International Journal of Geosynthetics and Ground Engineering (2022) 8:30
https://doi.org/10.1007/s40891-022-00369-z

DISCUSSION PAPER

Discussion of "Behaviour of a Foam Mixture as a Lightweight Construction Material" [Int J of Geosynth and Ground Eng (2021) 7(3), 51]

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Received: 28 September 2021 / Accepted: 13 January 2022

The Discussers read the Authors' paper with interest, having recently published findings on the geotechnical behaviour/properties of clayey sand–expanded polystyrene (EPS) beads mixtures [1]. The Authors purport a 'new' cement-treated sand–EPS beads mixture for use as lightweight fill in ground engineering applications, although the concept is not really new, with major research efforts [2–7] already reporting on the geotechnical properties of these cement-treated mixtures. The Authors' geotechnical laboratory investigation for sand–EPS beads mixtures amended with 7–10% (by weight) normal Portland cement (NPC) is a welcome addition to this research literature. The Discussers note that apart from some inconsistencies/weaknesses mostly related to the Authors' consolidated-undrained (CU) shearbox tests, as elaborated in the next paragraph, the results of the index properties, compaction, unconfined compression and California bearing ratio (CBR) tests presented in the Authors' paper are in general agreement with those reported for cement-treated sand–EPS beads mixtures by Miao et al. [6, 7].

However, the Discussers would appreciate clarification and/or additional information on the following points concerning the Authors' CU shearbox tests (reported as total stress).

- It would seem to the Discussers that the Authors' values of $c = 35.0$–45.8 kPa and $\phi = 10.5$–$14.0°$ (reported in Table 6 of the Authors' paper) for 7, 14 and 28 day cured cemented sand–EPS beads specimens are on the low side, given the specimens contained between 7% and 10% NPC. This is demonstrated, for instance, by considering the modest undrained shear strength predicted for high applied vertical stress (say, employing the Mohr–Coulomb model for calculation) on the basis of these c and ϕ ranges. This viewpoint is supported by the fact that the Authors' reported c value range (maximum of 45.8 kPa) is substantially below the unconfined compression strength q_u values they measured for the various cured, cemented sand–EPS beads mixtures, as evidenced, for instance, in Fig. 8 of the Authors' paper.
- The Authors do not report the range of vertical stress applied in performing their CU shearbox tests. Since the experimental failure envelope for cemented sand–EPS beads mixtures is likely curved when examined over a wide vertical stress range, this could be important information in view of the range of vertical stress anticipated in potential field applications for these mixtures; as such, it would be helpful if the Authors would report the vertical stress range they investigated in the CU shearbox tests.

As minor points, the Discussers note the Authors reported in Page 2 of their paper that the EPS foam beads tested, with 2–4 mm diameter range, had a density of about 0.01 kN/m^3. It is the Discussers' experience that this value would seem to be one order of magnitude too small, with the reported density (unit weight) of various 2–4 mm diameter EPS beads materials ranging 0.11–0.20 kN/m^3 [8–10]. Furthermore, the units of the axial (volumetric) strain for the one-dimensional compression (oedometer) results reported in the Authors' paper, including those for the y-axis of Fig. 13 in their paper, should presumably be dimensionless, rather than as presently reported as %?

The Discussers would also like to comment on the description provided in the Abstract of the Authors' paper

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Published online: 05 April 2022

referring to EPS beads as 'environmentally friendly' material, noting that they provided no discussion of (nor gave any consideration to) potential environmental impacts of blending myriads of EPS beads with soils in situ. For the ground engineering context (with the present case considering EPS beads mixed with soil), there are emerging, potentially significant threats of micro (nano) plastics (MNPs) pollution to aquatic and terrestrial ecosystems [1, 11–13], as well as ecological influences for soil–plant systems and even human health [14]. To compound the issue, MNPs have been shown to act as a transport vector in soil and groundwater for other potential pollutants, including human pathogens, heavy metals and organic contaminants [11, 15], and they can alter the behaviour of these contaminants, potentially including priority pollutants, such as plasticizers and flame retardants, which enter in the manufacturing of plastics to enhance their engineering properties. As such, MNPs can become an important conduit for the migration of these contaminants in the subsurface, including potentially significant negative implications for groundwater quality [11]. It should also be considered that at the end-of-life of a lightweight embankment whose construction includes soil–EPS beads mixture layers, the myriads of separate EPS beads contained in these soil layers are not alienable from the soil and hence they are not recyclable [1], such that the entombed EPS beads have potential for substantial negative environmental effects over time [1, 11].

Funding Open Access funding enabled and organized by CAUL and its Member Institutions.

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