BERGSCHENHOEK

CIVIELE TECHNIEK

SPIROsol

Helically Corrugated Steel Pipes
Round and Arch Profiles

General

Bergschenhoek Civiele Techniek (BCT) is your partner in civil engineering projects.
BCT constructs, delivers and produces corrugated steel SPIROsol pipe systems for this sector. BCT is located in the Netherlands, in Bergschenhoek and in Zevenbergen.

BERGSCHENHOEK
CIVIELE TECHNIEK

Content

For more information visit our website **www.spirosol.nl**

Introduction

Since 1973 BCT produces and develops a complete range of SPIROsol corrugated steel pipes. With the SPIROsol corrugated steel pipes and SIROsol Pipe Arches (type SPM) BCT has a strong position in the market. It is the largest producer of corrugated steel culverts in the Benelux. At first the pipes were mainly applied in drainage projects. The benefits of easy installation, long lengths, light weight and durability were also noticed by other clients. Nowadays SPIROsol is used in the entire market of civil engineering. SPIROsol is generally applied for Public Works and Water Boards.

Properties of SPIROsol and SPIROsol type SPM corrugated steel pipes

Sustainability and Environment
Steel is a very sustainable material. You don't consume steel, you use it!

- The steel for SPIROsol can be 100% recycled. Scrap can be turned into steel in all steel qualities. There is no question of 'down-cycling': the recycled steel retains its properties and remains suitable for high performance applications. Also, the zinc will be separated from steel and will be recycled to new zinc.
- Due the increasing involvement of used steel (scrap) in the production of new steel the need for the primary raw materials like iron ore and coal decreases.

Strong and light
The SPIROsol pipes are corrugated to provide a high strength with a minimum use of material. SPIROsol is light and very strong. With the choice of different types of corrugation and plate thicknesses an optimal design can be realized.

Applications
SPIROsol corrugated steel culverts produced by BCT are systems that are used in civil engineering for:

- Culverts for roads and railways;
- Pedestrian tunnels;
- Bicycle tunnels;
- Conveyer protection;
- Ecological passages;
- Temporarily tunnels for events;
- Rainwater retention tanks;
- Relining of existing old structures;
- Underground ventilation systems for example in parking garages.

The program is completed by elbows, pits, manholes, T-connections, etc. In accordance with European standards SPIROsol pipes can be applied for civil engineering solutions and can hold load models according the Eurocodes.

The installation time for SPIROsol pipes is shorter than the installation for concrete pipes. Simple and fast set-up help to install pipes in a brief short time and to minimize the postponement of the traffic. Building with SPIROsol pipes is cheaper than building with concrete.

Advantages:

- SPIROsol is lighter than concrete;
- Long culvert elements (max. 12 meter);
- Simple installation because of couplers;
- Flexible (limited uneven settlements allowable);
- Long product life;
- No foundation necessary, just a compacted sand/gravel bedding.

The SPIROsol pipes are manufactured in Zevenbergen (NL) and delivered in many European countries.

Steel

The steel that is applied for SPIROsol and SPIROsol type SPM and special parts meet the following European standards:

NEN-EN 10346:2009 Continuously-coated flat steel products – “technical delivery conditions”

NEN-EN 10143:2006 Plate and strip steel coated by continuously dipping – “tolerances on measurements and shape”

Mechanical properties of the steel for SPIROsol and SPIROsol SPM

Steel Grade	Standards	Yield Point (MPa)	Ultimate strength (MPa)	Elongation (%)
DX51D	NEN-EN 10346		270-500	22
S280GD	NEN-EN 10346	280	330	19

The steel coils will be delivered in the factory with an anti-corrosive coating according the applicable standards. The following possibilities for protecting steel against corrosion are deliverable:

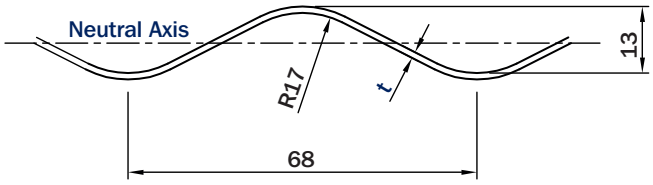
Type	gr/m²	Corrosion protection
Z600	600	Zinc coating thickness of 42 micron per side.
Z725	725	Zinc coating thickness of 51 micron per side.
Z1000	1000	Zinc coating thickness of 70 micron per side.
Z600TC	600	Zinc coating thickness of 42 micron per side, and an extra protection of 250 micron applied black PE-foil (trenchcoat or W-protection) at 1 or 2 sides.
Z275P	275	Zinc coating thickness of 21 micron per side, and an extra protection of 200 micron applied double-sided black Plastisol-coating.

Plate thickness and corrugation

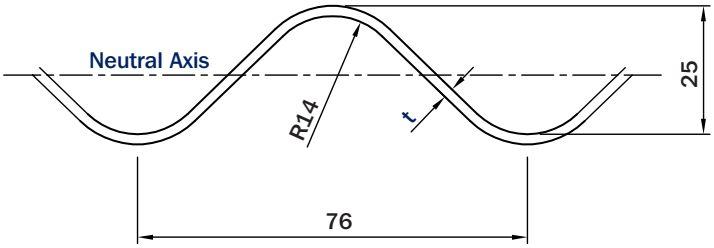
SPIROsol and SPIROsol type SPM are produced from steel strip with thickness from 1,2 mm till 2,7 mm. in 2 types of corrugation.

Corrugation 68 x 13 mm or 76 x 25 mm

68 x 13 mm



76 x 25 mm



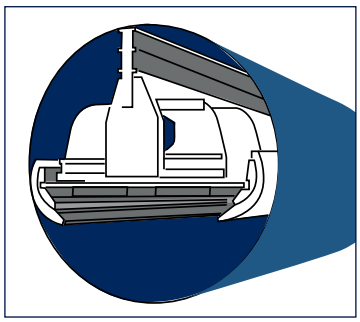
t = plate thickness
I = moment of inertia
W = section modules
F = area
EI = bending stiffness

Corrugation mm	t mm	I mm^4/mm	W mm^3/mm	F mm^2/mm	EI kNm^2/m
68 x 13	1,2	24,3	3,5	1,29	5,10
68 x 13	1,5	31,5	4,4	1,62	6,61
68 x 13	2,0	40,9	5,6	2,16	8,59
68 x 13	2,7	56,2	7,3	2,92	11,80
76 x 25	1,5	140,1	10,4	1,86	29,42
76 x 25	2,0	178,7	13,1	2,36	37,52
76 x 25	2,7	257,6	18,3	3,36	54,10

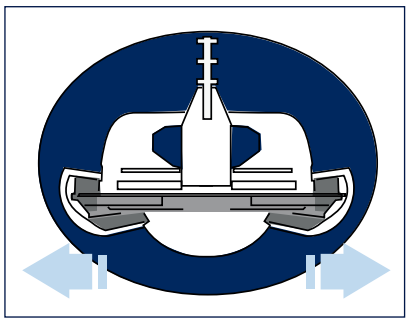
Production

SPIROsol pipes are produced by cold forming of the strip. Initially the strip of steel will be mechanically formed with corrugations and after that rolled in a diameter from 300 mm till 3000 mm.
During forming of the pipe a lockseam is performed to provide final strength and seal.

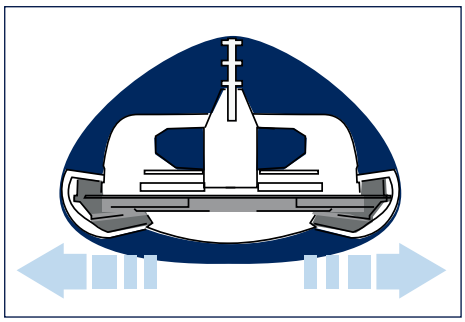
SPIROsol type SPM are produced through controlled mechanical cold deformation of round SPIROsol pipes with hydraulic cylinders.



Start with the round SPIROsol pipe



Transformation of the SPIROsol to type SPM



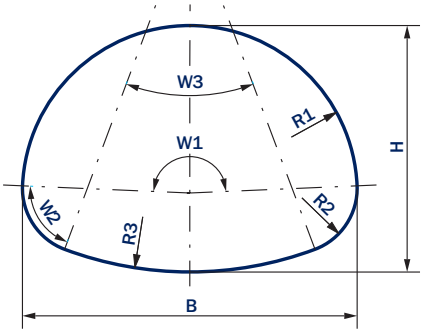
Final result: SPIROsol type SPM

Geometric parameters SPIROsol

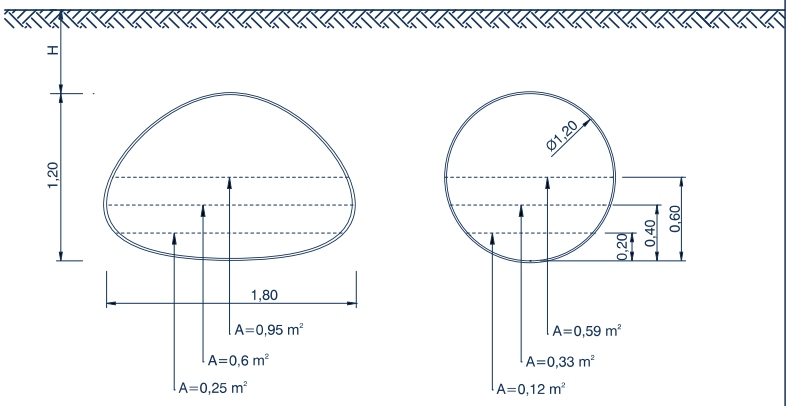
Geometric parameters SPIROsol						Coating	
Corrugation	Diameter	Plate thickness	Area	Circumference	Weight	Plastisol	Duflex 240 of Trenchcoat
mm	mm	mm	m²	m	kg/m¹		
68 x 13	300	1,2	0,07	0,94	12	•	•
	400		0,13	1,26	15	•	•
	500		0,20	1,57	19	•	•
	600		0,28	1,88	23	•	•
	700		0,38	2,20	26	•	•
	800		0,50	2,51	31	•	•
	900		0,64	2,83	35	•	•
68 x 13	700	1,5	0,38	2,20	33	•	•
	800		0,50	2,51	38	•	•
	900		0,64	2,83	43	•	•
	1000		0,79	3,14	47		•
	1100		0,95	3,45	52		•
	1200		1,13	3,77	56		•
76 x 25	1250	1,5	1,23	3,93	68		•
	1300		1,33	4,08	70		•
	1400		1,54	4,40	76		•
	1500		1,77	4,71	81		•
	1600		2,01	5,02	86		•
	1700		2,27	5,34	91		•
	1750		2,40	5,50	94		•
76 x 25	1700	2,0	2,27	5,34	112		•
	1750		2,40	5,50	115		•
	1800		2,54	5,65	119		•
	1900		2,83	5,97	125		•
	2000		3,14	6,28	131		•
	2100		3,46	6,59	138		•
	2200		3,80	6,91	144		•
	2250		3,97	7,07	147		•
76 x 25	2300	2,7	4,15	7,22	206		•
	2400		4,52	7,54	215		•
	2500		4,91	7,85	220		•
	2600		5,30	8,16	229		•
	2700		5,72	8,48	238		•
	2800		6,15	8,79	246		•
	2900		6,60	9,11	255		•
	3000		7,06	9,42	264		•

Geometric parameters SPIROsol type SPM

Corrugation mm	Width m	Height m	Plate thickness mm	Area m²	Weight kg/m¹	Type Nr.
68 x 13 or 76 x 25	1,34	1,05	2,0	1,13	71	SPM-01
	1,44	0,97		1,10	72	SPM-02
	1,49	1,24		1,46	81	SPM-03
	1,62	1,10		1,42	80	SPM-04
	1,65	1,38		1,82	90	SPM-05
76 x 25	1,80	1,20	2,5	1,70	112	SPM-06
	1,80	1,50		2,15	122	SPM-07
	1,84	1,39		2,04	120	SPM-08
	1,84	1,48		2,16	123	SPM-09
	1,89	1,55		2,32	127	SPM-10
	1,91	1,46		2,23	125	SPM-11
	1,95	1,32		2,04	121	SPM-12
	2,01	1,59		2,55	134	SPM-13
	2,04	1,49		2,41	131	SPM-14
	2,10	1,45		2,42	134	SPM-15



At the same water level SPIROsol type SPM has 65% to 100% better flow capacity in comparison with round SPIROsol with the same water level



Section lengths and couplers

The standard length of SPIROsol pipes are 6 and 8 meter, but it is possible to produce the pipes to any length between 3 and 12 m.

The production process of SPIROsol type SPM allows to produce pipes with 6 m length only.

Couplers are used to connect the pipes. The couplers are made of flat or corrugated strip steel with sheet thickness of 1,2mm. Depending on the diameter and application there are different systems you can choose from:

Type Spifix: parallel corrugated coupler. Applicable to the end finishing of the culvert. Diameter 300 mm to 2400 mm (standard);

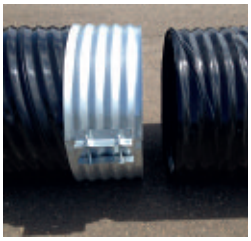
Type Flexcor: helically corrugated coupler. Applicable to the helical end of the culvert. Diameter 300 mm to 3000 mm;

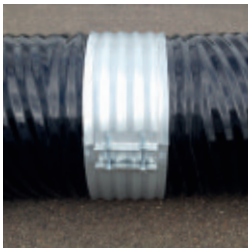
Type Widecor: extra wide parallel corrugated coupler. Applicable to the end finishing of the culvert. Diameter 2500 mm to 3000mm;

Type Refix: coupler with reduced external dimensions for re-lining.

Guidelines to unload and connect SPIROsol pipes by Spifix couplers:

1. Use hoisting belts to unload pipes. Do not use chains etc. to avoid damaging;
2. It is important that pipe ends and couplers are clean and not deformed;
3. Slide the Spifix coupler over one pipe end completely;
4. Put the pipe elements against each other and align horizontally and vertically;
5. Slide the coupler halfway over the other pipe end;
6. Tighten the bolts correctly.



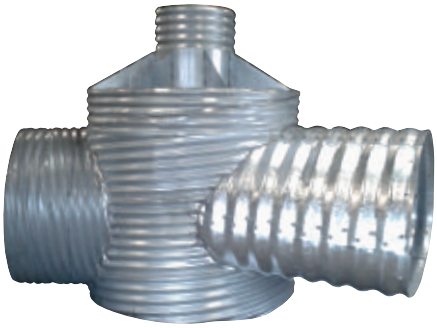


Flexcor coupler is used to extend the existing SPIROsol culvert without the standard recorrugated end.

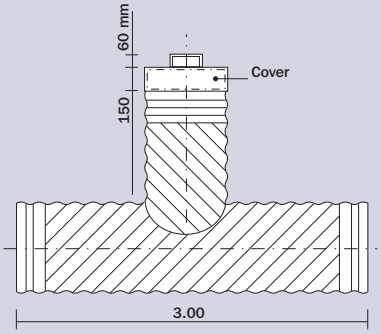
Standardized fittings

The SPIROsol pipe is made of corrugated steel. It is possible to weld pipe parts into elbows, etc. and to coat it afterwards with a Duflex 240 coating.

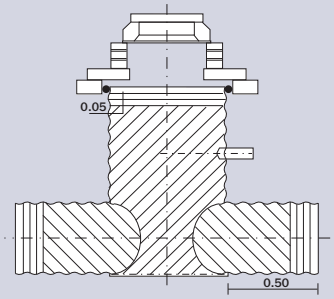
We can offer you many fittings for the corrugated steel pipes. Due delivery times and the design conveniences some dimensions of the accessories are standardized. For each project a customized solution is available.



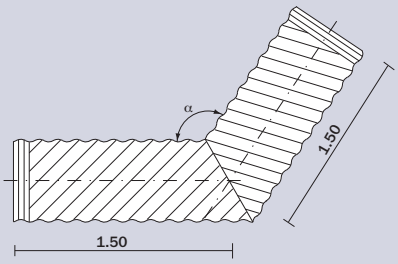
T-part (with cover)



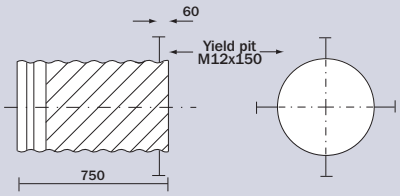
Inspection chamber (with road cover)



Elbow (α = 90° - 180°)

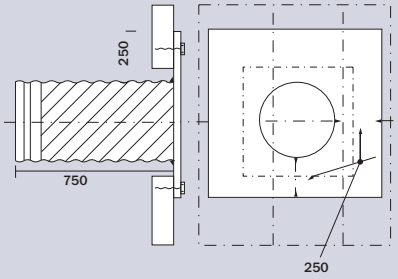


Pour-in part

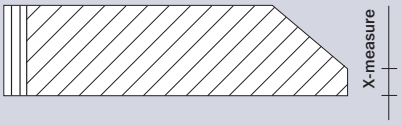


Diameter (mm)	number of anchors
300 - 500	3
600 - 800	4
900 - 1200	6
> 1200	7

End-shield



Bevel ends



Diameter (mm)	x-measure
300 - 500	100
600 - 800	200
900 - 1200	300
> 1200	500

Steel end protector / finishing for bevel end
The steel end protectors for bevel end provide protection to the end of a pipe. This sturdy coated steel edge provides also protection against damages caused by mowing and cleaning activities. The horseshoe shaped protection edge is installed in the factory, but it is also possible to assemble it afterwards using bolts and nuts.

HDPE end protector
The HDPE end protector provides a sturdy protection.

The end protector is installed to the pipe end in the factory so there will not be any extra activities for the contractor. This protection edge is also simple to install. This product provides extra protection.

Technical information
Material: HDPE 15 mm thick
Diameter: Ø400 – Ø1200 mm (larger diameter on request)
Length: 300 mm
Construction: with bolts and nuts at the end of the pipe

Grids

Sustainability and Durability

1. **Corrugated steel culvert pipes** exposed to air, water and soil require a special corrosion protection.
2. **SPIROsol culverts** are always provided with a zinc layer. The zinc layer is also coated with TRENCHCOAT, Plastisol or Duflex 240 Coating, for extra protection against corrosion. These protective coatings are provided according to the NEN7063 standards.
3. **The Duplex-system is more than just a zinc coating.** The zinc provides a protection and a top coating as well. The total period of protection is 1.5 to 2 times longer than the sum of both systems.
4. **The synergetic effect.** The mutual protection of zinc and topcoat is known as the synergetic effect. Due to this effect the protection period is considerably longer. What happens is the zinc coating eliminates corrosion underneath the coating and, on the other hand, the coating itself prevents the zinc coating from being removed. The coating protects the zinc surface against atmospheric attacks, even if it shows pores, cracks or scratches caused through weathering or damages.
5. **Formule:** Bos = 1,5 – 2,0 (Bzn + Bco)

Description of TRENCHCOAT™/ W-Protect®
The TRENCHCOAT (ASTM A742) c.q. the W-Protect (EN 10169) is directly sealed on the zinc after galvanizing in accordance with the standard. This patented technique has been applied in the USA since 1974 and is applied in Europe since 1998. At this time it is still the best coating for corrugated steel. The warm rolling strip steel is the basic material. First of all the strip steel is cleaned and heated to 450°C than conducted by a zinc bath at which it attains the required zinc coating.

The TRENCHCOAT PE (polyfine)- foil is directly sealed on the zinc after galvanizing. The steel temperature in combination with the roller pressure provide an excellent chemical and mechanical bonding between the film and the coated plate.

The TRENCHCOAT combines 3 properties in one product. Steel is the base material; it is strong and solid, zinc provides a chemical physical protection and the PE foil provides a mechanical protection to the product. The result is a product that is corrosion-resistant to moisture abrasion and chemical fluids.

Bos = protection period Duplexsystem till 5% rust at the steel surface
Note: if there is 5% rust it is possible to fix to surface
Bzn = protection period zinc coat
Bco = protection period topcoat on steel

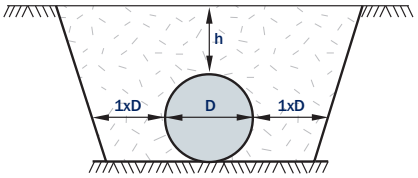
		No aggressive environment	Aggressive environment
Atmospheric aggression according to the EN ISO 12944-2		• C1 • C2	• C3
Water parameters		• pH of 6.0 to 8,0 • Hardness of water ≥ 20 mg Ca/l • Speed of water ≤ 1,5 m/s	• pH of 4,0 to 6,5 and 8,0 to 11,0 • Hardness of water < 20 mg Ca/l • Speed of water >1,5 m/s
Ground parameters		• pH of 6,0 to 8,0 • ground permeability • no organic parts • humidity ≤ 17%	• pH of 3,0 to 6,0 and 8,0 to 12,0 • ground permeability • no organic parts • humidity > 17%
corrosion protection	Zinc coating 42 um (600 g/m²)	20 - 40 years	Not recommended
	Zinc coating 70 um (1000 g/m²)	50 - 70 years	On request
	Zinc coating 42 µm (600 g/m²) + polymer coating 250 µm	over 100 years	On request

Minimum Cover

The cover is the vertical distance between the top of the culvert and the top of the road. For the live load at a culvert a load distribution in the soil is used according the Boussinesq-method.

See the table for the minimum cover. The mentioned cover is based on a road structure of 10 cm. asphalt, 30 cm. mixed aggregates and remaining sand and a modulus of stiffness of 20 MPa.

Other road structures and coverage can be calculated by BCT.
Note: If construction traffic drives on top of the culvert before the complete road construction is applied, special measures can be necessary.



Corrugation mm	Diameter mm	Plate thickness mm	Sv= 20 MPa		
			LM1	VOSB klasse 450	VOSB Klasse 600
68 x 13	300	1,2	0,50	0,50	0,50
	400		0,50	0,50	0,50
	500		0,50	0,50	0,50
	600		0,50	0,50	0,50
	700		0,50	0,50	0,50
	800		0,50	0,50	0,50
	900		0,55	0,50	0,50
68 x 13	1000	1,5	0,60	0,50	0,50
	1100		0,65	0,50	0,50
	1200		0,70	0,50	0,50
76 x 25	1250	1,5	0,50	0,50	0,50
	1300		0,50	0,50	0,50
	1400		0,50	0,50	0,50
	1500		0,55	0,50	0,50
	1600		0,55	0,50	0,50
76 x 25	1700	2,0	0,60	0,50	0,50
	1750		0,55	0,50	0,50
	1800		0,60	0,50	0,50
	1900		0,60	0,50	0,50
	2000		0,65	0,50	0,50
	2100		0,65	0,55	0,55
	2200		0,70	0,55	0,55
	2250		0,70	0,60	0,60
76 x 25	2300	2,7	0,65	0,60	0,55
	2400		0,70	0,60	0,60
	2500		0,70	0,65	0,65
	2600		0,75	0,65	0,65
	2700		0,75	0,70	0,70
	2800		0,80	0,70	0,70
	2900		0,80	0,75	0,75
	3000		0,85	0,75	0,75

LM1: load model according to the EUROCODE (NEN6707)
VOSB: traffic load with declared class

SPIROsol and SPIROsol type SPM installation instructions

1. Backfill material

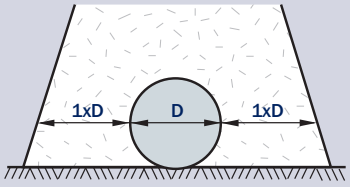
The foundation and backfill material must be of good quality like sandy ground, grit etc. The backfill must be close to the construction and must be clean of material like debris, wood, frozen soil, etc. Also a high percentage of aggressive and organic material are not permitted.

The surrounding ground layers should be able to provide sufficient support pressure. In the calculation of the constructions the support pressure assuming, 20MN/m². The volume weight of the backfill material has to be 20 kN/m³ by an internal angle of friction of 30°.

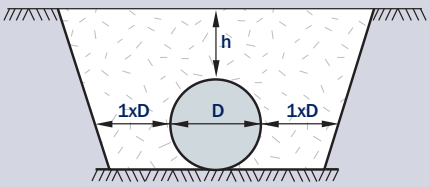
2. Foundation

If the soil meets the requirements as mentioned above than it can be used as foundation and the construction can be installed. To assemble the corrugated pipes in the foundation it is necessary to provide 5 cm of loose sand of the existing foundation. The existing foundation has to meet the requirements of point 1. Based on the surrounded soil improvement the norm should be 3x the diameter of width of the construction. If settlements are expected an arch is recommended. (ca ½% of the length).

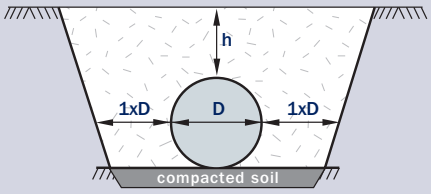
The best foundation is the foundation that correspondents the shape of the construction.



1. Placement on an embankment.



2. Placement in a burial of which the excavated material meets the requirements.



3. Placement in a burial of which the excavated material does not meet the requirement soil improvement is necessary.

3. Backfill

Backfill material should meet the requirements as mentioned in number 1. The required trench width is shown in figure 1 until 2. By burials the slope should meet the natural slope of the excavated material. By installation in a bedding foundation the backfill material should be installed underneath the pipe in the corners in 200 mm thick layers and it should be consolidated till a maximum Proctor density of 98%. The density may not be obtained by accomplishing the soil compaction so far that the construction will rise. When this is accomplished the actual filling of in layers of 200-300 mm thickness begins.

Every layer should be wiped out and mechanically compacted. The soil compaction should be done simultaneously on both sides of the pipe, from the side of the trench wall into the direction of the pipe. Distances nearby 700 mm and 500 mm above the construction and in position of the bevel end the soil compaction should be done by using tamper or light low frequency soil compaction material with a head of approx. 500 mm^2. Heavier soil compaction material can be applied at larger distance from the pipe.

4. Installation

By installation of the SPIROsol systems follow the next steps:

a. Damages, of any kind, must be avoided.
b. Before the construction traffic is allowed at the construction backfill and the soil compaction activities must be completed and meet the requirements of the design, calculation of construction phase or final phase.
c. Before the culvert will be used the backfill and the soil compaction have to be completed.

5. Remarks

When circumstances arise in which rules are insufficient our technical department need to be contacted. The rules can be changed or supplemented without any notice.

Structural design

For choosing the right diameter of an application of SPIROsol or SPIROsol type SPM a technical design with an index of loads and cross section is required. The selection of coating and steel thickness depends of the required corrosion reserve and lifespan. SPIROsol and SPIROsol type SPM are custom made according to the technical design.

Special applications

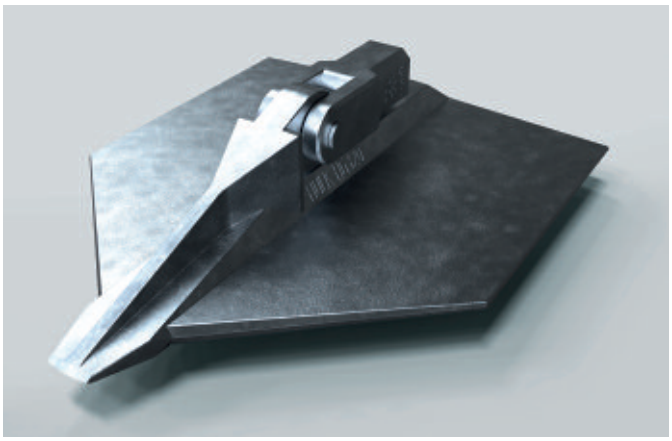
Multi-plate corrugated steel pipes and tunnels

SuperCor corrugated steel bridges and tunnel constructions

ROwat plastic sheet piling

ROwat plastic sheet piling

RObu PE pipe systems



ROwat ground anchors

BERGSCHENHOEK

CIVIELE TECHNIEK

Boterdorpseweg 10, 2661 AC Bergschenhoek
T +31 (0)10 524 26 50
F +31 (0)10 524 26 51
E infobct@bergschenhoek-ct.com
I www.bergschenhoek-ct.com
Bergschenhoek Civiele Techniek BV

Member of **BERGSCHENHOEK GROEP**

01 07 2017

FSC www.fsc.org FSC® Het keurmerk voor verantwoord bosbeheer

CO_2-PRESTATIELADDER® Samen zorgen voor minder CO_2

ISO 9001 BUREAU VERITAS Certification

MGMT. SYS. RvA C 248