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目　录

Behavior of expanded polystyrene (EPS) blocks under cyclic pavement foundation loading

S. M. A. Ghotbi Siabil[1], S. N. Moghaddas Tafreshi[2], A. R. Dawson[3] and M. Parvizi Omran[4]

1 PhD candidate, Department of Civil Engineering, K.N. Toosi University of Technology, Valiasr St.,Mirdamad Cr., Tehran, Iran, E-mail: aminghotbi@gmail.com

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

3 Associate Professor, Nottingham Transportation Engineering Centre, University of Nottingham,Nottingham, UK, E-mail: andrew.dawson@nottingham.ac.uk

4 MS Graduated, Department of Civil Engineering, K.N. Toosi University of Technology, Valiasr St.,Mirdamad Cr., Tehran, Iran, E-mail: milad.parvizi.omran@gmail.com

Abstract: This study introduces a mechanism for initial assessment and future development to improve understanding of expanded polystyrene (EPS) behavior as a super-lightweight material for road construction. Large scale cyclic plate load tests on model pavements were performed. The effect of several factors including thickness of soil, thickness of subsequent EPS layers and density of EPS on the surface deformations, resilient modulus (M_r) and interlayer pressure transfer were investigated. The results indicated that, compared to a covering soil layer of 300 mm, the rut depth on the loading surface reduced by 13.5% and 40.8% when the soil thickness was increased by 33% and 100%, respectively. With a constant soil thickness, increasing the thickness of an upper (denser) EPS layer with respect to a bottom (softer) EPS layer, from 200 mm to 600 mm, would only result in a 20% decrease in the peak settlements after loading. Resilient modulus of the system was found to be dependent on soil thickness. A designer can choose an appropriate resilient modulus assuming the soil-EPS composite acts as subgrade or subbase. In order to extend the results to a wider range of geofoams, soils and layer thicknesses, a simple stress analysis method was also trialed.

Keywords: Geosynthetics, EPS geofoam, Cyclic plate load tests, Pavements, Lightweight fill

Static and dynamic analysis of two mechanically stabilized earth walls

P. P. Capilleri[1], F. Ferraiolo[2], E. Motta[3], M. Scotto[4] and M. Todaro[5]

1 Researcher in Geotechnical Engineering, Department of Civil and Industrial Engineering, University of Pisa, Largo Lucio Lazzarino no 2, 56122 Pisa, Italy, E-mail: iera.capilleri@unipi.it

2 Corporate Technical Director, Officine Maccaferri S.P.A., Bologna, Italy, E-mail: francesco.ferraiolo@maccaferri.com

3 Associate Professor of Geotechnical Engineering, Department of Civil Engineering and Architecture, University of Catania, via Santa Sofia no 64, 95123 Catania, Italy, E-mail: emotta@dica.unict.it (corresponding author)

4 Corporate Manager, Geosynthetic Business Unit, Officine Maccaferri S.P.A., Bologna, Italy, E-mail: moreno.scotto_cons@maccaferri.com

5 Research Consultant in Geotechnical Engineering, Department of Civil Engineering and Architecture, University of Catania, via Santa Sofia no 64, 95123 Catania, Italy, E-mail: mtodaro@dica.unict.it

Abstract: The behavior of mechanically stabilized earth walls (MSEW), with vertical precast concrete facing panels and polymeric strips, was analyzed under harmonic loading to investigate dynamic wall performance. To this end, finite element method (FEM) analyses were carried out. The numerical model was based on a full-scale test of a 6 m-high wall built in Jundiai, Brazil. The wall was reinforced with polymeric strips made from high tenacity polyester and heavily-coated with low linear density polypropylene. The accuracy of the numerical model was verified first by comparing numerical and experimental results under static loading. The same 2D FEM model was then subjected to harmonic loading to analyze stress and deformation of the geostrips under dynamic loading conditions. In this case, it was found that the axial forces in the reinforcement strips deduced from the numerical analyses are less than those predicted using the American Association of State Highway and Transportation Officials (AASHTO) load and resistance factor design (LRFD) code under both static and harmonic loading. Under harmonic loading, and for the accelerations chosen in the simulations, the resulting active wedge was larger than for the static case.

Keywords: Geosynthetics, Reinforced earth, FEM analysis, Design methods, Seismic analysis, Harmonic load

Failure investigation of a geosynthetic-reinforced soil slope subjected to rainfall

K.-H. Yang[1], J. N. Thuo[2], J.-W. Chen[3] and C.-N. Liu[4]

1 Associate Professor, Department of Civil Engineering, National Taiwan University (NTU), 1, Sec. 4,Roosevelt Rd., Taipei 106, Taiwan, China,
E-mail: khyang@ntu.edu.tw (corresponding author)

2 Lecturer, Department of Civil Engineering, Dedan Kimathi University of Technology, Kenya,
E-mail: joseph.thuo@dkut.ac.ke

3 Research and Development Substitute Services, Research and Technology Development Team, Soil and Water Conservation Bureau, Taiwan, China, E-mail: wiwi820217@gmail.com

4 Professor, Department of Civil Engineering, National Chi-Nan University, Taiwan, China,
E-mail: cnliu2009@gmail.com

Abstract: This paper presents a comprehensive failure investigation of a geosynthetic-reinforced soil (GRS) slope subjected to rainfall. The investigated slope is a 26-m high, four-tier, geogrid-reinforced structure backfilled with low plasticity silty clay that contains more than 60% of fines. The GRS slope first exhibited excessive deformation after typhoons and heavy rainfall from 2010 to 2012. The slope collapsed in 2013 due to two sequential typhoon events with a total accumulated rainfall of more than 600 mm. The slope failed in a compound failure mode in which the failure surface partially cut through the reinforced zone and partially passed along the interface between the weathered sandstone and intact shale. By using the recorded rainfall, site geology, and measured soil and reinforcement parameters, a series of coupled hydro-mechanical finite element analyses were performed on the basis of the unsaturated soil mechanics to examine the failure mechanism and factors triggering the slope failure. The numerical results indicated that the slope failure occurred due to the development of positive porewater pressure within the reinforced zone and retained weather sandstone layer. Observations and lessons learned from this case history are discussed and remedial measures to improve the overall slope stability are proposed and evaluated.

Keywords: Geosynthetics, Reinforced slope, Marginal backfill, Rainfall infiltration, Failure, Coupled hydro-mechanical analysis

On the small-strain stiffness of polypropylene fibre-sand mixtures

H. Li[1], K. Senetakis[2] and A. Khoshghalb[3]

1 PhD student, School of Civil and Environmental Engineering, the University of New South Wales (UNSW), Sydney, NSW 2052, Australia, Email: haiwen.li@unsw.edu.au

2 Assistant Professor, Department of Architecture and Civil Engineering, City University of Hong Kong, Hong Kong SAR, China, E-mail: ksenetak@cityu.edu.hk (corresponding author)

3 Senior Lecturer, School of Civil and Environmental Engineering, the University of New South Wales (UNSW), Sydney, NSW 2052, Australia, Email: arman.khoshghalb@unsw.edu.au

Abstract: In this study, the effect of fibre reinforcement on the small-strain shear modulus (G_{max}) of sandy soils is investigated. A comprehensive set of 47 specimens composed of different types of sand reinforced with variable percentages of polypropylene fibres were tested using a Hardin-type resonant column apparatus embedded with bender element inserts to study the effect of fibre inclusion and content on the G_{max} of sands with different particle shapes and gradations. Accordingly, an expression of G_{max} for sands, previously proposed by the last two authors and their colleagues, was systematically modified in this study to include the effect of fibre content to estimate the small-strain shear modulus of fibre reinforced sands. An additional set of dynamic tests was performed to verify the newly proposed expression. It was shown that the newly developed expression can predict the G_{max} of sand-fibre mixtures with an accuracy of around ±20%, with the error being limited to ±10% in the majority of the cases.

Keywords: geosynthetics, laboratory tests, stiffness

Hydration of geosynthetic clay liners (GCLs) on compacted zeolite

T. Özdamar Kul[1] and A. H. Ören[2]
1 Research Assistant, Department of Civil Engineering, Graduate School of Natural and Applied Sciences, Dokuz Eylül University, Tınaztepe Campus, 35390 Buca-Izmir, Turkey, E-mail: tugceozdamarkul@gmail.com (corresponding author)
2 Associate Professor, Department of Civil Engineering, Dokuz Eylül University, Tınaztepe Campus,35390 Buca-Izmir, Turkey, E-mail: ali.oren@deu.edu.tr

Abstract: The hydration performance of two geosynthetic clay liners (GCLs) over compacted zeolite is investigated in this paper. Zeolite was chosen as the subsoil because of its greater optimum water content with respect to other natural soils (41%). The water content changes of GCL-1 and GCL-2, which each had distinct properties, were the same until 30 days of hydration. The water content of GCL-1 increased from 120% to 147% after 62 days of hydration and then decreased to 117% after 90 days of hydration. However, the water content of GCL-2 was greater than that of GCL-1 (149% vs. 117%) after 90 days of hydration. The reduction in the water content of GCL-1 after 90 days was due to cation replacement. The exchangeable mole fractions of sodium cations (X_{Na}) decreased whereas exchangeable mole fractions of divalent cations (X_{Ca} and X_{Mg}) increased with the duration of hydration. Cation replacement was more pronounced for GCL-1 than for GCL-2. Although swell indices decreased markedly with the durations of hydration, the final hydraulic conductivities of GCL-1 and GCL-2 were almost the same, around $2.0 \times 10{-}11$ m/s. This means higher water content masked the negative influence of cation replacement, resulting in comparable and low hydraulic conductivities for both GCLs.

Keywords: Geosynthetics, Geosynthetic clay liner, Hydration, Subsoil, Swell index, Water content, Zeolite

Physical and mechanical properties of Gravel-Tire Chips Mixture (GTCM)

S. M. K. Pasha[1], H. Hazarika[2] and N. Yoshimoto[3]

1 Graduate student, Department of Civil and Structural Engineering, Kyushu University, Fukuoka 819-0395, Japan, E-mail: manafi.siavash@gmail.com (corresponding author)

2 Professor, Department of Civil Engineering, Kyushu University, Fukuoka 819-0395, Japan, E-mail: hazarika@civil.kyushu-u.ac.jp

3 Associate Professor, Department of Civil and Environmental Engineering, Yamaguchi University, Ube 755-8611, Japan, E-mail: nyoshi@yamaguchi-u.ac.jp

Abstract: In this study, a series of experimental programs were conducted to investigate the physical properties and mechanical behavior of a gravel-tire chips mixture (GTCM). The effects of particle characteristics, tire chips-gravel particle size ratio, relative density, gravel fraction by volume in GTCM, effective confining pressure and drainage condition on shear strength and the deformation characteristics of gravel and GTCM have been investigated. Additionally, the influence of the tire chips-gravel particle ratio and gravel fraction on the maximum and minimum void ratio of GTCM were also examined. Three behavioral zones, gravel-like, gravel-tire chips-like and tire chips-like, were clearly observed and reported by varying the tire chips proportion in the mixture. Outcomes revealed that the gravel fraction along with the particle size ratio of the tire chips to gravel are the main parameters controlling the skeleton, as well as the compaction behavior of GTCM. Results of consolidated compression triaxial tests revealed that the gravel fraction, particle size ratio of tire chips to gravel and confining pressure have significant influence on the stress-strain and dilatancy behaviors of soil and the effects are more pronounced at lower tire chips content ratio in the mixture.

Keywords: Geosynthetics, Gravel-tire chips mixture, Shear strength, Triaxial compression test, Initial tangent modulus, Internal friction angle