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摘要集

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目 录

Experimental-numerical assessment of geogrid-EPS systems for protecting buried utilities

M. Abdollahi[1], S. N. Moghaddas Tafreshi[2] and B. Leshchinsky[3]

1 Graduate student, Department of Civil Engineering, K.N. Toosi University of Technology, Tehran, Iran, E-mail: masood.abdollahi@email.kntu.ac.ir

2 Professor, Department of Civil Engineering, K.N. Toosi University of Technology, Tehran, Iran, E-mail: nas_moghaddas@kntu.ac.ir (corresponding author)

3 Associate Professor, Forest Engineering, Resources and Management Department, College of Forestry, Oregon State University, Corvallis, Oregon, USA, E-mail: ben.leshchinsky@oregonstate.edu

Abstract: Expanded polystyrene (EPS) is a lightweight material commonly used in sensitive geotechnical applications, particularly in transportation applications that often see a confluence of buried utilities and traffic loading. This study investigates the behavior and efficacy of EPS geofoam post-beam (PB) systems as a means of protecting underground utilities. The PB system consists of two EPS geofoam 'post' blocks that both protect buried utilities and support a capping EPS beam and soil overburden. Two series of laboratory large-scale model tests of the EPS PB system under both unreinforced and geogrid-reinforced soil cover were conducted to explore the effect of beam thickness, soil cover thickness and density of geofoam blocks on system deformations and stress distributions. Experimental results showed that the EPS PB system was effective in bearing the applied load without transferring it to the utilities below. The improvement in system performance was most pronounced when higher geofoam density, thicker EPS beams, geogrid reinforcement and increased soil cover were used. Three-dimensional finite element (FE) numerical models were developed and validated based on test results, and leveraged to provide insight into internal system behavior and design parameter selection.

Keywords: Geosynthetics, EPS geofoam block, geogrid, laboratory test, lifeline, numerical modeling, post-beam system

Degradation of an HDPE geomembrane without HALS in chlorinated water

F. B. Abdelaal[1] and R. K. Rowe[2]

1 Assistant Professor in Geotechnical and Geoenvironmental Engineering, GeoEngineering Centre at Queen's-RMC, Queen's University, Ellis Hall, Kingston, ON, Canada K7L 3N6, E-mail: fady.abdelaal@queensu.ca

2 Professor and Canada Research Chair in Geotechnical and Geoenvironmental Engineering, GeoEngineering Centre at Queen's-RMC, Queen's University, Ellis Hall, Kingston, ON, Canada K7L 3N6, E-mail: kerry.rowe@queensu.ca (corresponding author)

Abstract: The degradation of a 1.5 mm high-density polyethylene geomembrane without hindered amine light stabilizers (HALS) immersed in four chlorinated water solutions is examined over a 3-year period at five temperatures (25, 40, 65, 75, and 85 ℃). To simulate field conditions in potable water reservoirs in which high successive chlorine doses are introduced into the system, the field mass loading of the chlorine was simulated in the laboratory instead of the more typical constant average chlorine concentration. The solutions had a boosted free chlorine content selected to maintain the same ratio of the mass of free chlorine in the water to the surface area of the geomembrane in the immersion jars, as experienced in field applications, for four nominal free chlorine concentrations (content of 0.5, 1.0, 2.5, and 5.0 ppm). The depletion of antioxidants and decrease in stress crack resistance (SCR) for a geomembrane immersed in a solution with 0.5 ppm free chlorine was much faster than in deionised and tap waters or synthetic municipal solid waste leachate. At this concentration, the geomembrane reached complete brittleness after 6 months of incubation at 85 ℃. Arrhenius modelling is used to predict the length of the antioxidant depletion stage and the time to brittleness (reaching SCR = 50 h) in chlorinated water.

Keywords: Geosynthetics, Polyethylene geomembranes, HDPE, Chlorine, Stress crack resistance, Oxidative degradation

Centrifuge model studies on geocomposite reinforced soil walls subjected to seepage

J. Mamaghanian[1], B. V. S. Viswanadham[2] and H. R. Razeghi[3]

1 PhD student, School of Civil Engineering, Iran University of Science and Technology, Tehran – 16765-163, Iran (Former visiting PhD student, Department of Civil Engineering, IIT Bombay, Powai, Mumbai − 400076, India.), E-mail: mamaghani@iust.ac.ir

2 Professor, Department of Civil Engineering, Indian Institute of Technology Bombay, Powai, Mumbai −400076, India, E-mail: viswam@civil.iitb.ac.in (corresponding author)

3 Associate Professor, School of Civil Engineering, Iran University of Science and Technology, Tehran – 16765163, Iran, E-mail: razeghi@iust.ac.ir

Abstract: This paper investigates the effect of geocomposite layers (as an internal drainage system) and a chimney sand drain (as an external drainage system) on the performance of reinforced soil walls with panel facing and marginal backfill. Four models subjected to seepage simulating a rising groundwater surface were tested at 40 gravities using a 4.5 m radius large beam centrifuge. In this study, geocomposite layers played a dual function of drainage and reinforcement. The behavior of wall models was monitored using displacement and pore water pressure transducers during centrifuge tests. An image analysis technique was also used to measure displacement and strain fields. A geogrid reinforced soil wall with no drainage system experienced catastrophic failure at the onset of seepage. Provision of geocomposite layers at the bottom portion of the wall improved the wall behavior. Further, including geocomposite layers up to the mid-height of the wall resulted in superior performance compared to geogrid-reinforced soil walls. The model with the chimney sand drain experienced piping failure at the toe of the wall. The performance of reinforced soil walls with geocomposite layers was found to be superior to the geogrid reinforced soil walls with the chimney drain.

Keywords: Geosynthetics, Geogrid reinforced soil walls, Marginal fills, Centrifuge modeling, Geocomposite, Chimney sand drain

Large-scale triaxial compression tests of geocell-reinforced sand

F. Song[1], H. Liu[2], B. Yang[3] and J. Zhao[4]

1 Associate Professor, Institute of Geotechnical Engineering, School of Highway Engineering, Chang'an University, Xi'an, 710064, P.R. China, E-mail: songf1980@163.com

2 Professor, School of Civil Engineering and Mechanics, Huazhong University of Science and Technology, Wuhan, 430074, P.R. China, E-mail: hbliu@hust.edu.cn (corresponding author)

3 Postgraduate, Institute of Geotechnical Engineering, School of Highway Engineering, Chang'an University, Xi'an, 710064, P.R. China, E-mail: 396277731@qq.com

4 Senior Engineer, Guizhou Electric Power Design and Research Institute, Guiyang, 550002, P.R. China, E-mail: 23498742@qq.com

Abstract: A series of large-scale triaxial compression tests were performed on sandy soil confined by a circular geocell in this study. The effects of the relative density of the infill sand, the stiffness and strength of the geocell, and the aspect ratio (height-to-diameter ratio) of the specimen on the overall behavior of the geocell-soil composite were investigated. Furthermore, the measured confining pressure increment and apparent cohesion induced by the geocell membrane confinement were compared to those predicted by existing equations. The study results indicated that the end effects were very small in this experimental study. The effect of geocell stiffness on the stress-strain behavior of geocell-soil composites is closely related to the relative density of the soil. The measured confining pressure increments and the apparent cohesion are generally in good agreement with those predicted by Bathurst and Karpurapu's equations. The effect of the axial strain at failure on the apparent cohesion is discussed, and a method is proposed to determine the axial strain at failure for medium dense sand and dense infill sand on the basis of the hyperbolic nonlinear elastic model.

Keywords: Geosynthetics, Geocell, Triaxial compression, Apparent cohesion, Axial strain at failure

Evaluation of recycled concrete aggregate backfill for geosynthetic-reinforced MSE walls

A. Soleimanbeigi[1], B. F. Tanyu[2], A. H. Aydilek[3], P. Florio[4], A. Abbaspour[5], A. Y. Dayioglu[6] and W. J. Likos[7]

1 Research Scientist, Department of Civil and Environmental Engineering University of Wisconsin, Madison, Wisconsin, USA, E-mail: soleimanbeig@wisc.edu

2 Associate Professor, Department of Geotechnical and Geological Engineering, George Mason University, USA, E-mail: btanyu@gmu.edu

3 Professor, Department of Civil and Environmental Engineering, University of Maryland, College Park, USA, E-mail: aydilek@umd.edu (corresponding author)

4 Geotechnical Engineer, AECOM, Middleton, WI, USA, E-mail: florio@wisc.edu

5 Geotechnical Engineer, ECS Ltd., Chantilly, VA, USA, E-mail: aabbaspour@ecslimited.com

6 Assistant Professor, Department of Civil Engineering, Istanbul Technical University, Istanbul, Turkey, E-mail: yalcinas@itu.edu.tr

7 Gary Wendt Professor, Department of Civil and Environmental Engineering, University of Wisconsin, Madison, Wisconsin, USA, E-mail: likos@wisc.edu

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

Calibration of PET strap pullout models using a statistical approach

Y. Miyata[1], R. J. Bathurst[2] and T. M. Allen[3]

1 Professor, Department of Civil and Environmental Engineering, National Defense Academy, 1-10-20 Hashirimizu, Yokosuka 239-8686, Japan, E-mail: miyamiya@nda.ac.jp

2 Professor and Research Director, Department of Civil Engineering, GeoEngineering Centre at Queen's-RMC, Royal Military College of Canada, Kingston, Ontario, K7K 7B4, Canada, E-mail: bathurst-r@rmc.ca (corresponding author)

3 State Geotechnical Engineer, Washington State Department of Transportation, State Materials Laboratory, Olympia, Washington, 98504-7365, USA, E-mail: allent@wsdot.wa.gov

Abstract: Polyester (PET) straps are being used more frequently in mechanically stabilized earth (MSE) walls. At present, there is no consensus on a model or models that are suitable for design codes to calculate the pullout capacity of these materials. A database of 296 pullout tests from 81 test series with single and closely-spaced parallel double PET strap configurations was collected by the writers. The data were taken from laboratory and in situ pullout tests. Existing linear and bi-linear pullout models for geosynthetic and steel strip reinforcement were investigated as candidate models and then empirically modified to improve pullout capacity predictions for both single and double PET strap arrangements. A non-linear exponential model with the same number of empirical coefficients was also investigated. The accuracy of each model was assessed quantitatively using bias analysis where bias is the ratio of measured to predicted capacity. The paper shows that non-linear models performed best based on mean and coefficient of variation (COV) of bias values and bias dependency with predicted pullout capacity and magnitude of vertical stress acting on the pullout length. The models investigated in this study are useful for pullout limit state calculations using both deterministic and reliability-based analysis and design approaches.

Keywords: Geosynthetics, Polyester (PET) strap, Mechanically stabilized earth (MSE) walls, Pullout capacity, Reinforced soil walls, Statistical analysis, FHWA, AASHTO

Resilient response of geosynthetics from cyclic and sustained in-air tensile loading

S. W. Perkins[1] and H. N. Haselton[2]

1 Professor, Civil Engineering, Montana State University, Bozeman, MT 59717, USA,
E-mail: stevep@montana.edu (corresponding author)

2 Staff Engineer, Aspect Consulting, Seattle, WA 98104, USA, E-mail: hhaselton@gmail.com

Abstract: Resilient response of geosynthetics is defined as the tensile stress-strain or load-strain response of the material after the application of many cycles of similar load and is used in the analysis of applications involving repetitive loads, such as highway pavements reinforced with geosynthetics. Cyclic loads experienced by geosynthetics in reinforced roadways produce both creep and stress relaxation. Current test standards use a load form corresponding to cyclic stress relaxation. This test standard does not address whether a simpler load form involving non-cyclic, monotonic sustained loads producing load relaxation or creep produces comparable values of resilient modulus. A series of wide-width uniaxial tensile tests were performed on a biaxial geogrid and a woven geotextile. Various load forms were employed involving cyclic and sustained loading, and loading producing load relaxation and creep. Resilient modulus at the end of each type of loading was measured and compared. The results show modest differences in resilient modulus between the different load forms examined and supports the development of a commercial test standard using the simplest type of load form available, which is sustained stress relaxation for displacement-controlled test frames and sustained creep for load-controlled test frames.

Keywords: Geosynthetics, Resilient response, Cyclic loading, Sustained creep loading, Sustained stress relaxation

Dynamic shear modulus and damping of expanded polystyrene composite soils at low strains

H. M. Gao[1], X. Li[2], Z. H. Wang[3], A. W. Stuedlein[4] and Y. Wang[5]

1 Associate Professor, Nanjing Tech University, 200 North Zhongshan Road, Nanjing, Jiangsu, 210009, China, E-mail: hongmei54@163.com

2 MS Candidate, Nanjing Tech University, 200 North Zhongshan Road, Nanjing, Jiangsu, 210009, China, E-mail: 15895878181@163.com

3 Professor, Nanjing Tech University, 200 North Zhongshan Road, Nanjing, Jiangsu, 210009, China, E-mail: wzhnjut@163.com (corresponding author)

4 Associate Professor, Oregon State University, 101 Kearney Hall, Corvallis, OR 97331, USA, E-mail: armin.stuedlein@oregonstate.edu

5 MS Candidate, Nanjing Tech University, 200 North Zhongshan Road, Nanjing, Jiangsu, 210009, China, E-mail: wangyongnjtech@163.com

Abstract: Expanded polystyrene composite soil (EPSCS) has been used extensively in various engineering applications. However, the dynamic characteristics of EPSCS are not well understood. In order to understand the dynamic performance of EPSCS, a series of unconfined compression and resonant column tests were carried out to investigate its stiffness and damping characteristics at low strains, with particular focus on the role of expanded polystyrene (EPS) bead content, cement content and confining pressures. First, the unconfined compressive strength (q_{ucs}) was quantified using replicate specimens to form a basis for quantifying its static strength and correlation to dynamic properties. Then, the dynamic shear modulus and damping ratio for EPSCS were quantified. It is found that the effects of EPS bead and cement content on q_{ucs} and initial shear modulus (G_0) are similar. The q_{ucs} or G_0 of EPSCS increases approximately linearly with the increasing cement content or confining pressure, whereas it decreases with EPS bead content. Empirical models were proposed to predict G_0 using the more readily determined q_{ucs}. Models used to describe the degradation in normalized shear modulus and damping ratio were calibrated for EPSCS at low strains considering EPS bead content, cement content and confining pressure.

Keywords: Geosynthetics, EPS composite soil, Low strain, Resonant column test, Unconfined compression test, Dynamic characteristic