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目　录

Experimental evaluation of geomembrane/geotextile interface as base isolating system

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Abstract: The objective of this study is to evaluate the effect of the geomembrane/geotextile interface on the seismic response of small-to-moderate height structures. Three building models with first-mode natural frequencies changing between 2–4 Hz (representing two, three and four storey structures) were tested with and without the addition of geomembrane/geotextile interface using the shaking table test setup by employing harmonic and modified/scaled ground motions. Experimental results showed that the geomembrane/geotextile interface significantly reduced the floor accelerations, especially at moderate-to-high ground shaking levels. The interaction between the first-mode natural frequency of the model and the predominant frequency of the input motion is significant, and the interface is most effective when these two frequencies are close to each other. This effect is more clearly seen when the harmonic motions are employed during the tests compared to the modified/scaled ground motions. The results of the tests with modified/scaled ground motions were used to evaluate the efficiency of the composite liner system in reducing the spectral accelerations in the frequency domain. The results presented here document that the geomembrane/geotextile interface reduces the floor accelerations in a certain frequency range and underline the potential of this interface to be used as a base isolation material.

Keywords: Geosynthetics, Seismic base isolation, Shaking table, Geotextile, Geomembrane, Liner, Harmonic motions, Ground motions, Response spectrum

Serviceability state deformation behaviour of two-tiered geosynthetic reinforced soil walls

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Abstract: This paper presents the results of a numerical investigation into the serviceability state deformation behaviour of two-tiered geosynthetic reinforced soil (GRS) walls. A parametric study was conducted using a calibrated finite element model to investigate the key influencing factors, such as the offset distance and reinforcement length. The results of the FE analyses were analysed to identify the fundamental interaction mechanism between the upper and lower tiers and to check the appropriateness of the preliminary design rules set by the FHWA design guideline. The results indicate that the interaction between the upper and lower tiers affects the internal stability of the lower tier while also influencing the external stability of the upper tier. Also, it is revealed that the interaction between the two tiers tends to induce larger wall deformations, leading to larger reinforcement forces at the base of the upper tier compared to an independent wall of the same height. The critical offset distance, beyond which two tiers act independently, is approximately 40% smaller than that recommended by the FHWA design guideline. However, the minimum reinforcement lengths defined by the FHWA design guideline are in good agreement with those determined by the current study.

Keywords: Geosynthetics, Geosynthetic reinforced soil wall, Tiered configuration, Offset distance, Reinforcement length, Finite element analysis

Performance evaluation of full-scale geosynthetic reinforced flexible pavement

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Abstract: An accelerated wheel load testing program was conducted to evaluate the benefits of using geosynthetics to enhance the performance of pavement constructed over soft subgrade. Six full-scale test sections were constructed, among which two sections were reinforced by one or two layers of triaxial geogrids, and two sections were reinforced by one layer of high strength geotextile with different base layer thickness. The test sections were instrumented by a variety of sensors to measure the load- and environment-associated pavement response and performance. The results of full-scale accelerated load testing demonstrate the benefits of using geosynthetics in terms of reducing the permanent deformation in the pavement structure. The geosynthetics benefit to reducing the maximum stress on top of subgrade is more distinguishable at a higher load level. It was also found that the geosynthetic placed at the base-subgrade interface was able to improve the performance of both subgrade and base layers. By placing an additional layer of geogrid at the upper one-third of the base layer, the performance of the base layer was further enhanced. While the geosynthetic showed appreciable benefit to reducing the permanent deformation of subgrade in this study, it showed little effect on the resilient properties of subgrade.
Keywords: Geosynthetics, Pavement, Accelerated loading test, Mechanical response, Permanent deformation

Geosynthetic reinforcement of pile-supported embankments

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Abstract: Rigid piles are used to reinforce soft soil foundations and thus increase embankment stability. This technique is improved by placing one or more geosynthetic reinforcement (GR) layers inside or at the base of the embankment. A series of 33 small scale models were tested using a geotechnical centrifuge. Soft soil settlement was imposed by the downward displacement of a tray. First, a series of models were prepared to examine how the load transmitted to the pile network increased with the embankment thickness. Using the same configuration, two identical models were prepared to successively test two different types of GR (geosynthetic reinforcement). Another approach was used to study how the external surcharges applied on the embankment affect load transfer. The results showed that, compared to the piled embankment, the load transfer increased for the case of the geosynthetic reinforced pile-supported embankment (GRPSE) due to the membrane effect. The membrane effect is higher when the GR is stiff and its vertical distance from the pile is reduced. Numerical modeling reveals that, when another GR layer is added, the second GR has an effect only if punching is sufficient. However, the second layer did not reduce embankment settlement.

Keywords: Geosynthetics, Piles, Embankment, Arching, Membrane effect

Practical approach to predict the shear strength of fibre-reinforced clay

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Abstract: Carpet waste fibres have a higher volume toweight ratio and once discarded into landfills, these fibres occupy a larger volume than other materials of similar weight. This research evaluates the efficiency of two types of carpet waste fibre as sustainable soil reinforcing materials to improve the shear strength of clay. A series of consolidated undrained (CU) triaxial compression tests were carried out to study the shear strength of reinforced clays with 1% to 5% carpet waste fibres. The results indicated that carpet waste fibres significantly improve the effective shear stress ratio and deviator stress of the host soil. Addition of 1%, 3% and 5% carpet fibres could improve the effective shear stress ratio of the unreinforced soil by 17.6%, 53.5% and 70.6%, respectively at an initial effective consolidation stress of 200 kPa. In this study, a nonlinear regression model was developed based on a modified form of the hyperbolic model to predict the relationship between effective shear stress ratio, deviator stress and axial strain of fibre-reinforced soil samples with various fibre contents when subjected to various initial effective consolidation stresses. The proposed model was validated using the published experimental data, with predictions using this model found to be in excellent agreement.

Keywords: Geosynthetics, Shear strength, Carpet waste fibre, Reinforced soil, Clays, Modified hyperbolic model

Methodology to evaluate hydraulic compatibility of geotextile and RCA in underdrain systems

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Abstract: Long-term filtration tests were conducted to assess the hydraulic compatibility of the recycled concrete aggregate (RCA) and nonwoven geotextile that is typically used in underdrains. The RCA samples used in this study were collected from a single facility, but with different ages (aged in the laboratory). Geotextile samples were also exhumed after each test and evaluated for reduction in their serviceability. The laboratory tests showed that aging does not adversely affect the hydraulic properties of the RCA in long-term filtration tests. The results showed that the previously defined serviceability criteria based on gradient and permeability ratios are not relevant to evaluate the hydraulic compatibility of RCA/geotextile tested in this study due to the existence of turbulent flow regime. An alternative limiting ratio called herein hydraulic conductivity ratio (HCRLFT) is proposed and validated with long-term filtration tests performed with natural aggregates. An acceptance criterion of HCRLFT $\leqslant 4$ is suggested to assess the compatibility of RCA (or natural aggregate)/nonwoven geotextile systems.

Keywords: Geosynthetics, nonwoven geotextile, recycled concrete aggregate, permittivity, physical clogging, digital image analyses

Durability of reinforced PVC-P geomembranes installed in reservoirs in eastern Spain

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Abstract: The aim of this paper is to study the durability of polyvinyl chloride (PVC-P) geomembranes reinforced with a synthetic fabric in hydraulic works in the Spanish Mediterranean basin. Therefore, a set of six geomembranes installed in irrigation reservoirs for 18–31 years were analysed. The initial characteristics of the geomembranes were determined to verify fulfilment of the Spanish regulations in force at the time. The characteristics were then assessed, and the results were interpreted with reference to the loss of plasticisers, tensile characteristics, foldability at low temperatures, dynamic impact resistance, puncture resistance, seam strength, reflected optical microscopy (ROM) and scanning electron microscopy (SEM). Additionally, the identification of the plasticisers in the geomembranes involved Fourier transform infrared spectroscopy (FTIR), gas chromatography (GC) and mass spectrometry (MS) tests. For the analysed samples, the loss of plasticisers was significant, ranging from 71.0% to 84.3%. However, the tensile strength results indicated current, regular waterproof working performances in the reservoirs. The results suggest that the durability of PVC-P geomembranes is a function of the loss of plasticisers and the state of the synthetic reinforced fibres.

Keywords: Geosynthetics, Geomembrane, PVC-P, Waterproofing, Water reservoir, Durability

Long-term response and design of two geosynthetics: effect of field installation damage

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Abstract: This paper contributes to understanding how installation damage of geosynthetics influences their long-term response and design. A geotextile and a geogrid were exhumed after installation under real conditions; their long-term tensile behaviour was investigated using conventional creep and creep rupture tests. Reduction factors for installation damage, creep and their combined effect were computed. The main aim of the paper was to assess how the long-term response of the geosynthetics was influenced by installation damage and whether it would be necessary to update current design approaches. The installation damage affected the mechanical response of both geosynthetics; important strength reductions were observed, particularly for the most severe installation conditions. The results indicate that, contrary to what has been reported in the literature, the creep rupture response of the geotextile changed after installation damage. When tested under similar creep loads (fraction of the sample tensile strength), both geosynthetics exhibited reduced potential for creep rupture and smaller strains at the end of primary creep. Changes in stiffness were less important than those for strength, for both short- and long-term response. There was synergy between installation damage and creep; the traditional approach to design was unsafe for the geotextile and slightly conservative for the geogrid.

Keywords: Geosynthetics, installation damage, tensile strength, creep, creep rupture, isochronous curves, reduction factors, synergy, stiffness