Challenges and recent progress in the analysis, design and modelling of geosynthetic reinforced soil walls

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ABSTRACT: Geosynthetic reinforced soil retaining walls are a mature technology with proven success extending back more than three decades. Nevertheless, new approaches for design and analysis of these systems are required to improve performance predictions for operational conditions, to extend their utility to harsher environments including earthquake areas, and to allow the use of alternative backfill materials. In North America, the move toward load and resistance factor design (LRFD) has highlighted the impact of conservativeness and inaccuracy of current limit equilibrium-based models to predict reinforcement loads and load capacity in limit-state equations for internal stability design. Better accuracy is a prerequi-site to perform probabilistic-based analysis and reliability theory-based calibration for selection of load and resistance factors within a LRFD framework. The increasing use of advanced numerical modelling using finite element and finite difference methods has refocused attention on the need for more accurate constitutive models for the component soil, polymeric materials and their interactions. The paper reviews a body of work by the writer and co-workers that addresses some of the issues identified above. Included in the paper are examples of data from instrumented field walls and laboratory tests that have been used to guide understanding of the performance of reinforced soil wall systems including those constructed with both geosynthetic and relatively inextensible steel reinforcement. These databases have been important for the development of empirically-calibrated stiffness-based working stress methods for both geosynthetic and steel reinforced soil wall systems. A comparison of design outcomes for a production wall using conventional and stiffness method approaches is presented. An example of the use of synthetic data to fill in the gaps in the knowledge base of physical test results is mentioned. Examples of the influence of details of numerical modelling on predicted behaviour are given. A novel experimental technique using a pullout box in combination with a transparent granular soil and a typical geogrid is described. The results are used to provide quantitative insight into soil-geogrid interaction mechanisms and to develop interface shear models for numerical simulation. New strategies to mitigate dynamic loads against rigid walls and geosynthetic reinforced soil walls due to earthquake using seismic geofoam buffers are described and the quantitative benefits demonstrated using results from models mounted on a large shaking table. The topics touched on in this paper are part of complimentary research programs carried out by the writer and co-workers to find answers to practical issues related to new approaches for the design, analysis and modelling of geosynthetic reinforced soil walls.

Keywords: geosynthetics, reinforced soil walls, steel reinforcement, limit equilibrium, K-stiffness Method, geofoam, pullout, transparent soil, earthquake