technical specification 4

BRIDGES AND VIADUCTS

Waterproofing of reinforced concrete and steel bridges and viaducts prior to the application of asphalt or other surface

The ageing process which takes place in the concrete and metal structures of motorway bridges is accelerated by the physical and chemical aggression of anti-freeze and other chemicals, polluted water, and the freeze and thaw cycles experienced during winters.
The superficial parts of concrete will crack when subjected to the expansion stresses of freezing liquid, whilst the corrosion to the exposed parts of metal structures will give rise to rust. The ingress of destructive elements will lead to the structure being subjected to rapid degradation. Where these conditions exist special care should be taken and a waterproof covering should be applied to the concrete to ensure durability and security of workings.
Where great stresses are present as in bridge structures, any waterproofing would need to be of a high performance type.
INDEX SpA of Italy have developed a product which can withstand the strains imposed by continuous traffic use. The product is **TESTUDO SPUNBOND**, a membrane which comprises polymer modified bitumen with a reinforcement of non-woven continuous thread TREVIRA polyester filament. The combination of these two materials gives an immensely strong and flexible waterproofing membrane suitable for civil engineering applications.
In use the membrane will be fully adhered to the substrate, the bonding being carried out using a propane gas torch. Prior to application, the surface to be covered will be cleaned and coated with a bituminous primer to ensure complete adhesion. The final operation is laying the tarmacadam directly on to the membrane in the normal way.
This system has been used and tested for a long time and conforms with ITALIAN norms (Capitolato d'Appalto della Società Autostradale Spa; Roma, January 1976) and French (tests of the Section des Liants Routiers of laboratoire Central des Ponts et Chaussees - PARIS).

SYSTEM

TESTUDO®

TESTS FOR THE APPLICATION OF WATERPROOFING ON MOTORWAY BRIDGES

Extensive tests have been carried out which have highlighted the need for performance characteristics of a particularly high standard. The waterproofing is required to withstand extreme levels of stress and will have to:

- be insoluble and impermeable to water, unaffected by freeze and thaw cycles, resistant to anti-freeze salts;
- offer high adhesion to concrete and not be subject to blistering or detachment;
- be resistant to high temperature, puncturing and sliding, when the hot tarmacadam is laid;
- be able to follow the deformities of the concrete surface without breaking;
- be resistant to fatigue and be able to absorb stresses created by micro-fissures in the concrete without breaking;
- be resistant to perforation and able to bear site traffic when the tarmacadam is rolled on;
- be flexible and able to adopt the contours of the surface during application.

TESTUDO SPUNBOND polyester membrane will meet all these requirements. The membrane has been examined in the Laboratoire Central des Ponts et Chaussees of Paris and by the Laboratoire d'Essais du Genie Civil of Liege University and the following tests have been carried out:

- **Ageing caused by freeze and thaw cycles** (LGC-Liege)

Results:		Long.	Tran.
	Max dimensional variations of upper face	− 0.25%	+ 0.12%
	Max dimensional variations of laying face	− 0.31%	+ 0.18%
	Tensile strength variations	− 5.5 %	− 5.0 %
	Percentage elongation variations	+ 3.3 %	+11.11%
	Weight variations	+ 0.23%	

- **Chemical ageing** (28 days in a saturated solution of $CaCl_2$ (calcium chloride), (LGC Liege)

Results:		Long.	Tran.
	Max dimensional variations of upper face	+ 0.02%	+ 0.09%
		− 0.09%	− 0.02%
	Max dimensional variations of laying face	− 0.07%	− 0.03%
	Tensile strength variations	− 7.2 %	−10.8 %
	Percentage elongation variations	+ 3.3 %	0.0 %
	Weight variations	+ 0.11%	

- **Thermal ageing** (28 days at 80 °C) (LGC Liege)

Results:		Long.	Tran.
	Max dimensional variations of upper face	− 0.18%	+ 0.19%
	Max dimensional variations of laying face	− 0.19%	+ 0.18%
	Tensile strenght variations	− 0.8 %	− 6.3 %
	Percentage elongation variations	+ 3.3 %	+ 4.76%
	Weight variations	− 0.05%	

- **Behaviour in water** (30 days total immersion) (LCPC)

Results:	
	Maximal absorbing 1st day +0.17%
	Maximal absorbing 2nd day +0.20%
	Maximal absorbing 3rd day +0.20%
	Maximal absorbing 6th day +0.35%
	Maximal absorbing 10th day +0.40%
	Maximal absorbing 20th day +0.60%
	Maximal absorbing 30th day +0.75%

- **Impermeability to water** (LCPC)

1st bar x 5 days
2nd bar x 1 day
3rd bar x 1 day
5th bar x 1 day — **No passage of water**

- **Resistance to thermal shock** (at 140 °C x 10 minutes and temperature gradual lowering until 40 °C) (LCPC)

Results:	Long.
Variations in tensile strength	−2.7%
Variations in percentage elongation	−8.7%

- **Adhesion to concrete** (LCPC) at 20°

Result: **5.30 kg/cm²**

- **Resistance to perforation** (NFQ 03001 - 1960) (LCPC)

Results: pole with 3 mm diameter finishing with 30° cone corner slightly rounded

Temperature	Speed	Results
20°C	500mm/min	10 daN
20°C	100mm/min	9.1 daN
−10°C	500mm/min	31.1 daN
−10°C	100mm/min	25.4 daN

- **Fatigue resistance on fissurometer (INDEX)**

500 cycles at 20°C with the membrane bonded between two pieces of asbestos cement across a gap 2 mm wide which opens and closes at a speed of 16mm/h
No breakage.

- **Crack resistance on fissurometer** (LCPC)

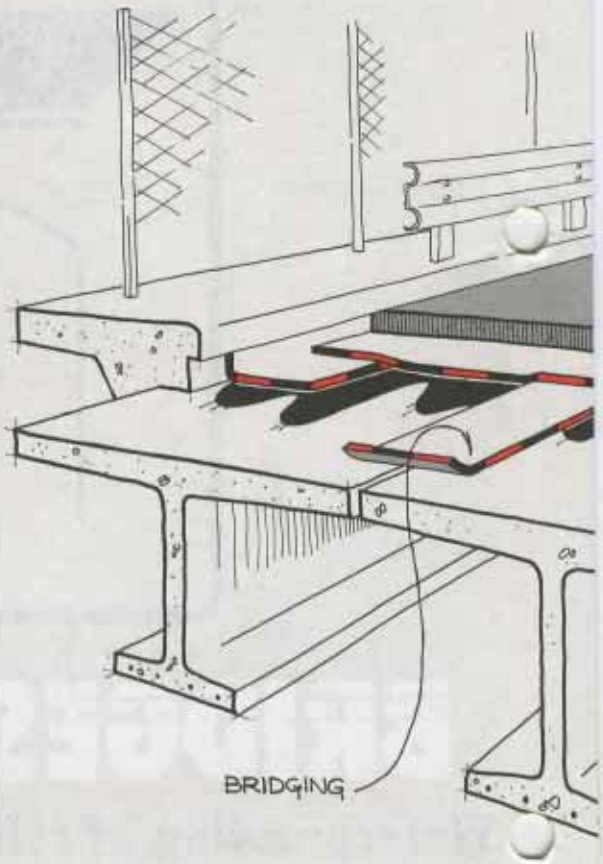
Results: **Using new material**
at −10°C across a gap of 10 mm a speed of 25mm/min - **no breaking of the membrane**, slight some loss of adhesion took place for 2 cm on both sides of the gap and the material showed a slight reduction in thickness.
After thermal shock:
at −10°C across a gap of 1.5 mm for a period of 5 minutes.

- **Flexibility** (NFP 84301 - LCPC) at 0°C

Results
Using a 10.5 cm diameter mandrel: **NO CRACKING**
Using a 2 cm diameter mandrel: **NO CRACKING**

BRIDGES ANI

Waterproofing of reinforced co viaducts prior to the applicatio

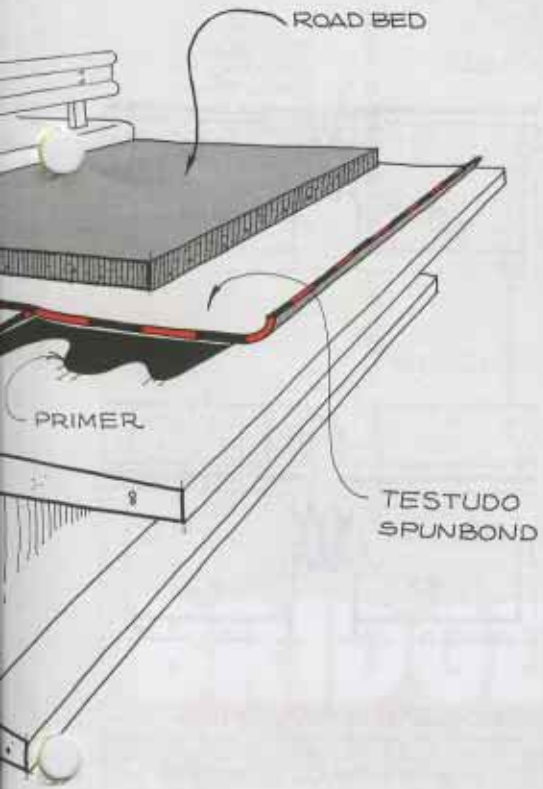


technical

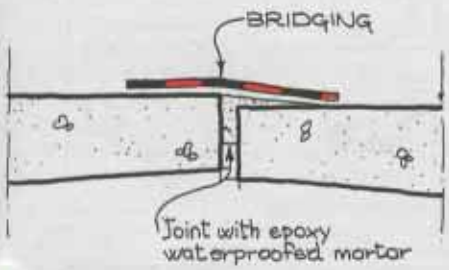
The laying surface will have to be sufficiently matured and set, free from oils, grease and dust and, if it is necessary, a pressurised water jet can be used to ensure the surface is properly cleaned. The surface of the concrete must be even and any loose material will need to be removed.
Should there be any major uneven areas, these will have to be levelled.
To ensure the surface of the concrete is level, any holes should be filled with epoxy waterproofed mortar and where the membrane is laid directly on to prefabricated elements the same mortar should be used to make up any difference in level. All

D VIADUCTS

ncrete and steel bridges and n of asphalt or other surface

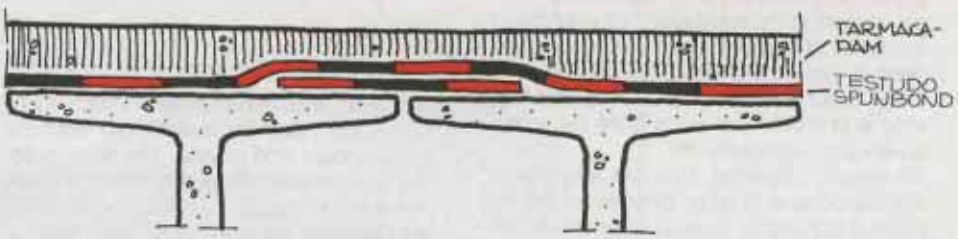


details



urfaces should be given a coat of bituminous primer prior to the application of the waterproofing membrane. This should be carried out when the surface is dry, allowing time for the primer to set; air temperature should not be below 10°C.

technical specification



testudo spunbond 30

In conformity with tests of Central laboratory of French Bridges and Roads and Civil Engineers Laboratory of Belgium.

PRIMER

All the surface to be waterproofed will be given a coat of 350-500 grs/m² of **INDEVER** bituminous primer manufactured using oxidised bitumen (R & B 85-90°C) additives and solvents with a dry residual of 50% and viscosity FORD 4 at 25°C of 20 to 25 sec. and adhering strength to concrete equal to 2 kg/cm².

COVERING

After allowing at least 24 hours for the primer to dry, a waterproofing layer of **TESTUDO SPUNBOND 30** will be fully flame bonded. The membrane will be manufactured using 300 gr/m² spunbond polyester continuous thread, non-woven, isotropic fabric and bitumen modified with atactic polypropylene and elastomers.
With a deforming speed of 25mm/min the membrane will have a tensile strength of LONG. 200 KG/8cm, TRAN. 175 KG/8cm, a percentage elongation LONG/TRAN. of 50%, and puncture resistance equal to 15 kg using a 5 mm diameter point at 40°C.
The membrane will have an adhesion strength to primed concrete of 2kg/cm² and will not creep when tested by winding round a 10 mm mandrel at a speed of 1.27 mm/min at +5°C.
The 300 g/m² non-woven polyester support, after being hot air conditioned at 180°C for 10 minutes, will have a puncture resistance to a 5 mm diameter point equal to 15 kg, a 3% dimensional variation between −30°C to 200°C and a melting point of 250°C. It does not rot and will be resistant to salts, acids, alkali and hydrocarbonous action.
The membrane will be laid allowing for a 10 cm overlap and will be carefully flame bonded using a propane gas torch to the entire surface, along overlaps and on all vertical sections to a height of at least 100 mm above paving level.

testudo spunbond 25

In conformity with Technical Chapter of the Motorways Contract Soc. Rome, January 1976.

PRIMER

All the surface to be waterproofed will be given a coat of 350-500 gr/m² **INDEVER** bituminous primer manufactured using oxidised bitumen (R & B 85-90°C) additives and solvents with a dry residual of 50% and viscosity FORD 4 at 25°C of 20 to 25 sec. and adhering strength to concrete equal to 2 kg/cm².

COVERING

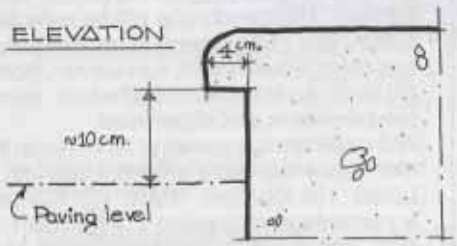
After allowing at least 24 hours for the primer to dry, a waterproofing layer of **TESTUDO SPUNBOND 25** will be fully flame bonded. The membrane will be manufactured using 250 gram/m² spunbond polyester continuous thread, non-woven, isotropic fabric and bitumen modified with atactic polypropylene and elastomers.
With a deforming speed of 25 mm/min the membrane will have a tensile strength of LONG. 180 KG/8cm, TRAN. 125 KG/8cm, a percentage elongation LONG/TRAN. of 50%, and puncture resistance equal to 12 kg using a 5 mm diameter point at 40°C.
The membrane will have an adhesion strength to primed concrete of 2 kg/cm² and will not creep when tested by winding round a 10 mm mandrel at a speed of 1.27 mm/min at 5°C.
The 250 g/m² non-woven polyester support after being hot air conditioned at 180°C for 10 minutes will have a puncture resistance to a 5 mm diameter point equal to 12 kg, a 3% dimensional variation between −30°C to 200°C and a melting point of 250°C. It does not rot and will be resistant to salts, acids, alkali and hydrocarbonous action.
The membrane will be laid allowing for a 10 cm overlap and will be carefully flame, bonded, using a propane gas torch, to the entire surface along overlaps and on all vertical sections to a height of at least 10 cm above paving level.

technical details

INDEVER primer will be preferably brush laid to ensure good impregnation into the concrete. Generally on prefabricated bridge girders a "slope-layer" of reinforced concrete is laid but when this is not present, a reinforcing strip 33-50 cm wide of **TESTUDO SPUNBOND** will be laid having first made the surface of the joints level using epoxy mortar.
To ensure blistering does not take place, the membrane must be bonded to ensure perfect adhesion. Special care should be taken to make certain the flame heats the lower part of the membrane, creating a small rivulet of bitumen which will run forward as the sheet is unrolled.

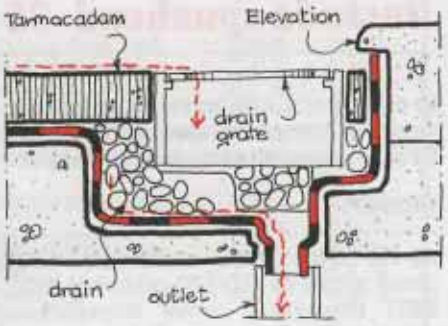
PAVEMENTS, ELEVATIONS, ETC.

The elevations must be prepared providing a recess up to 10 cm above paving level deep enough to house the 4 mm thick membrane. The membrane will be flame bonded on after a coat of bituminous primer has been applied.



OUTLETS

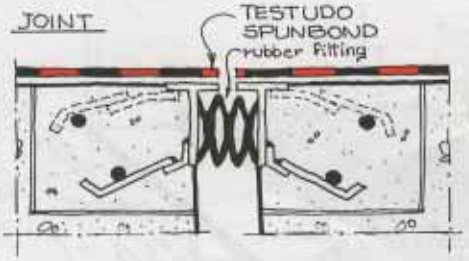
The drain should be formed in such a way that it will cater for water from both the tarmacadam and paving. The waterproofing membrane should be totally bonded throughout the drain area and then be moulded into the drain pipe opening.

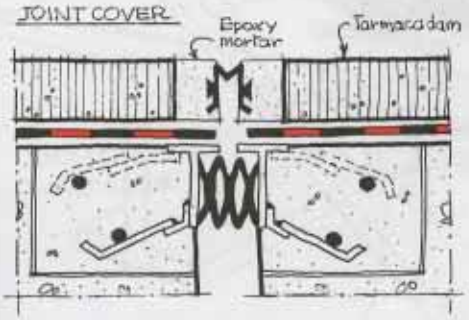


JOINTS AND JOINT COVERS

There are many types of joints available on the market at present, therefore it is not possible to give a common illustration.

However, it is important to remember that the membrane has to be connected to the joint to guarantee continuity of waterproofing. The joint will have an outlet system for meteoric and paving absorbed waters. The following operation, required once the tarmacadam has been laid, is to cut and demolish the paving near the joint where a provisional cover will be positioned; then the area will have to be restored using waterproof epoxy mortar before the definitive joint cover application.





ROAD ASPHALT APPLICATION

It is important that the tarmacadam acts as one body with the waterproof membrane; therefore the laying temperature must be high and the tarmacadam compacted immediately by a roller.