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摘要集

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目　录

Mitigation of lateral slope movement and soil improvement using the vacuum-PVD scheme

S. Soralump[1] , N. Koirala[2] and S. Phakdimek[3]
1 Associate Professor, Department of Civil Engineering, Faculty of Engineering, Kasetsart University, Bangkok, Thailand, E-mail: soralump_s@yahoo.com (corresponding author) (Orcid:0000-0001-7446-1860)
2 Graduate Research student, Department of Civil Engineering, Faculty of Engineering, Kasetsart University, Bangkok, Thailand, E-mail: nishkarsha.koirala8@gmail.com (Orcid:0000-0002-8274-3179)
3 Researcher, Geotechnical Engineering Research and Development Centre (GERD), Kasetsart University, Bangkok, Thailand, E-mail: sartsin.p@gmail.com (Orcid:0000-0001-5008-5282)

Abstract: This paper interprets the results from field monitoring which was carried out during vacuum-PVD improvement in a site located near an actively moving slope. Interestingly, the monitoring results showed, among other things, mitigation in the outward lateral movements during and after the preloading process indicating relative stability in the slope and the efficiency of vacuum to mitigate lateral movements during the preloading period. Analyses were made on other field parameters such as pore pressure and settlement, as well as back-calculation of flow parameters to be considered during vacuum preloading design, such as permeability ratio (k_h/k_s) and horizontal consolidation coefficient (C_h)due to vacuum-PVD, were carried out. Post improvement, appropriate geotechnical properties were obtained from laboratory tests of clay specimens from borehole samples and undrained shear strengths were measured from unconfined compression and field vane shear test. The obtained properties indicated improvement in soft soil properties with a reduction in water content and an increase in maximum past pressure, OCR and undrained shear strengths. The prediction made for final shear strength using past literature, where applied additional incremental stress was reduced with depth, matched well with the shear strengths recorded from field testing.

Keywords: Geosynthetics, Soft clay, Ground improvement, Field testing & Monitoring, Slope movement

Laboratory preparation and tensile signal response of sensor-enabled piezoelectric geobelt

Y. Rao[1], J. Ye[2], H. Wang[3], J. Wang[4], G. Ding[5] and J. Ni[6]

1 Graduate student, College of Civil Engineering and Architecture, Wenzhou University, Wenzhou, China, E-mail: raoyu20@163.com (Orcid:0000-0003-4754-9175)

2 Graduate student, Zhejiang Provincial Department of Transportation, Wenzhou, China, E-mail: yejianke666@163.com

3 Graduate student, Zhejiang Provincial Department of Transportation, Wenzhou, China, E-mail: wanghangyu777@163.com

4 Professor, College of Civil Engineering and Architecture, Wenzhou University, Wenzhou, China, E-mail: wangjunx9s@163.com

5 Professor, College of Civil Engineering and Architecture, Wenzhou University, Wenzhou, China, E-mail: zl6895xy@163.com

6 Graduate student, College of Civil Engineering and Architecture, Wenzhou University, Wenzhou, China, E-mail: nijunfeng007@163.com (corresponding author) (Orcid:0000-0002-1073-4628)

Abstract: In this study, a sensor-enabled piezoelectric geobelt (SPGB) was developed and its mechanical properties and signal output mode were analysed. It is found that the output voltage signal of SPGB increases with the increase of strain rate. Furthermore, the normalised impedance of SPGB samples at different strain rates has a linear relationship with their strain rate. This study shows that the self-sensing function of SPGB can monitor its deformation signal and quantify its deformation behaviour. Thus, this function can provide an early warning and has a reference significance for further engineering applications of SPGB.

Keywords: Geosynthetics, Sensor-enabled piezoelectric geobelt (SPGB), Sensor-enabled geosynthetics (SEG), Tensile properties, Piezoelectric effect, UN SDG 11: Sustainable cities and communities

Machine-learning modelling of tensile force in anchored geomembrane liners

K. V. N. S. Raviteja[1,2], K. V. B. S. Kavya[3], R. Senapati[4] and K. R. Reddy[5]

1 SIRE Research Fellow, Department of Civil, Materials, and Environmental Engineering, University of Illinois, Chicago, IL, USA

2 Assistant Professor, Department of Civil Engineering, SRM University AP, Amaravati, Guntur, India, E-mail: raviteja.k@srmap.edu.in

3 Research Scholar, Department of Civil Engineering, SRM University AP, Amaravati, Guntur, India, E-mail: kvbskavya@gmail.com

4 Assistant Professor, Department of Computer Science and Engineering, SRM University AP, Amaravati, Guntur, India, E-mail: rajiv.s@srmap.edu.in

5 Professor, Department of Civil, Materials, and Environmental Engineering, University of Illinois, Chicago, IL, USA, E-mail: kreddy@uic.edu (corresponding author)

Abstract: Geomembrane (GM) liners anchored in the trenches of municipal solid waste (MSW) landfills undergo pull-out failure when the applied tensile stresses exceed the ultimate strength of the liner. The present study estimates the tensile strength of GM liner against pull-out failure from anchorage with the help of machine-learning (ML) techniques. Five ML models, namely multilayer perceptron (MLP), extreme gradient boosting (XGB), support vector regression (SVR), random forest (RF) and locally weighted regression (LWR) were employed in this work. The effect of anchorage geometry, soil density and interface friction were studied with regards to the tensile strength of the GM. In this study, 1520 samples of soil – GM interface friction were used. The ML models were trained and tested with 90% and 10% of data, respectively. The performance of ML models was statistically examined using the coefficients of determination (R^2, R^2_{adj})and mean square errors (MSE, RMSE). In addition, an external validation model and K-fold cross-validation techniques were used to check the models' performance and accuracy. Among the chosen ML models, MLP was found to be superior in accurately predicting the tensile strength of GM liner. The developed methodology is useful for tensile strength estimation and can be beneficially employed in landfill design.

Keywords: Geosynthetics, Anchorage capacity, Machine learning, Geoenvironment, Landfill

Gas flow characteristics of GCL under distortions, wet-dry cycles, and hydrating fluids

V. Khan[1,2] and S. Rajesh[3]

1 Former Research Scholar, Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur, India

2 Associate Professor, Department of Civil Engineering, University of Engineering and Management, Jaipur, India, E-mail: vishwajeet.webmail@gmail.com

3 Professor, Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur, India, E-mail: hsrajesh@iitk.ac.in (corresponding author)

Abstract: Geosynthetic clay liner (GCL) is commonly used in cover system of engineered landfill to limit migration of gases and infiltration of water. In engineered landfill, gas transfer occurs by advection and diffusion, which may take place at different time frames or simultaneously depending on placement conditions. Hence, efficacy of GCL as a gas barrier under advection and diffusion needs to be assessed at various geoenvironmental settings. In the present study, the gas flow response of GCL under advection and diffusion were evaluated at various apparent degrees of saturation, distortion levels, hydrating fluids, and wet-dry cycles using custom-designed test apparatus. Gas permeability and gas diffusion coefficient of GCL were found to decrease by four and three orders of magnitude respectively with an increase in apparent degree of saturation from 7% to 80%. Gas permeability and gas diffusion coefficient were increased with an increase in distortion levels. With an increase in wet-dry cycles 1 to 5, gas permeability and gas diffusion of GCL were increased marginally when hydrated with distilled water while increased by one order of magnitude for hydrated with 0.0125 M $CaCl_2$ solution. The obtained results were compared with published results and found to be in good agreement.

Keywords: Geosynthetics, Geosynthetic clay liner, Gas permeability, Gas diffusion, Wet-dry cycle, Hydrating solutions, Distortion, UN SDG 13: climate action

Woven geotextile permeability under uniaxial and laterally constrained conditions

K. Y. Li[1], X. W. Tang[2], M. L. Fei[3], W. L. Chen[4], J. X. Liang[5] and Q. Q. Xiang[6]

1 PhD student, Research Center of Coastal and Urban Geotechnical Engineering, Zhejiang University, Hangzhou, P.R. China; Engineering Research Center of Urban Underground Space Development of Zhejiang Province, Hangzhou, P.R. China, E-mail: 20lky@zju.edu.cn **2** Professor, Research Center of Coastal and Urban Geotechnical Engineering, Zhejiang University, Hangzhou, P.R. China; Engineering Research Center of Urban Underground Space Development of Zhejiang Province, Hangzhou, P.R. China, E-mail: tangxiaowu@zju.edu.cn (corresponding author)

3 PhD student, MOE Key Laboratory of Soft Soils and Geoenvironmental Engineering, Institute of Geotechnical Engineering, College of Civil Engineering and Architecture, Zhejiang University, Hangzhou, P.R. China, E-mail: feiminliang@zju.edu.cn

4 Senior Engineer, Zhejiang Institute of Hydraulics & Estuary, Zhejiang Institute of Marine Planning and Design, Hangzhou, P.R. China, E-mail: 15958009319@139.com

5 PhD student, Research Center of Coastal and Urban Geotechnical Engineering, Zhejiang University, Hangzhou, P.R. China; Engineering Research Center of Urban Underground Space Development of Zhejiang Province, Hangzhou, P.R. China, E-mail: jaynaliang@zju.edu.cn

6 MS student, Research Center of Coastal and Urban Geotechnical Engineering, Zhejiang University, Hangzhou, P.R. China; Engineering Research Center of Urban Underground Space Development of Zhejiang Province, Hangzhou, P.R. China, E-mail: 22212010@zju.edu.cn

Abstract: Woven slit-film geotextiles are often subjected to in-plane tensile loads in engineering applications, which may alter relevant permeability properties. The fractal model of the permeability coefficient in woven geotextiles is extended to predict the permeability coefficient of geotextiles subjected to uniaxial and laterally constrained uniaxial tensile strains. Based on the observation and summary of the variation of the pore size distribution pattern with tensile strain, the pore unit model is introduced. The model is expressed as the functions of the fractal dimension, pore size characteristics, physical parameters and weft strain. A clamping device capable of applying uniaxial tension and laterally constrained uniaxial tension to geotextiles is invented. The validation of the model is verified using the vertical permeability coefficient test and the digital image analysis method on two selected woven geotextile samples. It is shown that the permeability coefficient increased with increasing uniaxial tensile strain. Furthermore, the experimental values tended to change more significantly under laterally constrained uniaxial strain conditions for thinner geotextiles approaching breaking strain and thicker geotextiles. The improved model can accurately predict the values and increasing rate of the permeability coefficient of woven geotextiles subjected to uniaxial and laterally constrained uniaxial tensile strains.

Keywords: Geosynthetics, Permeability, Uniaxial tensile strain, Laterally constrained uniaxial tensile strain, Fractals

Investigation on the long-term strain of geogrid in GRPS embankment under cyclic loading

K.-F. Liu[1], K.-R. Xue[2], M.-J. Wen[3] and L. Wang[4]
1 Professor, School of Civil Engineering and Architecture, Zhejiang Sci-Tech University, Hangzhou 310018, China, E-mail: liukaifu@zstu.edu.cn (corresponding author)
2 Master's student, School of Civil Engineering and Architecture, Zhejiang Sci-Tech University, Hangzhou 310018, China, E-mail: kairenxue@163.com
3 Associate Professor, School of Civil Engineering and Architecture, Zhejiang Sci-Tech University, Hangzhou 310018, China, E-mail: 7279026@163.com
4 Assistant Professor, Department of Civil and Architectural Engineering and Construction Management, University of Cincinnati, Cincinnati, OH 45221-0071, USA, E-mail: wang4li@ucmail.uc.edu)

Abstract: Geogrid is a horizontal reinforcement material that is used in geosynthetic-reinforced pile-supported (GRPS) embankments in freeways with soft soil. Nevertheless, the long-term deformation mechanics of geogrid in the GRPS embankment under cyclic loading is not clear enough. This paper presents a laboratory model study of a GRPS embankment to study the long-term geogrid strain under cyclic loading. The effects of parameters such as number of load cycles, load frequency, geogrid layer numbers, and length of supporting piles on the long-term strain of geogrid were investigated. The results showed that geogrid strain increased with the number of load cycles, mainly developed in the first 10000 load cycles and increased slowly in the later period. When the frequency was increased from 1 to 5 Hz, geogrid strain increased dramatically. When compared with the condition of a single geogrid layer, the upper layer of two geogrid layers caused a less geogrid strain. Compared with long piles and short piles GRPS embankments, a sufficient membrane effect of geogrid was found for long-short piles GRPS embankments. Finally, the 95% prediction interval proposed in this paper could be expressed using a logarithmic function, providing a theoretical foundation for future engineering applications.

Keywords: Geosynthetics, Geosynthetic-reinforced pile-supported embankment, Model tests, Strain, Prediction interval, UN SDG 9: Industry, innovation and infrastructure

Reliability analysis of compacted embankment with geocomposite under infiltration

R. Showkat[1] and G. L. Sivakumar Babu[2]
1 PhD candidate, Department of Civil Engineering, Indian Institute of Science, Bengaluru, India, E-mail: rakshandas@iisc.ac.in (corresponding author)
2 Professor, Department of Civil Engineering, Indian Institute of Science, Bengaluru, India, E-mail: gls@iisc.ac.in

Abstract: Embankment failures can be prevented by introducing geocomposites to act as drains. The effect of the geocomposite layer on the pore pressure distribution and surface displacements of an unsaturated embankment upon infiltration has been studied numerically using deterministic and probabilistic approaches. The inclusion of the geocomposite layer leads to an increase of suction below the interface and a decrease in suction above it by functioning both as a capillary barrier and a drainage layer, thereby reducing the surface displacements upon infiltration. The load in the form of rainfall and the resistance such as suction of the embankment material being variable leads to a variability in the displacements; therefore, reliability analysis has been carried out using hydraulic permeability and soil water characteristic curve (SWCC) parameters as random variables. To assess the probability of failure (P_f), a surrogate model based on augmented radial basis function has been used. Probabilistic analysis revealed that the embankment with geocomposite has less P_f compared to the embankment without geocomposite considering the rainfall infiltration. Moreover, sensitivity analysis predicted that SWCC parameters influence the P_f of embankment containing geosynthetics under infiltration to a larger extent.

Keywords: Geosynthetics, Unsaturated, Geocomposite, Radial basis function, Reliability, Capillary barrier

Strain assessment of polyethylene pipes in dense sand subjected to axial displacement

A. Reza[1], A. S. Dhar[2] and M. Rahman[3]

1 PhD candidate, Department of Civil Engineering, Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland and Labrador, Canada, E-mail: areza@mun.ca (corresponding author) (Orcid:0000-0001-6266-2913)

2 Associate Professor, Department of Civil Engineering, Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland and Labrador, Canada, E-mail: asdhar@mun.ca (Orcid:0000-0001-5137-3921)

3 Senior Integrity Engineer-Geotechnical, FortisBC Energy Inc., Surrey, BC, Canada, E-mail: mujib.rahman@fortisbc.com

Abstract: Buried polyethylene pipes used in gas distribution systems can experience excessive wall strain when exposed to ground movement that can affect the performance of the pipes in service. This paper presents full-scale laboratory tests performed to investigate the responses of medium-density polyethylene (MDPE) gas-distribution pipes in dense sand when subjected to axial ground movement. Pipes buried in sand in a large test box were pulled at the rates of 0.5 mm/min, 1 mm/min, and 2mm/min to simulate relative ground movement in the longitudinal direction. The test facility was instrumented to measure pulling force, pipe wall strain, and soil stress. The measured pullout force was significantly higher than predicted using the equations recommended in current design guidelines, which is attributed to the increase of normal stress on the pipe wall by shear-induced dilation of interface soil. The cavity expansion theory was successfully applied to calculate the normal stress increase. The distribution of measured strains was nonlinear along the pipe length. Assuming a parabolic distribution of the strains, simplified equations were developed to calculate pullout resistance and pipe wall strain from the relative ground displacement. The developed method reasonably predicted the pipe strain measured during the tests.

Keywords: Geosynthetics, Buried pipe, Medium-density polyethylene, Axial ground movement, Time-dependent response, Simplified design method

Transport of heavy metal contaminants in a composite liner under non-isothermal condition

W. Jiang[1], S. Ge[2], C. Feng[3] and J. Li[4]

1 PhD student, State Key Laboratory of Geomechanics and Geotechnical Engineering, Institute of Rock and Soil Mechanics, Chinese Academy of Sciences, Wuhan, China; University of Chinese Academy of Sciences, Beijing, China; Hubei Provincial Key Laboratory of Contaminated Sludge and Soil Science and Engineering, Wuhan, China, E-mail: geo_jiang2020@163.com

2 PhD student, College of Civil Engineering and Architecture, Zhejiang University, Hangzhou, China, E-mail: geshangqi@zju.edu.cn

3 PhD student, State Key Laboratory of Geomechanics and Geotechnical Engineering, Institute of Rock and Soil Mechanics, Chinese Academy of Sciences, Wuhan, China; University of Chinese Academy of Sciences, Beijing, China; PhD student, Hubei Provincial Key Laboratory of Contaminated Sludge and Soil Science and Engineering, Wuhan, China, E-mail: fengchen191@mails.ucas.ac.cn

4 Professor, Hubei Provincial Key Laboratory of Contaminated Sludge and Soil Science and Engineering, Wuhan, China, E-mail: jsli@whrsm.ac.cn (corresponding author)

Abstract: A mathematical model for the transport of heavy metal contaminants (HMCs) in a triple- layer composite liner with defective geomembrane under the non-isothermal condition is developed in this study, where the GMB/GCL/CCL (geomembrane, geosynthetic clay liner and compacted clay liner) composite liner is adopted as an example and the Langmuir adsorption model is incorporated. The proposed model is solved by the finite difference approach, and its correctness is validated by comparison with the experimental results, an existing analytical solution and another numerical method. Later, the transport behaviours of HMCs are explored with the established model. Compared with the isothermal condition, the non-isothermal condition enlarges the transport flux, but also reduces the concentration of HMCs. The relative concentration based on the Langmuir adsorption model is higher than that based on the linear adsorption model, which is related to the decrease of the retardation factor under the Langmuir adsorption model. Furthermore, the parametric study shows that when the leachate head h_t is between 1.0 and 3.0 m, the defined breakthrough time t_b increases by about 1.57 a with the increase of GCL thickness l_g by 1 cm, and the t_b increases by about 9.07 a with the increase of CCL thickness l_c by 0.1 m.

Keywords: Geoenvironment, Geosynthetics, Heavy metal contaminants, Triple-layer composite liner, Transport, Defective geomembrane, Thermal effects, Landfills, Langmuir adsorption