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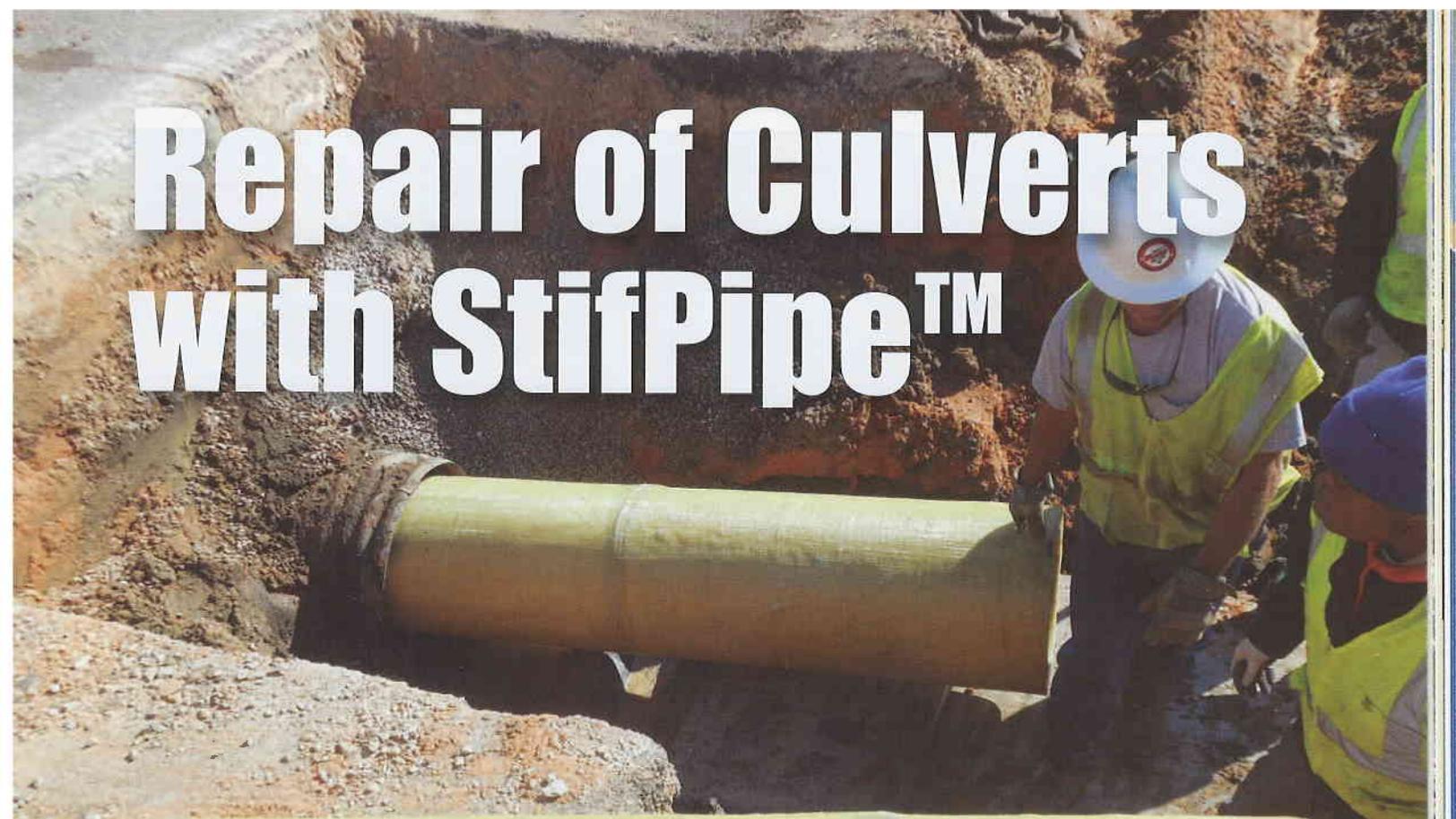
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Repair of Culverts with StifPipe™



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Corrugated metal pipe (CMP) culverts have been used for decades in highway construction. Many of these structures have deteriorated over the years and are in need of repair. In most cases, the culverts support traffic loads, so any repair or replacement must restore the structural integrity of the original culvert.

The newly developed StifPipe™ takes advantage of developments in the aerospace field to build a lightweight but very strong pipe. Unlike conventional pipes, the wall of this pipe is not solid. It consists of a lightweight honeycomb that is covered with glass or carbon fiber reinforced polymer (FRP) as skin reinforcement. Similar to an I-beam, the honeycomb acts as the web portion, while the strong FRP layers represent the flanges in an I-beam.

The construction of the pipe begins by building a mandrel of the desired size and

shape. The mandrel is covered with a non-bonding release material. Depending on the design requirements for internal pressure rating of the pipe, one or more layers of carbon fabric saturated with resin is wrapped around the mandrel. These fabrics typically have a thickness of less than 0.05 inches per layer. For gravity-flow pipes, lower-cost glass fabrics can be used in lieu of carbon.

Next, a honeycomb sheet is coated with epoxy and wrapped around the carbon fabric; the thickness of the honeycomb typically varies between a half-inch and 1 1/2 inches, and is determined based on the overall stiffness and strength requirements for the pipe.

Additional layers of carbon or glass fabric saturated with epoxy are wrapped on the outside of the honeycomb. The pipe section is cured in ambient condition

before it is removed from the mandrel. If necessary, the curing process can be accelerated by heating the assembly to a moderate temperature (e.g., 180 degrees Fahrenheit).

The relatively simple construction technique allows pipes to be made to virtually any size or shape (Fig. 1); this is particularly helpful for repair of non-circular culverts or sewer pipes. The pipe weighs only 10-15 percent of what conventional pipes weigh, which lowers transportation and installation costs. The non-metallic pipe does not corrode.

FIELD INSTALLATION

The first installation of StifPipe was recently completed at the Arc Terminal in Mobile, Alabama, to repair a 60-foot-long 24-inch CMP that was corroded. Due to access limitation, the client required pipe



Figure 1. StifPipe can be made to virtually any shape



Figure 2. StifPipe is made and connected on site

sections that were only eight feet long. The construction of the pipe consisted of two layers of glass fabric on each face of a half-inch-thick honeycomb. This resulted in a nominal wall thickness of 0.7 inches. In order to maximize the flow through the pipe, the internal diameter of the pipe was selected as 20 inches. Figure 2(a) shows the manufacturing of the pipe.

To connect the pipe segments, a slightly larger-diameter StifPipe of the same construction was built. As shown in Fig. 2(b), the pipe segments can be connected using the sleeves. The completed eight-foot-long pieces of the pipe weighing about 50 pounds each can also be seen in the photo. The pipe segments were shipped to the job site.

The corroded culvert is shown in Fig. 3. The lightweight StifPipe segments were easily lifted by hand and assembled together. The finished segments were manually pushed into the pipe. The annular space around the liner was filled with grout, and the completed installation is shown in Fig. 4.



Figure 3. Highly corroded culvert at Arc Terminal



Figure 4. StifPipe at Arc Terminal – completed installation

ADVANTAGES

The main advantage of the new StifPipe for gravity-flow applications is the fact that the pipe can be manufactured to virtually any size and shape. This will minimize flow loss and grouting requirements during installation. Depending on the size of the project, a temporary manu-

facturing facility can be set up at or close to the job site. The constituent materials are shipped in a compact container that will reduce transportation charges compared to shipping completed pipe sections. The lightweight pipe reduces labor costs and minimizes the need for heavy equipment during installation. A mobile manu-

facturing unit is currently being designed that will further facilitate on-site construction of the pipe.

The method of manufacturing StifPipe and repair of pipes described above are subject to pending U.S. and international patents by the author.

THE FRP PIPE EXPERTS!



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Professor Mo Ehsani is a pioneer in the development of applications of FRP technology and is internationally recognized as an expert on this subject.



A few of his innovations are listed below:

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Our fabrics are used for internal and external repair of high-pressure and gravity flow pipes, and are **the only structural repair products that are NSF-61 certified** for potable water pipes with diameters as small as 8 inches. Layers of carbon or glass FRP are applied inside the pipe to create a pressure vessel that can resist all or part of the internal pipe pressure.

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