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目　录

Dynamic properties of EPS-sand mixtures using cyclic triaxial and bender element tests

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Abstract: In this study, a series of strain-controlled cyclic triaxial as well as bender element tests are carried out, so that the dynamic properties of mixtures of sand and expanded polystyrene (EPS) beads can be assessed under large and small-scale shear strains, respectively. The effect of various parameters such as shear strain amplitude, confining pressure (25 kPa, 50 kPa and 100 kPa) and EPS weight content (up to 2% by weight) on the small strain shear modulus, secant shear modulus and damping ratio is investigated. Laboratory results indicated that the values of shear velocity and shear modulus obtained from the bender element tests decrease with increasing EPS content. The results also revealed that the damping and shear modulus of the samples are highly dependent on the weight percentage of EPS, such that the increase in EPS content results in the increase of damping ratio up to 100% or even more under constant confining pressure. On the contrary, for all the values of confining pressure, the shear modulus of the mixture undergoes a significant reduction with increasing EPS content. Moreover, it is shown that the confining pressure has a important impact on both the soil damping ratio and shear modulus.

Keywords: Geosynthetics, EPS beads, Chamkhaleh sand, Cyclic triaxial, Bender element, Shear modulus, Damping ratio

Field load tests and modelling of soft foundation reinforced by soilbags

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Abstract: A study was performed to investigate the bearing capacity of foundations reinforced by soilbags filled with excavated soft soils by conducting field load tests and numerical analysis. The effect of the number of reinforcement layers on the bearing capacity of the soilbag-reinforced foundation was investigated. Both the experimental and numerical studies indicated that soilbag reinforcement with reused exca vated soft soils as the contained soilbag material can substantially improve the bearing capacity of the soft foundation and reduce settlement under vertical loading conditions. The bearing capacity was also found to increase with increasing number of soilbag reinforcement layers. The numerical analysis indicated that stress dispersion occurred through the soilbag reinforcement to reduce the load transferred to the underlying soft soils. High-quality compaction of the soilbag layers during construction is very important to improve bearing capacity. In addition, the excess pore water pressure generated in the soft foundation was less with the soilbag reinforcement and decreased with an increasing number of reinforcement layers due to the relatively high permeability of the soilbag reinforcement.

Keywords: Geosynthetics, Soilbag-reinforced soft foundation, Bearing capacity, Field load test

Geosynthetic reinforcement stiffness characterization for MSE wall design

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Abstract: Reinforcement stiffness is a key parameter that influences the magnitude of tensile loads in geosynthetic mechanically stabilized earth (MSE) walls under operational conditions. An estimate of reinforcement creep stiffness at 2% strain and 1000 h is required to carry out internal stability design using the Simplified Stiffness Method. This paper provides equations that can be used to estimate the reinforcement creep stiffness based on the tensile strength for different reinforcement product types. The paper also explores how the tensile strength values of a product can vary depending on the population of tests used to compute strength values. The differences in choice of nominal tensile strength based on lot-specific and minimum average roll value (MARV) are discussed. The paper demonstrates that the Simplified Stiffness Method soil failure limit state will usually control the selection of the reinforcement and not the tensile strength limit state. While the primary motivation for this study is to find creep stiffness values for the Simplified Stiffness Method, the stiffness-strength equations are useful in other applications such as numerical modelling of geosynthetic-reinforced structures where a reinforcement stiffness value corresponding to post-construction low tensile strain conditions is required.

Keywords: Geosynthetics, Tensile stiffness, Geogrid, Geotextile, Polymer strap, HDPE, PP, PET , Mechanically stabilized earth (MSE) walls, Minimum average roll value (MARV), AASHTO National Transportation Product Evaluation Program (NTPEP), Simplified stiffness method, load and resistance factor design (LRFD), Tensile strength limit state, Soil failure limit state

Performance of GCLs in high salinity impoundment applications

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Abstract: The interface transmissivity (θ) and hydraulic conductivity (k) are measured for two geosynthetic clay liners (GCLs), one with polymer-enhanced bentonite, when hydrated and permeated with saline (brine) solutions at three different concentrations and Reverse Osmosis (RO) water. Two interface transmissivity values are reported, the 2-week ($\theta_{\text{2-week}}$) and the steady-state ($\theta_{\text{steady-state}}$) interface transmissivity. For saline solution (brine) permeation, the 2-week interface transmissivity ($\theta_{\text{2-week}}$) is one to two orders of magnitude higher than the steady-state values. In addition, the steady-state interface transmissivity ($\theta_{\text{steady-state}}$) with respect to brine is almost an order of magnitude higher than that for RO water permeation. Geomembrane (GMB) stiffness has a limited effect on interface transmissivity at 150 kPa, whereas at 10 kPa the interface transmissivity decreases as the GMB stiffness decreases. GMB texture has only a small effect on interface transmissivity at different stress levels. Water prehydration reduces the effect of brine permeation on interface transmissivity and hydraulic conductivity, especially at 150 kPa. Transmissivity tends to increase as the salt concentration increases but the effect was significant at all concentrations considered (440 to 4400 mmol/l). While the effect of bentonite enhancement on interface transmissivity is unclear, the hydraulic conductivity (k) is generally lower for enhanced bentonite.

Keywords: Geosynthetics, Interface transmissivity, Polymer-enhanced bentonite, Geosynthetic clay liner (GCL)

Centrifuge model tests of geogrid-reinforced slope supporting a high embankment

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Abstract: Mechanical and hydraulic properties of recycled concrete aggregate (RCA) were evaluated for use as backfill in mechanically stabilized earth (MSE) walls. Large-scale drained triaxial tests, direct shear tests and pullout tests were performed to obtain mechanical properties of RCA interacting with various geosynthetics. Long-term filtration (LTF) tests were performed to evaluate hydraulic conductivity of RCA-geotextile systems. Results showed that the RCA had an internal friction angle of 49°, which was within the typical range. The RCA-uniaxial geogrid had the highest interface friction angle of 36° – and the interface friction angles of RCA-biaxial geogrid, RCA-nonwoven geotextile, and RCA-woven geotextile were 32°, 26° and 22°, respectively. Reinforced RCA showed comparable pullout capacity to reinforced sand. No slippage was observed between the RCA and geotextiles or geogrids, and the failures occurred mainly due to rupture of the geotextiles and geogrids during the pullout test. Results of the LTF tests showed that, over a filtration period of 2500 h, the ratio of mean hydraulic conductivity of RCA only to that of RCA-nonwoven geotextile and RCA-woven geotextile systems remained between 0.91 and 3.2, suggesting that the clogging of the geotextiles with RCA was minimal.

Keywords: Geosynthetics, Filtration, Geogrid, Geotextile, Image analysis, Recycled concrete aggregate

Geogrid installation damage caused by recycled construction and demolition waste

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Abstract: Using recycled construction and demolition waste (RCDW) in geosynthetic reinforced soil (GRS) structures presents attractive environmental and economic aspects. However, bearing in mind installation damage can be responsible for significant changes in geosynthetic tensile-strain behavior, the damage caused by the RCDW must be assessed and quantified. This study aims to investigate the occurrence of mechanical damage during the installation of geogrids with RCDW backfill material using an in-field test facility. In order to understand the mechanisms related to the damage, the influences of the dropping height and compaction method were investigated. Statistical analysis using the Student's *t*-distribution was carried out to validate the occurrence of damage and calculate reduction factors for geogrids' tensile strengths. Results revealed that dropping processes reduced the geogrid ultimate tensile strengths, but the compaction methods caused the highest reductions. The reduction factor values encourage the design of GRS structures with RCDW, an interesting option to satisfy the technical and economic aspects required for these structures in agreement with the environmental concerns.

Keywords: Geosynthetics, mechanical damage, recycled construction and demolition waste, dropping height, compaction methods, reduction factors

Experimental and numerical study on square anchor plate groups in geogrid reinforced sand

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Abstract: The paper investigates the behaviour of groups of horizontal square anchor plates in geogrid-reinforced sand using laboratory model tests. The optimum spacing for two anchor plates in unreinforced sand is 3.4 times the anchor width. The unreinforced groups of anchor plates show a clear failure at a displacement of about 5% of the anchor width, whereas this value increases to more than 45% for reinforced groups along with a two-fold increase in uplift capacity. The optimum width and length of the geogrid reinforcement for groups of two anchors is found to be 5 and 9.4 times the width of the anchor plate, respectively. The performance improvement for isolated anchor plates is found to be maximum and gradually reduces with an increase in the number of plates; however, this reduction is much less in groups of two to four. Therefore, the results obtained from the model tests for reinforced groups of two to four anchor plates can be conveniently used to extrapolate the uplift capacity of multiple anchor plate systems in a reinforced soil mass. The model test results show a reasonably good agreement with the three-dimensional (3D) numerical analysis results.

Keywords: Geosynthetics, Groups of anchor plates, Uplift capacity, Model tests, Numerical analysis