technical specification 9

WATER MANAGEMENT

Waterproofing of water reservoir, canals and associated works.

The problem of conserving and transporting water is ever growing and requires continual attention to ensure that supplies are available when required. The increasing needs of industry, Agriculture and the domestic consumer put pressure on the water authorities to improve and develop their capacity to deliver water where and when it is required. When we think we are winning, one year's drought proves even more work is required.

Some countries have terrain where the water is lost below ground and is either too difficult or costly to bring to the surface again. In these areas where water is so precious and where permanent concrete reservoirs are excessive and still allow water loss, flexible waterproofing membranes are used as a continuous barrier to prevent water escaping.

In some cases these membranes can be laid directly onto the ground, overcoming the need for concrete and providing a relatively cheap method of water retention. They can also be used to protect the sides of excavated basins which would otherwise be affected by erosion caused by water movement and resulting in collapsing of the sides.

Where more permanent works are constructed, the membranes are also used to achieve completely waterproof structures.

The type of membranes used must be those which do not require protection from the sun's rays and can withstand periodic emptying of the reservoir. They must also be able to resist the penetrating action of plant roots and be sufficiently resistant to puncture to maintain the waterproofing even when the surface under protection is uneven and site traffic is heavy.

INDEX SpA has manufactured and tested a flexible membrane, **FLEXTER TESTUDO SPUNBOND POLYESTER 4 AGREMENT**, which is ideally suitable for laying directly on to the ground or onto concrete and other bituminous based materials used in the construction of works for water retention. This membrane is polymer bitumen based and manufactured using distilled bitumen, atactic polypropylene and other elastomers and reinforced using a continuous angle strand extruded, non-woven polyester fabric.

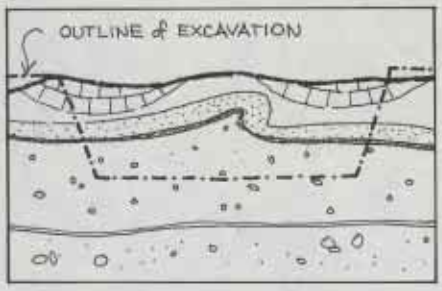
For the waterproofing of prepared works, the membrane is loose laid directly onto the earth with only the overlaps being flame welded. Where concrete or bituminous aggregates are employed, the membrane is fully flame bonded to the complete surface.

index complete systems

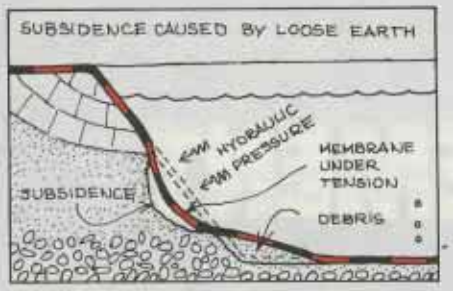
1 PROBLEMS

1) WATERPROOFING DIRECTLY OVER EARTH

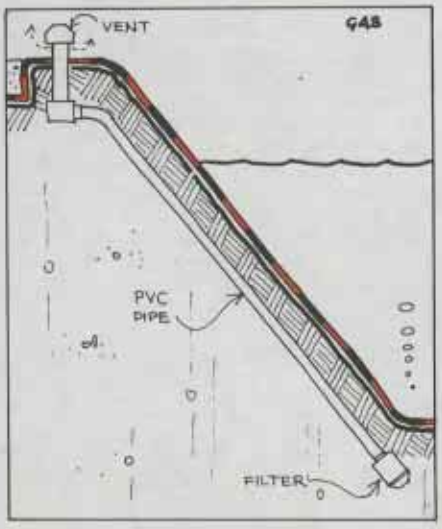
It is in this instance always necessary to carry out a geological study especially when planning a long narrow reservoir. The terrain may change through the length of the excavation and reaction to pressure may differ dramatically from area to area.



In the example shown below, movement of earth from the sides of the excavation caused tension to be placed on the membrane which could, in extreme cases, cause breakage.
It must be remembered that these membranes are not intended as a structural support, only as a waterproof covering and must be laid on a surface which is of uniform composition (homogeneous) as much as possible.

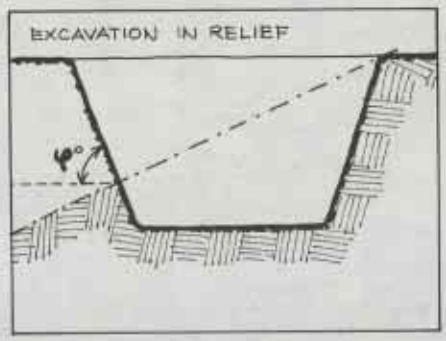


The geological study may, in addition to finding water, find gas. The existence of these agents could create a counter pressure condition which could affect the membrane, particularly when the reservoir is emptied.

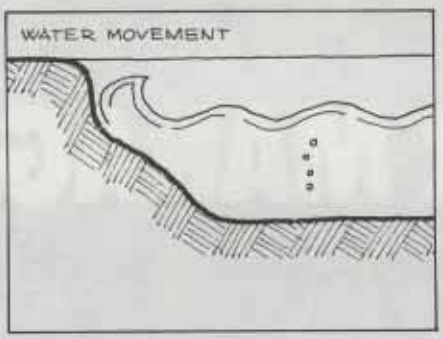


In this situation, it is necessary to set the level at the bottom on the excavation to a height of at least **1 metre** above the expected water bearing strata level and set up a system, before the membrane is laid, which will allow gas to escape.

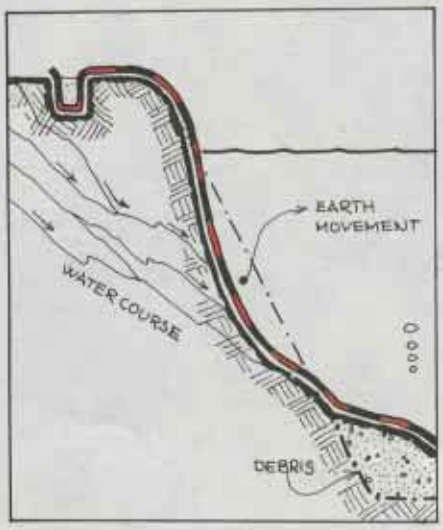
Where artificial lakes are constructed on sloping ground, the sides can be built up level using the earth which has been dug out. This type of built up side is made with loose earth and is more subject to settling or sliding. The slope on the sides should, therefore, be at such an angle as to minimise the possibility of slippage.



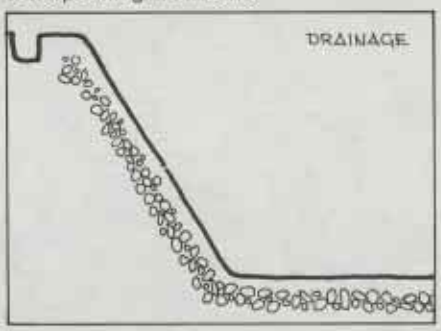
The movement of waves on large open areas of water can also cause collapse or erosion of the sides.

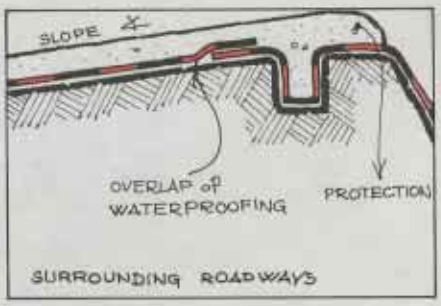


The presence of rainwater in the ground can also create streams which will wash away earth having infiltrated behind the waterproofing membrane.

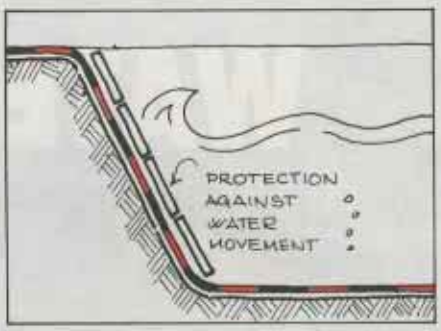


To overcome this problem, it is recommended that all roadways or walkways around the perimeter are sloping away from the reservoir and that drainage and drainage channels are prepared before laying the waterproofing membrane.

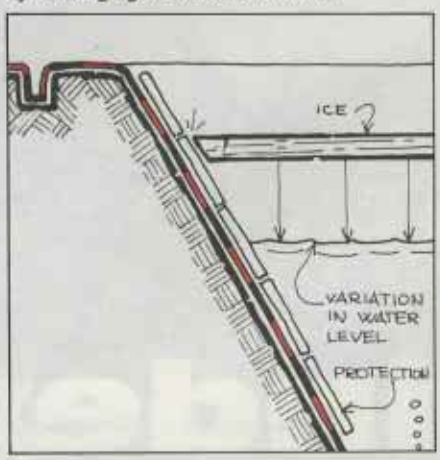




Problems caused by wave movement can be limited by building a protective covering for the sides.

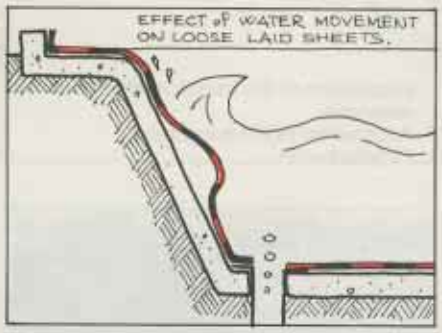


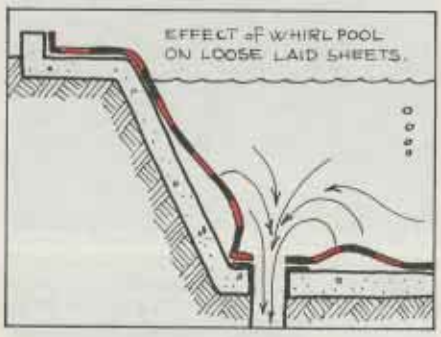
It is important that the sides of the lake or reservoir are protected in very cold or mountainous areas. Thick ice may form on the surface and if the water level is lowered, the sheet of ice could cause damage by rubbing against the membrane.



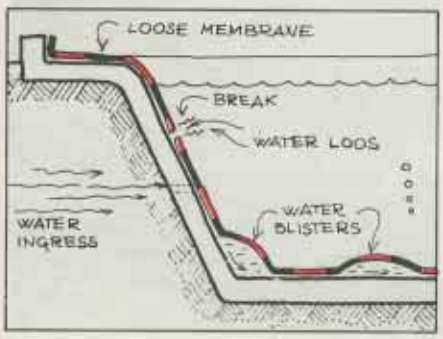
2) WATERPROOFING CONCRETE OR BITUMINOUS AGGREGATE

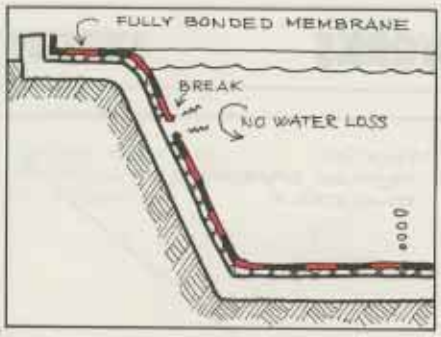
The main characteristic which distinguishes **FLEXTER TESTUDO** from other forms of synthetic sheet is that it can be completely bonded to the surface to be waterproofed. Membranes which are fixed using mechanical fixings cannot achieve total adhesion which can leave them susceptible to deterioration caused by movement.
Loose laid sheets are not only affected by wave movement, they are moved from side to side or lifted when fast emptying of water occurs. In these cases the membrane should be protected by a concrete capping.



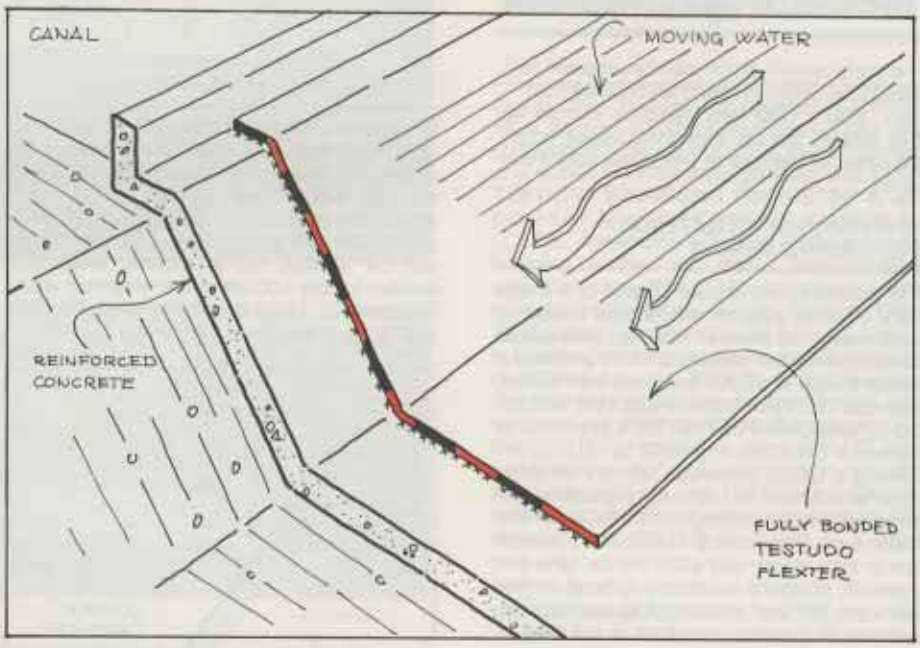


The fact that **FLEXTER TESTUDO** can be fully bonded to either concrete or asphalt aggregate, gives it an immediate advantage. If accidental breakage of the Testudo membrane should occur, only a small amount of water will be lost. A hole or break in a loose laid mechanically fixed sheet would result in vast losses and also contribute to the build-up of damaging blisters between the membrane and the structure. Blisters can also develop under loose laid sheets from water penetrating through from the outside of the concrete lining.





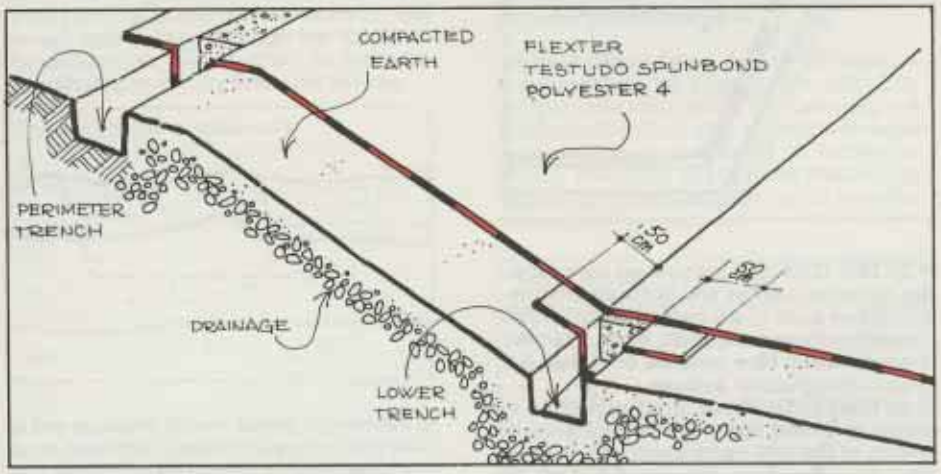
FLEXTER TESTUDO membranes have excellent adhesive qualities and this is an extremely important factor in any material which is used to waterproof reservoirs, pools, dams, channels or canals which have concrete or asphalt (bituminous aggregate) surfaces.
FLEXTER TESTUDO has an adhesive force in excess of **20.000 kg/m²** and a resistance to peeling of **300/500 kg/m** which makes it suitable for use where fast running water is present.



By heating the lower face of the **FLEXTER TESTUDO** membrane with a propane gas torch it causes the bituminous compound on the surface to melt, thus forming a very strong bond to the concrete surface on which it is laid. This avoids the need for complex and costly mechanical fixings which are in any case, unable to achieve a fully bonded condition.
A **TREVIRA** polyester is used as reinforcement for the membrane; this is the extruded single thread "non-woven" material produced by the **HOECHST** Company. This gives the membrane exceptional resistance to fatigue, and allows it to withstand the stresses caused by the opening and closing of small fissures on the surface to which it is bonded.

2 WATERPROOFING

GROUND WORKS



technical specification

The surfaces on which membranes will rest should be carefully rolled and compacted.
Two **500 x 500 mm** trenches should be dug, one at the top along the upper edge, the other at the foot of the slope within the basin.

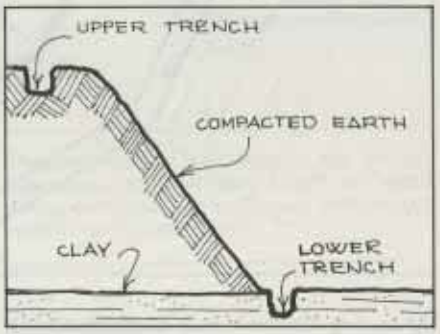
WATERPROOFING MATERIAL FOR GROUND WORKS

The waterproofing should consist of a **4 mm** thick bitumen polymer membrane based on elastomers and bitumen modified with atactic polypropylene and reinforced with a continuous single thread extruded polyester non-woven, isotropic **TREVIRA** fabric. **FLEXTER TESTUDO SPUNBOND POLYESTER 4** approved by Agrement Certificate nº 440/95 by I.C.I.T.E. According to UEAtc Directives January 1984, the material will have an ultimate longitudinal and transverse tensile strength of **800N/5 cm** and **700N/5 cm** respectively. The ultimate elongation in both length and width will be **50%** and hydraulic pressure resistance to burst on free discs per **177 cm²** equal to **2 kg/cm²** and resistance to dynamic puncture of **≥0.5 kg**.

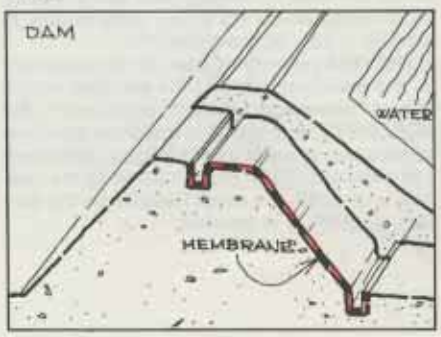
The membrane will be laid directly on to the impacted earth and the overlaps will be heat welded using a propane gas torch. Side laps should be **100 mm** and head laps **150 mm**. Treatment of the lower trench at the foot of the slope should be as follows: **FLEXTER TESTUDO** should be laid into the trench with **500 mm** protruding on each side. The trench should then be filled with either earth or concrete. **FLEXTER TESTUDO** membranes should be then laid in the upper trench allowing the rest of the material to lay down the slope. All side laps should be heat welded and the trench should be filled. Subsequent material laid down the slope should be heat welded at side and head laps. When the bottom of the slope is reached the membranes should be fully bonded to the two 500 mm laps of **FLEXTER TESTUDO** from the lower trench.

RESERVOIR EMPLOYING MIXED WATERPROOFING MATERIALS

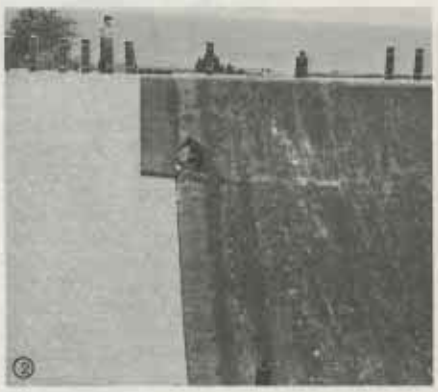
In some areas it might be an advantage to use more than one type of waterproofing, such as a flexible membrane for the sides and clay for the bottom.
Again, top and bottom trenches each **500 mm x 500 mm** will be used. The membrane will be applied as previously indicated, except for the bottom of the reservoir where a layer of clay should be applied unless it is already a feature of the terrain.



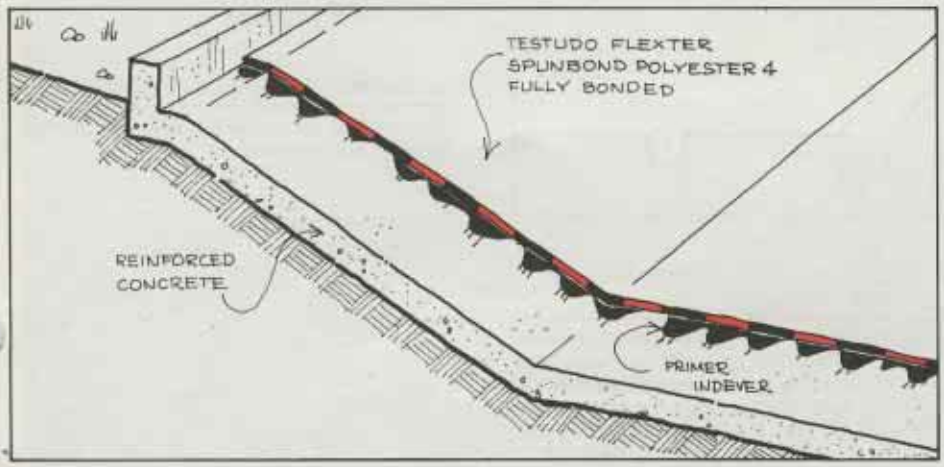
The same system can be used for waterproofing the sides of a dam, except in this case the membrane is covered with earth.



1. Excavation of the trench at the top of the reservoir.
2. Application of the membrane.
3. Finished work.



CONCRETE WORKS



technical specification

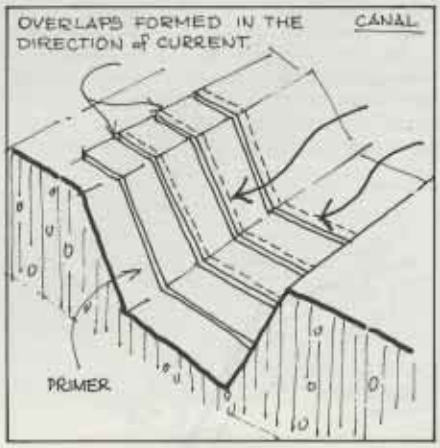
The complete surface to be covered will be primed using a 300 gm/m² bituminous primer, **INDEVER**, consisting of a solution based on oxidized bitumen, additives and solvents. The primer should have a 50% solids content and a Ford viscosity no. 4 from 20-25s at 25° C.

CONCRETE RESERVOIR: WATERPROOFING MATERIAL

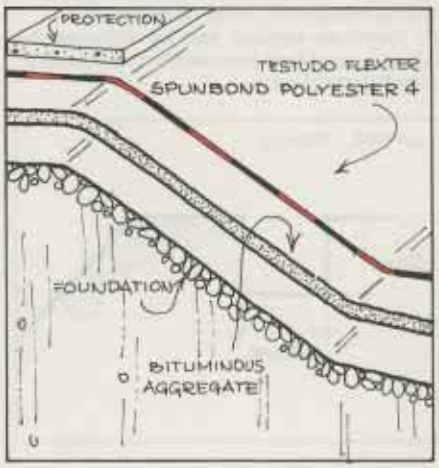
Having allowed 24 hours for the primer to dry thoroughly, the membrane should be applied. The waterproofing should consist of a **4 mm** thick bitumen polymer **FLEXTER TESTUDO SPUNBOND POLYESTER 4**, approved by Agrement Certificate n° 440/95 by I.C.I.T.E., membrane based on elastomers and bitumen modified with atactic polypropylene and reinforced with a continuous single thread extruded polyester non-woven, isotropic **TREVIRA** fabric. The material will have an ultimate longitudinal and transverse tensile strength of **800N/5 cm** and **700N/5 cm** respectively. The ultimate elongation in both length and width will be **50%** and hydraulic pressure resistance to burst on free discs per **177 cm²** equal to **2 kg/cm²** and resistance to dynamic puncture of **0.5 kg**. The **FLEXTER TESTUDO** will be fully flame bonded to the surface allowing for **100 mm** side and **150 mm** head laps.

CONCRETE CANALS

The same system as previously described may be used for waterproofing concrete canals. The membrane should be laid following the same procedure taking care to ensure that the length of the membrane is laid across the canal and that the laps are running in the same direction as the water.



BITUMINOUS AGGREGATE



technical specification

In this case the base will be asphalt (bituminous aggregate) which has been rolled and compacted. The waterproofing should consist of a **4 mm** thick bitumen polymer **FLEXTER TESTUDO SPUNBOND POLYESTER 4**, approved by Agrement Certificate n° 440/95 by I.C.I.T.E., membrane based on elastomers and bitumen modified with atactic polypropylene and reinforced with a continuous single thread extruded polyester non-woven, isotropic **TREVIRA** fabric. The material will have an ultimate longitudinal and transverse tensile strength of **800N/5 cm** and **700N/5 cm** respectively. The ultimate elongation in both length and width will be **50%** and hydraulic pressure resistance to burst on free discs per **177 cm²** equal to **2 kg/cm²** and resistance to dynamic puncture of **0.5 kg**. The **TESTUDO** will be fully flame bonded to the surface allowing for **100 mm** side and **150 mm** head laps.

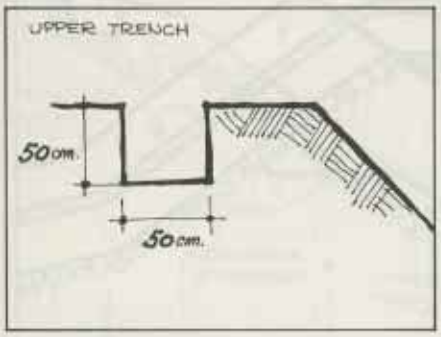
BITUMINOUS AGGREGATE CANALS

See concrete canals. Exclude primer.

3 TECHNICAL DETAILS

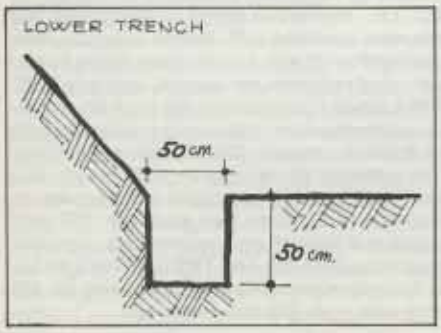
GROUND WORKS

The surface must be carefully prepared and the earth rolled and compacted. All stones or other sharp items which could cut the membrane, must be removed.
An improved surface can be achieved by laying a sand bed over which the membrane will be applied.

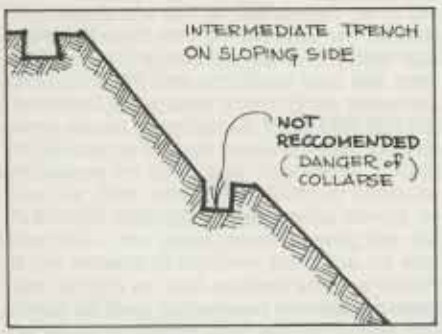


WATERPROOFING AT PERIMETER

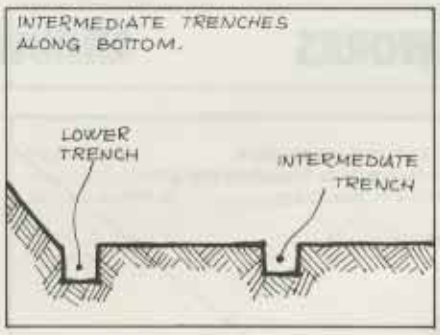
An upper and lower trench should be prepared as shown in the sketches. The waterproofing will be loose laid but held in position by the trenches which are filled with earth or concrete. All laps will be flame welded, **100 mm** at side and **150 mm** at head. When the membrane passes over the filled lower trench, it will be flame bonded to the protruding pieces of membrane as previously described in Section 2.



Intermediate trenches are not recommended in the sloping sides; these will, with the passage of time, collapse.

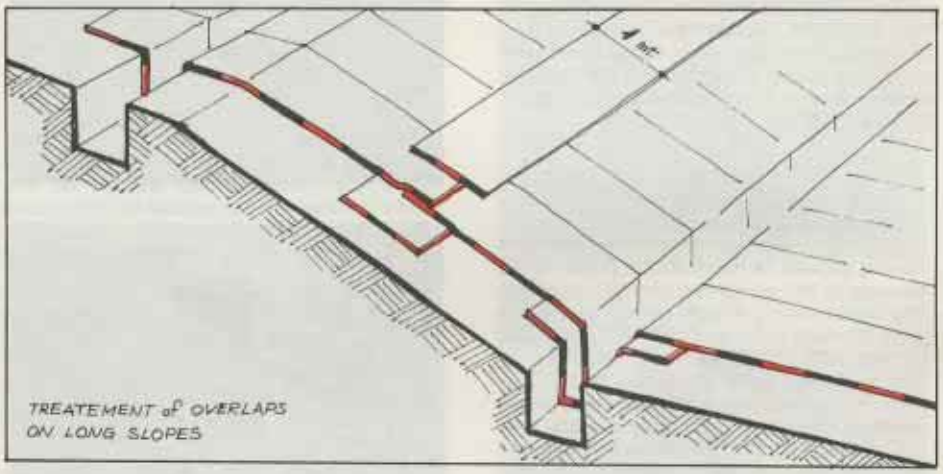


On very large areas it could be an advantage to have additional trenches. These might be useful to retain the position of the membrane during laying and also to reduce possible deformation caused by swirling water.



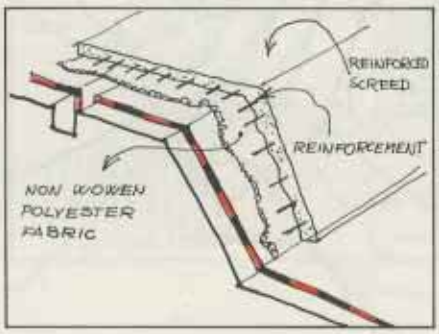
WATERPROOFING AT SIDES OF GROUND WORKS

Again, intermediate trenches are not suitable. It is advisable to reinforce head laps where slopes are in excess of **10 metres**. This is achieved by laying a **1 metre** strip of material at right angles to the slope and this will be positioned under the head lap of the membrane laid down the slope. All membranes should be fully bonded together. Finally a further **1 metre** strip placed over the laps of the waterproofing membrane and again, at right angles to the slope, should be fully bonded.



PROTECTION FOR WATERPROOFING ON SLOPES

It may be necessary to protect the waterproofing on slopes; in these cases sand bags, concrete slabs or layers of reinforced concrete laid on 300/500 gm/m² non woven polyester fabric may be used.

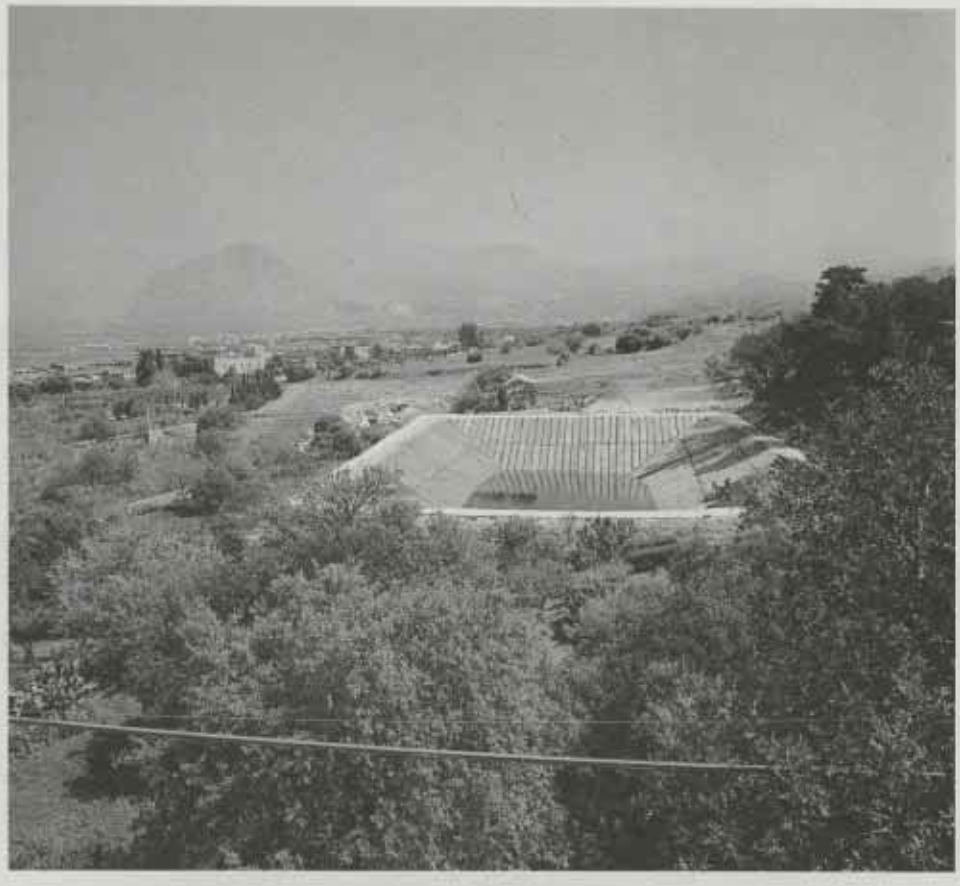


CONCRETE WORKS

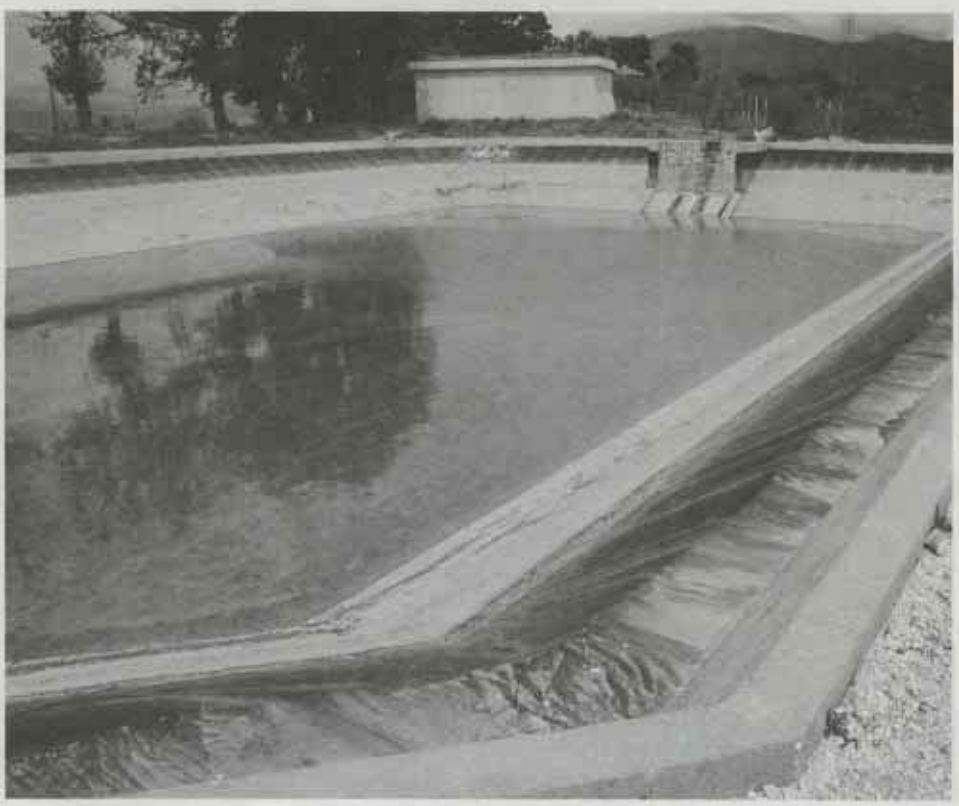
The whole of the surface must be seasoned, dry and clean. The surface should be smooth and any sharp, loose or flaking material should be removed.

BITUMINOUS AGGREGATE WORKS

The asphalt should be smooth and carefully rolled and compacted.



Earth based water reservoir.
Finished work.



Concrete based water
reservoir. Finished work.

4 THE PRODUCTS

TESTUDO FLEXTER SPUNBOND POLIESTERE 4

INDEX Spa manufacture a high performance product suitable for waterproofing reservoirs, pools, dams, channels and canals, under the brand name of **FLEXTER TESTUDO SPUNBOND POLYESTER 4** (I.C.I.T.E. n° 371/91). This product has been awarded an **AGREMENT CERTIFICATE**. The membrane is of the bitumen polymer type and is based on atactic polypropylene and other elastomers and is reinforced with a **TREVIRA** "non-woven" isotropic polyester fabric manufactured by the **HOECHST** Company.
The fibres of polyester are continuously extruded by the Spunbond method, drawing fibres directly from the die without a break in continuity.
The filaments are then needled and chemically bonded using thermosetting resins. Manufacturing by this method produces a material which differs greatly from those non woven fabrics produced from chopped fibres. In contrast, the Spunbond **TREVIRA** non woven fabrics have isotropic mechanical properties.
The bitumen polymer compound APP which coats the polyester reinforcement is flexible, does not rot, is resistant to ageing and to perforation and has extremely good fatigue and tear strenght. These characteristics make it suitable for waterproofing in areas of high stress. Testudo is thick enough **(4 mm or 5 mm)** to be used in applications where it is necessary to be laid directly on to the earth without a concrete substructure.

FLEXTER TESTUDO is easily applied by bonding using a propane gas torch. It is just as simple to carry out repairs, only requiring sufficient heat to be applied to the damaged area. This will melt the bitumen and allow a patch to be welded in place.
This method can be used even after several years as the membrane does not lose the characteristic of thermal bonding.

Anti-root treatment with PREVENTOL B2

Bayer Material Protection

PREVENTOL is a registered trade mark by BAYER AG Leverkusen.

PRIMER INDEVER

Primer should always be used on metal, also on concrete and other porous surfaces.

INDEX's production uses exclusive industrial patents covering secret processes employed during manufacturing.

MEMBER NBP

NATIONAL ROOFING CONTRACTORS ASSOCIATION

index

advanced waterproofing systems, insulations and refurbishment

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