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摘要集

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目　录

Reliability assessment of reinforced slopes with unknown probability distribution

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Abstract: In the proposed study, reliability assessment of the reinforced slope (RFS) is carried out using an efficient and accurate technique of Fourth Moment Normal Transformation (FMNT). The probabilistic analysis is performed using both analytical and numerical methods. FMNT can estimate the probability of failure (P_f) of a RFS with unknown marginal distribution of input random variables. Only the first four moments of any random variable with unknown distribution are required to estimate the P_f of RFS. The use of FMNT with commercially available numerical software packages is precisely explained. The accuracy of the proposed technique, when used with different distributions of random variables, is also illustrated. The present results show considerable efficiency of FMNT in estimating the P_f when used in the analytical domain as well as with a numerical software. A detailed comparison in terms of the efficiency of the proposed formulation is also made with similar literature. FMNT is very useful for the designers to perform the reliability-based analysis of RFS. The present analytical method is also capable of incorporating the pseudo-static seismic forces into calculations.

Keywords: Geosynthetics, FMNT, Geosynthetic-reinforced soils walls & slopes, Unknown distribution, HSM, Geosynthetic applications, Uncertainty, Reliability & risk

Reliability-based design of geogrid reinforced soil foundation using kriging surrogates

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Abstract: This paper investigates the benefits of using reinforced soil foundations to improve the bearing pressure of shallow foundations on soil using numerical methods. Numerical study of geogrid reinforced soil involves estimation and validation of geogrid properties. Reliability-based design of reinforced soil foundation is performed using kriging surrogates. This involves calibrating and validating a kriging model using samples generated by any deterministic geotechnical numerical model. Surrogate models simplify probabilistic computations and Monte Carlo simulations. The design methodology is applied for a shallow foundation on soils reinforced with multiple geogrid layers. Results demonstrate the possibilities of surrogate modelling to design geogrid reinforced soil foundations and their capability to reduce settlement and improve bearing capacity, thereby reducing foundation area.

Keywords: Geosynthetics, Foundations, Reinforced soil, Geotechnical engineering

Analytical solution for solute transport in a triple liner under non-isothermal conditions

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Abstract: Analytical solutions for the transport of contaminant through a 1D triple-layer composite liner system consisting of a geomembrane (GMB), a geosynthetic clay liner (GCL) and a compacted clay liner (CCL) under non-isothermal conditions are derived using the generalized integral transform technique. The proposed analytical solutions account for the combined effects of molecular diffusion, sorption and thermodiffusion as well as the temperature-dependent distribution coefficient and effective diffusion coefficient. The proposed analytical solutions are successfully validated against the experimental results of thermodiffusion tests and verified against an analytical solution available in the literature and a numerical model based on commercial finite element software. Using the verified analytical solutions, simulations are performed with representative geometry and material properties for a GMB/GCL/CCL liner system. The results indicate that neglecting the effect of non-isothermal condition can underestimate the benzene outflow rate by over 30% when the temperature difference between the surface and bottom of the liner system exceeds 10 K. The temperature-dependent CCL effective diffusion coefficient and CCL distribution coefficient have a significant effect on benzene transport through the GMB/GCL/CCL liner system, whereas the liner thermal conductivity and the temperature-dependent GCL effective diffusion coefficient and GCL distribution coefficient have a negligible effect.

Keywords: Geosynthetics, Geomembrane, Landfill composite liner, Non-isothermal condition, Analytical solution

Numerical investigation of the interaction of back-to-back MSE walls

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Abstract: This paper presents a numerical investigation of the interaction of back-to-back mechanically stabilized earth (MSE) walls under static loading. The numerical model was validated using measurements from instrumented field back-to-back MSE walls. A parametric study was then conducted to investigate the effects of horizontal distance between the MSE walls, soil friction angle, and wall height on the interaction of back-to-back MSE walls. Maximum facing displacement, lateral soil thrust behind reinforced soil zone, and required reinforcement tensile force generally increase nonlinearly with increasing horizontal distance up to a certain critical value, and the effects of interaction between back-to-back MSE walls are stronger for lower friction angle and higher wall. The critical horizontal distances for different soil friction angles and wall heights are generally close to the theoretical Federal Highway Administration (FHWA) values for the full active failure wedge to be developed and could be approximated as 0.5. The FHWA method significantly underestimates the lateral soil thrusts for the range of horizontal distances involving interaction between back-to-back MSE walls but significantly overestimates the required reinforcement tensile strengths. Design recommendations on lateral soil thrust and required reinforcement tensile strength calculations that account for the interaction between back-to-back MSE walls are provided.

Keywords: Geosynthetics, Geosynthetic reinforced soil, Mechanically stabilized earth, Retaining wall, Back-to-back wall

Reinforced soil design using the combined electrokinetic and mechanical properties of soil

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Abstract: The design of reinforced soil is usually based solely on the mechanical properties of the fill, in the case of new structures, or the soil in the case of soil nailing. All soils display electrokinetic properties but these have largely been ignored in geotechnical design. The development of electrokinetic geosynthetic materials, which act as both electrodes as well as providing the established geosynthetic functions, has made it possible to combine the electrokinetic and mechanical properties of soils in geotechnical design. Using this approach, it is possible to improve the mechanical properties of the soil or fill prior to or during construction. The objective of the electrokinetic improvement is to increase the availability of suitable fill or make soils/waste materials previously not suitable for soil reinforcement acceptable and hence extend the application of reinforced soil. The use of computer-controlled electrokinetic treatment has resulted in effective and economic design and construction protocols, which in turn have led to a growing number of applications which provide positive evidence of the economic and environmental benefits of combining both the electrokinetic and mechanical properties of the soil in the design of reinforced soil structures.
Keywords: Geosynthetics, Electrokinetic geosynthetics, Design, Reinforced soil, Slopes, Stabilisation, Observational method, Preventative maintenance, Cost and carbon footprint

Effects of reinforcement arrangements on load transfer in spring-based trapdoor tests

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Abstract: Five spring-based trapdoor tests allowing continuous displacement during both fill placement and localised static loading were conducted. Quartz sand was used as the test fill. Biaxial geogrids with and without ribs, having two different reinforcement stiffnesses, were used as reinforcement materials. Test results show that when two low-stiffness geogrid reinforcement layers were used, higher reinforcement spacing ratios (defined as the ratio of the reinforcement spacing between two reinforcement layers to the trapdoor width) induced more stable and efficient load transfer generally. Consequently, an optimum value of 0.3 and a worst-case value of 0.1 for the reinforcement spacing ratio were obtained and considered as representatives of two low-stiffness reinforcement layers for comparison with a single high-stiffness reinforcement layer, where their total reinforcement stiffnesses were approximately same. Generally, the inclusion of two low-stiffness reinforcement layers induced more stable load transfer. More importantly, compared with a single high-stiffness reinforcement layer, two low-stiffness reinforcement layers with the optimum reinforcement spacing ratio enhanced load transfer and induced less overall tensile forces, whereas the reinforcement arrangement with the worst reinforcement spacing ratio induced similar load transfer efficiency and overall tensile forces.
Keywords: Geosynthetics, Reinforcement arrangements, Localised static loading, Load transfer, Soil arching, Spring-based trapdoor test

Probabilistic stability analysis of reinforced soil slope with non-circular RLEM

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Abstract: Probabilistic analysis is an important step in assessing the reliability of geosynthetic reinforced slopes. In this paper, a practical procedure is developed to implement probabilistic stability analysis for reinforced slope considering both the spatial variability of soil strength and the uncertainty of geosynthetics. In the proposed procedure, the random limit equilibrium method (RLEM) is used to calculate the factor of safety (FOS) and the simple genetic algorithm (SGA) is used to find the non-circular critical slip surface. A comparison is elaborately conducted between the procedure and random finite difference method (RFDM), verifying the feasibility of the proposed procedure in probabilistic stability analysis of reinforced soil slopes. Based on the proposed procedure, a series of probabilistic analyses are performed to study the effects of uncertainties of some key parameters on FOS and slip mass volume. The results show that the soil variability, correlation length and geosynthetic length are significant factors, while geosynthetic variability shows limited effect on FOS. The geosynthetic length plays an important role within the statistical characteristics of FOS and slip mass volume by differentiating the failure mechanism into internal failure mode and external failure mode.

Keywords: Geosynthetics, Reinforced slope, Probabilistic analysis, Random field, Global stability