CASE STUDY: GeoFoam Road Construction Project at Sharpes Ferry Bridge, Florida

Project Summary

In mid-2010 the Florida Department of Transportation (FDOT) authorized the restoration, conversion, and expansion of an historic, single-lane swing truss bridge, known as the Sharpes Ferry Bridge over the Oklawaha River in Marion County. The project included a pedestrian bridge as part of a future trail, as well as a concrete roadway bridge with twelve-foot wide lanes and eight-foot wide shoulders. The old bridge was deemed to be functionally unsound by State officials since as its nine-foot wide single lane only allowed vehicle traffic at 15 mph. The project required demolition of existing structures and re-design/re-construction of the new structures. The project was awarded to Misener Marine Construction (MMC) with C.W. Roberts Contracting (CWR) as their highway subcontractor. Consultants (PSI) identified expanded polystyrene GeoFoam rather than soil as the optimal fill material since its weight allowed for the elimination of surcharge fill cost, and GeoFoam’s compressive strengths were superior to other alternatives. After a competitive bidding process, CWR awarded the GeoFoam supply contract to Dyplast Products based on its balance of quality, delivery, and cost. Project total duration was from May-December 2011.

The Project called for approximately 13,000 cubic yards of Dyplast GeoFoam blocks to be delivered within a short time frame between May and August 2011. This is the equivalent of 4.2 million board-feet of expanded polystyrene. Delivery windows were critical to the success of the project since the just-in-time deliveries of GeoFoam blocks minimized construction labor as well as storage and rolling stock expenses. Dyplast formed a project team headed by an Account Manager, and included selected members from Technical, Quality Assurance, Production, Fabrication, Maintenance, Transportation, Credit and Accounts Payable/ Receivable, Purchasing, and Customer Service. The objective was to plan and execute this order on-time and on-budget.

The Dyplast team worked hand-in-hand with FDOT, MMC, CWR, C3TS, FHR, and PSI on the design specification and quality assurance protocols for the GeoFoam. In addition to the density, compressive strengths, and water absorption requirements, a well-tested termiticide was requisite. Further, Dyplast personnel worked with CWR on the CAD/CAM drawing for the block and placement of the blocks.

The next task was to develop the protocols to produce the GeoFoam blocks, test, cure, deliver to the jobsite, and then efficiently store the GeoFoam in the site laydown area. The Dyplast Account Manager worked with CWR to develop the shipping schedule and storage procedures since the majority of the GeoFoam blocks had to be at the jobsite well before the bridge was shut down - and thereby ready to support the construction schedule.

Approach to Sharpes Ferry Bridge
Why Dyplast GeoFoam?

Dyplast GeoFoam is a closed cell, expanded polystyrene rigid foam material that is strong, yet has very low density (1% of traditional soil materials.) Our GeoFoam is manufactured in block form and meets ASTM D6817 "Standard Specification for Rigid, Cellular Polystyrene GeoFoam". Dyplast GeoFoam is available in a range of densities and compressive and shear strengths to provide control of structural integrity and cost effectiveness.:

- Excellent strengths, exceeding ASTM 6817 requirements
- Superior water and moisture resistance
- High production capacity to quickly meet peaks in demand
- Flexible production and delivery schedule to facilitate just-in-time delivery, thus minimizing laydown area and handling
- Availability of alternative densities
- Ability to cut blocks to custom dimensions and to close tolerances
- Technical advice regarding storage, handling and installation
- Cooperative, team-working culture
- Customer responsiveness

Fabrication and Quality Control

GeoFoam EPS blocks were manufactured from an expandable polystyrene resin, produced by Flint Hills Resources in Illinois, in the form of very small beads with sizes ranging in diameters between 400 microns (0.4 mm) and 1600 microns (1.6 mm). The beads contain a blowing agent in levels between 3 and 7 percent which allows Dyplast to expand the beads and then mold them into large blocks with pre-determined densities between 1 and 2 pounds per cubic foot. For the Sharpes Ferry Bridge project, Dyplast introduced a termiticide at low levels and molded the EPS into blocks (41 x 49 x 194 inches) with a density that exceeded the 1.35 lb/ft3 density specifications of ASTM D6817 for EPS 22 blocks. The GeoFoam blocks were then cured and QC tested per ASTM D7557 before being shipped to the job site. Tests included verifications that the GeoFoam met the stringent specifications for compressive strength under 1, 5, and 10% deflection, and compressive modulus for 1% deflection. Some GeoFoam blocks were cut at the manufacturing facility into specified dimensions to minimize field work and to conform to the foundation and walls of the new embankment leading up to the new bridge.

A hallmark of Dyplast’s Quality Control and Production Processes is the verification and audit by third-party, independent authorities such as UL, Miami-Dade, and RADCO on behalf of ICC. Although not every product is audited by all these parties, the QC and Process Controls are similarly stringent for all products. No other supplier of rigid foam products goes so far to ensure Quality.

Dyplast EPS GeoFoam: Physical Properties

Dyplast’s EPS GeoFoam at a density of 1.35 lb/ft3 has compressive strengths equivalent to compacted soil at weights approaching 50 times higher - - thus eliminating the need for excavating soils (and potentially disturbing ecosystems), transporting multiples of tonnage to the site, and then compacting the soils to meet specifications.

See www.dyplastproducts.com for more detailed information on physical properties of our EPS GeoFoam.
**GeoFoam versus Soil Fill**

Construction of roadway embankments (e.g. for ramps and bridges) on soft foundation soils such as peats or soft clays has long been problematic. The two main approaches for coping with the problems have been to improve the engineering properties of the foundation soils (e.g. shear strength and compressibility), or reduce the weight of the embankment and thus the load applied to the problematic foundation soils. Because of the uncertainty involved in using ground improvement techniques, DOT’s, municipal airports, and other owners have been increasingly using lightweight fill alternatives (GeoFoam) to reduce the weight of the embankment while providing comparable or improved shear and compressive strengths as well as other advantages.

The level of uncertainty involved in ground improvement techniques, such as quantifying the increase in foundation shear resistance, is high relative to the use of GeoFoam fill because strengthening of the foundation can be difficult to control and the soil strata may not be known accurately. In addition, the improvement in the engineering properties of the foundation soils must be verified prior to embankment construction to ensure satisfactory performance. Also, finding adequate and affordable quantities of soil that can be compacted to the requisite densities, excavating and trucking to the site, storing until needed, and then re-handling and compacting can be a challenging and expensive endeavor.

Conversely, the properties of GeoFoam are well defined:

- more confidence and less uncertainty in its use than soil foundation improvement techniques
- the lowest density versus strength ratios and thus the smallest impact on the soft foundation soils
- consistent material properties since it is manufactured under consistent quality protocols and tested before shipment
- easy and fast to construct even in adverse weather conditions
- decreased maintenance costs as a result of less settlement from the low density of GeoFoam blocks
- alleviates the need to acquire additional right-of-ways to construct flatter slopes since the low density of GeoFoam block and/or the use of a vertical embankment applies less lateral stress to bridge approach abutments
- can be used over existing utilities, additionally reducing or eliminating utility relocation
- improved environmental impact
- excellent durability

EPS block GeoFoam has been used as lightweight fill worldwide since at least 1972. The use of EPS-block GeoFoam in the U.S. for the lightweight fill application dates back to at least the 1980s although at least two conceptual U.S. patents for the use of plastic foams as lightweight fill were issued in the U.S.A. in the early 1970s. Since the Norwegian roadway project in 1972, the Japanese constructed their first lightweight fill project in 1985. Approximately ten years later, GeoFoam usage in Japan comprises approximately 50 percent of the worldwide usage. In the U.S. approximately 10 percent of annual sales of block molded EPS is now used in the GeoFoam market versus almost none just fifteen years ago.

On the Sharpes Ferry Project, the use of soil to shape the approach leading to the bridge had an estimated settlement time of 180 days. Considering the additional 100 day time line for road closure for the bridge to be built, the result would have been an unacceptable total road closure time of approximately nine months. The use of Dyplast EPS GeoFoam kept the bridge’s down time to just the 100 day closure time proposed by the contractor. The optimization of mass versus strength, just-in-time deliveries, minimal on-site storage requirements, minimal redundant handling, and mitigation of risks due to adverse weather making the site unworkable, made the selection of Dyplast GeoFoam an obvious choice for the Florida DOT.
Overall Project Scope and Qualification

Design and construction of the relocation (taken off the existing alignment) and restoration of a historic swing truss bridge (Sharpes Ferry Bridge) to a fixed position pedestrian bridge. Hazardous coatings remediation was required for the historic swing truss bridge. Construction of a vehicle bridge on the existing alignment and reconstruction and milling and resurfacing of CR 314 (Sharpes Ferry Road) at the bridge site location was required. Construction of two new ponds was also required. Design consultant services included preparation of complete construction plans in accordance with FDOT standards. Construction work will include roadway and drainage, Category II bridge, signing and pavement marking, utility coordination and maintenance of traffic.

The Contractor team members had to be pre-qualified under Rule 14-22, Florida Administrative Code, by the Contracts Administration Office by the due dates established by FDOT. The bridge work class corresponds to the type or level of bridge proposed by the Design Build Team. The design team members involved in professional services, as identified in Chapter 287.055, Florida Statutes, must be pre-qualified under Rule 14-75, Florida Administrative Code by the Contractual Services Office by the due date for letters of interest in the following types of work:

**Work Types:**

- 4.1.2 - Bridge Design
- 5.4 - Bridge Load Rating
- 7.1 - Signing, Pavement Marking and Channelization
- 7.2 - Lighting (Nautical)
- 8.1 - Control Survey
- 8.2 - Design, Right of Way and Construction Surveying
- 8.3 - Photogrammetric Mapping
- 9.1 - Soil Exploration
- 9.2 - Geotechnical Exploration Testing
- 9.3 - Highway Materials Testing
- 9.4 - Foundation Studies

GeoFoam Construction Details

Dyplast GeoFoam was used as fill for both approaches of the Sharpes Ferry Bridge located along SE Hwy - 314 & SE 1 St Road in Marion County, Florida. Basic project information was supplied by the Florida DOT and subsequently engineered by CWR in concert with consultant C3TS. One, two, or three layers of GeoFoam block, depending on the layout area, were staggered so that the GeoFoam block joints never overlapped. Spiked metal plates were positioned between layers to restrain the block from laterally shifts. The GeoFoam blocks with a density of 1.5 lb/ft³ (24 kg/m³) were placed overlying a thin 2-inch (50 mm) layer of crushed rock, pea gravel, and local sand on the east and west abutments. The bottom layer of Dyplast GeoFoam extended 34 feet (10.4 m) horizontally from the abutment, and the upper GeoFoam layer extended 35 feet (10.7m) from the abutment, about 10 feet (3m) beyond the approach slab. A polyethylene geo-membrane and a 6-inch reinforced concrete slab was placed on top of the GeoFoam to protect against petroleum spills and to insure proper distribution of the pavement and subgrade loads. A 4-foot wide layer of geo-membrane was placed above the slab construction joints and at the interface of the slab and prefab-panel and sheet wall piles.

A four foot (4’) thick layer of soil was placed on top of the protective slab, allowing the roadway components to be constructed with normal roadway products and provided an embedment area for the guardrail post.

Concluding Comments

This Case Study has described a recent project where Dyplast’s EPS GeoFoam established a prototype approach for a major road/bridge project in the State of Florida. The many benefits of using Dyplast GeoFoam have been amply confirmed. GeoFoam can provide safe, technical, economical, and environmental solutions to problems with construction of roadway embankments on soft soils. This Case Study is not intended as a comprehensive source of information on the present state-of-the-art knowledge of GeoFoam. So we encourage you to contact Dyplast for more information on how GeoFoam may be an alternative for your geotechnical challenges.