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The Utilization of Repurposed Whole Textiles to Modify the Mechanical and Hydrogeological Soil Properties: Green Media

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Abstract

The utilization of repurposed whole textiles to modify the mechanical and hydrogeological soil properties investigates the impact of adding repurposed textiles to lightweight engineered soil, documenting changes in unit weight, water content, and hydraulic conductivity. This study builds upon prior findings, which demonstrated significant alterations in hydrogeological properties when incorporating textile fabric (3% by weight at an aspect ratio of 1:1). Functioning as reinforcement, these fibers enhance the soil's strength, stability, and structural integrity—especially advantageous in erosion-prone areas, regions susceptible to landslides, or locations requiring heightened load-bearing capacity. The outcomes of this parametric study leads to green roof farms playing a pivotal role in extending the advantages of suburban living to urban environments, offering energy efficiency benefits by reducing the need for excessive heating and cooling in commercial buildings. This may offer crucial insights, potentially opening avenues for practical implementation in strengthening highway pavements. However, integrating green roof infrastructure, growing media, and vegetation poses a challenge due to the limited load capacity of buildings. To address this, a promising approach involves incorporating repurposed textiles into lightweight engineered soil, ensuring that the additional components maintain a minimal weight. This innovative technique aims to modify the hydraulic properties of the soil without compromising structural integrity.


Fig 1: Modified Proctor Hammer


Fig 2: Hydraulic Conductivity Test.

Methodology

Day 1: After determining and selecting the percentage of the whole textile by weight, the soil was compacted using a Modified Proctor Hammer and then submerged in a bath for 24-hours with weighted steel plates.

Day 2: Specimens were drained for a 120-minutes. The Maximum Media Density (MMD) and water permeability (kmmd20c) were recorded through a Hydraulic Conductivity Test.

Day 3: After drying the in an oven at 250°F for 24 hours, the specimen's weight was measured, and the moisture content (w%) was then calculated.

Results

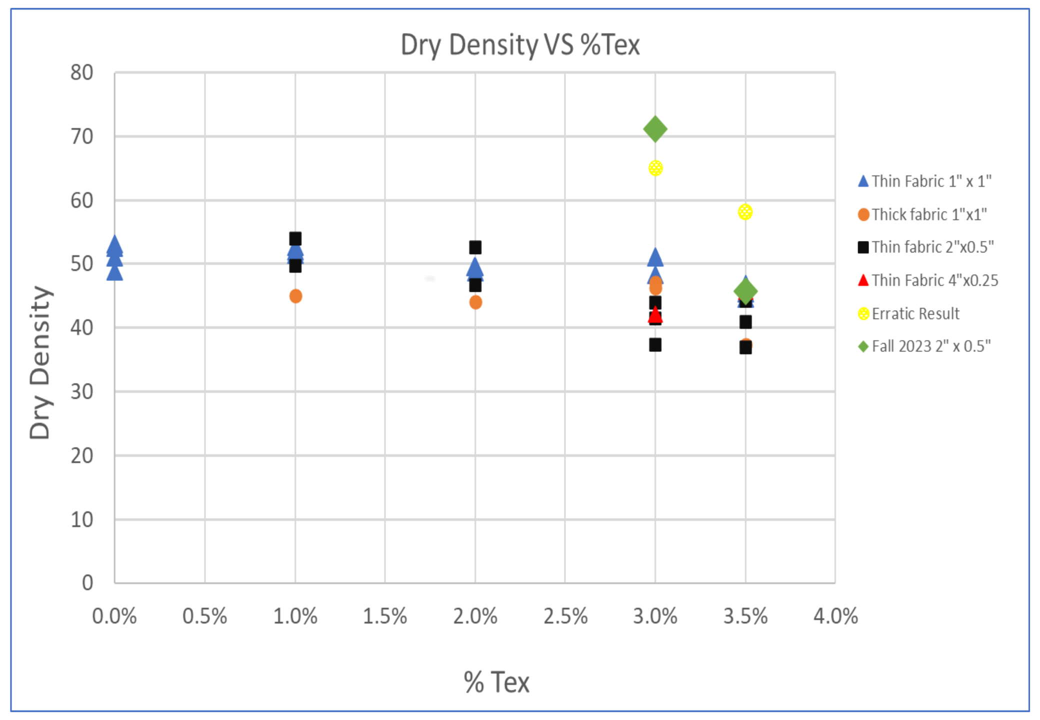

Fig 3: Dry Density

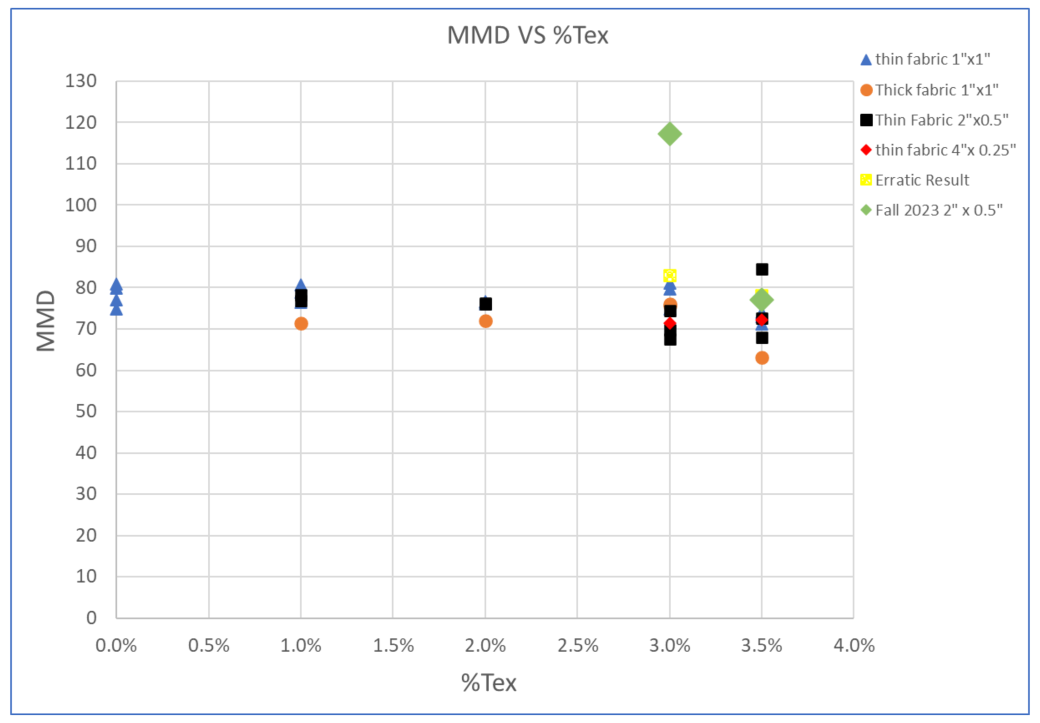

Fig 4: Maximum Media Density

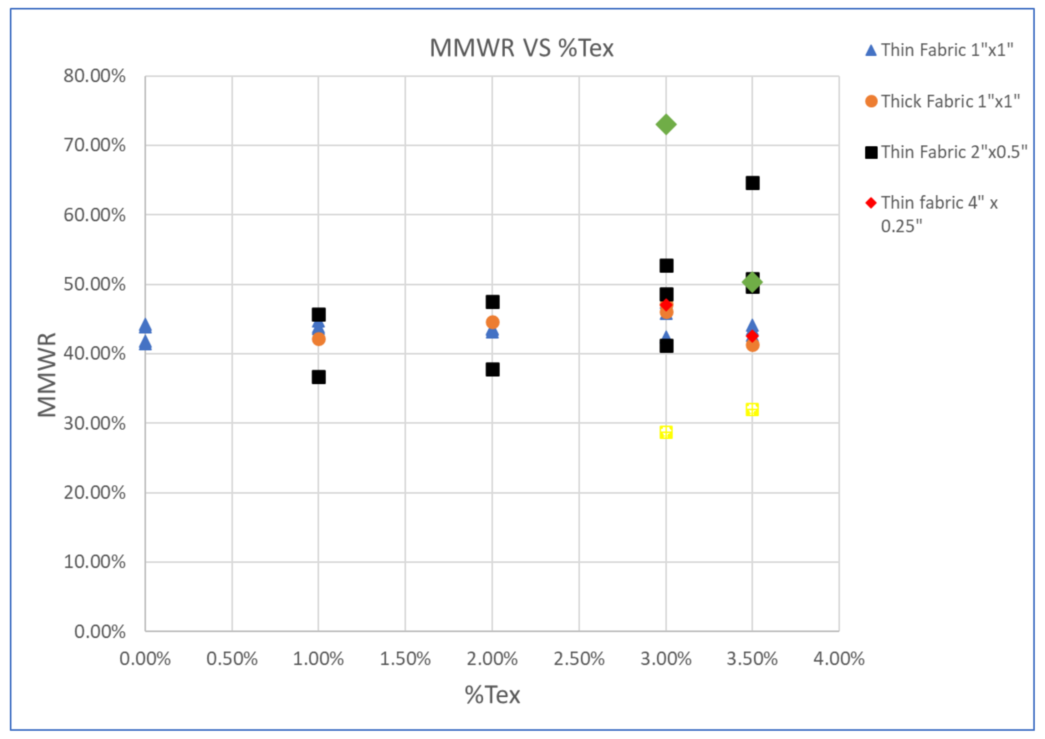

Fig 5: Maximum Media Density Water Retention

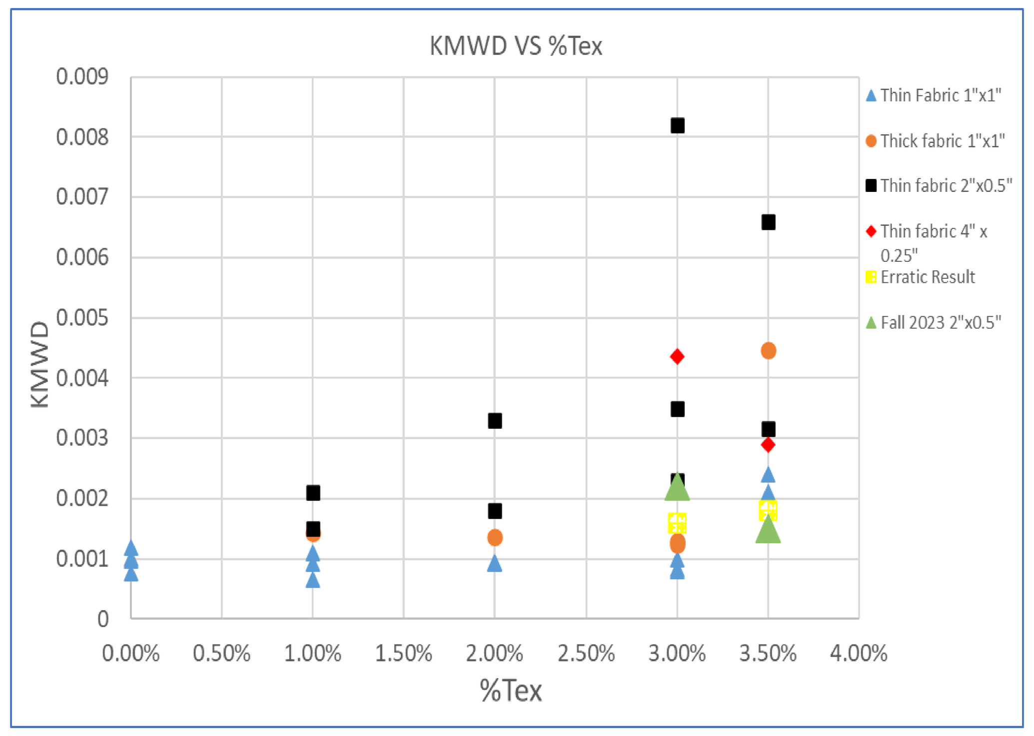

Fig 6: Water Permeability


Fig 7: Submerged specimen


Fig 9: Soils drying in oven


Fig 8: Draining Soils

Conclusion

In conclusion, the findings from previous experiments reveal a notable enhancement in soil moisture content, with a substantial increase resulting from incorporating recycled textiles at the tested levels. Remarkably, this improvement in moisture content does not adversely affect the soil's weight. Such an augmentation suggests a potential reduction in necessary irrigation for a commercial roof farm. The assessment of other parameters, namely MMD (mean mass diameter) and permeability, revealed no significant alterations in response to the introduction of textiles in the specified quantities.

After significant initial findings, we conducted additional trials, using distinct dimensions (2" x 0.5") to validate and further experiment on the enhanced soil strength and structural integrity provided by recycled textiles for green roofs. These results have implications for green roof infrastructures and extend to the potential improvement of highway pavement. The subsequent steps will go from focusing on green roofs to creating a standardized sample system for highways' pavement. The project will center around ensuring accurate data regarding the use of green media in determining its strength and permeability when implemented in highway pavement.

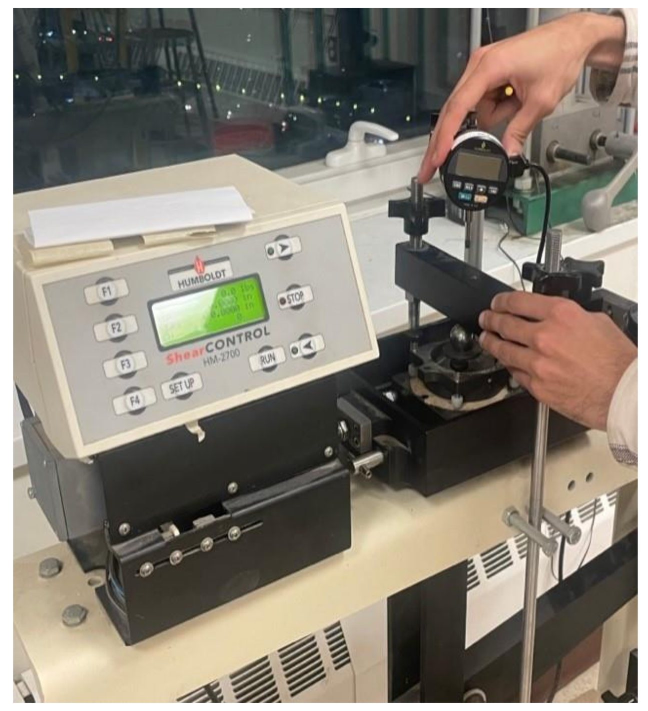
Fig 10: Direct Shear Machine


Fig 11: Compacting sample inside direct shear box

References

1. ASTM International. (2015). Standard Test Method for Maximum Media Density for Dead Load Analysis of Green Roof Systems. West Conshohocken, PA. Retrieved from www.astm.org
2. Guzman, Ivan L., and Cesar Payano. "Use of Repurposed Whole Textile for Enhancement of Pavement Soils - International Journal of Geo-Engineering." SpringerLink, Springer Nature Singapore, 25 July 2023, link.springer.com/article/10.1186/s40703-023-00190-1.
3. Guzman, Ivan L., and Sandra M. Torres. "Use of Repurposed Fibers to Decrease Hydraulic Conductivity without Compromising Load Restrictions in Urban Roof Farms." Geo-Congress 2019: Geoenvironmental Engineering and Sustainability. Reston, VA: American Society of Civil Engineers, 2019.