《Geotextiles and Geomembranes》

(土工织物与土工膜)

<双月刊>

2022年第50卷第4期

摘要集

中国土工合成材料工程协会秘书处

目　录

Performance of two-tiered reinforced-soil retaining walls under strip footing load

Majid Yazdandoust [a,*], Atanaz Bahrami Balfeh Taimouri [b]
a Department of Civil Engineering, Tafresh University, Tafresh, Iran
b Department of Civil Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran

Abstract: In the current study, an attempt was made to investigate the performance of two-tiered mechanically stabilized earth walls (T-TMSEWs) under static footing loading using reduced-scale model tests. For this purpose, twenty-four T-TMSEW models were constructed with three different types of reinforcement (metal strips, geogrid and geostraps) and were loaded using the rotatable and non-rotatable strip footings in different distances to the wall crest. Findings indicated that, although decreasing the reinforcement stiffness and the soil-reinforcement interaction reduces the ultimate bearing capacity of footings, the use of extensible reinforcements with low pull-out capacity and allowing the footing to tilt can be two effective solutions in T-TMSEWs to minimize deformations of backfill surface and connection loads as well as lateral pressures. It was observed that the use of a two-tiered configuration in MSE walls and also reducing tensile stiffness and soil-reinforcement interaction simultaneously, not only lead to change in the slip surface geometry but also prevent the development of deep slip surfaces in the lower tier. On the other hand, increasing the footing distance to the wall crest in the range of reinforced zone was found to be another influential solution to improve the bearing capacity, reduce wall deformations and also minimize lateral pressures.

Keywords: Geosynthetics; Two-tiered MSE wall; Strip footing; Geostrap; Geogrid; Metal-strip

Effect of basal reinforcement on performance of floating geosynthetic encased stone column-supported embankment

Jian-Feng Chen [a], Xu Zhang [a], Chungsik Yoo [b,*], Zi-Ang Gu [a]
a College of Civil Engineering, Tongji University, Shanghai, 200092, China
b School of Civil and Architectural Engineering, Landscape Architecture, Sungkyunkwan University, 2066 Seoboo-Ro, Jan-An Gu, Suwon, Kyong-Gi Do, 16419, Republic of Korea

Abstract: In this paper, two centrifuge modeling tests were performed to investigate the influence of basal reinforcement on the global performance of floating geosynthetic encased stone column (GESC)-supported embankments. Based on the centrifuge tests, a 3-dimensional (3D) numerical modeling was carried out to investigate the influence of basal reinforcement on the deformation behavior of the floating GESC-supported embankment. The centrifuge and numerical modeling results showed that the basal reinforcement reduced total and uneven settlement at the embankment crest and base significantly. Moreover, the inclusion of the basal reinforcement significantly reduced the lateral displacement on top of the column, preventing outward bending of the floating GESCs below the embankment toe. However, the basal reinforcement increased the lateral displacement at the bottom of columns.

Keywords: Geosynthetic encased stone column; Embankment; Floating column; Soft clay; Centrifuge test

Evaluation of geosynthetic reinforcement in unpaved road using moving wheel load test

Meenakshi Singh [a,*], Ashutosh Trivedi [a], Sanjay Kumar Shukla [b,a]
a Department of Civil Engineering, Delhi Technological University, Delhi, India
b Geotechnical and Geoenvironmental Engineering Research Group, School of Engineering, Edith Cowan University, Joondalup, Perth, Australia

Abstract: The common cause of failure of the unpaved road is associated with undesirable ruts and deformations. Use of geosynthetic reinforcement is a solution to this pavement distress problem as experienced in limited research works, especially in the laboratory studies. This study presents the performance of geosynthetic-reinforced unpaved roads subjected to moving wheel load tests to investigate the effect of geosynthetic reinforcement on the pavement surface deformation of the unpaved roads. Unreinforced and geosynthetic-reinforced unpaved road test sections consisting of varied reinforcements were constructed in a test pit, 9 m long and 2.7 m wide. Geogrid and geotextile were used for reinforcing the unpaved road test sections. The rut depth was measured in the transverse direction of the wheel path after certain number of wheel passes. Traffic Benefit Ratio (TBR) and Performance Index (PI) were employed in the study for the evaluation of the effectiveness of geosynthetic reinforcement in unpaved roads. After 350 vehicle passes, the geotextile-reinforced and geogrid-reinforced test sections get rutting reduced by 44.89% and 28.57%, respectively. The test results indicate that inclusion of geosynthetic reinforcement significantly improves the rutting resistance and stability of reinforced test sections compared to the unreinforced test sections.

Keywords: Moving wheel load test; Geogrid; Geotextile; Unpaved road; Rut depth

Influence of polymer enhancement on water uptake, retention and barrier performance of geosynthetic clay liners

Zhi Chong Lau [a], Abdelmalek Bouazza [b,*], Will P. Gates [c]

a Department of Civil Engineering, 23 College Walk, Monash University, Melbourne, Vic, 3800, Australia

b Department of Civil Engineering, 23 College Walk, Monash University, Melbourne, Vic, 3800, Australia

c Institute for Frontier Materials, Deakin University, Melbourne, Vic, 3125, Australia

Abstract: This paper explores the influence of polymer enhancement on water uptake and retention by geosynthetic clay liners (GCLs) across a wide suction range (up to 10^6 kPa), including the low suction regime (0.1–10 kPa) typically omitted in past studies. The suction measurement methods used enabled elucidation of water uptake and retention behaviour through the framework of GCL pore structures and their corresponding suction regimes. Polymer enhanced GCLs (PE-GCLs) have high maximum water uptake, and both the water entry and air expulsion values tend to be high. Due to high swelling, the onset of geotextile confinement for PE-GCLs was observed at high suctions. The impact of polymer becomes more apparent when the bentonite achieves a pseudo-two-layer interlayer hydration state at a suction of about 40 MPa (RH = 75%). The hydration mechanism for the polymer fraction in bentonite is unique to the specific polymer type, polymer dosage, and manufacturing process. The water retention behaviour at the low suction range is caused by the in-filling of geotextile pores, bentonite swelling and extrusion, and polymer water adsorption. Insights from this study can form the basis for developing a more suitable bimodal generalised model for fitting the water retention curves of GCLs.

Keywords: Geosynthetics; GCLs; Polymers; Unsaturated; Water retention curves

Effectiveness of a Geocomposite-PVD system in preventing subgrade instability and fluidisation under cyclic loading

Joseph Arivalagan [a], Buddhima Indraratna [b,*], Cholachat Rujikiatkamjorn [c], Andy Warwick [d]

a School of Civil & Environmental Engineering, University of Technology Sydney, NSW 2007, ARC Industrial Transformation Training Centre, ITTC-Rail, University of Wollongong, Wollongong City, NSW, 2522, Australia

b Distinguished Professor and Director, Transport Research Centre, University of Technology Sydney, NSW, 2007, Australia

c School of Civil & Environmental, Engineering, University of Technology Sydney, NSW, 2007, Australia

d Global Synthetics, Australia

Abstract: Instability of subgrade soil sometimes associated with soil fluidisation can lead to uncontrollable deformation and failure at a critical number of loading cycles for a given cyclic deviator stress and frequency. Although numerous laboratory experiments on the performance of Prefabricated Vertical Drains (PVDs) and geocomposites have already been carried out in the past, how effectively this combination can mitigate the potential for subgrade fluidisation under repeated (cyclic) loading is still not properly understood. The primary objective of this paper is to evaluate the integrated role of PVDs and geocomposite in preventing subgrade fluidisation using Dynamic Filtration Apparatus (DFA). Laboratory experiments show that the continuous dissipation of EPWP and the substantial reduction in drainage path lengths by PVDs can prevent subgrade fluidisation at shallow depths, while geocomposite can provide adequate surficial drainage and effective confinement at the ballast/subgrade interface. By measuring the Excess Pore Pressure Gradients (EPPGs) during cyclic loading, the test results convincingly reveal the promising performance of PVD-geocomposite combination under different loading conditions.

Keywords: Prefabricated vertical drains; Mud pumping; Geocomposite; Excess pore pressure gradients; Heavy haul trains

Mechanical property and deformation behavior of geogrid reinforced calcareous sand

Xuan-ming Ding [a,b], Zhao-gang Luo [a,b], Qiang Ou [a,b,*]
a College of Civil Engineering, Chongqing University, Chongqing, 400045, China
b Key Laboratory of New Technology for Construction of Cities in Mountain Area, Chongqing University, Chongqing, 400045, China

Abstract: The strength and deformation properties of maritime geotechnical structures made primarily of calcareous sand are critical for project safety, and geogrid reinforcement is a promising new approach. A series of consolidated drained triaxial experiments were conducted to evaluate the mechanical property and deformation behaviors of geogrid reinforced calcareous sand (GRCS), taking into consideration the impacts of the geogrid layer, relative density, particle size, and confining pressure. In comparison to the unreinforced calcareous sand, the strength of the GRCS is greatly enhanced, and the deviatoric stress-strain curves are altered from slightly softening to hardening, as well as the suppressed shearing dilatancy. The geogrid, relative compactness, particle size, and confining pressure are all intimately related to the volume changes and shearing dilatancy of reinforced specimens, but particle crushing is mostly impacted by the confining pressure. The interactions of geogrid ribs and calcareous sand particles are summarized as two types of constraint and friction using scanning electron microscope tests to establish a simplified calculation method of horizontal and vertical equivalent additional stresses that could provide a reference for revealing the mechanical mechanism of GRCS.

Keyword: Calcareous sand; Geogrid reinforcement; Strength and deformation; Particle crushing; Interface interaction; Equivalent additional stress; Mechanical mechanism

Experimental study on the load bearing behavior of geosynthetic reinforced soil bridge abutments with different facing conditions

Jun Zhang [a,b], Yafei Jia [c], Wenhao Guo [c], Jianbin Zhao [d], Jianming Ling [a], Yewei Zheng [c,*]

a College of Transportation Engineering, Tongji University, Shanghai, 201804, China

b Shanxi Transportation Technology Research & Development Co., Ltd., Key Laboratory of Highway Construction and Maintenance Technology in Loess Region, Taiyuan, 030032, China

c School of Civil Engineering, Wuhan University, Wuhan, Hubei, 430072, China

d School of Civil Engineering, Taiyuan University of Technology, Taiyuan, 030032, China

Abstract: This paper presents an experimental study on reduced-scale model tests of geosynthetic reinforced soil (GRS) bridge abutments with modular block facing, full-height panel facing, and geosynthetic wrapped facing to investigate the influence of facing conditions on the load bearing behavior. The GRS abutment models were constructed using sand backfill and geogrid reinforcement. Test results indicate that footing settlements and facing displacements under the same applied vertical stress generally increase from full-height panel facing abutment, to modular block facing abutment, to geosynthetic wrapped facing abutment. Measured incremental vertical and lateral soil stresses for the two GRS abutments with flexible facing are generally similar, while the GRS abutment with rigid facing has larger stresses. For the GRS abutments with flexible facing, maximum reinforcement tensile strain in each layer typically occurs under the footing for the upper reinforcement layers and near the facing connections for the lower layers. For the full-height panel facing abutment, maximum reinforcement tensile strains generally occur near the facing connections.

Keywords: Geosynthetic; Geosynthetic reinforced soil; Bridge abutment; GRS abutment Facing condition

An analytical solution for contaminant extraction from multilayered soil using PVD-enhanced system

Xue Zhou [a,b,1], Heng-Yu Wang [b,c,*,1], Dao-Sheng Ling [a,b], Xiao-Wu Tang [a]

a College of Civil Engineering and Architecture, Zhejiang University, No. 866, Yuhangtang Road, Hangzhou, 310058, China

b College of Civil Engineering and Architecture, NingboTech University, No. 1, Qianhu South Road, Ningbo, 315100, China

c Ningbo Research Institute, Zhejiang University, No. 1, Qianhu South Road, Ningbo, 315100, China

Abstract: Prefabricated vertical drains (PVDs) have been employed to enhance the in-situ remediation of contaminated fine-grained soils. Subsurface heterogeneity can interfere with the distribution and extraction of contaminants during the remediation process. In the present study, an analytical solution for contaminant extraction from multilayered soil using a PVD-enhanced system is developed based on an equivalent planar two-dimensional model. The analytical solution is derived using a procedure that combines the Laplace transform, eigenfunction method and numerical Laplace inversion. The validity and accuracy of the solution are verified by comparison with an existing analytical solution and the results obtained using a numerical model. The effects of several key parameters on the performance of a PVD remediation system in a triple-layered contaminated soil are evaluated. The results indicate that the remediation efficiency for clay layers decreases with increasing hydraulic conductivity or thickness of the sand layer. The PVD remediation system may be unfeasible for contaminated sites with high subsurface heterogeneity caused by permeability contrast. The remediation process for clay layers can be accelerated by increasing the clay vertical dispersivity.

Keywords: Analytical solution; Remediation; Multilayered soil; Prefabricated vertical drains

Field trial of a reinforced landfill cover system: performance and failure

Giampaolo Cortellazzo [a], Luis E. Russo [b], Stefano Busana [c], Laura Carbone [d], Marco Favaretti [a,*], Hartmut Hangen [d]

a Dept. ICEA, University of Padova, Italy

b Huesker Srl, Italy

c Freelance Engineer, Italy

d Huesker Synthetic GmbH, Germany

Abstract: The geotechnical stability of an inclined multilayer capping depends on the shear strength available along the various interfaces. If the slope is very steep an additional reinforcing geosynthetic may be used to obtain a safer condition. Full-scale field trials can provide better resolution data on the reinforcement behaviour than conventional calculation methods based only on laboratory tests. The paper deals with a field trial carried out on multilayer capping, reinforced with a geogrid, in an Italian landfill. The geogrid behaviour was monitored for a month using displacement sensors and pressure cells located along the slope and in the anchor trench. Subsequently, the cover system was led to collapse by cutting the reinforcement and an analysis of the reinforcement behaviour and its relevance in the system stability were studied. This paper discusses in detail the setup of the field trial and the experimental data recorded during installation, monitoring, and failure phases of the system. The deformation behaviour of the geogrid during the entire test was recorded and analysed. The resulting data highlight the effects of the construction process on the geogrid behaviour including the contribution of geogrid creep characteristics until the failure.

Keywords: Landfill; Capping; Geosynthetics; Reinforcement; Monitoring; Strains; Veneer stability Creep

Experimental study of PVD-improved dredged soil with vacuum preloading and air pressure

Yajun Wu, Rong Zhou, Yitian Lu *, Xudong Zhang **, Haiqiang Zhang, Quoc Cong Tran
Department of Civil Engineering, Shanghai University, 99 Shangda Road, Shanghai, 200444, China

Abstract: The PVD-vacuum method is the main method used to treat dredged soil, but sometimes it cannot completely meet engineering needs due to the limitations of vacuum pressure. Therefore, based on the traditional PVD-vacuum method, a method of air pressure combined with vacuum preloading is proposed in this paper. The air pressure is transmitted into the dredged soil by using an impermeable and flexible membrane airbag embedded in the dredged soil. A comparison of the traditional PVD-vacuum method and the combination of air pressure and vacuum preloading is investigated by the model test. The data of the settlement and water discharge during the test are monitored. After the tests, the water content and shear strength at different positions are measured. Finally, a method for calculating the volume change of dredged soil is proposed, and the results of the test are used to prove the correctness of the proposed method.

Keywords: Consolidation; Vacuum preloading; Air pressure; Dredged soils

Application of EPS geofoam in rockfall galleries: Insights from large-scale experiments and FDEM simulations

Shuaixing Yan [a], Yu Wang [b,c], Dongpo Wang [a,*], Siming He [b,c,**]

a State Key Laboratory of Geohazard Prevention and Geoenvironment Protection, Chengdu University of Technology, Chengdu, 610059, China

b Key Laboratory of Mountain Hazards and Surface Process, Institute of Mountain Hazards and Environment, Chinese Academy of Sciences, Chengdu, 610041, China

c University of Chinese Academy of Sciences, Beijing, 100049, China

Abstract: Expanded polystyrene (EPS) geofoam presents a promising application in the protection of galleries against rockfall. This paper focuses on experimental and numerical studies that aim to more effectively characterise the impact kinematics between single-block rockfalls and galleries with homogeneous sand and EPS, as well as the EPS-sand composite cushion system. The compression, tensile, and shear properties of EPS are firstly recognised with mathematical descriptions. Then, large-scale experiments considering the rock block mass and velocity help illustrate the general features of impact processes, and quantify the structural dynamic responses as well as the energy dissipation of the cushioning. Finally, the combined finite and discrete element method (FDEM) is first adopted to simulate the combined failure modes of EPS subjected to impact. The numerical model is well verified and exhibits great predictability in the contribution of different materials in the composite cushion system to energy dissipation. The results demonstrate the effective impact resistance of the EPS-sand cushioning. Additionally, they engender an extended methodology for analysing more EPS-based composite cushion systems applied in rockfall galleries.

Keywords: Rockfall gallery; EPS-Based cushion; Structural response; Impact test; FDEM simulation

A general solution for leakage through geomembrane defects overlain by saturated tailings and underlain by highly permeable subgrade

R. Kerry Rowe [a], Jiying Fan [b,*]

a Barrington Batchelor Distinguished University Professor, Canada Research Chair in Geotechnical and Geoenvironmental Engineering, GeoEngineering Centre at Queen's-RMC, Dept. of Civil Engineering, Queen's Univ., Kingston, ON, K7L 3N9, Canada

b GeoEngineering Centre at Queen's-RMC, Dept. of Civil Engineering, Queen's Univ., Kingston, ON, K7L 3N9, Canada

Abstract: Experimental data is presented for leakage through slits, square, and rectangular geomembrane defects overlain by silty sand tailings and underlain by a well-graded gravel. The rectangular GMB defects have a range of widths, B, lengths, L, and aspect ratios (L/B), and ratios of defect length to thickness of tailings above the geomembrane (L/T). A blade cut slit (or simulated stress crack) widens to an extent dependant on the subgrade and stress level. For L= 100 mm, increasing B ($0.15 < B/L \leq 1$) from 1.6 (slit) to 100 mm (square), decreases the leakage from about twice to essentially the same as that for a circular hole of equal area. The ratio (h_1/H) of head loss within the hole, h_1, relative to the total head loss, H, is independent of loading conditions and constant for any particular hole shape (B/L), area ($B{\cdot}L$), and relative depth (L/T). A semi-empirical general solution is developed for a rectangle within the range of $0 \leq B/L \leq 1$ with the solution converging to that for a strip for $B/L \rightarrow 0$ and to a circle for $B/L \rightarrow 1$. The solution gives calculated leakage in encouraging agreement with the experimental data.

Keywords: Geosynthetics; Geomembrane; Tailings; Leakage; Slit; Rectangular defect

Influence of water to cement ratio on mechanical performance of concrete canvas reinforced with warp-knitted spacer fabric

Xiaotao Ma [a], Zhiyong Mei [b], Pibo Ma [a,*]

a Engineering Research Center of Knitting Technology, Ministry of Education, College of Textile Science and Engineering, Jiangnan University, Wuxi, 214122, China

b The First Scientific Research Institute of Wuxi, Wuxi, 214100, China

Abstract: Concrete canvas (CC) has been studied and applied for more than a decade; it has yet to be substantially studied in the field of water dosage. The unreasonable choice of water to cement ratio (w/c) might affect the quality and performance of CC. Thus, in this study, the experimental tests on the setting time, mechanical properties, X-ray diffraction (XRD), optical microscopy (OM) and scanning electron microscopy (SEM) of CC were carried out. The flexural and bursting behaviors in the early curing stage were also illustrated. The selected w/c was based on the water saturation level of CC during spraying. The obtained results indicated that mechanical properties of CC improved with the increase of w/c, while too much water somewhat delayed the hydration process in the first 3 days of curing. On the other hand, the low w/c would lead to insufficient hydration products and large size of loose defective structure in the interlayer of CC. An appropriate overdosage of water is considered suitable for CC solidification by spraying.

Keywords: Concrete canvas; Water to cement ratio; Mechanical properties; Hydration; Interface region

Numerical modeling of floating geosynthetic-encased stone column–supported embankments with basal reinforcement

Xu Zhang [a], Chungsik Yoo [b,*], Jian-Feng Chen [a,**], Zi-Ang Gu [a]
a College of Civil Engineering, Tongji University, Shanghai, 200092, China
b School of Civil and Architectural Engineering, Landscape Architecture, Sungkyunkwan University, 2066 Seoboo-Ro, Jan-An Gu, Suwon, Kyong-Gi Do, 16419, South Korea

Abstract: The performance of the floating geosynthetic-encased stone column-(GESC)-supported embankments with basal reinforcement was examined using a 3-dimensional (3D) hydro-mechanical coupling finite element model. Comprehensive parametric analyses were performed on the governing factors such as consistency of substratum soil, tensile stiffness of basal reinforcement and encasement, and embankment height. The results indicated that a higher embankment load is transferred to the surrounding soil when a GESC was constructed on a weaker substratum. This causes larger increases in the settlement and lateral displacement of the GESC on the weaker substratum. The tensile strain of the basal reinforcement and hoop strain in the encasement also increases. In addition, high tensile stiffness in basal reinforcement and encasement is necessary to ensure feasible settlement reduction in a floating GESC-supported embankment with basal reinforcement.
Keywords: Geosynthetic; Numerical modeling; Floating encased stone column; Embankment; Soft clay

Experimental study on the mechanical behavior of shored mechanically stabilized earth walls for widening existing reinforced embankments

Fei-fan Ren [a,b,*], Huan Xu [a], Yan-jun Ji [b], Qiang-qiang Huang [a], Xun Tian [a]

a Key Laboratory of Geotechnical and Underground Engineering of Ministry of Education, Department of Geotechnical Engineering, Tongji Univ., 1239 Siping Rd., Shanghai, 200092, China

b Shaanxi Key Laboratory of Safety and Durability of Concrete Structures, Xijing Univ., No.1 Xijing Rd., Xi'an, 710123, China

Abstract: Shored mechanically stabilized earth (SMSE) walls have been increasingly applied in embankment widening projects because of their good mechanical performance, simple construction, low cost, and low site requirements. In this paper, several large-scale model tests were conducted to explore the mechanical behavior of the composite structures with different connection forms and relative densities, and the wall deformation, earth pressure, reinforcement strain, potential failure surface and the effects of the connection forms behind SMSE walls were also analyzed. The results show that the deformation of SMSE walls is mainly concentrated on the upper middle part, showing a "bulging" failure trend. The deformation of the SMSE walls can be effectively controlled by improving the relative density and adopting a "sandwich" connection behind the walls. The horizontal earth pressure against the SMSE wall facing shows a "K"-shaped distribution, and the vertical earth pressure is large in the upper part and small in the lower part. The potential failure surface originated at the junction of the old and new retaining walls, forming a "double-line" failure surface. For a "sandwich" connection, the failure surface moves forward and occurs where the primary and secondary reinforcements overlap, and this connection form is recommended in engineering practice.

Keywords: Geosynthetics; Shored mechanically stabilized earth wall; Large-scale model test; Mechanical behavior; Embankment widening

Influence of micro and macroroughness of geomembrane surfaces on soil-geomembrane and geotextile-geomembrane interface strength

Gregório Luís Silva Araújo [a,*], Nelson Padron Sánchez [b], Ennio Marques Palmeira [a], Maria das Graças Gardoni de Almeida [c]

a Department of Civil and Environmental Engineering, FT, University of Brasilia, 70910-900, Brasilia, DF, Brazil

b PROGEN Management and Engineering, Belo Horizonte, MG, Brazil c Department of Transportation and Geotechnics, Federal University of Minas Gerais, 31270-901, Belo Horizonte, MG, Brazil

Abstract: The interface shear strength involving geosynthetics and other materials can be influenced by various parameters, such as the material type and the normal stress on the interface. Although several investigations have been conducted over the years on this topic, the large variation of interfaces that can be used has led researchers to develop other sources of information to improve design methods. This paper investigates how roughness parameters can influence the shear strength developed between different interfaces based on many inclined plane tests and microscopic analyses of the surface roughness. One smooth and three textured geomembranes were used to simulate a barrier layer and sand, and two nonwoven geotextiles were installed on them to simulate drainage or protective layers. A powerful optical apparatus provided fifteen bidimensional and tridimensional surface parameters for the two faces of the analyzed geomembranes. The results showed that the mean height of profile elements (R_c) and the core material volume (V_{mc}) parameters presented stronger correlations with the interface shear strength. The concept of interface roughness factor was introduced to estimate the interface friction between different materials based on the materials properties for interfaces with geotextiles.

Keywords: Geosynthetics; Geomembranes; Surface roughness; Interface shear strength

Novel soil-pegged geogrid (PG) interactions in pull-out loading conditions

M.R. Abdi [a,*], H. Mirzaeifar [b], Y. Asgardun [a]

a K.N.Toosi University of Technology, Tehran, Iran

b Department of Civil Engineering, Pardis Branch, Islamic Azad University, Pardis New City, Iran

Abstract: In current study, large-scale pull-out tests were conducted to examine the behavior of a novel reinforcement system named "Pegged Geogrid" (PG) under pull-out loading condition. Metal pegs were combined with geogrid to enhance resistance to pull-out. Incorporating pegs with geogrids alleviates bolting, welding, clamping, increasing geogrid length or making alterations to the geogrid as recommended by previous researchers. Peg roots are simply inserted/driven through apertures into the soil, nailing the geogrid to the lower and subsequently the upper backfill layers. Effects of soil particle size, normal pressure, peg length, width, and numbers has been evaluated using two sandy and a gravely soil. Results show that inclusion of pegs significantly enhances soil passive resistance contribution to pull-out. Increasing the width and number of pegs, resulted in enhancing passive soil resistance activation in front of the bearing surfaces and thus greater pull-out resistance augmented by soil particle size and normal pressure. Displacements corresponding to maximum pull-out forces gradually improved by peg width and strain distribution along geogrid in the PG system progressively became linear in contrast to the non-linear distribution in the conventional soil-geogrid (NG) system. Normal pressure was more influential on enhancing pull-out resistance in coarser soil.

Keywords: Pegged-geogrid; Pull-out resistance; Interaction; Strain; Particle size

Effect of the particle size ratio on macro- and mesoscopic shear characteristics of the geogrid-reinforced rubber and sand mixture interface

Fei-yu Liu [a], Jun Fu [a], Jun Wang [b], Zi-yang Gao [b,*], Hao-ze Li [a], Jing-ting Li [a]

a School of Mechanics and Engineering Science, Shanghai University, Shanghai, 200444, China

b College of Architecture and Civil Engineering, Wenzhou University, Wenzhou, Zhejiang, 325035, China

Abstract: As a new type of material for civil engineering projects, the rubber and sand mixture is widely used in roadbed fillers, offering environmental benefits over traditional tyre disposal methods. This study uses a large-scale direct shear apparatus to examine the interface shear properties of the geogrid-reinforced rubber and sand mixture, considering different particle size ratios (r), rubber contents, and normal stresses. Based on indoor tests, direct shear models of the mixture with different values of r are established in PFC^{3D}, revealing the meso-mechanical mechanism of the mixture in the direct shear process. The results show that when r is greater than 1, incorporating a certain amount of rubber particles can increase the shear strength of the mixture. The r values of 15.78, 7.63, and 3.98 correspond to an optimal rubber content of 30%, 10%, and 20%, respectively. When r is less than 1, mixing rubber particles can only reduce the shear strength of the mixture. When the rubber content is low, the smaller the value of r, the greater is the thickness of the shear band. Furthermore, the normal and tangential contact forces are greater. The fabric anisotropy evolution law of the mixture is consistent with the change in the contact force distribution.

Keywords: Rubber and sand mixture; Reinforcement–soil interface; Particle size ratio; Shear band; Fabric anisotropy

Liquefaction behavior of fiber-reinforced calcareous sands in unidirectional and multidirectional simple shear tests

Lin Zhou [a], Jian-Feng Chen [a,*], Ming Peng [a], Yan Zhu [b]
a Department of Geotechnical Engineering, College of Civil Engineering, Tongji University, Shanghai, 200092, China
b China Shipbuilding NDRI Engineering Co., LTD, Shanghai, 200090, China

Abstract: A study on the liquefaction resistance of calcareous sands reinforced with polypropylene fibers was reported. Stress-controlled cyclic simple shear tests were conducted on specimens prepared at a relative density of 50%, with and without fiber reinforcements. The liquefaction behavior was investigated by considering the effects of fiber contents ranging from 0% to 1%, fiber lengths varying from 3 mm to 12 mm and loading patterns. The results indicated that increasing fiber content and fiber length resulted in a decrease in the deformation, a reduction in pore pressure accumulation rate, and improved the liquefaction resistance of calcareous sands. Additionally, the risk of soil liquefaction could be significantly reduced when the fiber content was greater than 0.8%. The multidirectional loading had a considerable effect in reducing the liquefaction resistance compared to unidirectional loading. Further, the stiffness degradation of calcareous sands decreased with increasing fiber content and fiber length. The pore pressure generated in the cyclic tests was analyzed and was found to be affected by fiber content. A pore pressure prediction model was proposed to obtain the pore pressure charac-teristics of fiber-reinforced calcareous sands under various fiber content condition

Keywords: Fiber-reinforced calcareous sands; Liquefaction resistance; Stiffness degradation; Pore pressure prediction model; Cyclic simple shear tests

Numerical study of the impact of climate conditions on stability of geocomposite and geogrid reinforced soil walls

G.B. Nunes [a], F.H.M. Portelinha [a,*], M.M. Futai [b], C. Yoo [c]

a Federal University of Sao Carlos, Civil Engineering Department, Washington Luis Rd., Km 235, Sao Carlos, Sao Paulo, 13.565-905, Brazil

b School of Engineering, University of Sao Paulo, Prof. Almeida Prado Ave., 83, Sao Paulo, SP, 05508-900, Brazil

c Dept. of Civil and Environmental Engineering, Sungkyunkwan Univ, 300 Chun-Chun Dong, Jang-An Gu, Suwon, 440-746, South Korea

Abstract: Geosynthetic-reinforced soil (GRS) walls using marginal soils can operate under unsaturated conditions depending on climate conditions and drainage inside the reinforced zone. Geocomposite reinforcements have been suggested to act as internal drainage layers, but their hydraulic behavior can also be strongly affected by climate conditions. Numerical analyses were conducted to observe the impact of four distinct tropical climate conditions (arid, semi-arid, humid subtropical and humid tropical) on suction profiles and stability of reinforced soil walls constructed using geogrid and geocomposite reinforcements. The climate simulation involved the incorporation of a soil-atmosphere interaction on water balance and on the unsaturated transient infiltration. Results indicate the GRS walls can operate under relatively high suction levels under arid climates in which cumulative evaporation overcomes infiltration. Any climate that has rainy seasons with consecutive rainfalls with intensities close to the infiltration capacity of soil and/or monthly cumulative precipitation higher than 200 mm/day led to critical conditions in terms of soil water saturation and stability. Under unsaturated conditions of soil, the drainage effectiveness of geocomposites is significantly reduced and adverse capillary break effects become critical.

Keywords: Geosynthetic; Climate; Walls; Unsaturated soil; Evaporation; Rainfall

Evaluating wettability of geotextiles with contact angles

Md Wasif Zaman[a], Jie Han[a,*], Xiong Zhang[b]
a Department of Civil, Environmental, & Architectural Engineering, The University of Kansas, Kansas, 66045, Lawrence, USA
b Civil, Architectural, and Environmental Engineering Department, Missouri University of Science and Technology, Missouri, 65409, Rolla, USA

Abstract: Geotextiles have been used for drainage purposes in pavements for many years. To drain water out of road sections, the geotextiles need to get wet first. In this study, the wettability of three different types of geotextiles, namely wicking woven (WW) geotextile, non-wicking woven (NWW) geotextile, and nonwoven (NW) geotextile, was investigated in terms of their contact angles dependent on water-geotextile interaction. Contact angle was observed by the VCA Optima XE tensiometer for up to 12 s after a water droplet was dropped at the center of a geotextile's surface. Water droplets of two different sizes (2μL and 5μL) were used to demonstrate the droplet size effect on the contact angles of water on undisturbed geotextiles. Test results show that the contact angle decreased to smaller than 90° and the droplet disappeared on the wicking woven geotextile within a few seconds after water dropping, while the contact angle remained larger than or approximately equal to 90° on the other two types of geotextiles within the observation period. This comparison indicates that water penetrated faster into the wicking woven geotextile than other geotextiles. Furthermore, this study investigated the effects of soil particle intrusion and geotextile or fiber deep groove flattening associated with compaction on the wettability of geotextiles.
Keywords: Geosynthetics; Compaction; Contact angle; Geotextile; Wettability; Wicking