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Discussion

Discussion of "An updated skeleton void ratio for gravelly sand mixtures considering the effect of grain size distribution"

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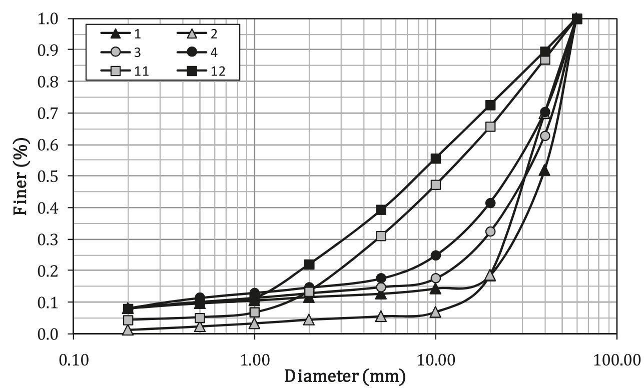
Wang et al. (2022) have presented a good paper related to estimating the skeleton void ratio of grave–sand mixtures. The most important contribution is that Wang et al. (2022) presented a new relationship to determine the skeleton void ratio and the parameters used in the relationship are easy to be obtained. Their paper related the grain size distribution properties of the coarse and fine materials, namely, coefficient of uniformity of fine material and coarse material and the ratio of the diameter corresponding to 50% of the coarse materials and the fine materials. The method is promising, though the discusser has some observations related to the methods of analysis and definition of coarse and fine materials.

1. The separation limit between coarse and fine materials

Wang et al. (2022) defined the particle diameter 4.75 mm (sieve number 4) as a separation limit between coarse and fine materials. They reasoned the limit "according to the Unified Soil Classification System (USCS classification, 2017), aggregates with grain size ranging from 4.75 mm to 20 mm were selected as gravel grains and grains with grain size below 4.75 mm and over 0.075 mm were selected as sand grains.". This definition means that a low sand content, less than the threshold value, $(s_c)_{th}$, does not contribute to the load (i.e., the gravel constituting the stress-bearing skeleton). The discusser believes that such a sharp and specific limit (4.75 mm) should not be generalized for all gravel–sand mixtures with different shapes and ranges of particle sizes and shapes of grain size distributions. This opinion is explained with the aid of Fig. 1 that is based on the study of Burenkova (1993), where several experimental tests were performed on cohesionless soils to determine the limiting size that separates the stress-bearing skeleton and the particles that do not contribute to stress bearing (fill material in the voids of the larger particles). Burenkova (1993) found that each soil mixture, shown in Fig. 1, is composed of stress-bearing skeleton particles and loose fill materials. The limiting size, separating these two types, ranges from 0.5 to 10 mm for the gravel–sand mixtures shown in Fig. 1. Based on the results of these tests, it is not justifiable to assume a constant value of 4.75 mm as a separation limit size for all gravel–sand mixtures.

Fig. 1. Grain size distribution of the soils tested by Burenkova (1993).



The discusser's justification can also be supported by considering a pack of spherical particles and determine the maximum size, d, of particle that can fit in the cavities formed among the largest particles, D. This can be expressed as $D/d = 6.46$ (Yan et al. 2018). For the gravel–sand mixtures tested in the paper under discussion, the maximum size was 20 mm and this makes the value of $d = 3.1$ mm, which is less than 4.75 mm as adopted by Wang et al. (2022).

Due to the nice V-shape, questions may arise such as: if the 4.75 mm is not always a valid separation limit between the stress-bearing skeleton and the fine filler material, then why there a nice V-shape, see Fig. 8 (in the paper under discussion), was obtained when the relationship between the void ratio and sand content was drawn? Does that mean 4.75 mm is a valid separation limit? To answer these questions, the discusser used the data presented in Fig. 7 (in the paper under discussion) and investigated various separation limits ranging from 1 to 7 mm and the results are shown in Fig. 2 here. Nice V-shapes can be obtained for all random separation limits tested.

Fig. 2. V-shapes for separation limits ranging from 1 to 7 mm.

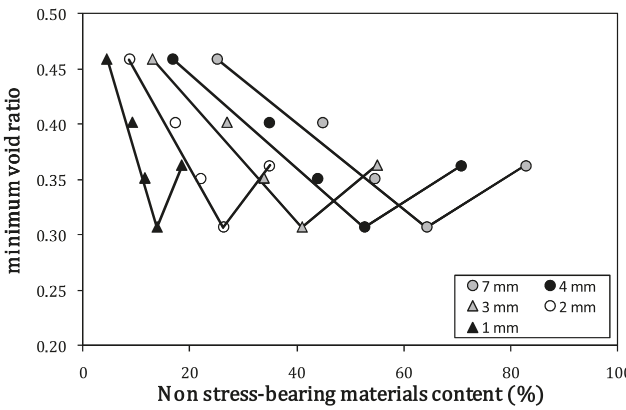
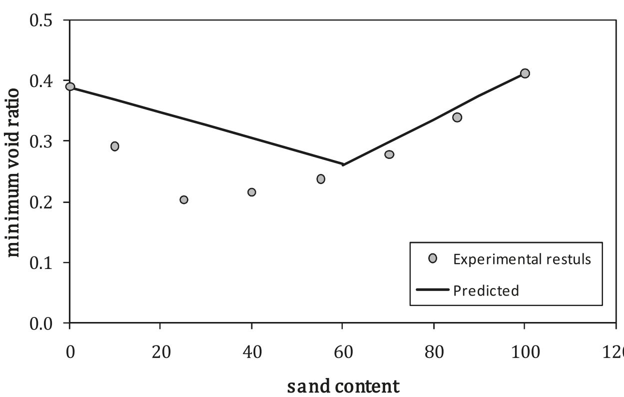


Fig. 3. Experimental and predicted minimum void ratios.



2. The validity of the parameters α and β

Wang et al. (2022) presented the parameters α and β (see eqs. 10 and 11 in the paper under discussion) to calculate the skeleton void ratio of the gravel–sand mixtures. The calculations performed by Wang et al. (2022) gave accurate predictions based on α and β. To validate their predictions with other soils, the discusser used the data presented by Wang and Wang (2017), as shown in Fig. 3. The prediction of α value (slope of the left line (gravel-dominated structure)) was not close for this soil, while the value of β (slope of the right line (sand-dominated structure)) was close to the experimental data. This means that the empirical equations (see eqs. 10 and 11 in the paper under discussion), which are based on a limited number of experimental tests performed by Wang et al. (2022), need to be validated with more experimental data.

3. Calculating the parameters α and β

The authors stated that the values of α and β are ranging from ($1 \leq \alpha \leq 1 + e_s$) and $\beta \leq e_g$ and they can be computed from eqs. 8 and 9 (in the paper under discussion), respectively. The correct range should be $1 \leq \alpha \leq 1 + e_g$ and $\beta \leq e_s$, and their values are computed as

$$\alpha = \frac{a}{1 + e_g}$$

and

$$\beta = \frac{b}{e_s}$$

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