NATIONAL SLAG ASSOCIATION

MF 185-7

Lightweight Blast Slag Used as Sub Base Aggregate to Minimize Load Stresses on Soft Soils

Lightweight Blast Furnace Slag is used in unique design for highway base to bridge soft sub soil conditions and provide a stable platform for Oakland County (MI) roadway.

Challenge:

In 1984 the Oakland County (near Detroit) Road Commission was faced with a very difficult design problem for the expansion of a two-lane to a four-lane roadway built over very soft, unstable sub grades. Site sub-soil conditions for a six hundred (600) foot length of this roadway consisted of very soft, saturated, silty, marly clays extending to depths as great as twenty-five (25) feet. Site inspection prior to construction showed the existing utility poles that parallel the roadway were displaced laterally and were considerably out of plumb. This was thought to be the direct result of the lateral squeezing pressure of these very soft subsoils. Previous history of the two-lane roadway had shown it to be fraught with problems, requiring it to be resurfaced every few years in order for it to support the current traffic volume. These unusual site problems coupled with the high and ever-increasing traffic volumes required an innovative approach toward this roadway expansion project.

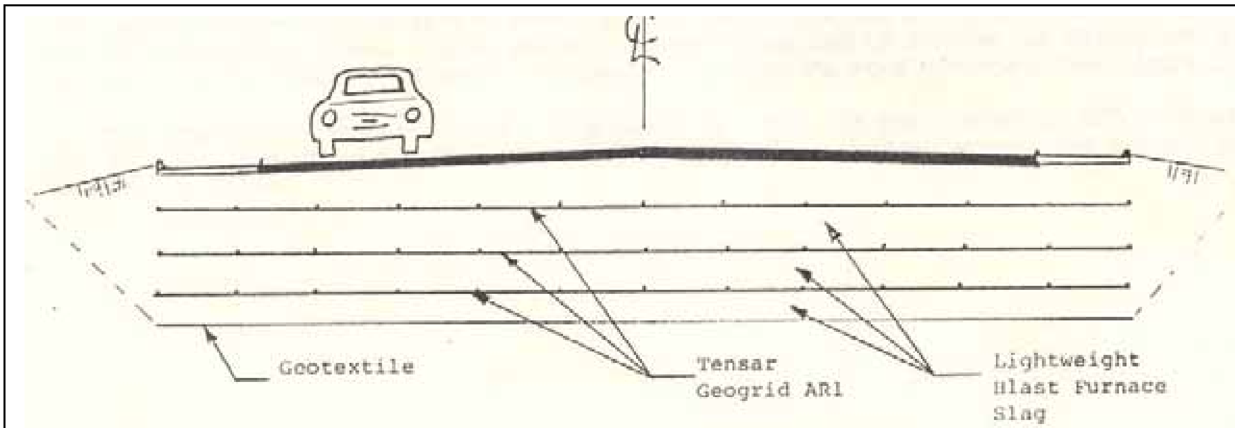
Solution:

The solution was to use Tensar High Strength Polymer Reinforcing geogrids and lightweight blast-furnace slag as shown in figure 1. The final design paralleled the multiple-layer roadway project which was successfully constructed in England several years ago and has performed well.

Three layers of geogrid with 12" of slag were considered sufficient to tie the sub base together and distribute any induced horizontal stresses. The design intent was also to minimize the change in sub grade stresses so as to minimize consolidation and settlement of the underlying roadway. This was achieved by over excavating two (2) feet, and then refilling the entire area with high-strength, low-density blast-furnace slag. Slag graded from 1” – 3” size was used.

First the old road was stripped and excavated. The geotextile was placed first, followed by 10” to 12" of slag, the first layer of geogrid, 10 to 12 additional inches of slag, the second layer of geogrid, etc.. This was carried continuously across the road with overlapping of the geogrid rolls to assure continuity in both the longitudinal and the transverse roadway direction. Light construction equipment was used to spread the first course of sub base aggregate. It was soon found, however, that with the inclusion of the reinforcing geogrid, the performance of the construction equipment on the sub grade improved dramatically. This facilitated faster construction, using heavier equipment.

The use of high-strength/high-modulus grid reinforcing, coupled with a lightweight blast furnace slag for fill resulted in a stable, reinforced roadway section over a previously unstable sub grade. This provided a cost-effective, environmentally-satisfactory road expansion. After 16 months of service, with ADT’s of about 22,400, there has been no sign of distress.



NOTE: Overlap Geogrid 15" On Bottom Layer
12" Center and Upper Layer

TYPICAL CROSS SECTION

Figure 1
Orchard Lake Road

A similar design encapsulating slag was used by the Oakland County Road Commission for a mat foundation over soft compressible soil - to widen an existing two-lane road to a five lane highway to service both the General Motors Truck and Coach Plant and Pontiac's Silverdome, as shown in figure 2.

Blast-furnace slag with a Michigan 6A gradation (1-1/4"-3/8") was placed as the aggregate sub base and compacted to an 18" depth. The fabric was wrapped to encapsulate the slag. Next, a standard 12.5 foot wide roll of stabilization fabric was placed parallel to and directly over the encapsulating fabric's top lap to form a six-plus foot fabric friction lap. The completed fabric-slag aggregate capsule formed a mat foundation over which the remaining road structure was constructed. Above the mat, an additional 18" of 6A slag was placed and compacted. Approximately 4" of asphalt concrete completed the road structure (see fig 1).

This construction was completed in the summer of 1981. It has carried an ADT of about 18,000 since then without differential settlement cracks or ridges between the new and old pavement sections.

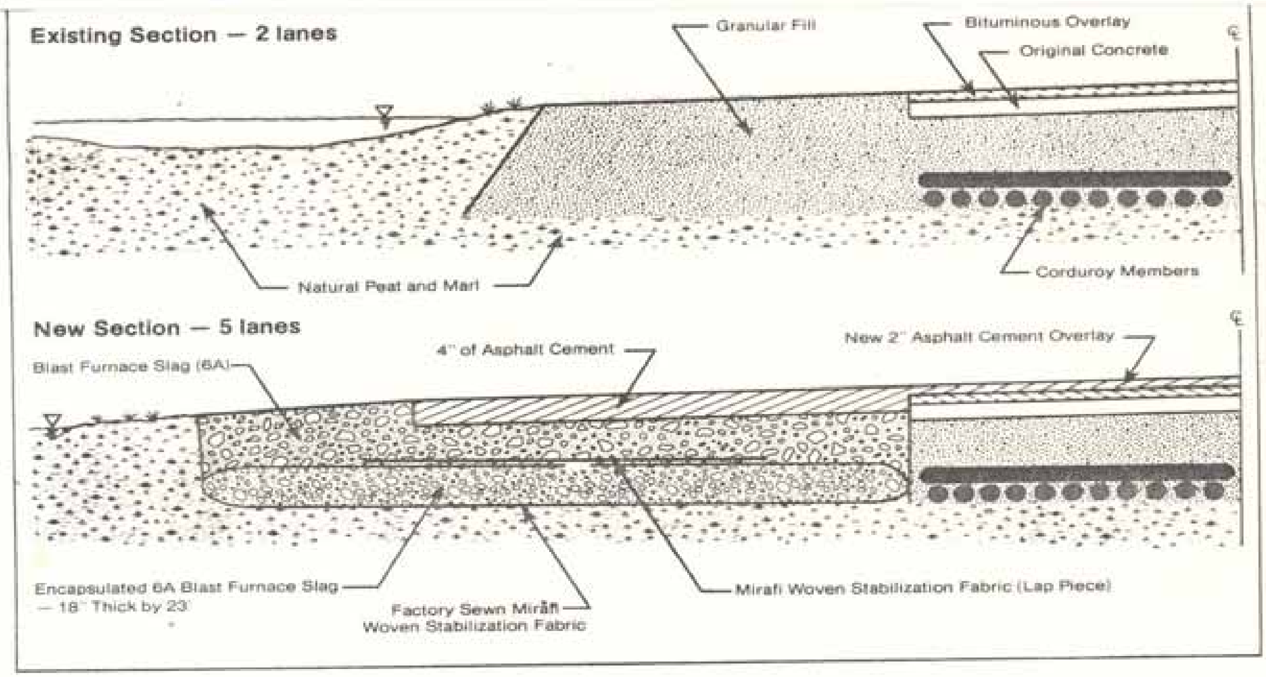


Figure 2
Opdyke Road

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Geogrids provide highway support

How do you support a new four-lane highway when it has to cross a 600-ft stretch of very soft unstable subgrade? That was the dilemma faced by the Road Commission of Oakland County, MI, when they decided that increasing traffic volume dictated that an existing two-lane road should be upgraded. As explained by Jack Franklin, soil supervisor for the county, "We knew that we had a problem because of the history of the existing road. It had required frequent resurfacing to maintain its trafficability." In addition, a line of utility poles that paralleled the road had been displaced laterally and the poles were out of plumb. These effects were judged to be the direct result of the lateral squeezing produced by the soft subgrade.

Several alternative solutions were considered, including removal and replacement of the subgrade. However, because the soft subgrade extended to depths as great as 25 ft, this approach was rejected as being too costly. In addition, it was considered that it would negatively impact the local lowlands and environment. And, the time required would lead to an unacceptably long closure of the vitally needed highway.

All approaches considered took into account the deflection due to the soft spot and estimated the resultant tensile force caused by this deflection. The alternative ultimately selected was based on the use of multiple layers of Tensar® geogrid and blast-furnace slag.

First, after closure of the existing road, it was stripped and the base excavated to a depth of two feet. Then, a geotextile was installed to maintain separation between the slag particles and the underlying clay. Next, a 10 to 12-in. layer of slag with particle size measuring one to three inches was placed. This was followed by a geogrid of suitable aperture size. The geogrid develops working loads at small strains (about three percent). The grid configuration adds to the integrity of the subbase because of its tendency to interlock with the aggregate particles.

Geogrid material is unrolled on aggregate in preparation for next layer of aggregate.

Earlier courses of aggregate and geogrids provide adequate support for use of heavy equipment on later courses.

Similar layers of slag were alternated with geogrids until a total of four layers of slag and three geogrids were in place.

Small lightweight construction equipment was used to spread the first course of slag. However, this first course then provided enough support to permit the use of heavier and larger equipment, reducing construction time.

After the layers of slag and the geogrids were all in place, the base course and pavement followed to complete the highway section.

As summarized by Franklin, "The use of high strength/high modulus grid reinforcing, coupled with a lightweight blast-furnace slag for fill, resulted in a stable roadway section over a previously unstable subgrade. This provided for a cost-effective, environmentally satisfactory highway." ■

For more information, write 01021 on ROADFAX card.