《Geotextiles and Geomembranes》

（土工织物与土工膜）

<双月刊>

2026年第54卷第5期

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中国土工合成材料工程协会秘书处

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Stability analytical solution for the geosynthetic-reinforced pile-supported embankments based on an improved three-wedge model

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Abstract: Geosynthetic-reinforced pile-supported (GRPS) embankments have been widely adopted for soft ground treatment owing to their effectiveness in controlling settlement, enhancing bearing capacity, and accelerating consolidation. However, existing research has primarily focused on their load-bearing performance and settlement characteristics, while theoretical analysis of embankment slope stability remains insufficient. Although the three-wedge model has been applied to assess the slope stability of such embankments, it typically requires preset assumptions for certain parameters, resulting in limited accuracy in the calculated factor of safety. Based on the generalized three-wedge model and incorporating the structural characteristics of features of GRPS embankments, this study extends and refines the geometric configuration, segmentation approach, and boundary conditions of the wedges. An analytical three-wedge model for slope stability analysis of GRPS embankments is developed, and a solution framework for calculating the factor of safety is proposed. The accuracy of the proposed analytical model is validated through two case studies reported in the literature. The results provide a theoretical basis for the engineering design and parameter optimization of GRPS embankments.

Keywords: Geosynthetic-reinforced, Pile-supported embankment, Slope stability, Safety factor, Analytical solution

Seismic analysis of GRS walls with polylinear failure surfaces using modified pseudo-dynamic approach

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Abstract: This study presents an advanced analytical framework for assessing the seismic stability of Geosynthetic-Reinforced Soil walls using the modified pseudo-dynamic approach. The Kelvin-Voigt model is adopted to represent visco-elastic behaviour of backfill soil. The proposed methodology incorporates a polylinear failure surface. It employs the simplest (2n+1) formulation in Horizontal Slice Method. This refined approach leads to a more accurate determination of reinforcement demands under dynamic loading conditions. The investigation systematically examines the influence of critical parameters including normalized seismic frequency, damping ratio, shear strength characteristics, surcharge loading, and base acceleration amplitude on wall stability. Key outcomes include the determination of required reinforcement strength, critical reinforcement length, failure surface geometry, and the impact of vertical seismic acceleration. A computational algorithm is developed in MATLAB to simultaneously compute the normalized reinforcement strength and location of failure surface, providing an efficient and reliable design tool for seismic-resistant reinforced walls. The findings offer new insights into the seismic behavior of reinforced walls and present a practical methodology for optimizing stability under earthquake loading.
Keywords: GRS wall, Modified pseudo-dynamic method, Horizontal slice method, Polylinear, Reinforcement strength, Critical reinforcement length

Comparative performance of ordinary and encased granular piles in layered soils: Experimental and numerical investigation

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Abstract: This study investigates the behaviour of ordinary and encased granular piles (OGPs and EGPs) in homogeneous and layered clays using model tests and three-dimensional numerical analysis. Two soil configurations were considered: very soft clay over stiff clay (L_1) and stiff clay over very soft clay (L_2). Experimental unit-cell configuration was simulated in PLAXIS 3D to examine the influence of area replacement ratio, GP friction angle, encasement stiffness, and length-to-diameter ratio on ultimate load intensity (q_{ult}), stress concentration ratio (SCR), and deformation behaviour. Results show that soil layering alters load-transfer mechanisms. In the L_1 system, increasing the thickness of the weak upper layer reduces q_{ult} by up to 50% for OGPs and 39% for EGPs, whereas in the L_2 system, a thicker stiff upper layer increases q_{ult} by about 47–48%. The influence of the upper clay layer becomes negligible beyond thicknesses of about 2 d_{gp} for OGPs and 3 d_{gp} for EGPs. SCR peaks at $H_t/d_{gp} \approx 1$ (H_t = upper layer thickness) in the L_1 system and remains higher for EGPs due to encasement confinement. Deformation is governed by bulging within approximately 0.5–1.5 d_{gp}. The results identify a critical GP length beyond which increasing L/d_{gp} provides little improvement in load transfer.

Keywords: Granular piles, Geosynthetic encasement, Layered soil, Stress concentration ratio, Bulging deformation

Comprehensive study on the optimum aspect ratio of geocells

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Abstract: The geometric configuration of geocells including their height, shape, and pocket diameter plays a crucial role in their effectiveness for soil reinforcement. The current study investigates the influence of aspect ratio on the performance of geocells through triaxial, interface shear, and plate load tests. The key novelty of the study is the use of customized 3D printed geocells to overcome scaling issues in experiments. Interface shear tests and plate load tests were carried out on sand reinforced with geocells of aspect ratios 0.7, 1.0, and 1.3, while the aspect ratio was varied between 0.5 and 2.0 in triaxial tests. Analysis of results from experiments and numerical analysis revealed that geocells showed optimum reinforcing efficiency at aspect ratio close to unity. Irrespective of height and diameter, geocells of same aspect ratio showed almost similar performance. The interface shear strength is not significantly affected by geocell aspect ratio. At an aspect ratio of 1.0, geocell was able to completely cover the bulging zone in triaxial tests, providing highest shear strength. The load carrying capacity, reduction in settlements, and mitigation of heave in load tests increased with increase in aspect ratio of geocells, but improvement is insignificant beyond an aspect ratio of 1.0.

Keywords: Geocells, 3D printing, Aspect ratio, Triaxial test, Interface shear test, Plate load test

Experimental evaluation of flexible and rigid wall embankments supported by geocell foundations subjected to reverse faulting

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Abstract: This study conducted reduced-model tests on embankment and foundation systems subjected to reverse-fault movement. Measurement and image analysis techniques were used to capture the mechanical responses of geosynthetic-reinforced soil (GRS) and RC wall embankments overlying unreinforced and geocell foundations. The effectiveness of the geocell foundation in reducing fault-induced facing displacement, as well as its reinforcement mechanisms, was evaluated. The influence of reinforcement configuration on GRS embankment stability was also explored. Test results indicated that the RC wall embankment exhibited rigid-body sliding and overturning during reverse faulting, whereas the GRS embankment remained stable by accommodating lateral earth pressure through reinforced-soil deformation. The geocell mattress in the foundation effectively intercepted and dispersed fault-induced shear bands through the slab effect, thereby further reducing facing displacement. Extending the reinforcement length in the GRS embankment was also found to effectively decrease facing displacement. On the basis of the test results, a wrap-around GRS embankment overlying a geocell foundation is recommended as an effective mitigation measure for highway embankments subjected to reverse-fault movement. Such an embankment and foundation system can remain within the serviceability state under small to moderate earthquakes and within the ultimate limit state under strong earthquakes.
Keywords: Geosynthetic, Geocell, Reverse fault, Embankment, Facing displacement

Estimation of ultimate bearing capacity for geosynthetic-reinforced sandy soil foundations by physics-informed deep learning model

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Abstract: Accurate estimation of ultimate bearing capacity of reinforced soil foundations is essential for the safety of geotechnical structures, but remains challenging due to the difficulty in quantifying the contribution of geosynthetic reinforcement. Accordingly, a physics-informed deep learning model was developed, incorporating a modified theoretical solution that accounts for both the unreinforced soil contribution and the geosynthetic reinforcement effect. A multi-branch architecture was adopted. Within this framework, the geosynthetic reinforcement effect was quantitatively represented by a mobilization factor for reinforcement tensile force (λ), whose value was inferred via a sub-branch of the developed model based on eight selected influencing factors. The mobilization factor λ was then integrated by the main branch with ten influencing factors characterizing soil properties, foundation geometry, and the configuration and mechanical properties of the reinforcement to estimate the total bearing capacity. Model hyperparameters optimization, using 90% of the literature-derived dataset, identified five optimal configurations with different configuration sizes, all using the ReLU (Rectified Linear Unit) activation function and a learning rate of 0.001. Evaluation on the remaining 10% dataset showed strong agreement between estimated and actual values, with low errors of MAE (Mean Absolute Error), RMSE (Root Mean Square Error), and high R^2 (coefficient of determination).

Keywords: Geosynthetic-reinforced sandy soil foundations, Ultimate bearing capacity, Physics-informed deep learning model, Reinforcement effect, Data-physics-driven estimation

Characterization of microstructure and water retention characteristics of nonwoven polyester geotextiles: effects of manufacturing parameters

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Abstract: This study systematically investigated the effects of manufacturing parameters (fiber length and area density) on the microstructure and water retention properties of nonwoven polyester geotextiles. Continuous filament (CF) and staple fiber (SF) geotextiles with area densities ranging from 120 to 600 g/m^2 were characterized using X-ray computed tomography (CT) to quantify fiber orientation, pore size distributions, and porosity. Water retention curves (WRCs) were experimentally measured using the hanging column method, and two widely adopted soil WRC models were evaluated against the experimental data. The results indicated that CF geotextiles exhibited predominantly planar fiber alignment, whereas SF geotextiles displayed a more three-dimensional and random fiber entanglement. The pore and throat diameters of both geotextile types followed lognormal distributions. Increasing area density shifted pore and throat diameters toward smaller sizes, reduced porosity, and enhanced water retention capacity. Power functions effectively described the relationships among mean pore diameter, mean throat diameter, porosity, and area density. The van Genuchten model provided good fits for both geotextile types but requires experimental calibration. The capillary tube model successfully predicted the WRCs of CF geotextiles using a water contact angle of 40°; however, it failed for SF geotextiles due to its inability to account for complex pore connectivity and residual water content.

Keywords: Nonwoven geotextile, Fiber length, Area density, Microstructure, Water retention characteristics

Evaluation of the 3D Response of Geosynthetic Reinforced Soil Bridge Abutments Under Service Load Conditions

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Abstract: This paper presents 3D numerical simulations of GRS bridge abutments under different conditions of bridge surcharge stress, with the goal of better understanding 3D deformation behavior and evaluating the internal stability for 3D loading conditions. Backfill soil was modeled using a nonlinear elastoplastic model with the Duncan–Chang hyperbolic stress–strain relationship and the Mohr–Coulomb failure criterion. A corresponding 2D model representative of that typically used in the routine analysis and design of GRS bridge abutments was also developed for comparison. Results show that the facing displacements, bridge seat settlements, and maximum reinforcement tensile forces obtained from the 2D simulations are close to those of the longitudinal centerline section in the 3D simulations. These findings suggest that 2D simulations can reasonably predict the deformations and reinforcement tensile forces in the abutment despite the simplified plane strain assumption. Parametric analyses further reveal that facing displacements increase with abutment width but stabilize for larger widths, while abutment width has a negligible influence on bridge seat settlements. Increasing abutment height results in greater facing displacements, bridge seat settlements, and reinforcement tensile forces due to increased stress levels within the abutment structure.

Keywords: Geosynthetic, Geosynthetic reinforced soil, Bridge abutment, Numerical simulation, Reinforcement tensile force

Mechanical and hydraulic behaviour of overlapped geosynthetic clay liners under differential settlement

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Abstract: Flow through overlapped Geosynthetic Clay Liners (GCLs) under differential settlement is investigated. A numerical model is validated against published data. Due to slippage, the overlap width decreases from do = 151 mm to full separation (d = 0) as vertical differential settlement Δ increases from 0 to 185 mm. The overburden stress on the overlap can also drop to 20%-40% of its initial value due to arching. The transmissivity of the interface between overlapping GCL panels increases as the overburden stress decreases for both good- (≥400 g/m bentonite in overlap) and poor-quality overlaps (<400 g/m). Good overlap transmissivity decreased from ~ 1×10^{-9} to ~ 2×10^{-12} m^2/s ($m^3/s/m$) as effective stress increased from 2 to 250 kPa. Poor overlap transmissivity was one to two orders of magnitude higher than good overlaps. By linking these stress–transmissivity relationships with modelled overburden stress and overlap slippage, overlap transmissivities were estimated at various levels of differential settlement below the overlap. Results show that the leakage through GCLs with a 150 mm overlap increases by over two orders of magnitude as Δ increases from 0 to 180 mm. An overlap of 300 mm significantly reduces leakage compared to a 150 mm overlap.

Keywords: Geosynthetics, Geosynthetic clay liner, Overlap, Differential settlement, Leakage

Protective mechanism of wrapped woven geotextile for cohesionless soils against seepage erosion under compression

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Abstract: Wrapped woven geotextiles (WWG) have been widely used in engineering, while their filtration performance has not been investigated. To address this issue, a seepage test apparatus was innovatively developed based on the working mechanism of compressed WWG, which involves the coupled effects of geotextile tension and soil confining pressure. Seepage tests under monotonically increasing water head were conducted on three different soil-geotextile systems. Effects of compressive strain (ε_C) and geotextile type on the velocity-gradient relationship, average hydraulic conductivity (k_a), and post-test particle size distribution characteristics were systematically investigated. Test results show that the variation patterns of k_a with ε_C are primarily governed by the competition mechanism between the reduction of soil pore channels due to confining pressure and the enlargement of geotextile pores due to tension. For WWG with small pores, there is a potential for clogging when uncompressed. This clogging phenomenon is alleviated with increasing ε_C, attributed to the enhanced soil erosion resistance provided by the confining pressure and the promotion of bridging structures facilitated by geotextile tension. Conversely, WWG with large pores faces a risk of piping, which can be mitigated by increasing the geotextile strength. These findings offer practical guidance for the filtration design of WWG.

Keywords: Wrapped woven geotextile, Seepage erosion, Hydraulic conductivity, Clogging, Piping

Depth-dependent regulation of soil desiccation cracking by geotextiles

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Abstract: Geotextiles are widely used for soil stabilization and erosion control, yet the role of burial depth in regulating soil desiccation cracking and evaporation remains unclear. This study investigates the depth-dependent effects of geotextiles on crack evolution and evaporation behavior through controlled laboratory experiments. Crack development was quantified using crack area ratio and probability entropy, while evaporation behavior was characterized by evaporation rate, stage transitions, and residual water content. Results show that increasing geotextile burial depth accelerates crack development but significantly reduces crack network disorder. When burial depth increased from 0.5 to 2.0 cm, the final crack area ratio showed a relative increase of 159.36%, whereas the probability entropy showed a relative decrease of 0.77%. Deeper burial also simplified the evaporation process from five to three stages and increased the proportion of the residual evaporation stage to 49.3%, accompanied by a substantial reduction in residual water content. Based on these observations, a depth-dependent evaporative cracking framework is proposed to explain how geotextile burial depth governs evaporation resistance, crack initiation, and final crack intensity. The findings identify burial depth as a key design parameter for optimizing geotextile-based soil stabilization and moisture management, particularly in arid and semi-arid regions.

Keywords: Geotextile, Burial depth, Desiccation cracking, Soil evaporation, Soil-geotextile interaction

Geosynthetic-reinforced soil check dam: Case study and numerical analyses

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Abstract: This study investigates the performance of a geosynthetic-reinforced soil (GRS) system constructed across a creek in Taiwan, based on field observations and coupled hydromechanical finite element analyses. The system, consisting of a GRS revetment and three GRS check dams, functions as a slope stabilization measure in a mountainous area by reinforcing the riverbed and mitigating retrogressive landslides induced by riverbed scouring and toe erosion during typhoons and intense rainfall. Field observations after Typhoon Gaemi indicated that the GRS check dams remained stable, with no observable structural distress or significant deformation. In addition, post-event UAV surveys and inclinometer measurements demonstrate the effectiveness of the GRS system in enhancing slope stability and mitigating toe erosion. Numerical analyses were conducted to investigate the hydraulic response and stability of the GRS check dams under rainfall- and flood-induced seepage conditions associated with Typhoon Gaemi. The influence of internal drainage was evaluated by comparing models with and without a chimney drain. The results indicate that the chimney drain contributes to reducing pore water pressure and lowering the phreatic surface within the reinforced zone, thereby limiting deformation, reducing reinforcement load mobilization, and improving overall stability. These findings demonstrate the feasibility and applicability of GRS check dams with chimney drains for slope stabilization in hazard-prone mountainous terrains subjected to extreme hydrological events.

Keywords: Geosynthetics, Marginal soils, Geosynthetic-reinforced soil (GRS) check dam, Case study, Coupled hydromechanical analyses

Optimizing the drainage segment ratio of stacked prefabricated vertical drain (S-PVD) vacuum preloading method to improve vacuum pressure transmission efficiency

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Abstract: A novel stacked prefabricated vertical drain (S-PVD) equipped with a side-sealed structure is presented to mitigate the pronounced attenuation of vacuum pressure with depth in conventional vacuum preloading. The length ratio of its drainage segments is a critical design parameter, yet its specific effects on reinforcement performance and underlying mechanisms remain unclear. This research systematically investigates this issue through laboratory model tests and numerical simulations. Test results demonstrate that compared with conventional prefabricated vertical drain (PVD), S-PVD significantly enhances reinforcement effectiveness: total drainage increases by 5.08%-13.15%, surface settlement rises by 12.30%-32.40%, and reinforcement uniformity is remarkably improved. The optimal performance is achieved when the shallow-middle-deep drainage segment ratio is 1:2:1. Numerical analysis revealed the underlying mechanism: the side-sealed structure effectively inhibits lateral vacuum loss promoting downward negative pressure transfer and reducing well resistance. Furthermore, an empirical settlement prediction formula is derived from large-scale parametric calculations, supplying a quantitative basis for S-PVD design and evaluation. This study deepens the understanding of the efficiency-enhancing mechanism of S-PVD's structural configuration and offers methodological support for the refined design of S-PVD vacuum preloading technology in soft ground reinforcement.
Keywords: Vacuum preloading, Stacked prefabricated vertical drain, Reinforcement effect, Improvement method

EPS geofoam effects on the seismic response of integral abutment bridges in liquefiable soil

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Abstract: Integral abutment bridges (IABs) eliminate bearings and joints but intensify soil–structure interaction during earthquakes. EPS geofoam is used as a compressible backfill, though its seismic performance under saturated conditions is not well understood. This study presents a 60 g centrifuge test of a single-span IAB on spread footings in saturated loose sand, comparing conventional backfill with a 1 m EPS inclusion behind each abutment. Six earthquake motions (PGA up to ~ 0.35g) were applied, measuring settlements, rotations, accelerations, bending moments, excess pore pressures, and soil deformation.

EPS effects were found to be strongly earthquake-intensity dependent. At low shaking levels (PGA < 0.1 g), responses were similar for both configurations. At higher intensities (PGA ≈ 0.25–0.35 g), EPS significantly reduced excess pore-pressure generation and foundation settlements despite higher recorded base accelerations. Settlements beneath the left and right abutments were reduced by approximately 70% and 40%, respectively, relative to the conventional backfill configuration. In contrast, EPS increased global rocking, with peak bridge rotations during the strongest motion increasing by approximately an order of magnitude (from ~0.004 ° to 0.005 °). EPS also amplified structural demand: deck accelerations increased by roughly 10%–40%, while cyclic oscillations of abutment and deck bending moments were nearly doubled, whereas soil-surface accelerations remained broadly similar.

These findings show that EPS geofoam does not uniformly reduce seismic demand. Its compressibility lowers earth pressures and settlements but shifts more inertial demand to the bridge superstructure, underscoring the need for design approaches that account for demand redistribution.

Keywords: EPS geofoam, Integral abutment bridge, Liquefaction, Centrifuge modelling, Soil–structure interaction, Seismic response

Bearing behaviors of annular geotube dams considering interface friction effects

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Abstract: This study proposes a sludge storage dam constructed by stacking sand-filled annular geotubes of geotextile, and investigates its design and stability via model tests and DEM simulations. Model tests on a multi-layered dam reveal non-uniform local tension distribution in the geotextile due to interface friction between sand-geotextile and geotube-geotube contacts. Interlayer friction suppresses tension in the bearing zone, while tension in the non-bearing zone exhibits a gradient distribution, peaking at the junction. Geotextile ultimate tensile strength positively correlates with bearing strength, whereas modulus and filling ratio indirectly affect tension by altering tube geometry. A DEM framework was established, calibrating mesoscopic parameters to characterize macroscopic responses of the geotextile, sand, and their interfaces. Simulations analyzed evolution of geotextile stress, displacement patterns, and the influence of key parameters on bearing behavior. The mechanism by which interface friction regulates tension distribution and gradient, thereby affecting ultimate bearing capacity, was clarified. Finally, by introducing a modified principal stress ratio function and a tension attenuation model incorporating interface friction effects, a calculation method for ultimate bearing strength based on maximum local geotextile tension is proposed, considering non-uniform tension distribution and sand strain-softening. DEM results agree well with the proposed formula, verifying its accuracy.

Keywords: Annular geotubes, Bearing capacity, Model test, DEM modeling, Analytical method

Assessment of a full-scale test on soft soil stabilized by vacuum preloading technique with airtight membrane in Mexico

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Abstract: A full-scale test using vacuum consolidation method with an airtight membrane and vertical-band drains was implemented for the first time in Mexico and at a high-altitude site (2227 m. a.s.l). The trial embankment was constructed at the former Texcoco Lake on an extremely compressible clayey soil. This paper describes the soil conditions, characteristics of the embankment, phases of construction, instrumentation, monitored results, and the application of observational methods to estimate the degree of consolidation. The embankment monitoring period was one year, with six months of vacuum application. The maximum vacuum pressure applied was −73 kPa and an average vacuum pressure of −63 kPa. The decrease in the pore pressures due to the vacuum was 57.14% of the average vacuum pressure. The monitoring results show that the vacuum preloading system effectively accelerated consolidation. At the end of the vacuum application period, the settlement at the center of the embankment was 2.90 m. Given the above, it was estimated that a consolidation degree of 87.8% was reached accordingly to the settlement plates records. Field observations additionally highlight the importance of maintaining the vacuum pumps at elevations similar to the prefabricated horizontal drains to preserve effective vacuum transmission during large settlements.

Keywords: Geosynthetics, Vacuum preloading, Airtight membrane, PVDs, Full-scale in situ test, Soft soil

Degradation of modified PVC-P geomembranes under elevated-temperature air exposure

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Abstract: This study investigates the degradation behavior of three plasticized polyvinyl chloride (PVC-P) geomembranes (GMBs) through accelerated aging tests in air. Physical properties, mechanical characteristics, and plasticiser content were periodically monitored. A correlation between the break elongation loss rate and plasticiser content was established. The time to nominal failure (t_{NF}) was estimated using Arrhenius modeling based on three failure criteria. Results indicate that PVC-P GMBs undergo a continuous increase in hardness over time, accompanied by a rise in break strength and a decline in break elongation. The degradation rates of break elongation for Materials B and C were lower than that of Material A, suggesting that improved plasticiser stability in modified PVC-P GMBs effectively mitigates plasticiser loss. The predicted time to nominal failure for modified PVC-P GMBs was substantially longer than that of the unmodified material. Based on a plasticiser content criterion of 20%, the tNF of Materials B and C at 20 °C were 122.1 and 147.8 years, respectively, indicating that an increased thickness can extend service life. These findings provide insight into the degradation behavior of PVC-P GMBs and offer valuable references for their application and durability assessment in water conservancy and hydropower engineering.

Keywords: Geosynthetics, PVC-P GMBs, Break elongation, Arrhenius equation, Plasticiser loss, Time to nominal failure

Interface shear properties of sand treated geotextile and soil under freezing condition

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Abstract: This study examines the shear behavior of soil interfaces with sand-treated geotextiles (STGTs) under controlled variations in surface roughness, normal stress, water content, and temperature, with relevance to cold-region geotechnical applications. Temperature-controlled direct shear tests show that bonding sand particles to the geotextile surface markedly increases roughness and strengthens soil-STGT interfacial resistance through enhanced particle embedment and interlocking. As temperature decreases from 20 °C to subzero conditions, the shear response transitions from strain hardening to strain softening, accompanied by a progressive increase in peak shear strength and a reduction in vertical displacement and dilation. Increasing roughness deepens soil–STGT contact and further increases peak strength. At normal stress of 25 kPa, raising roughness from untreated geotextile to the highest roughness level increased peak shear strength by 32.8 kPa at 20 °C and by 32.4 kPa at −8 °C, corresponding to relative gains of 105.1% and 76.2%, respectively. Post-shear surface observations indicate a roughness- and stress-dependent shift of the shearing zone toward the soil mass, while freezing promotes partially interfacial failure due to different strengthening rates of soil and interface bonding.

Keywords: Sand treated geotextile, Frozen soil, Shear behavior, Temperature, Roughness

Insights from fifteen years of electrical leak location application in Brazilian landfills and comparative analysis

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Abstract: This study presents the results of fifteen years of electrical leak location (ELL) methods to locate holes in installed and soil-covered geomembranes at Brazilian landfills. A total of 21 landfill projects were inspected, resulting in the detection and repair of 194 holes across an analyzed area of 95 ha of geomembrane. From 2011 to 2025, the average of 2.1 holes/ha was detected, with values ranging from 0 to 8.4 holes/ha. Approximately 83% of the holes were attributed to puncturing and heavy machinery, mainly associated with placement of cover soil above the geomembrane. Around 43% of the identified holes exceeded 10 cm in length, and machine and weld failures were responsible for the largest holes (which can reach up to 80 cm). Statistical analyses indicate that the frequency of holes in Brazilian landfills is consistent with values reported in Chinese landfills, as demonstrated by overlapping confidence intervals. However, the frequencies observed in both countries were generally higher than those reported in U.S. projects. The results of this study provide data that may support the development of measures to minimize the occurrence of holes and leachate leakage in countries where the adoption of electrical methods is still recent.

Keywords: Electrical leak location, Geomembrane, Leachate, Landfill, Leak, Hole