Steel reinforced high density polyethylene (SRHDPE) pipe is being marketed to agencies and municipalities for use in storm drainage systems throughout the United States. SRHDPE pipe is a spirally formed HDPE pipe with vertical steel ribs inserted into a vertical plastic profile. This pipe product has been compared to precast concrete pipe, corrugated metal pipe (CMP), and high density polyethylene (HDPE) pipe. It purportedly combines the strength of steel and the non-corrosive properties of HDPE pipe. Additional claims are also being made that are worth discussion. The purpose of this document is to provide you with specific information related to SRHDPE pipe.

Design

While there are national standards addressing the design, installation, and materials for precast concrete pipe, CMP and HDPE pipe products, there are no nationally accepted installation standards or design methods for SRHDPE pipe. There is an American Society for Testing and Materials (ASTM) specification for the product(1) that covers its materials requirements. However, this specification merely defines the pipe material. It does not provide engineers, owners and contractors guidance as to how the product is to be designed or installed. Without design and installation standards, it is virtually impossible for an engineer to determine what pipe strength is required for a given installation condition. The review of any such design calculations would be an equally difficult task.

The American Association of State Highway and Transportation Officials (AASHTO) is the leading national specification and design authority for transportation projects. AASHTO design methods ensure that products have acceptable mechanical properties and that the composite system of the pipe and soil envelope is correctly designed so that they act together. There is currently no AASHTO design or installation standard for SRHDPE pipe.

Section 12 of the AASHTO LRFD Bridge Design Specifications covers design methods for buried structures to include all recognized types of drainage pipe. There is no allowable modification of AASHTO Section 12 to incorporate the design of SRHDPE pipe, nor is there any ballot item currently within AASHTO to incorporate a design method at this time. A manufacturer of SRHDPE pipe has made claims that a design method is pending and that design is per "Section 12 Modified". Neither of these claims is true.

Installation

Due to its unusual construction, comprised of relatively thin metal hoops encapsulated in plastic, SRHDPE pipe presents distinct installation issues. Since any stiffness that the SRHDPE pipe has is dependent on the ribs not being crushed or pushed out of position due to handling or construction loads, defining the installation must be part of the engineer's design process.

As with all flexible pipe materials, post-installation deflection testing is critical since it is the only way to verify that the pipe was designed, manufactured, and installed correctly. While most flexible pipes are tested to a deflection limit of 5%, a much lower limit is appropriate for SRHDPE pipe. Documented testing of three large diameter SRHDPE pipes (1900mm, 2000mm, and 2000mm) has shown that local buckling occurred at approximately 2.5% deflection(2). The reference goes on to state: "Also, failure is much more catastrophic in the steel-ribbed polyethylene than in either corrugated steel or HDPE (i.e. collapse can progress without an increase in load)."

Considering the early inception of local buckling, coupled with a rapid progression to failure, perhaps an initial deflection limit less than 2.5% would be appropriate for SRHDPE pipe.

There is also concern regarding how two dissimilar materials utilized in a composite pipe structure will interact with each other once in an installed condition. With the time dependent behavior of HDPE, the differences between these two materials may become more pronounced over time and result in future problems not readily apparent upon initial installation.

Temperatures will also likely affect SRHDPE pipe. The coefficient of thermal expansion of HDPE is approximately 10 times greater than steel. This raises concerns of thermal effects on the structural capacity of the pipe profile.

Hydraulics

A manufacturer of SRHDPE pipe has proposed downsizing required pipe diameters on projects utilizing concrete pipe based on claims of better hydraulic efficiency. SRHDPE pipe does not provide an improved hydraulic efficiency when compared to concrete pipe. Laboratory tests have shown that the opposite is true; concrete pipe has an edge in hydraulic efficiency and inside diameter. In laboratory tests, pipe runs are straight and there are no associated pipe system losses that occur due to the layout of the system. The American Concrete Pipe Association (ACPA), as well as other pipe associations, suggests that a design factor of 20% to 30% be added to laboratory results to account for hydraulic losses due to bends, inlets/outlets, contractions/expansions and other minor losses in the system. Under laboratory conditions concrete pipe has a Manning's n of 0.010(3) and has a generally accepted Manning's n design value of 0.012 when a 20% design factor is taken into account.

Recent tests completed at Utah State University and sponsored by a manufacturer of SRHDPE pipe indicate that it has an average laboratory Manning's n of 0.012(4). However, it should be noted that over half of the test runs were at unrealistically high velocities, raising the Reynolds number and lowering both the Darcy-Weisbach and Manning's n friction factor values. Nevertheless, using the laboratory's Manning's n value and adding the design factor of 20%, the resulting Manning's n for SRHDPE pipe is 0.014.

Use and Durability

SRHDPE pipe is a new product and its use has been limited to a few small diameter test installations for public works projects in the United States. It is troubling that the manufacturer has sponsored a rebate program for contractors that can get this product substituted into projects. Yet this product is not an equal substitution for precast concrete pipe. Concrete pipe is a rigid product. SRHDPE pipe is a flexible product, and has to be designed as such (although as stated previously it is unclear how a product like this is designed with no nationally accepted design standard).

Finally, durability and life expectancy are important considerations for any agency which is responsible for long-term ownership and maintenance of infrastructure. In recent years brush fires and other accidents have demonstrated the flammability of HDPE pipelines[5]. Furthermore SRHDPE may also be vulnerable to corrosion of the steel reinforcing if portions of the steel rib become exposed. There is no information available for expected durability or life expectancy of SRHDPE.

Conclusion

This document provides information specific to SRHDPE pipe and offers insight that should cause designers and owners to question claims about this new product. With no nationally accepted design method, how is the pipe designed to support dead and live loads initially and long term? What national specifications are there for installation of SRHDPE pipe?

Documented testing has shown a potential for catastrophic failures at deflection limits less than most flexible products; should the deflection limit be less than 2.5%? How are time and temperature dependent performance factors taken into account? What is the correct Manning's n for SRHDPE pipe? Finally, how do durability concerns, including flammability and corrosion influence the expected product service life?

Experience, long-term testing, and monitoring of field installations will provide some information, but they will not answer all of these questions. Until national specifications are adopted for installation and design of SRHDPE pipe, daring designers and owners who use this product will likely be liable for the damages caused by its failure.

1) ASTM F 2562, Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage, 2007.
2) Moser, A.P., Buried Pipe Design Second Edition, McGraw Hill, 2001.
3) Tullis, J. Paul, Utah State University Foundation, Friction Factor Tests on Concrete Pipe, 1986.
4) Tullis, Blake P., Utah State University Research Foundation, Flow Testing 24-inch Duromaxx Pipe, 2008.
5) Reuters, Texas Brushfires Heat Up Debate on Roadway Support Materials, May 21, 2009, http://www.reuters.com/article/pressRelease/idUS127744+21-May-2009+PRN20090521.