Special Issue on “Materials and Processes for Ground Engineering Infrastructure”

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With the growing carbon emission and concerns of climate change, the demand for sustainable infrastructure development around the world is increasing. Numerous investigations have been carried out for utilization of sustainable materials in ground engineering owing to their benefits to environment and lower project costs.

This special issue aims to disseminate and communicate scientific knowledge on the subject related to the development of materials and processes for ground improvement. Fundamental understanding of geomaterials–fluid–environment interaction is complex, and it requires multi-disciplinary approach, involving expertise of geotechnical, environmental, biological, ecological and material science perspectives. The topics of this special issue cover various aspects, including laboratory testing and evaluation of material properties, field monitoring of ground improvement practices, data processing techniques, theoretical and numerical modelling, and supporting technologies and methodologies in ground engineering infrastructure.

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This special issue contains several papers dealing with the usage of new materials ranging from fibres to powder-based materials (waste marble, eggshell, flyash, and bio-char) and pre-fabricated drains from different perspectives (freeze–thaw, dry–wet resistance, dynamic shear, compressive and tensile loading as well as gas flow) [1–12]. Coir and hemp fibres along with fly ash based alkaline binders are found to have profound effect on geotechnical properties of soils, such as tensile strength under the condition of freeze–thaw cycles [1]. Improvement in unconfined compressive strength of soil by mixing with fibres is observed with an increase in aggregate size [2]. However, optimal fibre content and length are required for achieving the maximum efficiency in enhancement of strength [2]. Polypropylene fibres along with silica fume have also been utilized for the treatment of expansive soil subgrades [3].

Apart from fibres, some powder form materials, such as waste marble powder in combination with magnesium phosphate cement, are useful in improving the shear strength of soil [4]. These powder forms are originated from waste materials and have less alternative usage compared with fibres, which are agricultural residues and have alternative use in food chain of animals and also in textile manufacturing in developing countries. The requirement of percentage content of powder form materials from 7.5% for waste marble powder [1] to 30% for biochar powder [5] to achieve peak performance is much higher than that of fiber content (within 1% mainly [1]). This could be related to tensile strength of fibre itself, which enhances mobilization of shear forces within amended soil specimens. Dynamic properties of soil are also found to improve with an addition of nano-MgO [6]. However, there is a need to further understand the use of chemicals on leaching effects under water infiltration. An innovative combination of eggshell powder (ESP) and fly ash (FA) has been explored for the use as a sustainable base course material [7]. The internal mechanism reveals that for the ESP–FA geopolymer, cementitious products are formed at a given optimum activator ratio and heat condition [7]. In

addition to static loads, sustainable materials, such as pond ash, have been found to be effective in enhancing stiffness of silty soil at large displacements [8].

Another popular powder form sustainable material, that has been explored for landfill covers recently is “biochar” [5, 9, 10]. Biochar, as a carbon-based material, has been used extensively in the past few decades for enhancing crop productivity and soil fertility [9]. However, its usage in geotechnical engineering is limited. Biochar has been found to be able to reduce compressibility of clay fraction rich soils. However, its effect on soil swelling is yet to be concluded [10]. Finer biochar is found to be more effective than coarser one [10]. In landfill cover, it is also essential to minimize landfill gas (CH_4 and CO_2) emissions [5]. Since biochars can be produced from different waste materials such as wood or herbaceous, it is important to quantify the effect of feed-stock type on the performance of landfill gas adsorption. The results of a series of batch tests reveal that wood-based biochar (at 20% content) is able to adsorb landfill gases and also causes methane oxidation more significantly than corn or straw biochars [5]. This finding is useful for engineers to narrow down the selection of appropriate biochar for usage in cover material in landfill. Based on field study in semi-evergreen and moist deciduous forest in north-eastern part of India, it is found that CO_2 emission is reduced significantly upon addition of biochar [9]. Though, biochar is beneficial for enhancing the hydraulic properties, its effect on mechanical strength needs further investigation.

Apart from the above use of ground improvement, pre-fabricated vertical drains are well-proven technology for accelerating the consolidation of soft soil in field, and hence, increases the stiffness and shear strength [11]. Foundation is expected to be more stable on a ground installed with pre-fabricated vertical drains due to reduced water content [11]. A new economic and non-destructive (i.e., image processing) approach has been explored for monitoring of soil water content [12]. The technique uses “colour” analysis principle for indicating the soil water content [12]. Such a technique can be further customized for usage in ground engineering infrastructure. The distributed fibre optic sensing (DFOS) technology has also been investigated for monitoring internal strain, and hence, stability of geogrid-reinforced slope [13]. In terms of loading conditions, it is essential that performance analysis and preliminary design of ground engineering infrastructure are carried out under combined vertical and lateral loadings [14]. Long-term behaviour considering creep settlement is also important for assessment of serviceability of ground engineering infrastructure, which is investigated in the experimental study by Singh et al. [15].

This special issue has included papers dealing with some alternative new materials (fibres, waste marble, eggshell, fly ash, magnesium oxide and biochar) for geotechnical engineering applications. Fundamental mechanisms involved

in their use, depending on certain conditions, have been investigated. In addition, new technologies for monitoring soil water content and strain are explored. We hope that this special issue would shed light on development and applications of new materials and processes in ground engineering infrastructures and attract attention by the scientific community and civil engineering industry to pursue further investigations leading to the rapid implementation of these methods and technologies.

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