TTCI is investigating and testing potential soft-subgrade remedies under heavy axle loads.

In the Summer of 1999, upon completion of the GEOWEB test, a hot-mix-asphalt underlayment was to be applied over the soft subgrade to measure its effectiveness under heavy axle loads.

The investigations and tests of potential soft-subgrade remedies under heavy axle loads are a cooperative effort between TTCI, a subsidiary of the Association of American Railroads; the Federal Railroad Administration; the railroad industry and various suppliers.

From 1991 to 1996, approximately 130 mgt was accumulated over the LTM section. Under 39-ton axle loads, the LTM track with the early conventional construction (ballast and subballast) required frequent surfacing and three track rebuildings (or three phases) in order to maintain an acceptable track geometry for normal train operation.

To define soft-subgrade failures under heavy axle loads, the LTM section was installed in 1991 by excavating a 700-foot-long, 12-foot-wide and five-foot-deep trench, which was then backfilled with buckshot clay brought from Vicksburg, Miss.

The average moisture content is approximately 33 percent (optimum moisture content is 23 percent).
Figure 1 shows LTM subgrade and track cross sections.

However, at 9.3 mgt, a heavy rainfall completely flooded the thick subballast layer, limiting the ability of the subballast layer to distribute traffic-load-induced stresses to the subgrade.

Due to increased subgrade stresses, the subgrade deformed rapidly and track geometry was out of specification within the next several mgt.

**Application, performance**

In early 1997, following the Phase Three test, the track was rebuilt again with the application of a geosynthetic reinforcement called GEOWEB. 
*The Dictionary of Railway Track Terms,* Simmons-Boardman, 1993, defines GEOWEB as a material consisting of honeycomb shapes placed in the roadbed to stabilize weak soil.*

When expanded from its collapsed state, the interconnected cells attain an approximate honeycomb structure with open tops and bottoms, as shown on page 15. GEOWEB cell height can vary, but is eight inches for the LTM application.

Figure 1 (c) shows the cross section of the LTM track with the geo-synthetic reinforcement. As shown, the GEOWEB was placed over a four-inch subballast layer. Upon its placement, the openings of cells were backfilled with granular material (i.e., subballast).

A steel drum vibratory roller was then used to compact the fill material, as Figure 2 (b) shows. For this LTM test, subballast also extended a few inches above the cells, providing a nominal subballast/GEOWEB layer thickness of 16 inches. With eight inches of ballast, the total reinforced granular thickness above the subgrade is 24 inches.

One of the most effective methods to reduce the stresses transmitted to a soft subgrade is to increase the stiffness of the overlying layer. This is one of the benefits that the reinforced granular layer can provide.

Because the sides of the cell walls provide lateral confinement to the subballast, the composite subballast layer becomes much reinforced, resulting in increased stiffness and, therefore, more load-bearing capacity than the subballast alone. *(Note: Transportation Research Record 1188, 1988, “Large-Scale Model Tests of Geocomposite Mattresses over Peat Subgrades,” stated that a GEOWEB-reinforced layer could be considered to be equivalent to about twice the thickness of an un-reinforced gravel base.)*

For the LTM track, the increased layer stiffness and decreased subgrade stresses due to use of GEOWEB can be seen in Figure 2. In this figure, the track modulus and subgrade vertical stress are compared for the conventional track (18-inch granular-layer thickness) and the reinforced track (24-inch total thickness).

The average track modulus for the GEOWEB track was 2,500 lb/in./in. compared to 2,000 lb/in./in. for the conventional LTM track. Consequently, the average subgrade stress under the rail seat was decreased from 13 psi for the conventional track to 10 psi for the GEOWEB track.

Since the installation of the GEOWEB reinforced track, more than 180 mgt has been accumulated over the LTM section. As stated earlier, the average tamping cycle duration before the GEOWEB placement was about 15 mgt. However, after more than 180 mgt of traffic, the track geometry is still well within the limits of FRA Class 4 track.

Figure 3 shows vertical profile (offsets based on 62-foot chord length) degradation with the amount of traffic since the placement of GEOWEB.
The results are the measured 95th percentile values (a 95th percentile value—magnitude larger than 95 percent of the measured results) versus traffic. The FRA limit is two inches.

As shown, the degradation of track vertical profiles was not significant, and the track has been stable throughout more than 180 mgt of heavy-axle-load traffic.

**Hot-mix asphalt underlayment**

Following two-and-a-half years of heavy-axle-load traffic (a total of more than 200 mgt), the GEOWEB test concluded in the Summer of 1999.

Upon completion of the test, a hot-mix asphalt underlayment was to be placed under the ballast and above the subgrade.

The LTM zone will be divided into two subsections (each 350 feet in length).

One subsection will have a four-inch HMA layer, the other will have an eight-inch HMA. The planned HMA track cross sections are shown in Figure 1 (d).

For the entire test zone, a four-inch subballast layer will be used between the HMA and the subgrade. The ballast thickness above the HMA will be 12 inches over the four-inch HMA, but will be eight inches over the eight-inch HMA.

For both HMA subsections, the total granular/HMA thickness will be 20 inches.

This test will be the first to apply the HMA underlayment over a soft subgrade under 39-ton axle loads. The purpose of the HMA underlayment is to reduce traffic-load-induced stresses to the subgrade (like the GEOWEB layer does) and to provide a waterproof layer over the underlying soil.

The HMA performance will be evaluated in terms of the surfacing cycles required, the amount of subgrade stress reduction compared to the convention granular layer construction, and the asphalt fatigue life in terms of cracking. If the test section does not fail, the HMA test is planned to last at least 200 mgt over a period at least two years.

1. GEOWEB is a registered trademark of Presto Products Co.