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Executive Summary Report

Evaluation of Geofabric in Undercut on MSE Wall Stability

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Project Background

Compaction of granular base materials at sites with fine grained native soils often causes unwanted material loss due to penetration. In 2007, ODOT began placing geofabrics in the undercut of MSE walls at the soil/ granular material interface to facilitate construction. It is probable that the sliding resistances of the retaining walls are affected by this practice. To address this issue, a systematic investigation of the frictional resistance between soil/geofabric interface and soil/stone interface was conducted by Large Scale Direct Shear (LSDS) test. The research involved Type C granular material, textured geofabrics and fine-grained soils.

Study Objectives

The objective of the proposed research was to determine how the presence of geofabric at the MSE wall undercuts affected the sliding resistance. To evaluate this effect, the shear parameters were evaluated between geofabric and stone and compared to those of base soil and stone interface.

Description of Work

A Large Scale Direct Shear Apparatus (LSDS) with 12 inch square shear box was designed according to ASTM D 5321-08 specifications. The shear boxes were fabricated at the Cleveland State University machine shop with one inch thick steel plates, and mounted on a *Dake Hand Hydraulic Press utility H-frame* with 16 ton capacity. The hydraulic press allowed application of a high vertical pressure on the sample during testing. The top shear box was stationary while the bottom shear box was mounted on smooth sliding rails. A lateral force was applied to the bottom box with a manual screw system during the shear tests. A digital displacement transducer was attached to the bottom box for measuring the horizontal displacement and an S-type load cell was used to measure the resistance developed during the shear tests. A disc type *Loadstar* load cell was used for measuring the normal load. The load and displacement data was continuously recorded by a data acquisition system during the test.

The investigation was conducted with various combinations of Type C granular material, two types of base soils (clay & silt) and two different geofabrics obtained from ODOT construction sites. The direct shear tests were conducted with base soils in the bottom shear box, stones in the top shear box and geofabrics at the interface. The geofabrics were then removed from the interface and shear parameters between the base soils and stones were determined. The first set of tests provided friction angles and adhesions between the geofabrics and the stones and the second set provided friction angles and adhesions between the base soils and stones. The investigation was organized and performed in three phases. The shear tests were conducted at normal stress ranges consistent with 30 ft. MSE walls.

Research Findings & Conclusions

The valuable insight obtained from this research was that the geofabric at the MSE wall undercut could either increase or decrease the interface friction angle with stone depending on the type of soil present at the base, but, the net effect on the shear strength, with the inclusion of adhesion, was adverse. Up to 30 % reduction in shear strength could occur at the geofabric/soil interface for a 30 ft. MSE wall constructed on cohesionless base soil. A summary of the effect two geofabrics at the soil/stone interface is shown in Table 1. Soil A was predominantly clay while Soil B was predominantly silt.

	Soil A	Soil B
Geofabric A	-4%	-24%
Geofabric B	-7%	-26%

Table 1: Reduction of Shear strength (average values) for the geofabric/soil Interface compared to the stone/soil interface.

The primary conclusion drawn from the research was that the placement of geofabric at the MSE wall undercut adversely effected the shear strength parameters and could reduce the interface shear strength significantly in case of cohesionless base soil and less notably in case of cohesive base soils. Based on the results of the research, the following specific conclusions were drawn.

- The shear parameters between the soil/stone interfaces were significantly affected by the properties of the base soil. Cohesionless soil generated higher shear resistance at the stone interface than cohesive soils.

- The shear strength parameters at the geofabric/stone interfaces were not affected significantly by the type of stones or the type of geofabrics used in the research.

- For cohesive soil, the shear parameters at the geofabric/stone interface changed from those of the soil/stone interface such that friction angle increased and the adhesion decreased. However, the shear strength at the geofabric interface, calculated with 25 psi normal stress, was slightly lower. Therefore, if the native soil was primarily cohesive, placement of geofabric at the MSE wall undercut would not significantly affect the sliding resistance of the wall.

- For cohesionless soil, the shear parameters at the geofabric/stone interface changed from those of the soil/stone interface such that both, friction angle and adhesion decreased. Therefore, at sites where the native soil was primarily cohesionless, a significant (up to 30% under 25 psi normal pressure) reduction in the shear strength could occur if geofabric was placed at the MSE wall undercut.

Implementation Recommendations

In most instances, the design of MSE walls is dictated by the soil reinforcement lengths (local stability) and the resulting $FS_{sliding}$ (global stability) exceeds the minimum value required by the design. Nonetheless, the findings of this research indicate that the design of MSE walls with geofabric at the undercut may require modification of the sliding safety factor to reflect the reduced shear strength at the interface. A conservative suggestion is to calculate the $FS_{sliding}$ by reducing the shear strengths by 70 % and 85% for cohesionless and cohesive base soils respectively. However, depending on the site conditions, this modification might not affect the final design at the end.

It should be kept in mind that the results of this research are applicable only to the materials used in this investigation and should not be generalized to field conditions with different materials.