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摘要集

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目　录

Performance and design of reinforced slopes considering regional hydrological conditions

K-H Yang[1], T. S. Nguyen[2], Y-H Li[3], B. Leshchinsky[4]

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

2 PhD candidate, Department of Civil and Construction Engineering, National Taiwan University of Science and Technology (Taiwan Tech), Taipei 106, Taiwan, China, E-mail: sonnt@nuce.edu.vn

3 Research Assistant, Department of Civil and Construction Engineering, National Taiwan University of Science and Technology (Taiwan Tech), Taipei 106, Taiwan, China, E-mail: rm325896@gmail.com

4 Associate Professor and Richardson Chair, Department of Forest Engineering, Resources and Management, Oregon State University, Corvallis, OR, USA, E-mail: ben.leshchinsky@oregonstate.edu

Abstract: This study presents a series of numerical analyses investigating the impact of rainfall on the performance and design of geosynthetic-reinforced soil slopes (RSSs). The importance of considering regional hydrological conditions for designs of RSSs, particularly when marginal soil is used as backfill, is demonstrated and highlighted. RSSs with backfills containing five different fines contents subjected to various combinations of initial hydraulic conditions and major rainfall events were modeled. The input rainfall was determined from the rainfall intensity–duration–frequency (I–D–F) curves to realistically account for the impact of regional hydrological conditions. The hydraulic responses and stability of the RSSs including their porewater pressure development and factor of safety were then evaluated and compared. The results revealed that the applied rainfall scenarios had little influence on the performance of RSSs with high-quality backfills (i.e. backfill with low fines content), whereas those with prolonged rainfall duration substantially affected the performance of RSSs with high fines content backfills. Rainfall thresholds were established for the RSSs with various backfills and initial conditions and compared with the regional I–D–F curves to provide a simplified and robust method for facilitating backfill selection and assessing the failure risk of RSSs.

Keywords: Geosynthetics, Geosynthetic-reinforced soil, Marginal backfill, Rainfall threshold, Intensity–duration–frequency curve

Seismic bearing capacity of strip footing placed on a reinforced slope

K. Halder[1] and D. Chakraborty[2]

1 Research scholar, Department of Civil Engineering, Indian Institute of Technology Kharagpur, West Bengal-721302, India, E-mail: koushikhalder@iitkgp.ac.in

2 Assistant Professor, Department of Civil Engineering, Indian Institute of Technology Kharagpur, West Bengal-721302, India, E-mail: debarghya@civil.iitkgp.ac.in (corresponding author)

Abstract: The study estimates the lower bound values of the seismic bearing capacity of a strip footing placed on a reinforced cohesionless soil slope. The influence of slope angle, soil friction angle, horizontal seismic acceleration coefficient, depth of first reinforcement layer from the footing base and vertical spacing between two reinforcement layers was investigated. The effectiveness of using a reinforcement layer is expressed by an efficiency factor, which is the ratio of the bearing capacity factor for reinforced and unreinforced slopes. The bearing capacity increases by approximately 15 times for a few cases with a single layer reinforced slope. With the inclusion of another layer of reinforcement, this improvement is doubled. The influence of setback position of footing with respect to the slope edge is also investigated for a few representative slopes subjected to both static and seismic loading. Beyond a critical distance, the setback effect is negligible. Several design charts are presented. Stress contours are plotted to understand the failure mechanisms of unreinforced and reinforced slopes.

Keywords: Geosynthetics, Bearing capacity, Seismic loading, Single and double reinforced slope, Lower bound finite elements limit analysis, Failure mechanism

Seismic sliding stability analysis of reinforced soil retaining walls

P. Xu[1], K. Hatami[2], G. Jiang[3]

1 PhD candidate, Key Laboratory of High-Speed Railway Engineering of Ministry of Education, School of Civil Engineering, Southwest Jiaotong University, Chengdu 610031, China, E-mail: bk20090201@my.swjtu.edu.cn

2 Professor, School of Civil Engineering and Environmental Science, University of Oklahoma, 202 W. Boyd St., Room 334, Norman, OK 73019, USA, E-mail: kianoosh@ou.edu (corresponding author)

3 Professor, Key Laboratory of High-Speed Railway Engineering of Ministry of Education, School of Civil Engineering, Southwest Jiaotong University, Chengdu 610031, China, E-mail: sdxplt@gmail.com

Abstract: The Coulomb linear slip plane is adopted in most of the current design guidelines for reinforced soils walls based on the assumption that the reinforced zone acts as a rigid body. However, among major shortcomings of the Coulomb linear slip plane assumption is that its geometry is not consistent with the two-part wedge failure geometry that is typically observed in many model tests and numerical simulations, and the influence of reinforcement design on the sliding stability of reinforced mass cannot be included in the analysis. In this paper, a kinematic limit analysis method is developed for sliding stability calculations of reinforced soil retaining walls subjected to ground acceleration, which is based on the more commonly-observed, two-part wedge failure mechanism. The proposed analysis method is validated against the results of two shaking table model tests. It is subsequently used to investigate the influence of reinforcement and backfill properties, as well as those of vertical acceleration and wall height, on the predicted sliding yield acceleration and failure plane inclination angle in the reinforced zone of the reinforced soil retaining wall systems.

Keywords: Geosynthetics, Reinforced soil retaining wall, Two-part wedge failure mechanism, Kinematic limit analysis, Sliding yield acceleration

A comparison of frictional and socketed concrete injected columns in a transition zone

H. Mahdavi[1], B. Fatahi[2], H. Khabbaz[3]

1 PhD candidate, School of Civil and Environmental Engineering, University of Technology Sydney (UTS), Sydney, Australia, E-mail: hamed.mahdavi@student.uts.edu.au

2 Associate Professor of Geotechnical Engineering, School of Civil and Environmental Engineering, University of Technology Sydney (UTS), Sydney, Australia, E-mail: behzad.fatahi@uts.edu.au (corresponding author)

3 Associate Professor of Geotechnical Engineering, School of Civil and Environmental Engineering, University of Technology Sydney (UTS), Sydney, Australia, E-mail: hadi.khabbaz@uts.edu.au

Abstract: This paper sets out to investigate the options available for the transition from Concrete Injected Columns (CICs) to other ground improvement methods, used away from the bridge abutment. Two possible alternatives, widely spaced CICs socketed into stiff material and shorter, closely spaced, frictional CICs, were numerically simulated using FLAC^{3D} software considering the dissipation of porewater pressure and variation of soil permeability with time. The total length of the CICs and the total volume of concrete used for their construction were the same for both alternatives. A geosynthetic layer was introduced into the load transfer platform, and interface elements were incorporated to simulate CIC-soil interaction. The numerical results were also compared with an established analytical solution and a good agreement was achieved. A comparison was then made between the two scenarios; indeed, the embankment on frictional CICs experienced less settlement on the surface, less loads in the geosynthetic, and the bending moments and shear forces generated in the columns were less than the corresponding values for socketed CICs. This study offers an enhanced understanding of the available options to practising engineers when designing road embankments on soft soil.

Keywords: Geosynthetics, Concrete injected columns (CICs), Transition zone, Soft soil, Ground improvement, Frictional, Socketed, Load transfer platform (LTP)

Experimental investigations on inclined pullout behaviour of geogrids anchored in trenches

R. Bhowmik[1], J. T. Shahu[2], M. Datta[3]

1 PhD student, Department of Civil Engineering, Indian Institute of Technology Delhi, New Delhi 110 016, India, E-mail: riyabhowmik89@gmail.com (corresponding author)

2 Professor, Department of Civil Engineering, Indian Institute of Technology Delhi, New Delhi 110 016, India, E-mail: shahu@civil.iitd.ac.in

3 Professor, Department of Civil Engineering, Indian Institute of Technology Delhi, New Delhi 110 016, India, E-mail: mdatta@civil.iitd.ac.in

Abstract: Stability of geosynthetics along slopes in covers and liners of landfills depends partly on their tensile strength and partly on the efficiency of anchors holding the geosynthetics at berms or the top of the slope. The pull induced in these geosynthetics is in an inclined direction parallel to the slope. But due to difficulty in modelling inclined pullout behaviour experimentally, very few studies have so far been conducted on geosynthetics embedded in anchor trenches. This paper presents details of a device that can perform inclined pullout tests on geosynthetics at variable inclinations. Since geogrids are widely used as veneer reinforcement, inclined pullout tests are conducted on geogrids embedded in run-out, I-type and L-type anchors in sand. The maximum pullout force in the geogrid increases by more than 20% as the pull inclination increases from 0° to 20° in all the three types of anchors. The geogrids exhibit markedly different force-displacement behaviour for the three types of anchors, though the length of reinforcement remains the same. The peak pullout force for the I-type anchor was 1.6–1.7 times higher, and that for the L-type anchor was 2 times higher than that of the run-out anchor at all pullout inclinations.

Keywords: Geosynthetics, Geogrid, Inclined pullout, Anchor trench, Landfill cover, Low confinement

Fibre-reinforced sand-coal fly ash-lime-NaCl blends under severe environmental conditions

N. C. Consoli[1], V. B. Godoy[2], L. F. T omasi[3], T. M. De Paula[4], M. S. Bortolotto[5] and F. Favretto[6]

1 Professor, Department of Civil Engineering, Federal University of Rio Grande do Sul, Brazil, E-mail: consoli@ufrgs.br (corresponding author)

2 PhD student, Department of Civil Engineering, Federal University of Rio Grande do Sul, Brazil, E-mail: vinigodoy@msn.com

3 PhD student, Department of Civil Engineering, Federal University of Rio Grande do Sul, Brazil, E-mail: lennontomasi@hotmail.com

4 PhD student, Department of Civil Engineering, Federal University of Rio Grande do Sul, Brazil, E-mail: thaismartinsdepaula@gmail.com

5 MSc Fellow Researcher , Department of Civil Engineering, Federal University of Rio Grande do Sul, Brazil, E-mail: marinasbortolotto@gmail.com

6 Research Assistant, Department of Civil Engineering, Federal University of Rio Grande do Sul, Brazil, E-mail: filipefavretto@hotmail.com

Abstract: The use of industrial residues instead of virgin materials is a good alternative for a more sustainable approach to disposing of and managing waste. Soil improvement with coal fly ash (CFA) is particularly attractive for geotechnical earthworks. This study investigated the strength, stiffness and durability of Osorio sand-CFA-lime blends with a variety of improvements by assessing the impact of varying the lime content, fibres, sodium chloride (NaCl) and dry unit weight. Moreover, to contribute to a more rational dosing methodology, strength, stiffness and durability results were correlated to the porosity/binder index [$\eta/(B_{iv})^{0.28}$]. Durability was assessed by comparing wet-dry (WD) and freeze-thaw (FT) cycles, and WD cycles were found to present better performance than FT cycles. Ranks were established for the different components of the blends according to the WD and FT results. The addition of NaCl alone was more effective in improving unconfined compression strength (q_u) results than fibres alone. While fibres significantly decreased stiffness at very small-strain shear modulus (G_0), NaCl increased G_0. The application of $\eta/(B_{iv})^{0.28}$ demonstrated that not only can it predict mechanical behaviour, but also the long-term performance of Osorio sand-CFA-lime blends with or without the addition of NaCl and fibres.

Keywords: Geosynthetics, recycling and reuse of materials, geotechnical engineering

Assessment of approaches to obtain ebullition pressures for organophilic clay blankets

J. Eun[1], J. S. McCartney[2] and D. Znidarčić[3]
1 Assistant Professor, Department of Civil and Environmental Engineering, University of Nebraska Lincoln, Lincoln, NE, USA, E-mail: jeun2@unl.edu
2 Professor and Department Chair, Department of Structural Engineering, University of California San Diego, La Jolla, CA, USA, E-mail: mccartney@ucsd.edu (corresponding author)
3 Professor, Department of Civil, Architectural and Environmental Engineering, University of Colorado Boulder, Boulder, CO, USA, E-mail: znidarci@colorado.edu

Abstract: The objective of this study is to compare two experimental approaches to characterize the ebullition pressure (or air-entry suction) of initially water-saturated organophilic clay blankets. The first is an indirect approach using the water-retention curve (WRC) and the second is a direct approach using ebullition experiments. The WRC along with the hydraulic conductivity of organophilic clay blankets in saturated and unsaturated conditions were measured using a flexible-wall permeameter with suction saturation control. This device was also adapted to measure the ebullition pressure and the air permeability. The comparison of the experimental approaches was performed on organophilic clay blanket specimens in different initial conditions (unrinsed and rinsed to remove loose fines) under high and low effective confining stresses (20 and 5 kPa). The indirect estimates of air-entry suction from the WRC were similar to those obtained from the ebullition tests. This good agreement between the two approaches may add flexibility to the development of design specifications for capping systems. The hydraulic properties were found to be sensitive to rinsing and effective stress, with greater hydraulic conductivity and air permeability for the rinsed specimen due to the removal of fines, and greater air-entry suctions for specimens under higher effective stress

Keywords: Geosynthetics, Organophilic clay blankets, Gas ebullition, Air-entry suction, Water retention curve

Experiments and DEM analysis on vibration reduction of soilbags

Y. Q. Wang[1], X. Li[2], K. Liu[3] and G. Liu[4]

1 Assistant Professor, College of Civil Engineering, Hefei University of Technology, Tun-Xi Road 193#, Hefei 230009, China, E-mail: wangyq0726@163.com

2 Assistant Professor, College of Civil Engineering, Hefei University of Technology, Tun-Xi Road 193#, Hefei 230009, China, E-mail: lixian110387@sina.com (corresponding author)

3 Assistant Professor, College of Civil Engineering, Hefei University of Technology, Tun-Xi Road 193#, Hefei 230009, China, E-mail: k.liu@hfut.edu.cn

4 Assistant Professor, College of Civil Engineering, Hefei University of Technology, Tun-Xi Road 193#, Hefei 230009, China, E-mail: guang_liu@hfut.edu.cn

Abstract: Soilbags have been widely used to reinforce foundations since they effectively reduce vibrations. The vibration reduction effects of soilbags were illustrated through vertical excitations and the discrete element method (DEM) from two different perspectives. The frequency response and theoretical analyses of the wave propagation were used with excitations from a macroscopic perspective. The results show that the attenuation of vibrations using soilbags can be greatly reduced. The DEM simulations for a single soilbag were performed from the microscale perspective. The results revealed that the energy transfer and dissipation within a particulate system can be well captured, and the calculated energy obeyed the law of energy conservation. Under different loading rates, the percentage of energy dissipation exhibited wavy fluctuations with loading and unloading. The percentage of total energy dissipation was more than 70%, which also effectively proved that soilbags have good damping effects.

Keywords: Geosynthetics, Discrete element method (DEM), Energy dissipation, Frequency response function, Vibration reduction