

Large Diameter Steel Reinforced Corrugated Plastic Pipe For The Buried Sewer Application in China

The Rapid Developing of the Plastic Buried Sewage Pipe Industries And The Technical Innovation

At the moment, sustainable development is the common goal of the whole world. To prevent the environment pollution, all countries have to establish the complete, reliable and economy water draining pipeline system. The buried plastic pipe is approved as the best solution after a long term practice.

Different kinds of the buried plastic pipe products from the world have been applied in China. After years' practices, only few kinds of pipes are being survived in the competition. On the small and middle diameter ranges (Dn200 to 800mm), the main products are double wall corrugated PVC, PE or PP pipe. On the large diameter ranges (over 800mm until 3000mm), the steel reinforced spiral corrugated pipe becomes the winner in the market.



To make the buried plastic pipe in large diameter, the wall thickness of the pipe must be very heavy, enough to keep the pipe stiffness and against the soil weight and loading on the road. Thus the high plastic material cost is a big problem for using the large diameter plastic pipe in the project. Therefore, in the large diameter sewage pipe field, the composite & reinforced pipe becomes the priority selection. There are various reinforce and composite methods and solutions, for example, the spiral reinforced pipe with PP tube reinforcement (by Krah or Bauku technology, German), and the spiral HDPE pipe with the steel ribs (developed by Rib Loc, Australia) and the steel reinforced corrugated pipe (by Kanaflex Japan and Goldstone China). Those pipes have an intense competition from the properties, pipe cost, safety and installation. Finally, most of the Chinese pipe makers adopt the solution of Steel Reinforced Polyethylene Corrugated Pipe (hereinafter called SRPCP).

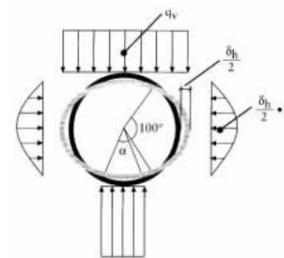
Developing of the Steel Reinforced Plastic Buried Pipe



Compared with the traditional steel and concrete pipe, the plastic pipe has big advantages, such as anti-corrosive, less leakage, light weight and easy installation. But the serious disadvantage of the plastic pipe is the low elastic modulus, e.g. polyethylene E_p value is about 800 Mpa. This character makes the full plastic pipe can not provide a high ring stiffness easily. Or, even we can approach to the high ring stiffness by increasing the wall thickness and material grade, but the expensive pipe cost is not acceptable by most of end users. So before the developing of the reinforced structure wall pipe, the full plastic pipe is mainly used in the area of small and middle diameter ranges.

Before using the steel reinforced corrugated pipe, the typical structure wall pipes are double wall spiral pipe developed by KWH, Finland and the reinforced spiral pipe from Krah, Germany. KWH's spiral pipe is wrapped with a rectangle profile on the mandrel to form a structure wall polyethylene pipe with the flat wall. And Krah's technology is to warp the pipe on a long drum and the pipe rib is reinforced by a small polypropylene tube. Another supplier of reinforced spiral pipe is Bauku GmbH from Germany.

In principle, if the soil is in good geological condition and the pipe is installed with correct process, then under the soil-pipe interaction, even the plastic sewage pipe has low ring stiffness; it could be also used safely. The evaluations of pipe stiffness please refer to "The Design of Buried Thermoplastics Pipe (1999)" which was published by TEPPFA (European Thermoplastics Pipe and Fitting Association) and APME (Association of Plastics Manufactures in Europe). However, a number of failure evidences tell us that the main reason of pipe bulking is using the low stiffness pipe. So if the project adapts low stiffness pipes, the requirements of the soil quality, installation quality and loading of the pipe are very restrictive, any tiny mistake may bring the fatal failure risk. In another hand, the high ring stiffness buried pipe can reduce the risk of the pipe failure.



Pipe deformed to ellipse, compact the soil around the pipe. The soil will support the pipe to against the pressure.



In the ring stiffness classification, there are SN2, SN4, SN8 and SN16 four grades. Usually SN4 and SN8 will be selected. SN8 is preferred for some areas with worse geological condition, e.g. at the Shanghai area, the loading capacity of soil is less and the underground water level is relative higher, so in designing the SN8 plastic pipe is required.

However, only few plastic structure wall pipes could offer the stiffness up to SN8 in large diameter, most of pipes can only provide the ring stiffness from SN2 to SN6, even less. The large diameter buried sewage pipe is usually installed at the downstream of main pipeline or drain water networks, so it has stricter requirement in safety, that cause many contractors and designers worry about using of plastic wrapped structure wall pipe.



The elastic modulus of carbon steel is about 190,000 Mpa, while the polyethylene is only about 800Mpa; the steel EP value is almost 200 times higher than polyethylene. As well, the price of steel is half of the polyethylene. So if we can combine the advantages of two kinds of materials, steel and plastic, that will be an ideal solution to get a perfect pipe with high stiffness and less cost. The question is how to compose two kinds of materials in a good way, keep their advantages but avoid the defects, let them complement each other. There are many manufacturers are researching the answer, among them, the steel reinforced corrugated pipe (SRPCP) is a relative successful solution which proved by mass evidences.



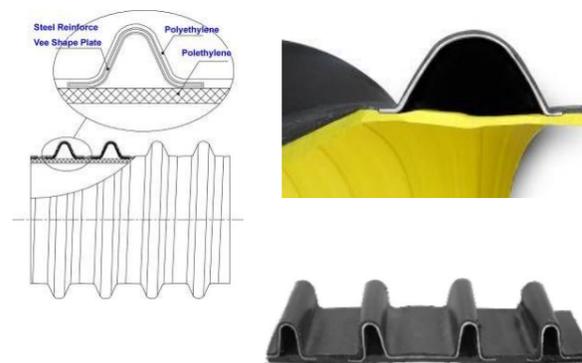
The conception of steel reinforced corrugated pipe (SRPCP) was developed by Kanaflex of Japan. In 1990's, Kanaflex started to use the steel profile to reinforce the polyethylene pipe. There are many projects in Japan, American and Israel. In year 2005, the ASTM F 2435-05 standard was published and implemented. And in 2012, the standard was upgraded to ASTM F 2435-12. Since 2003, Goldstone Orient company in China started to develop the SRPCP with their owned technology. With the new designed powerful steel forming units and process, the pipe stiffness was raised to SN16 or higher, and the pipe diameter was enlarged to Dn2500mm from Kanaflex original Dn1000.

Because of its obvious advantages on material cost and stiffness, during the last 10 years of time, SRPCP was rapidly developed in China, became the winner in competition with other kinds of structure wall pipe. About 300 SRPCP pipe production lines are installed in every province all over the China. On the drainage and sewage pipe market, if the pipe diameter is larger than Dn800, more than 50% of the projects adopt SRPCP pipe; and if the pipe is bigger than Dn1500, the SRPCP occupied 80% of the market.

Structure of SRPCP

The structure of the pipe is shown as the diagram.

From the diagram we know that the main pipe body of SRPCP is formed by the HDPE layer (inner and outer layer), and V-shape steel rib which pre-coated with adhesive resin on the surface undertakes the primary support of the pipe; the steel and HDPE is wrapped on the mandrel and bond together to be one integrated spiral-corrugated pipe.



The Advantage of the SRPCP pipe

1) High Ring Stiffness

There are huge demands on the large diameter drain pipe in the global market, especially under developing countries.

Because the plastic spirally structure wall pipe can not match with high stiffness requirement, so the traditional concrete pipe still be used. But the poor anti-corrosive and sealing properties are always the problem of environment protection for the concrete pipe. After the steel reinforced corrugated pipe has been created, the first time pipe engineers could have a selection of a high stiffness large diameter plastic composite pipe.

The new composite pipe can provide ring stiffness of SN8, SN12.5 and SN16 generally; even higher stiffness could be made if necessary. The pipe ranges from 600mm till 2400mm, suitable for various buried storm water system and waste water system. As well, the composite corrosive-proof pipe could be applied under different kinds of hard conditions like deeply buried, heavy loading or salty soil.

2) Saving Material Cost

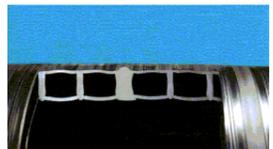
Besides the enhanced performance, the other primary advantage is that the new pipe can save material cost obviously. When pipe diameter is over Dn1000, SRPCP can save the plastic materials consumption nearly in 50% when compared with other plastic sewage pipe in same stiffness.

The composite pipe can obtain the desired stiffness easily by adjusting the thickness of steel reinforcement and the pitch of the steel ribs.

The following table is the material weight of SRPCP pipe and comparison with other pipes.

DN mm	Krah & Bauku Pipe			SRPCP			Weight Saved	Pipe Cost Saved
								
	Ring Stiffness SN	Pipe Weight Kg/m	Pipe Cost USD/m	Ring Stiffness SN	Pipe Weight Kg/m	Pipe Cost USD/m		
800	6.5	72	137	12	32	41	44.5%	30.23%
1000	6.5	112	2137	8~10	47	60	42.02%	28.24%
1200	6.5	159	303	8~10	65	82	40.92%	27.11%
1600	6.5	282	537	≥8	110	138	39.00%	25.59%
1800	6.5	360	686	≥8	136	169	37.76%	24.71%
2000	6.5	440	839	≥8	160	200	36.32%	23.83%
2200	6.5	529	1008	≥8	190	239	35.92%	23.72%
2400	6.5	635	1209	≥8	231	290	36.39%	24.03%

DN (mm)	HDPE weight kg/meter	Steel weight kg/meter	Adhesive weight kg/meter	Total Pipe Weight kg/meter
300	3.3	3.5	0.5	7.3
400	5.5	4.7	0.8	11
500	7.0	7.0	1.0	15
600	10	9.5	1.5	21
800	15	14	3.0	32
1000	22	21	4.0	47
1200	30	30	5.0	65
1500	47	45	6.0	98
1600	52	51	7.0	110
1800	65	63	8.0	136
2000	76	74	10.0	160
2200	90	87	13.0	190
2400	115	101	15.0	231

DN mm	KWH Spiral Pipe			SRPCP			Weight Ratio	Pipe Cost Ratio
								
	Ring Stiffness SN	Pipe Weight Kg/m	Pipe Cost USD/m	Ring Stiffness SN	Pipe Weight Kg/m	Pipe Cost USD/m		
600	8	28.8	54.9	≥10	21	26.56	72.9%	48.37%
700	8	44.6	92	≥10	26	32.81	58.3%	35.66%
800	8	60.4	115	≥10	32	41.41	53.0%	36.00%
900	8	75.1	143	8~10	40	50.78	53.2%	35.51%
1000	8	96.8	184.4	8~10	47	60.16	48.6%	32.62%
1200	8	136.1	259.2	8~10	65	82.03	47.8%	31.64%
1500	8	205	390.5	≥8	98	115.5	47.8%	29.5%
1800	8	407	775.2	≥8	136	169.53	33.4%	21.86%
2000	8	499	950.5	≥8	160	200.00	32.1%	21.04%

The Connection Methods of SRPCP

The connection method of the SRPCP pipe has been classified by its pipe end structure. Except the original "V" shape rib pipe can select both spiral pipe end and flat pipe end, other two pipes are using flat pipe end joints either socket or welding. There are various kinds of joint methods could be selected to match the different engineering demand.

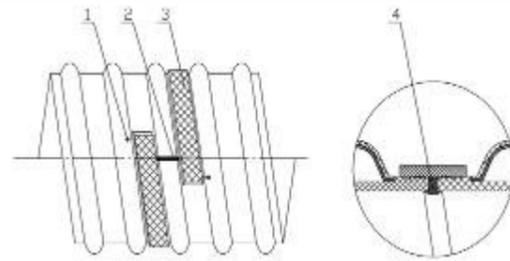
(1) Extrusion Welding

The welding of the pipe is done by a hand extruder and polyethylene welding rod. The extrusion melting material will connect the two pipes together. Normally the pipe is suggested welding on both inner and outer side. The operator could enter inside the pipe for welding when pipe diameter over 800mm. The heat shrinkage sleeve or electro-fusion belt sometimes is used to enhance the joint strength too. The advantage of this method is flexible in connection and guarantee sealing without leaking. The tools are simple and portable. The disadvantage is manpower and longer operation time.



(2) Electro Fusion Welding

You can use the electro fusion belt from outside on the spiral way to enhance the join



(3) Socket Connection with Gasket

The socket connection with gasket seaming is the most popular junction for the buried draining pipe system. It has been developed on the SRPCP pipe as well. The sealing is by a rubber gasket.

The advantage of this connection is easy operation and less manpower, the installation of pipe is fast. The disadvantage is the cost of the pipe end preparing and socket making is expensive. There are various socket connections for SRPCP.



(4) Socket with Electro-fusion

Electro-fusion is a kind of good and safe plastic pipe connection method. By making the socket on the end of SRPCP pipe, and then put the electric wires inside the female one. When two pipes inserted, use the electro fusion welder to melt them together. It is one of the rigid connection methods, easy in field installation and good water sealing.

Prospects of SRPCP Pipe

Since 2004, there are plenty of projects have been operating SRPCP pipe in China, including the applications of water drainage, waste water, storm-water pipelines and low pressure irrigation pipe. The SRPCP pipe has been confirmed as a good solution under the very difficult installation conditions. And in some of the very important places like stadiums, airport, seaport and highway, SRPCP can satisfy the censorious requirement of the customers. The SRPCP pipes had been installed both in Beijing Olympic Games and Sochi 2014 Olympics as its main drainage system. The dozen years' experiences concluded that if the pipe has been produced by qualified materials, and it is installed on the correct process, then the SRPCP pipe will not be failed within its service shelflife.

The practical evidents show that the SRPCP pipe is one of the ideal large diameter corrugated pipe. Because of the population increasing, currently many cities are planning ahead of innovating the civil drainage and sewage pipe, the SRPCP pipe will give you a different economical and convenient solutions.