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目　录

Design methodology for reinforced railway tracks based on threshold stress approach

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Abstract: The success of a design methodology for railway track depends on its ability to keep the maximum deviator stress induced on the subgrade due to rail traffic below the threshold stress of the subgrade soil. Considering this, the present study proposes a new design methodology using geosynthetic reinforcement in the track layers to adopt a suitable formation thickness. Geosynthetic reinforcement in one or two layers at suitable interfaces in the track section has been used to reduce the induced deviator stress to acceptable limits. The new method is advantageous in reducing the requirement for formation layer thickness by incorporating geosynthetics. This method also proposes two methods of track design: direct and indirect. The direct method of design uses design charts developed on the basis of numerical and experimental results, whereas the indirect method makes use of empirical equations developed by a computational intelligence technique, Genetic Programming (GP). The accuracy of the indirect method is tested by comparing it with the results of the direct method and verifying by statistical criteria. The indirect method can be very fast to implement for the given set of conditions.

Keywords: Geosynthetics, Model test, Railway track, Displacement, Stress, Subgrade, Genetic Programming

EPS inclusion to reduce vertical stresses on shallow tunnels

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Abstract: Expanded polystyrene (EPS) has long been used to reduce stresses acting on buried structures. In this study, the efficiency of utilising EPS in reducing vertical stresses acting on cut-and-cover tunnels was investigated. To gauge this, short- and long-term shear strength parameters of EPS with densities of 25, 30, and 35 kg/m^3 were determined. Interface friction of EPS with various materials was measured considering the use of geotextile as a protective cover for EPS. Laboratory testing included unconfined compression, creep strain based on time-temperature-stress superposition, and modified direct shear. Then, a numerical model was developed and verified to simulate shallow tunnels with EPS inclusion. A parametric study was conducted using EPS with various thicknesses to tunnel depth ratios (t_g/z_1). It was found that the total vertical stress acting on the tunnel can be reduced by 35% using tg/z1 limited to 0.4. Also, the effect of positive soil arching amplified at $t_g/z_1 \geqslant 0.6$, leading to a reduction that exceeded 50% in the net vertical stress acting on the tunnel. The magnitude of vertical displacement was found to be directly proportional to t_g/z_1, but with an influence zone that can be controlled by increasing the EPS thickness.
Keywords: Geosynthetics, EPS, Geofoam, Inclusion, Creep strain, Cut-and-cover tunnel, Positive soil arching, Stress reduction

Impact of acid leachates on microtexture of bentonites used in geosynthetic clay liners

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Abstract: This study reports supportive evidence, from scanning electron microscopy (SEM) and high-resolution transmission electron microscopy (TEM) of bentonite cakes, of the textural effects caused by reaction of concentrated sulfuric acid on the bentonite component of geosynthetic clay liners (GCLs) and how these effects may influence observed bentonite hydraulic performance. SEM images revealed that changes to the natural micro-textures of bentonite were due to interaction with acidic leachate, the effects being greater with increased concentration. It was observed from high resolution TEM images that most of the effects detrimental to hydraulic performance were related to re-arrangement of smectite quasi-crystals, as expected for textural responses to increased ionic strength. Significant bentonite dissolution was also observed in both SEM and TEM images after reaction at room temperature for as much as 48 h with sulfuric acid. The observed changes in the microtexture of the bentonite component by both SEM and TEM provide a physical explanation to the bulk experimental results as well as a benchmark for the application of GCLs under acidic conditions.

Keywords: Geosynthetics, Acid degradation, Bentonite, Geosynthetic clay liners

Seismic responses of vertical-faced wrap-around reinforced soil walls

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Abstract: A series of shaking table tests on geosynthetic-reinforced walls with a height of H=0.6 m is performed to investigate the seismic performance of prototype walls with H = 6 m. Ground-wall resonance occurs at small values of horizontal peak ground acceleration (HPGA), namely 0.1–0.5g, with an amplification factor of A_m =1.2–2.2 at the crest of the wall. This factor decreases with increasing HPGA. For walls that attain states of maximum horizontal displacement (D_{max})/H > 5%, the failure mechanism consists of a vertical failure surface at a distance from the facing of 0.3H for the upper half of the wall and a Rankine triangular wedge over the lower half of the wall. Mononobe-Okabe theory gives dynamic earth pressure coefficients that agree well with experimental results based on $k_h=\eta$ HPGA/g, where k_h and η are the horizontal seismic coefficient and an empirical constant, respectively, with values of η ranging from 1/4 to 1/3. Furthermore, the maximum tensile forces induced by shaking increase as the depth of reinforcement increases, generating a trapezoidal shape rather than the inverted trapezoidal shape proposed in the literature.
Keywords: Geosynthetics, Reinforced wall, Shaking table test, Resonance, Failure mechanism, Lateral earth pressure

Interfacial shear strength of rubber-reinforced clays: a dimensional analysis perspective

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Abstract: The present study aims towards the development of practical dimensional models capable of simulating the interfacial shear strength of rubber-reinforced clays. Two types of recycled tire rubbers (of fine and coarse categories) were each incorporated into the soil at four different contents (by weight), and statically compacted at their respective Proctor optimum condition for direct shear testing. The rubber inclusions amended the soil through improvements achieved in two aspects: (i) frictional resistance generated as a result of soil–rubber contact; and (ii) mechanical interlocking of rubber particles and soil grains. In general, both amending mechanisms were in favor of a higher rubber content, and to a lesser degree a larger rubber size. The dimensional analysis concept was extended to the soil–rubber shear strength problem, thereby leading to the development of practical dimensional models capable of simulating the shear stress–horizontal displacement response as a function of the composite's basic index properties. The predictive capacity of the proposed models was examined and validated by statistical techniques. The proposed dimensional models contain a limited number of fitting parameters, which can be calibrated by minimal experimental effort and hence implemented for predictive purposes.

Keywords: Geosynthetics, Rubber-reinforced clay, Interfacial shear strength, Frictional resistance, Mechanical interlocking, Dimensional analysis

Buried flexible pipes behaviour in unreinforced and reinforced soils under cyclic loading

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Abstract: In this research, large-scale fully instrumented laboratory tests were conducted to investigate the behaviour of flexible high-density polyethylene (HDPE) pipes, in unreinforced and geogrid-reinforced sand, subjected to incrementally increasing cyclic loading; for example, due to different vehicle capacities or load increase with passing time. Results illustrated that the deformation rate in the pipe and footing, the strain generation rate in the pipe and reinforcing layers are rapidly increased in the initial loading cycles, in particular during the first 300 cycles, and then the rate of change decreases significantly as more cycles are applied. In the unreinforced case, increasing the pipe burial depth significantly reduced the generated deformation and strain in the pipe; however, it has a situational effect on the footing settlement, where it increased after pipe burial depth to its diameter ratio (H/D) of 2.5. In reinforced cases, deformation and strain significantly reduced with the increase in pipe burial depth and number of reinforcing layers. Measurement of strain illustrated that strain generated in the lower reinforcing layer is always higher than that recorded in the upper one, regardless of pipe burial depth and value of applied load.

Keywords: Geosynthetics, Buried flexible pipe, Geogrid-reinforced soil, Incrementally cyclic loading, Large-scale laboratory tests, Strain gauge

Evaluation of soil-geogrid interaction using transparent soil with laser illumination

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Abstract: An experimental methodology was developed involving techniques that allow non-intrusive measurement of confined geogrid deformations and soil particle displacements under pullout loading condition, which together are expected to generate a comprehensive volume of data including the entire displacement field in both geogrid and surrounding soil. The techniques involve the use of transparent soil with laser-aided imaging, which allows visualization and facilitates subsequent evaluation of the load-transfer mechanisms that develop between soil particles and the different rib elements in geogrids. A laser beam was employed to track the transparent soil particles in a plane perpendicular to the soil-geogrid interface. The collimated laser beam produced well-defined individual particles in the selected plane of the soil model. Digital cameras were used to track the displacement fields of both the confined geogrid specimen and soil particles within the laser-illuminated plane. Digital image correlation as well as other image-processing techniques were used to define the displacement fields based on images captured during the tests. The field displacements resulting after processing the data gathered from the newly developed experimental system led to well defined manifestations of the load transfer mechanisms, including the deflection patterns in geogrid ribs and shear bands within the soil mass.

Keywords: Geosynthetics, Soil-geogrid interaction, Transparent soil, Laser illumination, Digital image correlation, Shear band