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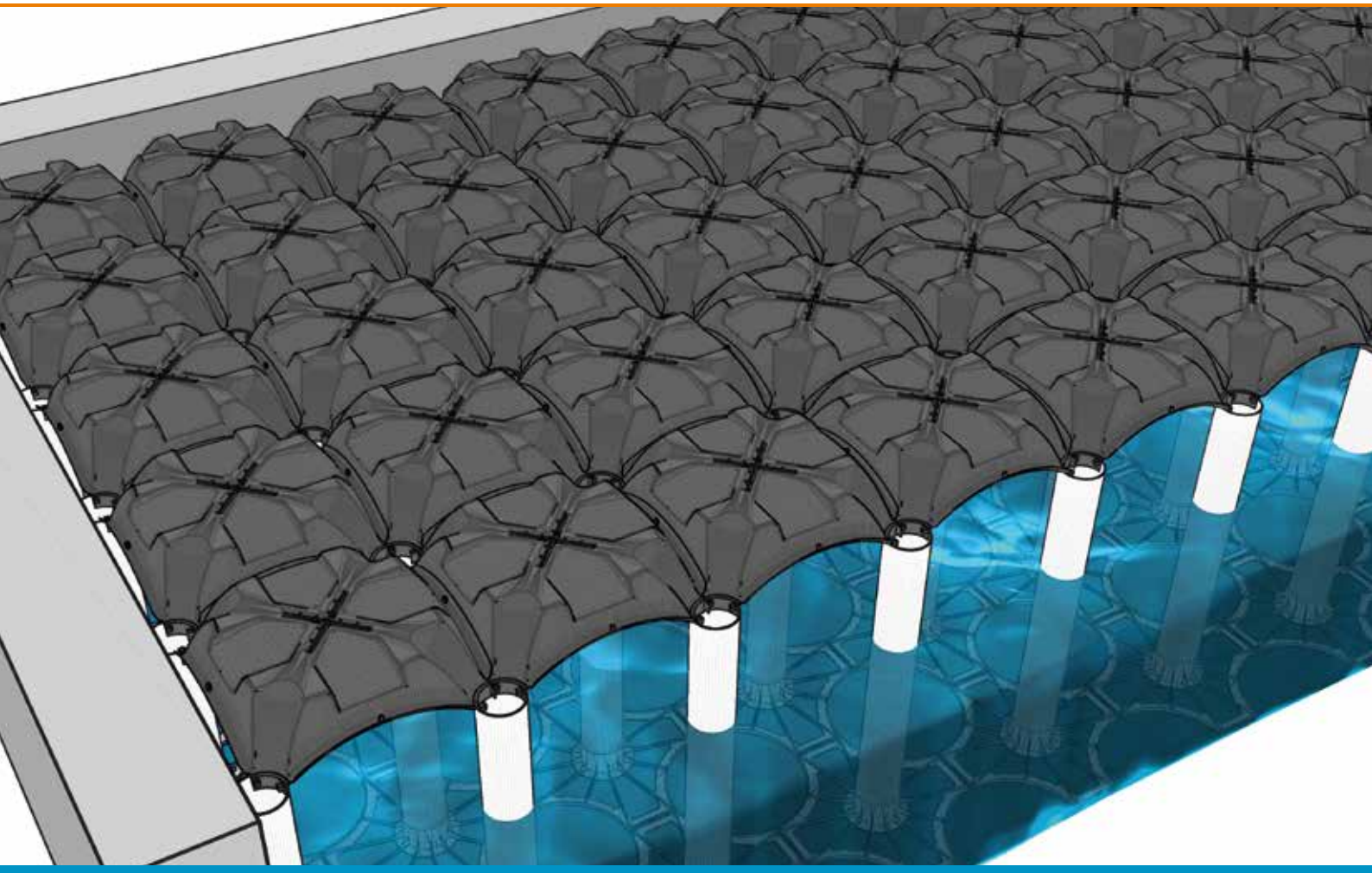
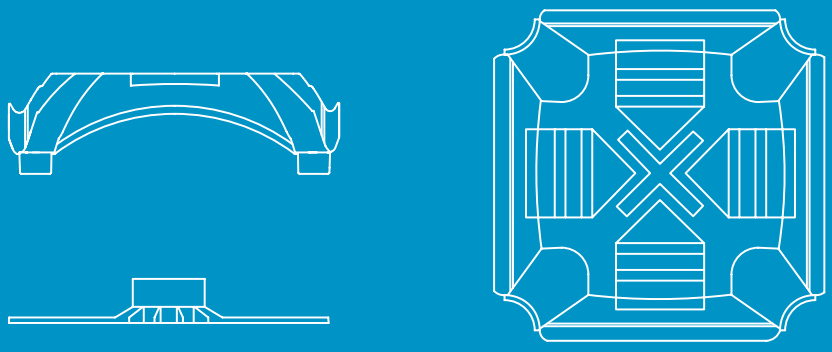


NEW ELEVETOR TANK TECHNICAL MANUAL

PERMANENT FORMWORK FOR IN SITU CAST CONCRETE WATER STORAGE SYSTEMS



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TECHNICAL DATA

1.INTRODUCTION

1.1 GENERALITIES

NEW ELEVETOR TANK is a non-reusable system made of 100% regenerated PP, designed for the construction of lightweight concrete tanks and paving. The formwork rests on PVC pipes with a diameter of 125 mm. The length of the PVC pipes varies according to the height of the tank as specified in the project.

1.2 USE OF THE PRODUCT

NEW ELEVETOR TANK system is used for the creation of:

- Lamination tanks for the regulation of rain flow rates;
- Water storage tanks for water storage and subsequent reuse (irrigation, fire prevention, sanitary use, etc.).

1.3 FUNCTIONALITY

1.3.1 COLLECTION AND RETURN

The system allows the construction of tanks with a high reservoir capacity, which allow temporary storage of rainwater from the collection network. Depending on the drainage system the tank can:

- Release water into the drainage system at controlled flow rate;
- Store a predefined volume of water according to usage, releasing excess volume into the drainage system.

1.3.2 STRUCTURAL CHARACTERISTICS

NEW ELEVETOR TANK system allows the maintenance of the upper surface, which can be left green or paved. Depending on the expected project loads vary:

- Maximum height of the system;
- Reinforcement and thickness of concrete slab;
- Reinforcement of the pillars.

1.3.3 ACCESSIBILITY

The light between the pillars allows the inspection and the cleaning of the system. If the tank is sufficiently high, a person can also pass through. Access to the inside of the tanks must be made through appropriate inspection wells.

1.4 COMPONENTS

1.4.1 NEW ELEVETOR TANK FORMWORK

The formwork has plan dimensions of 58x58 cm and a height of 15 cm. It is moulded in regenerated polypropylene (PP). It is equipped with a special connector to facilitate a solid connection with the PVC pipe.

1.4.2 NEW ELEVETOR TANK BASE

The base is a cross-shaped element with 4 arms of equal shape and size with a "glass" in the middle to receive the PVC tube. The base is 58x58 cm in size and 2.5 cm thick, with the glass 8 cm high; it is also made of regenerated polypropylene (PP). The functions of the base are as follows:

- Create a mesh on the bottom of the tank that speeds up the installation of the pipes, avoiding the need for preliminary tracing operations
- Keep the PVC pipes in a perfectly vertical position, in order to facilitate the installation of the formwork and maintain the stability of the system, which can be compromised in subsequent stages due to trampling or concrete pouring.

1.4.3 PIPES

The pipes are the typical orange PVC hoses for sewage connections with a diameter of Φ125 mm. They are cut to size according to the required height and become the feet of the formwork. For maximum simplicity and flexibility in the worksite NEW ELEVETOR TANK uses only tubes of the indicated diameter.

1.4.4 LISTEL

It is an 8x10x100 cm polystyrene (PS) element that has a compensation function; it is inserted between the wall of the tank and the formwork, resting on the part of the pipe not covered by the formwork, to prevent the concrete from penetrating inside the under-floor cavity during the pouring of the slab.

2. MATERIAL AND MANUFACTURING

2.1 MATERIAL

The formwork and base of NEW ELEVETOR TANK are made of 100% regenerated polypropylene (PP). The material is chemically inert and does not release substances into the stored water. It may suffer prolonged exposure to UV. Material properties are listed in the table.

CHARACTERISTIC	METHOD	U.O.M.	VALUE
MFI (190°C / 2,16 kg)	ASTM-D-1238	g/10'	5±1
Izod Resistance	ASTM-D-256	J/m	70-90
Flexible elastic modulus	ASTM-D-790	MPa	1.200-1.300
The softening temperature . vicat b/50n	ASTM-D-1525	°C	70-80
Density	ASTM-D-792	g/cm^3	0,89-0,92

The pipes are made of virgin PVC.
The material is chemically inert and does not release substances into the stored water. It may suffer prolonged exposure to UV.
Material properties are listed in the table.

CHARACTERISTIC	METHOD	U.O.M.	VALUE
Resistance	DIN EN ISO 179	kJ/m^2	4
Yield strength	DIN EN ISO 527	MPa	58
Elastic modulus	DIN EN ISO 527	MPa	3.000
Melting point	-	°C	86-90
Density	ISO 1183	g/cm^3	1,40-1,42

Please refer to Appendix A for safety information on the use of materials.

2.2 MANUFACTURING PROCESS

NEW ELEVETOR TANK formworks and bases are manufactured by injection moulding at the Geoplast plant in Grantorto (PD), Italy.

Geoplast Spa is a company with UNI EN ISO 9001:2000 quality certification.
Geoplast supplies extruded PVC pipes exclusively from certified suppliers.

3. TECHNICAL DATA

3.1 FORMWORK AND BASE NEW ELEVETOR TANK

The technical characteristics of the formwork and base NEW ELEVETOR TANK are shown in the table and dimensional drawings (Figure 1). The components are grey-black, with a smooth surface without engravings, air bubbles or inclusions.

		FORMWORK	BASE
Product code	-	EELEVEN5858	EELBASE5858
Dimensions	cm	58x58	58x58
Height	cm	15	2,5
Weight	kg	1,78	0,52

The formwork and base units can be easily interlocked with each other. Installation is from right to left and from top to bottom. The installation mode is marked on the lower left-hand side of the formwork. Marker arrows are also moulded on the formwork and bases to facilitate the correct installation. The elements must be installed taking care of the arrows and always pointing upwards.
No fastening system required (screws, glues/silicones, clips).

The formwork and bases can be cut/shaped according to the design characteristics. The modifications shall be made as specified by Geoplast (see Appendix C) using an angle grinder or disc cutter.

3.2 PIPE

The characteristics of the PVC pipes to be used are shown in the table and dimensional drawings. The product is orange in colour, with a smooth surface without cuts, air bubbles or inclusions. The pipe is cut to size according to the design specifications.

Product code*	-	EELTUBOXXX
Diameter	mm	125
Length	cm	75÷250
Material	-	PVC
Thickness	mm	1,8-2,0

*The code varies depending on the pipe length.

PVC pipes are supplied cut to size according to Geoplast's required height. If pipes from another supplier are used, they must necessarily have compatible characteristics with those given in this table.

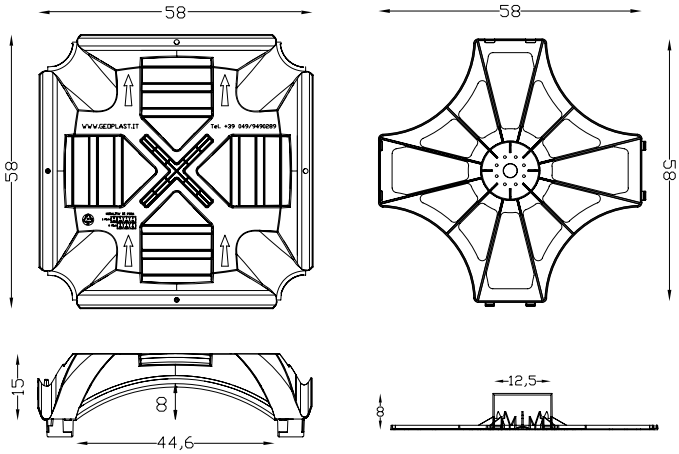


Fig. 1: Shaft and base of the dimensional drawings NEW ELEVETOR TANK

3.3 LISTEL

The listel is a compensation element used for the closure of the space between the pipes and the formwork along the perimeter walls of the tank; it has the function of blocking the penetration of concrete into the under-floor cavity during the pouring phase. The length is equal to 1 m so that the support is always on at least 2 PVC pipes. It may be shortened as required.

Product code	-	EELLIST0100
Width	cm	8
Thickness	cm	10
Length	cm	100

3.4 CONCRETE CONSUMPTION

The consumption of concrete at the edge of the formwork must be calculated according to the following formula:

[0,037 x (H system – 0,15)] + 0,030 [m^3/m^2]

With H system expressed in [m].

Example: Consumption of concrete in a 100 cm high system concrete consumption = **[0,037 x (1 – 0,15)] + 0,030 = 0,061 m^3/m^2**

3.5 SAFETY MEASURES

The installation of the product is completely manual, there is no mechanical handling. The installation can be carried out by the operator only because the weight of the components is less than the maximum liftable weight in optimal conditions (ISO 11228). When handling NEW ELEVETOR TANK elements, attention should be paid to the following risks:

- It is possible to glide when walking over the formwork in wet weather conditions or in the presence of ice;
- Possible risk of falling if the system is not correctly installed or the operator does not pay due attention when walking over the structure;
- Risk of deformation during the mechanical handling of pallets;
- Risk of crushing during dismemberment operations;
- Risk of injury during the cutting of plastic parts.

For the installation of systems with a height of more than 150 cm, it is advisable to use stairs or raised platforms to install the formwork correctly. Do not place stairs or other structures directly on the plastic system.
During the installation phase of the formwork, if the construction site is unattended, it is essential to prevent access with appropriate physical barriers.

4. TRANSPORT AND STORING

The bases and the formwork of NEW ELEVETOR TANK are stored and transported in pallets; the packaging characteristics are as follows:

	Dimensions (cm)	No. elements	surface m^2
FORMWORK	120x120xh265	225	75
BASE	110x110xh240	310	-

PVC pipes are also stored and transported in pallets, as well as polystyrene strips. Pallet sizes vary depending on the length and number of pieces.

For the loading and unloading of the pallets it is possible to use mechanical means like cranes or equipped lifting straps. For a correct storage it is recommended to choose a stable and as regular surface as possible; the product must remain protected from contact with fuels, lubricants, chemicals or acids.
Exposure to UV radiation should be as limited as possible.

The following operations must be avoided once the elements are removed from the pallet:

- Improper storage of components (overlapping pallets, bulk stacking of components,...);
- Inadequate handling (steering, dragging,....);
- Contact or impact with sharp or blunt bodies (stones, blades,....).

IMPORTANT: Before installation, it must be verified that the elements are intact (the characteristics described in paragraphs 3.1 and 3.2 must be observed). Avoid installation if there is any damage or defects in the formwork, grids or PVC pipes.

APPLICATIONS

5. RAINWATER DRAINAGE

5.1 PRELIMINARY RESEARCH

It is advisable to carry out geo-technical and geological surveys at the site where the tank will be built in order to verify its suitability. In particular, they should be assessed:

- Load-bearing capacity and ground thrust.
- Maximum free aquifer level.

For discharge into a surface water system it is also necessary to know:

- The average level.
- Maximum flow rate (according to the requirements of the Managing Authority).

With regard to the quality of waste water, reference should be made to the legal limits in force for discharge into the subsoil or into a receiving water system, in order to provide adequate treatment plants upstream to the tank.

5.2 POSITIONING

There are no particular limitations or criteria to follow for the positioning of the tank. It is recommended to:

- Avoid the proximity to tall trees.
- Provide an adequate covering thickness if there is the presence of a rainwater collection system above the structure (drainage canals or drainage channels)

The system can also be installed under buildings or in the presence of aquifers, taking the necessary precautions.

5.3 DIMENSIONING CRITERIA

Geoplast can provide a pre-dimensioning of the lamination tank on the basis of customer data. The calculation must be validated by the designer of the work.

5.3.1 REQUIRED DATA

The following data are required for a correct calculation of the system:

- Drainage surfaces.
- Outflow coefficients: typical values of this parameter are indicated in the table (source: Sewerage, Da Deppo-Datei, e. g. Cortina 2005); some local regulations define the values to be adopted.

TYPE OF SURFACE	Φ
Roofs with sheet metal or tiles	0,9 – 1
Concrete roofs	0,7 – 0,8
Flat green roofs	0,3 – 0,4
Paved surfaces	0,7 – 0,9
Dirt roads	0,4 – 0,6
Green surfaces	0,1 – 0,4
Residential areas	0,3 – 0,7
Woods	0,1 – 0,3
Cultivated lands	0,2 – 0,6

- Rainfalls: data extrapolated from rainfall analysis. It is recommended that you refer to a return time of 50 years (unless otherwise specified by law).
- Maximum discharge flow rate in the network: data generally provided by the competent authority.
- Applied loads: variable depending on the use of the site.

5.3.2 CALCULATION PRINCIPLE

In order to calculate the void ratio, it is possible to use the same methods used for the dimensioning of a lamination tank (rainfall method, reservoir method,…).

Once the volume of the basin has been obtained, the height of NEW ELEVETOR TANK needs to be defined, in order to obtain the surface of the tank.
At a sefety level, the maximum height of the storage tank is considered to be the height of the system reduced by 15 cm of the formwork height. The following table shows the storage values depending on the height of the system. These values take into account the overall dimensions of 3 pillars with a diameter of Φ125 mm per unit of the interior area of the tank. A void ratio of the 96,3% (ratio between the actual tank and the reservoir that you would have without the footprint of the pillars) can be estimated.

H System	H MAX ratio	Void ratio	
cm	cm	m^3/m^2	l/m^2
80	65	0,626	626
90	75	0,722	722
100	85	0,819	819
110	95	0,915	915
120	105	1,011	1.011
130	115	1,108	1.108
140	125	1,204	1.204
150	135	1,300	1.300
160	145	1,397	1.397
170	155	1,493	1.493
180	165	1,589	1.589
190	175	1,686	1.686
200	185	1,782	1.782
210	195	1,878	1.878
220	205	1,975	1.975
230	215	2,071	2.071
240	225	2,167	2.167
250	235	2,264	2.264

5.4 LOADS

The height of the system influences the maximum permissible loads that the structure can withstand. For example, if fire fighters vehicles are expected to pass over the tanks, NEW ELEVETOR TANK should be installed with a maximum height of about 2 m. In presence of pedestrian areas, it is possible to reach maximal heights of about 2,5 m.

The contribution of the plastic structure of NEW ELEVETOR TANK in terms of load resistance can be considered (on a simplified level) negligible. Therefore, during the structural calculation it needs to be considered only the contribution of the reinforced concrete.

Depending on the applied loads, they must be defined:
- Thickness and type of reinforcement of the upper floor sub- structure;
- Type of reinforcement irons that need to be inserted in the pillar;
- Thickness of the foundation base on which the formwork system is installed;
- Side wall thickness;
- Identification of any internal partition.

Geoplast Technical Office can provide technical advices as regard the reinforced slab (thickness and type of electro-welded mesh) and reinforcement rods to be inserted in the pillars.
The structure is designed according to the calculation method at the limit states and the following checks are carried out:
- Checking the upper slab:
  - Bending check;
  - Punching verification;
- Check of the pillars buckling resistance;
- Check of the ground contact pressure.

Further details on structural audits can be found in Appendix B.

5.4.1 SEISMIC BEHAVIOUR

The structure created with NEW ELEVETOR TANK is not intended to withstand horizontal stresses caused by earthquakes; the structure body needs be designed to support the insertion of some elements capable of dissipating such actions. In this case, reference is made to the perimeter walls that contain the tank rather than internal vertical elements (partitions) inserted in the plastic system.

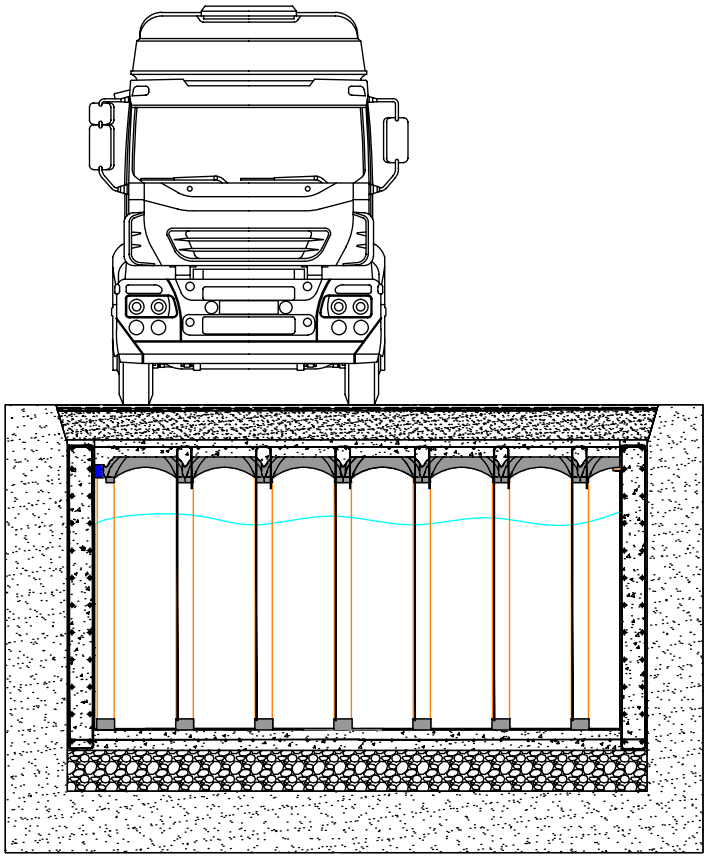


Figure 2: NEW ELEVETOR TANK section.

5.5 INSTALLATION PROCESS

5.5.1 CREATION OF THE CONTAINMENT STRUCTURE

Before the installation of NEW ELEVETOR TANK the following elements should be set:

- Tank base;
- Side walls;
- Access points to the system;
- Hydraulic connections (supplying/discharge).

The entire structure needs to be completed before the formwork's installation. It is recommended to incline slightly the bottom (approximate values between 0,1-0,5%) downwards in order to faciliate the tank's emptying. The slope does not affect the pillars verticality, provided that the maximum difference in height between the upwards and downwards is a few centimeters. In case of special conditions, it is advisable to refer to Geoplast Technical Office to study a specific solution.

5.5.2 NEW ELEVETOR TANK INSTALLATION

The installation sequency is the following:

- Shaping and installation of the basis;
- Laying of PVC pipes;
- Shaping and installation of the formworks;
- Insertion of polystyrene listels to compensate the spaces between wall/crawl spaces.

The installation of the formworks and of the base grids must proceed from right to left and from top to bottom. Once installed, the system is walkable.
It is walkable during the installation stage, only if 5 rows of formworks are in full support of at least 3 perimeter walls which can support the tank. The complete installation instructions are described in Appendix C.

5.5.3 SYSTEM'S REINFORCEMENTS

The welded wire mesh must be laid above the formwork, possibly with spacers to be placed between the iron and plastic to ensure that the mesh is in the middle of the slab.

The reinforcements have to be inserted into the pillars. They must be long enough to cover the entire length of the PVC pipe, touching the support bases, and can be hooked to the upper mesh. The reinforcements are shaped according to the specifications provided:

- “Umbrella-shaped” in case 1 reinforcement per pillar is sufficient;
- “U-shaped” in case 2 or 4 should be inserted.

Attention should be paid during this stage when walking above the formwork, especially where the welded mesh has already been positioned.

5.5.4 POUR

We recommend the use of concrete with minimum strength class C25/30 and consistency class S4.
The procedure involves the filling of the PVC pipes first, until the edge of the formwork and then with pouring of the slab.
It is advisable to pour at close distance, keeping the pump entrance at 20-30 cm of distance from the formworks.
Immersion vibrators must not be used inside the PVC pipes.

5.5.5 FINISHING

Depending on the intended use of the area, the system is backfilled up to the design level and the required finishing.

It should be noted that Geoplast is not liable for any damage to the system if the above prescriptions are not observed.

5.6 HYDRAULIC CONNECTIONS

5.6.1 INCOMING WATER TREATMENTS

The water entering the basin must be as clean as possible in order to avoid clogging of the system and contamination of the final receptor.
The degree of purification to be achieved depends on:

- Incoming water quality.
- Current regulatory requirements
- Final receptor.

In absence of regulatory requirements, we reccomend:

- Systems should be provided for the removal of coarse solids (sediment traps). It is possible to create calm zone before the entrance of the tank in order to facilitate the sediment settling and slowing down the incoming flow.
- Install an oil separator if the system disposes of run-off water from a parking lot.

5.6.2 SUPPLYING PIPES

The sizing of the collectors is responsibility of the project designer.
There are no restrictions on the maximum diameters allowed for the entry into the tank.

5.6.3 DISCHARGE PIPELINES

The diameter of the exhaust pipe must be calculated according to the maximum allowable flow rate that can be sent to the final receptor; some regional regulations prescribe this value. It is usually positioned at the bottom of the tank, if gravity discharge is possible.
If it is not possible to discharge the tank by gravity, it must be equipped with a lifting station.

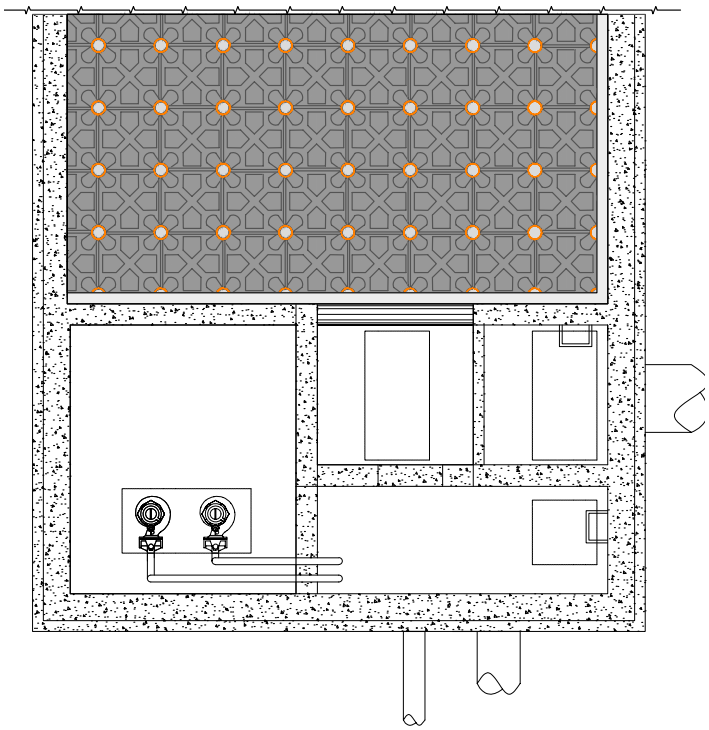


Figure 3: Particular lamination tank with lifting station.

5.7 MAINTENANCE

The maintenance of a tank carried out with NEW ELEVETOR TANK system follows the same criteria as the maintenance of a normal laminate/harvest tank. It is intended to preserve the maximum void ratio over time. Specific studies (Report CIRIA 737) have shown that in a time span of 50 years, without adequate system maintenance, it is possible to lose up to 10% of the basin capacity due to sedimentation of the fine fraction of solids (silts and clays), which are difficult to remove from the upstream treatment units.
Geoplast provides simple guidelines for system maintenance and inspection. The drawing up of the maintenance plan is left to the project designer.
The main operations to be performed periodically are as follows:

- Tank inspection;
- Tank cleaning;
- Control of the correct functioning of the manufactured products connected to it (valves, pumps, etc.).

5.7.1 INSPECTION

The inspection of the system can be carried out by means of motorized cameras on wheels, or directly by an operator if the height of the system allows access.
System access points must be provided during the design stage. It is possible to make them inside the structure by appropriately interrupting the under-floor cavity or by making appropriate septa.

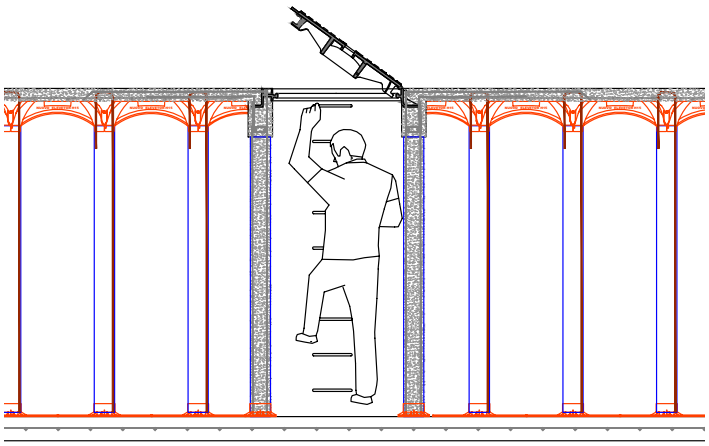


Figure 4: Inspection of a section of wells.

The inspection must be first carried out in the supplying pipelines, in the distribution wells and in the calm tanks; then it must be performed in the area closer to the pipes entrance in the tank, which is a more susceptible area to sedimentation materials, and then extended to the rest of the structure.
If the tank has an irregular geometry or there are internal partitions, attention must be paid to any material deposit in the presence of obstacles.

5.7.2 CLEANING

Cleaning can be carried out through the water jets normally used for sewer cleaning, accessing inside the system through the expected wells.
Cleaning operations must follow the same order as previously described for basin inspection.
Attention should be paid to the cleaning in proximity of any "obstacle" like crawl spaces or septa in the interior of the tank.

5.7.2 FREQUENCY OF INTERVENTION

It is recommended the drawing of a system maintenance plan in order to perform a systematic control of the system. The system's control is fundamental in the following periods:

- Finishing of construction site operation or, in any case, after the first rainfalls after the completion of the works;
- After particularly intense weather events;
- If there is a failure or malfunction of the system in the pre-treatment units (where provided);
- Usually at least once a year.

6. HARVESTING AND REUSE OF RAINWATER

6.1 PRELIMINARY RESEARCH

It is advisable to carry out geotechnical and geological surveys at the site where the basin will be built in order to verify its suitability. In particular, it should be assessed:

- Load-bearing capacity of the ground;
- Maximal level of the free aquifer.

To discharge excess flow rates into a receptor, it is necessary to know:

- Medium level and maximum discharge flow rate (according to the requirements of the managing body) if it is a surface water body;
- Permeability of the ground in case of undergound discharge.

6.2 POSITIONING

There are no particular limitations or criteria to follow for the positioning of the tank.
It is recommended to:

- Avoid the positioning in proximity of tall trees;
- Provide an adequate covering thickness in case a rainwater collection system is installed above the structure (machicolation or drainage channels).

The system can also be installed under buildings or in the presence of an aquifer, taking the necessary precautions.

6.3 DIMENSIONING CRITERIA

Geoplast can provide a pre-dimensioning of the collection tank on the basis of the data provided by the customer. The calculation must be validated by the designer of the work.

6.3.1 REQUIRED DATA

The following data are required for a correct calculation of the system:

- Draining surfaces;
- Outflow coefficients: typical values of this parameter are indicated in the table (Source: Sewerage, Da Deppo-Datei, e. g. Cortina 2005); some local regulations define the values to be adopted.

TYPE OF SURFACE	Φ
Roofs with sheet metal or tiles	0,9 – 1
Concrete flat roofs	0,7 – 0,8
Flat green roofs	0,3 – 0,4
Paved surfaces	0,7 – 0,9
Dirt roads	0,4 – 0,6
Green surfaces	0,1 – 0,4
Residential areas	0,3 – 0,7
Woods	0,1 – 0,3
Cultivated lands	0,2 – 0,6

- Rainfalls: the annual average value is taken into consideration, which can be obtained from the rainfall analysis or local studies.
- Rainfall frequency: it is taken from local studies. Alternatively, the average dry weather (TSM) data should be searched.
- Water consumption: some typical values are given in the table (EN DIN 1989:2000-12).

	Daily consumption per capita	Year consumption [l/m²]
Domestic bathrooms	24	
Office bathrooms	12	
Schools bathrooms	6	
Irrigation of green areas		60
Irrigation of sports fields (6 months)		200
Lawn irrigation with light soil (6 months)		100-200
Lawn irrigation with heavy soil (6 months)		80-150

- Applied loads: variable depending on the use of the site.
- Maximum discharge capacity in the network: data generally provided by the competent authority.

6.3.2 CALCULATION PRINCIPLE

The system calculation is left to the designer of the work. The sizing can be carried out according to the criteria of EN DIN 1989:2000-12, concerning the sizing of tanks for rainwater recovery.

The main steps are as follows:

1) Maximum estimated cumulative volume $\mathbf{V_{ACC}}$.
2) Estimation of the water demand **F**.
3) Evaluation of the average dry time [gg] through the following relation:

TSM = (365 – FR)/12 with FR Rainfall frequency

4) Calculation of the tank volume with relation:

$$V_R = TSM \times (F/365)$$

Valid if $\mathbf{F<V_{ACC}}$
If $\mathbf{F>V_{ACC}}$:
- Replace in the report **F** with $\mathbf{V_{ACC}}$.
- Or use the average value between **F** and $\mathbf{V_{ACC}}$.

5) Once the volume has been obtained, the height of NEW ELEVETOR TANK system must be defined in order to obtain the surface of the tank. At a safety level, the maximum height of the storage tank is considered to be the height of the system reduced by 15 cm in respect to the formwork height. The following table shows the storage values depending on the height of the system. These values take into account the overall dimensions of 3 pillars of Φ125 mm per unit of the internal area of the tank. A void ratio of the 96,3% is estimated (the relation between the effective void ratio and the ratio without pillars).

H System	H MAX void	Void ratio	
cm	cm	m^3/m^2	l/m^2
80	65	0,626	626
90	75	0,722	722
100	85	0,819	819
110	95	0,915	915
120	105	1,011	1.011
130	115	1,108	1.108
140	125	1,204	1.204
150	135	1,300	1.300
160	145	1,397	1.397
170	155	1,493	1.493
180	165	1,589	1.589
190	175	1,686	1.686
200	185	1,782	1.782
210	195	1,878	1.878
220	205	1,975	1.975
230	215	2,071	2.071
240	225	2,167	2.167
250	235	2,264	2.264

6.4 LOADS

The height of the system influences the maximum permissible loads that the structure can withstand. For example if fire fighters are expected to transit over site where the tank will be placed, the maximal height of NEW ELEVETOR TANK should be equal to 2 m ca. In presence of pedestrian areas, it is possible to reach maximum height of 2,5 m.

The contribution of NEW ELEVETOR TANK's plastic structure in terms of load resistance can be considered negligible (at simplified level). Therefore, only the contribution of reinforced concrete should be taken into account in the structural calculation.

Depending on the applied loads, the following data must be defined:

- Thickness and type of reinforcement of the upper floor sub-structure;
- Type of reinforcement to insert in the pillars;
- Base foundation thickness
- Thickness of the side walls;
- Searching of any internal septum.

Geoplast Technical Office give assitance on the requirements for reinforced slab and reinforcements insert in the pillars. The structure is designed following the calculation method at the limit state and the following checks are carried out:

- Checking of the upper slab:
  - Bending check;
  - Punching Check;
- Check of the buckling resistance of the pillars;
- Check of the pressure when in contact with the ground.

Further details on structural audits can be found in Appendix B.

6.4.1 SEISMIC BEHAVIOUR

The structural system composed of NEW ELEVETOR TANK is not intended to withstand horizontal stress due to the earthquake; the body structure must be studied in such a way as to insert some elements to dissipate these actions. In this case, reference is made to the perimeter walls that contain the tank rather than internal vertical elements (septa) inserted in the arrangement of the plastic system.

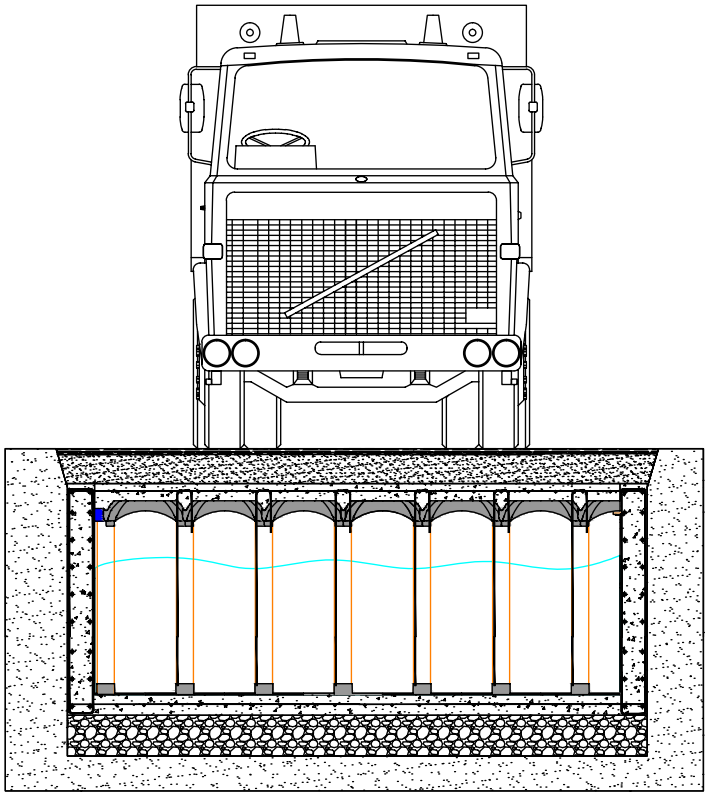


Figure 5: NEW ELEVETOR TANK tank section

6.5 INSTALLATION PROCESS

6.5.1 CREATION OF THE CONTAINMENT STRUCTURE

Prior to installation of the NEW ELEVETOR TANK system, the following elements must be prepared:

- Basement of the tank;
- Side walls;
- Any technical compartments and interior partitions;
- System access points;
- Hydraulic connections (supplying/discharge).

The entire structure must be completed before the formwork is installed.
It is advisable to give a slight slope to the bottom (indicative values between 0.1-0.5%) downwards to facilitate the emptying of the tank. The slope does not affect the verticality of the pillars, provided that the maximum difference in height between upwards and downwards is in the range of a few centimetres. In case of special conditions, it is advisable to refer to Geoplast Technical Department to study a specific solution.

6.5.2 INSTALLATION OF NEW ELEVETOR TANK

The laying sequence is as follows:
- Shaping and laying of the bases;
- Laying of PVC pipes;
- Shaping and laying of formworks;
- System access points;
- Insertion of polystyrene strips to compensate for wall/ crawl spaces.

The installation of formworks and base grids must proceed from right to left and from top to bottom. The system can be walked on during the installation phase, only if at least 5 rows of formworks have been placed and if they are in full support of at least 3 perimeter walls of the tank.
Once installed, the system can be walked on.
The complete installation instructions are described in Appendix C.

6.5.3 SYSTEM REINFORCEMENT

Initially, the welded wire mesh must be laid above the formworks, possibly with spacers to be placed between iron and plastic to ensure that the mesh is in the middle of the slab.

The needles are then inserted into the pillars. The rods must be long enough to cover the entire length of the PVC pipe, touching the support bases, and can be hooked to the overhanging mesh. The needles are shaped according to the specifications provided:
- "Umbrella-shaped" in the case in which the insertion of 1iron per pillar is sufficient.
- "U-shaped" in the case in which 2 or 4 irons must be inserted.

Attention must be paid in this phase to the walkway above the formworks, especially where the electro-welded wire mesh has already been positioned.

6.5.4 CONCRETE POUR

We recommend the use of concrete with minimum strength class C25/30 and consistency class S4. The procedure involves first filling the PVC pipes up to the level of the formwork and then the pouring of the slab.
It is advisable to cast at close range, holding the pump mouth 20-30 cm away from the formwork.
Immersion vibrators must not be used inside PVC pipes.

6.5.5 FINISHING

Depending on the intended use of the area, the system is backfilled to the design level and the foreseen finish is completed.

Geoplast Technical Department is not responsible for any damage to the system if the above prescriptions are not observed.

6.6 HYDRAULIC CONNECTIONS

6.6.1 WATER TREATMENTS

The water entering the basin must be as free as possible from coarse solids in order to avoid clogging the tank.
It is therefore advisable to provide for removal systems (sediment traps), which can simply consist of filters or the creation of calm tanks to facilitate the decanting of the material.
Removal of coarse solids is also important to preserve the long-term functionality of the pumping station.
Depending on the end use of the water, finishing treatments must be provided to remove any impurities.

6.6.2 SUPPLYING PIPELINES

The sizing of the collectors is the responsibility of the designer of the work.
There are no restrictions on the maximum diameters allowed for entry into the tank.

6.6.3 DISCHARGE PIPELINES

The diameter of the discharge pipe must be calculated according to the maximum allowable flow rate that can be sent to the final receptor; some regional regulations prescribe this value (e. g. for the Veneto Region the limit is usually Ø200 mm).
It is usually positioned at the top of the tank.

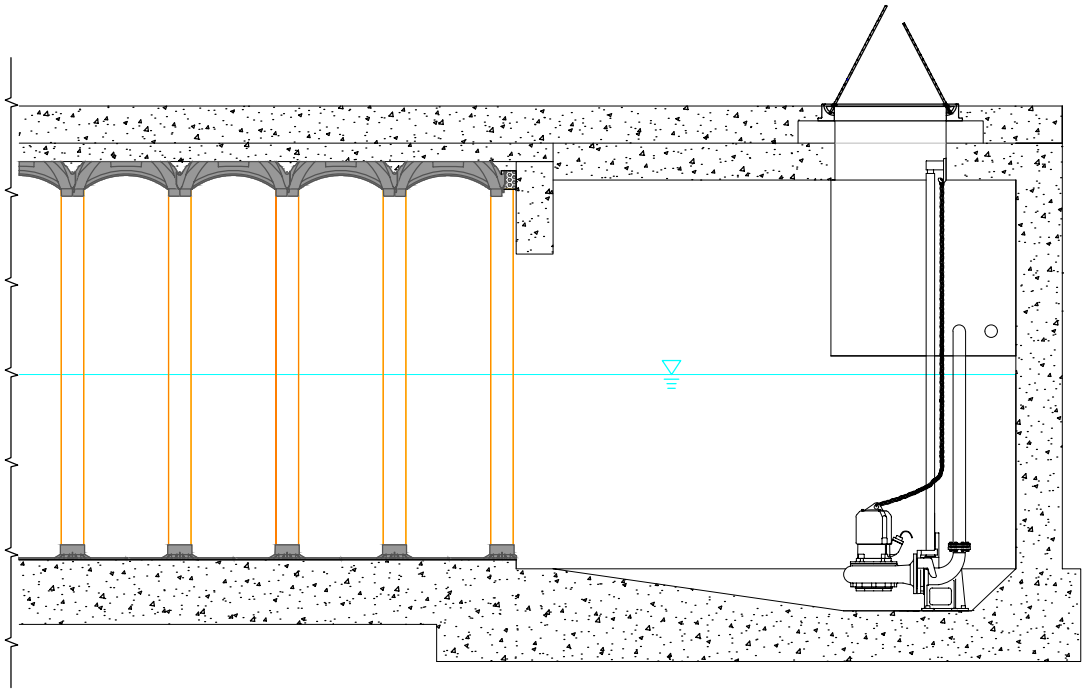


Figure 6: Particular collection tank with raising station.

6.7 MAINTENANCE

The maintenance of a tank carried out with the NEW ELEVETOR TANK system follows the same criteria as the maintenance of a normal laminate/collecting tank. It is intended to preserve the maximum capacity for storage over time.
Specific studies have shown that in a time span of 50 years, without adequate maintenance of the system, it is possible to lose up to 10% of the basin capacity due to sedimentation of the fine fraction of solids (limians and clays) which are difficult to remove from the upstream treatment units.
Geoplast provides simple guidelines for system maintenance and inspection. The drawing up of the maintenance plan is left to the project designer.
The main operations to be performed periodically are as follows:

- Tank inspection;
- Cleaning the tank;
- Control of the correct functioning of the manufactured products connected to it (valves, pumps, etc.).

6.7.1 INSPECTION

The inspection of the system can be carried out by means of motorized cameras on wheels, or directly by an operator if the system is too high (higher than H170 cm). The points of access to the system must be foreseen during the design phases. It is possible to realize them inside the structure by appropriately interrupting the under-floor cavity or by making appropriate septa.

The inspection must first be carried out in the feed piping and distribution wells or calm tanks; then the area closest to the pipe engagement in the tub body must be checked, an area more susceptible to sedimentation of the material, and then extended to the rest of the structure.

If the tank has an irregular geometry, or there are internal partitions, attention must be paid to any material deposits in correspondence with the obstacles.

6.7.2 CLEANING

Cleaning can be carried out by means of the water jets normally used for sewer cleaning, accessing inside the system through the foreseen wells.
Cleaning operations must follow the same order as previously described for basin inspection.
Care must be taken when cleaning at any "obstacles" such as compartments or septa inside the tank body.

6.7.3 FREQUENCY OF INTERVENTIONS

It is advisable to draw up a maintenance plan for the system in order to carry out a systematic periodic inspection.
System control is essential during the following periods:

- End of construction site operations or, in any case, after the first rainy event after completion of works;
- After particularly intense weather events;
- In the event of failure or malfunction of pre-treatment units (where applicable);
- Normally at least once a year.

APPENDIXES

APPENDIX A

MATERIAL SAFETY DATA SHEET

A1 – NEW ELEVETOR TANK FORMWORK AND BASE

COMPOSITION / POLYMER INFORMATION

INGREDIENTS	N° C.A.S.	%
Polyethylene Random	9010-79-1	97-99
Additives	Not available	1-3

DANGEROUS COMPONENTS

This product does not fall within the definition of hazardous material provided by EEC 1999/45 and subsequent regulatory measures.
Physical state: Solid.
Problems: If the polymer is subjected to high temperatures it can produce vapours irritating to the respiratory system and eyes.

FIRST AID MEASURES

Inhalation of decomposition products: Keep patient calm, move patient to fresh air and call for medical help.
Skin contact: parts that come into contact with molten material must be quickly brought under running water and the doctor must be contacted.
Eye contact: flush eyes for at least 15 minutes under running water while holding eyelids open. Contact with material particles does not present any particular danger, except for the possibility of abrasion wounds. Fine particles can cause irritation.
Ingestion: No particular measures to be taken.

FIRE-FIGHTING MEASURES

Extinguishing materials: water, foam or dry extinguishing materials.
Unsuitable extinguishing materials: none.
Substances released in the event of fire: carbon dioxide (CO2) and mainly steam. Other substances that may form: carbon monoxide (CO), monomers, other degradation products.
Special protective equipment: Wear breathing apparatus in case of fire.
Other requirements: Dispose of contaminated combustion slag and fire extinguishing material in accordance with local regulations.

ACCIDENTAL RELEASE MEASURES

It is not classified as a hazardous material. It can be recycled, incinerated or disposed of in landfills in accordance with local regulations.

STORAGE AND HANDLING

When the product is ground, the applicable dust regulations must be taken into account.
Keep it in a dry place.

EXPOSURE CONTROL/PERSONAL PROTECTION

Respiratory tract protection: if respirable dust forms, P1 filters (DIN 3181) must be used.
Skin protection: no special precautions.
Eye protection: safety glasses in the presence of free particles.

PHYSICO-CHEMICAL PROPERTIES

Shape	Panels
Color	Dark grey-black
Smell	Soft
Change in physical state	Melting temperature: above 140°C Combustion temperature: above 400°C
Flammable properties	None
Density	0.91-0.97 kg/dm^3
Solubility in water	Insoluble
Solubility in other solvents	Soluble in aromatic solvents

STABILITY AND REACTIVITY

Conditions to avoid	Do not overheat to prevent thermal decomposition. The process begins at around 300°C
Thermal degradation products	Monomers and other sub-products

TOXICOLOGICAL INFORMATION

Acute toxicity: data not available (no animal experiments due to impossibility related to product conformation).
Insoluble in water.

ECOLOGICAL INFORMATION

Degradation in nature: no data available.
Insoluble in water.
Behaviour and environmental purpose: the product is environmentally friendly because it is made of recycled plastic. It is not apparently biodegradable due to its water insolubility and consistency.

DISPOSAL CONSIDERATIONS

Product 100% recyclable. It can be disposed of in landfills or incinerated, in accordance with local regulations.

TRANSPORT INFORMATION

It is not classified as dangerous for transport purposes.

REGULATORY INFORMATION

It is not subject to the CE marking.

A2 – PIPES

COMPOSITION / POLYMER INFORMATION

INGREDIENTS	N° C.A.S.	%
Polyvinyl chloride	9002-86-2	about 75
Calcium carbonate	1317-65-3	about 25
Other (waxes-stabilizers)	Not available	1-2
Pigments	Not available	2

DANGEROUS COMPONENTS

This product does not fall within the definition of hazardous material provided by EEC 1999/45 and subsequent regulatory measures.
Physical state: Solid.
Problems: If the polymer is subjected to high temperatures it can produce vapours irritating to the respiratory system and eyes.

FIRST AID MEASURES

Inhalation of combustion products: Keep the patient calm, move him/her to fresh air and call for medical help.
Contact of molten material with skin: parts that come into contact with molten material must be quickly brought under running water and the doctor must be contacted.
Contact of dust or material particles with eyes: wash eyes for at least 15 minutes under running water while holding eyelids open. Contact with material particles does not present any particular danger, except for the possibility of abrasion wounds. Fine particles can cause irritation.
Ingestion: No particular measures to be taken.

FIRE-FIGHTING MEASURES

Extinguishing materials: water, foam or dry extinguishing materials.
Unsuitable extinguishing materials: none.
Substances released in the event of fire: carbon dioxide (CO2) and mainly steam. Other substances that may form: carbon monoxide (CO), monomers, other degradation products.
Special protective equipment: Wear breathing apparatus in case of fire.
Other requirements: Dispose of contaminated combustion slag and fire extinguishing material in accordance with local regulations.

ACCIDENTAL RELEASE MEASURES

It is not classified as a hazardous material. It can be recycled, incinerated or disposed of in landfills in accordance with local regulations.

STORAGE AND HANDLING

When the product is ground, the applicable dust regulations must be taken into account.
Keep it in a dry place.

EXPOSURE CONTROL/ PERSONAL PROTECTION

Respiratory tract protection: if respirable dust forms, P1 filters (DIN 3181) must be used.
Skin protection: no special precautions.
Eye protection: safety glasses in the presence of free particles.

PHYSICO-CHEMICAL PROPERTIES

Shape	Tubular
Color	Grey or orange
Smell	Soft
Change in physical state	Melting temperature: above 75°C Combustion temperature: above 400°C
Flammable properties	None
Density	1,7 kg/dm^3
Solubility in water	Insoluble
Solubility in other solvents	Soluble in aromatic solvents

STABILITY AND REACTIVITY

Conditions to avoid	Do not overheat to prevent thermal decomposition. The process begins at around 300°C
Thermal degradation products	Monomers and other sub-products

TOXICOLOGICAL INFORMATION

Acute toxicity: data not available (no animal experiments due to impossibility related to product conformation).
Insoluble in water.

ECOLOGICAL INFORMATION

Degradation in nature: no data available.
Insoluble in water.
Behaviour and environmental purpose: the product is environmentally friendly because it is made of recycled plastic. It is not apparently biodegradable due to its water insolubility and consistency.

DISPOSAL CONSIDERATIONS

Product 100% recyclable. It can be disposed of in landfills or incinerated, in accordance with local regulations.

TRANSPORT INFORMATION

It is not classified as dangerous for transport purposes.

REGULATORY INFORMATION

It is not subject to the CE marking.

A3 – LISTEL

COMPOSITION / POLYMER INFORMATION

INGREDIENTS	N° C.A.S.	%
Polystyrene	9003-53-6	97-99
Additives	Not available	1-3

DANGEROUS COMPONENTS

This product does not fall within the definition of hazardous material provided by EEC 1999/45 and subsequent regulatory measures.
Physical state: Solid.
Problems: If the polymer is subjected to high temperatures it can produce vapours irritating to the respiratory system and eyes.

FIRST AID MEASURES

Inhalation of combustion products: Keep the patient calm, move him/her to fresh air and call for medical help.
Contact of molten material with skin: parts that come into contact with molten material must be quickly brought under running water and the doctor must be contacted.
Contact of dust or material particles with eyes: wash eyes for at least 15 minutes under running water while holding eyelids open. Contact with material particles does not present any particular danger, except for the possibility of abrasion wounds. Fine particles can cause irritation.
Ingestion: No particular measures to be taken.

FIRE-FIGHTING MEASURES

Extinguishing materials: water, foam or dry extinguishing materials.
Unsuitable extinguishing materials: none.
Substances released in the event of fire: carbon dioxide (CO2) and mainly steam. Other substances that may form: carbon monoxide (CO), monomers, other degradation products.
Special protective equipment: Wear breathing apparatus in case of fire.
Other requirements: Dispose of contaminated combustion slag and fire extinguishing material in accordance with local regulations.

ACCIDENTAL RELEASE MEASURES

It is not classified as a hazardous material. It can be recycled, incinerated or disposed of in landfills in accordance with local regulations.

STORAGE AND HANDLING

When the product is ground, the applicable dust regulations must be taken into account.
Keep it in a dry place.

EXPOSURE CONTROL/PERSONAL PROTECTION

Respiratory tract protection: if respirable dust forms, P1 filters (DIN 3181) must be used.
Skin protection: no special precautions.
Eye protection: safety glasses in the presence of free particles.

PHYSICO-CHEMICAL PROPERTIES

Shape	Panels, profiled
Color	White-grey
Smell	Soft
Change in physical state	Melting temperature: above 100-140°C Combustion temperature: above 450°C
Flammable properties	None
Density	1,04 kg/dm^3
Solubility in water	Insoluble
Solubility in other solvents	Soluble in aromatic solvents

STABILITY AND REACTIVITY

Conditions to avoid	Do not overheat to prevent thermal decomposition. The process begins at around 270°C
Thermal degradation products	Monomers and other sub-products

TOXICOLOGICAL INFORMATION

Acute toxicity: data not available (no animal experiments due to impossibility related to product conformation).
Insoluble in water.

ECOLOGICAL INFORMATION

Degradation in nature: no data available.
Insoluble in water.
Behaviour and environmental purpose: the product is environmentally friendly because it is made of recycled plastic. It is not apparently biodegradable due to its water insolubility and consistency.

DISPOSAL CONSIDERATIONS

Product 100% recyclable. It can be disposed of in landfills or incinerated, in accordance with local regulations.

TRANSPORT INFORMATION

It is not classified as dangerous for transport purposes.

REGULATORY INFORMATION

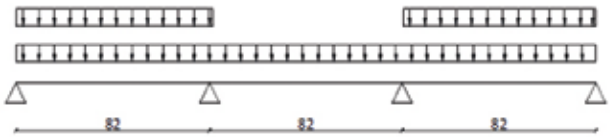
It is not subject to the CE marking.

APPENDIX B

DIMENSIONING INDICATIONS

BENDING CHECK

The flexing test of the upper slab is carried out by taking as reference a strip of slab equal to the diagonal distance between two pillars, therefore, since the system is made up of cylindrical elements placed at a distance of 58 cm, the width of the strip to be taken into consideration will be equal to 58√2 or 82 cm.
This strip is calculated as a continuous beam on multiple supports identifiable with pillars, the situation that occurs is identified in the following scheme where you look for the combination of load that maximizes the moment in span:



PUNCHING VERIFICATION

The punching test of the upper slab is carried out by requiring that:

$$v_{sd} = \frac{V_{sd}}{u} < V_{Rd1} = \tau_{rd} \cdot k \cdot (1.2 + 40\rho)d$$

Where::
V_{sd} is the driving force.
u represents the critical perimeter variable according to the characteristic load footprint of the acting concentrated action:

$$v_{sd} = \frac{V_{sd}}{u}$$

T_{rd} represents the tangential tension depending on the class of concrete d represents the useful height of the section and K is the correcting parameter related to it:

K = 1.6-d

ρ represents the percentage of reinforcement, therefore the residual cut is obtained and compared to the stressing action.

PILLARS VERIFICATION

The verification calculation of the pillars is carried out with reference to the press-flex verification and the calculation is carried out with reference to an isolated pillar, this simplification is also to the benefit of safety, because it does not consider the advantageous effect that close pillars operate.
The process begins with checking the leanness ratio λ whose value must be less than 50 in order not to have problems of instability.
The instability depends on the free length of inflection l0 influenced by the type of constraint to which the element is subjected, which in the case of the NEW ELEVETOR system is represented by interlocking in the upper part and hinge in the lower part, and by the radius of inertia of the section, therefore:

$$\lambda = \frac{l_0}{i_m}$$

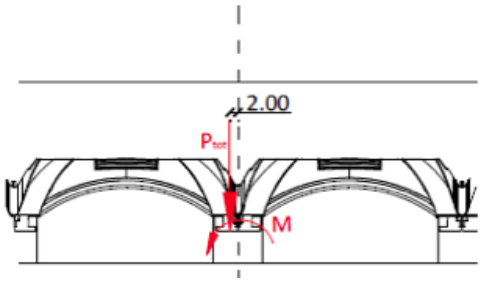
The calculation of the pile must lead to the verification that the voltage acting is lower than the permissible concrete tension, i. e:

$$\sigma_{\max} = -\frac{P_{tot}}{A_c + nA_a} - \frac{M}{W} < \bar{\sigma}_{amm}$$

Where:
P_{tot} represents the total load acting on the pillar.
A_c+ nA_a is the ideal section area:

$$A_c + nA_a = \pi \cdot r^2 + 15 \cdot (1 \cdot \varnothing 6) = \pi \cdot 6.25^2 + 15 \cdot (1 \cdot 0.28) = 127 cm^2$$

M is the stimulating moment acting on the section composed of two factors:
M1: Assuming that the load (Ptot) is applied with respect to the barycentre of the section with an eccentricity of 2cm, i. e. internal to one third of the section.



M2: represents the moment due to a braking action of a possible vehicle; supposing that the braking action is equal to 1/10 of the vertical action, and given the geometry of the loading system it is plausible to assume that the load dissipates along the thickness of the pavement until it becomes almost zero in correspondence of the foot, so it is assumed to take an aliquot of 5% of the load to be applied as a stressing moment, therefore it appears that the braking force is equal to:

$$F = (P /10) \times 0.05 = 0.275kN$$

The arm of this force is equal to the distance between the upper surface application line of the slab and the reinforcement line, i. e. d, so moment M2 is equal to:

$$M2 = F \times d$$

Therefore:

$$M = M1 + M2$$

W represents the resistance module of the cross section, which for a circular section is equal to:

$$W = \frac{\pi \cdot D^3}{32}$$

GROUND PRESSURE CHECK

Each pillar unloads a pressure on the ground on an area identified by the area of the pillar itself, the pressure calculation, which must be compared with the structural system on which the system rests, takes place in the following way:

$$\sigma_{ter} = \frac{N}{A_p}$$

Where:
N represents the total agent force at the base of the pillar equal to :

$$N = P_{tot} + P_P$$

A_p represents the foot area:

$$Ap = \pi r^2 = \pi 6{,}25^2 = 122{,}7 \text{ cm}^2$$

The contact pressure thus determined must be supported by a suitably rated and dimensioned base.

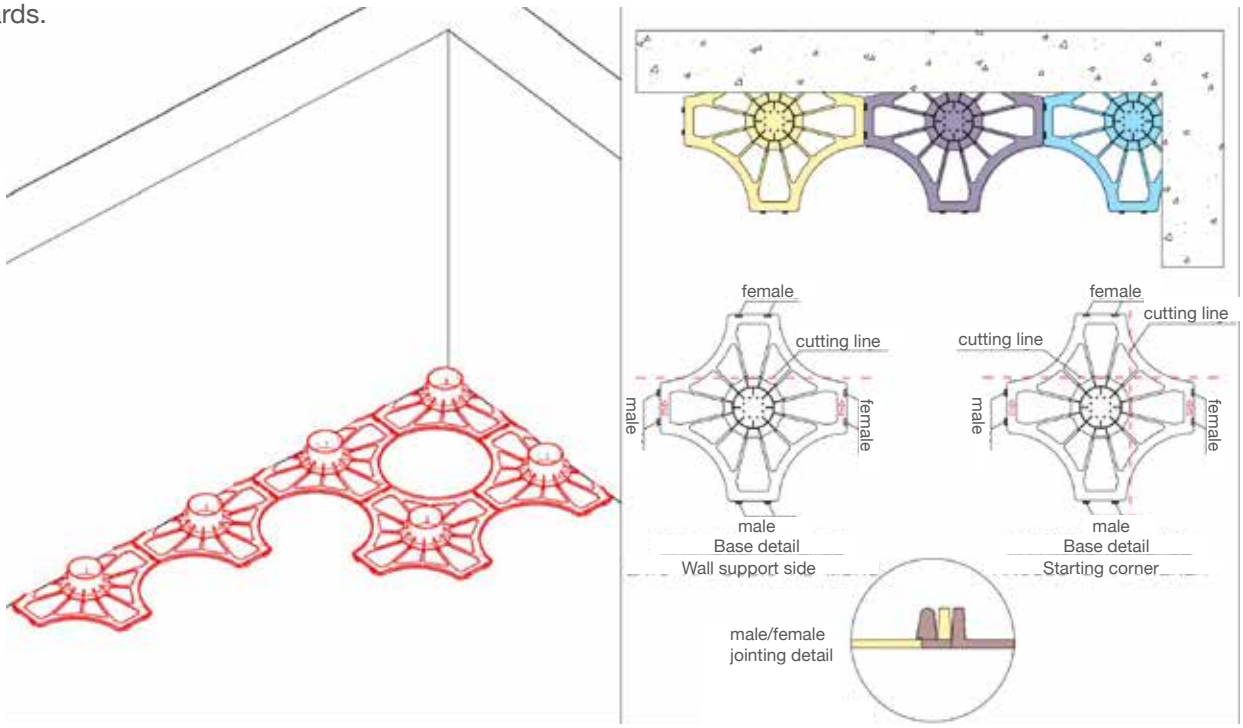
APPENDIX C

INSTALLATION MODE

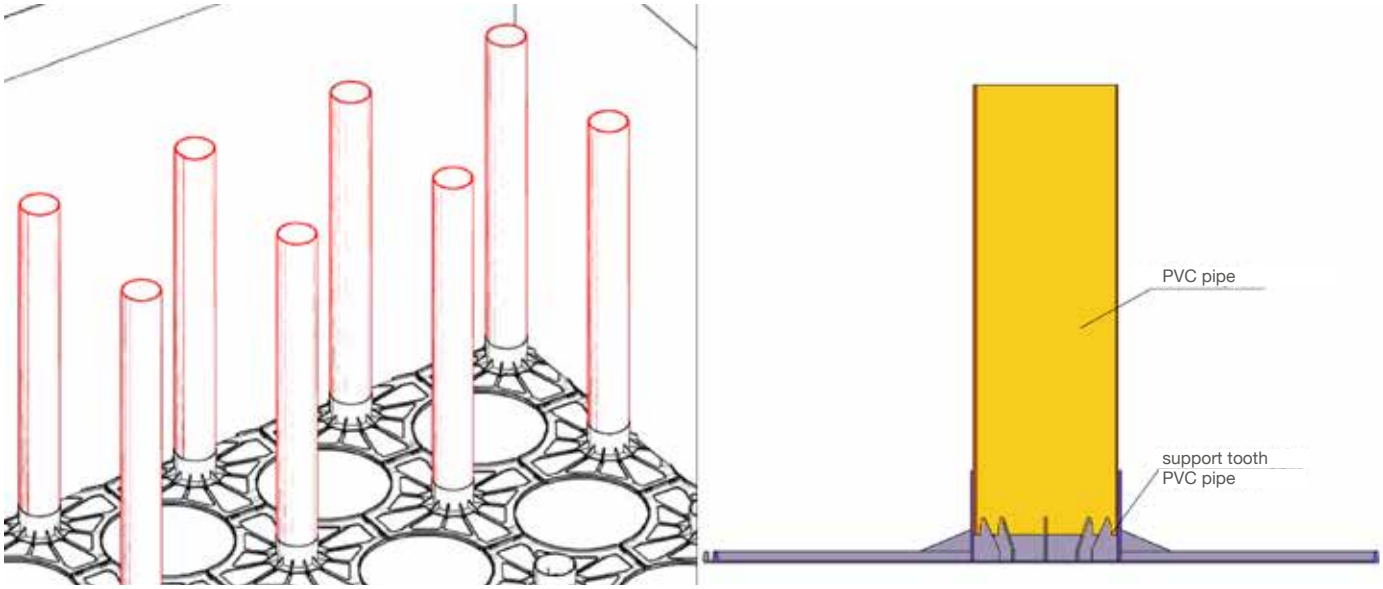
Before proceeding with the installation of the New Elevetor Tank system, the following aspects must be checked:
- The walls and bottom of the tank must have been completely constructed, including any internal partitions.
- The bottom must be perfectly flat, smooth, free of obstacles and with the slope planned by the project.
- The side walls and internal partitions must be perfectly vertical.
- The supplying/discharge pipes must already be prepared.

It is advisable to consult carefully the graphical drawing of the project plan provided by Geoplast's technical office, indicating the starting point of the installation and the direction.

OPERATION N°1: cut the bases as shown in the diagram and place the first row on the wall. Lay from left to right and from top to bottom.
On the sides of the bases there are 2 indicator arrows for correct installation. Make sure that they are always facing upwards.

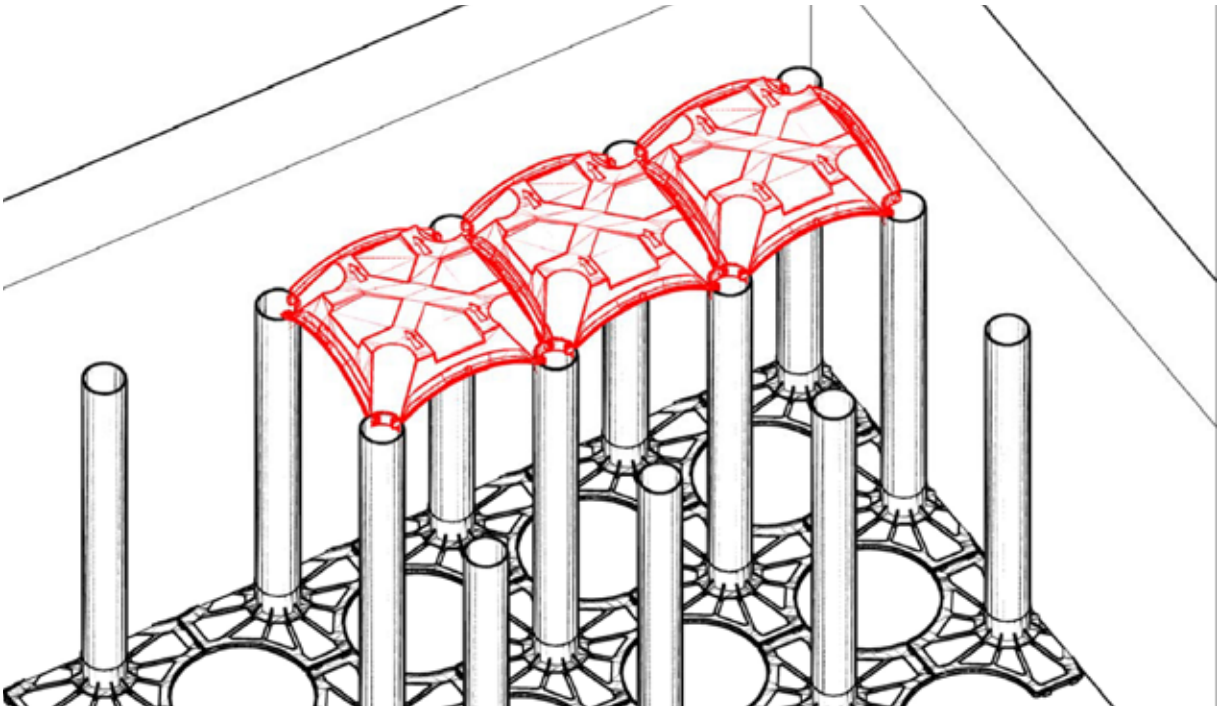


OPERATION N°2: position the pvc pipes in the bases exerting an adequate pressure to ensure correct interlocking. Make sure that the tube is fully positioned at the bottom of the base.

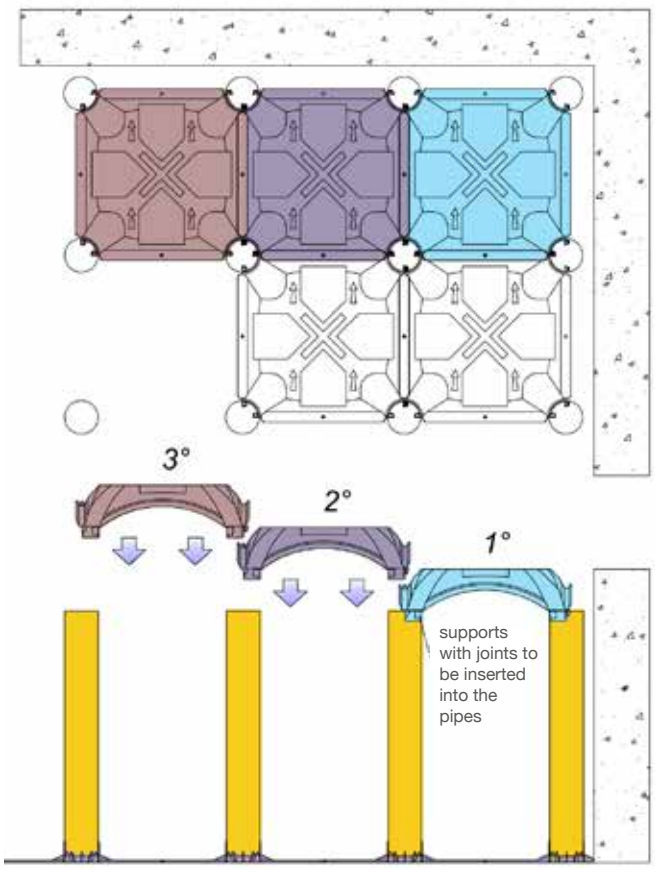


OPERATION N°3: install the NEW ELEVETOR TANK, taking care to ensure that it fits perfectly into the pipes.
Lay the formwork from left to right and from top to bottom. Be careful to place the formwork with the arrows on top of it facing upwards. Observe the instructions in the installation diagram supplied by Geoplast's technical department.

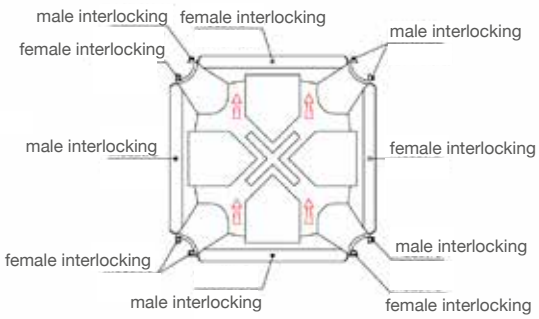
The system becomes dry walkable when at least 5 rows of formworks have been laid and these rows are placed on at least 3 sides of the tank. For the installation of systems higher than h=150 cm it is possible to use stairs or raised structures, provided they do not rest directly on the plastic system.

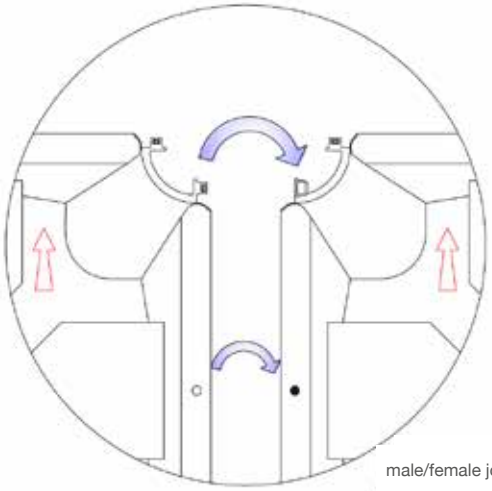


position the domes by placing them from right to left



Initial position of New Elevetor dome laying

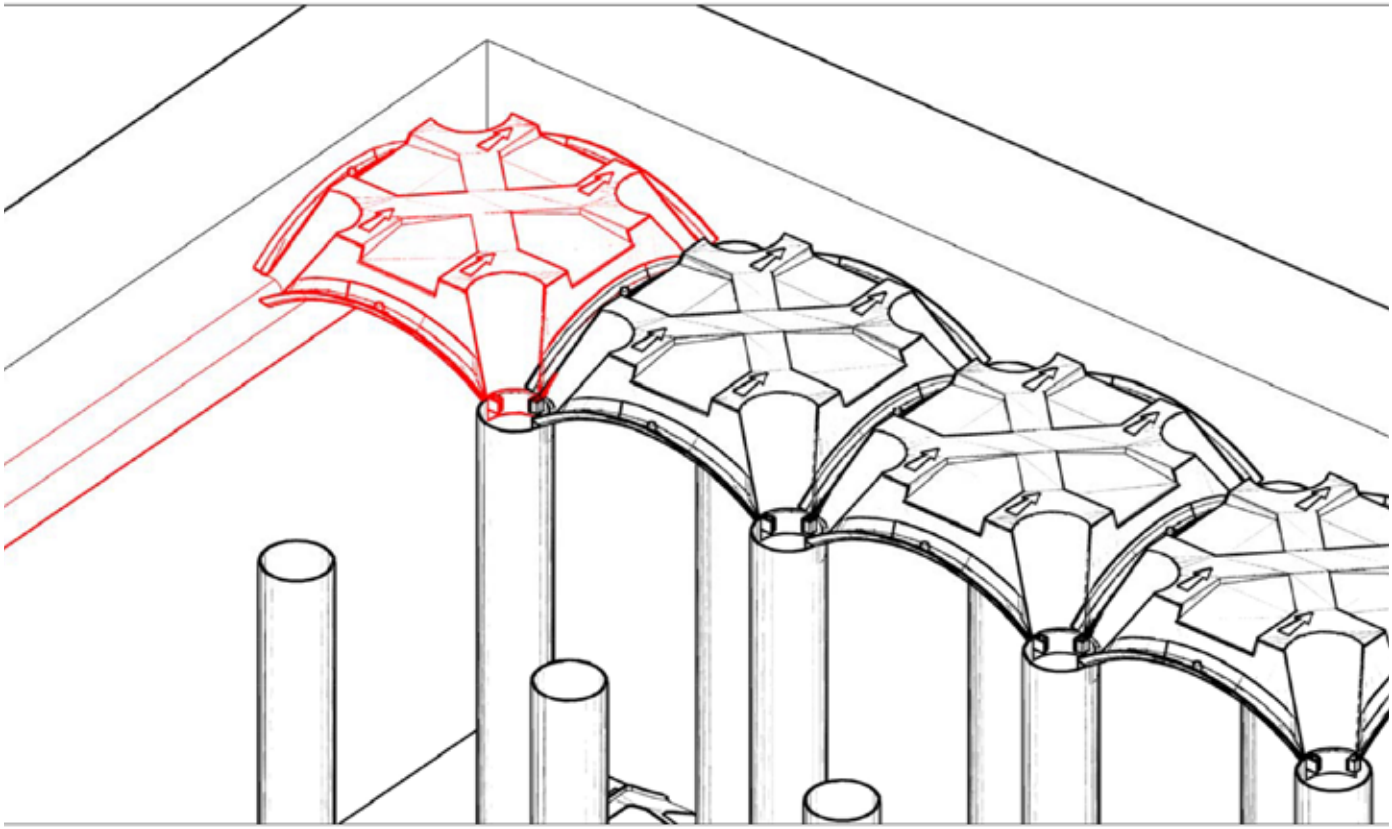




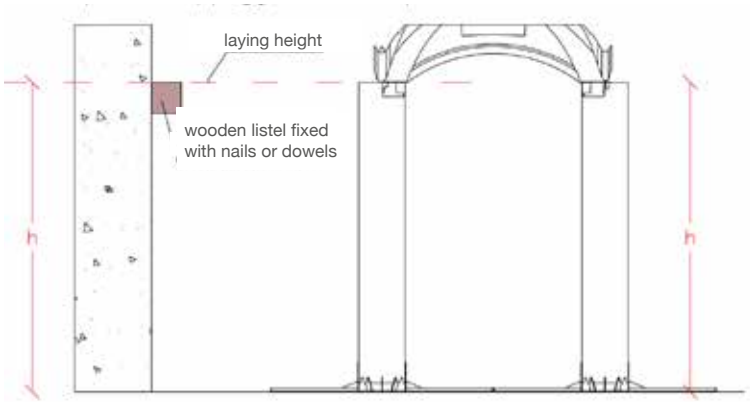
male/female jointing detail

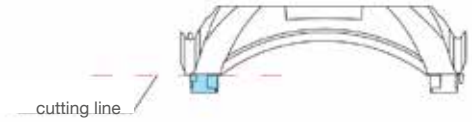
OPERATION N° 3 - INSTALLATION OF FORMWORK CLOSE TO THE PERIMETER WALLS.

CASE 1: Full dome behind the wall. In this case it is necessary to create a support for the formwork by fixing a wooden listel to the wall.

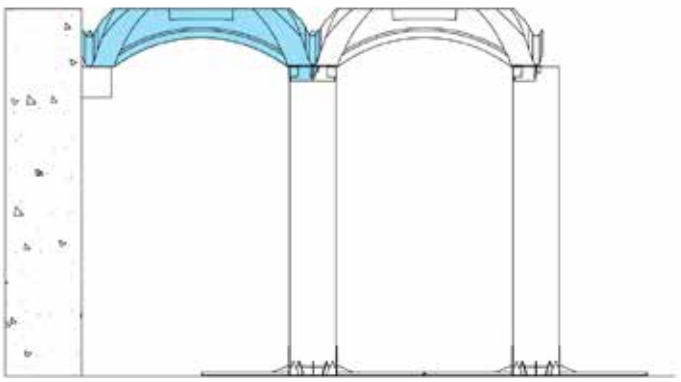


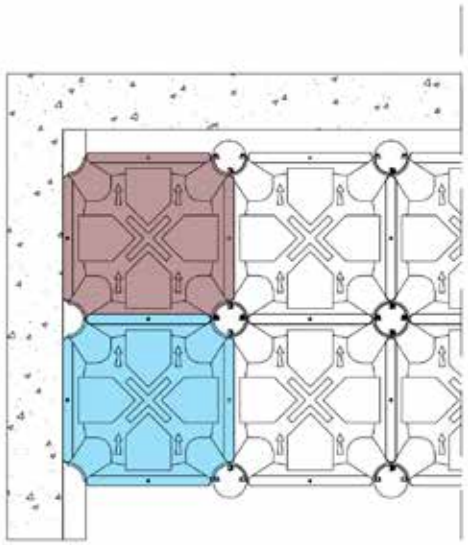
Fix the wooden batten to the same height as the dome to the pipe using pressure dowels.



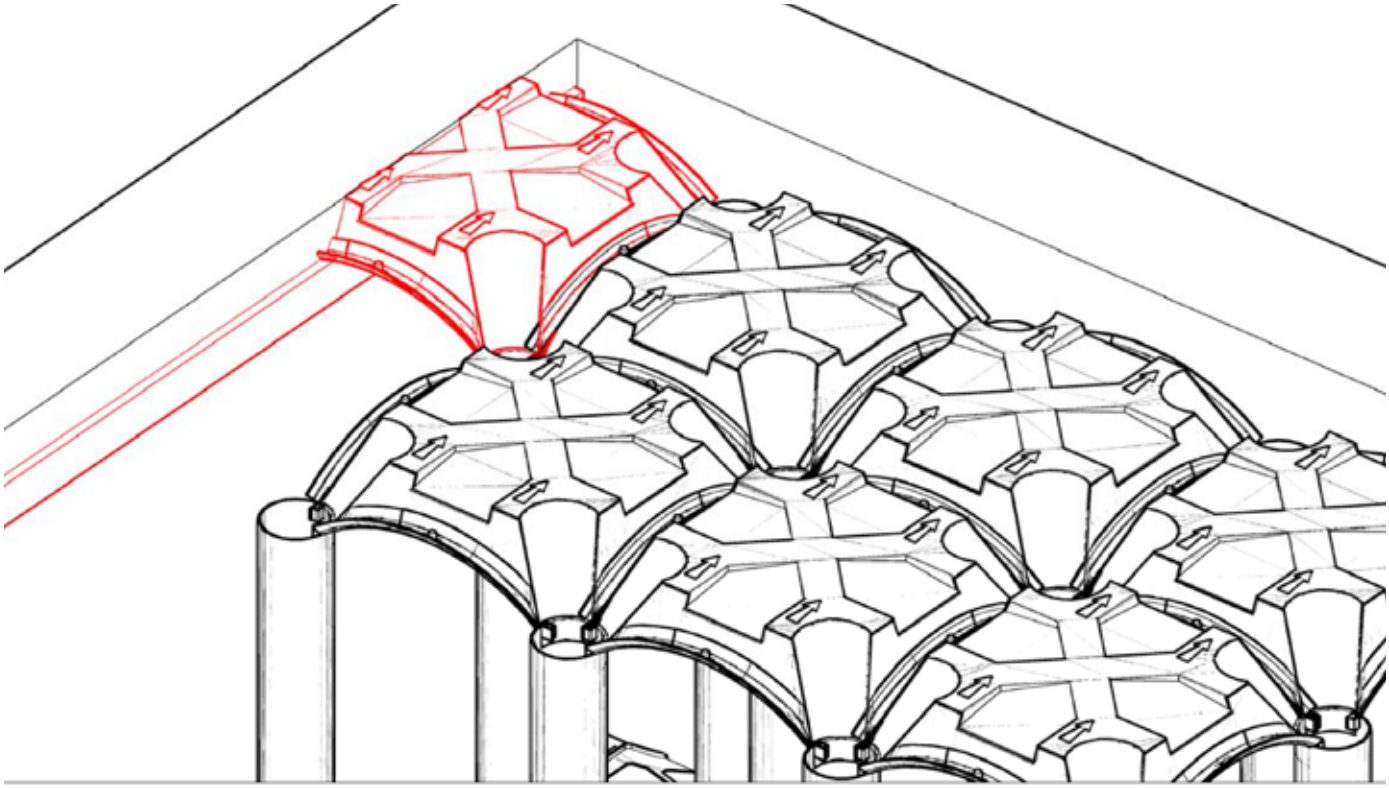


Cut the pipe fastening inserts and place the dome on the wooden listel.

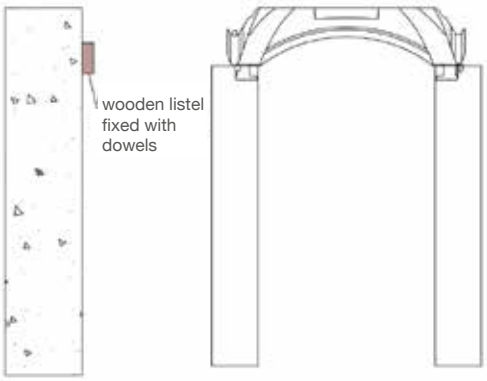




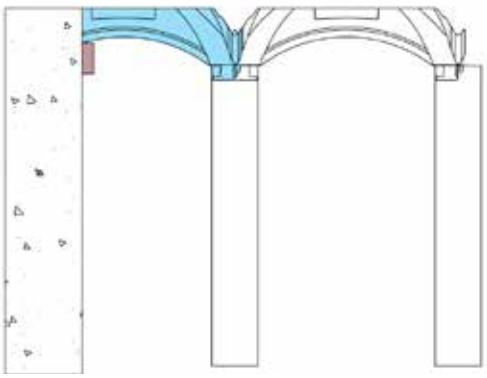
CASE 2: dome cut close to the wall. The formwork can be shaped with a flexible hose. Before cutting, accurately measure the space available for the formwork.

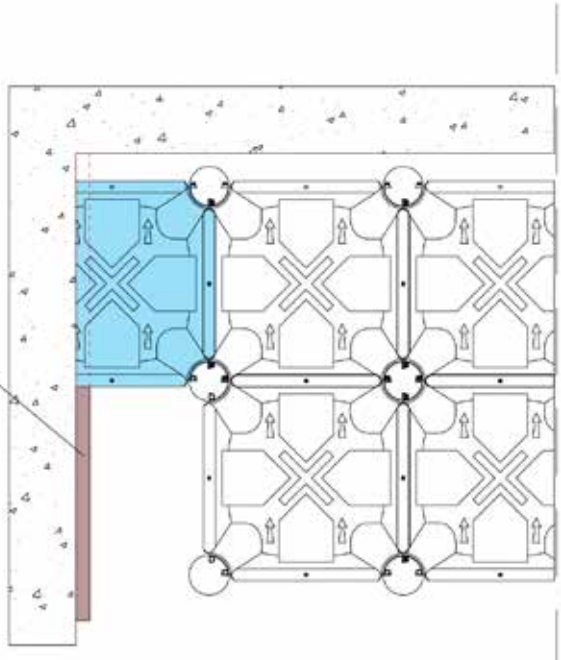


Fix the wooden listel to the same height as the dome cut.

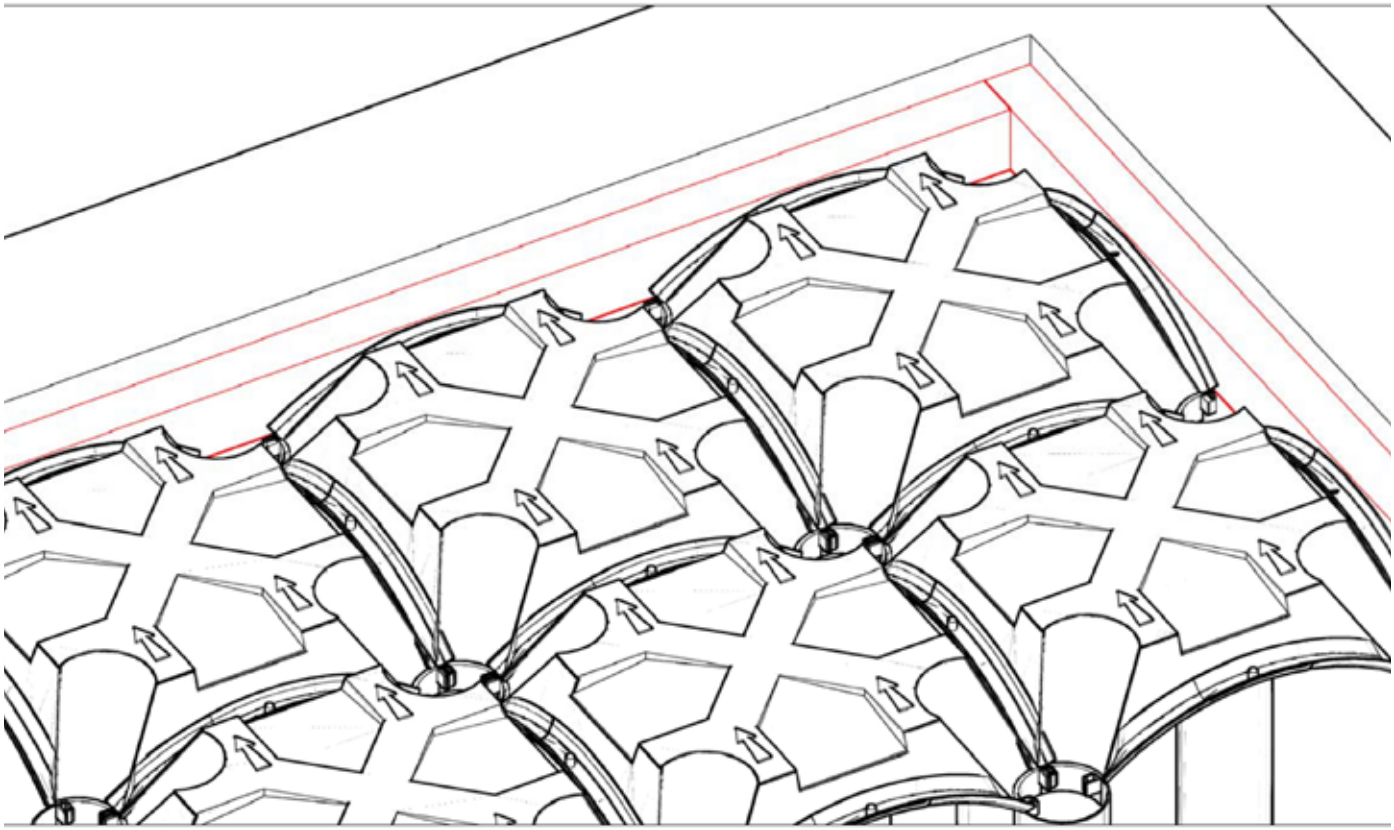


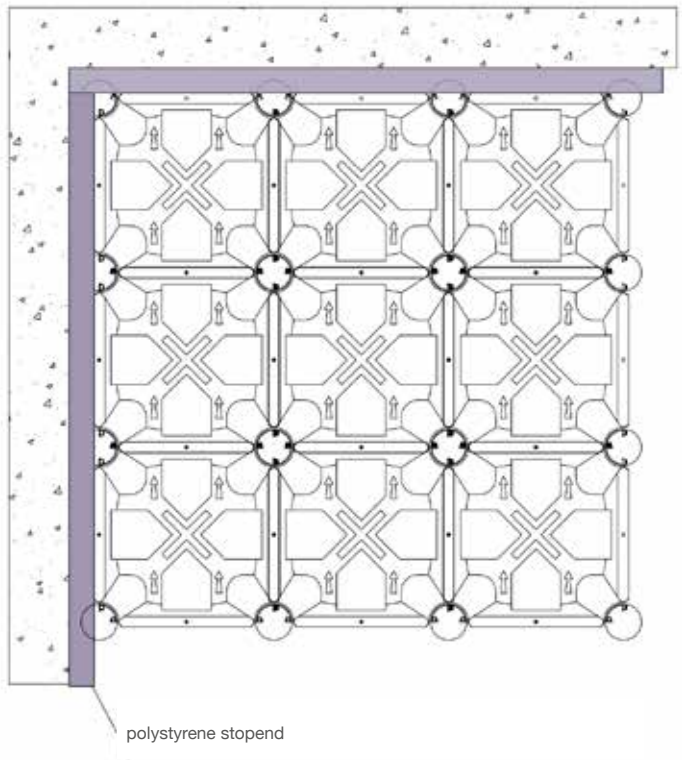
Cut the dome and place it on the wooden listel.

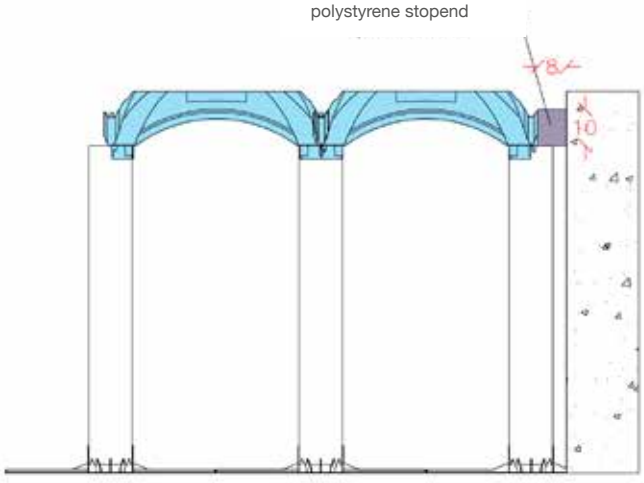




CASE 3: In this case, it is not necessary to create a support, but polystyrene listels (supplied by Geoplast) must be laid between the formwork and the wall. It must be ensured that each listel has at least 2 supports on the PVC pipes. It is not necessary to fix the listels to the wall.

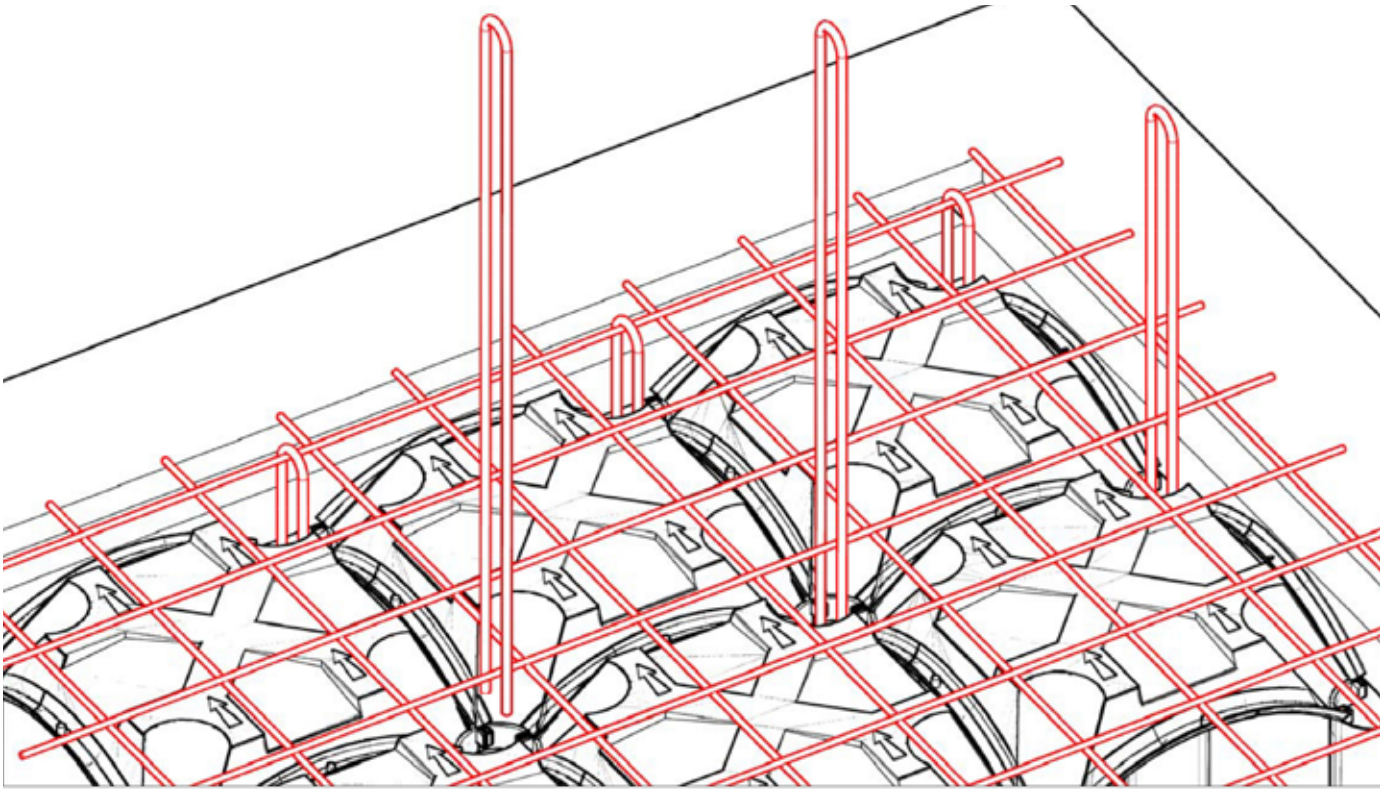


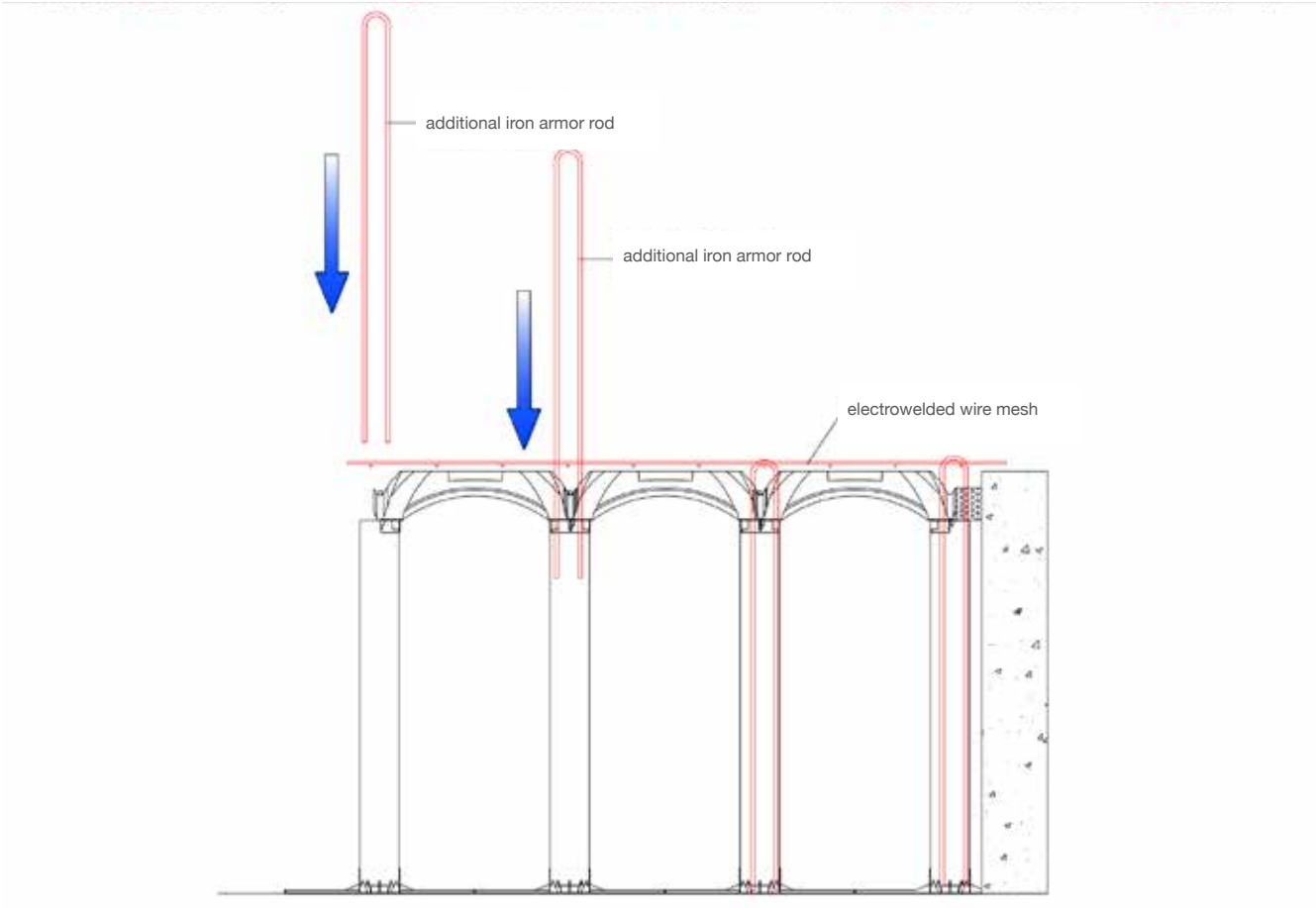




NOTE: If, in each of the 3 cases, there are any discontinuity points between the formwork and the tub edge, it is possible to close the holes using polyurethane foams.

OPERATION N°4: Lay the electrowelded wire mesh and additional armour rods in the piles.
If you want the mesh to be lifted from the formwork, make sure that the spacers above the formwork are available before installation. The needles must be long enough to reach the bottom of the pipe and must be capable of being connected to the welded wire mesh.





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rev.001
01.2018