Repair of Culverts with *StifPipe*™

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INTRODUCTION

Corroguated 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 the 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 it is wrapped around the carbon fabric; the thickness of the honeycomb typically varies between ½ -1½ inch and it 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 ºF.

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

FIELD INSTALLATION

The first instalation of *StifPipe*™ was recently completed at the Arc Terminal in Mobile, AL to repair a 60-ft long 24-inch CMP that was corroded. Due to access limitation, the client requied pipe sections that were only 8-ft long. The construction of the pipe consisted of two layers of glass fabric on each face of a ½ inch thick honeycomb. This resulted in a nominl wall thickness of 0.7 inches. In order to

maximize the flow through the pipe, the internal diamter 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 diamter *StifPipe*™ of the same construction was built. As shown in Fig. 2(b), the pipe segments can be connected using the sleeves. The completed 8-ft long pieces of the pipe weighing about 50 pounds can also be seen in the photo. The pipe segments were shipped to the job site.

The corroded cuvert is shown in Fig. 2(c). The lightweight *StifPipe*™ segments were easily lifted by hand and assembled together, Fig. 2(d). The finished segments were manually pushed into the pipe, Fig. 2(e). The annulaar space around the liner was filled with grout and the completed installation is shown in Fig 2(f).

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 (Fig. 1). This will minimize flow loss and grouting requirements during installation. Depending on the size of the project, a temporary manufacturing 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 light-weight pipe reduces labor costs and minimizes the need for heavy equipment during installation. A mobile manufacturing unit is currently being designed that will further facilitate onsite construction of the pipe.

ACKNOWLEDGEMENT

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

Fig. 1. Samples of *StifPipe*™ for repair of non-circular culverts and sewer pipes.

Fig. 2. *StifPipe*™: (a) construction, (b) completed sections, (c) corroded CMP culvert, (d) pushing pipe segments by hand, (e) partially lined culvert, and (f) completed installation