ATE
OPERATIONAL EXPERTISE

DESIGN GUIDE FOR PERIPHERAL DRAINAGE USING BATIFIBRE SN4

UNDER TECHNICAL ADVICE No. 17/16-317_V4

DRAINING FOUNDATIONS WITHOUT GRAVEL

VERSION 09/2023 - INVALIDATES AND REPLACES ALL PREVIOUS DESIGN MANUALS

PREFACE

A.T.E. is a French industrial SME founded and located in Château-Gontier, in Mayenne (53), which has specialised in drainage, water infiltration and rainwater management since 2001. For more than 15 years, A.T.E. and its teams have been known and recognised for the quality of their production, their commitment to innovation and the development of new products that are increasingly adapted for installers.

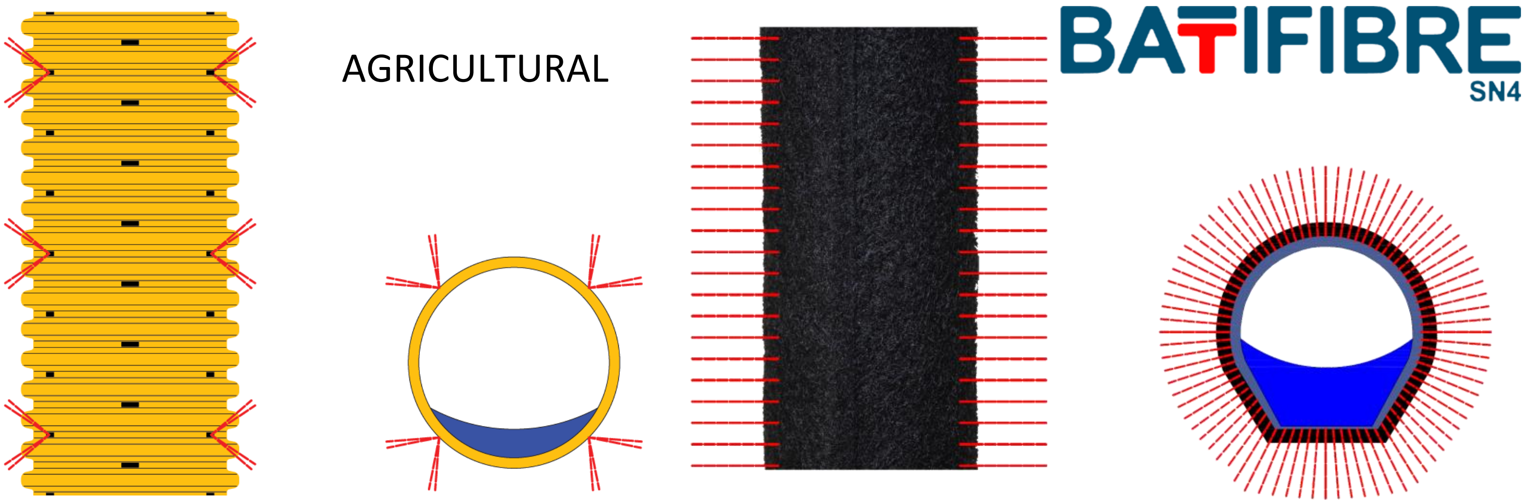
Since 2009, A.T.E. has developed, marketed, installed and helped installers to use BatiFIBRE SN4 . Thick filter technology made from pure and/or recycled polypropylene fibres was developed in the Netherlands more than 40 years ago to address a shortage of gravel and the issue of drainage products becoming blocked by fine clay and silt soils.

Numerous studies and feedback from France and around the world have demonstrated the effectiveness of a thick filter on drainage systems compared to a traditional drain design, namely a geotextile filter, a gravel coating and a land drain (agricultural style).

The purposes of coating a drain are:

- **Filtration / separation (traditionally a geotextile)** : to prevent or restrict soil particles from passing through into the pipe where they could potentially become lodged and block the pipe,
- **Hydraulic conductivity/draining function (traditionally gravel)** : to reduce the resistance to water entering the tube through the perforations by ensuring the water flows in 3 dimensions,
- **Protection** : to provide support around the whole tube in order to prevent damage caused by the weight of soil or by a sharp object accidentally falling on it.

Behaviour of the water around the drains in accordance with the technology used



PRELIMINARY STUDY

THIS MANUAL DEALS WITH DESIGNING PERIPHERAL DRAINAGE SYSTEMS USING BATIFIBRE SN4

IT IS NOT INTENDED AS A GUIDE TO REPLACE INVESTIGATIONS, SURVEYS, SIZING OR STUDIES CARRIED OUT DURING THE DESIGN AND CONSTRUCTION OF THE SYSTEM.

The preliminary study, carried out by a geotechnician, state services and the project manager, allows you to determine the feasibility of the project and the most suitable constructive techniques.

There is a solution for every type of land

While your neighbour may have constructed something successfully, it will not necessarily be suitable for your site.

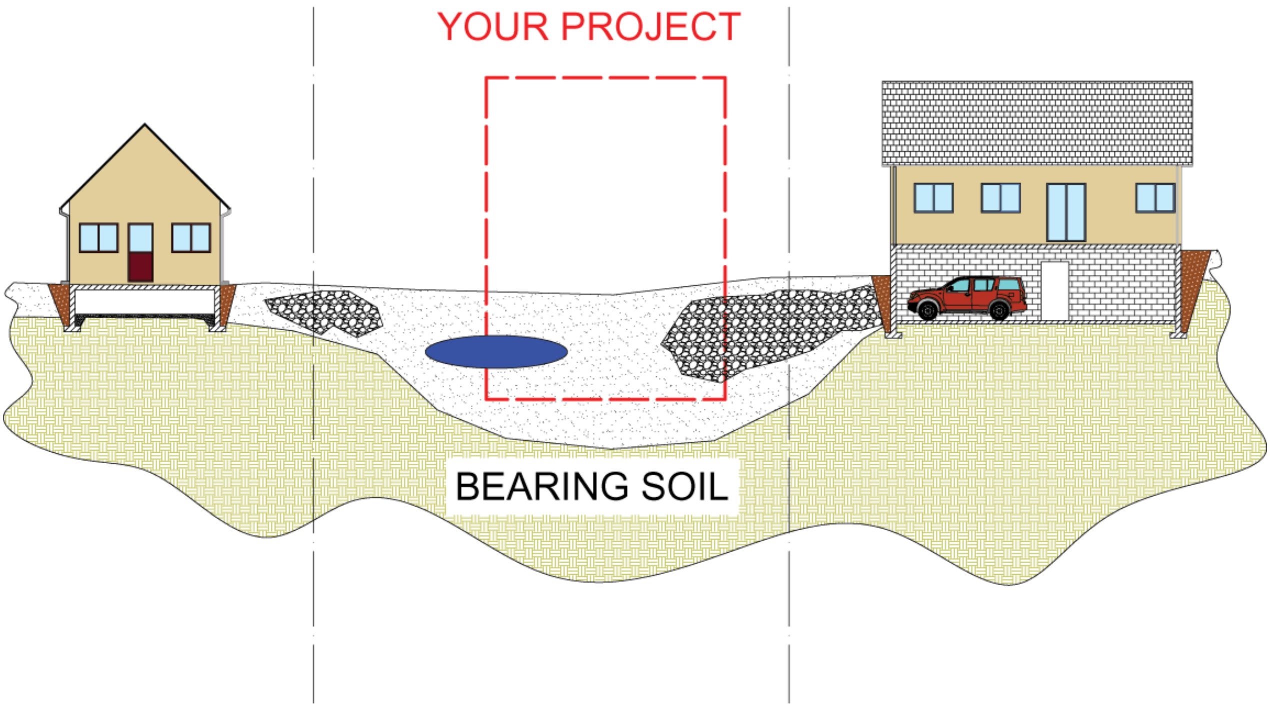


FIGURE No. 1: EXAMPLE OF CUTTING A FOUNDATION IN THE GROUND AND ITS HETEROGENEITIES

With the help of a series of tests, the preliminary study allows you to determine the foundation, drainage and stability theories for your project. A preliminary study could include:

- Visiting the site
- Surveying the surroundings
- A geotechnical study
- A hydrogeological study

NATURE, HETEROGENEITY & PERMEABILITY OF THE SOIL

FIGURE No. 2: EXCAVATING THE SOIL FOR EXAMINATION (SOIL ANALYSIS PIT)

They will carry out a series of surveys on site in order to determine precisely the type (rock, sand, clay, silt, etc.), their mechanical features (sensitiviy to sinking or expanding, bearing capacity, etc.) and the thickness of the different layers of soil, as well as to detect potential heterogeneities (backfills, cavities, seams, etc.)

Afterwards, one or multiple excavations will be performed, in order to carry out tests that measure the permeability within the soil analysis pit , allowing the permeability of the different layers of soil to be measured.

Afterwards, one or more pits will be dug, in order to carry out tests that measure the permeability of the different layers of soil affected by your future project. There are several testing methods, such as PORCHER, GUELPH, etc.

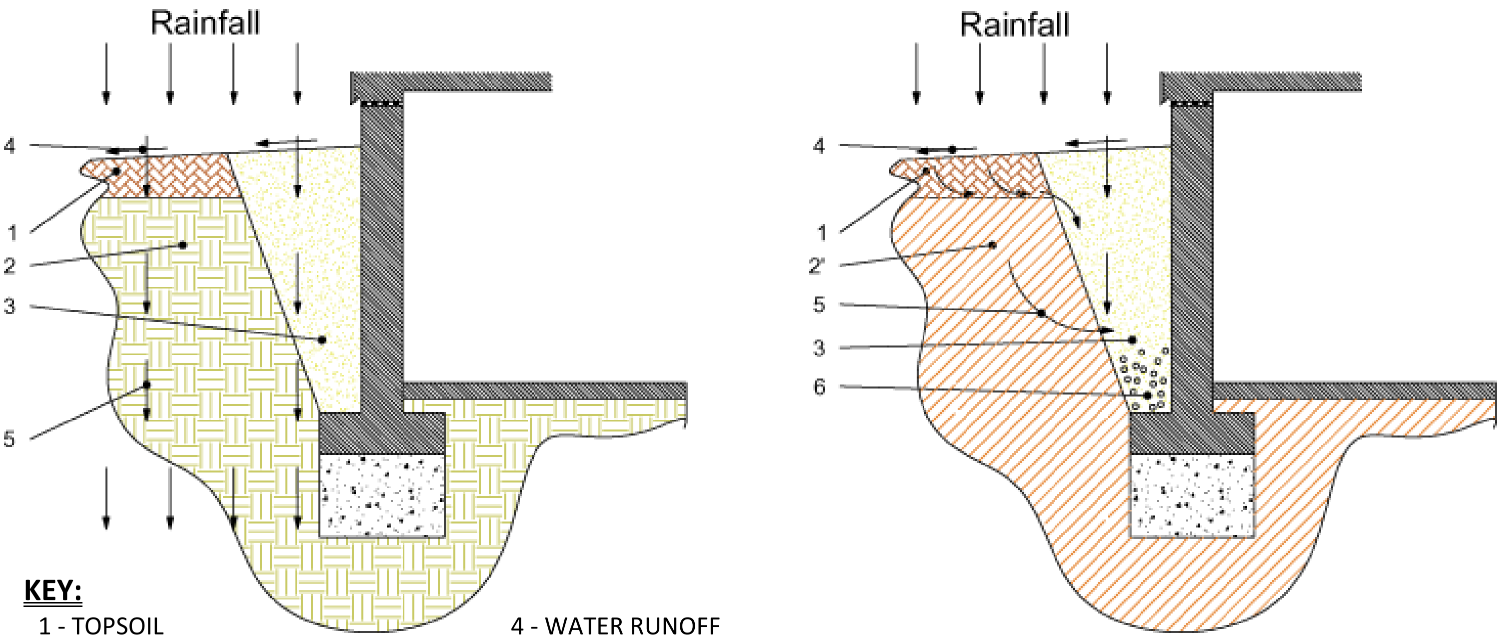
	K:Permeability coefficient [m/s] (logarithmic scale)			
1	10^{-1} '10^{-2}	10^{-3} '10^{-4} '10^{-5}	'10^{-6} '10^{-7} '10^{-8}	'10^{-9} '10^{-10} '10^{-11} '10^{-12} '10^{-13}
Permeability of the soil		**Permeable soil**	**Slightly permeable soil**	**Almost impermeable soil**
Type of soil	Clean gravel	-clean sand - Mixture of clean sand and gravel	Very fine sand -Layers of clay -Organic and inorganic silts -Mixture of sand, silt and clay	,Naturally "impermeable" soil: Homogeneous clay beneath the deterioration zone ,"Impermeable" soil modified by the effects of vegetation and deterioration

FIGURE No. 3: PERMEABILITY OF THE SOIL DEPENDING ON ITS FEATURES

HOLTZ & KOVACS - INTRODUCTION TO GEOTECHNICS (1981)

Depending on the results, the designer will decide whether or not a peripheral drainage system is necessary (or if a different solution would be better).

IF THE SOIL IS PERMEABLE - DRAINAGE IS NOT ***IF THE SOIL IS NOT VERY PERMEABLE - DRAINAGE IS***



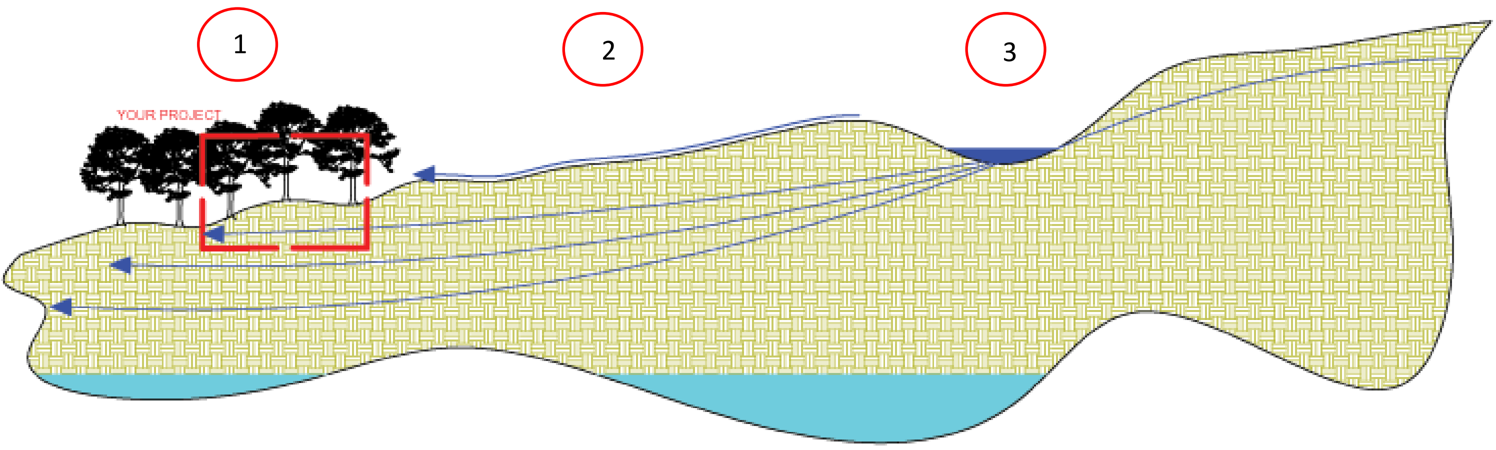
KEY:

1 - TOPSOIL
2 - PERMEABLE LAND
2' - LAND WHICH IS NOT VERY
4 - WATER RUNOFF
5 - PERMEATED WATER
6 - ACCUMULATION OF WATER

FIGURE No. 4: IMPACT OF THE PERMEABILITY OF THE SOIL ON FOUNDATIONS

TOPOGRAPHY OF SITE & SURROUNDINGS

During the preliminary study, the nature of the soil will be taken into account, but also the topography of the site and the immediate surroundings (presence of trees nearby, natural gradients before construction, aquifer recharge zone, etc.):



1. Vegetation: the presence of trees and bushes near to the project before and after construction greatly influences the mechanical properties of the soil,
2. Agricultural plain: large cultivated surfaces, without slopes, cause large quantities of surface water to accumulate during storms, which could come into contact with the system,
3. Recharge zone: Standing water has time to percolate into the ground either to enter the zone of saturation or to run along the surface layers to emerge again nearby.

FIGURE No. 5: EXAMPLE OF A PARTICULARITY THAT COULD AFFECT WATER ENTERING THE SYSTEM

PLANNED OR EXISTING FOUNDATIONS

If the preliminary study reveals a risk of water coming to and accumulating at the foot of the system, requiring the implementation of a drain, plans should be made to adapt the foundations so as not to destabilise the project.

Where work is being carried out on an existing structure, individual surveys should be carried out to determine the level and type of existing foundations.

FIGURE No. 6: LOCALISED SURVEY TO DETERMINE THE NATURE AND DEPTH OF THE EXISTING FOUNDATIONS

ZONE OF SATURATION

Peripheral drainage is not intended to drain (lower) the zone of saturation.

In cases where the site of your project has such a zone, a specific study must be carried out in order to identify a solution or multiple solutions that are best suited to limiting its impact. Potential solutions include:

- A watertight lining,
- draining trenches
- well + pump,
- etc.

DRAINING WATER THAT HAS COLLECTED

The preliminary study must show the setting and the method for disposing of water that has collected.

This outlet must not be submersible when the collection system is in operation.

CONTROLLING SURFACE WATER

Peripheral drainage systems for buildings aim to remove excess water in the ground.
Surface water (from rooftops and runoff) should be managed by a specific network.

RAINWATER FROM ROOFTOPS

Rainwater that has fallen on rooftops will be collected by guttering and then directed to a collection box, which is connected to a network, independent of the drainage network, to be drained through the outlet.

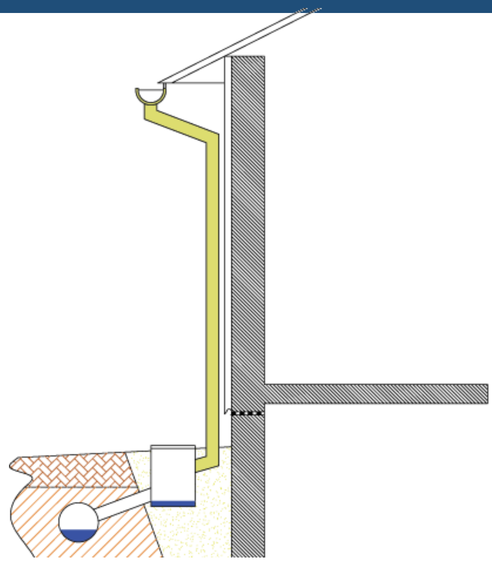
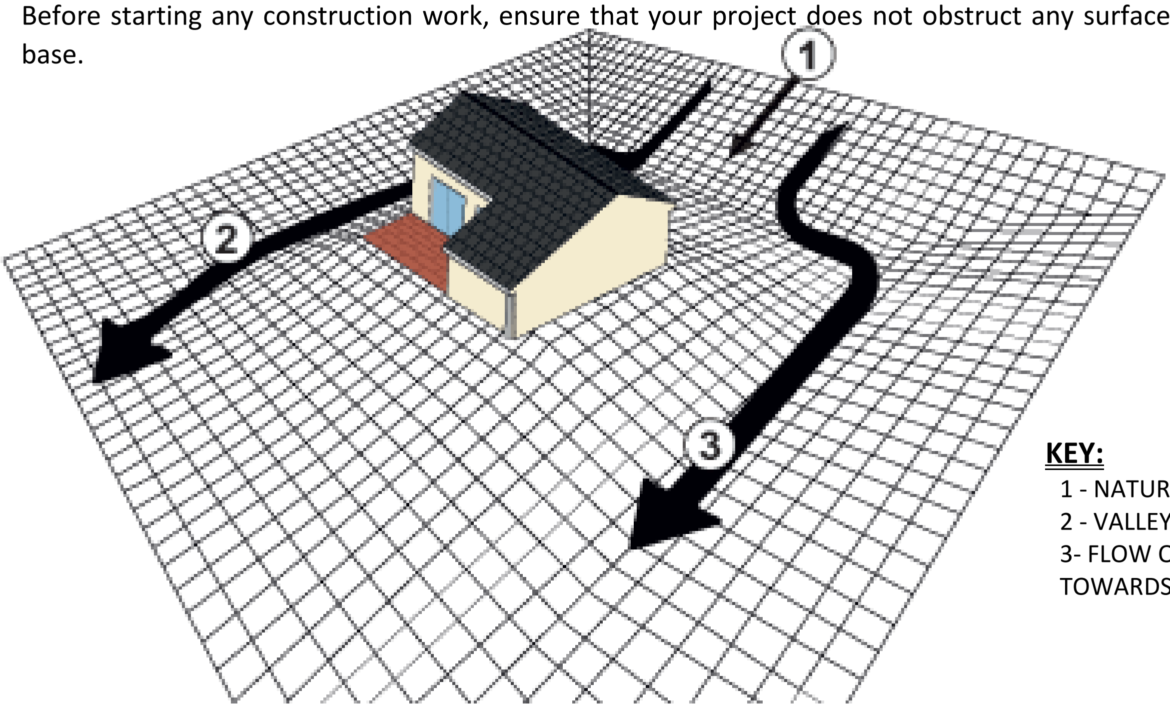


FIGURE No. 7: PRINCIPLE OF COLLECTING RAINWATER FROM ROOFTOPS

WATER RUNOFF

Before starting any construction work, ensure that your project does not obstruct any surface water flowing over your base.



KEY:

1 - NATURAL GRADIENT OF SITE
2 - VALLEY
3- FLOW OF SURFACE WATER TOWARDS AN OUTLET

FIGURE No. 8: PRINCIPLE OF THE RUNOFF BYPASSING THE HOUSE

If this is not the case, plans will have to be made to collect the surface water so that it can bypass the construction without coming into contact with it.

Two stages to follow:

- Moving the ground: Creating a slope directing water away from the building
- Creating collection and drainage systems for surface water:
  - Valley/ditch

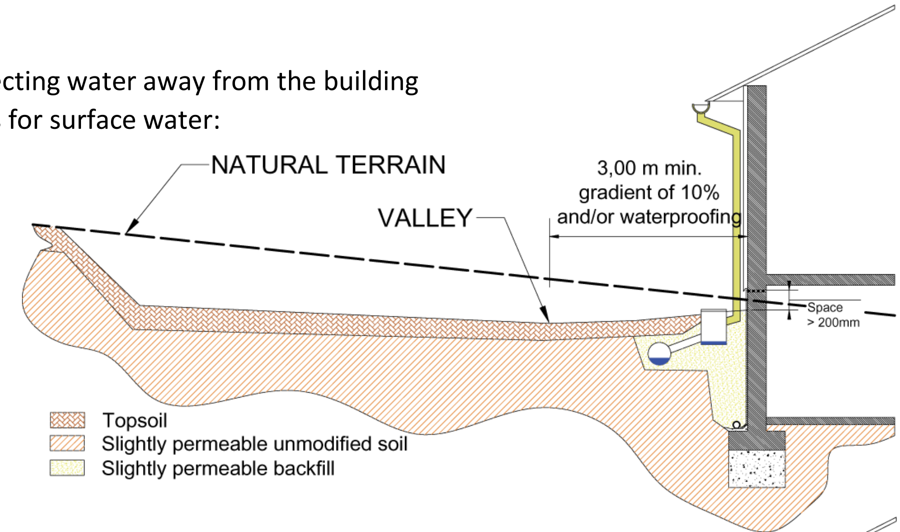


FIGURE No. 9: PRINCIPLE OF COLLECTING WATER USING A VALLEY

  - Installing a gutter, drain and outflow system

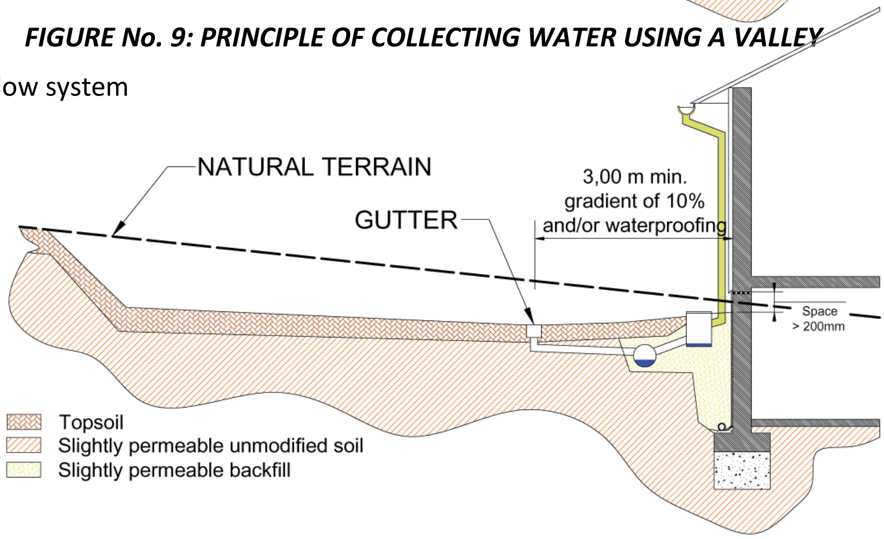


FIGURE No. 10: PRINCIPLE OF COLLECTING WATER USING A GUTTER/DRAIN

  - Draining trench

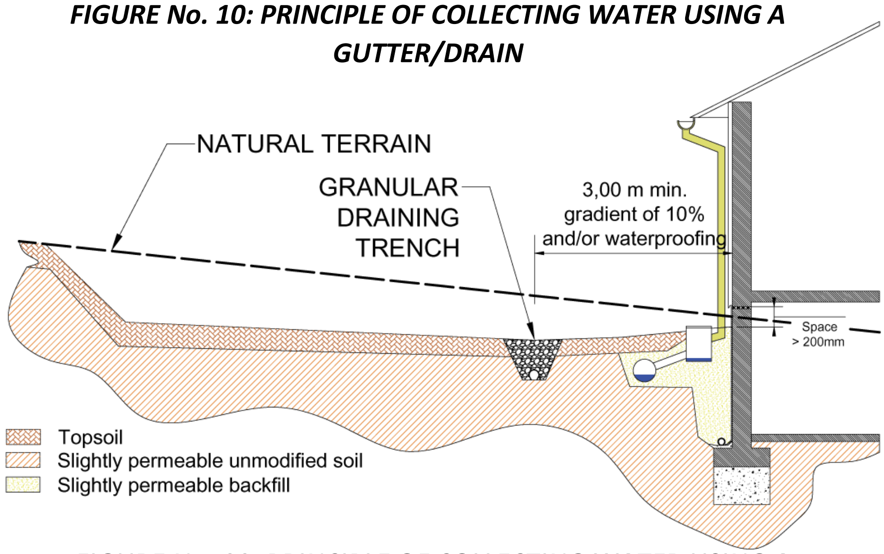


FIGURE No. 11: PRINCIPLE OF COLLECTING WATER USING A GRANULAR DRAINING TRENCH

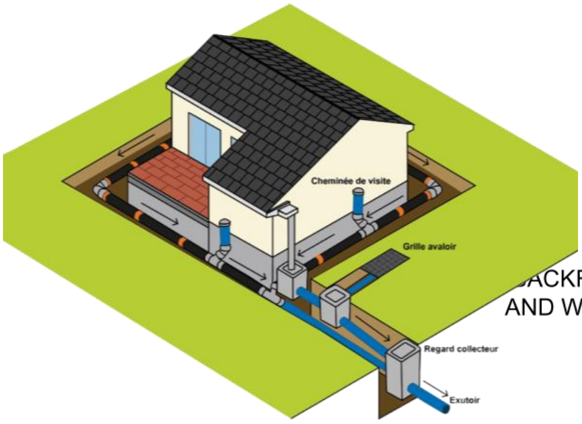
You must channel your water flows and discharges.
Only naturally flowing water is allowed over your neighbour's site.

PERIPHERAL DRAINAGE

OUTLET & DISCHARGE LEVEL

In order to make the drainage effective, collected water should be removed in a satisfactory manner towards any of the following:

- The public network.
- A surface waterway.
- An adapted infiltration system (correctly positioned and sized).



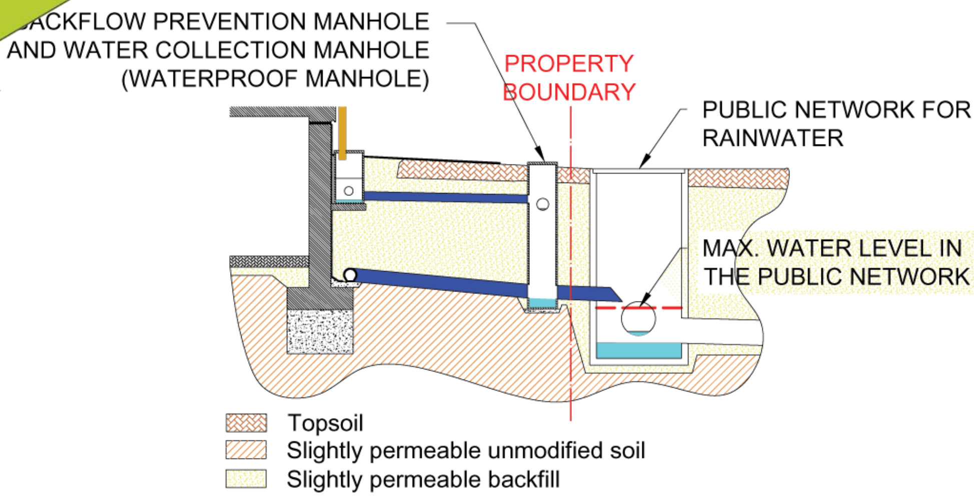
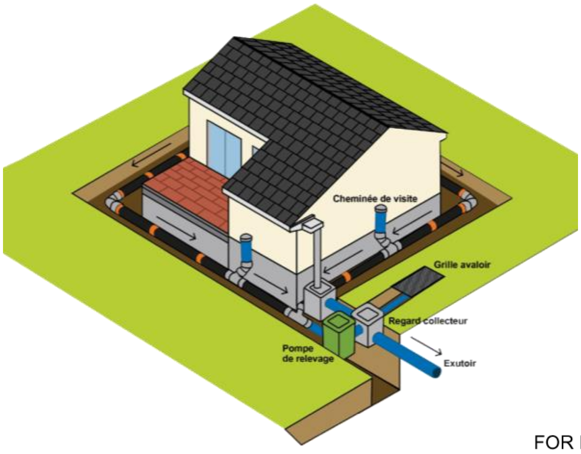


FIGURE No. 12: PRINCIPLE OF REMOVING WATER COLLECTED THROUGH GRAVITY



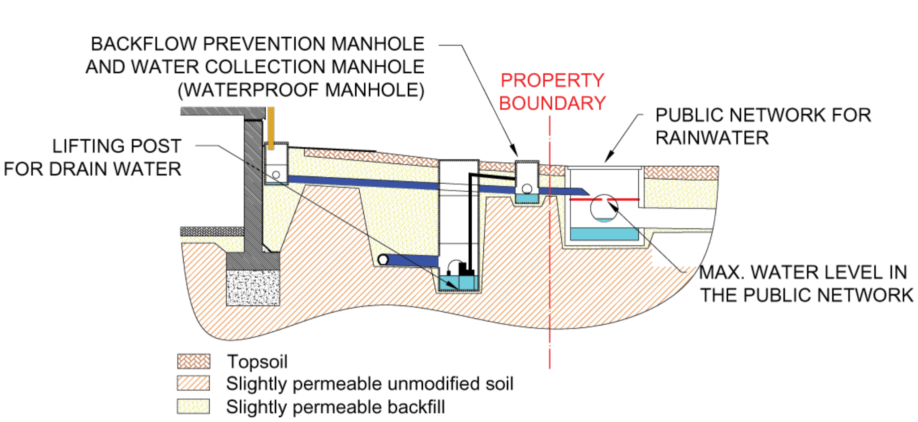


FIGURE No. 13: PRINCIPLE OF REMOVING WATER COLLECTED USING A LIFTING PUMP

POSITIONING THE DRAIN

In order to optimise the efficiency of the peripheral drainage system, the drain should always:

- Be below the inside paving level
- Not be below the top foundation level (influence of humidity level of the supporting soil),
- In cases where the ground is susceptible to sinking or expanding, the drain should be removed from the foundations and constructive measures should be implemented.

NEW SYSTEMS

SOIL THAT IS NOT OR IS BARELY SUSCEPTIBLE TO CLAY SINKING OR EXPANDING:

The BATIFIBRE SN4 drain can be positioned along the foundation, on a thin, concrete channel in order to create a runoff slope or to give it distance (see below)

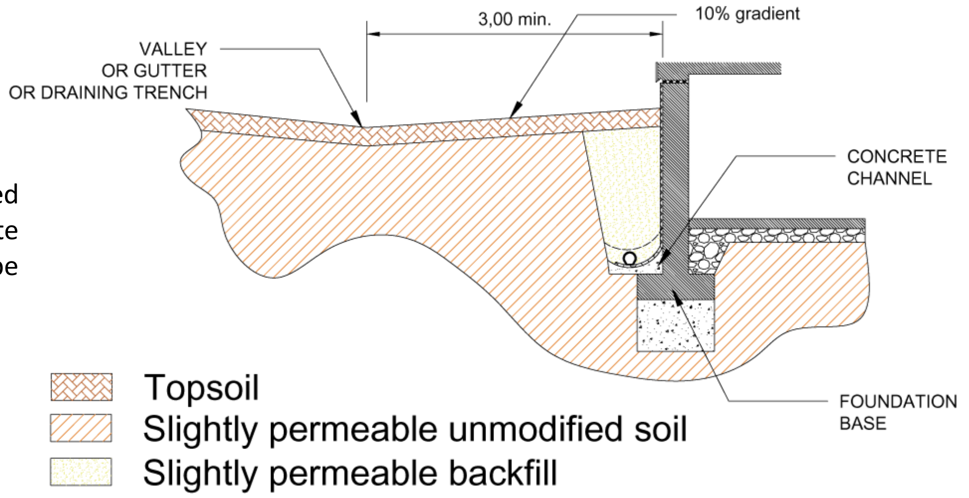


FIGURE No. 14: PERIPHERAL DRAINAGE NEAR TO FOUNDATIONS

SOIL THAT IS QUITE OR IS VERY SUSCEPTIBLE TO CLAY SINKING OR EXPANDING:

The BATIFIBRE SN4 drain will be positioned about two metres from the foundations, with care taken not to drop the drain too low and destabilise the foundations.

An angle of:

- 30° in clay soil
- 15° in sandy soil, should be

used so as not to impact the soil bearing the foundations.

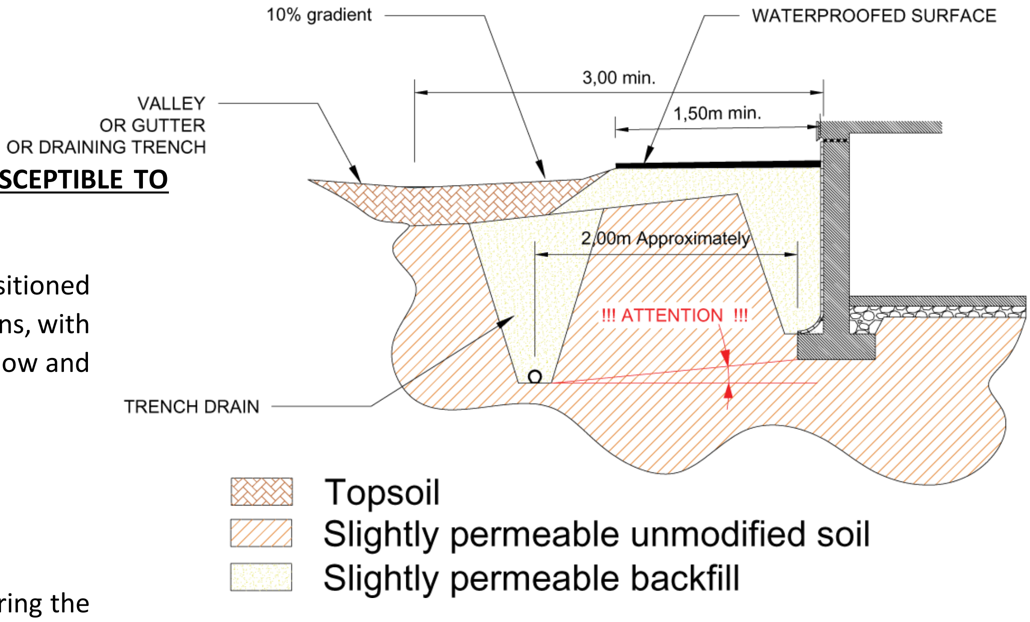


FIGURE No. 15: PERIPHERAL DRAINAGE USING DRAINING TRENCH

A waterproof surface (terrace, geomembrane, etc.) of about 1.5m around the whole building, will be installed to limit changes in the hygrometry of the soil.

The draining trench created is not a trench drain and is therefore not intended to manage surface water. Plans should be made for a suitable system.

OLD SYSTEMS

SOIL THAT IS NOT OR IS BARELY SUSCEPTIBLE TO CLAY SINKING OR EXPANDING:

In order to position the drain beneath the inside paving level, the existing foundations can be underpinned.

Underpinning consists of creating new, deeper foundations. This technique requires expertise in masonry so as not to destabilise the whole structure and risk accidents.

The foundations go down deep enough to comply with previous regulations.

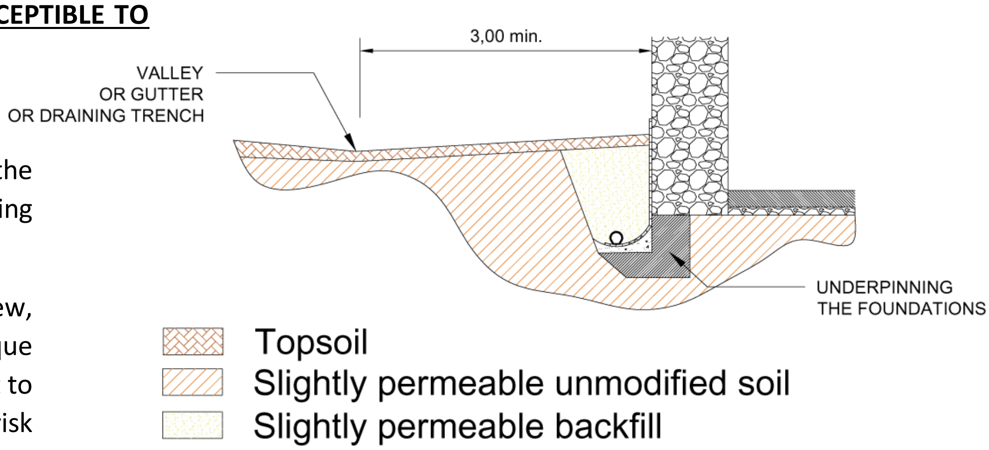


FIGURE No. 16: PERIPHERAL DRAINAGE NEAR TO THE UNDERPINNED FOUNDATIONS

SOIL THAT IS QUITE OR IS VERY SUSCEPTIBLE TO CLAY SINKING OR EXPANDING:

The same provisions explained previously apply here.

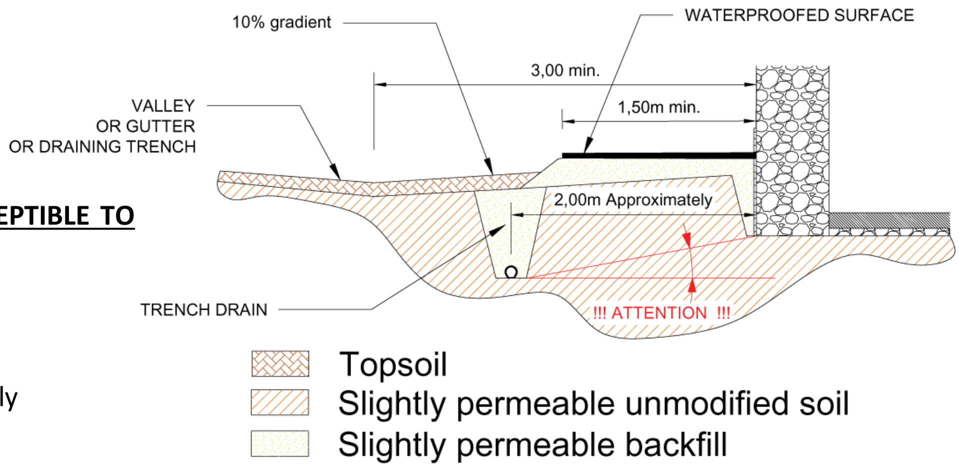


FIGURE No. 17: PERIPHERAL DRAINAGE USING DRAINING TRENCH

GENERAL FEATURES OF THE CHANNEL

When the drain is located along the foundations, it should be positioned on a concrete channel.

The channel should be rounded in shape in order to help the drain to collect water more easily. A steeper slope will be created along the wall to accompany the future draining sheet so as to avoid it becoming torn or compressed during backfilling.

The channel is made with a longitudinal slope of at least 0.5%.

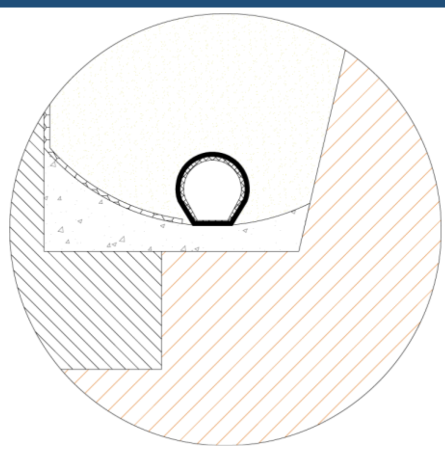


FIGURE No. 18: PRINCIPLE OF THE SHAPE OF THE CONCRETE CHANNEL

HETEROGENEITIES

The presence of heterogeneity at the site:

- Former tree pit,
- Seam of ground that is more permeable - emerging or not,
- etc.,

create retention zones near the foundations.

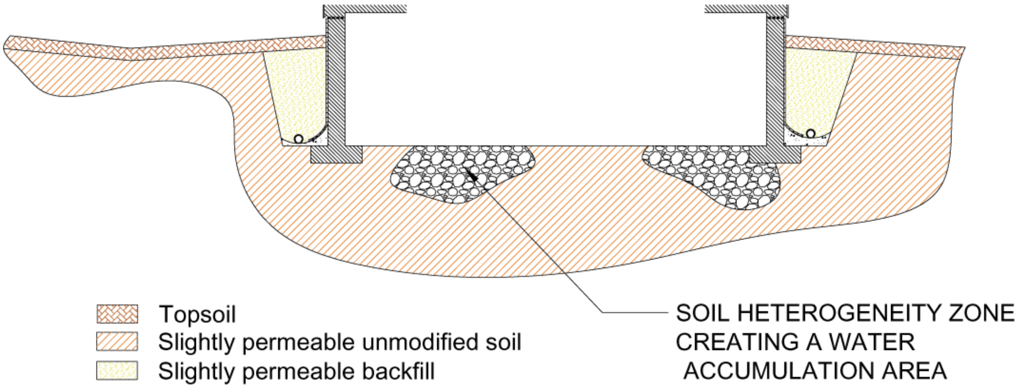


FIGURE No. 19: PRESENCE OF HETEROGENEITIES NEAR TO FOUNDATIONS

In order to avoid any future structural issues, these heterogeneities should be addressed (drain and fill cavities with concrete for example)

> The absence of a slope at the bottom of the excavation, or the drainage system being placed on the edge of the foundations without a channel, may generate water accumulation areas at the foot of the structure and risks causing structural problems.

INTERNAL DRAINAGE

In certain instances, an internal drainage system should be installed to limit or eliminate:

- Capillary rises,
- Hydrostatic pressure that is too low and could cause paving to crack or be lifted,
- etc.

FIGURE No. 20: PAVING RAISED BY WATER UNDERGROUND

UNDERGROUND WATER FLOW

Underground water flow occurs notably:

- At sites where the natural gradient is greater than 15%.

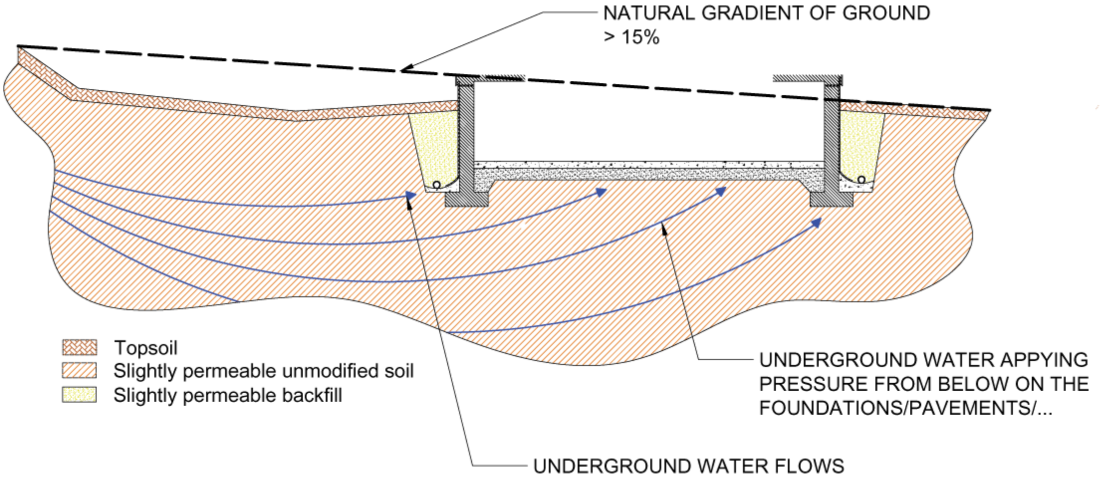
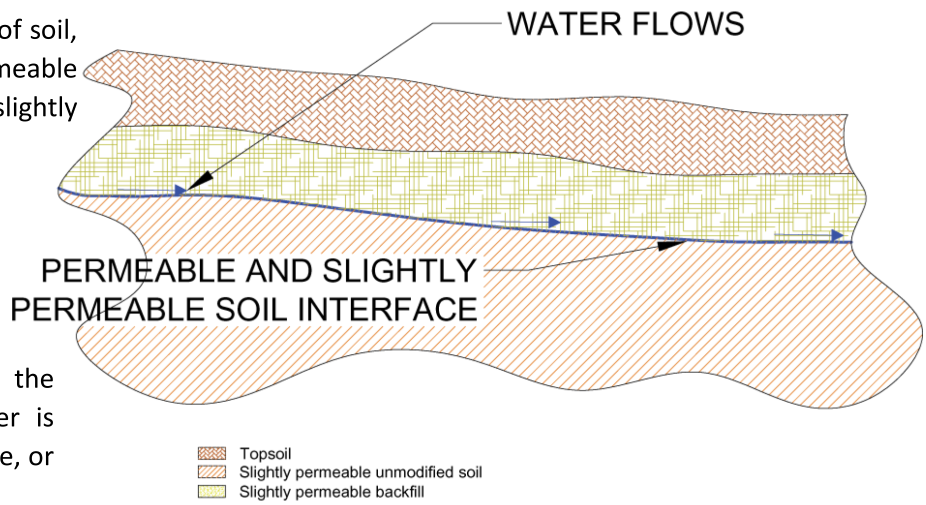


FIGURE No. 21: WATER FLOW ON A SLOPING SITE

- At the interface between two types of soil, the permeability should differ (Permeable soil rising above soil that is slightly permeable or impermeable)

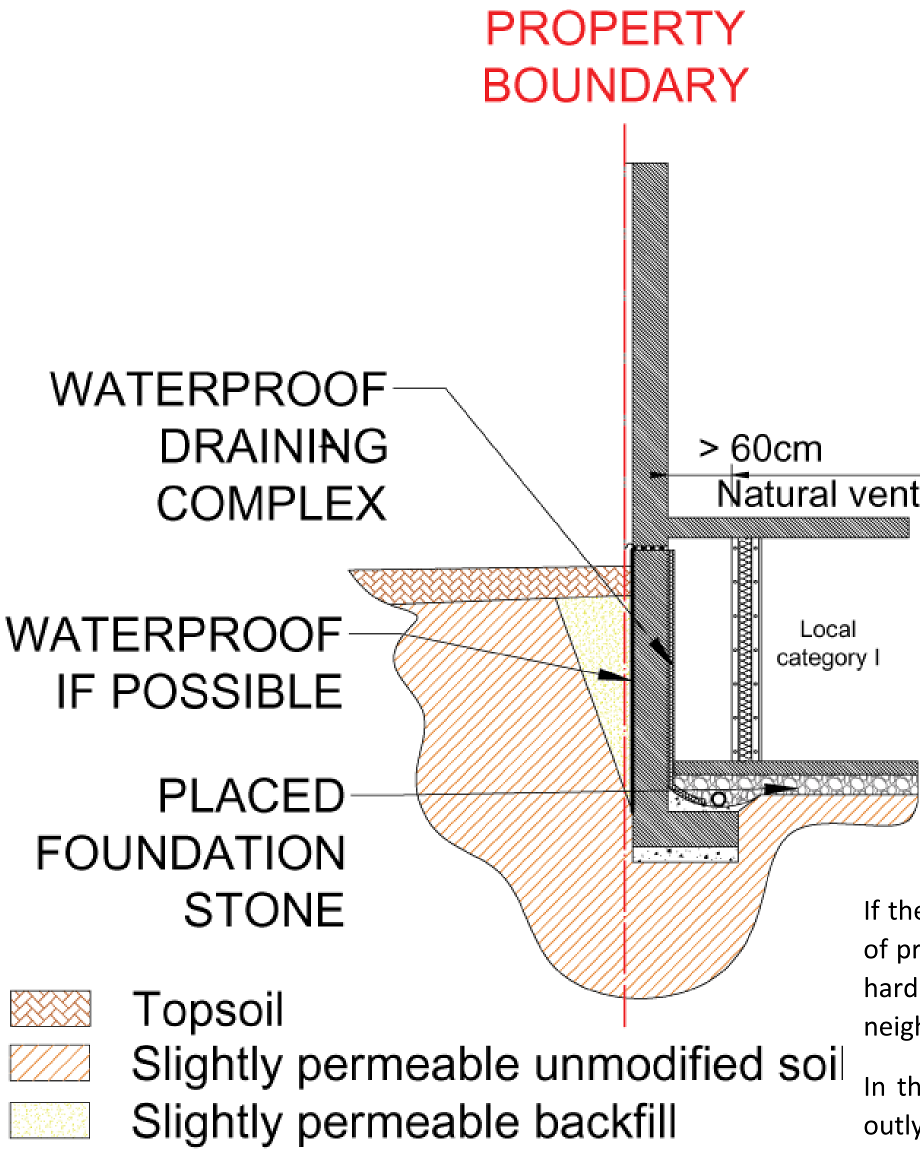


When the foundations are being made, the contractor should monitor where any water is coming from or detect the occasional presence, or absence, of water (rising sheets, etc.)

FIGURE No. 22: PERMEABLE AND IMPERMEABLE SOIL INTERFACE

The contractor should identify the "sources" of these arrivals and correctly evaluate the flow rate in order to make the drainage system and the adjacent systems the correct size.

DRAINAGE WITHIN THE PROPERTY



If the structure is being built within the boundary of property, foundation drainage to the outside is hard to achieve (establishing constraints on your neighbour's land, etc.)

In this case, the drainage should be internal. An outlying drain will be positioned underneath the pavement and a waterproof draining lining will be positioned against the wall.

FIGURE No. 23: INTERNAL DRAINAGE WITHIN THE PROPERTY

If the underground space is due to become a "noble" space (CATEGORY I according to DTU (building code) 20.1), such as a bedroom, a technical space of at least 60cm will be planned between the wall fitted with a waterproof draining complex and the insulation or the partition to ensure natural ventilation and accessibility.

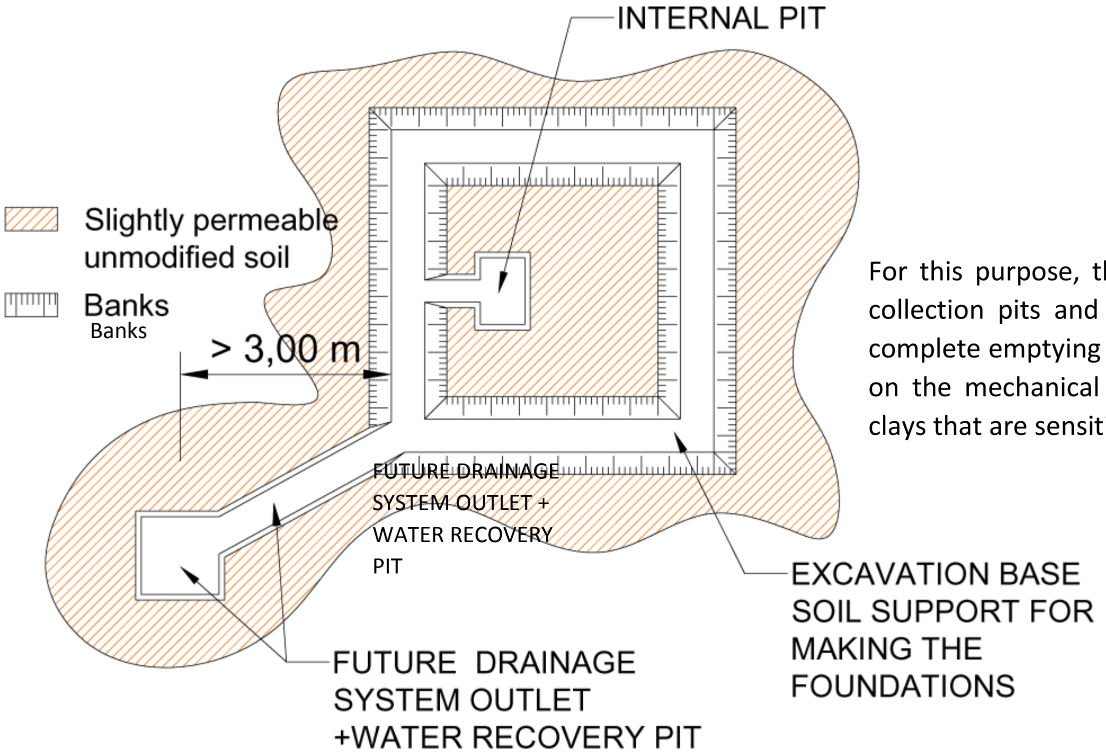
There are not any special requirements for a category II space.

MANAGING WATER DURING THE

During the construction period, water could collect at the base of the foundations if there are not any definitives rainwater management systems in place.

The contractor in charge of the work should:

- Move any ground that is necessary to remove such water from the construction site
- Drain the water properly when they have just accumulated at foundation level, whatever the status of the building work is (excavation, casting the foundations, casting the low floor, etc.)



For this purpose, the contractor can create water collection pits and install lifting pumps to ensure complete emptying and to limit the impact of water on the mechanical strength of the soil, especially clays that are sensitive to sinking or expanding.

FIGURE No. 24: PRINCIPLE OF COLLECTING RAINWATER DURING THE CONSTRUCTION PERIOD

Once the foundations have been "taken out of the ground", the contractor will ensure the waterproof complex is implemented on them, as well as the outlying drainage system and backfill the excavations; this is done to avoid the accumulation of construction waste at the foot of the wall and risking water coming in that can affect the mechanical strength of the soil.

If construction takes place below the points where electricity and telecom wires come in, the technical trench between the road and the construction site then becomes the preferred way to bring water to the construction site.

To avoid this problem, the contractor will ensure that the trenches concerned pass through a draining trench or drain, and he will pierce the protective sleeves to drain the water that could be there.

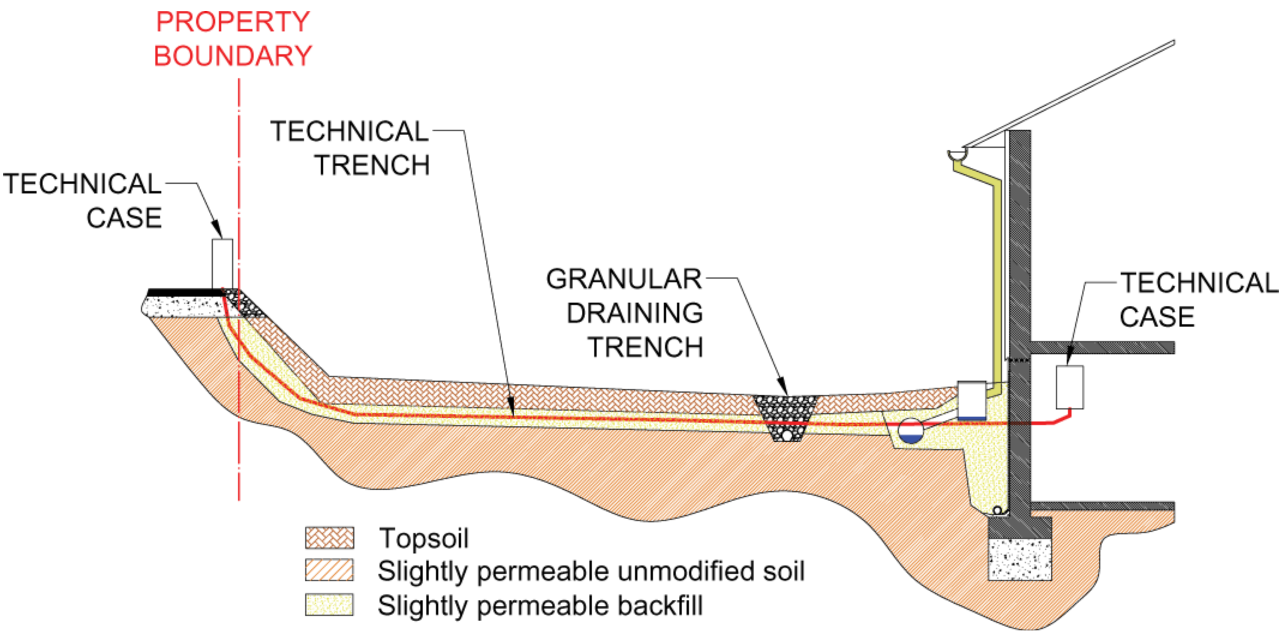


FIGURE No. 25: DRAINING THE TECHNICAL TRENCHES

MEASURING THE OUTLYING DRAIN

DEFINITION OF WATER INTAKE

Depending on the nature and the permeability of the soils being evaluated during the preliminary study, you can estimate the amount of water (water that has already entered into the soil) coming near to the buried construction walls.

	K:Permeability coefficient [m/s] (logarithmic scale)			
	1 10^{-1} '10^{-2} 10^{-3} '10^{-4} '10^{-5} '10^{-6} '10^{-7} '10^{-8} '10^{-9} '10^{-10} '10^{-11} '10^{-12} '10^{-13}			
Permeability of the soil		**Permeable soil**	**Slightly permeable soil**	**Almost impermeable soil**
Type of soil	Clean gravel	-clean sand - Mixture of clean sand and gravel	Very fine sand -Layers of clay -Organic and inorganic silts -Mixture of sand, silt and clay	,Naturally "impermeable" soil: Homogeneous clay beneath the deterioration zone ,"Impermeable" soil modified by the effects of vegetation and deterioration

FIGURE No. 26: REPORT ON THE MEASURED PERMEABILITY FOR COMPARISON WITH TYPES OF SOIL

Once the type of soil has been determined, estimate the amount of water collected using the table below

PERMEABILITY OF THE FOUNDATION SOILS	*WATER INGRESS* (D_{soil})
Permeable soil ($k > 10^{-5}$) or draining trench	Substantial (0.2 - 0.3l/s.m)
Slightly permeable soil ($10^{-5} < k < 10^{-9}$)	Average (0.1 l/s.m)
Impermeable soil ($k < 10^{-9}$)	Low (0.05 l/s.m)

FIGURE No. 27: ESTIMATING THE AMOUNT OF WATER ENTERING NEAR TO THE FOUNDATIONS ACCORDING TO THE MEASURED IN SITU PERMEABILITY

DETERMINING THE LENGTH OF THE DRAINS

Measure the total length (L_{total}) between the high point (HP) and the low point (LP)

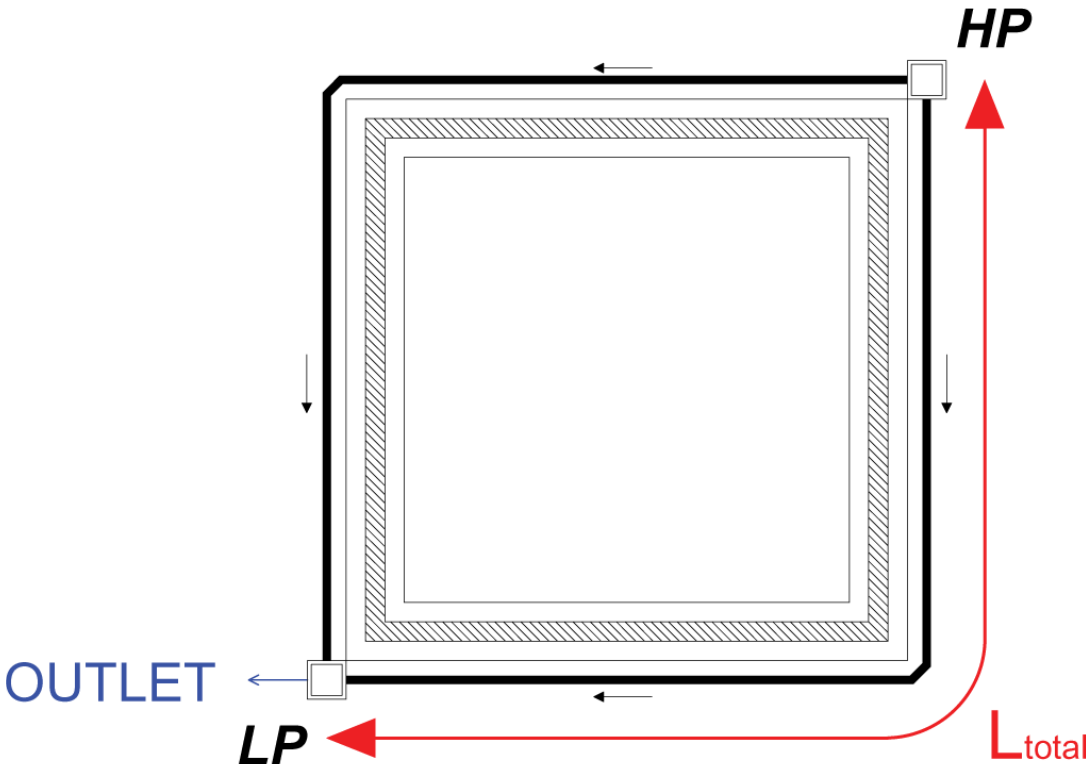


FIGURE No. 28: SETTING UP A "SIMPLE" OUTLYING DRAIN

For multiple drains, measure the lengths between the high and low points and the manholes in between

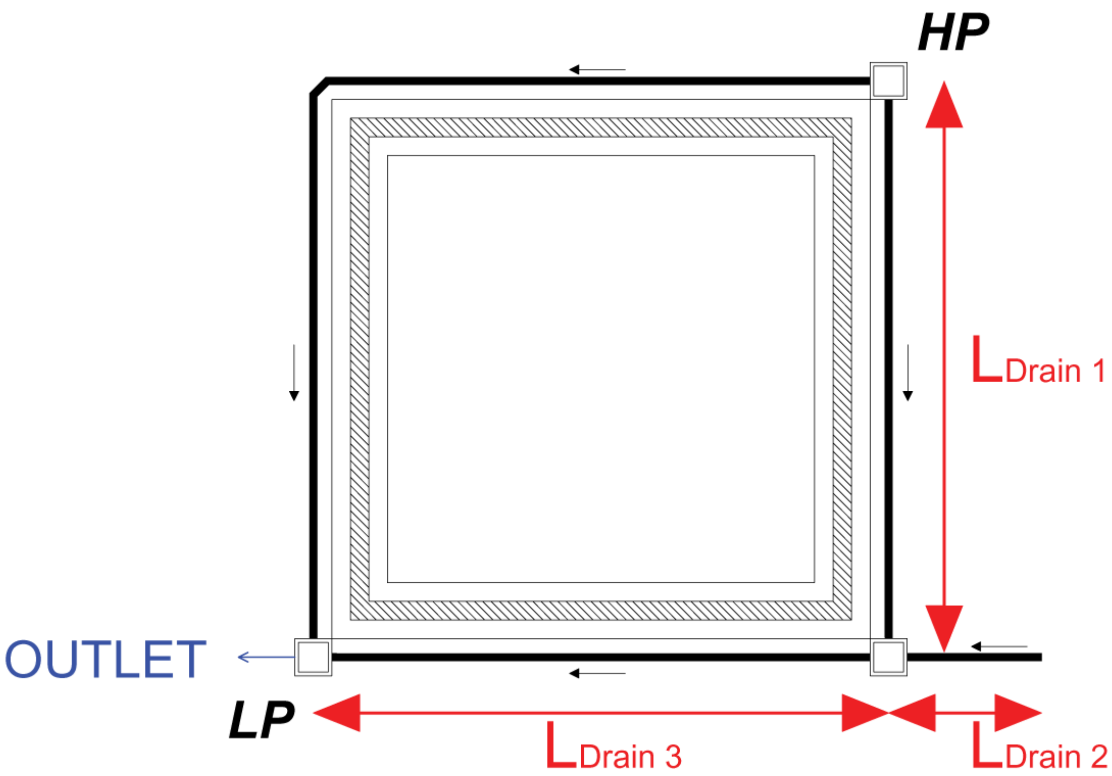


FIGURE No. 29: SETTING UP AN OUTLYING DRAIN WITH MULTIPLE SECTIONS

OUTLET FLOW & DISTANCE

The linear flow of a drain is calculated according to the gradient used; see chart below

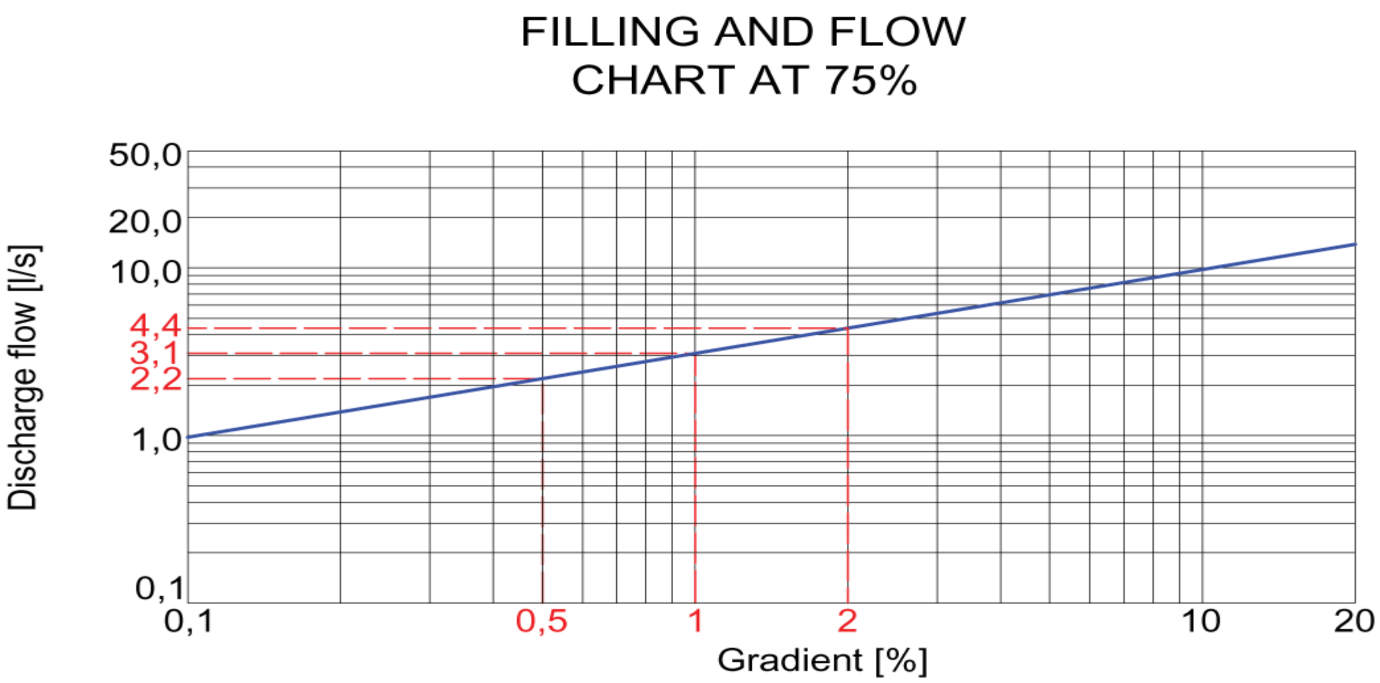


FIGURE No. 30: FILLING AND FLOW CHART FOR BATIFIBRE SN4 DRAIN DEPENDING ON THE GRADIENT USED

The flow of the water collected is calculated using the following formula:

$$Qdrain = Ltotal \times Dsoil$$

For drains with multiple sections, the formula is:

$$Q_{intermediate\ manhole} = L_{drain1} \times D_{soil1} + L_{drain2} \times D_{soil2}$$

$$Q_{low\ point} = Q_{intermediate\ manhole} + L_{drain\ 3} \times D_{soil3}$$

In order to ensure the BATIFIBRE SN4 drain works properly, discharge outlets that lead to collectors or something else must be provided so as not to saturate the drain.

The maximum distances for filling to 75% of the internal height of the drain are given here.

Gradient	MAXIMUM DISTANCE BETWEEN TWO OUTLETS		
	WATER INGRESS		
	LOW	AVERAGE	SUBSTANTIAL
0.5%	44 ml	22 ml	11 ml
1%	62 ml	31 ml	15 ml
2%	88 ml	44 ml	22 ml

FIGURE No. 31: MAXIMUM DISTANCE BETWEEN TWO OUTLETS DEPENDING ON THE GRADIENT OF THE DRAIN AND THE PERMEABILITY OF THE SOIL

NOTES

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OPERATIONAL EXPERTISE

MORE INFORMATION. BATIFIBRE SN4