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摘要集

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目 录

Experimental studies on geogrid efficiency against moderate to highly expansive subgrades

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Abstract: Moisture infiltration into expansive subgrades induces differential swell pressures, leading to surface heave, cracking, and deterioration of pavement serviceability. To replicate this behavior, extensive large-scale model experiments were conducted in a 1.5 m × 1.5 m × 1.1 m test tank, where differential heave was induced using a 250 mm diameter circular plate embedded within the existing subgrade. The model pavement section was comprised of an existing subgrade, overlain by a prepared subgrade made up of a 250 mm-thick compacted clayey sand (with CBR = 10% and 15%) and a 400 mm-thick base layer. Differential swell pressures corresponding to potential vertical rises (PVR) of subgrade equal to 12.5 mm and 25 mm were evaluated in unreinforced sections. To maximize performance, geosynthetic reinforcements—two polypropylene geogrids (PP 30 and PP 40) and two polyester geogrids (PET 100 and PET 200)—were placed at the interface between existing and prepared subgrades. A comparative analysis of unreinforced and reinforced pavements demonstrated that high-stiffness geogrids, PET 200 and PP 40, significantly enhanced performance. For instance, for the case of prepared subgrade with CBR = 10%, PET 200 and PP 40 reduced surface heave by up to 83% and 95%, vertical stress by over 61% and 77%, and increased swell pressure resilience by 50% and 54%, respectively.

Keywords: Geosynthetics, Geogrid, Swell Pressure, Heave, Unpaved Road, Expansive Soils, Pavement & Roads

Performance of geosynthetic-encased stone column groups in soft clay: field tests and numerical study

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Abstract: Ground improvement is essential when constructing on soft soils with low shear strength. While ordinary stone columns (OSCs) are commonly used, their effectiveness is limited in very soft soils due to inadequate lateral confining support. This is due to a lack of lateral support. Geosynthetic-encased stone columns (GESCs) provide additional lateral support and improve load-bearing capacity. This study compares GESCs and OSCs in a soft clay layer. Field load tests were conducted in Kurimamachi Yachō, Mie Prefecture, Japan. Numerical simulations were validated using PLAXIS 3D (v22). Instruments like earth pressure cells (EPCs) and piezometers measured stress distribution and excess pore water pressure (EPWP). Results showed OSCs had lower EPWP at low stress but higher EPWP at high loads due to clogging. In contrast, GESCs showed greater stress concentration with larger area replacement ratios. The critical column length for maximum bearing capacity was about 6.67 times the column diameter. A predictive model and design charts were created to match published test results. This will help engineers optimize GESC-improved ground design in construction projects.

Keywords: Geosynthetics, Geosynthetic Encased Stone Columns, Geosynthetic Applications, Stone Column, Ground Improvement, Ultimate Bearing Capacity, Numerical Modeling, Soil-Geosynthetic Stone Columns

Design of geomembrane specimen for biaxial tensile testing

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Abstract: A numerical–experimental framework is developed to optimise the design of geomembrane specimens for biaxial tensile testing. Specifically, the geometry and adhesive bonding method of specimens are optimised to maximise strain in the central measuring region while reducing premature failure caused by stress concentrations outside this region. Numerical simulations are used to generate stress distribution datasets, and an objective function integrating two metrics—stress concentration and load transfer efficiency—was used to evaluate specimen geometries. Four key geometric parameters are optimised using a derivative-free subdivision method. Specimens are reinforced by adhesive bonding outside the central region, with bonding methods optimised through uniaxial tensile tests to minimise the effect on inherent material properties. Biaxial tensile tests are conducted to validate and compare three promising geometries obtained from numerical optimisation. The final optimal specimen design achieves a peak central strain of 160.2%, significantly exceeding the previous results. This optimised specimen design provides a valuable basis for future studies on geomembrane biaxial tensile testing.

Keywords: Geosynthetics, Geomembranes, PVC, Biaxial Tensile Test, Specimen Design, Geometry Optimisation, Adhesive Bonding Method

Expanded polystyrene inclusion behind yielding wall: numerical study and cost analysis

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Abstract: The standard Expanded Polystyrene (EPS) effectiveness as compressible inclusion behind rigid non-yielding walls is verified by previous studies, but limited literature addresses its performance with rigid yielding walls, such as a cantilever retaining wall. The present study uses numerical modeling to examine the behavior of the yielding wall-inclusion system. The effects of inclusion thickness, density, placement height, and wall height are investigated. Among these, the EPS thickness is a governing parameter in the pressure reduction. The study further examines the mechanism of pressure reduction, and it is observed that major pressure reduction occurs at the bottom one-third of the wall. A cost analysis correlating the efficiency and cost of inclusion is presented, providing guidelines for practitioners to select inclusion thickness and estimate the associated costs to achieve a desired reduction in lateral pressure. Additionally, the cost analysis reveals that although the standard EPS reduces lateral pressure, it can cost up to 7% of the project cost, which is substantial. Alternatively, the use of elasticized EPS instead of standard EPS as an inclusion can reduce the thickness of the inclusion by 9% to 38% compared to standard EPS without compromising the inclusion efficiency, making it a more economical and effective solution.
Keywords: Geosynthetics, EPS inclusion, Retaining wall, Cost analysis, Elasticized EPS, Numerical modelling

In-situ evaluation of geosynthetic-reinforced pavement on variable subgrade conditions

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Abstract: A 225 m-long instrumented pavement was constructed on a local road in Australia to assess the performance of flexible pavements reinforced with polymeric geogrid, polymeric geocomposite, and fibreglass geocomposite over a soft subgrade. The lane was divided into 15 sections with variations in base thickness, reinforcement type, and placement. In-situ tests, including the Dynamic Cone Penetrometer (DCP) and Falling Weight Deflectometer (FWD), were conducted during and immediately after construction in December 2019. Long-term performance data, including static Plate Load Tests (PLTs) and a second round of FWD tests in June 2022, were incorporated to evaluate reinforcement effectiveness over time. Performance was assessed using vertical surface displacement from PLTs and normalized maximum deflection from FWD tests, while accounting for subgrade spatial variability. Results show that sections reinforced with two geosynthetic layers exhibited up to 29.5% lower deflections compared with unreinforced sections. Although Sections S7 and S8 had similar reinforcement configurations, S8, constructed over a weaker subgrade, mobilized reinforcement more effectively and showed greater reductions in deflection. Overall, the results demonstrate that PLTs and FWD tests are effective for revealing subgrade spatial variability and for assessing and comparing the performance of reinforced and unreinforced pavement sections, highlighting the importance of long-term monitoring.

Keywords: Geosynthetics, Flexible Pavements, Full-Scale Field Trial, FWD Test, Plate Load Test, Sustainable Transport, Pavements & Roads

Experimental study on rubber-sand geobags for protecting buried pipes against rockfall

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Abstract: One of the challenging problems in mountainous regions is protecting pipelines from impact load due to the rockfall. Rockfall characteristics and impact loading have been studied by many researchers; however, there is still a lack of large-scale studies to investigate protection of the steel buried pipelines against the impact of rockfall. In this study, a series of large-scale physical models were developed to simulate the performance of steel pipe buried in protective and unprotective installations. The protection system was geotextile-made bags filled with rubber-sand mixtures. During the falling mass penetration, a few different crucial design parameters including the impact force, the vertical deformation and the circumferential strains at the crown and springline were investigated. As a whole using geobags with the proposed configuration could delay the contribution of the buried pipe in stress bearing, provide more flexible interactions between falling mass, trench soil and the buried pipe, successfully detour the vertical stress to the sides of the pipeline, change the deflection mode to a sort of ring deflection, and protect the buried pipe against the impact stress. The results showed that, depending on the rubber content of the mixture in the geobags, the vertical deformation of the buried pipe was considerably reduced between 31 and 62%.
Keywords: Geosynthetics, Buried Pipe, Rockfall

Framework for designing optimized next-generation geogrids

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Abstract: Understanding the role of geogrid apertures and their role in interactions with the surrounding soil is critical. For the last 40 years, numerous attempts have been made to enhance geogrid performance by using different aperture shapes and sizes. These efforts have largely been conducted without a formal procedure and instead have relied largely on experience and manufacturability considerations. To enable a more robust design protocol that is based on topological considerations, a framework that incorporates structural optimization considerations is presented. The initial approach for this framework utilizes one of the most common structural optimization methods, mass-constrained compliance minimization. The application of the methods is demonstrated by evaluating a candidate geometry. Various parametric analyses are conducted by varying the input parameters and constraints within the optimization algorithm. To more effectively demonstrate the proposed approach, a complex bio-inspired geogrid structure is selected from which an optimized structure is generated. The resulting topological differences of the optimized design are compared with those of several commercially available geogrid designs. Finally, manufacturing options for optimized designs are discussed, and their suitability is evaluated in relation to both current manufacturing techniques and potential new approaches.

Keywords: Geosynthetics, Optimization, Structure, Ribs, Apertures, Numerical modelling, Geogrids

A testing framework for estimating the contribution of geogrid to base course performance

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Abstract: Geogrids are widely used to enhance the performance of roadways, especially to improve the conditions associated with soft subgrade. However, the results in the literature do not always show the contribution of the geogrid to improve the elastic modulus of the base course layers consistently. This study demonstrates the use of an existing methodology to overcome such inconsistency. The method used in this study is based on sequentially loading the base course surface with three side-by-side lightweight deflectometers (LWD). The findings of this study showed that such an approach enables us to demonstrate the deterioration of the base course when no geogrid is present and the improved behavior with geogrid placed in between the base course and soft subgrade. The study demonstrates the effective use of KenPave analyses and the results from LWD testing to determine modulus improvement factor (MIF) when geogrids are used. Four different geogrids with different characteristics were evaluated and the determined MIF values ranged between 1.39 and 1.64. The findings were used to develop a relationship between the base course thickness and the allowed maximum stress on the base course for different geogrids, where the applied load is limited to keep the base course elastic.

Keywords: Geosynthetics, Geogrids, Light weight deflectometer, Reinforcement, Soft subgrade, UN SDG 9: Industry, innovation and infrasturcture, UN SDG 11: Sustainable cities and communities

Experimental and numerical study on flexural behaviour of geogrid-reinforced beams

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Abstract: The deterioration of non-structural concrete elements in harsh environments presents a significant concern, particularly in Canada's cold regions. Conventional steel reinforcements are prone to corrosion, and anticipated climate changes, such as increased temperature fluctuations and freeze-thaw cycles, demand more durable alternatives to prevent premature cracking. This study investigates the use of low-ductility fibreglass geogrids and high-ductility polymeric geogrids to enhance the flexural performance of plain concrete beams. Twenty-one beams (550 mm × 150 mm × 150 mm) with varying reinforcement configurations were tested under four-point bending to assess load-deflection behaviour, mode-I fracture energy, and failure modes. Results showed that fibreglass geogrid reinforcement improved flexural stiffness by 40%, fracture energy by 11%–34%, and displacement capacity by 15%–45%, outperforming polymeric geogrids, which only enhanced deformation by 10%. Additionally, finite element models validated against experimental data were developed to examine the influence of temperature on fibreglass-reinforced beams. The models incorporated temperature-dependent material properties and evaluated midspan deflection and ultimate load under varying conditions. Findings revealed improved performance with decreasing temperatures (down to −30°C), with consistent cracking strength observed from 23°C to 60°C. This research highlights the promise of fibreglass geogrid reinforcement as a viable strategy for enhancing concrete durability in cold climate regions.

Keywords: Geosynthetics, Concrete, UN Sd9

Plastic shakedown and creep limit of geocell-reinforced sand: experiments and modeling

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Abstract: In geotechnical engineering, geocells are widely utilized to reinforce soil, thereby enhancing its resistance to cyclic loads such as traffic, machinery vibrations, and wind or wave actions. While extensive research has been conducted on geocell-reinforced soils under static conditions, there remains a gap in understanding their deformation responses and shakedown behavior under long-term cyclic loading. This study explores this gap through a series of cyclic triaxial tests, investigating the effects of geocell material stiffness, confining pressure, and cyclic stress amplitude on the accumulated plastic deformation of geocell-reinforced soil. The efficacy of geocells in mitigating dynamic loads is assessed. Furthermore, the study analyzes the shakedown response of the reinforced soil and introduces an empirical model that identifies two critical stress thresholds: (1) the plastic shakedown limit stress, at which accumulated plastic strain stabilizes to a negligible level; and (2) the plastic creep limit stress, beyond which failure occurs due to the continual accumulation of plastic strain. The model is validated against the experimental results, providing a quantitative basis for assessing deformation behaviors in geocell-reinforced soil under cyclic loading.

Keywords: Geosynthetics, Accumulated axial strain, Cyclic triaxial test, Plastic shakedown limit, Geogrids, Kinetics

Sustainable and resilient reinforced soil structures: insights into interface mechanics

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Abstract: Geotechnical engineering is fundamental to sustainable development and the resilience of infrastructure against natural hazards. Sustainability, prioritising ecological protection and societal well-being, is intrinsically linked to resilience, the capacity of structures to withstand and rapidly recover from disruptive events. Achieving resilient geotechnical designs requires a dynamic approach integrating technical robustness with environmental, social, and economic considerations. Geosynthetics have become essential in civil engineering, significantly enhancing structural safety, durability, and serviceability while minimising ecological impact. As reinforcements, geosynthetics enhance structural resilience under cyclic, seismic, and sustained loading conditions. However, fully leveraging these benefits requires a comprehensive understanding of soil-geosynthetic interface mechanics and load transfer mechanisms. Drawing from the *keynote lecture at the 12th International Conference on Geosynthetics*, this article synthesises over 15 years of experimental research on soil-geosynthetic interfaces under various pullout conditions. Results highlight the critical influence of reinforcement extensibility, confinement, and loading history on interface behaviour. Long-term tests indicate that creep reduction factors derived from in-air tests may be overly conservative. New interface-specific isochronous curves offer more realistic and safer serviceability limit state assessments. Additionally, cyclic pullout tests reveal reduced post-cyclic resistance at lower confinement pressures, an aspect not currently addressed by existing design standards.
Keywords: Geosynthetics, Sustainability, Resilience, Reinforced soil, Soil-geosynthetic interface, Soil-geosynthetic interaction, Pullout tests, Cyclic loading, Long-term loading, Pull-out testing, Geosynthetic-reinforced soils walls & slopes