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Centrifuge Model Tests for Investigation of Fiber Reinforced Soil Walls

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ABSTRACT

The geotechnical qualities of fiber-reinforced soil barriers were analyzed using centrifuge model tests. Models of centrifuges were constructed on a smaller scale utilizing kaoline-amended silty soil for the barrier. When compared to fiber reinforced soil barrier, the water-tightness and integrity of the unreinforced soil barrier was shown to be compromised at lower distortion levels. It was subsequently shown that the inclusion of silty soil in the centrifuge models, which is often thought to have low creep, did not preclude the emergence of time-dependent deformations. So, the geotechnical structure of fiber reinforced soil walls wall systems may undergo large time-dependent deformations. Using a centrifuge model, we analyzed the long-term behavior of reinforced soil walls structures in a range of stress conditions

.**Key words: Fiber, Centrifuge Model; Silty Soil, Geotechnical Properties.**

1. INTRODUCTION

In earth retention projects during the past decade, experts have examined the construction of reinforced soil walls (1-3). The time-dependent behavior under constant demand, however, presents the greatest difficulty for projects. As a result, under continual stress, reinforced soil barriers must undergo deformations in their geotechnical qualities over time. Due to the large deformations and even creep failure of reinforced soil, the time-dependent behavior of reinforced soil walls is a crucial component in the design of reinforced soil structures (4, 5). In order to learn about the long-term behavior of a soil-reinforcement structure, geotechnical specimens are subjected to creep tests (6). Nearly all time-dependent behavior is now prepared using creep testing. However, the long-term deformation of reinforced soil walls is poorly understood, and research in this area is sparse (7–10). The centrifuge model's scaled-down representation of reinforced soil walls is a different way to study these interactions. The design of full-scale instrumented walls is crucial in studying the durability of reinforced soil walls.

However, for the long-term behavior of reinforced soil walls, the complete size of walls was not considered in majority of the published investigations. Significant time-dependent deformations of reinforced soil walls may be well characterized by means of the full-scale walls (12-14). Standard creep tests may be used to forecast the strain rate in these walls, at certain times. However, there is scant data on how reinforced earth barriers deform over time. Time-dependent deformation variations in geotextile-reinforced walls were evaluated using a centrifuge test by Costa et al. (6). They found that reducing the ultimate tensile strength of reinforcements by utilizing large creep reduction factors is not necessarily as formal as was previously believed. The creep rates recorded in isolation were compared to those measured in full-scale walls by Allen and Bathurst (7). They discovered that at first, reinforcing showed signs of creep and just minimal stress relaxation. The tension of reinforcement, however, tends to ease down with time. And because of how the full-scale walls have behaved over time, we know that the reinforcing loads are not high enough to produce creep rupture throughout the structures' expected service lives (15). To examine how silty soil and fibers interact throughout time, centrifuge model experiments were employed in the present study.

fortified dirt enclosures. The time-dependent response of the reinforced soil walls under sustained stress was evaluated by long-term testing including models monitored over extended periods of time while subjected to steady acceleration. Soil and reinforcement interaction processes as a function of time were isolated using the centrifuge model. Using a centrifuge model, we also looked at how reinforced soil wall constructions hold up over time while subjected to various stresses.

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2. CENTRIFUGE MODEL

The centrifuge models' backfill was kaoline-amended silty soil, while the reinforcing zone was made from interfacing fabrics. One of the walls of the enclosure was constructed from a clear Plexiglas plate coated with a Mylar sheet.

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square (200mm 400mm 300mm) box. Aluminum plates made up the rest of the strong box's walls. Figure 1 is a schematic depicting how the box is put together. The centrifuge experiments were conducted at Tehran University in Iran. Suspending basket, centrifuge boom, adjustable counterweight, fluids rotational joint, electrical slip ring, driver system, aerodynamic covering, and automated balancing system were all components of the beam type centrifuge that was put to use. The relative density of the reinforced soil in the zoon was 60%, whereas it was 100% in the base layer. Scaled-down walls in the C1–C4 models were exposed to constant accelerations of 25, 40, 60, and 80%.

of the g-level tests.

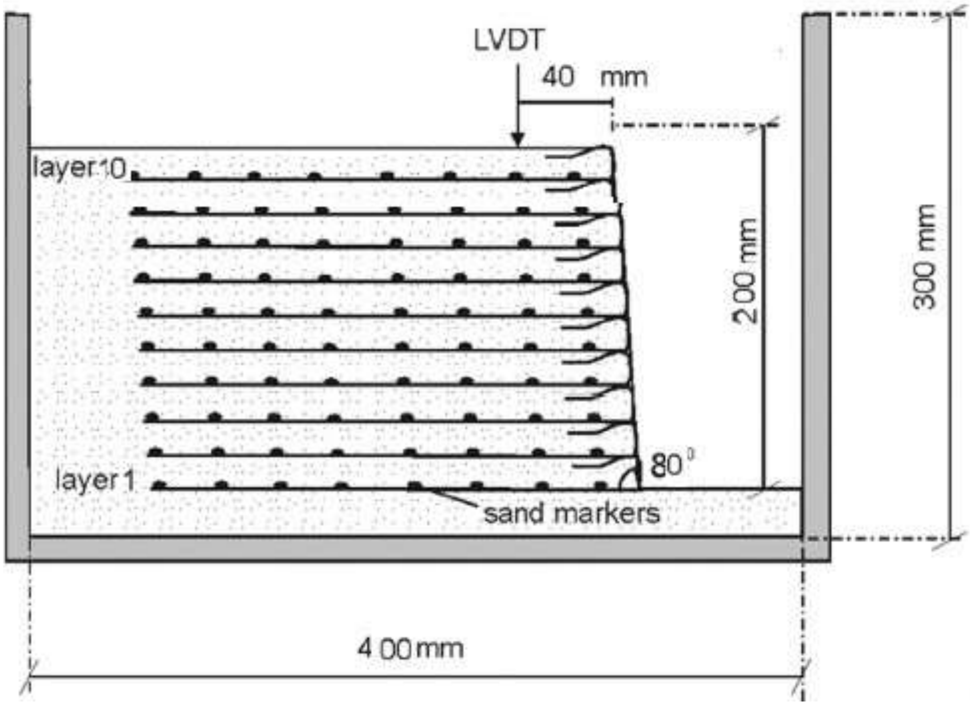

Figure 1. Schematic of centrifuge model (6)

3. MATERIALS

For this purpose, a mixture of sand and kaolin, by dry weight 4:1, was utilized. Discrete fiber reinforcement was accomplished by the employment of polyester (PET) fibers with an equivalent diameter of 40 m and an elongation strain of 19.25% strain. To create fiber reinforced soil barriers, the soil was mixed by hand with the fibers at the required fiber content and length, and then half as much water was added as was originally planned. Figure 2 depicts the study's fiber of choice. Used PET and kaolin characteristics are detailed in Table 1 and Table 2, respectively.

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Figure 2. Polyester fibers in this work

Table 1. Properties of used PET fibers

D (μm)	*SG (g/cm³)*	*E (GPa)*	*UTS (MPa)*
49	1.12	19.25	480

Table 2. Properties of used kaolin

	pH_{PZC}	*SSA (m²/g)*	*Metal concentrations (mg/kg)*			
			Fe	Zn	Pb	Cd
16.50	4.60	16.20	1180.0	75.0	16.1	9.8

4. RESULTS

Figure 3 depicts the tensile tests with the tensile tests with a mean ultimate tensile stability of 0.033 kN/m in the cross-machine direction. Four different percentages of the material's ultimate tensile strength were used as the applied loads: 25%, 40%, 60%, and 80%. As can be seen, the strain rate increased quite rapidly alongside the rise in applied load. Figure 4 displays the results of standard creep testing performed in line with ASTM D5262 (2012) but without soil confinement. In order to further characterize the creep failure circumstances, the tests were performed three times at the maximum load level. Time to creep failure for the samples loaded to 80% of their telic tensile strength varied from 1.0 to 2.5 hours.

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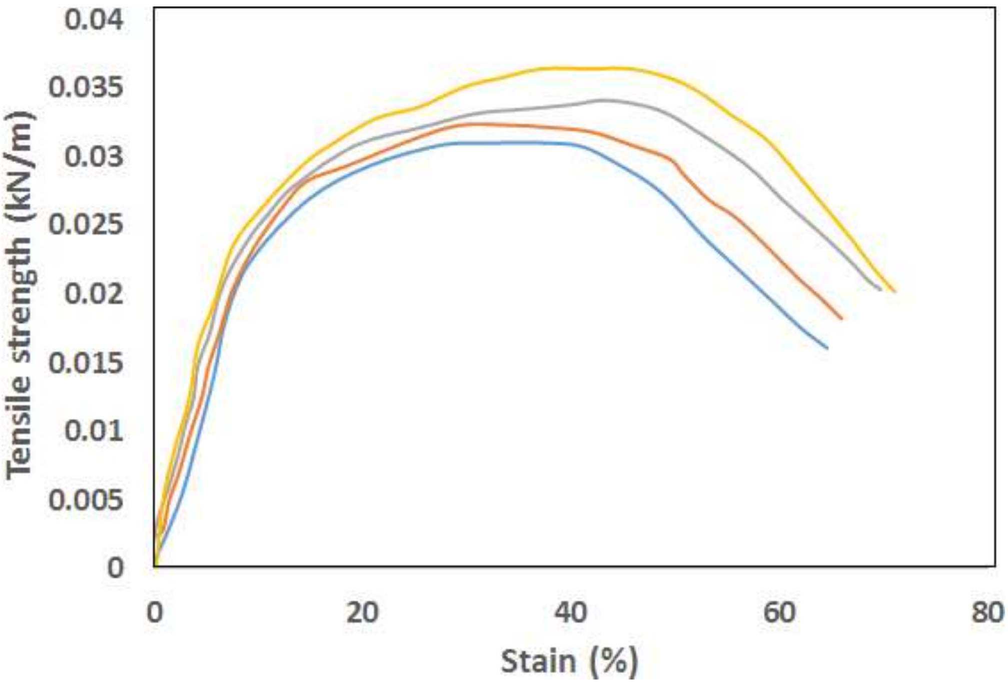

Figure 3. Tensile tests conducted in the cross-machine direction

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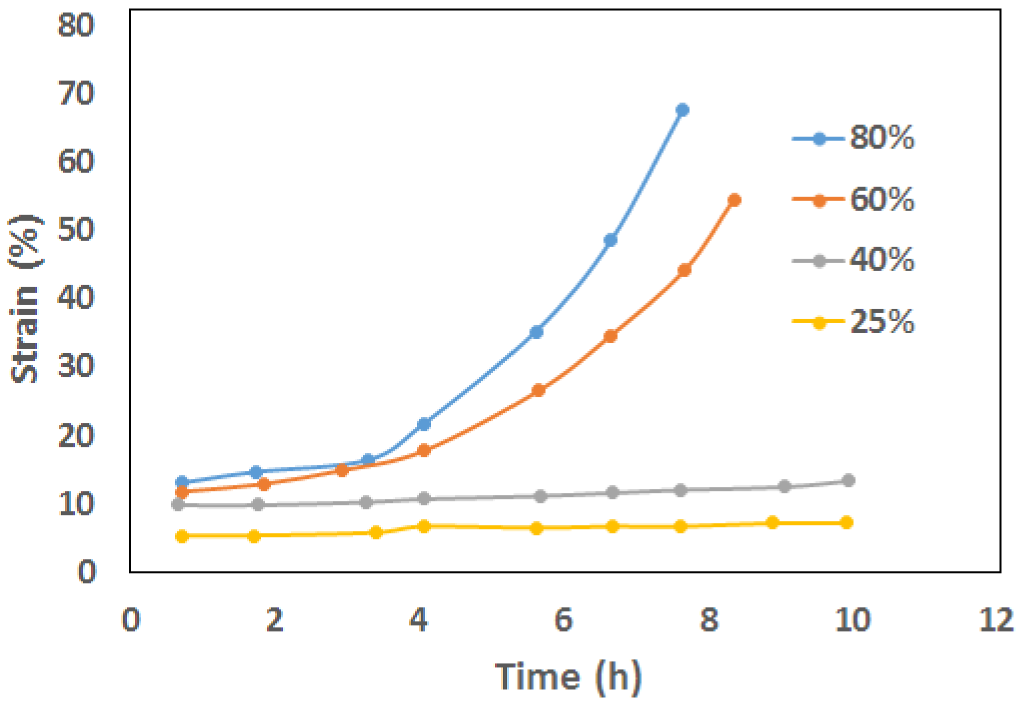

Figure 4. Conventional creep test of samples

Figure 5 shows the time-dependent settlements established at the top of walls built using PET support. The long-term conduct of the walls under stable centrifugal haste wasevaluated within 10 h. The time in the figures was the passed time after having reached the objective accelerationin tests. As shown in the Figure 5, time-dependent

settlements were observed to occur in all the tests in this series, by increasing settlement rate for increasing acceleration values. The obtained results revealed that the time-dependent specs of the reinforcements affected the overall time-dependent efficiency of the reinforced soilwalls.

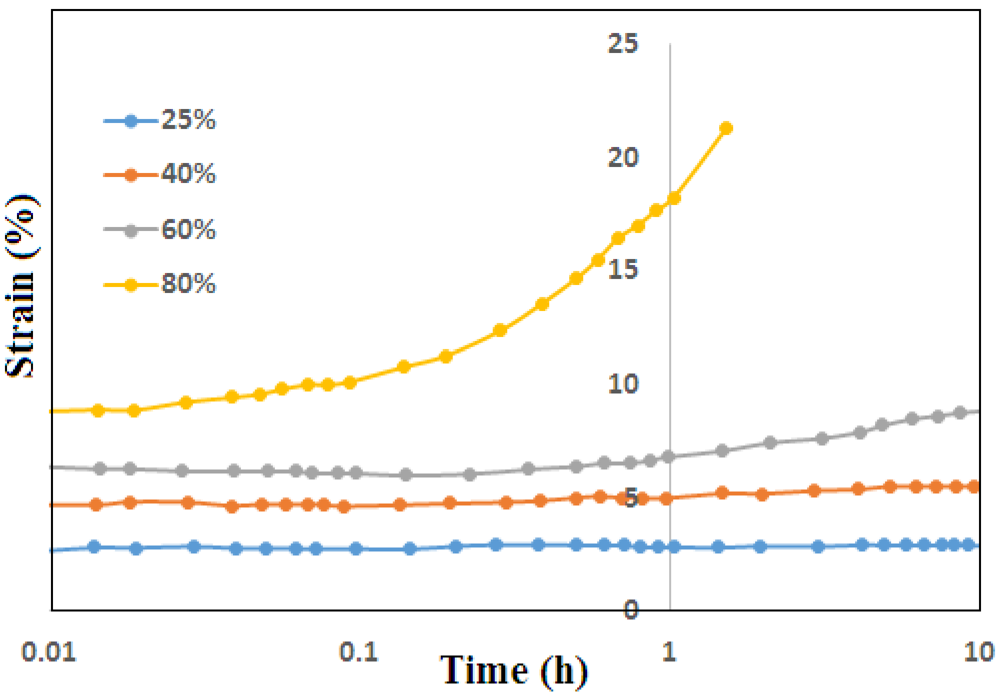

Figure 5. Time-dependent settlements obtained at the crest of models

Figure 6 shows the reinforcing strains found in "Long-term" testing using the C4 model. Target centrifuge acceleration (in N) values were used, which were 80% of the g-level at failure for the testing. Time histories of stresses measured on the same geotextile subjected to unconfined creep testing are displayed in Figure 6.

As was previously noted, the time scaling factor in centrifuge testing creep assessments was assumed to be 1. Initial stresses for the various layers ranged from 7.8% to 9.8% in magnitude. The range of initial strains for several unconfined tests is quite constant, ranging from 7.9 to 9.7 percent. Figure 7 shows the range of creep strain rates found in the technical literature for several types of geotextile. The results of standard creep tests on geotextile specimens were used to generate the curves, with each curve representing the behavior of a distinct specimen under a constant load.

It has been demonstrated that the centrifuge models' geotextile simulants' creep strain rates are in agreement with those published in the literature for geotextile used in reinforced soil structures.

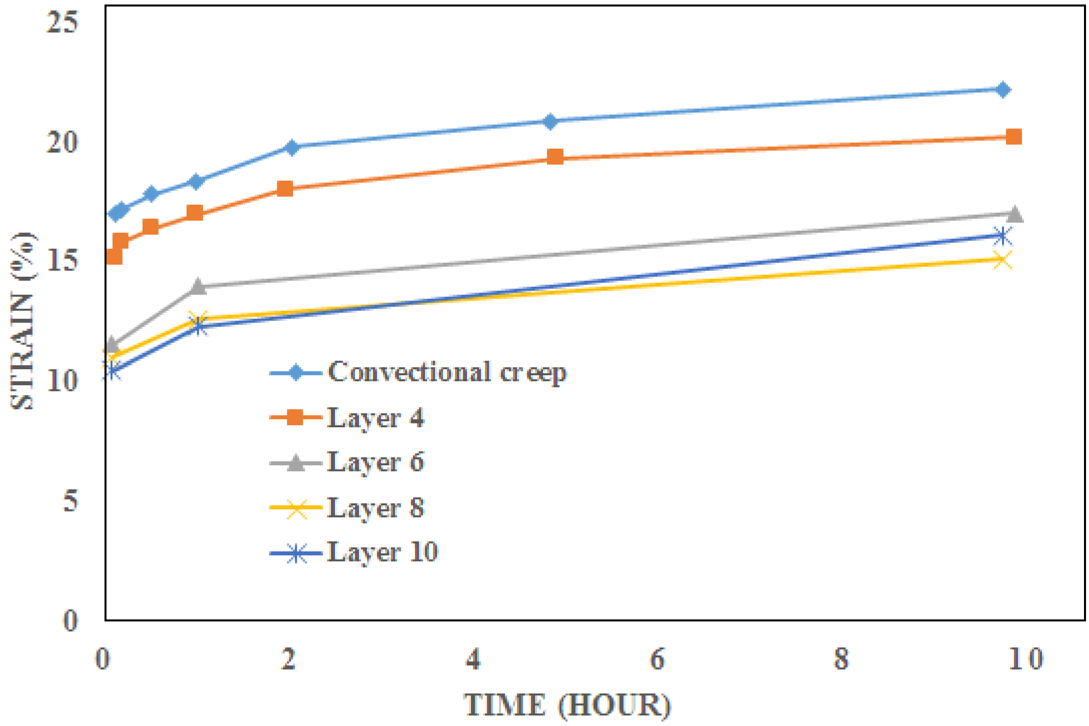

Figure 6. Time-dependent strains from model C4

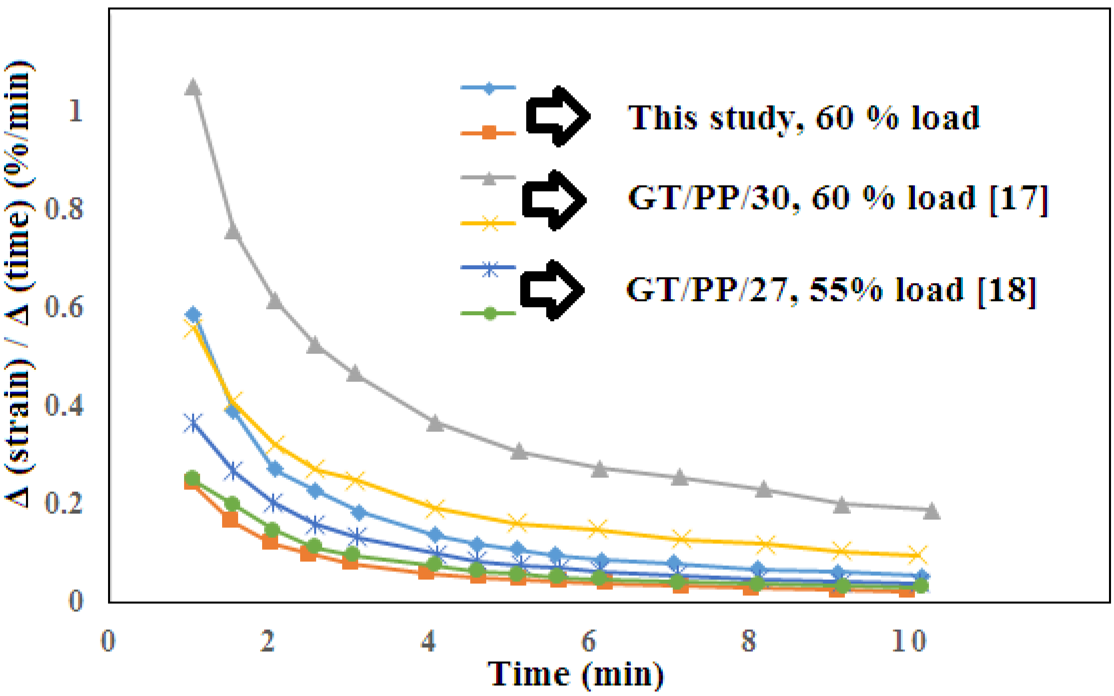

Figure 7. Creep strain rate for geotextile reported in literature, (GT: geotextile, and PP: polypropylene (16, 17))

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5. CONCLUSION

The amount of time-dependent creep stresses created in the centrifuge models was found to be comparable to that obtained from traditional creep testing, according to the results. Soil shear stress may be rather substantial and responsible for this behavior. When creep strain rates were compared between soil and reinforcement, it was clear that tension was relatively low in the reinforcement but high in the soil. Allen and Bathurst (18) find the same tendency. Figure 5 displays the strain rate data for soil creep, which showed a linear logarithmic trend. Tests conducted over extended periods of time revealed time-varying stresses in the reinforcements and time-varying deformations at the long-term models' crest. It was revealed that centrifuge models' time-dependent strain rates were comparable to those of conventional creep's unconfined samples. The centrifuge tests showed that geotextiles' creep characteristic can cause geosynthetic reinforced walls to disintegrate slowly over time.

REFERENCES

1. Ling HI, D. Leshchinsky, and N. N. Chou. Aftermath analysis of the Ji-Ji earthquake in Taiwan's geosynthetic-reinforced soil retaining walls and slopes. 2001;21(4):297-313, Soil Dynamics and Earthquake Engineering.
2. A. Fakher, M. Sabermahani, and A. Ghalandarzadeh. Modes of seismic deformation of reinforced-soil walls: an experimental investigation. 2009;27(2):121-36 Geotextiles and Geomembranes.
3. 3 Koseki, J., R. Bathurst, E. Guler, J. Kuwano, and M. Maugeri (eds.). Reinforced soil wall seismic stability. Geosynthetics: Proceedings of the Eighth International Conference, Yokohama, Japan, 2006.
4.
5. Yeo S.-S. and Hsuan Y. High density polyethylene and polyethylene-terephthalate geogrids' creep behavior is analyzed. 2010.28(5):409-21 Geotextiles and Geomembranes.
6. Tatsuoka F, Kongkitkul W. 5. Theoretical basis for interpreting results from temperature-accelerated creep tests of polymer geosynthetic reinforcement. 2007;14(1):23-38. Geosynthetics International.
7. CML Costa, JG Zornberg, and DS de Souza The authors are Bueno B. and Costa Y.D.J. Analyzing the behavior of geotextile-reinforced soil barriers over time using a centrifuge. 2016;44(2):188-200 in the journal Geotextiles and Geomembranes.
8. Soil reinforcement loads in geosynthetic walls under operating stress, Allen T. and R. Bathurst. 2002, at 9(5-6):525-66, Geosynthetics International.
9. Geotextiles' inherent confined and unconfined load-deformation qualities, by Ballegeer JP and Wu JT. The ASTM International Standard Test Methods for Geosynthetic Soil Reinforcement, 1993.
10. Geosynthetic reinforcement residual strength after accelerated creep testing and simulated seismic events. Jones, C., and D. Clarke. 2007;25(3):155-69. Geotextiles and Geomembranes.
11. Zornberg, John G.; Byler, Brian R.; Knudsen, James W. Superposition of time and temperature to study the creep of geotextiles. 2004;130(11):1158-68 Journal of Geotechnical and Geoenvironmental Engineering.
12. Helwany, S., and Wu, J. An evaluation of soil-geosynthetic composite performance based on their long-term creep behavior. Journal of Geosynthetics, 1996, Vol. 3, No. 1, pp. 107-24.
13. Gourc, J., Divya P., and Viswanadham B. The effectiveness of fiber-reinforced clay-based landfill coverings under flexural distress was investigated using a centrifuge model. 2017;142:173-84. Applied Clay Science.
14. Li Z, S. Escoffier, and P. Kotronis. Fontainebleau sand as an example of using centrifuge test results to determine dynamic soil qualities. The Journal of Earthquake Engineering and Soil Dynamics 52 (2013):77-87.
15. Jabary R. and S. Madabhushi. The response of multi-story buildings may be altered by using a tuned mass damper, as seen in geotechnical centrifuge experiments. Engineered Seismic Safety of Buildings and Other Structures (2015);77:373-80.
16. Mirshekari, M., and M. Ghayoomi. Seismic site evaluation using centrifuge experiments on sand layers that have been partly soaked. Structure and Dynamics of Soils for Seismic Design 2017;94:254-65.
17. Edited by S. Shrestha and J. Bell. Geotextile creep is the deformation that occurs under constant stress. Geotextiles: Proceedings of the Second International Conference, 1982.
18. Edited by John Greenwood, Gary Kempton, Gordon Watts, and David Bush. Evaluation of geosynthetic reinforcements for creep during a 12-year period. Mercer lecture, keynote presentations, and geotechnical applications are included in volume 1 of the proceedings of the second European Geosynthetics Conference, published in 2000 as Eurogeo 2000.
19. 18 Allen, T., and R. Bathurst. Observed long-term performance of geosynthetic walls and implications for design. 2002;9(5-6):567-606 in Geosynthetics International.

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