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摘要集

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目　录

Effect of geocell-reinforced sand base on bearing capacity of twin circular footings

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Abstract: The presence of a rigid layer underlying a soil bed layer supporting twin footings affects the footing bearing capacity and settlement. In this study, the bearing capacity and settlement of twin large-scale circular footings on unreinforced and geocell-reinforced sand layers with various thicknesses are investigated. The role of layer thickness, distance between two adjacent footings, and footing diameter indicates that the rigid base substantially influences the footing bearing pressure, settlement and tilt. The results show that the maximum bearing capacity is achieved when two footings are in contact and the rigid base is at shallow depth. The influence of the footing interference on settlement and tilting of closely spaced footings at a given load decreases with decreasing depth of rigid base and reinforcing the sand with geocells. This is observed for rigid bases located at less than about 2B, where B is the footing diameter.

Keywords: Geosynthetics, Geocell reinforcement, Circular footing, Footing settlement, Bearing capacity, Interference effect, Rigid base

Large-scale pullout testing and numerical evaluation of U-shape polymeric straps

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Abstract: In this paper, U-shape polymeric strap (UPS) reinforcement, which can develop passive resistance in the soil, is investigated. The curved (looped) part of the strap at the free end of the reinforcement generates a passive resistance in the soil and increases the pullout resistance beyond what is available due to friction of the horizontal portions of the strap. In this paper, UPS pullout resistance is first compared with that of the typical double polymeric strap (DPS) through large-scale pullout experiments. The experimental results in compacted granular soil show that the curved strap part of the DPS configuration is capable of increasing the pullout resistance by about 130–194%. To improve understanding of pullout behavior, 3D finite element modeling was used to model the pullout behavior of the DPS and UPS configurations. In addition, the bearing resistance factor (*N*q) was calculated using three equations for general shear failure, punching shear failure and 'hybrid' failure. The equation for general shear failure gave the best agreement with measured values of *N*q from the laboratory pullout tests.

Keywords: Bearing resistance factor, Geosynthetics, Large-scale pullout test, Polymeric strap, Soil-reinforcement interaction, U-shape

Load behaviour of model strip footings on reinforced transparent soils

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Abstract: A number of loading tests were performed in the laboratory on strip footings resting on unreinforced and geotextile reinforced transparent soils. Fused silica sand and white oil were used to manufacture the transparent soils. Reinforcement layers with different lengths were placed at a vertical spacing of 0.25*B* and 0.5*B*, with reinforcing depths varying from 0.5*B* to 2*B* (*B* is the width of the strip footing), and reinforcing widths ranging from 1*B* to 7*B*. The deformation of the reinforcement layers and soil was monitored using digital cameras with the aid of a laser transmitter to highlight the deformation of the reinforcement layers. Two peaks were observed in the load-settlement curves of some footings on soils with reinforcements at 0.5*B* spacing. The deformation of the reinforcement layers showed that each peak point is related to the failure of one layer of reinforcement, indicating the progressive development of reinforcement failure into deeper layers. Most of the footings on soils with reinforcement layers at 0.25*B* spacing showed brittle failure behavior, which was due to the near-simultaneous rupture of the reinforcement layers. It was also found that longer reinforcement does not always provide greater bearing capacity at certain reinforcement spacings.

Keywords: Geosynthetics, Bearing capacity, Failure mechanism, Reinforced soil foundation, Transparent soil

A new image-based technique for measuring pore size distribution of nonwoven geotextiles

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Abstract: The use of digital images to evaluate geotextile characteristics has appeared in the scientific literature, particularly for estimating the pore size distribution (PSD) of nonwoven geotextiles used for filtration purposes. While numerous image analysis techniques for PSD curve estimation have been proposed, automation of the analysis methods has received almost no attention. The goal of the present study is to quantify PSD curves from images of representative geotextile specimens using a fully automatic algorithm and considering the concept of largest inscribing opening size. These features are incorporated in a software program (GeotexInspector) developed by the second author. GeotexInspector is based on the concept of classification using the Support Vector Machine technique and digital image processing. These techniques are combined to develop a tool with a robust learning algorithm to identify geotextile fibers and pores. PSD curves from continuous filament and staple fiber nonwoven geotextiles are estimated using GeotexInspector and then compared with theoretical models that have appeared in the literature. The results indicate that the curves obtained from image analysis are in good agreement with model outcomes for models focused on the structure of geotextiles that are similar to the geotextiles used in this study.

Keywords: Geosynthetics, Nonwoven geotextiles, Image analysis, SVM, Pore size distribution

Mechanistic-empirical analysis of geogrid-stabilized layered systems: Part I. Solutions

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Abstract: It is well known that the mechanisms of geogrids in stabilizing base courses over subgrade include lateral restraint and tensioned membrane effects. However, no elastic solutions are available to quantify the responses of base and subgrade due to the effect of a geogrid. This study aimed to develop elastic solutions for geogrid-stabilized base courses over subgrade by considering lateral restraint and tensioned membrane effects. For the analysis of the geogrid-stabilized layered elastic system, lateral resistance and vertical support of the geogrid were expressed as two external stresses determined by the vertical and lateral deformations. The external stresses were then applied at the interface of the two-layer elastic system as continuity conditions and the elastic solutions under a circular load in a cylindrical coordinate were developed according to the elastic theory. The solutions are able to simulate the elastic responses of soil layers due to the effect of the geogrid, for example, elastic strains, vertical stresses, and radial stresses. In addition, the lateral restraint and tensioned membrane effects can be separated by only applying the corresponding external stress at the interface. In the companion paper, the solutions are first verified by test data and then discussed.

Keywords: Geosynthetics, Layered elastic system, Mechanistic-empirical approach, Lateral restraint, Tensioned membrane effect

Mechanistic-empirical analysis of geogrid-stabilized layered systems: Part II. Analysis

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Abstract: In recent years, the mechanistic-empirical design method has become popular for pavement design. In the mechanistic-empirical design of geogrid-stabilized roads, elastic solutions for the geogrid-stabilized layered system are necessary but not yet available. In the companion paper, the analytical solutions for the geogrid-stabilized layered system were derived according to the layered elastic theory and the mechanistic-empirical approach. In this study, the elastic responses (i.e. vertical stresses, radial stresses, and elastic strains) due to the effect of the geogrid were investigated based on these solutions. The analytical solutions were then employed to estimate the reduction of vertical stresses underneath the geogrid compared with the measured results, which show reasonable agreement. A parametric study was conducted to investigate the effect of lateral restraint and tensioned membrane on the elastic responses, with the surface deformation at different base thicknesses and base-to-subgrade modulus ratios. The results clearly show that the lateral restraint effect is more significant compared to the tensioned membrane effect when the surface displacement is less than 75 mm, especially in a section with a relatively thick base course. The analytical solutions may be implemented in the mechanistic-empirical design of geogrid-stabilized unpaved roads.

Keywords: Geosynthetics, Layered elastic system, Mechanistic-empirical approach, Simplified solutions, Vertical stress

Prediction of footing settlements with geogrid reinforcement and eccentricity

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Abstract: This study presents settlement predictions for footings with geogrid reinforcement and biaxial eccentricity using multi-linear regression (MLR) and artificial neural network (ANN) methods. The effects of central, uniaxial and biaxial eccentric loading conditions on embedded and non-embedded square footings in unreinforced and reinforced soils were investigated with laboratory model tests given in the first part of the study. Variations in the bearing capacity were determined through vertical load versus settlement curves drawn after each test. In the second part of this study, MLR and ANN models used to predict settlement were improved using independent variables related with the footings and geogrid. The results showed that fluctuations in the datasets of the settlement were very well reflected by the ANN methods.

Keywords: Geosynthetics, Settlement, Bearing capacity, Square footing, Biaxial eccentricity, MLR, ANN

Performance of a geosynthetic cementitious composite mat for stabilising sandy slopes

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Abstract: In recent years, there has been much research interest in soil erosion and slope failure due to seepage and rainfall, especially toward finding new technologies/materials with which to stabilise soil slopes. Many geosynthetic materials have been developed to stabilise soil slopes while also being environmentally friendly and convenient for construction. In this study, the performance of a novel geosynthetic cementitious composite mat (GCCM) is studied regarding its ability to stabilise soil slopes. Physical model tests are performed on sandy soil slopes under seepage conditions both with and without GCCM stabilisation. Particle image velocimetry is used to measure the soil displacement, and standpipe piezometers are used to monitor the pore water pressure of the slope. The results show that the slope displacement with GCCM stabilisation is much smaller than that without it. The presence of the GCCM constrains the displacement near the slope surface to being along the slope, whereas without the GCCM the slope can deform freely especially in the middle to upper zone of slope area. The results indicate that the GCCM performs well at slope stabilisation.

Keywords: Geosynthetics, Composite materials, Slope stabilisation, 1G physical model, Particle image velocimetry, Deformation

Natural frequencies of full-height panel reinforced soil walls of variable cross-section

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Abstract: Natural frequency has a significant influence on the dynamic response of structures. In this study, a new transfer matrix method is proposed to calculate the natural frequencies of reinforced soil retaining walls by modeling the facing and reinforcement layers as a beam-and-spring assembly using beam-on-elastic foundation theory. Among the advantages of the proposed method are that the method can be applied to both the uniform and tapering facing cross-sections, and it can be used to calculate higher-order natural frequencies of reinforced soil retaining walls. The accuracy of the proposed method is demonstrated by comparing its predicted frequency results with those using analytical and numerical methods reported in related literature. A parametric analysis is carried out, which indicates that the size and geometry of the facing panel have more significant influences on the natural frequencies of the full-height panel reinforced soil walls than their reinforcement properties.

Keywords: Geosynthetics, Full-height panel facing, Natural frequency, Reinforced soil retaining wall, Transfer matrix method