technical specification 5

FOUNDATIONS

Waterproofing of Works in Contact with the Ground

The waterproofing of works in contact with the ground has to be both carefully specified and executed, bearing in mind that the life of the waterproofing has to be equal to that which it is protecting. Since on underground construction it is extremely expensive to carry out any restoration work, a lack of or a defective waterproofing would result in the need for major reconstruction at a high cost.
The choice of materials will then rest between those products which maintain their characteristics of impermeability to water and vapour over many years, which do not rot and which have good mechanical resistance to construction traffic.
It must always be remembered that there is a strong connection between the problem of dampness in underground spaces and the lack of thermal insulation. The presence of humidity due to condensation in the air is caused by lack of thermal resistance of floors and walls in contact with the ground, rather than the poor performance of waterproofing membranes.
The architect must therefore always check:

- The effect of water being drawn up from the ground by capillary action or water contained in water bearing stratum or water from rainfall which needs to drain away.

And also:

- The water contained as vapour in underground air which when affected by barometric or temperature variations causes condensation on cold surfaces.
- The water produced and contained as vapour in the hair of underground rooms which can condense on cold surfaces.

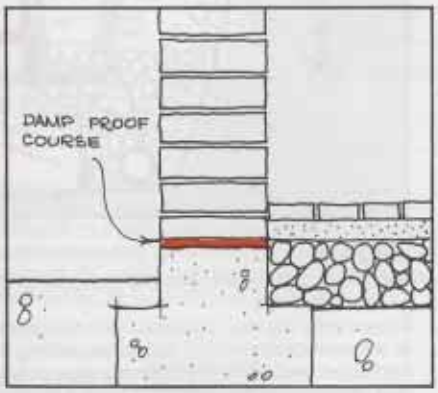
To overcome all these problems **INDEX S.p.A.** manufactures waterproofing membranes which are based on polymer bitumen reinforced with a continuous single strand extruded polyester non-woven isotropic fabric: **Flexter Testudo** & **Helasta P**. These membranes do not rot, have high mechanical resistance, are not easily punctured and have excellent resistance to the diffusion of vapour. They are, therefore, ideal for use as waterproofing for walls and all underground structures where water or water vapour is present.
With this publication we also suggest some methods of dealing with insulation and the associated works where room surfaces, floors or walls are in contact with or below ground level.

1 INTRODUCTION

Brick work in direct contact with the ground is subject to the entry of water due to capillary action inside the bricks. The force of the capillary action is helped by the porosity of the construction materials (bricks), by the presence of diluted salts in the water and low temperature.
Dampness or water in the ground may be due to:

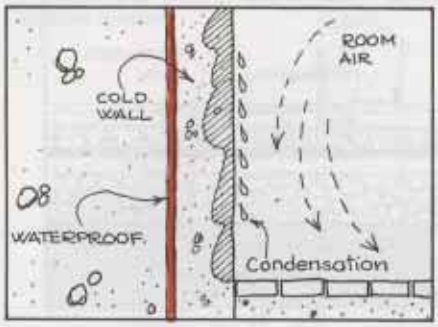
- **dispersed rain water**
- **water coming from a water-bearing stratum**

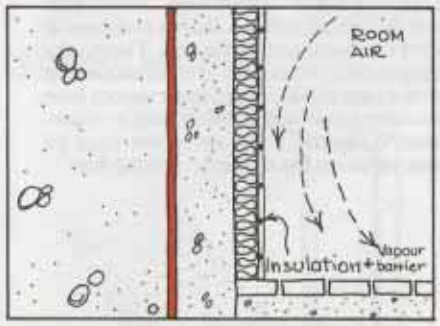
In particular situations where the terrain drains easily into a deep water-bearing stratum and for rooms which are not below ground, the installation of a damp proof course in brickwork will usually be sufficient.



When the building is situated in a zone with a shallow water-bearing stratum, or where there may be possible accumulations of infiltrating water, one must also take into consideration that different types of land structure attract and disperse water in differing ways.
A sandy soil fed by a water-bearing stratum can result in water being drawn up by capillary action to a height of between 0.3 metres and a maximum of 1.5 metres whilst a clay terrain can lift water from 3 metres to 8 metres.

Waterproofing is designed to stop water dispersed in the ground from entering a building through the wall. Often, dampness which afflicts walls in contact with the ground is not due only to phenomenon of rising damp. In many cases it is a thermal problem brought about by a cold wall in contact with warm internal air.
The water contained in the air in the form of vapour can condense on what is called the 'cold wall' which in this case is all the surfaces in direct contact with the ground. Even though a good waterproofing system has been applied, walls can still be affected by dampness.





Due to thermal inertia of ground and structures, during spring and summer time the phenomenon of condensation is typical on surfaces in contact with the ground particularly in rooms where there has been no heating system during the winter. Therefore, it is necessary to use a good thermal insulation in the structure in addition to waterproofing protection. The problem of dampness is particularly apparent in instances where site cast concrete has been used. In these cases it is always recommended that underground rooms are not inhabited until they are completely dry. Another situation where condensation forms, although it is more rare and requires particular conditions (large underground rooms on filtrating terrains with a deep waterbearing stratum) is the one of humidity contained in underground air trapped between the water-bearing stratum level and the structure. After a strong barometric depression during the winter season or during summer nights when the temperature outside is higher than that of a non-heated room, humidity may rise and condense on colder surfaces. In this case the waterproofing membranes which have very good resistance to the diffusion of vapour will function as a 'vapour barrier'.

LEGEND:

SHOWS EXACT NUMBER OF WATERPROOFING LAYERS

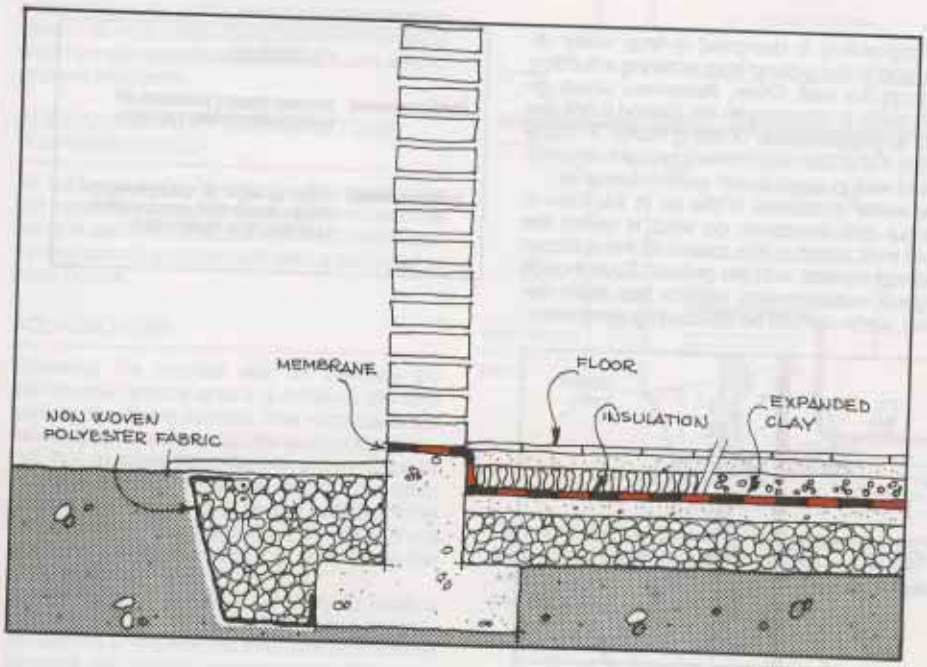
THIS IS NOT A WATERPROOFING LAYER BUT USED FOR ILLUSTRATION PURPOSES

All information is given in good faith but normal tolerances of manufacture and testing will apply. INDEX reserves the right to improve and changes their products at any time without prior notice or advice. The use of INDEX products is determined by local conditions and the individual requirements of each contract. In consideration of the many factors involved, INDEX cannot be held responsible for the application of their products and for conditions beyond their control.

1500 - 6/97 - Leardini

2 WATERPROOFING SOLUTI

Floors in contact with the ground on damp and humid terrain.

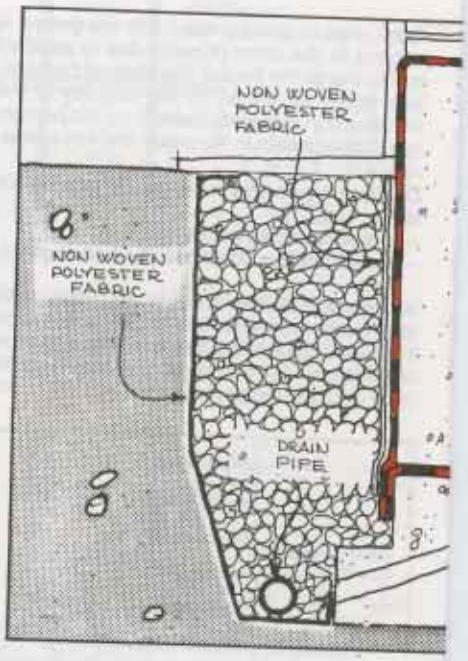


Situation:
Floors in direct contact with the ground in the vicinity of a waterbearing stratum on clay soil where the rain water accumulates on ground sloping towards the structure.
The dispersed water will be gathered by drainage pipe positioned under the floor level and the possibility of rising damp will be stopped by a continuous waterproofing membrane applied on a layer of concrete using:

technical specification

The waterproofing shall consist of a 4 mm thick elastomeric-plastomeric polymer bitumen waterproofing membrane based on distilled bitumen with added plastomer and elastomer and reinforced with a "non-woven" continuos single strand Spunbond polyester and be of the type **FLEXTER TESTUDO SPUNBOND POLYESTER 4**, Agrement Certificate no 400/95 approved by I.C.I.T.E. This material, according to UEAtc directive January 1984, has longitudinal and transverse tensile strength of **800 N/5 cm** and **700 N/5 cm** respectively, and ultimate L/T elongation in excess of **45%**, flexibility at low temperature to **-15°C**, flexibility after thermal aging **-5°C**.
It will be resistant to 500 fatigue cycles on an active fissure at **-10°C** both on new and aged material. The membranes will be loose laid on concrete and be flame welded only at the overlaps allowing for 100 mm laps.
A second membrane will be fully bonded to the first layer using a propane gas torch. In order to prevent water rising in the walls the sheets will be turned and inserted as a damp proof course bonding along all vertical sections and on the foundation base. Insulation should be laid on top of the waterproofing, this may be either loose expanded clay (granulometric 8-15) or insulating panels which can withstand pressure and vapour diffusion (cellular glass, extruded or expanded polystyrene, etc.). This should be applied with a sufficient thickness to prevent condensation on the floor. Finally, the flooring surface will be laid. In instances where there is a high production of water vapour from within rooms and where the insulation is permeable to vapour, a vapour barrier must be applied between the insulation and the floor.

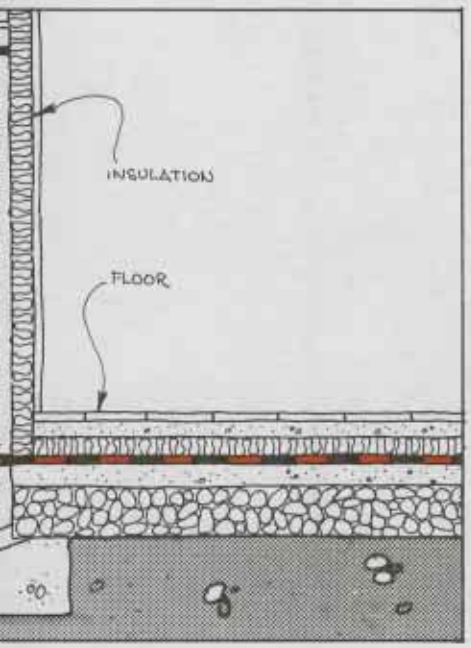
Cellars, basements and ground on humid terrain.



Situation:
Buried works in the ground subject to capillary humidity
Where only the wall in contact with the ground is waterproofed and the task of protecting the floor is left entirely to the drainage pipe positioned underneath it could prove to be a mistake. Occasionally rainwater pockets will form with which the drainage is unable to cope and this could result in floors,which have not been protected with a waterproofing barrier, becoming wet. Furthermore, it is important to remember that the level of a water-bearing stratum is not constant. It is subject to change. On sloping terrain, for example, where there are already existing buildings, further construction could change the way in which water drains away and result in the formation of pockets of water which are difficult to disperse. Often the waterproofing of these surfaces is achieved with bituminous paints or hot laid spread bituminous materials. For these treatments to be really successful, the material should have a thickness of at least 3-4 mm but it is difficult to achieve an even layer and as, in addition, there is no reinforcement the coatings will adopt the shape of the fissures and the surface to which they are applied.
Therefore it makes sense to use a waterproofing membrane which is reinforced and of a known thickness. **Testudo** has the advantage of being reinforced with a non-woven polyester fabric and of course this membrane can be used on vertical as well as horizontal surfaces.
In all instances the foundations should be provided with an efficient draining system which will avoid the possibility of stagnant rainwater lying next to the waterproofing.
The next stage is for a layer of concrete to be cast above the horizontal drainage strata which has already been established and for this to be waterproofed as follows:

ONS

walls in contact with the

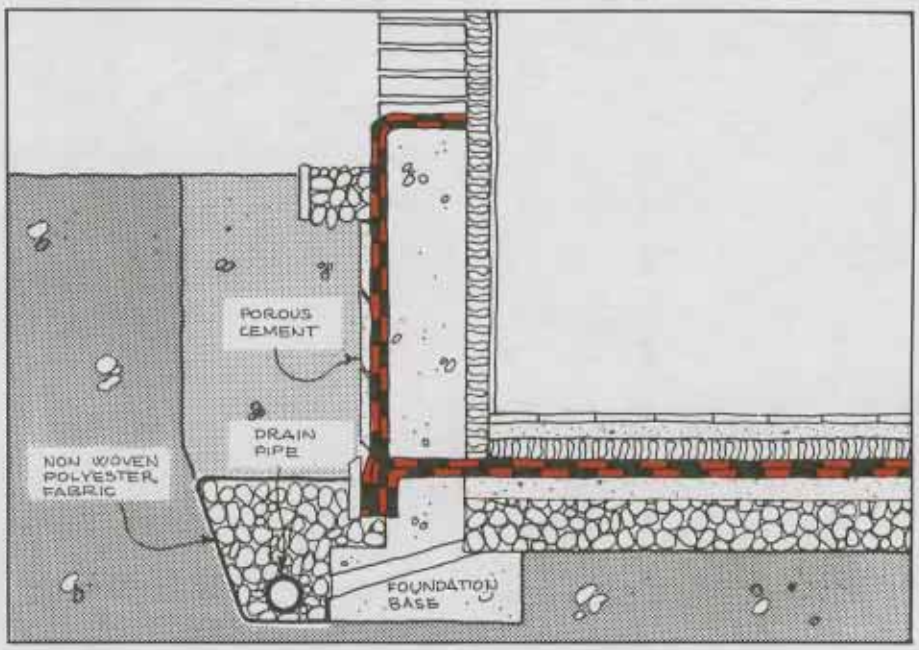


technical specification

The waterproofing shall consist of a 4 mm thick elastomeric-plastomeric polymer bitumen waterproofing membrane based on distilled bitumen with added plastomer and elastomer and reinforced with a "non-woven" continuos single strand Spunbond polyester and be of the type **FLEXTER TESTUDO SPUNBOND POLYESTER 4**, Agrement Certificate no 400/95 approved by I.C.I.T.E. This material, according to UEAtc directive January 1984, has longitudinal and transverse tensile strength of **800 N/5 cm** and **700 N/5 cm** respectively, and ultimate L/T elongation in excess of **45%**, flexibility at low temperature to **-15°C**, flexibility after thermal aging **-5°C**.
It will be resistant to 500 fatigue cycles on an active fissure at **-10°C** both on new and aged material. The membranes willl be loose laid on the concrete and on the foundation base allowing for a 100 mm overlap. The bonding of the overlaps will be executed using a propane gas torch. That pert of the membrane which covers the foundation base will then be turned down and flame bonded over the outside face of the foundation allowing for a minimum 200 mm overlap.

Prior to applying the waterproofing membrane to that part of the wall which is underground, the whole surface should be treated with a coat of bituminous primer. The membrane should now be completely flame-bonded to a height of at least 300/500 mm above the ground. Care should be taken to ensure that all laps are properly sealed particularly at the damp course detail. When considering thermal insulation only use those materials with good resistance to the diffusion of vapour (expanded glass extruded and expanded polystyrene, expanded polyethylene) and materials with good compression resistance for use under the paving (cellular glass, expanded and extruded polystyrene). When permeable insulations are used a 'vapour barrier' covering the hot face of the insulation should always be applied.

Cellars, basements and walls in contact with the ground on humid terrain in the vicinity of a water-bearing stratum.



Situation:
Underground rooms on clay soil in the vicinity of a water-bearing stratum with a variable level, sloping terrain which results in the accumulation of water pockets.
In this situation the risk of water penetration is high, due to the accumulation of entrapped rainwater or to the presence of a water-bearing stratum in direct contact with the waterproofing; therefore it will be necessary to strenghten the covering using at least two waterproofing membranes reinforced with 'non woven' polyester fabric. On top of the concrete cap which has been cast above the horizontal draining stratum apply:

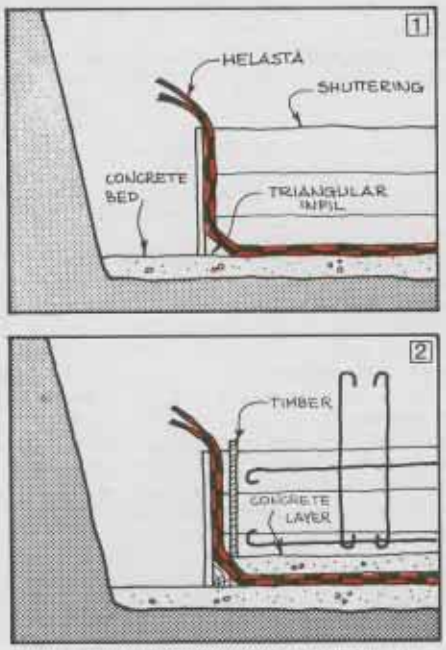
technical specification

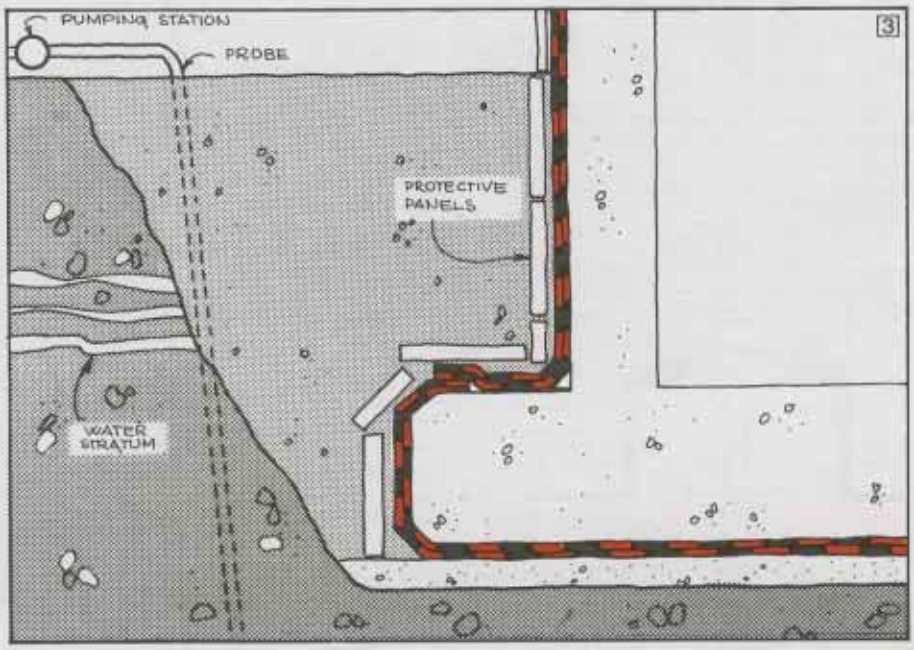
The waterproofing shall consist of a 4 mm thick elastomeric-plastomeric polymer bitumen waterproofing membrane based on distilled bitumen with added plastomer and elastomer and reinforced with a "non-woven" continuos single strand Spunbond polyester and be of the type **FLEXTER TESTUDO SPUNBOND POLYESTER 4**, Agrement Certificate no 400/95 approved by I.C.I.T.E. This material, according to UEAtc directive January 1984, has longitudinal and transverse tensile strength of **800 N/5 cm** and **700 N/5 cm** respectively, and ultimate L/T elongation in excess of **45%**, flexibility at low temperature to **-15°C**, flexibility after thermal aging **-5°C**.
It will be resistant to 500 fatigue cycles on an active fissure at **-10°C** both on new and aged material. The sheet will be loose laid on the concrete and flame bonded 200 mm down the outside face of the foundation base, whilst a second membrane will be laid astride and parallel with the previous layer and be fully bonded to it.

Again, a 100 mm overlap will be allowed and the bonding will be executed using a recommended propane gas torch. Prior to waterproofing, the wall should be given a coat of bituminous primer. The sheet covering the foundation base will now be bonded to the membrane which will be applied to the wall, allowing for a 200 mm overlap. The membrane will be taken vertically up the wall and be fully bonded to a height of 300/500 mm above the ground level and following the same procedure a second layer of **Testudo** laid astride and parallel with the laps of the previous one should be applied.

Underground rooms constantly under water-bearing stratum.

Procedure 1





Situation:
Underground rooms constantly under a water-bearing stratum

This type of waterproofing is far more demanding than those previously described, therefore special care should be taken in choosing the right materials. For the waterproofing protection, in the construction of the foundation and in the planning of the associated works; some suggestions are included in the following chapters. The proposed material, **Helasta P 4**, is an elastomeric bituminous membrane reinforced with the non-woven isotropic polyester fabric. Due to the high elasticity of the compound which is used in the manufacture of this membrane it is able to absorb the stress created by cracking of the substrata surface on which it is applied and the friction which occurs between the foundation and the concrete bed. Generally the whole main foundation which must be resistant to water pressure is waterproofed.

Firstly, to enable the works to be carried out it will be necessary to lower the water-stratum level around the excavation area. For the purpose, a pumping system of the 'well-point' type will be used.

It is very important to guarantee pumping continuity because if this should stop, the water stratum will rise removing or breaking all those works which have not achieved resistance or strenght enough to withstand the force of water.

Having excavated the site and in order to level the excavation base, a concrete bed is site cast and smoothed. This will act as a laying surface for the waterproofing membranes and afterwards for the foundation itself. On top of the concrete bed, two membranes of **Helasta P** will be applied. When the foundations have been completed and the perimeter walls erected, the waterproofing will be extended 300/500 mm above ground level being bonded to the layer which was previously applied to the below ground foundations.

technical specification

In the proposed excavation area the level of the water-bearing stratum will be lowered and kept at least 500 mm below the excavation level.

The excavation bottom will be made even by casting a smooth concrete bed on to which the foundation shuttering shall be positioned. In order to remove the possibility of stress at the corners a wooden triangular infil, 50 mm wide, is positioned in the inside part of the shuttering to round off the corner between the horizontal and vertical surface. Two waterproofing layers of **Helasta P** 4 mm thick will be applied. The membrane to be used is manufactured from bitumen modified with thermoplastics which can be stretched 2000% and is reinforced with continuos single strand extruded "non-woven" polyester fabric. **Helasta P 4**, Agrement Certificate no 400/93, approved by I.C.I.T.E. This material according to UEAtc directives January 1984, has an ultimate long. and tras. elongation of **800 N/5 cm** and **700 N/ 5 cm** respectively. An ultimate elongation L/T in excess of **50%**, it is flexible at temperature below **-25°C**, and resistant to static puncturing on concrete equal to 20 Kg. It is resistant to fatigue when subjected to 10,000 cycles at **0°C** an active fissure which opens 3 mm in each direction.

The sheet should be loose laid on the concrete bed allowing for a 10 cm overlap at the sides which should be welded using a propane gas torch. The membrane should be loose laid over the vertical shuttering leaving 200/300 mm protruding at the top. The second covering should be laid astride and parallel with the previous one and fully bonded to it again allowing a 100mm overlap.

In order to avoid damage to the membrane during the erection of the steel reinforcing, a concrete cap 3-4 cm thick shall be cast on top of the membranes. For the vertical sections of the membrane covering the shuttering, further timber should be used for protection. Once the metal structure is ready and the concrete has been poured, the protective timber can be removed and whilst the concrete is till wet, all the edges between the foundation base and the vertical wall should be rounded off. The foundation shuttering will be left in situ until the walls are erected; prior to waterproofing, the walls will be given a coat of bituminous primer.

When the shuttering has been removed the loose part of the membrane is bonded to the foundation base. The vertical waterproofing covering would be two membranes of **Helasta P 4** fully flame bonded to the already applied membrane allowing for a 200 mm end lap. The first sheet shall be flamebonded to the wall up to a height of 300/500 mm above the ground. The second layer will be laid astride and parallel with the previous layer and fully bonded to it following the same procedure. In all cases a 100 mm overlap should be allowed.

ILLUSTRATING STAGES OF WORKS BELOW A WATER BEARING STRATA

Detail of the pumping phase to lower the water level.

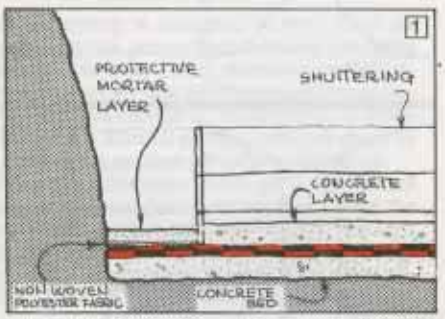
Laying the waterproofing directly on to the concrete bed followed by the protective concrete layer.

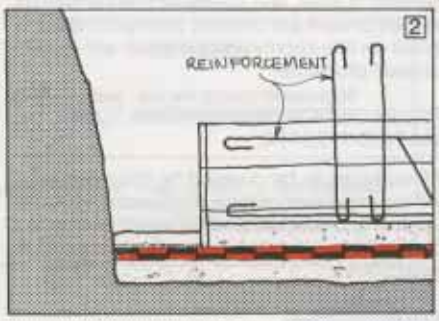
Smoothing the surfce of the concrete prior to extending the waterproofing layer.

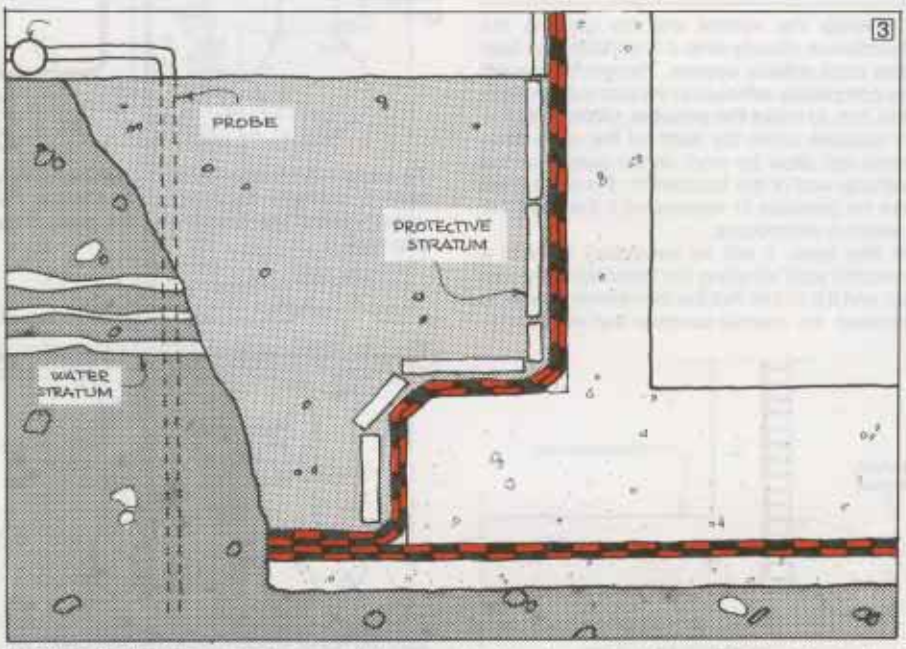
Detail of waterproofing on vertical section.

Underground rooms constantly under water-bearing stratum.

Procedure 2



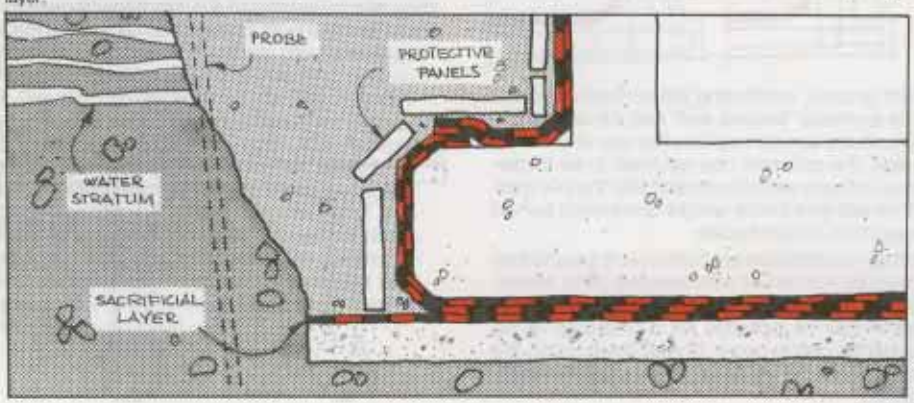




Procedure 2 differs from the previous one only because of the different connection between the horizontal and vertical waterproofing. The waterproofing layer is loose laid on the concrete ben and that part which will not immediately be covered by the foundation will be protected by a loose laid 500 gr/m² non woven polyester fabric. On top of this a further mechanical protection in the form of a layer of mortar 20/30 mm thick will be applied. This will allow work to continue without the possibility of damage to the waterproofing membrane. The mortar applied to the non woven fabric will not adhere, therefore it will be simple to remove when the waterproofing is continued on the vertical and horizontal surfaces.

Underground rooms constantly under water bearing stratum in seismic areas

The waterproofing membrane on foundations can considerably reduce the effects of movement of a building caused by earthquake, but a maximum movement canbe no more than 20mm. Therefore to avoid the breakage of the membrane due to movement of the foundation "sliding" on the concrete bed, it will be necessary to follow proceedure 1 but with the addition of a sacrificial layer of waterproofing, bonded to the concrete bed.
The extra layer has the task of localising the movement in the "interface" between the sacrificial layer and the real waterproofing layer.



3 TECHNICAL DETAILS

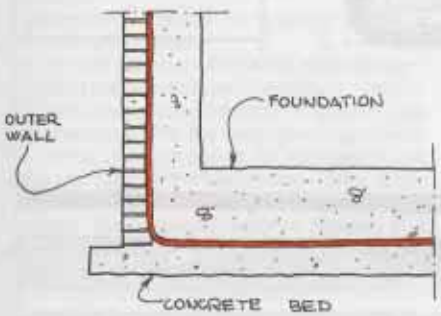
Where the waterproofing of underground works is concerned, it is very important to re-check all the technical details before commencement of work, and to ensure that the various stages of work are properly planned in order to avoid on site improvisations which can lead to unseen problems.

PREPARATION OF SURFACES TO BE WATERPROOFED

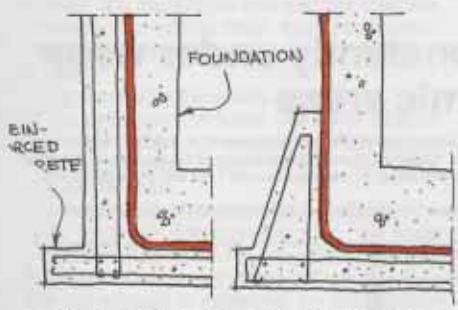
All surfaces to be covered by the membrane will have to be smoothed and the connection at vertical and horizontal surfaces will be effected by the use of a corner infil with a radius of at least 50mm.

FOUNDATIONS

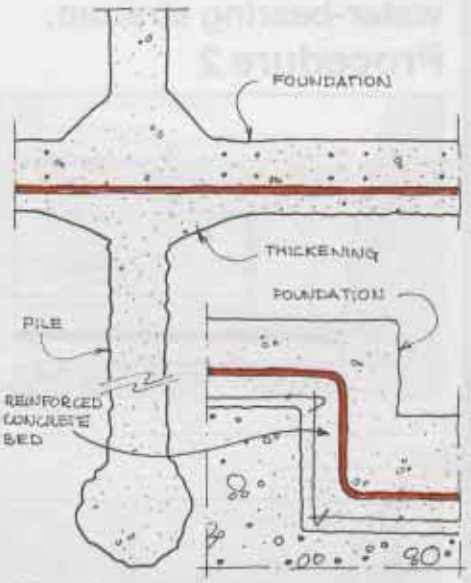
Covering the vertical wall by bonding the membrane directly onto it is certainly the best and most reliable system. The membrane will be completely adhered to the part to be protected, but, to make this possible, plenty of space is needed. often the width of the excavation does not allow for work on the outside of the vertical wall of the foundation, therefore it will not be possible to waterproof it following the previous procedures.
In this case, it will be necessary to build a 'second wall' all along the foundation perimeter and it is to this that the membrane should be bonded. An internal concrete wall will then be



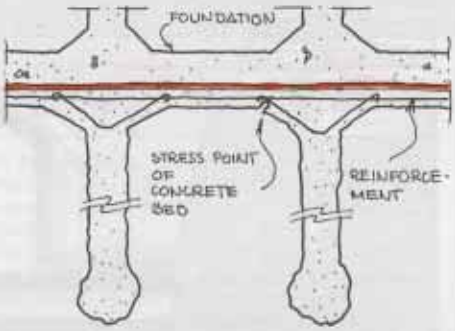
made with the membrane sandwiched between the two walls. Due to the nature of cer-



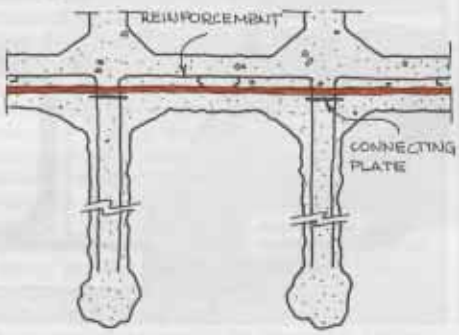
tain ground, reinforcing the concrete bed and the eventual 'second wall' may be necessary. When the terrain requires the use of concrete piles, the concrete bed will have to be thickened in those areas in contact with the pile tops. This will give better weight distribution but will require to be reinforced.
When foundations are built on soft ground they must be reinforced with concrete piles. However, this does not guarantee complete safety as it may be possible for a breakage of the concrete bed to occur. Should this happen, the integrity of the waterproofing would be endangered.



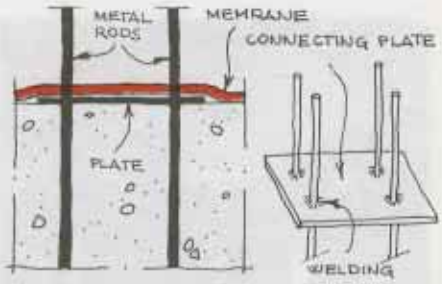
To avoid this situation arising it will be necessary to reinforce the concrete bed below the waterproofing membrane and the area of the pile caps.



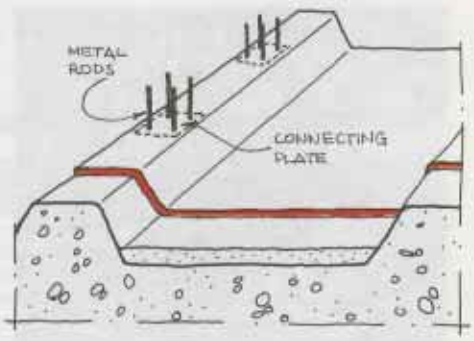
In certain isolated situations, with the possibility of the water stratum lifting the resistant foundation, it may be necessary to connect the reinforcement in the foundation to the reinforcement in the piles with the steel rods passing through the waterproofing membranes. Those areas where the metal passes through will produce weak points in the membrane. Therefore this problem will have to be overcome by using special metal plates with holes drilled through which will pass over the reinforcing rods and these will then pass through the membrane, thus allowing them to be extended. The membrane will then be flame-bonded onto the connecting wing which has been previously coated with a bituminous primer. This solution may not be successful if it is badly executed therefore it should be adopted only when nothing else can be done.



CONNECTING DEVICE

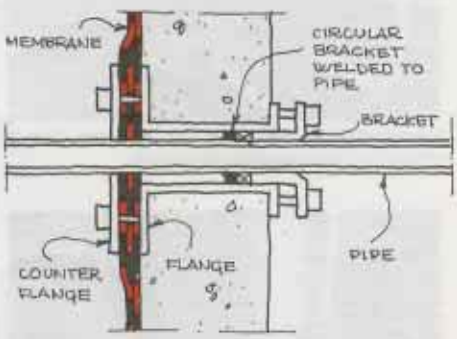


This system may also be employed when the continuity of the membrane positioned under the pillars of reinforced concrete structures has to be guaranteed without the use of flanges.



PIPES

The number of passages through walls which are in contact with the ground should be kept to a minimum. The connecting device for the membrane may be a metal coupling which has a large flange and welded bolts that will be inserted in the cast.
A piece of membrane 150 mm wider than the flange should be applied to function as a connection for the main waterproof covering. The coupling shoud be provided with a metal ring

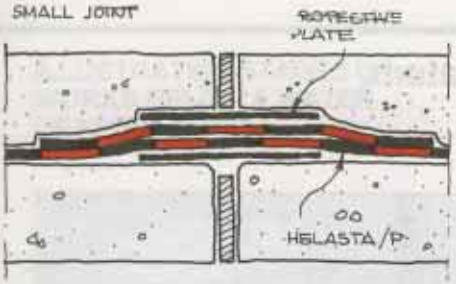


for the application of a circular bracket and with flange and bolts in its internal part for the fixing of the bracket on the pipe. All surfaces to which the membrane is bonded should be previously coated with primer.

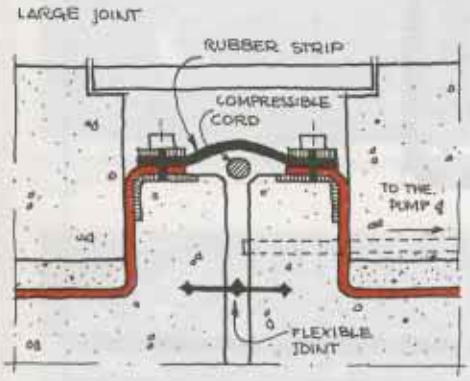
JOINTS

Positioning a joint or expansion joint between two prefabricated parts of a structure which may be subject to different settlement should

be avoided when possible; should it be necessary these are the possible solutions: where the gap is large the waterproofing should be bonded to the surface of the inner wall.

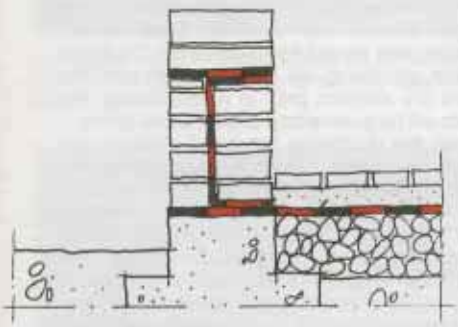


When a large joint is present, the membrane of the vertical section should rest against the second wall.



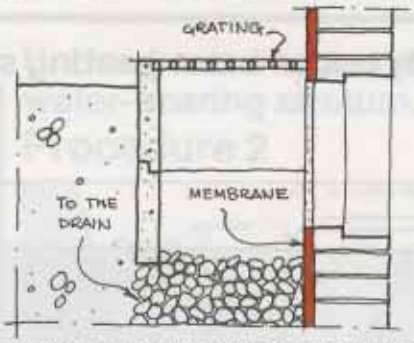
WALL-CUTTER

In order to avoid water penetration due to rainwater bouncing up from the pavement it will be correct to install two wallcutter membranes connected by a vertical waterproof shield.

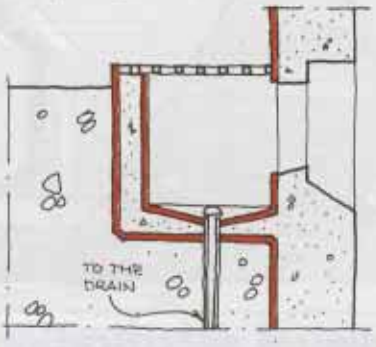


BASEMENT WINDOWS

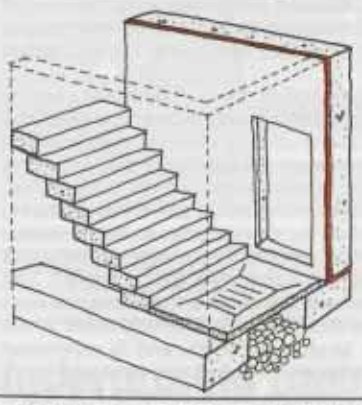
When windows are situated below ground, it is preferable to create the drainage area separately away from the building wall. The bottom of the drainage area should ideally be filled with pebbles and water should be allowed to escape via the perimeter drains. By coping with the



problem in this way there is little danger of waterproofing damage from building settlement. If the drainage area is to be an integral part of the building both the internal and external surfaces will need to be waterproofed. The bottom of the drainage area will be sloped to ensure that all water is cleared away from the window opening.



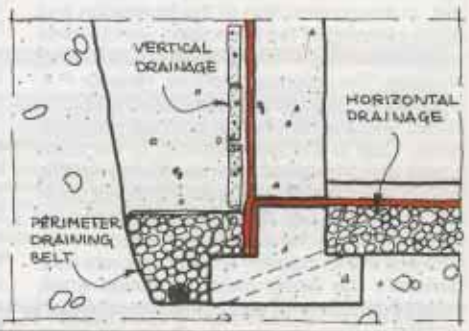
EXTERNAL BASEMENT STAIRS



The stairs should be built after the waterproofing of the wall in contact with the ground and there should be a gap of at least 20 mm between the wall and the stairs. Arrangements should be made at the bottom of the stairs in the form of a grating to allow water to drain away into the drainage system.

DRAINAGE AND PROTECTION FOR THE WATERPROOFING MATERIAL

Well planned drainage can constitute a real security system to stop water from entering the building even if a waterproofing system is not present.
It is always important to prepare efficient drainage to reduce the hydrostatic pressure against the waterproofing layer, then even if faults do occur in the waterproofing the passage of water will be greatly reduced.
The drainage system will cover:
– horizontal drainage (under floor)
– perimeter draining belt (at the foot of the foundation)
– vertical drainage (against the walls in contact with the ground).
The horizontal drainage will be connected to that of the perimeter by holed pipes and it will be kept at a higher level. With a regulated slope of 1% the perimeter drainage with holed pipes will be connected to an outlet. The vertical drainage that has been connected to the perimeter belt will also function as a protective layer for the waterproofing when the foundation is buried. The vertical drainage will be made up from porous concrete slabs, dry piled against the vertical wall. Alternatively, polystyrene panels can be used.
Gravel may also be used but in this case it is necessary to protect the membrane with a 300/500 gr/m² non woven polyester fabric.
When the foundations are built on clay soil, in order to prevent blockage of the drainage system it is necessary to protect the three elements by using a non woven polyester filter of 200 gr/m² allowing an overlap between sheets of 100 mm.



INDEX production is strengthened by exclusive manufactturing systems covered by industrial patents.

Company with certified quality system

TOTAL QUALITY Q.S. ISO 9001

1st DIVISION: POLYMER BITUMEN WATERPROOFING MEMBRANES

2nd DIVISION: THERMAL INSULATION IN ROHS AND PANELS COMBINED WITH A POLYMER BITUMEN MEMBRANE

3rd DIVISION: PRODUCTS FOR REFURBISHMENT OF ASBESTOS CEMENT SHEETS, PRIMER, LIQUID WATERPROOFING, PAINT, BITUMINOUS MASTICS FOR INSULATING PANELS, SEALANTS

4th DIVISION:
1st LINE: BONDING AGENTS FOR TILES, NATURAL STONE AND WOOD
2nd LINE: DAMP PROOFING PLASTERS AND FINISHES FOR THE RESTORATION AND IMPROVEMENT OF HISTORICAL AND MODERN BUILDINGS
3rd LINE: WATERPROOFING-CEMENTS, SHRINK-RESISTANT MORTARS AND PROTECTIVE COATINGS FOR CONCRETE AND MASONRY

index S.p.A. - Via G. Rossini, 22 - 37060 Castel D'Azzano (VR) - Italy - Tel. 045/512233 - Fax 045/512444 - **INTERNET: http://www.intesys.it/index**

All information is given in good faith but normal tolerances of manufacture and testing will apply. INDEX reserves the right to improve and changes their products at any time without prior notice or advice. The use of INDEX products is consideration of the many factors involved. INDEX cannot be held responsable for determined by local conditions and the individual requirements of each contract. In the application of their products and for conditions beyond their control.

1500 - 6/97 - Leardini