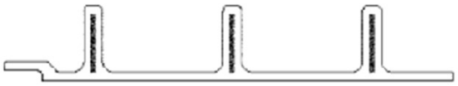
Spirolite and Steel-Reinforced HDPE are both considered profile pipes that use an increased moment of inertia to act like a conventional pipe wall, but that is where the comparison between the two ends. Spirolite Profile HDPE pipe offers distinct advantages for long-term service over steel-reinforced HDPE piping (SRHDPE).

SRHDPE uses thin metal sheets encapsulated within a thin coating of HDPE. Because SRHDPE receives all of its stiffness from the steel rib, it behaves essentially the same as a low stiffness corrugated metal pipe with similar localized failure modes. The comparison of SRHDPE and low-stiffness corrugated metal pipe is significant because SRHDPE's horizontal and vertical deflections are nearly equal until the point of failure; whereas, HDPE pipes, such as Spirolite, deflect horizontally substantially less than vertically. This allows for greater deflection prior to failure which is an advantageous characteristic of HDPE pipe and in specific Spirolite Pipe. Per Moser in Buried Pipe Design Third Edition, the maximum deflection limits of SRHDPE are in some cases less than 1% before local buckling occurs for test specimens provided to Utah State University. Per ASTM F2562, the specification for steel reinforced thermoplastic ribbed pipe and fittings for non-pressure drainage and sewerage, the maximum deflection limits for SRHDPE are limited to 5%. The observed discrepancies between studies of SRHDPE and ASTM F2562 are concerning. Because Spirolite behaves like a thermoplastic pipe, the deflection limits exceed 5% in laboratory and field settings. As a matter of fact, ASTM F894 recommends a limit of 7.5% for sewer piping. Spirolite pipe has been successfully deflected for multiple state departments of transportation for use in culvert relining up to about a 20% deflection. There are other recorded field conditions where Spirolite has operated at a deflection of more than 15%.

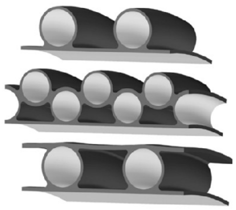
Also, temperature is a concern for SRHDPE pipe. The thermal expansion coefficient of HDPE is nearly 10 times that of steel. This means that the thinly encapsulated steel rib could deflect or buckle the HDPE encapsulation during minor temperature changes.

Installation of profile HDPE pipes can vary dramatically. SRHDPE, because of its thin ribs, must be carefully installed. Any deflection of the ribs by pushing forces, construction loads, handling, installation, etc., will significantly alter the profile construction thus reducing the stiffness. Because SRHDPE is a profile dependent pipe, damaging the profile through deflection will cause premature failure. In direct bury applications, careful attention must be paid to SRHDPE. If the contractor uses a sling near the SRHDPE profile, the thin SRHDPE profile might twist, deflect and weaken the pipe structure. On the next page is a profile comparison between SRHDPE and Spirolite.

Notice the Spirolite profile offers structural protection because of the contact area between the circular profile and the wall area. SRHDPE's thin, rectangular profile is exposed to damage which will significantly reduce the long-term performance of the material. Also because Spirolite uses a round profile, the profile does not deflect like the SRHDPE when horizontal forces are acting against the profile.



SRHDPE Profiles



Spirolite Profiles

Further, ASTM F2562 and ASTM F894 both require flattening tests. However, ASTM F2562 only requires a 20% flattening test and allows the profile to deform. As previously mentioned, profile pipes like SRHDPE and Spirolite are designed to increase the moment of inertia per length. When a profile begins to deform, the moment of inertia changes very quickly and may lead to buckling. Spirolite and ASTM F894 requires a 40% flattening test without pipe deformation. Further, the pipe is expected to re-round post flattening.

Next, wall buckling must be taken into consideration for all buried pipe and conduits. Moser states, “Failure is much more catastrophic in the steel-ribbed polyethylene than in either corrugated steel or HDPE (i.e., collapse can progress without an increased load). The behavior of this pipe shows that stiffness alone will not control localized buckling.” The premise behind adding the steel to reinforce the SRHDPE is to increase stiffness. According to Moser, the steel will increase stiffness but it does not, however, control localized buckling. Moser’s data shows the SRHDPE pipe tested by Utah State exhibited wall buckling as its primary failure mode and concludes, “Higher pipe stiffness without a sufficient wall area can lead to premature pipe failure”. Spirolite, because of its superior profile, has a much greater wall area per unit length than SRHDPE, thus controlling wall buckling in comparison to SRHDPE.

Additionally, not all HDPE Resins are equal. The HDPE specification in ASTM F2562 for SRHDPE do not meet the minimum acceptable pressure rated resin requirements of Spirolite. Spirolite and ASTM F894. The minimum acceptable material per ASTM F894 shall have a cell classification per ASTM D3355 of 334433C. Spirolite’ s minimum cell classification is 445574C which will ensure 100 year design life. The key digit is the very last one (3 for F894 or 4 for Spirolite). This ensures the base resin has a Hydrostatic Design Basis recognized by the Hydrostatic Stress Board. Per ASTM F2562 for SRHDPE, their cell classification is 335420C. The zero at the end means the base resin is not suitable for pressure applications. You might say, why do I need a pressure rated material for a gravity application? The answer is simple —buried pipes are subjected to both compressive and tensile stresses. Ring tensile stresses occur due to normal pipe deflection and longitudinal tensile stresses occur due to variations in pipeline subgrade stiffness. To ensure that Spirolite pipe can handle these stress long term, ASTM produced a standard requiring pressure rated resin. Pressure rating requires that the resin be made into pipes and subjected to hydrostatic testing. Some of the tests last over 18 months. If an engineer expects pipe to last 100 or more years in service under stress he is best served by a pressure rated resin —a pipe that can handle internal pressure can handle external pressure as well. In an effort to improve their products, the SRHDPE pipe companies developed a stress crack test that is supposed to help select more resistant materials. These materials are not stress or pressure rated, just more resistant to cracking. The proposed stress crack test is completed in a matter of hours, not months, and the test stress levels are rather low. Spirolite piping material would breeze through these tests. Bottom line, SRHDPE pipe material does not meet the material requirements of ASTM F894 and, as you might imagine, these lower grade materials are much less expensive than resins used to produce Spirolite pipe —thus giving manufacturers the incentive to want to use them.

When designing a gasketed bell and spigot joint for HDPE pipe for long term sealing (50 to 100 years), several criteria must be met. First, the joint must be made with pressure/stress rated materials like the materials specified in ASTM F894. ASTM F894 requires the same cell classification for all HDPE materials within the pipe and fittings. ASTM F2562, however, allows for multiple inferior materials to be used for the joints, fittings and couplings. Their allowable cell classifications are 213330C for rotationally molded materials and 314430C for injection molded materials. Both of these materials will not allow for long term sealing.

Next, gasketed bell and spigot joints rely on precise dimensions to maintain an effective seal. The compression range of elastomeric gaskets is about 30% of the height of the gasket to maintain a proper seal. Large diameter pipe joints made with bells and gaskets constructed of visco-elastic polyethylene, respond to the stresses imposed by the interference fit that provides the 30% compression required to make a seal. The response to this stress is induced strain. Plastic bell ends that are not sufficiently robust may experience significant stress, and in elatively short order, strain and develop a leak as gasket compression is lost. An alternative approach is to stabilize the bell and spigot so that they are less visco-elastic, and more able to maintain the geometry required to compress the gasket. Spirolite's gasketed joint is a robust design and uses ASTM F894 Table 1 for the minimum bell thickness for an effective seal. SRHDPE uses thin rotationally molded or injection molded joints which do not meet the requirements of ASTM F894 Table 1.

Further, the SRHDPE manufacturer states in their literature their pipe is rated for long term pressure (50 years) up to 15 PSI when tested in accordance with ASTM D3212. First, ASTM D3212 is a short term test which does not bring HDPE to tensile failure. ASTM D3212 is a joint specific test and does not effectively rate the pipe for pressure applications. This test rates the joint to 25' of head pressure for 10 minutes. Next, AWWA C906-15, DIN 8075/8074, ASTM F714, ISO 4427 or other HDPE pressure pipe standard should be used to determine the pressure rating of HDPE pipe based upon minimum waterway wall thickness using Barlow's Formula.

$$P = \frac{2St}{D}$$

Where:

P = Pressure
S = Stress
t = Minimum Wall Thickness
D = Diameter

HDPE Specific formula per AWWA C906-15

$$P = \frac{2HDS}{SIDr + 1}$$

Where:

P = Pressure
HDS = Hydrostatic Design Stress (1000 for PE4710 per PPI TR-4)
SIDR = Standard Inside Dimension Ratio (ID/min wall)

Other methods of pressure rating are not considered adequate for HDPE but could be adequate for other non-thermoplastic materials. These referenced HDPE standards have manufacturers qualify their pipes based upon Barlow's Formula and a series of tests included elevated temperature sustained pressure (80°C) testing for up to 1000 hours, short term pressurization testing of 3200 psi hoop for up to 5 minutes and other testing methods. Below is an excerpt of pressure ratings per Barlow's Formula (per AWWA C906) for SRHDPE sizes 54" and larger based upon data from ASTM F2562-15

ID	ID	Min Wall	Min Wall	Dimension Ratio	Pressure rating per Barlow's Formula
in	mm	in	mm	IDR	PSI
54	1350	0.079	2	675	2.37
60	1500	0.079	2	750	2.13
66	1650	0.087	2.2	750	2.13
72	1800	0.087	2.2	818	1.95
78	1950	0.094	2.4	813	1.97
90	2250	0.094	2.4	938	1.70
96	2400	0.118	3	800	2.00
100	2500	0.118	3	833	1.92
108	2700	0.118	3	900	1.78
120	3000	0.188	3	1000	1.60

Spirolite, because it is used to manufacture feedstock for pressure pipe components, is designed and tested per the HDPE pressure pipe standards, as well as, ASTM F3034-13 (Standard Specification for Billets made by Winding Molten Extruded Stress-Rated High Density Polyethylene (HDPE)). The Spirolite process allows for minimum wall thicknesses of 0.10” to in excess of 12” for sizes 12” through 120”. Spirolite has even made 120” ID IDR 10 Pipe for buried structures. This wall thickness exceeded 12” minimum wall. Spirolite has the ability to customize a profile and wall thickness to meet all of the expectations for a project.

In conclusion, Spirolite Profile pipe offers a more flexible solution coupled with fewer installation considerations for longer-term performance than SRHDPE. Spirolite allows for more pipe deflection and the proper wall area per unit length to resist wall crushing and buckling. Spirolite offers a robust joint that offer long term effective sealing, and Spirolite is made only using the best pipe grade, long term stress rated materials.

Timmy Tipton

Director of Operations

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