TUBOSIDER

ASSEMBLY MANUAL

CULVERTS AND LOAD BEARING STRUCTURES

VERSION 2023

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INTRODUCTION

The underground culverts in corrugated sheet, otherwise known as Corrugated Steel Culverts or Soil Steel Composite Bridges, are flexible metallic structures, consist of more corrugated metal plates, appropriately curved and joined together by means of bolted joints, available in various shapes such as circular, elliptical, lowered and arch.

The load-bearing function of the culverts is based on the exploitation soil-structure interaction that is established between the metal structural profile and the detected technical surrounding, which plays a fundamental role in ensuring the structural stability.

The underground culverts are comunamente employed in the civil engineering sector for road applications, hydraulic or railway, such as bridges, culverts crossing, vehicle or pedestrian underpasses, ducts.

The market for Soil Composite Steel Bridges grew rapidly, starting from the first applications of the ‘70s up to today's implementations they see the metal culvert in great light itself as a viable alternative to other more conventional types of construction of major engineering works such as bridges road, rail or concrete or structural steel concrete tunnels.

They are structures that provide great savings in terms of material, time and resources, thanks to the high resistance of the sheet, the reduced thickness used, the high level of prefabrication, the optimization of transportation time and implementation.

This structural methodology was implemented by Tubosider the late '70s.

The span currently covered by the types of standard ducts arrive to a maximum of 7 ÷ 8 m., up to reach 10 ÷ 12 m. of light in the case of culverts arch equipped with lateral thrust reinforced concrete beams.

1.0 WORKING PRINCIPLES

Culvert design is based on the compressed ring theory.

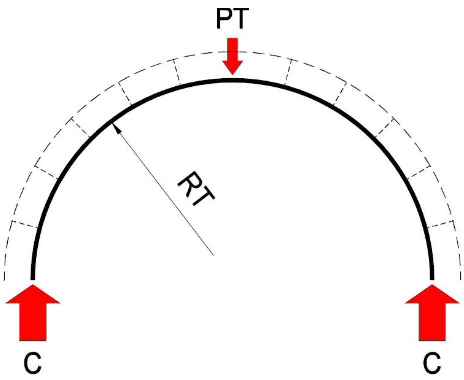
Because of its elasticity, the metal structure interacts with the soil surrounding it.

The loads transmitted by the soil are distributed evenly over the whole surface of the culvert.

The structure is therefore compressed and the stress induced, “C” (ring compression) is proportional to:

- the pressure exerted by the soil on the ring, “**PT**”;
- the crown curvature of the structure, “**RT**” (in a circular structure RT corresponds to half the diameter);

according to the formula: **C** = **PT · RT**



The theory assumes that the soil transfers the loads evenly to the metal structure and that this reacts in a uniform manner, without any points of discontinuity.

If the principle of the loads being correctly distributed over the ring is missing, i.e. if the structure does not work perfectly under compression, then the culvert must be considered critical.

In pratical terms, great importance is therefore given to:

- the formation of the technical block, i.e. the composition and degree of compaction selected and laid for the materials that make up the sub-base and the covering for the culvert: materials which must ensure that, in order for the culvert to hold, the pressure of the soil PT is in fact translated totally into radial pressure C;
- the sizing of the joints for the plates that make up the culvert, because they must be able to ensure the structure continuity.

The vertical drop of the culvert, or rather its deformation under load, is not considered as a calculation criteria for determining the longitudinal section of the structure and therefore the thickness.
Experience has in fact shown that the presence of a technical block built to perfection is more than adequate to allow the culvert to bear working loads when the ring is compressed up to full resistance.

For a technical block built to perfection, deformations less than or equal to 2 % of the theoretical rise of the culvert are permitted.

Deformations greater than this can be attributed to defects in how the technical block has been made.

In any case the steel structure is able to behave flexibly also in the presence of deformations less than or equal to 5 % of the culvert rise.

2.0 MATERIAL CHARACTERISTICS

All the culverts are produced with materials of the following types:

2.1 Plates

According to standard EN 10025-2 April 2005, grade **S235JR** steel plates must have the following mechanical properties:

• ***tensile strength***		Rm	360 ÷ 510	N/mm^2
• ***yield strength***		ReH	235	N/mm^2
• ***resilience***	***Temperature***		20	°C
	Energy		27	J
• ***elongation percentage***	Th. > 1.0 ÷ ≤ 1.5 mm.	A	≥ 18	%
	Th. > 1.5 ÷ ≤ 2.0 mm.	A	≥ 19	%
	Th. > 2.0 ÷ ≤ 2.5 mm.	A	≥ 20	%
	Th. > 2.5 ÷ < 3.0 mm.	A	≥ 21	%
	Th. ≥ 3.0 ÷ ≤ 40.0 mm.	A	≥ 26	%

The thicknesses shown on the tables are the nominal ones and refer to raw material without galvanization coating.
Tolerance on thicknesses according to EN 10051 standards.
The weights too are the theoretical ones so they may vary according to the sane tolerances on the thicknesses.

According to standard EN 10149-2 May 1997, grade **S355MC** steel plates must have the following mechanical properties:

• ***tensile strength***		Rm	430 ÷ 550	N/mm^2
• ***yield strength***		ReH	355	N/mm^2
• ***resilience***	***Temperature***		20	°C
	Energy		40	J
• ***elongation percentage***	Th. < 3.0 mm.	A	≥ 19	%
	Th. ≥ 3.0 mm.	A	≥ 23	%

The thicknesses shown on the tables are the nominal ones and refer to raw material without galvanization coating.
Tolerance on thicknesses according to EN 10051 standards.
The weights too are the theoretical ones so they may vary according to the sane tolerances on the thicknesses.

2.2 Nuts and bolts

High resistance class 8.8 bolts are used, with the mechanical properties stated in standard EN ISO 898-1 (screws) and in standard EN ISO 898-2 (nuts).

Depending on the type of corrugation, the following types of bolts are used with the relative tightening torques [a]:

Type of corrugation	**Bolt type**	**Tightening torques [a] Class 8.8**	
		Min. [b] Nm.	**Max.** [c] Nm.
T70 **T100**	M12	45	90 [d]
T200	M20	220	439 [d]

a Tubosider SpA recommends to carry out the regular calibration of the tools (torque wrench, air impact wrench,etc..).

b The acceptability limit is anyway at the discretion of the Third Party Engineer.

c According NTC D.M. 17 January 2018 (NTC 2018) 4.2.8. Joints – Table 4.2…… Tightening torques for bolts 8.8, Factor K = 0.16.

d Higher values of the maximum tightening torque are admitted at the discretion of the Third Party Engineer provided that the tightening torque applied does not lead to breakage of the bolts and/or the deformation of the plates to be connected.

2.3 Surface protection

In order to protect against corrosion, a hot-dip galvanisation bath is prescribed for plates and nuts and bolts, with a quantity of zinc that varies according to the thickness of the plates and the type of nuts and bolts, complying with standard EN ISO 1461: 2009, and more specifically :

Plates

Steel thickness mm.	**Minimum local thickness of the coating** μm.	**Minimum average thickness of the coating** μm.
> 6.0	70	85
> 3.0 ÷ ≤ 6.0	55	70
≥ 1.5 ÷ ≤ 3.0	45	55
< 1.5	35	45

Nuts and bolts

Diameter mm.	**Minimum local thickness of the coating** μm.	**Minimum average thickness of the coating** μm.
> 6	40	50
≤ 6	20	25

or other current standards.

The protection is adequate for ensuring product durability under normal environment conditions.

Aggressive environmental conditions other than those identified above must be the subject of a special study, in order to decide the type of supplementary protection to be given (sacrificial thicknesses or epoxy treatments).

Environmental categories, risks of corrosion and corrosion levels

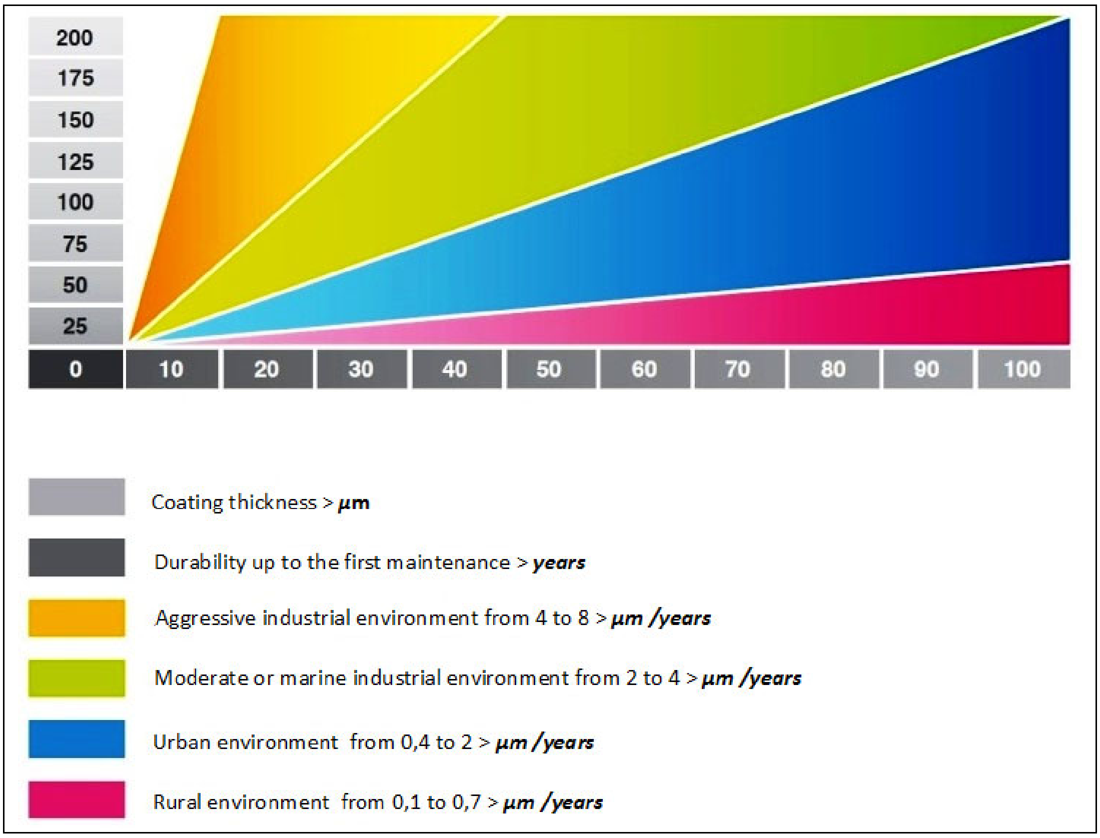
Code	Corrosion category	Risk of corrosion	Corrosion level average zinc thickness loss [e, f] µm/year
C1	Inside: dry	Very low	≤ 0.1
C2	Inside: occasional condensation Outside: rural environment	Low	From 0.1 to 0.7
C3	Inside: high humidity slight pollution Outside: urban or temperate coastal environment	Average	From 0.7 to 2
C4	Inside: swimming pools, chemical plants, etc. Outside: industrial environment or urban coastal	High	From 2 to 4
C5	Outside: industrial environment with high humidity or high coastal salinity	Very high	From 4 to 8
Lm2	Sea water in temperate regions	Very high	From 10 to 20 [g]

e The thickness loss values are identical to those in ISO 9223, except for the levels of 2 mm. (per year) or more, which have been rounded up to the nearest whole number.

f Changes in the air for the different environments through the years.
A substantial reduction in pollution, especially of sulphur dioxide, has taken place over the past 30 years world-wide.
This means that the current corrosion levels (the table is based on data for the period 1990 to 1995) for each environmental category are much lower that historical levels, even lower levels can be foreseen in the future if pollution continues to diminish.

g Sea water in temperate regions is less corrosive to zinc than tropical sea water, which is usually warmer.
This table can be used in marine environments in European temperate regions.
For tropical conditions the advice of a galvanising specialist should be sought.

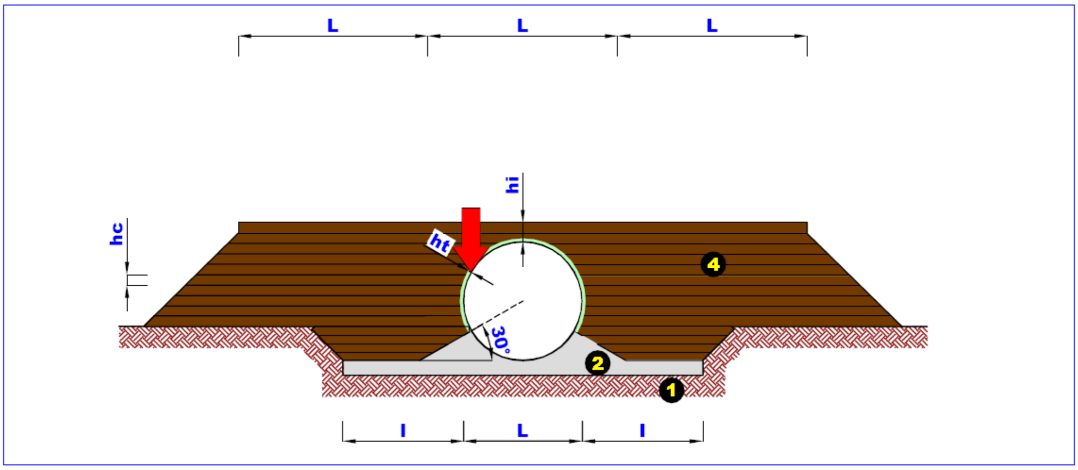
Typical durability of zinc coating up to the first maintenance in different environmental situations



2.4 Technical block

The static function of the culvert is guaranteed not only by the steel structure but also by the compacted soil around it that forms the technical block.

The correct sizing of the technical block and its perfect execution are illustrated in *Chapter 5.0*.
For a layer around the culvert of 20 cm., called layer "**ht**", the use of monogranular material with a max. diameter of 5 mm. is recommended.



1	general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2	artificial foundations and bedding
4	side holding backfill
l	≥ 1.00 m. on a good soil - L otherwise
L	culvert span
ht	20 cm. sand ∅ max. 5 mm.
hc	20 ÷ 30 cm. max. layer height
hi	minimun backfill level, enough to allow site vehicles to circulate

The remaining part of the technical block will be made with backfill classified according to AASHTO M145-91 standards, i.e. according to CNR UNI 10006, of the group A1-A2-A3, free of any organic and non-organic impurities.

Soil classification according to AASHTO M145-91/CNR UNI 10006

General Classification	Granular Materials (35% or less passing 75µm) [No. 200]							Silt-Clay Materials (More than 35% passing 75µm) [No. 200]			
Group Classification	A-1		A-3*	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve Analysis:											
Percent passing:											
2mm (No. 10)	50 max.	---	---	---	---		---	---	---	---	---
425µm (No. 40)	30 max.	50 max.	51 min.	---	---	---	---	---	---	---	---
75µm (No. 200)	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing No. 425µm (No. 40):											
Liquid Limit	---		---	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.
Plasticity Index	6 max.		N.P.	10 max.	10 max.	11 min.	11 min.	10 max.	10 max.	11 min.	11 min**
Usual Types of Significant Constituent Materials	Stone Fragments Gravel and Sand		Fine Sand	Silty or Clayey Gravel and Sand				Silty Soils		Clayey Soils	
General Rating as Subgrade	Excellent to Good							Fair to Poor			

*The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate the superiority of A-3 over A-2.
**The plasticity index of A-7-5 is equal to or less than the liquid limit minus 30. The plasticity index of the A-7-6 subgroup is greater than the liquid limit minus 30.

For the final layer, before the road foundation, the use of a layer with a minimum height of 30 cm. is recommended, using materials from the group A1-A2-4-A2-5.

The granulometry of the pieces must satisfy the general requirements specified in standard EN 13242.

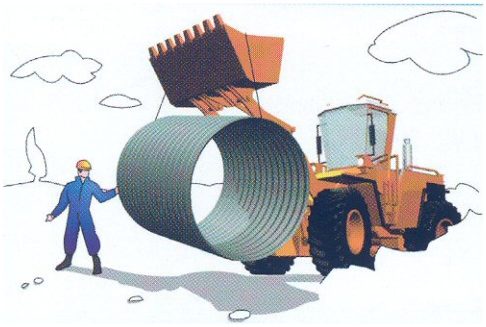
For durability, in order to prevent premature onset of steel corrosion and to ensure the perfomance stated in *chapter 2.3*, it is recommended the use of materials which offer electrical resistance of more than 8000 Ohm/cm and with a Ph close to the neutral value of 7 (values between 6 and 8).

In addition, water leakage into the technical block of ground around the structure should be avoided, as in time this could affect the mechanical and material compaction properties.

To ensure compaction of the technical block to no less than 85 % of the maximum density provided by the Proctor test modified according to standard EN 13286-2 the material used must be able to achieve a module of elasticity “**Es**” at least equal to 100 MPa (120 MPa for 90 % compaction of the maximum density provided by the modified Proctor test).

3.0 SITE PREPARATION AND ORGANISATION

The plates must be unloaded by mechanical means or by hand, but dumpers cannot be used because the sheets could be deformed and the edges could be bent, making assembly more difficult and therefore more expensive.



Transfer to the place of installation must be carried out rationally, making sure that the sheets are subjected to as little movement and dragging as possible, in order to prevent damage being caused to the zinc coating that protects the steel, or any additional protection.

A copy of the “ASSEMBLY MANUAL” is always enclosed with the supply.

3.1 Staff

Installation team must consist of a minimum of 4 to a maximum of 6 persons.

Several teams can work simultaneously on the same site.

3.2 Equipment

The minimum assembly equipment (although not always required) for each installation team, consists of:

- hammers;
- hooks;
- keys 22 (T70/T100 corrugation) and/or 32 (T200 corrugation);
- crowbars;
- scales;
- scaffolding;
- truck with crane;
- chains for lifting with shackles;
- current source;
- compressor;
- an electric or pneumatic Impact Gun (capable of achieving the required torque settings) should be used to assemble the seams.

This will save time and ensure regularity in the seams.

To ensure the required torque settings for the bolts are achieved, a torque wrench "dynamometer" (with suitable capacity) can be used to confirm this.

3.3 Times of installation

The typical times for installation using a team of specialized technicians (4 people) with suitable equipment and with the materials available on site, will be approximately 4 ÷ 6 tonnes per day.

The installation times can vary from site to site depending on the preparation of the bed and also access for lifting equipment.

4.0 INSTALLING THE CULVERTS

4.1 Assembling the structure

Each supply consists of the material and the relative “ASSEMBLY DIAGRAM”.

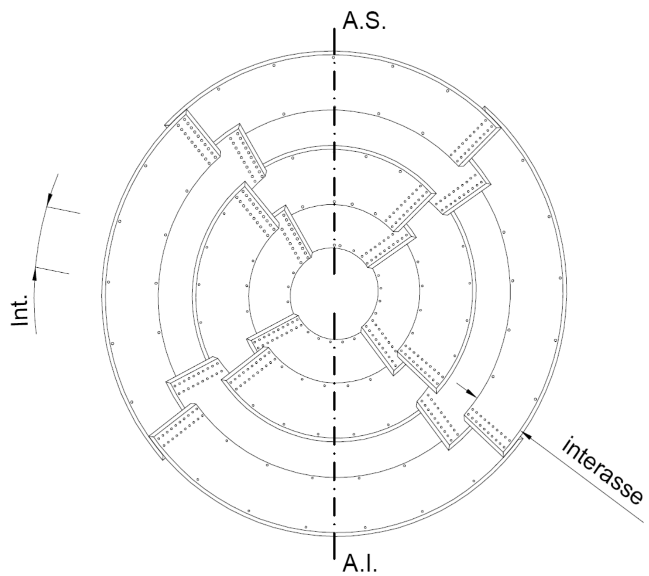
The standard plates are identified by the type of corrugation and the number of intervals.

The type of corrugation (T70, T100, T200) is however always the same for each type of pipe.

The number of intervals on the contrary varies from plate to plate depending on its culvert sizes.

The term “**interval**” means the linear distance between two adjacent holes along the circumferential joint.

The above mentioned diagram clearly shows the progression of the plates, always referred to the top and bottom axis of the culvert, and to the number of intervals for each plate.



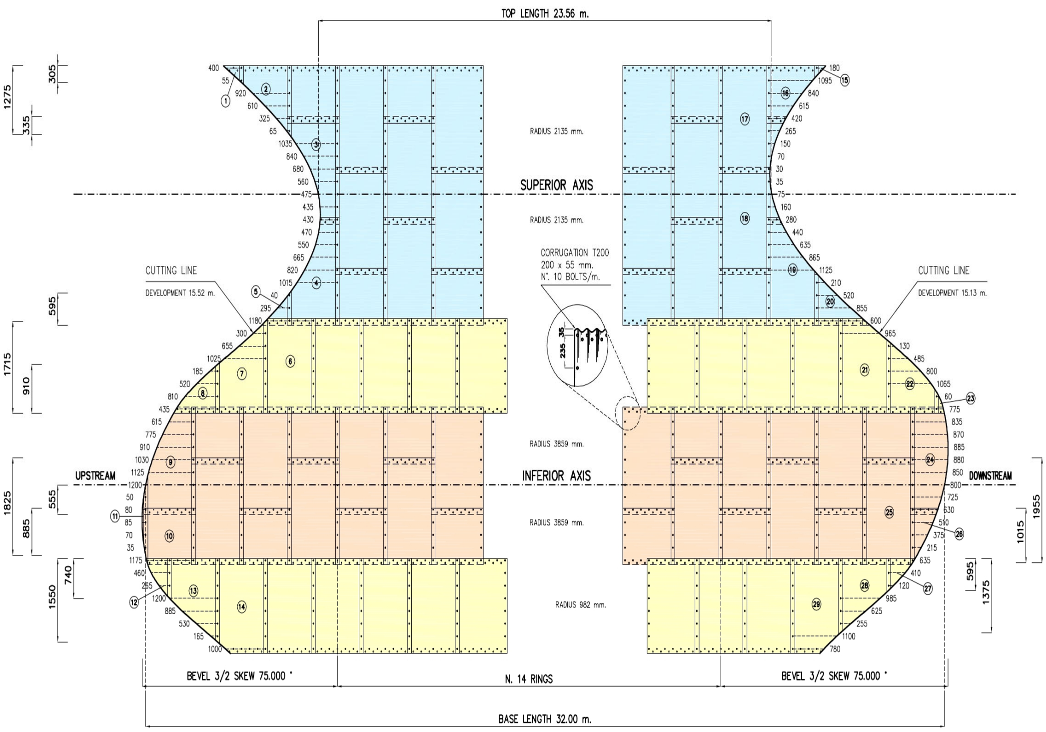
Where special processes are to be carried out on the culvert (cutting the bevelled ends, planimetric/altimetric curves, side joins, etc…) relevant detailed drawings are supplied with the structure.

In this case the individual shaped sheets will be marked so their exact position on the detailed drawing can be identified.

Assembly takes place by fitting a limited number of bolts to hold the plates together in the correct position.

Only after a certain number of rings have been assembled should the rest of the bolts be fitted.

The bolts should be left loose to allow the plates to undergo those small movements that allow them to settle in correctly.



Ends bevelled according to embankment slope, plane development, internal view

In the case of a culvert with a high total length, it is recommended to create some reinforced concrete dividing strips by means of which the total length will be divided for its better stability and in order to reduce its moment and its deformability and therefore avoiding possible rotation of the plates forming the rings of the structure itself.

4.2 Tightening the bolts

Once the whole structure has been assembled, the bolts can then be tightened up to the requested torque level (See *chapter 2.2*).

This operation is very important and the bolts must be tight enough to make the structure an integral unit.

Pay special attention to the longitudinal joints which are the ones that bear the loads.

In case of assembly of the culvert out of its natural site, it is necessary, after its positioning on-site by means of a suitable lifting gear, to tighten again all the bolts to the required tightening torque.

Lifting and handling of loads are always under the sole responsibility of the crane operator, as well as the following other operations :

- choosing a lifting machine with suitable capacity;

- choosing a lifting machine in compliance with the European Standard 2006/42/CE (with CE marking);

- submitting the machine to the controls and checks provided by the laws of the Member State in which it is used;

- using the machine in accordance with the manufacturer's operating instructions.

TUBOSIDER under no circumstances can be responsible for such liabilities as they fall into areas where it can not exercise any kind of control.

For culverts that can be inspected it is recommended that, once the technical block has been made, the tightness of the bolts be checked again and provision made, where necessary, to adjust the torques to the values prescribed.

4.3 Tolerances

The actual dimensions of the culverts, referred to the neutral axis, may differ from the theoretical ones within a tolerance of $\pm$ 2 %.

5.0 FORMING THE TECHNICAL BLOCK

The "**technical block**" is defined as the entire backfill that surrounds the culvert and which in fact contributes substantially to the static strength of the steel structure.

The technical block is made up of the bedding, the side embankments and the top covering.

The height "**H**" of the covering backfill, referred to the extrados of the culvert, is always specified and prescribed when establishing the dimensions of the structure, or indicated in the catalogue, for standard production culverts.

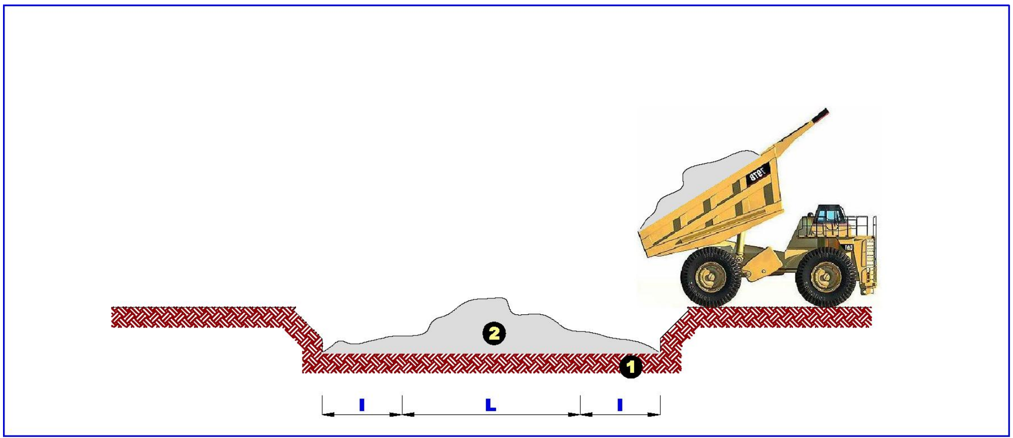
The technical block must be formed observing the height prescribed, according to the geometric and laying rules described below.

5.1 Preparing the surface on which the culvert will lie

5.1.1 Bedding

It is absolutely essential that the metal culvert be laid over an even, homogeneous, stable and resistant bed, avoiding rigid bottoms with asperity.

Under no circumstances should the structure be laid directly over a rocky bed or a concrete platform.



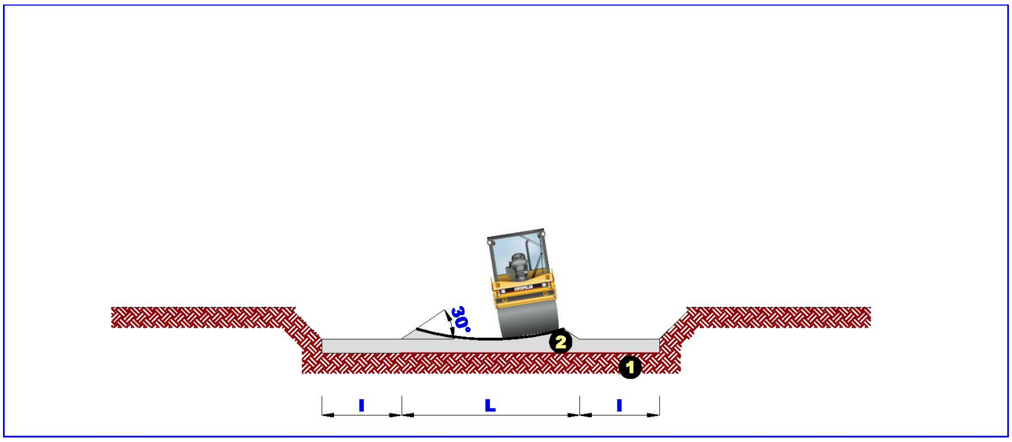
1	general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2	artificial foundation and bedding
l	≥ 1.00 m. on good ground - L otherwise
L	culvert span

The ground beneath the bedding must be able to guarantee enough support to prevent differentiated settling of the technical block in operation (as an indication, a load bearing capacity of at least 150 kPa is recommended).

For ground with weak capacity it is best to create a bedding using a cushion of compacted granular material, of a width at least three times the culvert span, of suitable depth, to ensure that the pressures are evenly distributed over the ground beneath.

Instead for rocky beds it is advisable to place a compacted granular material of 30 ÷ 40 cm. in depth between the structure and the base.

For the culvert bedding it is in any case recommended that the bed be profiled according to the curvature of the base plates of the structure.



1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2 artificial foundation and bedding
l ≥ 1.00 m. on good ground - L otherwise
L culvert span

This makes the subsequent burying phase easier, not having to fill in and compress the ground between the base of the structure and the bedding.

5.1.2 Presence of ground water

The presence of groundwater in the excavation areas is quite usual, especially when operating in specific geographical areas.

Through a preventive evaluation and an increased attention at the project phase, it is possible to prevent or partially solve the problems arising during the executive phase by defining the most adequate solution for drainage.

In presence of groundwater, in order to install the culverts, it is required to lower the ground water level below the excavation bottom.

In case of sandy or silty grounds, good results can be obtained by using a wellpoint system before the excavation; through this solution the excavation can be performed in conditions of dry ground.

In these cases, it is necessary to perform a preliminary study regarding the behavior over time of the water-bearing stratum, in order to perform the excavation when the stratum is poorer of water, according to the theoretical information deriving from the over-mentioned study.

In case of coherent grounds (not sandy nor silty), if the water drainage cannot be performed by means of a wellpoint system, it is necessary to proceed first with the excavation, and only in a later phase with the pumping.

The water must be pumped away gradually, in order to avoid the removal of solid fine-grained material from the ground.

In case of excavations having big dimensions, it is suggested to use a double row of wells, each row being opposite to the other and placed along the excavation sides.

Sometimes it is possible to obtain the same effect by using only a single row from one side, but it is necessary to pump away the water more deeply in the ground.

Usually there are two rows for big culverts and just one row for small pipes.

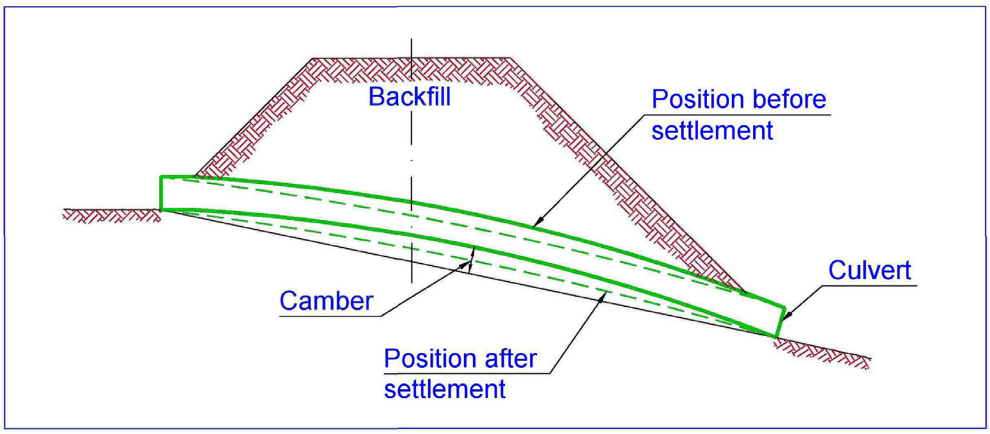
Those considerations are valid if the water bearing stratum is uniformly fed along the excavation section; if this is not the case, the water drainage solution must be studied case by case.

As a standard, **TUBOSIDER** requires the absence of water in the foundation ground, both of water flowing upstream (by diffuseness) and of groundwater; the ground load bearing capacity must be no less than 0.5 kg./cm^2.

A thorough geological analysis is required and additional considerations can be expressed only performing a specific planning of the intervention.

5.1.3 Settlement below the backfill load

When faced with large backfills it is a good rule to raise the centre of the artificial foundation.



One practical method is that of keeping the half uphill of the structure at a lesser angle than the downhill half, but being careful not to raise the centre too much to prevent puddles forming at the entry.
The value of the camber to be given to the central part of the structure, compared to the straight condition is between 0.5 ÷ 1.0 % of the length of the culvert.

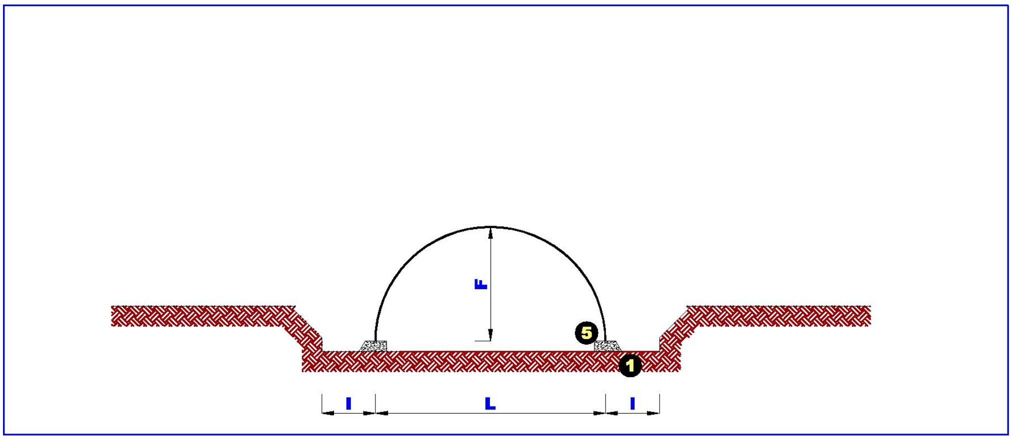
This procedure will guarantee the culvert, once it has settled, a constant slope therefore preventing any pools of water from forming inside it.

5.1.4 Foundations of arch sections

The foundations in reinforced concrete of the base channels of the metal structure must be sized by the client according to the "**Rh**" (horizontal), and "**Rv**" (vertical) loads derived from the design calculations.

Reinforcement should be improved adherence type B450C, while the concrete shall have a minimum resistance Rck minimo di classe C25/30.

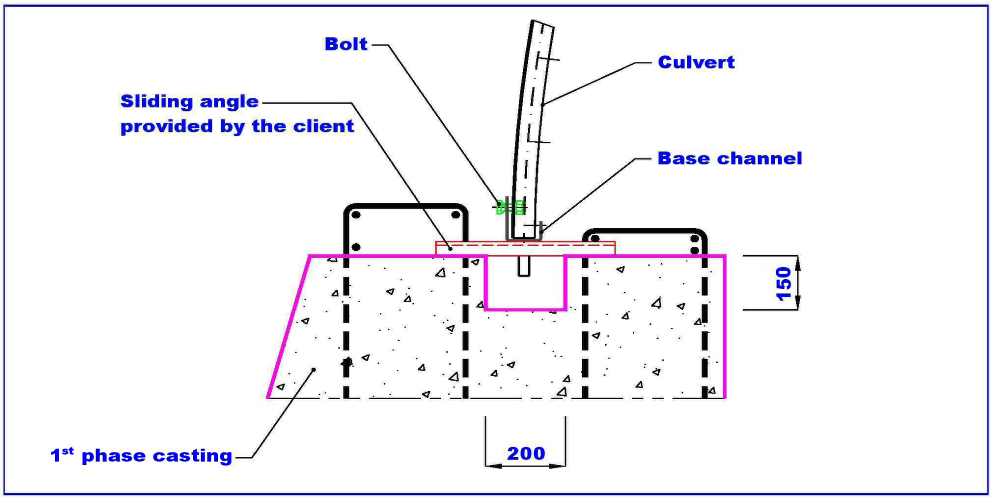
Depending on the capacity of the ground on site, the foundations in reinforced concrete can be formed of a single bed of reinforced concrete, or continuous beams in reinforced concrete.



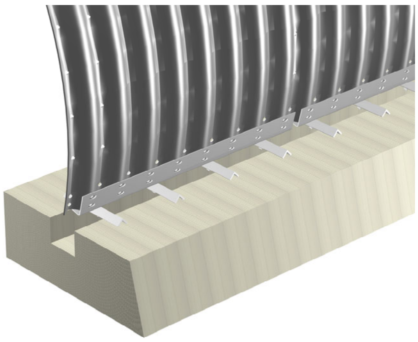
1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
5 foundation in reinforced concrete
I ≥ 1.00 m. on good ground - L otherwise
L culvert span
F culvert rise

In both cases, as for all rigid foundations, it will be necessary to prevent differential failures along the axis of the metal structure great enough to cause additional stress to the metal structure above.

The plates that form the feet of the arch will be equipped with base channels; as the structure assembly progresses these channels will be placed against the 1st phase casting by means of angle sctions or other suitable supports, to be supplied by the client.

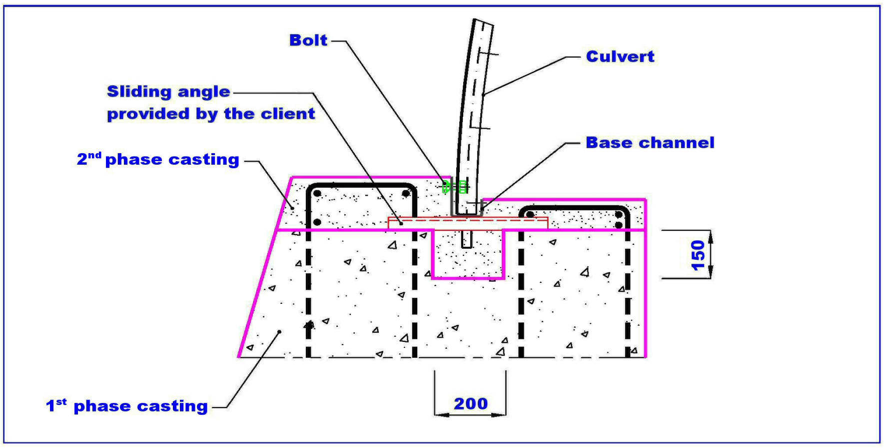


During the construction phase, it may be necessary to temporarily secure the base channels to the steel reinforcements either by spot welding or using steel tie wires to prevent them from sliding.



As the assembly progresses distances, measurements and diagonals will be checked to keep the channels perfectly parallel and coplanar with the rings of the structure which are at right angles to the channel line observing the measurements and indications given in the drawing that will be supplied by **TUBOSIDER**.

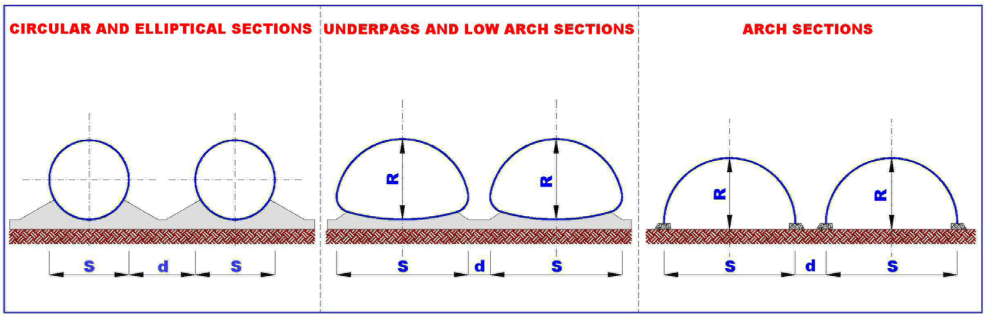
Once the arch has been assembled a final check will be made and if this gives positive results the arch can then be cemented to the base channel by carrying out the 2nd phase casting.



The arch can be buried once this casting has set.

5.1.5 Multiple installations

In order to allow adeguate compaction of the ground, when two or more structures are installed in sequence a minimum space must be left between the various pipes:



d ≥ • S/2 for circular and elliptical sections – minimum d 1.00 m.
d ≥ • S/3 for low arch and underpass sections – minimum d 1.00 m.
d ≥ • S/3 for arch sections – minimum d 1.00 m.

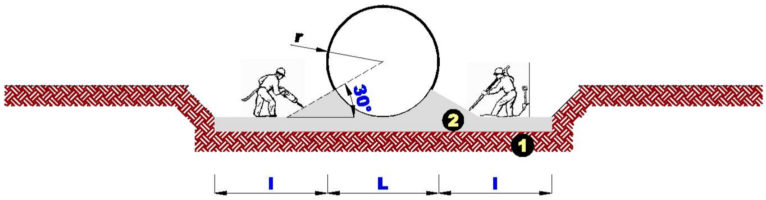
5.2 Side compaction and covering

5.2.1 In backfill

Special care should be taken over this operation, as the resistance of the culvert depends on the lateral support of the compacted ground around it.

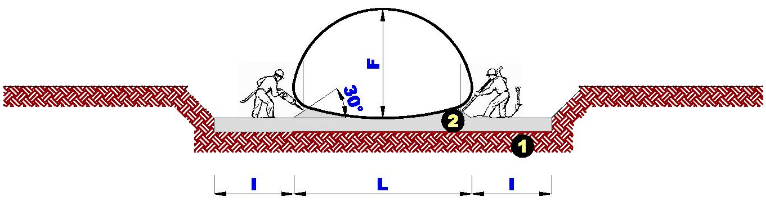
The material is initially laid in contact with the soil where it must be strongly compacted and wetted at frequent intervals (when the filling material is suitable), to enable it to penetrate:

- under the lower quarters of the circular section structure;

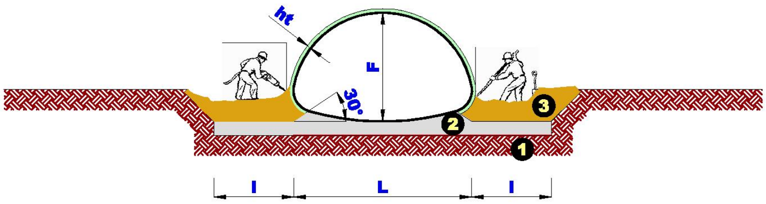


1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2 artificial foundation and bedding
r culvert radius
l ≥ 1.00 m. on good ground - L otherwise
L culvert span

- under the corner plates at the bottom for pipe arch or underpass structures;

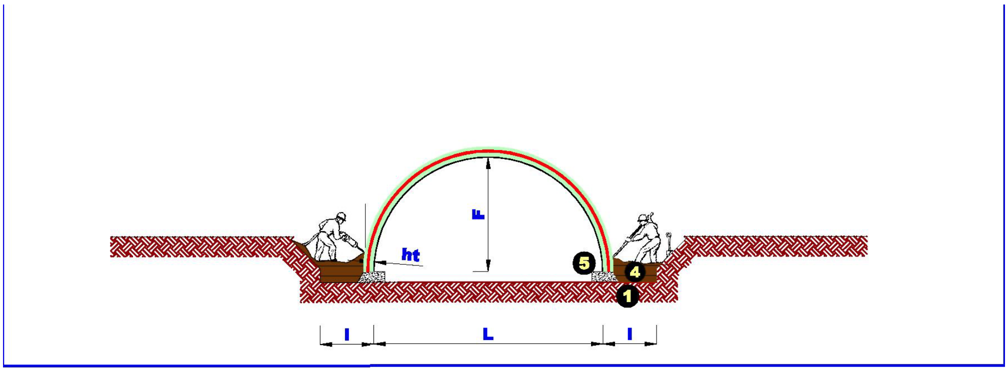


1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2 artificial foundation and bedding
l ≥ 1.00 m. on good ground - L otherwise
L culvert span
F culvert rise



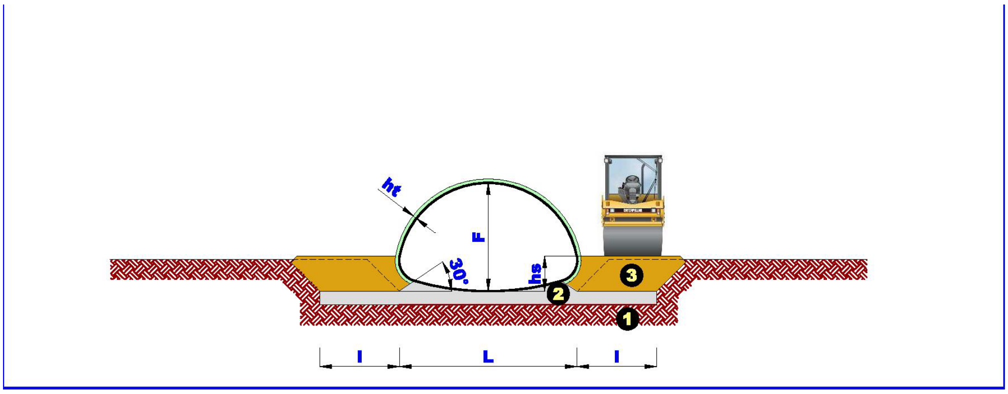
1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2 artificial foundation and bedding
3 side bank
l ≥ 1.00 m. on good ground - L otherwise
L culvert span
F culvert rise
ht 20 cm. sand ∅ max. 5 mm.

- on the natural existing bed for arch section structures.



1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
4 side retention backfill
5 foundation in reinforced concrete
l ≥ 1.00 m. on good ground - L otherwise
L culvert span
F culvert rise
ht 20 cm. sand ∅ max. 5 mm.

For polycentric sections, where the side bank is (**3**), a load bearing capacity of the ground of no less than 300 kPa (3 kg/cm^2), is prescribed, unless the specific design calculation report indicates differently.
In general, for all other type of culvert, the load bearing capacity of the ground where the side bank is should not be less than 150 kPa (1.5 kg/cm^2).

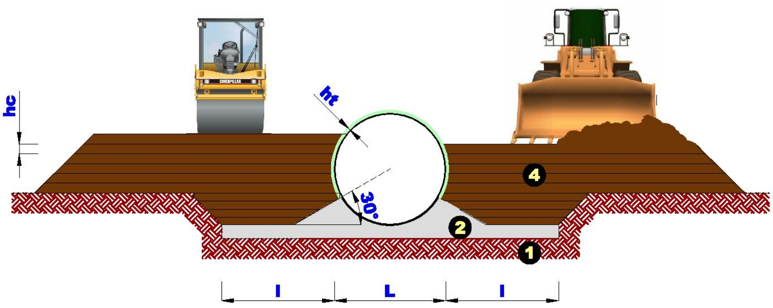


1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2 artificial foundation and bedding
3 side bank
l ≥ 1.00 m. on good ground - L otherwise
L culvert span
F culvert rise
ht 20 cm. sand ∅ max. 5 mm.
hs step height (base-corner-roof curvature radius change)

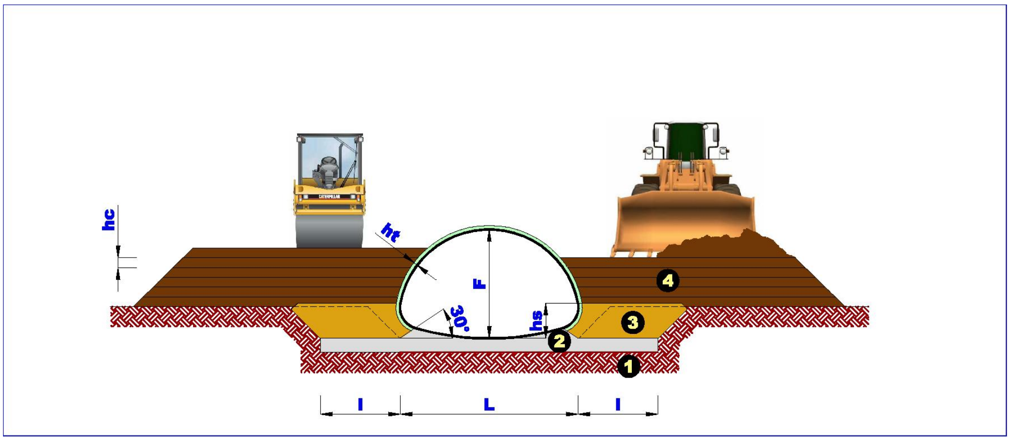
The compaction material must be laid and compacted in horizontal layers of a max. thickness of 20 ÷ 30 cm. (**hc**).

The layers must progress symmetrically, from one side of the culvert to the other, so that the burial level is always the same.

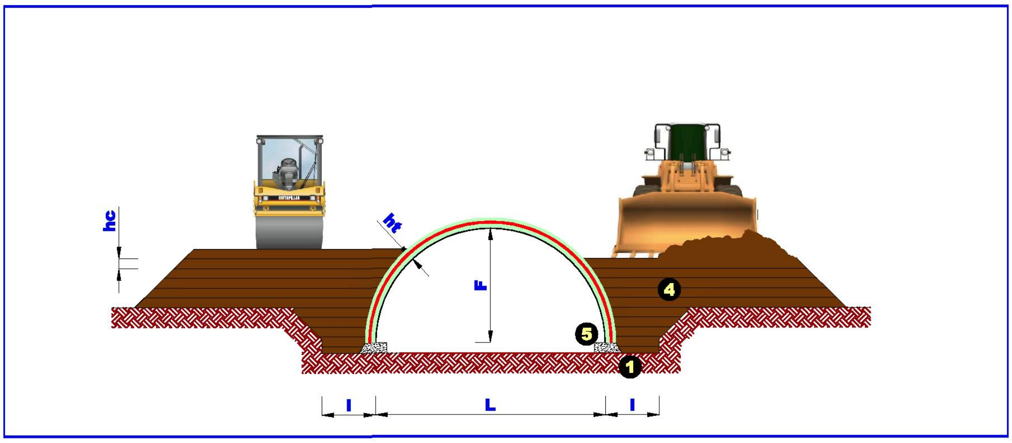
Where necessary or stated in the manufacturer’s specifications the compaction should be raised to 90 % of the maximum density given by the modified Proctor test, according to standard EN 13286-2.



1 general main embankment (level to be determined depending on the capacity of the ground on site, client’s responsability)
2 artificial foundation and bedding
4 side retention backfill
l ≥ 1.00 m. on good ground - L otherwise
L culvert span
ht 20 cm. sand ∅ max. 5 mm.
hc 20 ÷ 30 cm. max. height of the layer

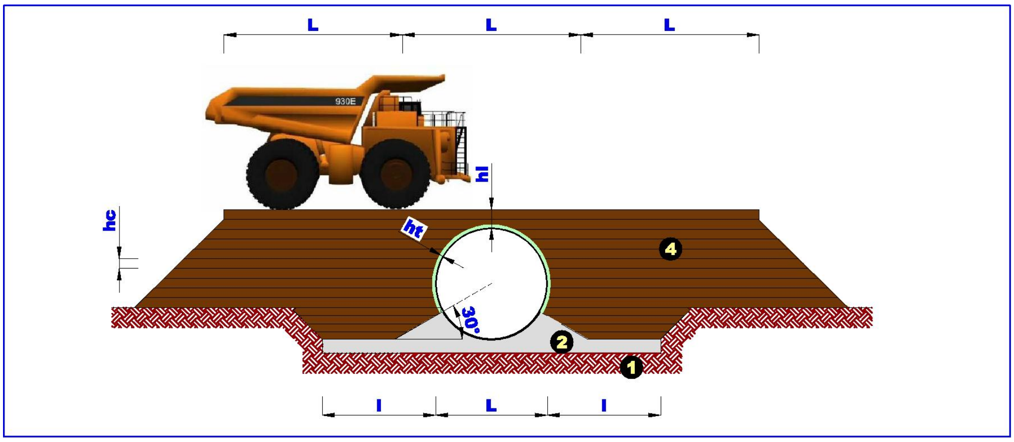


1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2 artificial foundation and bedding
3 side bank
4 side retention backfill
l ≥ 1.00 m. on good ground - L otherwise
L culvert span
F culvert rise
ht 20 cm. sand ∅ max. 5 mm.
hs step height (base-corner-roof curvature radius change)
hc 20 ÷ 30 cm. max. height of the layer



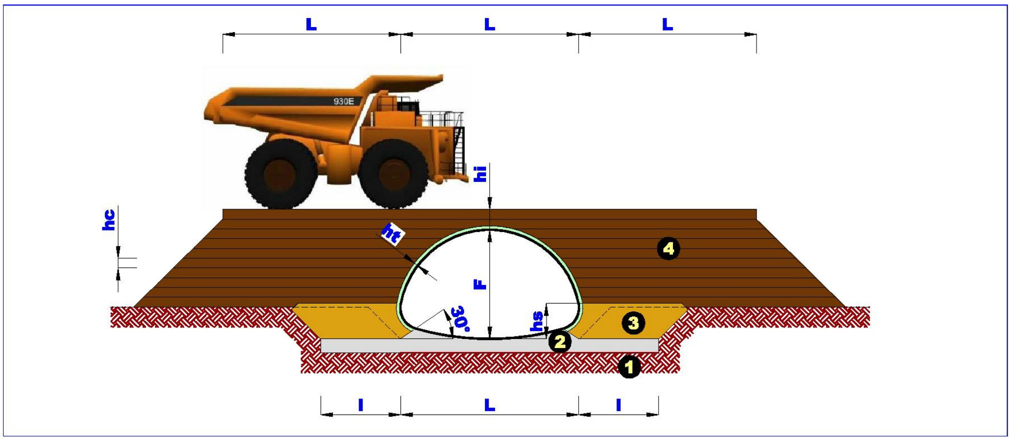
1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
4 side retention backfill
5 foundation in reinforced concrete
l ≥ 1.00 m. on good ground - L otherwise
L culvert span
F culvert rise
ht 20 cm. sand ∅ max. 5 mm.
hc 20 ÷ 30 cm. max. height of the layer

During the compaction phase it is advisable to take care when using heavy vehicles in proximity of the culvert, so that no damage is caused to it.



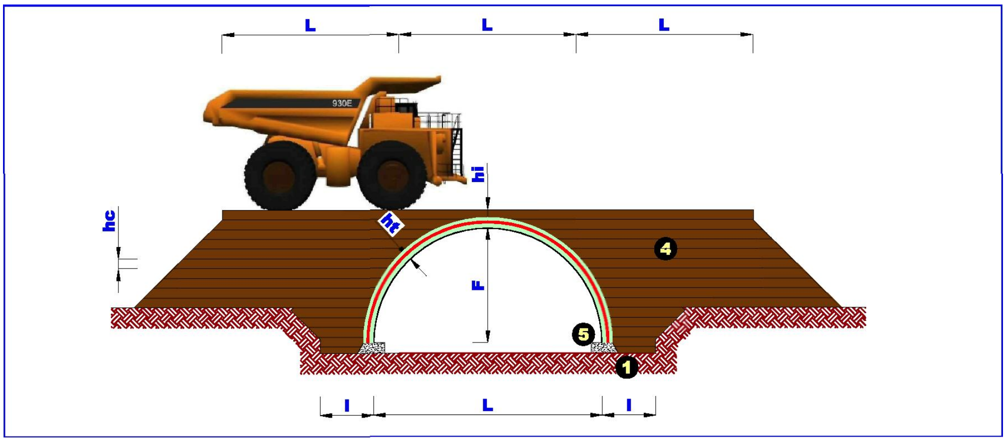
1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2 artificial foundation and bedding
4 side retention backfill
l ≥ 1.00 m. on good ground - L otherwise
L culvert span
ht 20 cm. sand ∅ max. 5 mm.
hc 20 ÷ 30 cm. max. height of the layer
hi minimum backfill height, in order to allow site vehicles to circulate

The minimum backfill height "**hi**", in order to allow site vehicles to circulate is always specified by the manufacturer or specified in the catalogue for standard production culverts.
At the culvert extrados the width of the technical block will be three times the span of the structure (**L**).



1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2 artificial foundation and bedding
3 side bank
4 side retention backfill
l ≥ 1.00 m. on good ground - L otherwise
L culvert span
F culvert rise

ht 20 cm. sand ∅ max. 5 mm.
hs step height (base-corner-roof curvature radius change)
hc 20 ÷ 30 cm. max. height of the layer
hi minimum backfill height, in order to allow site vehicles to circulate

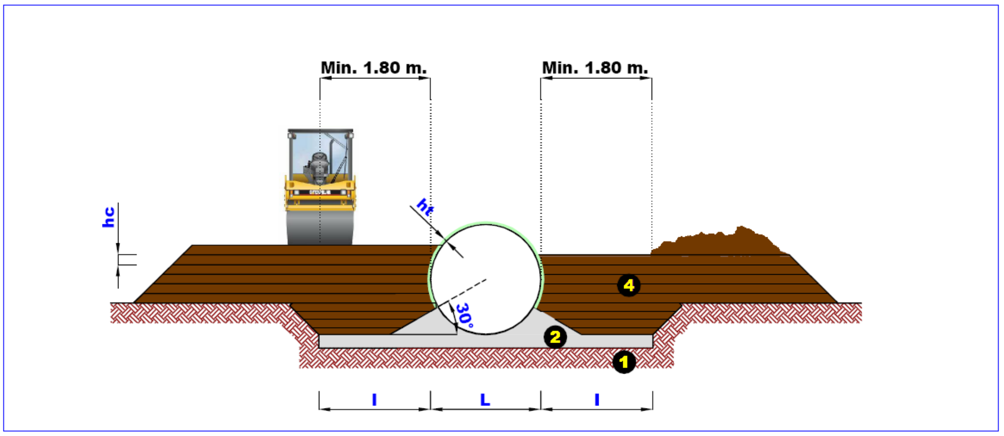


1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
4 side retention backfill
5 foundation in reinforced concrete
l ≥ 1.00 m. on good ground - L otherwise
L culvert span
F culvert rise
ht 20 cm. sand ∅ max. 5 mm.
hc 20 ÷ 30 cm. max. height of the layer
hi minimum backfill height, in order to allow site vehicles to circulate

The use of a compaction roller is recommended for compacting fine grade material and a compaction roller plus a rammer for granular mixes.

Rollers must not come near the structure as this may damage it.

Use manual rammers to compact the soil behind the culvert.



1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2 artificial foundation and bedding
4 side retention backfill
l ≥ 1.00 m. on good ground - L otherwise
L culvert span
ht 20 cm. sand ∅ max. 5 mm.
hc 20 ÷ 30 cm. max. height of the layer

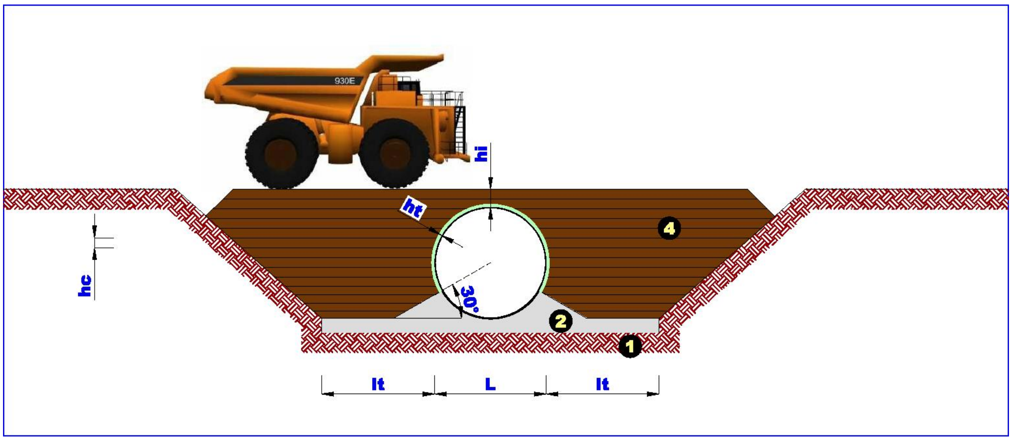
5.2.2 In the trench

The specifications illustrated in the previous *paragraph 5.2.1* apply, apart from the points raised here below.

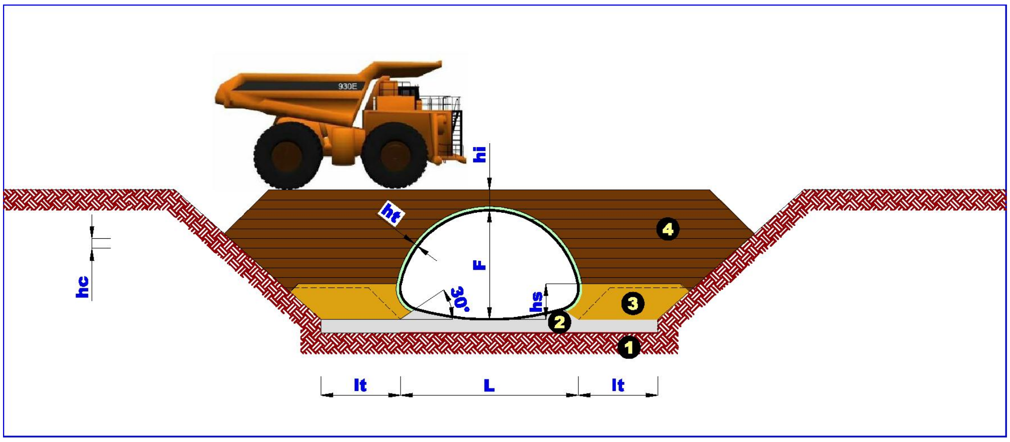
The technical block must have side banks of a width of at least 1.50 ÷ 2.00 m. (**lt**) (3.00 ÷ 5.00 m., for structures with spans ≥ 8.00 m.) and in any case banks of such a width that no compaction machinery can pass are not permitted.

The side walls of the trench must be judged as suitable for offering enough counter force to the force transmitted by the metal structure to the technical backfill surrounding it, as well as being suitable for compaction of the backfill itself.

If it is not, the walls must be remedied by excavating any material thought to be unsuitable and replacing it with material that conforms to the specifications of *chapter 2.4*.

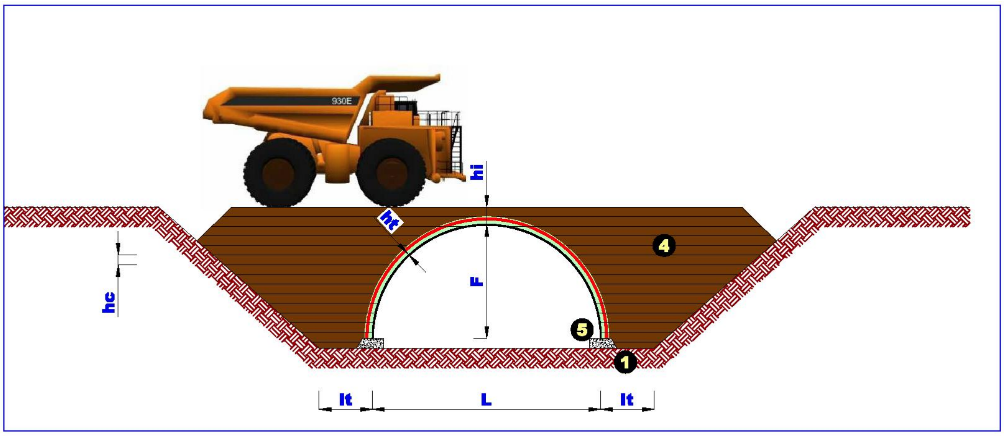


1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2 artificial foundation and bedding
4 side retention backfill
lt ≥ 1.50 ÷ 2.00 m. on good ground - L otherwise
L culvert span
ht 20 cm. sand ∅ max. 5 mm.
hc 20 ÷ 30 cm. max. height of the layer
hi minimum backfill height, in order to allow site vehicles to circulate



1 general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2 artificial foundation and bedding
3 side bank
4 side retention backfill
lt ≥ 1.50 ÷ 2.00 m. on good ground - L otherwise
L culvert span
F culvert rise
ht 20 cm. sand ∅ max. 5 mm.
hs step height (base-corner-roof curvature radius change)
hc 20 ÷ 30 cm. max. height of the layer

hi minimum backfill height, in order to allow site vehicles to circulate



- **1** general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
- **4** side retention backfill
- **5** foundation in reinforced concrete
- **lt** ≥ 1.50 ÷ 2.00 m. on good ground - L otherwise
- **L** culvert span
- **F** culvert rise
- **ht** 20 cm. sand ∅ max. 5 mm.
- **hc** 20 ÷ 30 cm. max. height of the layer
- **hi** minimum backfill height, in order to allow site vehicles to circulate

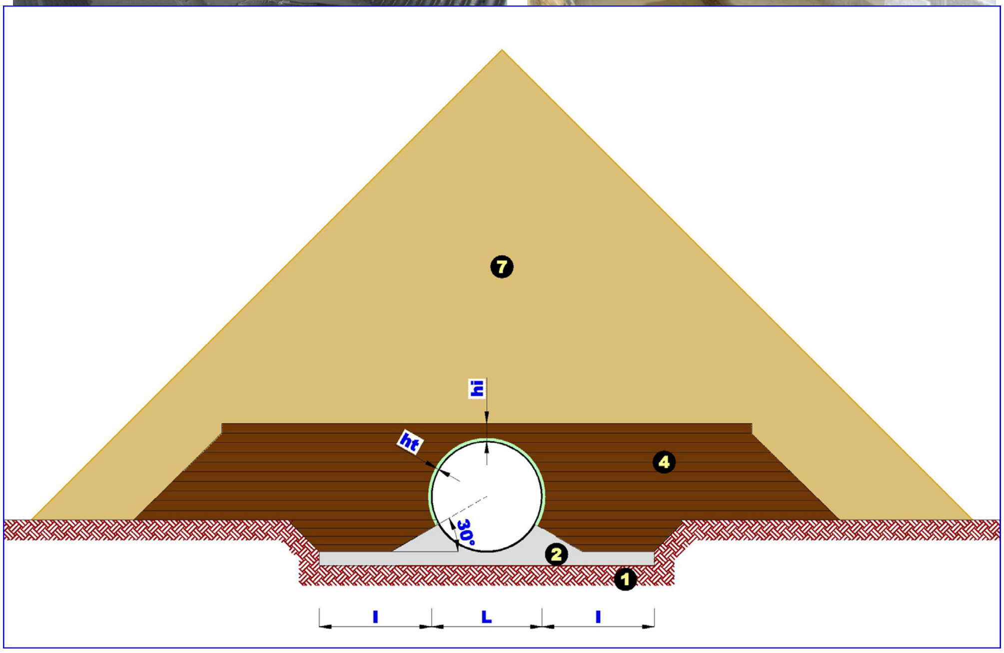
5.3 Special applications

5.3.1 In quarry

Culverts in a quarry should be covered with inert material to create the stockpile only once the technical block is complete.

Aside from this consideration, the technical block must be formed to the same specifications as those illustrated in *paragraph 5.2.1* and *chapter 5.1*.

If any equipment is to be installed inside the culvert, it must be ensured that this equipment is not compromised by any deformation that the structure may be subject to under load.



1	general main embankment (level to be determined depending on the capacity of the ground on site, client's responsability)
2	artificial foundation and bedding
4	side retention backfill
7	stockpile of inert material
l	≥ 1.00 m. on good ground - L otherwise
L	culvert span
ht	20 cm. sand ∅ max. 5 mm.
hc	20 ÷ 30 cm. max. height of the layer
hi	minimum backfill height, in order to allow site vehicles to circulate

If the technical block is properly formed deformations could also be up to 2% of the culvert theoretical rise.

It is recommended that spaces between the crown of the structure and position of the equipment be checked according to the procedures described in *chapter 6.3*, with reference to the actual span of the installed culvert.

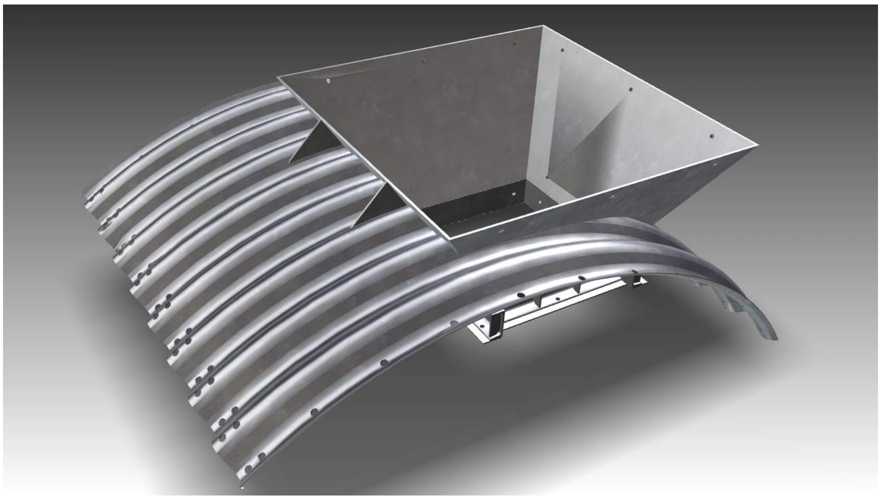
Installing the equipment inside the culvert as well as the laying of any concrete bases should only take place once the technical block is complete and after the tightening torques of the bolts have been checked again.

Where any openings are to be made in the crown, suitable reinforcing frameworks should be provided.

TUBOSIDER sizes the frames according to the specific needs of the client.

If the client carries out his own sizing and fixes the frame it is recommended that, as a minimum, the frame be connected to the structure by means of suitable continuous welds, on both the inside and the outside of the culvert, around the entire perimeter of the opening.
The welds must be perfectly executed by qualified welders, after the surfaces have been cleaned.

Restore the protective film by laying cold zinc and then coat the parts in question with epoxy resins.



5.3.2 Culverts with above average slope

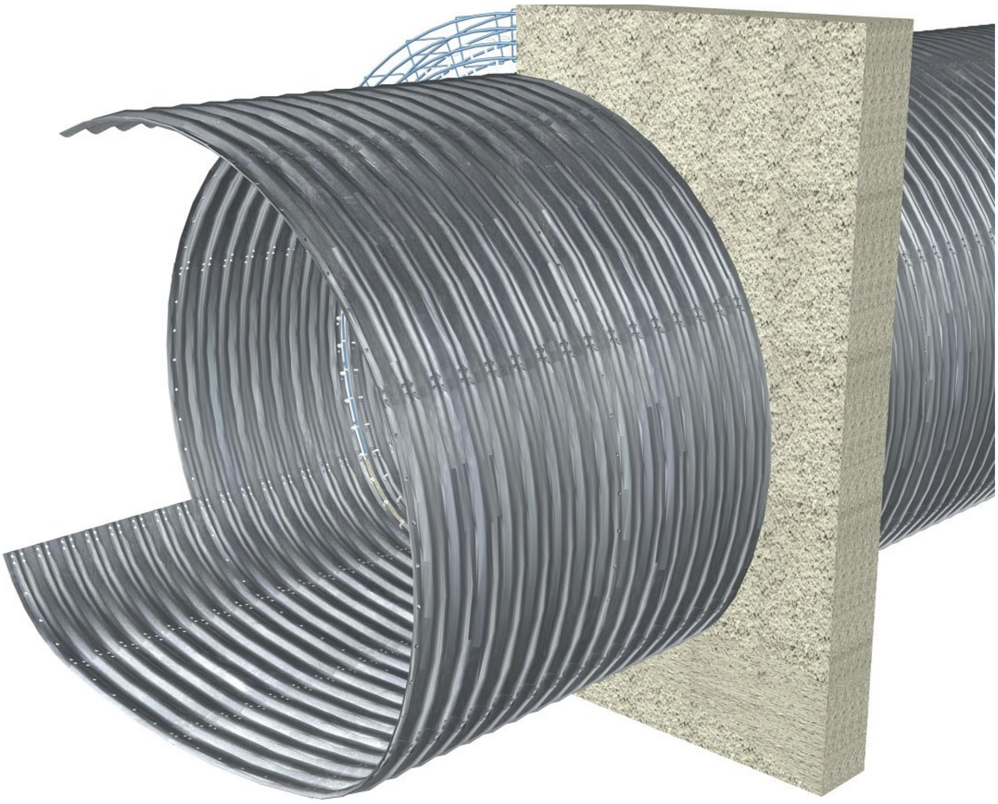
The behaviour and operating conditions of a culvert are not conditioned by the slope of the bed when the average slope of the longitudinal profile is less than 8 %, and this applies to the majority of structures.

For higher values, situations found if the drainage structures are on a hillside, in general it will be necessary to provide "special" devices, specifically designed and constructed with all due precision.

These special devices must ensure that with each slope change the continuity of the culvert is guaranteed and allow anchorage to the ground; they must be designed so that they adapt to the type of ground that forms the bedding, and to the material that makes up the backfill.

The most commonly used solution is that of head-walls and foundation seats in reinforced concrete, finished with a relative collar kerb to the culvert or with steel blades.

The number of seats should be decided on the basis of the soil characteristics, considering that they have to counteract the load generated by the backfill tending to slip downhill.



To improve anchorage between the culvert and the dividing walls threaded, anchor bolts will be needed for fixing, secured with double nuts.

Likewise if the slope of the metal culvert is to be maintained above average values consideration will have to be given to the possibility of taking measures to limit abrasion.

Therefore a concrete floor will have to be laid inside the metal culvert.

5.3.3 Installation of side

When a culvert is installed across the mountain it is therefore necessary to consider the following point :

a) general observance of the rules relating to the construction of the bedding , side compaction of backfilling and characteristics of the materials to be used according to our "ASSEMBLY MANUAL".

b) Adequate compaction of backfilling at the level of the corners at the base of the culvert , which is the critical point of the load transmission of the culvert to the surrounding soil.

   In particular we strongly recommend the realization of the laying surface profiled according to the radius of curvature of the base plates .

c) It is necessary to broaden the trench at downstream , in order to allow the better backfilling around this side and to permit an adequate passage of the mechanical means required for compaction works.

d) Given the excavating conditions of the transversal trench with respect to the line of the maximum declivity of the slope , it is recommended to extend the backfill enough on the downstream side of the culvert and this in order to avoid asymmetrical loads on the structure (dynamic thrust of the upstream backfill not sufficiently countered by the backfilling at downstream side) .

   When it is not possible to take this solution you should use some containment works on the downstream side of the culvert , such as reinforced concrete wall, gabions and reinforced earths.

   It is furthermore important to control and/or drain any precipitating water coming from upstream to avoid infiltrations in the backfilling with subsequent loosening of compaction .

e) We underline the need to control the shape and dimensions of the culvert during the whole burial phase through a system of measurements performed on

Correct installation

Incorrect installation

plumb lines positioned inside the culvert , which allow to evaluate both horizontally and vertically any dimensional variation of the profile of the section of the culvert with respect to the theoretical dimensions and eventual deviations of the culvert top from the longitudinal axis of the structure.

5.3.4 Temporary phases

All operations carried out in the time between the beginning and the end of assembly phases are defined temporary phases.

In particular the following temporary phases can be highlighted :

- culvert erection
- culvert placement in the designed position;
- technical cover carrying out.

The Company making the installation during temporary phases is responsible of the site as well as of the final success and good result of the culvert.

Therefore in case of damages to totally or also partially assembled culverts during temporary phases the Company is the only responsible one as all cautions and precautions shall be taken to prevent any form of damage to the culvert.

Here below the particular assembly situations that require a special care by the Company:

- installation in trench with ground water table;
- installation in water collection zones or drainage zones, and surrounding areas water collection;
- installation under road cover (in case of road carriageway enlargement) made in different lengths crosswise the road and in the culvert longitudinal way.

5.3.4.1 Installation in trench with ground water table

In case of ground water table the requirements specified in paragraph 5.1.2 of this "ASSEMBLY MANUAL" shall be followed.

5.3.4.2 Installation in water collection zone or drainage zones and surrounding areas water collection

In case of risk of flooding of the installation area, being in water collection zones or in presence of ground water table , it is necessary , during the assembly phase , to fix the structures to the basement if any , or to ballast them to the ground because , where the technical cover is not completed , the culverts , due to their lightness , could be moved or damaged by the strength of current water .

The fixing to the basement or to precast concrete blocks forming the anchor ballast , is done by means of steel wire ropes to be calculated from time to time depending on the weight of the culvert, on its shape and on the height of the head of water.

In case it is not possible to perform ballasting to the ground, temporary banks shall be built around the structure in order to protect it, preventing it from being flooded , and avoiding that culvert moves from the installation point and becomes deformed and damaged, due to the strength of the water flow.

5.3.4.3 Installation below the road embankment performed in different phases, in crosswise the roadway and longitudinally to the culvert

An example of such an installation can be a culvert realized perpendicularly to the longitudinal axis of the embankment of a highway formed by two carriageways, in which the first part of the culvert and of the embankment (technical block) is implemented below the first roadway and opened to the passage of vehicles above, with the subsequent installation of the second part of the culvert below the embankment of the second carriageway.

In such a situation it is necessary to realize the technical block of the first part of the culvert in accordance with the requirements set out in Chapter 5.0 of this "ASSEMBLY MANUAL" .

The area of connection between the first part of the culvert and its second part, is made, in a transition phase, by a free end, as both the second portion of the culvert and the technical block (road embankment) are missing; in such a situation the extremity must anyway be protected in accordance with paragraph 5.3.5 of this "ASSEMBLY MANUAL".

5.3.5 Provisional water-crossings

The project for the construction of a provisional ford, realized with load-bearing galvanised steel multiple-plate structures to allow the connection among two banks during the realization of the principal works, and acting as access road to the yard in the river bed for the operational means of the job contractor, involves at the same time different types of works to be developped in various phases.

The installation of pipelines in streams or in river beds must herefore take place in the manner specified here below in order to avoid static problems.

Installation phases :

- steel culvert erection in a dry and flat place
- transportation of the steel culvert to the installation place by homologated excavator or truck equipped with a crane;
- formation of the culvert laying bed without water coming from the ground water table or from the river bed;
- laying of the culvert on the bed previously made;
- construction of head-walls in reinforced concrete and concrete platforms for the entry and exit of water from the pipes, in order to prevent the compacted backfill surrounding the culvert from being washed out;
- compacted backfilling according to TUBOSIDER's prescriptions;
- tightening of the bolts by means of a torque wrench "dynamometer" , before technical block is carried out.

Particular attention should be paid during culvert laying in the riverbed that must be completely dry and made below the water level.

Culvert laying on a bed with water or with wet material may generate a deformation of the culvert itself and a settling of the entire backfill.

The presence of flowing water does not allow a compacting of the material according to the prescriptions of **TUBOSIDER**.

For the construction of fords and for culvert laying in the a river bed, **TUBOSIDER** recommend to perform the work in two phases.

In the first phase an earth barrier (riverbank) shall be built crosswise half width of the riverbed, upstream the area where the ford is made, suitable to deviate the course of water in the second half of the water course.

After the earth barrier is built and the part of riverbed for culvert (protected by the barrier) laying is dry the installation of the culverts takes place in accordance with the a.m. instructions.

On phase completion the earth barrier must be removed allowing water to flow inside the culverts.

In the second phase an earth barrier (riverbank) shall be built crosswise half width of the riverbed, upstream the area where the ford is made, suitable to deviate the course of water inside the culverts installed in the first phase.

After having deviated the course of the riverbed inside the culverts pleased proceed with the same steps described above for the construction of the first part of the ford.

Please note the importance of laying culverts in absence both of groundwater and of river water.

The Contractor must anyway build an embankment upstream the culvert laying area, and if deemed useful also downstream and laterally in order to avoid flooding of the working area, and culvert laying during river flooding and in case of intense meteoric precipitations.

To this end it is essential to have pumping systems or emergency forced draining systems able to avoid the flooding of the area by pumping the water outside the zone.

The realization of the ford in two or more stages allows anyway to preserve the fish fauna, because the drying up of the river stretch is performed, where technically possible, by slow and progressive water flowing.

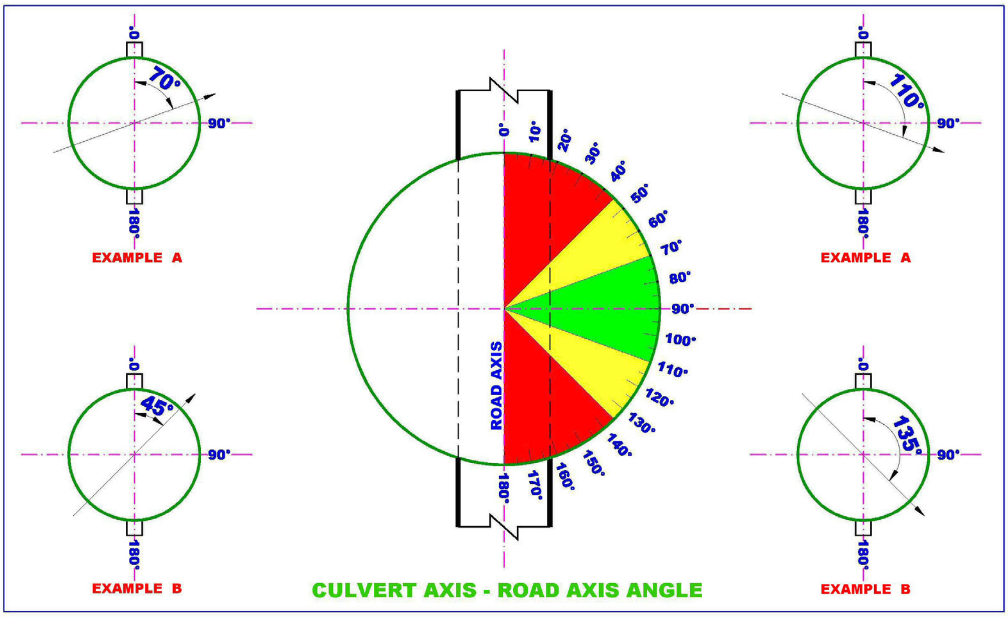
Drying up is carried out by the execution of a small channel dug by moving the bottom of the riverbed in order to cause a slow and gradual water flowing enabling the fish fauna to flow downstream and out of the working areas.

5.3.6 Protecting the ends

The ends of culverts installed under backfill with a longitudinal axis at right angles or at an angle in relation to that of the roadway, can be cut according to the slope of the escarpments of the backfill itself in order to follow the shape of the road.

At these ends, because of the cut the complete culvert ring closure is missing and consequently so is the thin ring static regime in simple compression.

Therefore to prevent the deformation of these ends, the free length of cut of the structure must be kept within acceptable limits, taking into account the skew angle between the longitudinal axis of the culvert and the axis of the roadway (measured counter clockwise) between:



Example A

- 70° ≤ skew ≤ 110°

no reinforcement at the ends needed.

Example B

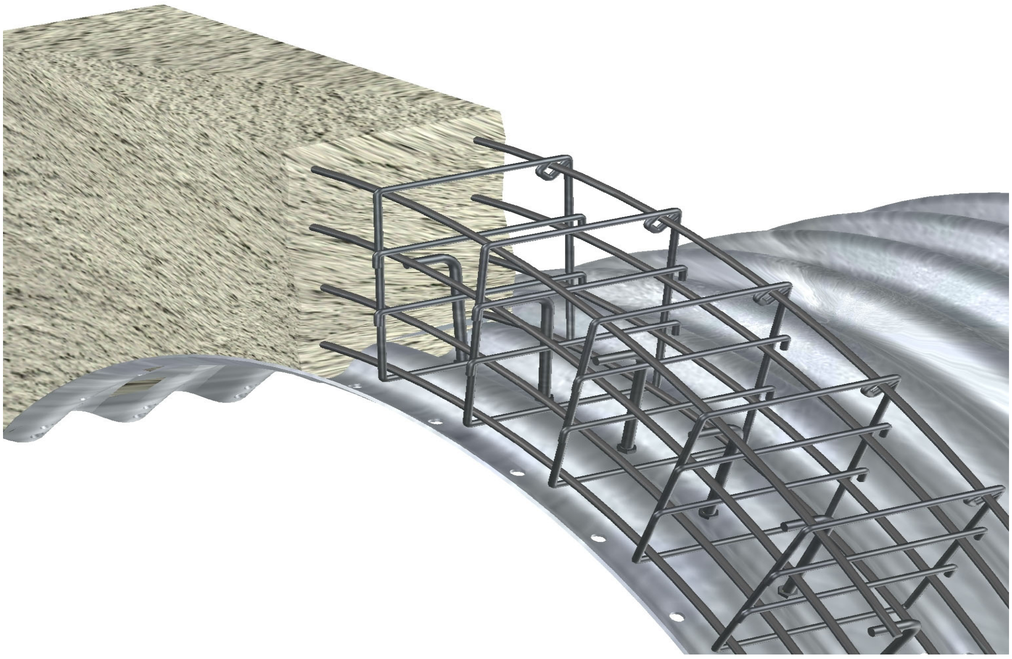
- 45° ≤ skew ≤ 135°

reinforcement at the ends needed with structures subject to special studies, such as collar beams in reinforced concrete anchored to the metal structure by means of anchor bolts.

- 45° ≥ skew ≥ 135°

contact the **TUBOSIDER** Technical Department.

The purpose of the collar beam in reinforced concrete will therefore be to prevent the cut metal parts at the end of the pipe from flexing towards the inside of the structure, due to the thrust of the soil that makes up the backfill at the ends of the structure.



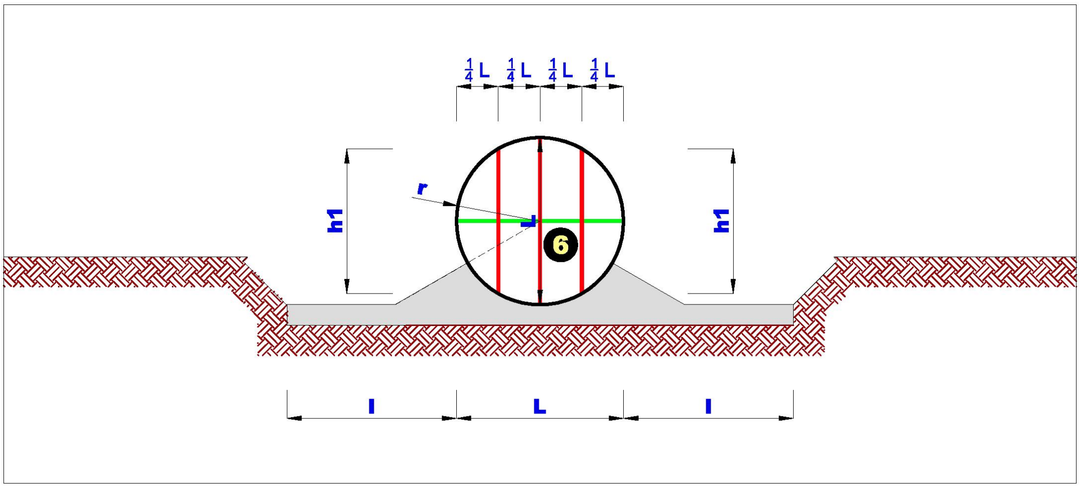
Reinforcement should be improved adherence type B450C, while the concrete shall have a minimum resistance Rck minimo di classe C25/30.

If the culverts are used for hydraulic applications, the ends of the structures must be protected by head-walls in reinforced concrete and draft mats for the entry and exit of water from the pipes, in order to prevent the compacted backfill surrounding the culvert from being washed out.

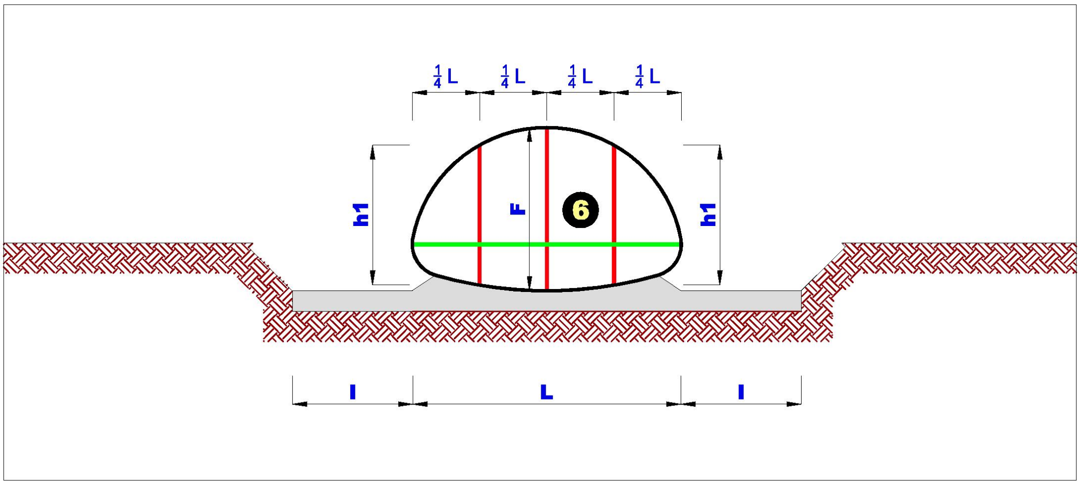
6.0 CHECKS

6.1 Dimensions of the culvert

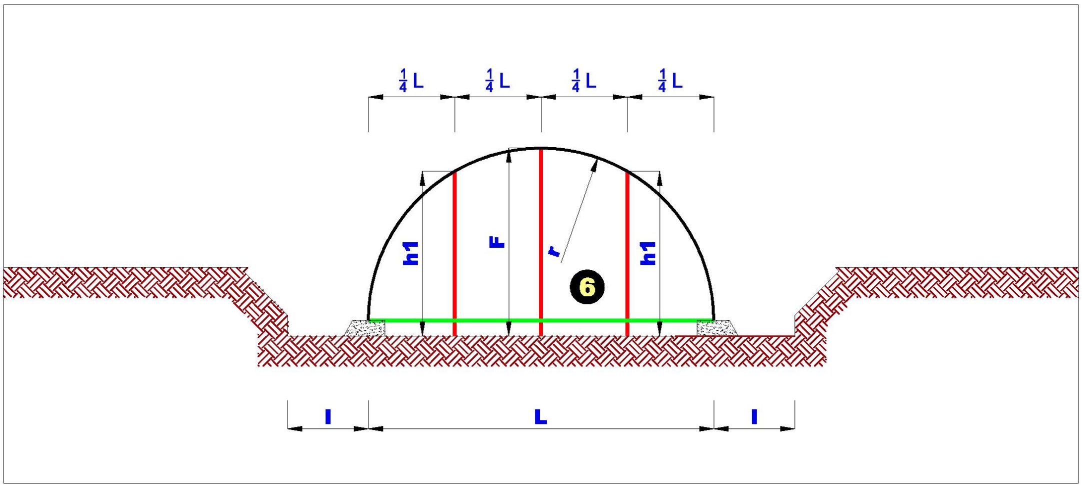
While making the backfill, the dimensions of the structure must be checked in order to prevent excessive deformation.



6 positioning of plumb lines
l ≥ 1.00 m. on good ground - L otherwise
L culvert span – horizontal and vertical measurement
h1 vertical measurement
1/4L distance between vertical measurements



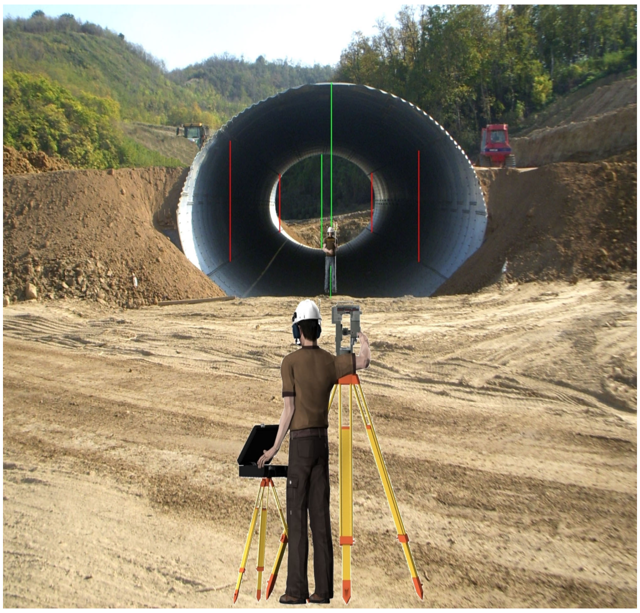
6 positioning of plumb lines
l ≥ 1.00 m. on good ground - L otherwise
L culvert span – horizontal measurement
F culvert rise – vertical measurement
h1 vertical measurement
1/4L distance between vertical measurements



6 positioning of plumb lines
l ≥ 1.00 m. on good ground - L otherwise
L culvert span – horizontal measurement
F culvert rise – vertical measurement
h1 vertical measurement
1/4L distance between vertical measurements

This check can be carried out through a system of measurements taken during the burial phase, to identify horizontally and vertically at various points of the structure the dimensional variations compared to the theoretical measurements of the pipe and those found once assembly is complete (i.e. before commencing burial).

Normally plumb lines (**6**) are dropped inside the arch at various key points of the structure, which with constant monitoring during the burial phase allow the side shifts (right-left) of the structure axis and the vertical drops and rises in the crown of the structure to be evaluated, at the same time permitting adjustments to the compaction to correct these deformations.



Alternatively, you can use them with qualified personnel topographic measurement tools.

Checking the dimensions, to be carried out by the Director of Works, should prevent that during the burial phase the culvert becomes so deformed as to change the shape of the structure from its theoretical one with the tendency of the structure walls to lose their original curvature radius.

In particular it is necessary to prevent the formation of cusps towards the interior of the structure, that is, rotations of the plates at the joints providing bolted to re-tighten, where necessary, the bolts of joint that may be subject to loosening during burial.

With reference to the burial diagrams for the structure and compaction of the technical block, we emphaisize once again that, in laying and compacting layers of soil, deformations of the metal structure could take place limited to below 2 % of the theoretical rise of the culvert.

Greater deformations can be attributed purely to incorrect formation of the technical block.

The steel structure is in any case able to flexibly withstand deformations below 5 % of the true rise of the culvert.

For the express purpose of preventing any technical problems or even exceeding the prescribed deformation limits, the dimensions of the culvert must be measured when forming the technical block (before, during and after), in order to monitor the behaviour of the structure.

For the culverts having small dimensions (<2.0m both in terms of diameter or span L and rise F) that don't allow the operator to perform an inspection in safe conditions and/or install the necessary measuring instruments, at the decision of the Third Party Engineer, such checks can be avoided; in these particular situations Tubosider SpA recommends the following checks (geometrical and visual) :

- values of chord and rise of each plate (indirect check of the bending radius) before performing the assembly
- geometry/shape of the section at the level of the ends once the assembly is completed (before backfilling) and then during the different phases of backfilling

- alignment of the plates connections (once the assembly is completed before backfilling)

6.2 Compaction and load bearing capacity of the technical block

Checking the quality and perfomance of the technical block must be carried out by means of laboratory tests on the materials used to create it and, on site, on each individual finished layer, once laid and compacted.

A check must be made that the material granulometry conforms to what is prescribed in *chapter 2.4*, taking samples of material to be subjected to laboratory tests aimed at identifying geometric, mechanical and chemical properties.

The Proctor compaction test, modified according to AASHTO, on the materials that form the technical block must be verified in the laboratory according to EN 13286-2 and then confirmed on site, with samples taken of each layer, using suitable equipment for measuring the density on site (for example: calibrated sand method).

It must be ascertained that the density on site reaches at least 85 ÷ 90 % (according to the contractual specifications) of the maximum found in the laboratory.

In general the value of 21,0 kN/m^3 is taken as typical of the maximum Proctor density measured in the laboratory and on site comparison of 85 % (17,9 kN/ m^3) or 90 % (18,9 kN/ m^3) is expected.

The load bearing capacity of the soil must also be measured for each individual layer of soil by means of a load test on a circular plate aimed at verifying the modulus of elasticity of the soil, the pressures and yields, the modulus of deformation $E_{v2} \geq 100$ MN/m^2 (100 MPa) and with ratio $E_{v2} / E_{v1} \leq 2.15$, according to DIN 18134.

The requisites of the relationship E_{v2} / E_{v1}, according to the granulometries of the compacted grounds, should be included in the values here below :

- ≤ 2.0 fine-grain soils
- ≤ 2.2 a 2.6 large-grain soils
- ≤ 3.0 mixed fine-grain soils
- ≤ 4.0 rock as filling material

Higher ratios compared with the a.m. values indicate that the soil is not compacted properly.

Depending on the length of the culvert and on the number of layers, a congruous number of samples and tests must be carried out.

A minimum number of tests for each layer of soil laid should in any case be carried out.

Documentation regarding the tests carried out and the succession of works phases (photographic documentation) must be kept and made available in the event of any structural malfunctions in order to identify better the possible causes and solutions.

6.3 Deformation under load

The vertical drop of a culvert is an important parameter to take into account when determining the camber to be applied in the mid point, or when there is the need to limit deformation of the structure or to prevent a vertical drop in the surface soil.

Ii is a good rule to take the vertical deformation of the structure as being equal to the vertical drop of the ground.

The vertical drops of the soil, under a given load, can only be determined by a knowledge of the tension – deformation ratio of the soil itself.

It is therefore essential to know the modulus of elasticity of the soil in relation to the compaction to be carried out during installation, the loads and the consequent pressures caused by the height of the backfill.

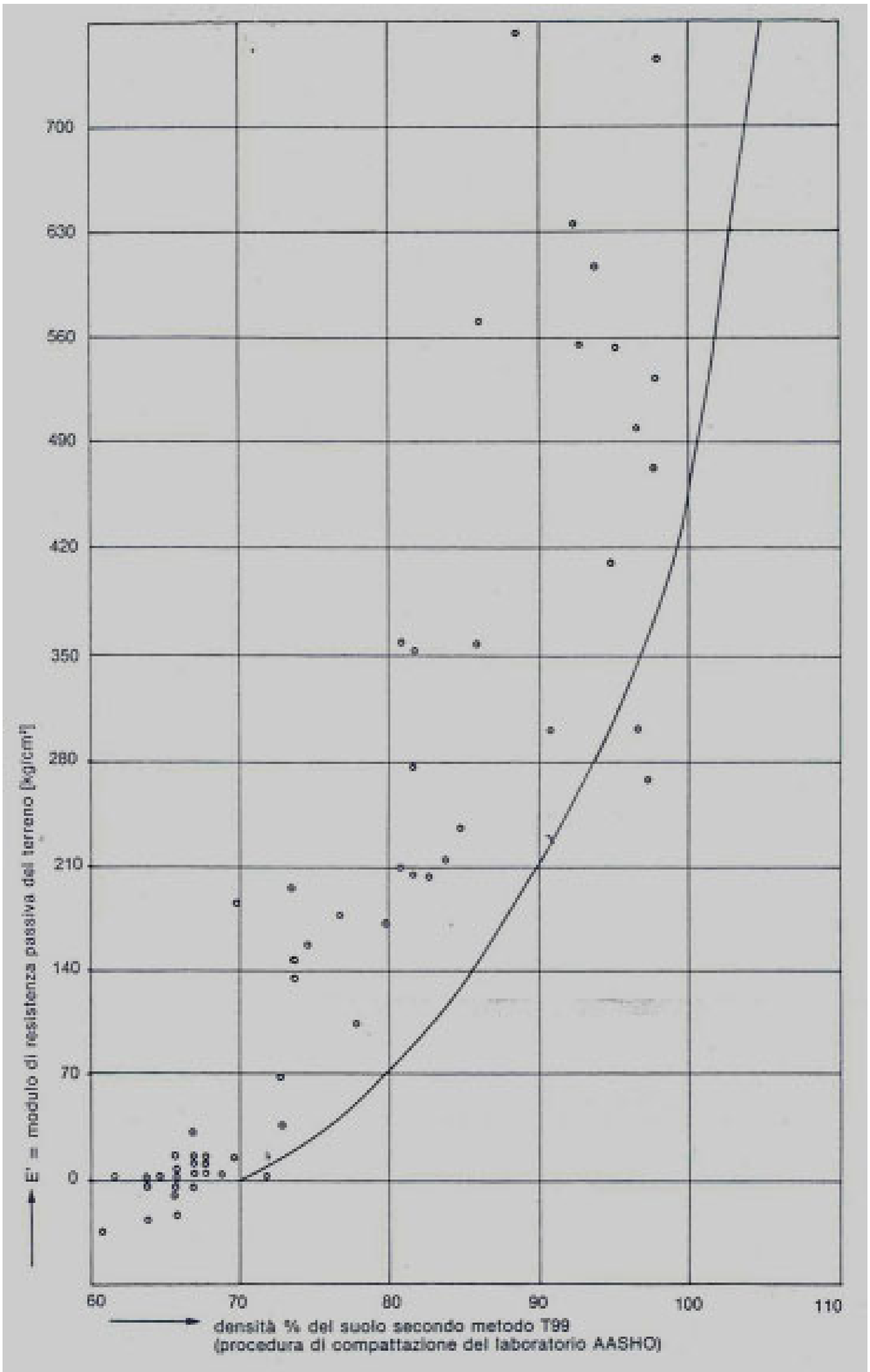
The maximum culvert deformation according to the Spangler-Jowa formula is calculated as follows:

$$\eta = Fd \cdot Fk \frac{W \cdot r^3}{(E \cdot I) + 0.061 \cdot (E' \cdot r^3)}$$

where:

- η culvert deformation
- **Fd** 1.25 soil creep coefficient
- **Fk** 0.1 installation angle constant
- **r** radius or ½ span of the culvert
- **W** 2r (PS+PD) K vertical load per longitudinal centimetre of culvert
- **PS** static load (kg./cm^2)
- **PD** dynamic load (kg./cm^2)
- **I** moment of inertia of the corrugation (cm^4/cm.)
- **E** 2039400 modulus of elasticity of the steel (kg./cm^2)
- **E’** compressibility modulus of the soil (taken from the graph that follows)

For installations of significant importance it is better to take the value of **E’** depending on the results of the laboratory tests on the soil samples actually used to obtain the Standard Proctor compaction required.


700
630
560
490
420
350
280
210
140
70
0
E' = modulo di resistenza passiva del terreno [kg/cm²]
60
70
80
90
100
110
densità % del suolo secondo metodo T99
(procedura di compattazione del laboratorio AASHO)

7.0 RESPONSIBILITY

The sizing of the metal structures in corrugated steel is carried out following the project characteristics indicated by the client.

The calculations used follow the Construction Science criteria with special reference to calculation theories developed on these structures, and in accordance with the applicable laws.

The height "**H**" of the covering backfill, referred to the culvert extrados, is always specified by **TUBOSIDER**:

- in the catalogue for standard production culverts;
- in special technical documentation enclosed with the sales contract for culverts not in the catalogue.

The following fall outside the responsibility of **TUBOSIDER**, and are the client's responsibility:

- an evaluation of the load bearing capacity of the soil on which the structure will be laid;
- the choice of materials that make up the technical block, and their putting in place;
- execution of the burial phases, and the relative compaction of the technical backfill;
- observation of the directions given in this manual.

The presence of a **TUBOSIDER** representative on site in no way absolves the client from the above stated responsibilities.

8.0 CERTIFICATE OF CONFORMITY OF THE FACTORY PRODUCTION CONTROL

IGQ

ISTITUTO ITALIANO DI GARANZIA DELLA QUALITÀ

Certificate of conformity of the factory production control

1608 CPR P126

In compliance with Regulation 305/2011/EU of the European Parliament and of the Council of 9 March 2011 (the Construction Products Regulation or CPR), this certificate applies to the constructions product:

Steel structural components
Steel corrugated plates for load bearing structures

whose characteristics are detailed in the attached annex,

produced by or for

Tubosider Spa

Corso Torino, 236 14100 Asti - IT

and produced in the manufacturing plant(s)

CBS Monticello d'Alba CN - IT

This certificate attests that all provisions concerning the assessment and verification of performance described in Annex ZA of the standard

EN 1090-1:2009+A1:2011

under system 2+ are applied and that

the factory production control fulfils all the prescribed requirements set out above.

This certificate was first issued on **20/12/2012** and will remain valid as long as the test method and/or factory production control requirements included in the harmonized standard, used to assess the performance of the declared characteristics, do not change, and the product, and the manufacturing conditions in the plant are not modified significantly.

Current issue: **25/06/2018**

The Director
Ing. Dario Agalbato
Dario Agalbato

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9.0 APPENDIX TO CERTIFICATE 1608 CPR P126

IGQ

ISTITUTO ITALIANO DI GARANZIA DELLA QUALITÀ

APPENDIX TO CERTIFICATE **1608 CPR P126**

Design[1)] and manufacture of multiplate corrugated steel for load bearing structures according to EN 1090-1

Product name	Standard	Class of steel	Class of execution	Sizes	Delivery condition
Steel corrugated plates	EN 1090-2	EN 10025-2: S235JR EN 10149: up to S355 MC	EXC2	T70 - T100 -T150 - T200	Hot dipped galvanizing in accordance to EN ISO 1461
Bolts and threaded bars in accordance to Tubosider Spa drawing	Screw EN ISO 898-1 Nut EN ISO 898-2	Class of resistance 8.8		From M12 to M20	

Note 1): The applicability of the design shall be checked in compliance with the technical rules of each EU Member State.

first issue: 20/12/2012
current issue: 25/06/2018

Il Direttore
ing. Dario Agalbato
Dario Agalbato

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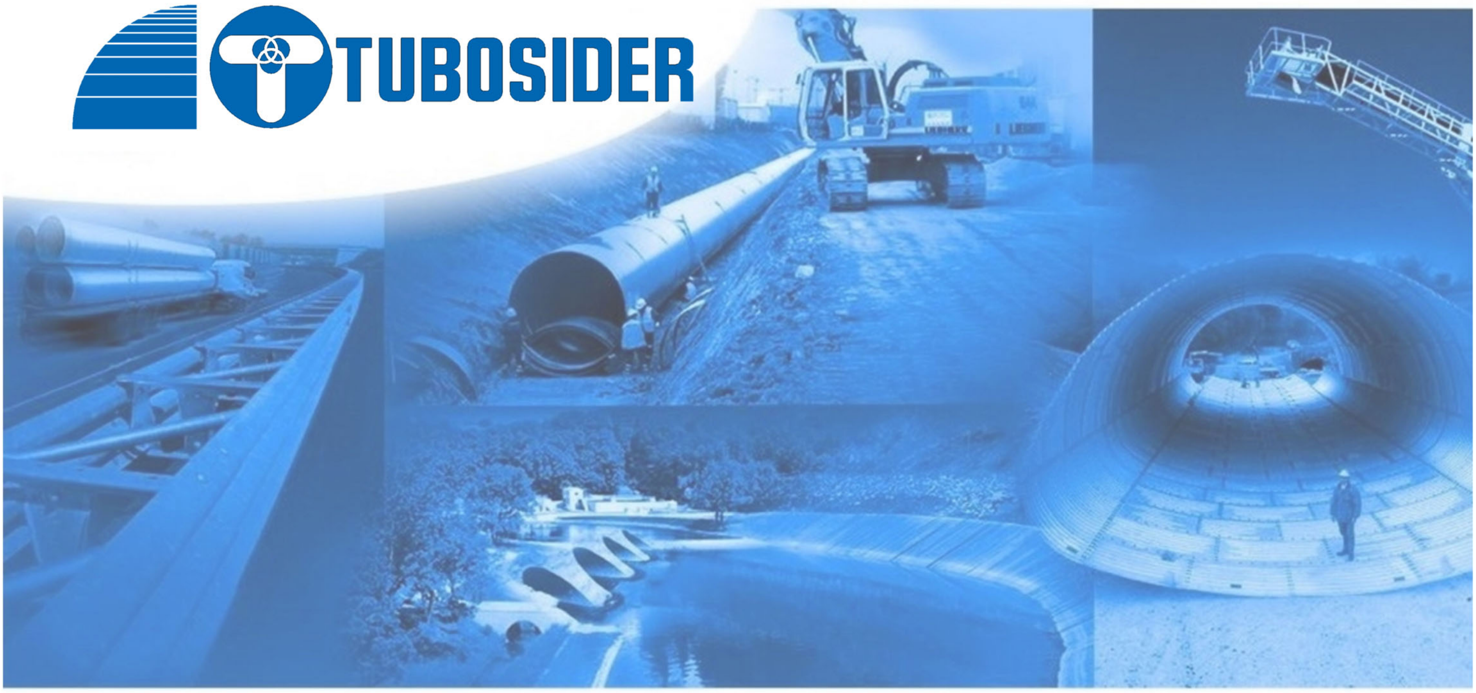
10.0 NOTE



"As the product is subject to continuous improvements, it is recommended that the user, before ordering, verifies with the Technical Department if the information contained in this document is updated".

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PREMIO
CIVILTÀ DEL LAVORO

Cod.Fisc. e P.IVA 03141780019
P.IVA Intracomunitaria IT 03141780019
Cap. Soc. Delib., Sott. e Versato € 10.000.000,00
Iscrizione Reg. Imprese Cuneo al n. di Cod. Fisc. 03141780019
Iscrizione R.E.A. della C.C.I.A.A. Cuneo al n. 218830
Tubosider S.p.A.
società soggetta alla direzione ed al coordinamento di Itinera S.p.a.

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