These two trends suggest that crushed particles, such as crushed stone aggregates and recycled concrete aggregates (RCA), can be a necessity for concrete production to accommodate resource scarcity. When recycling concrete as aggregates, an important part to investigate is to use the fraction of fine recycled concrete aggregates (FRCA) as it constitutes 40-60% of the crushed concrete.

The proportioning of aggregates for the use in concrete is influenced by morphology characteristics of particles, such as shape, angularity and surface texture, which has a significant effect on the workability, rheology and mechanical properties of cementitious suspensions. This study investigates the morphology of crushed particles, FRCA, with nonspherical shapes.

RESULTS

Four sands were studied (Fig. 1), the first sand is a naturally rounded sea dredge 0-4mm sand (S1), whereas the other three sands S2, S3 and S4 are produced by crushed concrete (0-4mm). The sands particle shape, shown in Fig. 2, is quantified by the roundness, R (the average radius of curvature of the surface features) [3], the sphericity, S (reflecting the similarity between the length and height of a particle) [4], and regularity, ρ, described as $\rho = \frac{R+S}{2}$. The particle shape was determined as the average values of a visual assessment from microscope images.

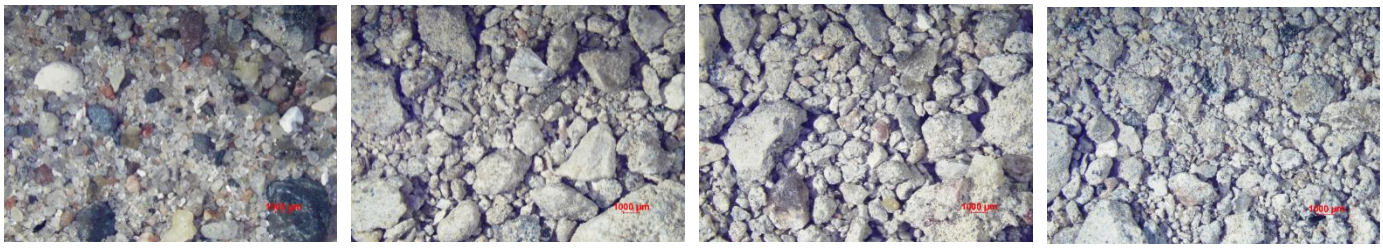

Figure 1. The four sands studied in this paper.

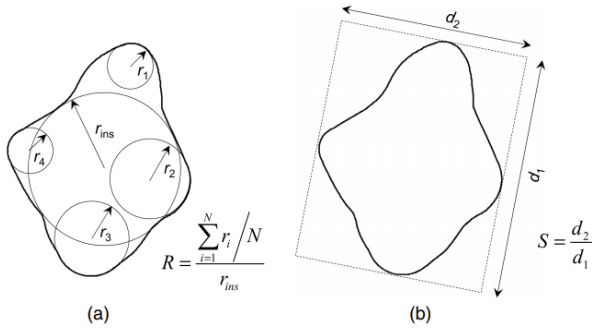

Figure 2. Definitions of (a) roundness, *R*, (b) sphericity, *S*, (adapted from [5]).

The particle size distributions were determined according to DS/EN 933-1 [4] and are shown in Fig. 3 for the four sands. Two specific packing fractions were measured for the four sands to characterize their properties further. The packing fractions were determined according to [5], the random loose packing fraction (RLP fraction), which theoretical is defined as the loosest packing fraction by pouring grains, and the random dense packing fraction, this value is empirically defined and depends on the specific amount of energy brought to the system. All FRCA tested here have lower packing fractions than the reference sea dredged sand.

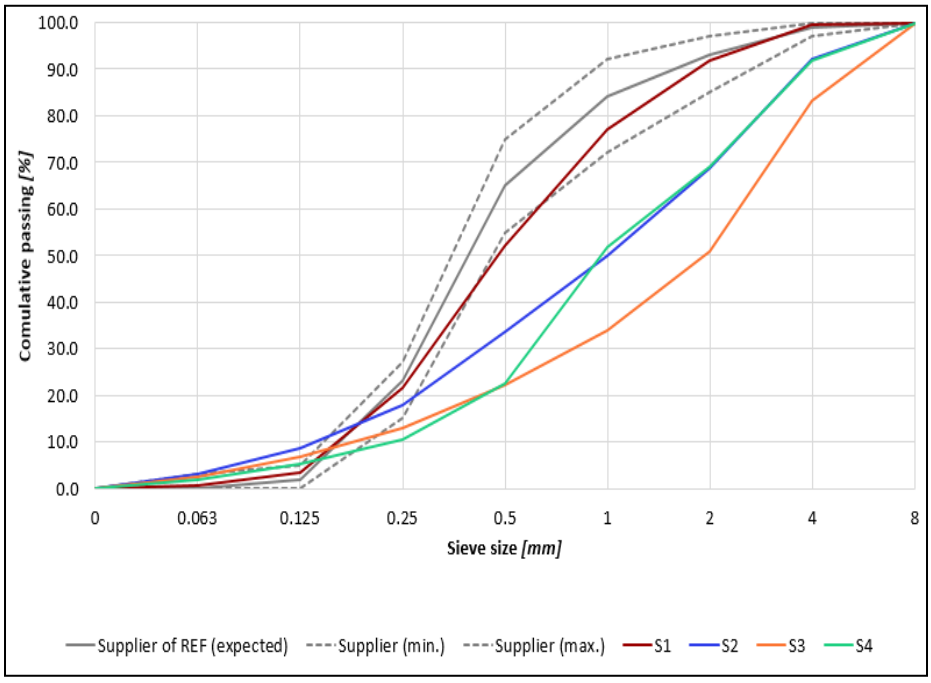

Figure 3. Particle size distribution of the sands.

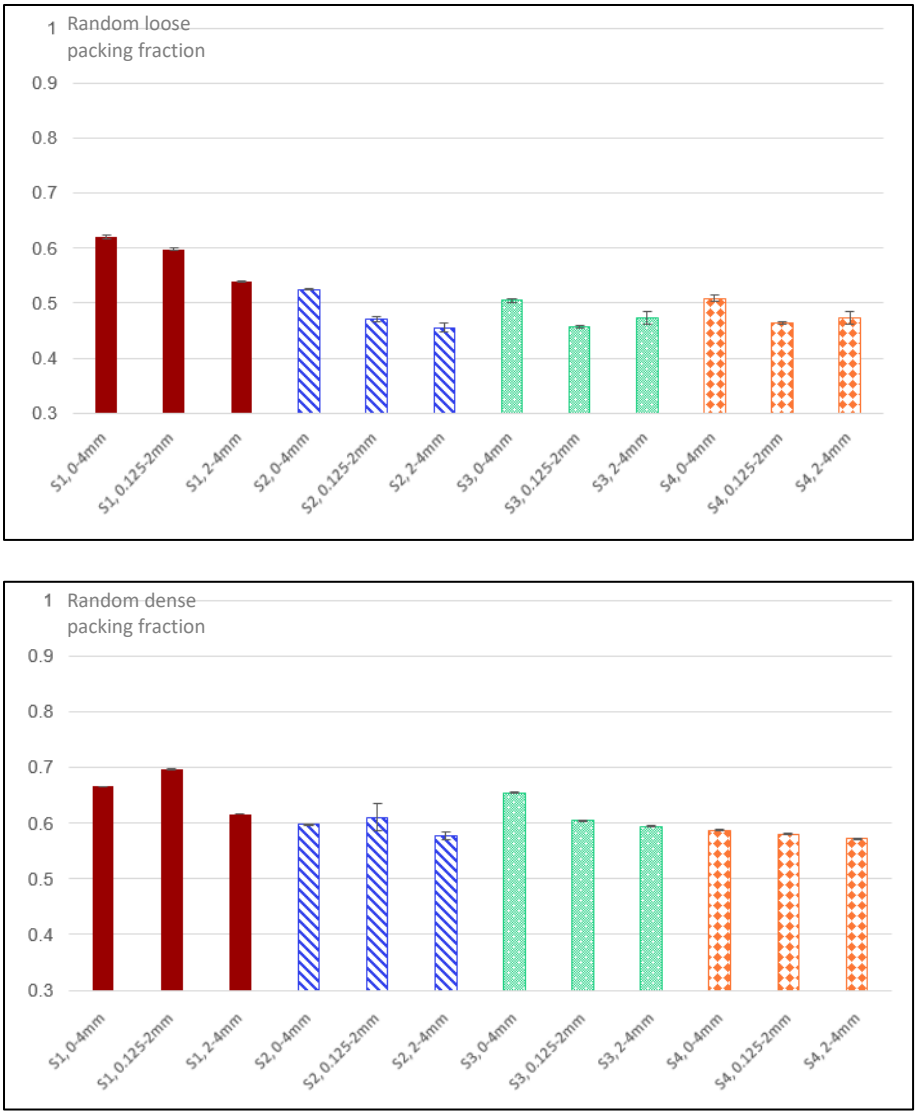

Figure 4. Random loose packing fraction (top) and random dense packing fraction (bottom) for the sands and various fractions.

CONCLUSIONS

In this study, the particle morphology and packing properties were investigated for various FRCAs, and the FRCAs are more angular than the sea dredge sand where weathering has beside rounding the particles removed most of the weak minerals. The packing properties showed the sphericity of the particles as the dominant morphological parameter regarding packing. The study also showed that the packing properties similar to the morphology parameters depends on the type of sand and not on the sand fraction.

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