NaturalPave®

NTNU Laboratory Evaluation of Treated Aggregate

Background

The mechanical properties of pavement layers are of major importance when it comes to ensuring a well-performing road and/or runway. Very little research and testing is available for non-traditional stabilization chemistries. A series of laboratory studies were conducted by the Norwegian University of Science and Technology to assess the performance and mechanical properties of aggregate treated with 14 traditional and non-traditional stabilization technologies. The following three NaturalPave products were submitted from Midwest and categorized in the report as synthetic polymers:

- **Eco-Pave H** (STB)
- **Eco-Pave E** (ACE-A)
- **Soil Sement EF** (ACE-B)

Testing

Laboratory testing was performed on quality base course aggregate.

Repeated Load Triaxial Testing (RLTT) – Phase 1

The Repeated Load Triaxial Test is a comprehensive method for evaluating the mechanical properties of a pavement layer when subjected to simulated traffic loading. RLTT evaluates the treated aggregate's resilient modulus (stiffness) and resistance to deformation.

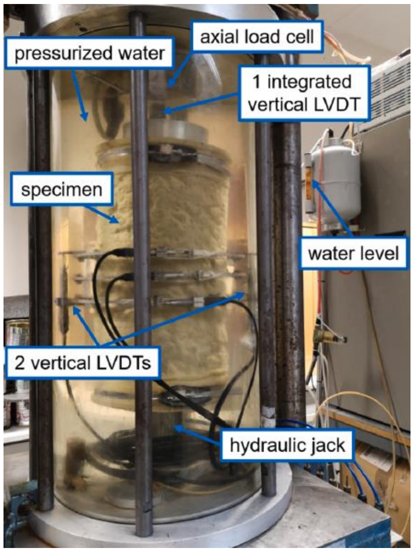

Figure 1: RLTT Specimen Setup

Freeze / Thaw RLTT Evaluation – Phase 2

Freeze-thaw testing was performed on RLTT specimens to evaluate performance after being exposed to 10 freeze/thaw cycles. Each treated specimen was submerged in water for 5 minutes then removed and allowed to free drain for 5 minutes. The specimens were then placed in a freezer for 24 hours after which they were allowed to thaw at room temperature. This process was repeated for 10 cycles before performing the RLTT testing.

Figure 2: Rolling Bottle Test Setup

Rolling Bottle Testing (RBT)

The Rolling Bottle Test is a standardized procedure to assess the adhesion between the aggregate particles and product. Loose aggregate particles were coated with the product then placed at room temperature for 30 days to allow bonding to occur. The treated loose aggregate was then placed in glass bottles filled with distilled water. A glass road was inserted into the bottles to provide the mechanical stirring action and prevent clumping. The bottles were then placed on a roller at a speed of 60 rounds per minute. The specimens were subjected to 14 different time intervals up to 24 hours. After the cycles were completed the samples were weighed and visually evaluated to determine the product's susceptibility to stripping from the coated aggregate and leaching out of the aggregate.

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Phase 1 Results: Dry RLTT Testing

All three NaturalPave products significantly improved the mechanical properties of the aggregate. ***(Note the difference in the y-axis between untreated and treated in the charts below)***

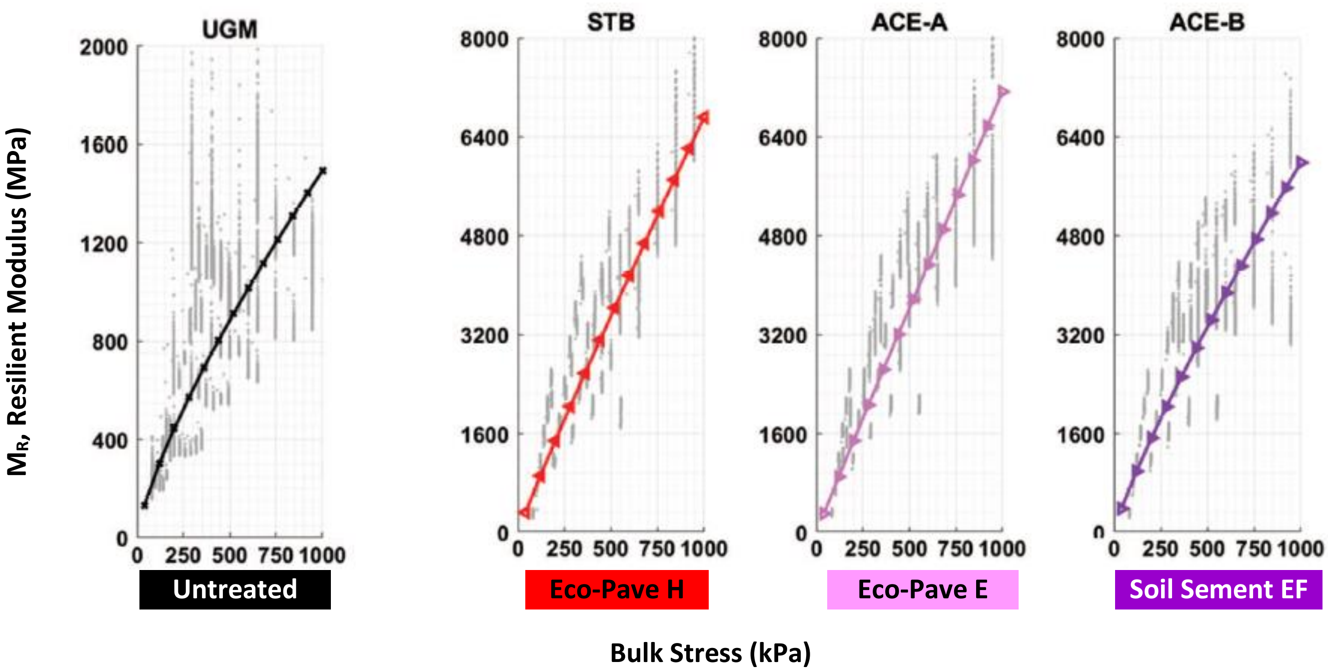

Figure 3: Comparison of resilient modulus between untreated aggregate (left) and NaturalPave treated aggregate.

All NaturalPave products improved the stiffness and resistance to permanent deformation. The two ACE products (Soil Sement EF and Eco-Pave E) displayed good resistance to stripping while the STB displayed a low resistance to stripping when exposed to excess moisture and agitation.

Based on the results of the Phase 1 laboratory testing, the following suitability chart was created to easily compare the performance of the different stabilization chemistries.

	Suitability assessment		
Additive	Increase in resilient modulus	Decrease in permanent deformation	Resistance to stripping
CEM	Medium	High	Low
BIT	Medium	Low	High
SAL-A	Very high	High	Very low
SAL-B[a]	High	High	Low
BEN	Very high	Medium	Low
LIG	High	High	Low
SUG	Medium	Very high	Low
RES	Medium	Medium	Low
POL	Low	Very low	Very high
ACR	Low	Medium	Medium
STB	Medium	High	Low
ACE-A	Medium	High	High
ACE-B	Medium	Medium	Medium

Figure 4: Phase 1 suitability assessment. NaturalPave products are in green box.

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Phase 2 Results: Freeze/Thaw RLTT Testing

The mechanical properties of the three NaturalPave treated specimens were not effected by freeze/thaw cycles and therefore indicate good freeze/thaw durability. In fact, the results show that the stabilization properties improved after the 10 freeze/thaw cycles.

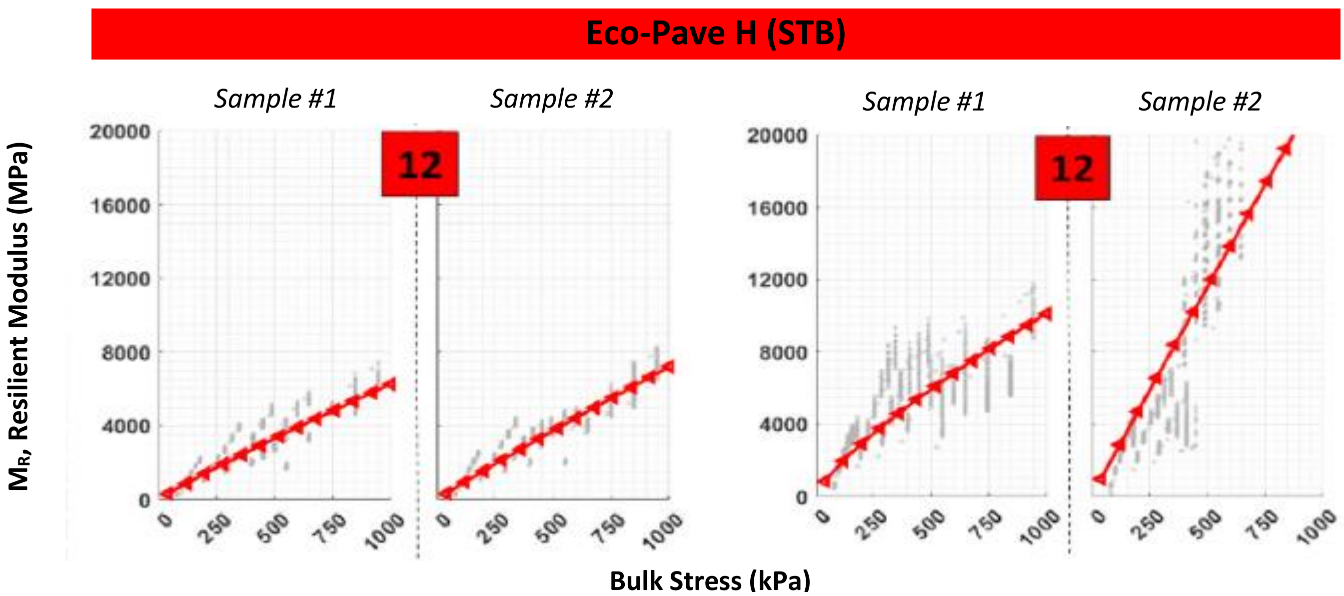

Figure 5: Eco-Pave H (STB) Resilient Modulus (M_R) before (left) and after (right) 10 Freeze/Thaw cycles.

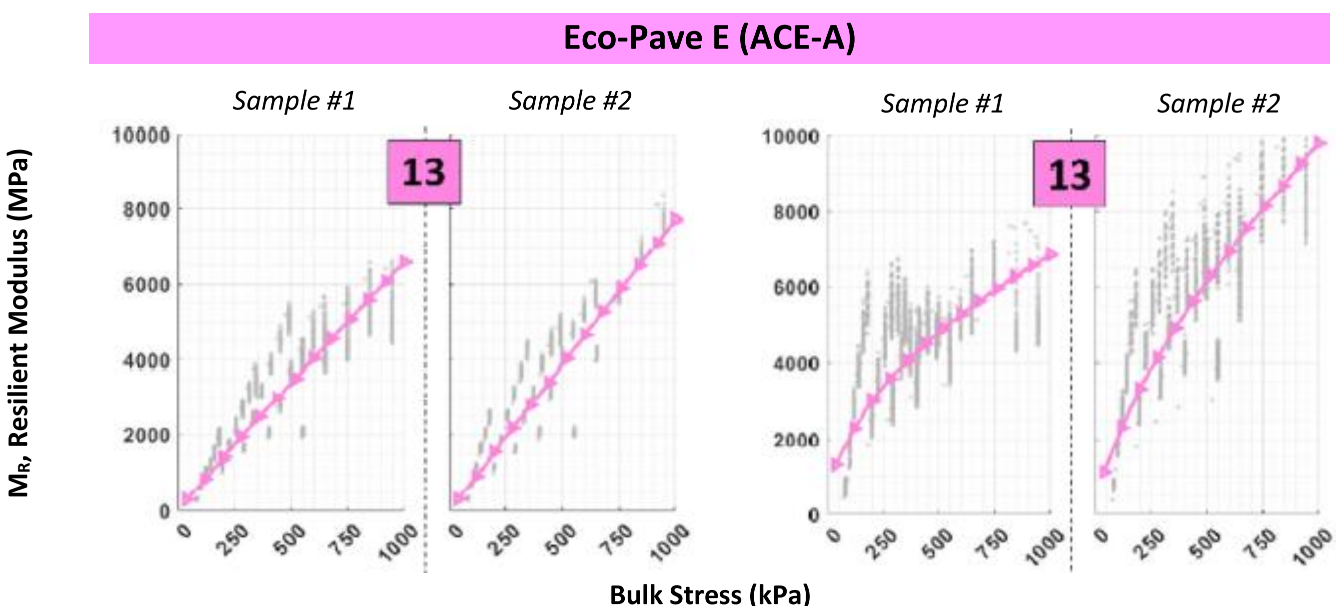

Figure 6: Eco-Pave E (ACE-A) Resilient Modulus (M_R) before (left) and after (right) 10 Freeze/Thaw cycles.

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Soil Sement EF (ACE-B)

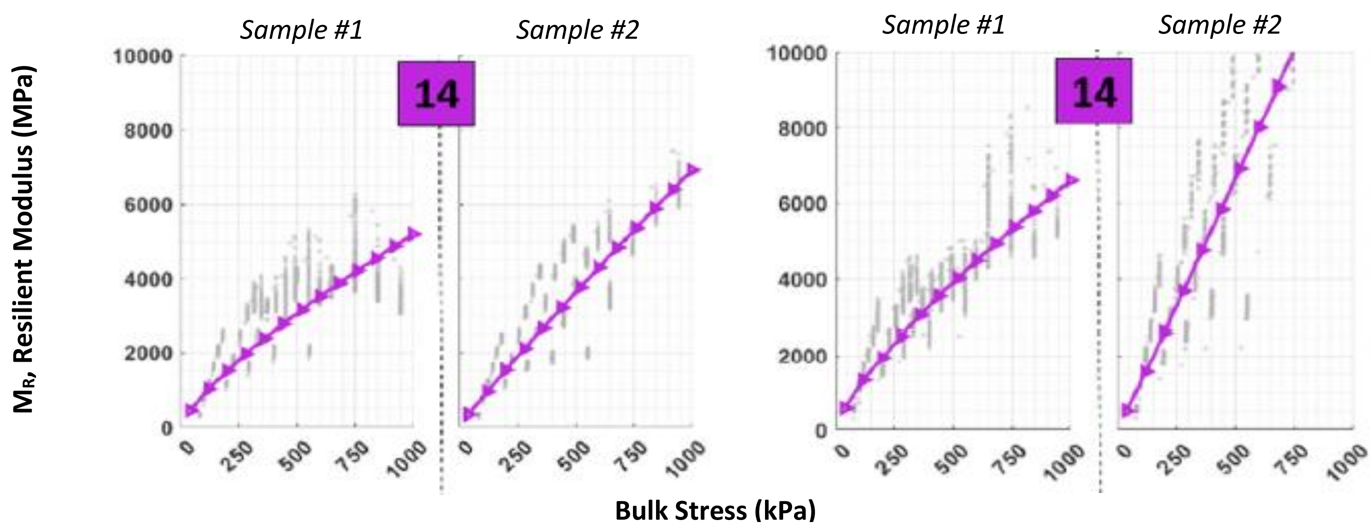

Figure 7: Soil Sement EF (ACE-B) Resilient Modulus (M_R) before (left) and after (right) 10 Freeze/Thaw cycles

Conclusions – NaturalPave Products

- "All the stabilization technologies improved the stiffness of the aggregates under dry test conditions."
- Specimens stabilized with Eco-Pave H (STB), Eco-Pave E (ACE-A), and Soil Sement EF (ACE-B) were shown to be effective in reducing permanent deformation compared to the untreated specimens.
- Specimens stabilized with Eco-Pave H (STB), Eco-Pave E (ACE-A), and Soil Sement EF (ACE-B) "show improved mechanical performance both before and after exposure to 10 FT cycles."
    - "Therefore, the results of this study indicate that the stabilization effects achieved with [….] STB, ACE-A and ACE-B are not impaired by freezing-thawing actions."
- "The studied stabilizers can significantly reduce the thickness of a traditional untreated base layer by an average of 50%. This diminishes the amount of needed construction aggregate as well as lowers the related transport and construction costs."
- ACE-A and ACE-B displayed good resistance to stripping.

Click Here to View the Full Report – Phase 1

Click Here to View the Full Report – Phase 2

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