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目　录

Lifetime assessment of exposed PVC-P geomembranes installed on Italian Dams

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Abstract: The aim of this paper is to study the performance of plasticised polyvinyl chloride (PVC) geomembranes used in the rehabilitation of concrete and masonry dams. In such applications, the geomembranes are left exposed on the upstream face, without external protection, to environmental factors and weather conditions, especially to UV rays. Evaluation of the performance and the lifetime assessment of the geomembranes is very important from a managerial point of view. Therefore, the results from a 25-year ongoing study on the long term performance of PVC-P geomembranes installed on the upstream face of Italian dams are presented. The sampled geomembranes have been subjected to physical and mechanical tests and the results interpreted with reference to the variation of plasticiser, tensile characteristics, fold ability at low temperatures, volumic mass and water vapour permeability. In the analysed samples, the loss of plasticiser range from 14.83% to 21.86%. This decrease in plasticiser content resulted in slightly higher modulus and tensile strength. The functionality of the geomembranes was not affected, as evaluated also by on site inspection. On the basis of the experimental results, lifetime predictions of the exposed geomembranes using the function of the loss of plasticiser were made.

Keywords: Geomembranes; Dam; Rehabilitation; Upstream face; Monitoring; Lifetime prediction

Geosynthetic clay liners: Perceptions and misconceptions☆

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Abstract: The behaviour of geosynthetic clay liners (GCLs) as part of a physical-environmental system is examined. Consideration is given to: (a) both the physical and hydraulic interactions with the materials, and the chemical interactions with the fluids, above and below the liner, (b) time-dependent changes in the materials, (c) heat generated from the material to be contained, as well as (d) the climatic conditions both during construction and during service. This paper explores some common perceptions about GCL behaviour and then examines the misconceptions that can arise and their implications. It demonstrates how what may first appear obvious is not always as one expects and that more is not always better. It discusses: (i) the pore structure of a GCL, (i) the dependency of the water retention curve of the GCL on its structure, bentonite particle sizes and applied stress,(ii) the effect of the subgrade pore water chemistry, (iv) the mineralogy of the subgrade, and (v) thermal effects. The desirability of a GCL being reasonably well-hydrated before being permeated is examined. The critical sizeof needle-punch bundles at which preferential flow can increase hydraulic conductivity by orders of magnitude is illustrated. The dependency of self-healing of holes on the interaction between GCL and subgrade is discussed. Finally, the transmissivity of the geomembrane/GCL interface is shown to be a function of GCL and geomembrane characteristics and to be poorly correlated with GCL hydraulic conductivity.
Keywords: Geosynthetics; Geosynthetic clay liner; Hydration; Hydraulic conductivity; Interface transmissivity; Composite liner performance

Analyses and design of steep slope with Geo Barrier system (GBS) under heavy rainfall

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Abstract: A GeoBarrier system (GBS) is a combination system of reinforced soil walls to stabilize near-vertical cut slopes and capillary barrier principles to protect the wall from the effect of rainfall infiltration. Singapore requires construction materials that are cost-effective to support sustainable urban development. Therefore, recycled materials are utilized as GBS materials to avoid the use of high-cost materials, such as steel or concrete. GBS consists of planting geobags with unique geosynthetic pockets for sustainable plant growth as a facing layer of GBS. The negative pore-water pressure (suction) within the reinforced soil behind GBS was assured to be constant during rainfall since GBS is designed specially to minimize the rainfall infiltration into the reinforced soil. This paper presents the practical design and stability analysis of the GBS, considering the presence of suction within the reinforced soil body. The monitoring of GBS performance in the field was carried out via field instrumentation. Finite element analyses of the GBS under extreme rainfalls were also performed for evaluation of the GBS performance. The field instrumentations and numerical analysis results showed that GBS was able to protect the slope from rainfall infiltration; therefore, the stability of the slope retained by GBS was not affected by the rainfall. Results from the analytical calculation showed that the most critical mode of failure is sliding along the base, followed by the global and local slope stability. The GBS is not susceptible to local instability.
Keywords: Geo Barrier system (GBS); Reinforced soil wall; Capillary barrier; Suction contribution

Predicting the depletion of antioxidants in high density polyethylene (HDPE) under sunlight using the reciprocity law

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Abstract: Depletion of antioxidants in HDPE subjected to sunlight exposure was studied. Sunlight radiation was simulated using a laboratory xenon light weather ometer at three irradiation levels. Oxidative induction time (OIT) test was performed on different layers along the thickness of the test coupons to establish the antioxidant depletion throughout the exposure duration. The highest drop in OIT was obtained for the surface layer facing the radiation, followed by the backside layer which was exposed to indirect radiation reflected from the wall of the weather ometer. The core section showed a slower decrease under the same exposure conditions. Furthermore, the OIT depletion rate in the surface layer increased with radiation intensity. The study proved that the sunlight degradation of the tested polyethylene can be accelerated by increasing the irradiation intensity based on the reciprocity law.
Keywords: HDPE; Antioxidants; Sunlight; Degradation; Reciprocity law

Determination of geomembrane – protective geotextile friction angle: An insight into the shear rate effect

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Abstract: This study investigates how the shear rate can affect the geomembrane - protective geotextile friction angle. Four types of geomembranes (GMB) were considered (EPDM, HPDE, PP, and PVC) and a single nonwoven needle-punched geotextile (GTXnw) was used to make the interfaces with the geomembrane. Three shear devices were used: a large-scale inclined plane (IP), a shear box (SB), and a small-scale shear device (ssSD). The ssSD allows two shear modes to be compared: one mode involves incrementally increasing the shear stress, and the other involves imposing a constant tangential velocity at the interface. Only the PP GMB- GTXnw was tested with the SB and the ssSD. Inclined plane standardised tests show that for the three interfaces that undergoes gradual sliding (EPDM, PP and PVC GMB-GTXnw), it is shown that a step-by-step experimental procedure gives significantly lower interface friction angle than that given by the procedure from the current international standard, which is explained by the increase of interface shear stress with sliding speed. These observations are confirmed by shear box tests. One major practical result is that, following the nature of geosynthetics, the shear rate applied in large-scale shear box tests should be adapted to assess a safety value of a geosynthetic - geosynthetic interface friction angle.
Keywords: Geosynthetic; Geomembrane lining system; Friction angle; Inclined plane; Shear box

Seismic performance and numerical simulation of earth-fill dam with geosynthetic clay liner in shaking table test

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Abstract: In this paper, shaking table tests were carried out on both a small-scale and a full-scale earth-fill dams with geosynthetic clay liners to examine their seismic performance. The behavior of these fully instrumented earth-fill dams when subjected to seismic loading was also simulated by numerical analysis. Firstly, in the small-scale shaking table test, no failure was observed along the geosynthetic clay liner when the earth- fill dam was subjected to seismic motion. Numerical analysis confirmed that the behavior of the model earth-fill dam was unaffected by the geosynthetic clay liner. Secondly, a comparative shaking table test was carried out on full-scale earth-fill dams, one with a sloping core zone and another with a geosynthetic clay liner. Both model dams showed similar acceleration response and deformation behavior. It should be mentioned that the acceleration response increased gradually toward the top of the dam, and the deformation, after shaking, was relatively large near the foot of the slope. These observations were successfully simulated by the numerical analysis.

Keywords: Earth-fill dam; Clay liner; Shaking table test; Numerical analysis; Aseismicity

Damage to geomembrane liners from tire derived aggregate

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Abstract: Tire derived aggregate (TDA) is currently being used as a cost-effective substitute for gravel in landfill leachate collection systems. TDA is composed of tires that have been shredded into pieces. However, the particles often contain a small portion of high risk protruding wires that may puncture a geomembrane placed below the TDA. The chance that these wires puncture is a function of the number of wires present in a sample, how the particles land, and the efficiency of the protection layer to prevent punctures. Using heavier nonwoven geotextile protection layers with larger size TDA and thicker geomembranes, the number of punctures may be expected to be fewer than 20 per hectare for the materials tested in this study. A second component to long term geomembrane performance is the presence of localised zones of high strain resulting from the point loading on the geomembrane. The strain resulting from TDA was found to be less than the strain which occurred from gravel using the same protection layers. It is concluded that, for different reasons, gravel and TDA both require effective protection layers of soil or heavy nonwoven geotextile to ensure long term performance.

Keywords: Geosynthetics; Geomembrane; Tire derived aggregate; Protection layer; Strain; Puncture

Modelling of hydraulic deterioration of geotextile filter in tunnel drainage System

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Abstract: The discharge capacity of a tunnel drainage system generally decreases with time because of the hydraulic deterioration of the geotextile filter. Hydraulic deterioration restricts groundwater flow into a tunnel and increases water pressure resulting in detrimental effects on the tunnel lining. Hydraulic deterioration of tunnel drainage system is unique in terms of clogging materials, deterioration mechanism, and flow conditions. Current studies and models investigating the clogging mechanism and hydraulic deterioration are not directly applicable to the geotextile filter of the tunnel drainage system. In this study, a theoretical model of the hydraulic deterioration of tunnel geotextile filter has been proposed considering the mechanical and hydraulic behavior of blinding, clogging and squeezing. A parametric study was carried out to evaluate the performance of the model. An experimental study has been conducted to investigate the clogging behavior of the tunnel drainage system and validate the theoretical model. Several types of clogging materials were selected: cement-leaching calcium oxide, calcium carbonate, iron oxide, and bentonite. Agglutinated clogging was mainly observed during the short-term testing. The findings suggest that the in-plane permeability of the geotextile filter decreased by approximately 90%. The proposed model corroborated the experimental results.
Keywords: Geosynthetics; Tunnel drainage system; Geotextile filter; Hydraulic deterioration; Permeability model