《Geotextiles and Geomembranes》

（土工织物与土工膜）

<双月刊>

2024年第52卷第3期

摘要集

中国土工合成材料工程协会秘书处

目　录

Axisymmetric finite strain consolidation model for soft soil consolidation with vertical drains under combined loading considering creep and non-Darcy flow

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Abstract: Vertical drain assisted by vacuum and/or surcharge preloading is an effective method for improvement of soft ground with high water content. A large settlement will occur, and the water flow may deviate from the Darcy's law. The creep is also non-negligible in estimating the long-term settlement of such soft ground. To accurately predict the consolidation process, this study develops an axisymmetric finite strain consolidation model based on Barron's free-strain theory incorporating the creep, radial and vertical flows, non-Darcian flow law, and void ratio-dependent hydraulic conductivity during the consolidation process. First, to mathematically validate the model and highlight the new model's features, the existing model not considering the creep and the non-Darcy flow is also adopted as a reference for comparison based on a benchmark simulation. Then, Rowe cell tests involving non-Darcian flow are simulated by the new model to experimentally validate the predictive performance. Furthermore, the model is applied to simulate the consolidation process of a long-term monitoring embankment to examine the applicability of the model for engineering practice. All results demonstrate that the model is capable of accurately describing the consolidation of soft soils with vertical drains under combined loading with features of creep and non-Darcy flow.

Keywords: Soft clay, Consolidation, Finite strain, Creep, Non-darcian flow, Prefabricated vertical drain

Novel technique to mitigate the earthquake-induced damage of rubble mound breakwater

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Abstract: In past, the 2004 Indian Ocean earthquake and the 2011 Great East Japan earthquake had caused collapse of many breakwaters due to failure of their foundations. The seismic behaviour of rubble mound (RM) breakwater is not well understood may be due to limited number of research works done in the area. Therefore, in the present study, a series of shaking table tests were conducted for RM breakwater in order to determine the exact reasons and mechanisms of failure of the breakwater during an earthquake. In addition, a novel countermeasure technique was developed to mitigate the earthquake-induced damage of RM breakwater. The countermeasure model dealt with geobags as armour units on the both sides instead of conventional armours to increase the stability. The developed model has geogrid and sheet piles in seabed foundation soils of the breakwater. The effectiveness of countermeasure model was examined by comparing with conventional RM breakwater model considering parameters like settlement, horizontal displacement, acceleration-time histories, excess pore water pressure and deformation patterns. Numerical analyses were done to elucidate the failure mechanisms. Overall, the developed model was found to be resilient breakwater against the earthquakes; and the technique could be adopted in practical use on the real ground.

Keywords: Rubble mound breakwater, Geobag, Sheet piles, Geogrid, Resilient foundation

Liquefaction and post-liquefaction behaviors of unreinforced and geogrid reinforced calcareous sand

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Abstract: To explore the feasibility of geogrid reinforcement as a promising countermeasure to improve the liquefaction and post-liquefaction resistance of calcareous sand, extensive undrained monotonic and multi-stage triaxial tests were performed on unreinforced and geogrid reinforced calcareous sand with different relative densities. The test results illustrate that pore pressure generation curves of unreinforced and reinforced calcareous sand gradually evolve from S-shaped to hyperbolic-shaped with the increase in relative density, cyclic stress ratio, and effective confining pressure. Following this, a pore pressure model applicable to both unreinforced and reinforced calcareous sand is proposed. The liquefaction resistance of calcareous sand increases with the increase in relative density, whereas an elevated cyclic stress ratio increases its liquefaction susceptibility. A virtually unique relationship can be observed between the liquefaction resistance normalized to the product of phase transformation strength ratio and relative density against the number of cycles for triggering liquefaction, providing an effective means of early assessing sand liquefaction resistance. Moreover, the geogrid exhibits excellent reinforcement efficiency in enhancing the liquefaction resistance of calcareous sand at relative densities of 50% and 70%. During the post-liquefaction stage, increasing relative density and geogrid reinforcement can accelerate the recovery of stiffness and strength for liquefied calcareous sand and improve the post-liquefaction strength. In general, geogrid reinforcement is considered a good alternative to densification for improving the engineering properties of calcareous sand and offers great application prospects in marine engineering construction.

Keywords: Geogrid reinforcement, Relative density, Pore pressure, Liquefaction resistance, Post-liquefaction, Calcareous sand, Multi-stage triaxial tests

Long-term durability of two HDPE geomembranes formulated with polyethylene of raised temperature resistance (PE-RT)

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Abstract: The performance of four 1.5-mm HDPE geomembranes from the same manufacturer each with a different resin and additive package is examined in a synthetic municipal solid waste leachate at five temperatures (40, 65, 75, 85, 95 °C) for 7.5 years. Two geomembranes used polyethylene with raised temperature resistance (PE-RT) resins and two used more conventional polyethylene resins. All four geomembranes were inferred to contain hindered amines stabilizers (HAS) and had very high off-the-roll stress crack resistance (SCR_o) values that decreased to stable, more representative SCR_m values shortly after immersion and it was found that the 3-stage GMB degradation model applied to both Std-OIT and HP-OIT. The time to nominal failure is predicted for a range of temperatures using Arrhenius modelling and the representative SCR_m values. Despite the fact that all four GMBs had similar times to nominal failure at constant elevated temperatures (65–95 °C), it is shown that the HAS used in one of the PE-RT GMBs served a useful function in extending its life in situations such as elevated temperature landfills where there is a time-temperature history to be accommodat by the GMB. The value of considering both Std- and HP-OIT is also demonstrated.

Keywords: Geosynthetics, Geomembrane, Durability, High temperature, PE-RT, Stress crack resistance

New geocell utilisation as a pipe uplifting countermeasure and its validation using model experiments

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Abstract: In this study, we proposed a new method for preventing the uplift of a pipe using geocells, to improve the workability of the pipelines and increase the uplift resistance. As a fundamental study, push-up tests were conducted on the model pipe to verify the effectiveness of the geocell reinforcement. The experimental results showed that geocell reinforcement increased the peak resistance by more than 1.5 times and the resistance at large displacement (at a displacement of 40 mm) by more than 3 times at maximum, compared to the unreinforced method, indicating that geocell reinforcement is an effective countermeasure against pipe uplift. The combination of geocells and geotextiles increased the resistance at large displacement (at a displacement of 40 mm) by 1.41 times more than only geocell, contributing significantly to the increase in uplift resistance. In particular, increasing the number of geocells downward from the top of the pipe (on the side of the pipe), and integrating the left and right geocells with the geotextile, increased considerably the peak resistance and resistance at large displacement (at a displacement of 40 mm).

Keywords: Pipeline, Geocell, Model tests, Uplift displacement, Uplift resistance

Laboratory investigation and theoretical analysis of lateral pressure exerted by expansive soils on retaining walls with expanded polystyrene geofoam block upon water infiltration

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Abstract: The lateral pressure exerted by expansive soils on retaining walls constructed with expanded polystyrene geofoam blocks (EXRW-EPS), upon water infiltration to saturation, is crucial for designing these structures. In this study, model tests were employed to examine the behavior of EXRW-EPS subjected to water infiltration, with concurrent monitoring of deformation and lateral pressure. The results showed that the compressive deformation of the expanded polystyrene (EPS) geofoam block facilitated swelling deformations of the backfilled expansive soil, effectively mitigating the lateral pressure experienced by the retaining wall. Upon saturation of the backfilled expansive soil, the total lateral force on the wall decreased by approximately 44% by the EPS geofoam block with a density of 12 kg/m^3. A practical method for predicting the lateral pressure on EXRW-EPS upon water infiltration to saturation was developed based on the relationship between the EPS geofoam block and the backfilled expansive soil. The reliability of this method was corroborated by the model test results. Additionally, the effects of the density and thickness of the EPS geofoam block on the lateral pressure of EXRW-EPS were analyzed using the prediction method.

Keywords: Geofoam, Expansive soil, Retaining wall, Lateral pressure, Practical prediction method