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目　录

Experimental study on behaviour of encased stone column with tyre chips as aggregates

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Abstract: Stone columns are constructed using stone aggregates of typical size ranging from 15 to 75 mm. Alternatively, building debris and shredded tyre chips can be used to replace the stone aggregates either partially or totally, which can be an environment-friendly solution to the disposal of solid waste materials. This paper presents the results of model tests on ordinary floating stone columns (OSC) and encased floating stone columns (ESC) constructed with a mixture of stone aggregates and shredded tyre chips. Tyre chips of 10 mm size, 2 to 3 mm thick after removing steel wires, were used in this study. Large size direct shear tests were also conducted for different mix proportions of tyre chips and stone aggregates to assess their shear strength properties. Model tests were conducted on ordinary and encased floating stone columns of diameter (d) 100 mm and l/d ratio of 4.5. Loading was applied through hydraulic jack and reaction loading frame. Model test results show that an ordinary stone column made of stone aggregates can be replaced by an encased stone column made of 100% tyre chips. This confirms the possibility of either partial or full replacement of stone aggregates with tyre chips in stone columns.

Keywords: Geosynthetics, Stone columns, Waste management and disposal, Tyre chips, Clay

Numerical simulation of the deformation response of geosynthetic reinforced soil mini-piers

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Abstract: This paper presents a numerical investigation of the deformation response of geosynthetic reinforced soil (GRS) mini-piers under service load conditions. The backfill soil was characterized using a nonlinear elasto-plastic constitutive model that incorporates a hyperbolic stress-strain relationship and the Mohr-Coulomb failure criterion. The geotextile reinforcement was characterized using linearly elastic elements with orthotropic stiffness. Various interfaces were included to simulate the interaction between different components. The three-dimensional numerical model was validated using experimental data from GRS mini-pier loading tests, including average settlements and maximum lateral facing displacements. Simulation results from a parametric study indicate that backfill soil friction angle, backfill soil cohesion, reinforcement vertical spacing, and reinforcement stiffness have the most significant effects on settlements and lateral facing displacements for GRS mini-piers under service load conditions.

Keywords: Geosynthetics, Geosynthetic reinforced soil, Mini-pier, Deformation, Service load, Numerical model

Effects of temperature rise on load-strain-time behavior of geogrids and simulations

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Abstract: To evaluate the effects of ambient temperature history on the load-strain-time behaviour, a series of tensile tests were performed on three geogrid types. The applied loading and temperature (T) schemes included: (i) continuous monotonic loading (ML) at different constant values of T; (ii) sustained (creep) loading (SL) during otherwise ML at different constant values of T and (iii) SL during which T was incrementally increased during otherwise ML. With an increase in T, the rupture tensile strength (V_{max}) and the elastic stiffness decreased while the creep strain increased. For the same ultimate T, the creep strain by scheme (iii) was significantly larger than the one by scheme (ii). The residual rupture tensile strength (V_{res}) observed in ML that followed SL was nearly the same as V_{max} in continuous ML at the same T, showing that creep is not a degrading phenomenon reducing V_{res}. A non-linear three-component (NTC) model was modified to incorporate the temperature effects. By modelling the trend that V_{max} and stiffness decrease with an increase of T as a negative ageing effect, the modified NTC model successfully simulated all the different trends of load-strain-time behaviour, including creep strains, observed along various load and temperature histories in the experiments.

Keywords: Geosynthetics, Tensile loading test, Temperature, Elastic, Viscous, Non-linear three-component model

Rubber powder–polymer combined stabilization of South Australian expansive soils

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Abstract: This study examines the combined capacity of rubber powder inclusion and polymer treatment in solving the swelling problem of South Australian expansive soils. The rubber powder was incorporated into the soil at three different rubber contents (by weight) of 10%, 20% and 30%. The preliminary testing phase consisted of a series of consistency limits and free swell ratio tests, the results of which were analyzed to arrive at the optimum polymer concentration. The main test program included standard Proctor compaction, oedometer swell–compression, soil reactivity (shrink–swell index), cyclic wetting and drying, crack intensity, and micro-structure analysis by means of the scanning electron microscopy (SEM) technique. The improvement in swelling potential and swelling pressure was dependent on the rubber content, with polymer–treated mixtures holding a notable advantage over similar untreated cases. A similar dependency was also observed for the crack intensity factor and the shrink–swell index. The beneficial effects of rubber inclusion were compromised under the cyclic wetting and drying condition. However, this influence was eliminated where the rubber powder was paired with the polymer agent. A rubber inclusion of 20%, preferably paired with 0.2 g/l polymer, was suggested to effectively stabilize South Australian expansive soils.

Keywords: Geosynthetics, Expansive soil, Rubber powder, Polymer, Swelling potential, Swelling pressure, Crack intensity, Cyclic wetting and drying

Experimental study on vibration reduction by using soilbag cushions under traffic loads

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Abstract: The dynamic behaviour of a subgrade with soilbags (filled with different materials) under traffic loads was investigated through a series of laboratory experiments. Three spaced hydraulic jacks with phase-shifted excitations were used to simulate moving loads. Different materials, namely gravel, coarse sand, and fine sand, were filled into the subgrade soilbags underneath the ballast. Equations of the peak acceleration and effective soil pressure with respect to the subgrade depth were derived to obtain an insight into the subgrade-load interactions. In addition, the effects of subgrades with and without the soilbags on the vibration and settlement were investigated and compared. The experimental results show that the peak acceleration decreases linearly with increasing depth from the vibration source, while the attenuation of the effective soil pressure increases with increasing distance from the vibration source. The settlement in reinforced subgrade is much smaller than that in unreinforced subgrade under three-jack excitation.

Keywords: Geosynthetics, Soilbag, Subgrade, Railway, Dynamic behaviour

Prediction of creep behaviour from load relaxation behaviour of polymer geogrids

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Abstract: Evaluation of creep behaviour of polymer geosynthetic reinforcement is important for predicting the long-term performance of geosynthetic-reinforced soil (GRS) structures and determining the creep reduction factor of geosynthetic reinforcement for the design lifetime of a GRS structure. The inherent link between the creep behaviour and the stress relaxation behaviour was confirmed by performing a comprehensive series of sustained loading (SL) tests and stress relaxation (SR) tests and numerical simulations of SL and SR tests on several geogrid types. In the framework of the non-linear three-component (NTC) model, the creep strain in SL is entirely irreversible, while the tensile load decrement in SR is associated with the developed positive irreversible strain with zero total strain rate.

Measured systematic relationships between the elapsed times necessary to reach the same irreversible strain rate in SL and SR tests and those between the irreversible strain increments necessary to reach the same irreversible strain rate in SL and SR tests are presented and simulated by the NTC model. It is shown that, based on these relationships, the time history of creep strain can be predicted from given results of SR tests performed for a much shorter period. This method is validated by successful simulations of experimental results.

Keywords: Geosynthetics, Creep, Stress relaxation, Strain rate, Non-linear three-component model

Direct shear testing of GCLs at elevated temperature and in a non-standard solution

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Abstract: The objective of this study was to develop, verify, and assess a direct shear apparatus to measure the internal shear strength of geosynthetic clay liners (GCLs) when exposed to elevated temperature and non-standard hydration solutions. Shear boxes were developed to facilitate testing 300 mm square and 150 mm square specimens. Preliminary experiments documented the effectiveness of a GCL gripping system and a two-stage hydration procedure. Direct shear experiments were performed to evaluate the new apparatus with respect to the following variables: (i) specimen size; (ii) GCL peel strength; (iii) GCL heat treatment; (iv) test temperature; and (v) hydration solution. Direct shear results were verified via comparison to literature, which also supported the use of 150 mm square GCL specimens to measure internal shear behavior and shear strength. Shear tests on heat-treated and non-heat-treated GCLs at 20 ℃ and 80 ℃ yielded a 40% reduction in internal peak strength with increase in temperature. Hydration in a high-alkaline synthetic mining solution indicated a loss in peak strength with increasing hydration times from 15 to 60 days. A systematic reduction in peak and large displacement shear strength with increasing normal stress was observed for 60 days' hydration in the alkaline solution relative to hydration for 4 days in de-ionized water.

Keywords: Geosynthetics, Direct shear, Geosynthetic clay liner, Shear strength, Solution chemistry, Temperature