GEOWEB® GEOCELL SYSTEM
PRESTO PRODUCTS GEOSYSTEMS
PERFORMANCE TESTING – REINFORCED RAIL BALLAST & SMARTROCK

Summary of University of Kansas Research:

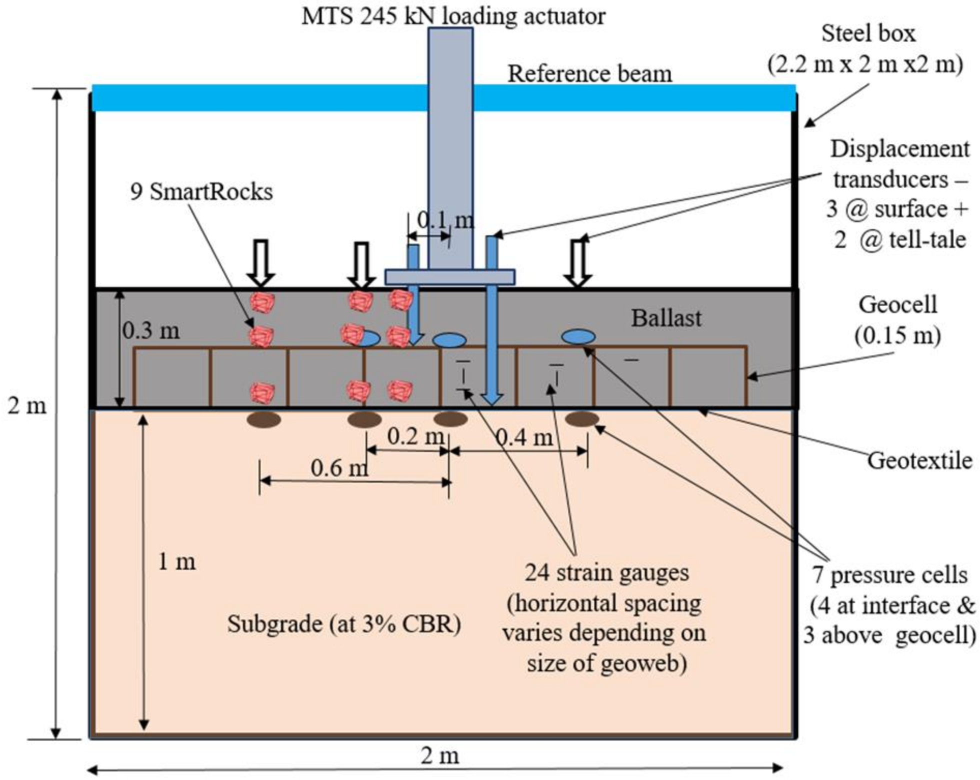
GEOWEB® geocell confinement is a three-dimensional geosynthetic product, which can be used to stabilize granular material (e.g., ballast in railroads) through lateral confinement. This experimental study included plate loading tests and track loading tests (Figs. 1 and 2) to investigate the behavior of geocell-stabilized ballast over weak subgrade. For comparison purposes, both geocell-stabilized and non-stabilized sections were tested. In each test, the ballast was subjected to multi-stage cyclic loading in a large test box at the University of Kansas. Each test section included 300 mm thick trap rock (rhyolite) ballast on weak subgrade with a CBR value of 3%. In the plate loading test, 1000 loading cycles were applied for each load increment with loads ranging from 10 to 60 kN. In the track loading test, 1000 loading cycles were also applied for each load increment with loads from 21 to 240 kN.

Each test was instrumented with earth pressure cells, telltales, and SmartRocks as shown in Fig. 3. Earth pressure cells and telltales were used to measure the vertical stresses and displacements at the interface between ballast and subgrade, respectively. Each SmartRock included a 9-degree-of-freedom motion/vibration sensor consisting of a tri-axial gyroscope, a tri-axial accelerometer, and a tri-axial magnetometer that could record rotation, translation, and orientation, respectively.

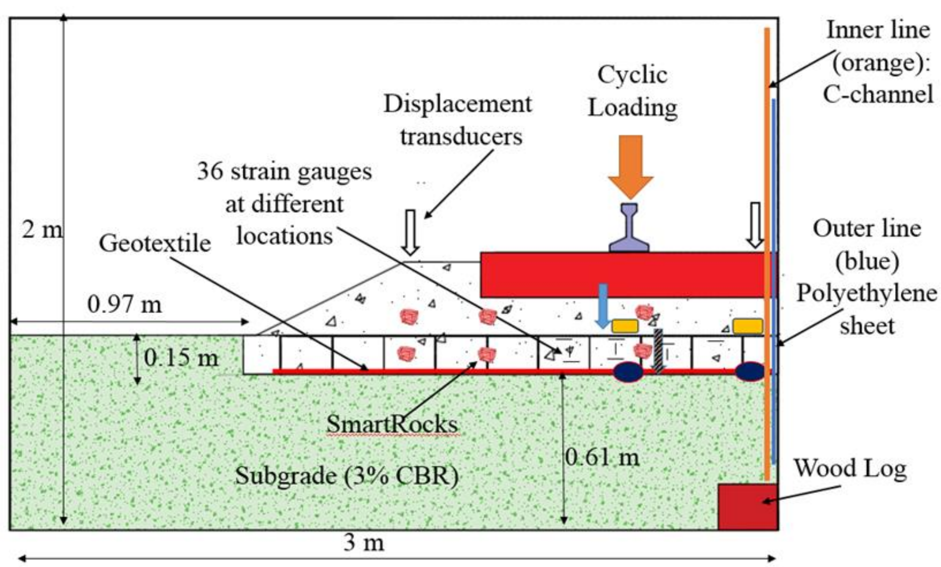
(a) Plate loading test (b) Track loading test

Figure 1. Photos of Loading Test Setup in the Large Test Box

PRESTO GEOSYSTEMS
670 N PERKINS STREET, APPLETON, WISCONSIN, USA 54914
Ph: 920-738-1328 or 800-548-3424 ■ Fax: 920-738-1222
e-mail: INFO@PRESTOGEO.COM WWW.PRESTOGEO.COM



(a) Plate loading test



(b) Track loading test

Figure 2. Cross Sections of Loading Tests

Figure 3. Earth Pressure Cells, Telltales, and SmartRocks

Figure 4 shows the compressions of non-stabilized and geocell-stabilized ballast versus load cycles under plate loading. This figure clearly shows that geocell stabilization reduced the compression of the ballast under cyclic loading, due to lateral confinement.

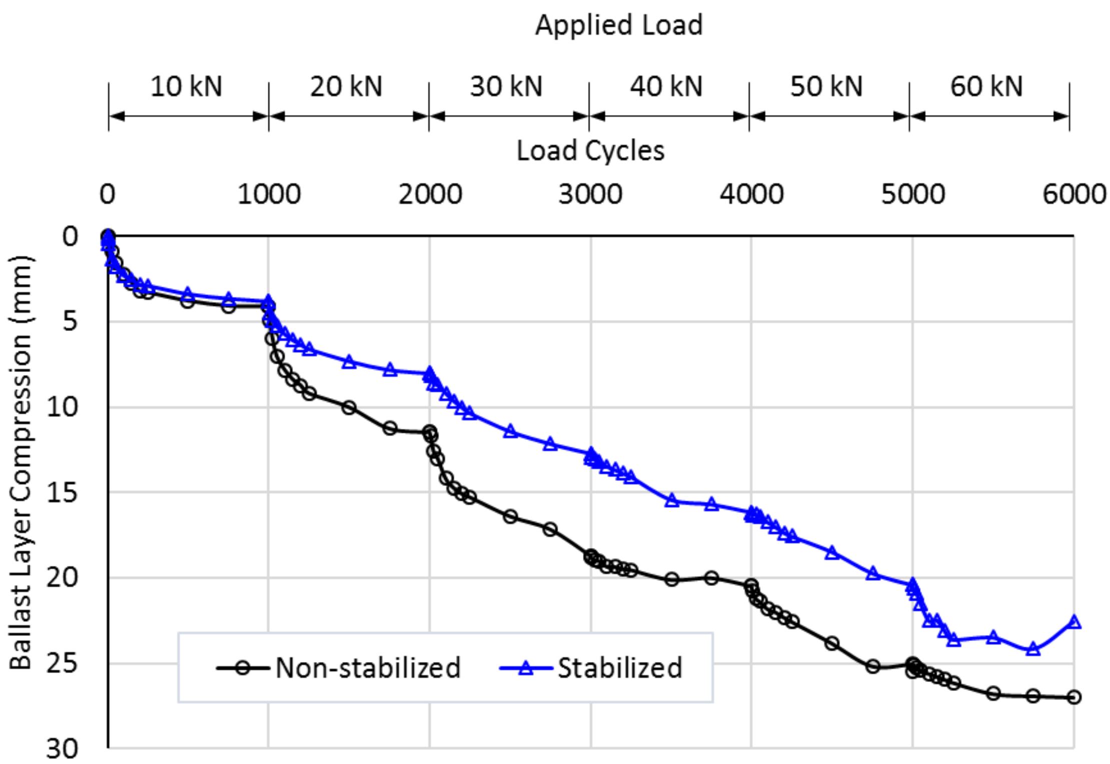


Figure 4. Ballast Layer Compression versus Load Cycles under Plate Loading

Figure 5 shows the surface permanent displacements of the plate and the railroad track versus load cycles under cyclic loading. The test results show that geocell stabilization significantly reduced the surface permanent displacements of the plate and the railroad track on the ballast over weak subgrade. Plate loading and track loading with equivalent load magnitudes resulted in similar displacement responses of non-stabilized and geocell-stabilized ballast over weak subgrade under cyclic loading.

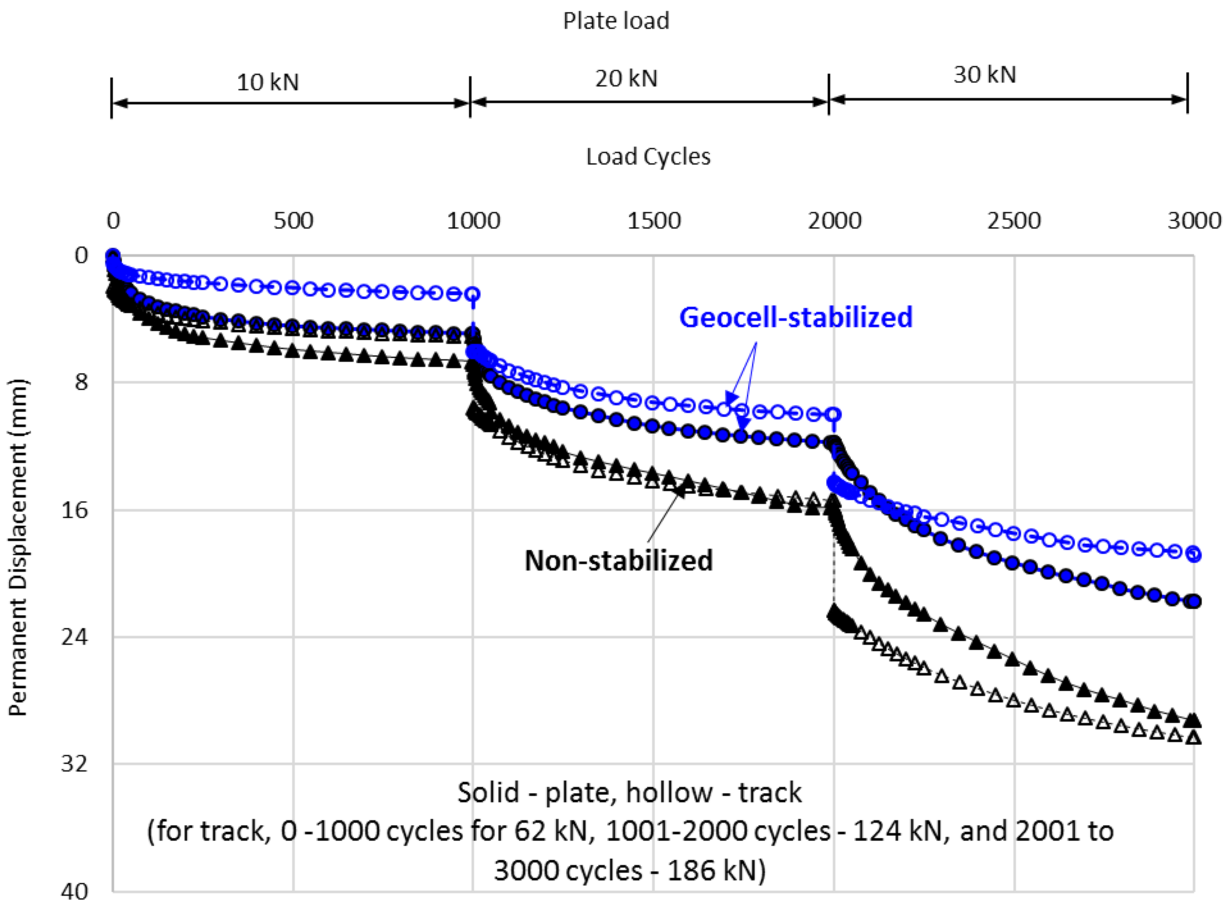


Figure 5. Surface Permanent Displacements of Plate and Track under Cyclic Loading

Figure 6 shows the measured vertical stresses at the center of the interface between ballast and subgrade versus load cycles under cyclic plate and track loading. The test results show that geocell stabilization significantly reduced the vertical stresses at the interface between ballast and weak subgrade. Plate loading and track loading with equivalent load magnitudes resulted in similar stress responses of non-stabilized and geocell-stabilized ballast over weak subgrade under cyclic loading.

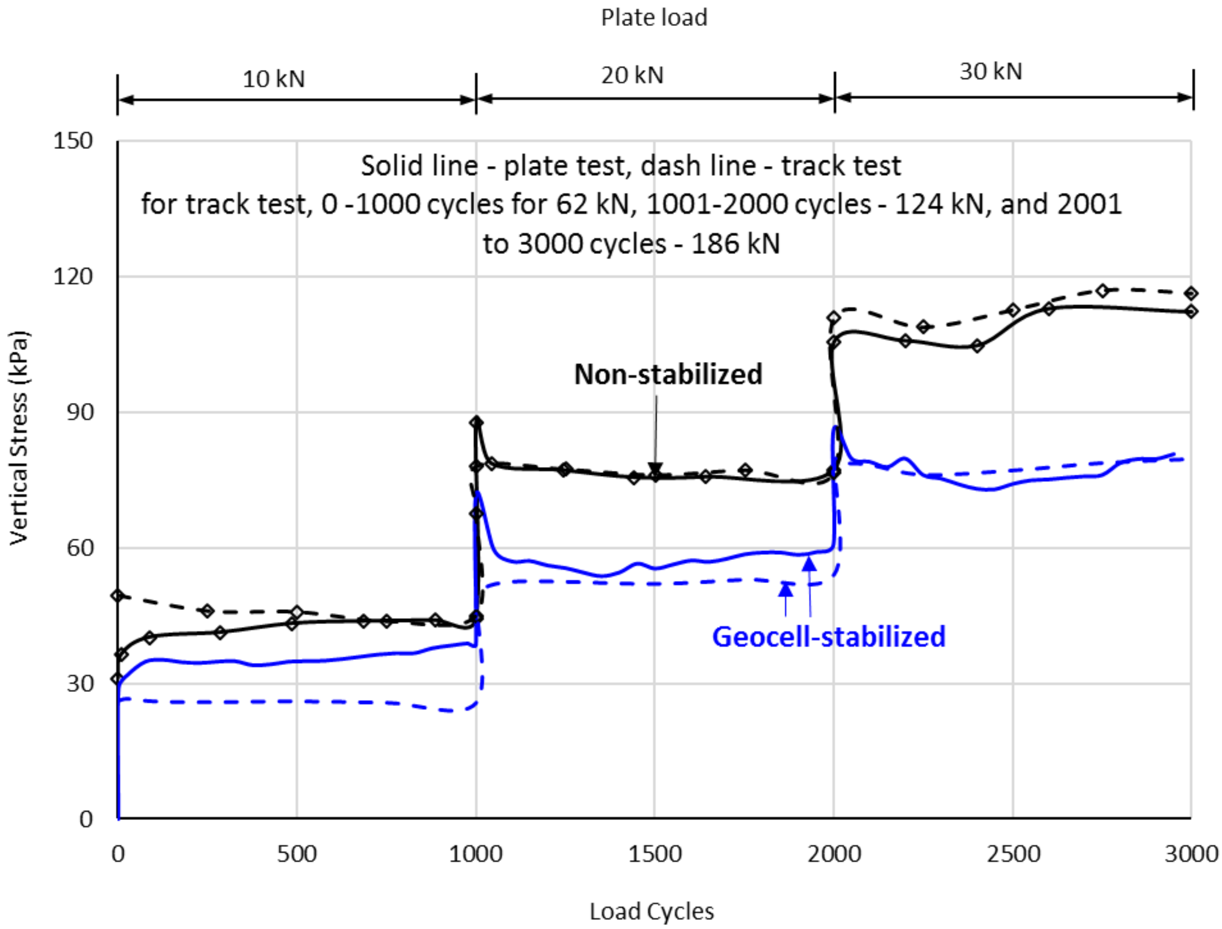


Figure 6. Measured Vertical Stresses at the Center of the Interface between Ballast and Subgrade versus Load Cycles under Cyclic Plate and Track Loading

Figure 7 shows the measured particle translational accelerations in the x, y, and z directions of the SmartRocks placed inside the ballast in non-stabilized and stabilized sections under cyclic plate loading. The test results clearly show that geocell stabilization significantly reduced the particle translational accelerations of the SmartRocks and ballast. These results confirm that geocell could effectively and significantly minimize the movement of ballast particles by providing lateral confinement so that breakage, vertical compression, and lateral spreading of ballast could be minimized and the performance of the railroad could be improved.

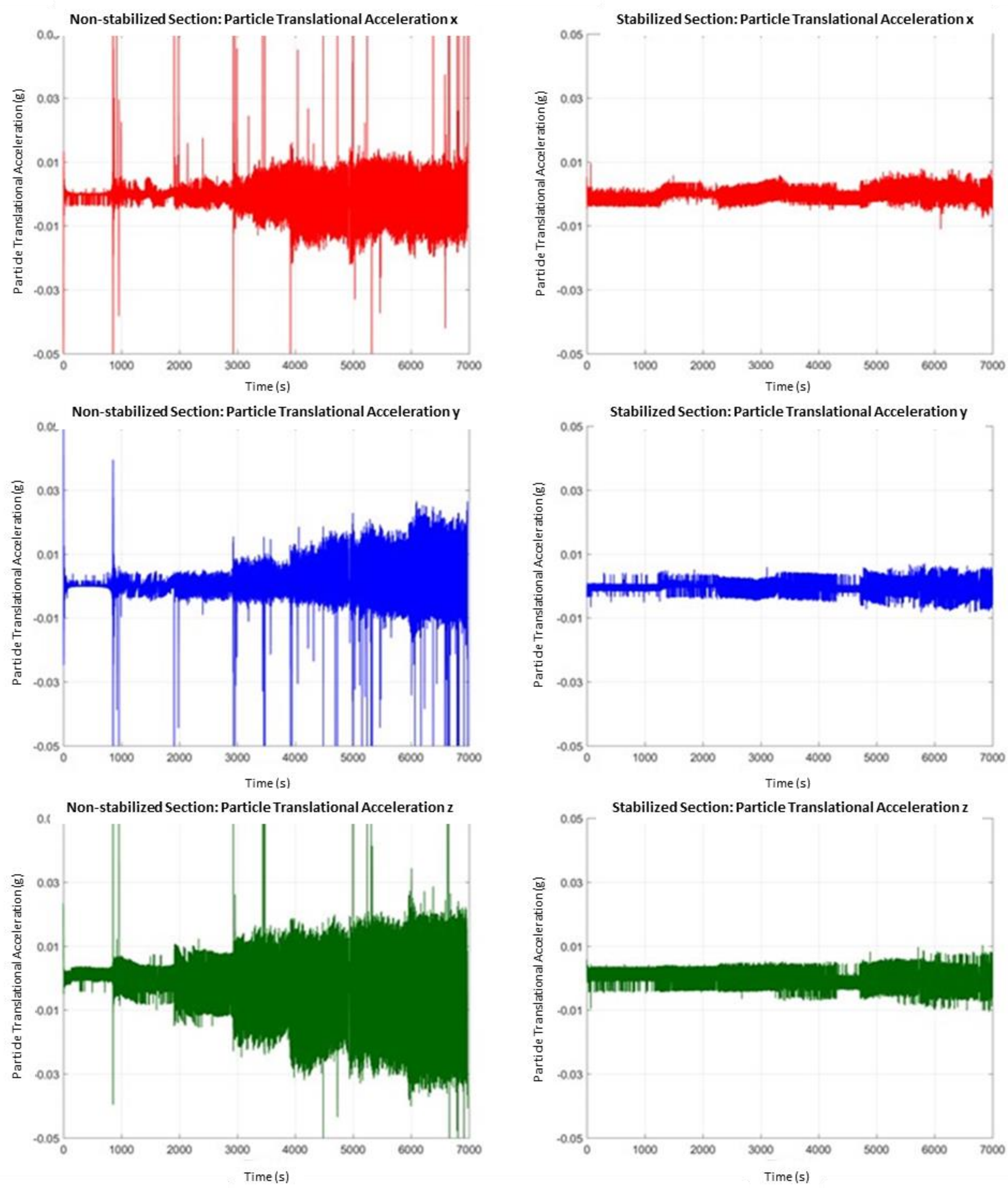


Figure 7. Particle Translational Acceleration in Non-stabilized and Geocell-stabilized Sections under the Loading Plate

Summary Results

The benefits of applying GEOWEB geocell confinement for reinforcement of rail ballast over weak subgrades, as acknowledged by this research summary are summarized below:

- Significant decrease in settlement of the railway ballast. Geoweb confinement influence reduced settlement equivalent of more than 8 inches (20 cm) of ballast.
- Geoweb confinement decreased sub grade interface pressure by nearly 50% for weak subgrades. The decreased pressure in subgrade results in lower subgrade settlements.
- For the largest loading conditions used in the analysis, the strains in the geocell were low (less than 1%) and with the elastic range for typical geosynthetic materials. The maximum tensile stress were localized at the bottom corners of the Geoweb, showing the importance of adequately durable seams.
- SmartRock placed in the ballast layer indicated the advantages of Geoweb confinement.
- Geoweb confinement significantly reduced the particle translational acceleration and angular velocity inside the ballast layer both vertically and laterally and therefore effectively limited ballast particle movement under heavy, freight loadings over very soft sub grades.
- Due to Geoweb confinement, little particle movement and rotation occurred compared to significant spikes in non-stabilized section due to particle rearrangement and significant movement under cyclic loadings.
- Geoweb limited upward movement of ballast particles and thus significantly increased stability of the track.