

SBS  
modified bitumen:  
applications  
on Terraces and  
Roof Gardens.

Subject presented by Mr. Pierre F. GEISEN, during the National Convention of the  
American Institute of Architects in San Francisco, ca, June 12th 1985.



The speaker is Mr. Pierre F. GEISEN, President and General Manager of one of the largest European companies, dealing since 76 years with roofing as Contractor and Manufacturer of bituminous roofing material (6 plants: 3 in France, 1 in Canada, 1 in Germany and 1 in Switzerland).

Mr. Pierre F. GEISEN has been leading the company since 1939. The company was founded in 1908 by his father Charles A. GEISEN. He is Honorary Vice President of the French National Roofing Association, Vice President of the International Waterproofing Association and member of the RILEM joint committee on single layer roofing.

---

**Roofing** has been my job for more than 50 years and I am still very involved in every up to date research project in all industrial countries.

Bituminous roofing is still the most important system used and I **believe** that it **will** last for yet a very long time to come.

The last improvements made by oil people producers of asphalt for roofing was 50 years ago; the oxydized bitumen.

Nowadays we improve its quality by blending bitumen with various substances.

The question is:

**Why did we choose, in France, the SBS bitumen roofing system?**

The French experience seems a most interesting one:

1. A law enforced since 1804, stipulates that all important parts of a building must be guaranteed for ten **years**. If a failure occurs, a leakage for instance after 9 years and 11 months, the contractor is bond to repair, free of expense, and to pay all the damages caused by the leakage. Therefore, the minimum standards for a roofing job have to be well examined, as well as the composition of the roof, the support of the roofing membrane and the protection (if the roofing membrane is not self-protected).

2. Any new membranes appearing on the French market are carefully examined by Official Boards. They are admitted only if their quality has proven to be at least equivalent to the quality of the roofing systems successfully used on the market

3. There are only 6 Companies manufacturing bituminous roofing materials in France. All of them have produced materials with modified bitumen. All 6 have chosen **SBS modified bitumen**. At least 50% of all flat roofs laid last year in France were made with SBS bitumen products, **and more** than 50% in reroofing.

This percentage is steadily growing and we expect at least 10 points more in 1985.

Because of the relatively high standards required as well as the legal obligation of guarantee, the use of thin polymeric membranes such as PVC, Butyl, EPDM, E.C.B. a.s.o. is very limited (less than 1%), and this in spite of the Common Market and the proximity of big chemical plants in Germany and Switzerland, where such membranes are produced.

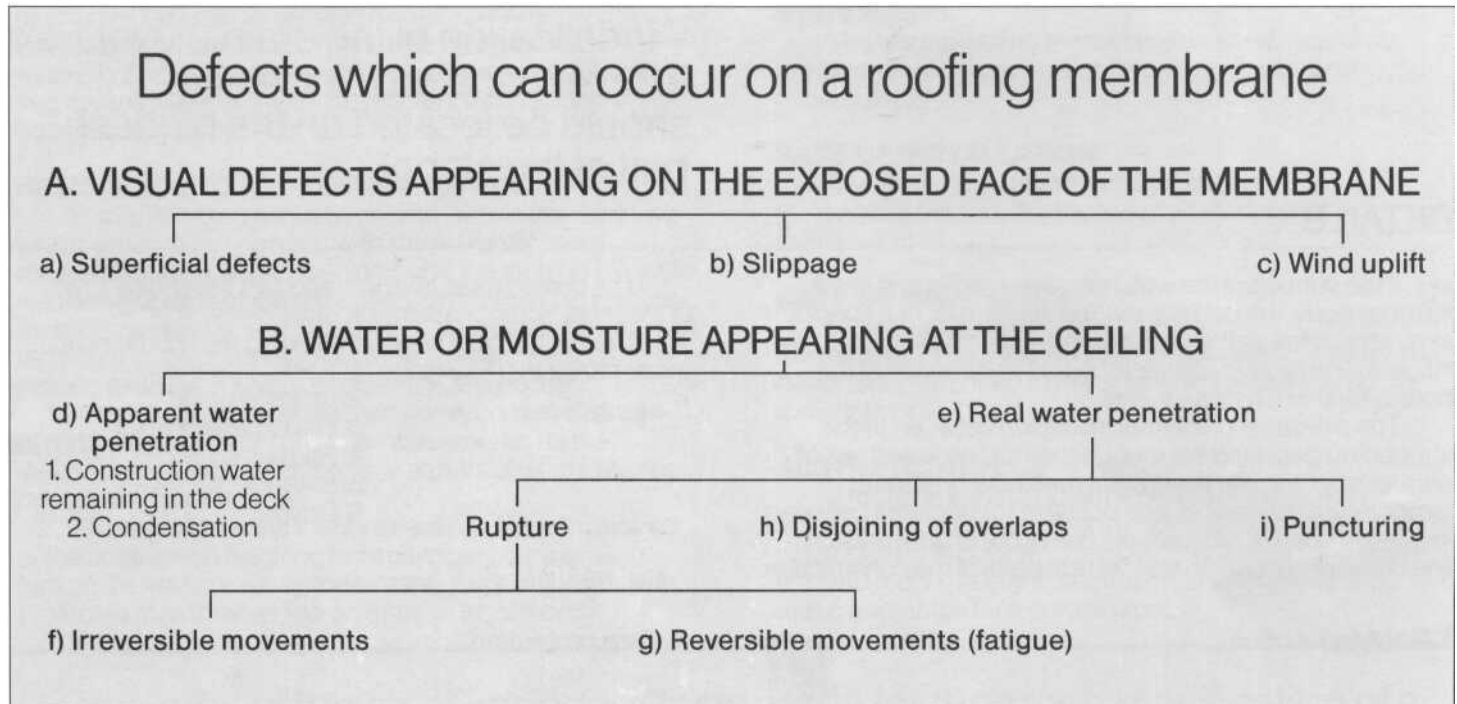
Most of the manufacturers in Germany, U.K. and other European countries follow the French example.

# The choice of SBS modified bitumen is the result of a methodical step-by-step research.

## First STEP

**A** A good roof must remain clear of defects as long as possible.

Which are the defects occurring on a roofing membrane?



## Comments to Table 1

### A. VISUAL DEFECTS

#### a) SUPERFICIAL DEFECTS

Cracks, blisters, wrinkles - Unfastened laps, fishmouth, surface erosion, defects on metal flashings.

#### b) SLIPPAGE

Use of bitumen which is too soft; or lack of fastening (nailing)

#### c) WIND UPLIFT

Does not occur when the membrane is adherent, except when the upper layer of the thermal insulation delaminates (fibres of mineral wool not sufficiently glued together) or too light a protection.

With membranes installed in independence the load of the protection must be calculated according to the local rules.

### B. WATER APPEARING AT THE CEILING

#### d) APPARENT WATER PENETRATION

1. Construction Water
2. Condensation

- Easy to detect: When boring a hole from the ceiling up to the source of water in the deck.
- Easy to avoid in calculating the location of the dew-point.

#### e) REAL WATER PENETRATION

Rupture

#### f) IRREVERSIBLE MOVEMENT

It is a crack in the support. A local mending will often be sufficient to restore the watertightness of the membrane.

#### g) REVERSIBLE MOVEMENTS

These are the main causes of fatigue.

Can be avoided:

1. Through independence of the waterproofing membrane
2. In using elastic membranes (materials with elastomeric-bitumen).

#### h) DISJOINING OF OVERLAPS

This happens when the operation of bending or torching was done too fast, with perhaps, some moisture on the surface of the felts, by cold weather or with a reinforcing which shrinks inducing a stress. Should be avoided when good material is used by a reliable roofer.

#### i) PUNCTURING

The causes of puncturing are to be avoided.

When it is not possible, a special protection should be provided; a good puncturing resistance can be provided with reinforcement of sufficiently strong non woven polyester: 350 gr., 250 or at minimum 180 grams/sq meter. Reinforced glass-fibers have a good puncturing resistance but very low expansion before breaking which can lead to other defects (disjoining or tearing).

## B. The design.

The design must be conceived after consideration of all possible causes of failures. Generally the designer should avoid the following difficulties which constitute a risk for good behaviour of the roof:

- lack of slope (if the membrane is not particularly proof for slope zero)
- too long a distance between expansion joints,
- available height for flashings, especially on door sills or door steps, superstructures, chimneys, skylight, a.s.o...
- the location of the drain (never next to an expansion joint which should be located on the highest part of the slope).

### DETAILS:

If the support of the waterproofing membrane is not homogenous, it must be provided with a joint, or a special strip, able to follow the possible movements (without fatigue). The roofing contractor ought to be aware of the possibility of such movements.

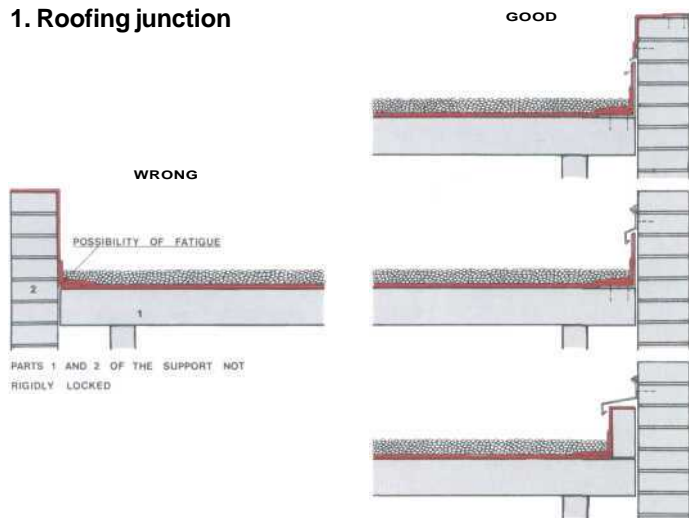
The presence of thermal insulation between the supporting deck and the roofing membrane is a cause of greater fatigue in the membrane because of greater temperature differences and possible movements between insulation boards. Movements can occur on the junction line between insulation and vertical parts of the construction.

The design must take into account the choice of the most appropriate membrane.

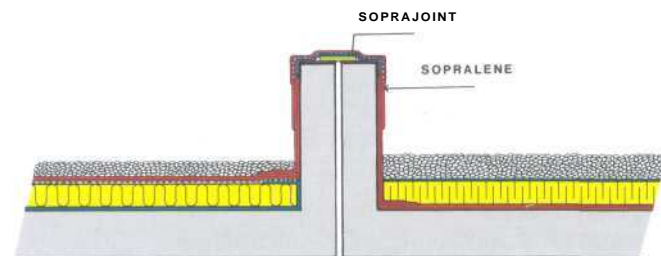
The design of all details must be done according to these principles: Examples:

1. Roofing junction
2. Expansion joint
3. Flat expansion joint
4. Hard protection
5. Skylight
6. Drain

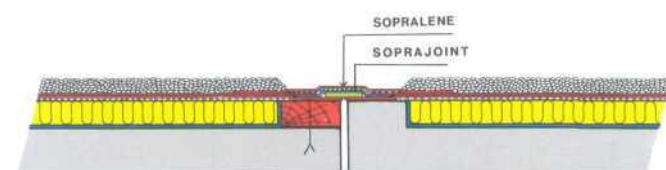
#### 1. Roofing junction



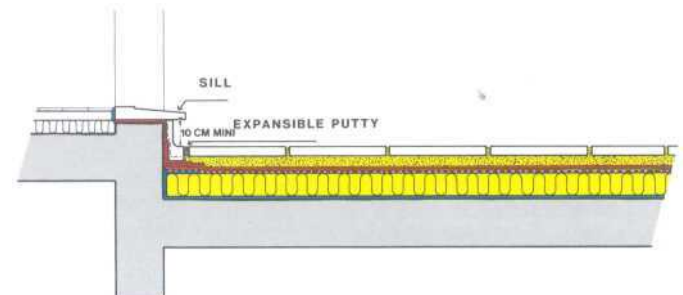
#### 2. Expansion joint



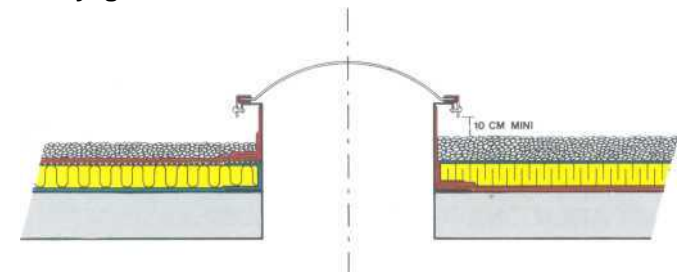
#### 3. Flat expansion joint



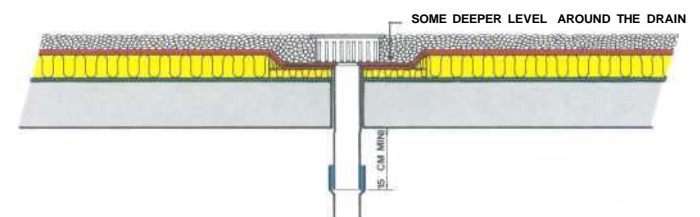
#### 4. Hard protection



#### 5. Skylight



#### 6. Drain



# Second STEP

## The quality of the waterproofing membrane

Which are its **Requirements:**

- DURABILITY
- RESISTANCE TO ALL KINDS OF STRESS
- STEADINESS
- EASE OF INSTALLATION
- EASE OF MAINTENANCE
- AESTHETIC ASPECT

### DURABILITY:

A waterproofing membrane should last as long as the building. Is that possible? Our answer is YES, if the conditions of a good environment (of the waterproofing membrane) are mainly satisfied as well as the requirements. But aside from the environment, the material of the waterproofing membrane must present the best durability, that means resist very well the different factors contributing to the ageing of its substance.

### RESISTANCE TO ALL KINDS OF STRESS:

Stress can be created by movements in the elements which are in close contact with the waterproofing membrane: the load supporting deck, the sloping layer, the insulating boards or the protection. Normally a bituminous membrane does not crack because of small movements of elements in close contact. But these movements can induce **fatigue** in layers of plastic substances.

Another source of stress can come from **shrinkage** of certain materials or certain reinforcements, as the result of temperature variations or of moisture (for instance on cellulosic roofing felt).

**Thermal stress** is the consequence of the expansion or the contraction resulting from changing temperature on the waterproofing membrane, especially with self-protected membranes laid on thermal insulations.

In most cases, rupture is the result of fatigue which does not occur rapidly, but often after several years when the material is not fit for a long period of good wear.

### STEADINESS

The waterproofing membrane must withstand the tendency to slippage on slopes and particularly on upstandings.

### EASE OF INSTALLATION

The easier the installation (easy bonding of the overlap) the less the hazard of workmanship's failure will exist.

### EASE OF MAINTENANCE

Depends on the kind of protection. **These two requirements are important**, because it is never recommended to rely solely on the skill of the roofing people.

### AESTHETIC ASPECT

It must be easy to obtain a pleasant aspect of the finished roof, for the pride of the contractor and the satisfaction of the owner of the building. A nicely and neatly finished roof is mostly a warrant of good workmanship and a guarantee for a durable roof.

## Here is a list of the most important tests made for thorough qualification of a waterproofing membrane

### Table III.

#### A. PERFORMANCES CHARACTERIZING THE DURABILITY OF THE ROOF

(independently of stress).

- Ageing resistance
- Weather resistance (by Q.U.V. Meter)

- Dimensional stability (restraint shrinkage test)
- Flexibility at low temperature
- Moisture effect on strength.

#### B. PERFORMANCES CHARACTERIZING THE RESISTANCE AGAINST STRESS

- Tensile strength - expansion at break
- Tensile fatigue - strength
- Flexural strength
- Flexural fatigue strength
- Shear strength

- Tear resistance
- Flow resistance at high temperature
- Puncture resistance against static load
- Puncture resistance against dynamic load.

#### C. MISCELLANEOUS FOR SELF-PROTECTED MEMBRANES

- Adherence of granules
  - Wind uplift resistance
  - Fire-resistance
- Factory mutual approval

#### D. SPECIAL CASES

- Fungus attack resistance
- Root resistance
- Chemical resistance in use of special environments.

#### E. FOR SINGLE LAYER

- Resistance to leakage at joints
- Tensile strength of joints
- Behaviour of joints due to ageing by exposure to elevated temperature
- Behaviour of joints due to ageing by exposure to water.

# Third STEP

## The choice of the membrane

### 1. What is SBS modified bitumen?

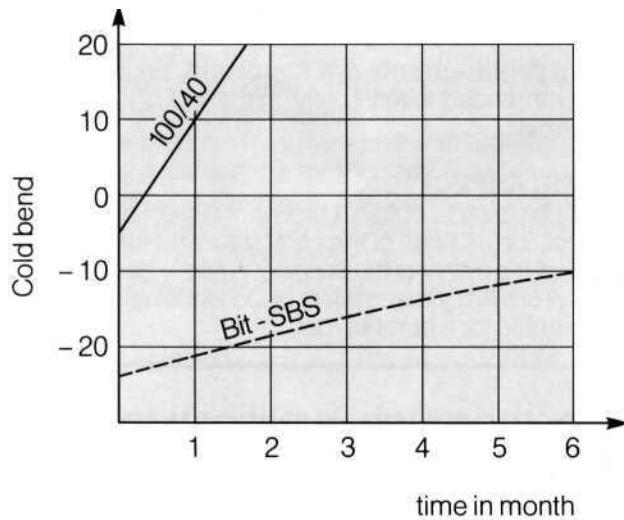
As all of you know, the initials SBS characterize a class of thermoplastic elastomers of the type styrene-butadiene-styrene. Its characteristic consists of the relatively easy way it is combined with selected bitumen. This has allowed the creation of a very interesting new material: the **SBS modified Bitumen**. At high temperature it has low viscosity, fluidity, plasticity, and at low temperature, properties similar to vulcanized rubber.

### 2. The major reasons of the superiority of SBS modified bitumen materials are:

#### - Durability and Elasticity

##### a) Durability:

The ageing resistance tests shows that the rheologic qualities of SBS bitumen are at least 3 times more durable than those of the best oxydized bitumen.



### 3. Polyester Reinforcement

The advantages of reinforcement in a roofing membrane are quite clear.

The excellence of reinforcement with polyestermats (non-woven polyester fleece) is the result of several high qualities:



Self-protected membranes with Soprane Granules.

Compared with oxydized bitumen, it has a higher softening point and a lower cold brittle point, with an SBS rate of 12 to 15%. The resistance against ageing influences is very much increased and the elasticity is almost 100 times that of oxydized bitumen.

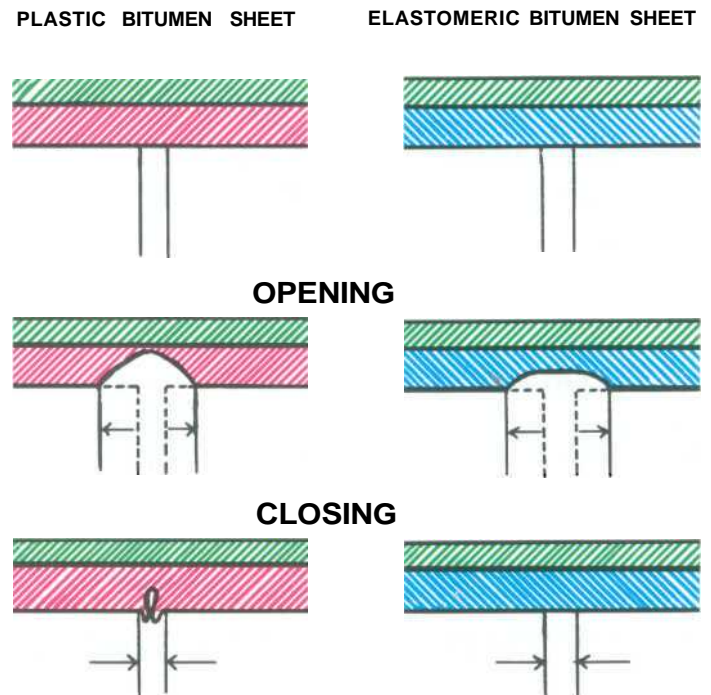
These high qualities explain the reasons why, we think that SBS modified bitumen is by far more superior to other modified bitumen. Although the latter are easier to produce, they show much less performance.

##### b) Elasticity:

If you take a look at our diagram you may see the difference of behaviour between a plastic membrane and an elastomeric membrane over a joint.

- in the first case there are small irreversible movements,
- in the second the deformation is cancelled out each time the support returns to its initial position.

### BEHAVIOUR ON A JOINT



- a) Absolute passiveness in contact with water or moisture,
- b) Very good affinity with bituminous substances as compared to glass fiber which at low temperature has poor adherence to bitumen.
- c) Elasticity-Flexibility
- d) Strength
- e) Puncture resistance.

The heavier the mat, the better the resistance.

### Self protected membranes.

All the qualities mentioned above lead to the conclusion that SBS modified bitumen is the best material for self-protected roofing membranes, especially when applied on thermal insulation. In this case the difference between the highest and the lowest temperature in the membrane can exceed 100° C.

Among all roofs which are designed for a special use (other than protection of the construction against rain, cold and heat) there are the terraces for pedestrians, walking or sojourning, the circulation and parking of cars, practising sports and last but not least the roof gardens.

#### FIRST

It is the most resistant, among all bituminous products, against ageing. - all experimental tests agree on that point-.

In all these cases there must be a **special protection** on top of the waterproofing membrane. Let us examine why the SBS modified bitumen is recommended in all these cases!

#### SECOND

To repair, restore or reroof a building covered with a self-protected membrane or protected only with a layer of gravel is an easy job. If a utilized roof, for pedestrians, cars sports or gardens, shows a leakage, the removal of the layers above the membrane and their reinstallation is more expensive than the cost of the new membrane.

Therefore, the **best** waterproofing membrane is a "**must**" for all utilized roofs, and the best way to defer reroofing, as many years as possible !

## Terraces - Protections

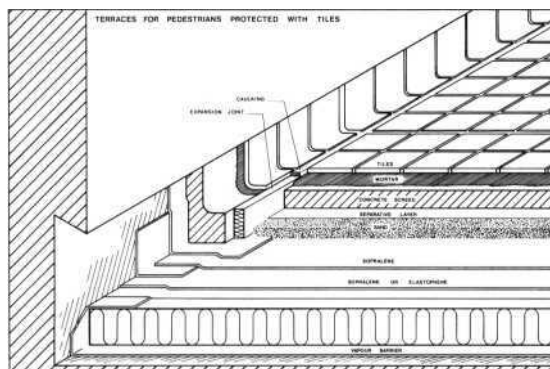
### I. PEDESTRIAN TRAFFIC

#### 1. Tiles

These may be covered with **tiles made out of fired clay or decorative stones**. On the SBS modified bitumen membrane, one spreads a layer of sand, a protective cement and sand screed provided with expansion joints.

The tiles are embedded with cement mortar. It is important to avoid that pressure occurs on the vertical parts of the bituminous membrane, as a consequence of the thermal dilatation of the tiles or of the concrete protection layer. When temperatures drop drastically the shrinking of the hard protection could cause a rupture of the vertical membrane at a spot, where leakages could be the inevitable consequence.

Therefore, special care must be given to the installation of the expansion joints in the protection, near all upstands of the membrane.

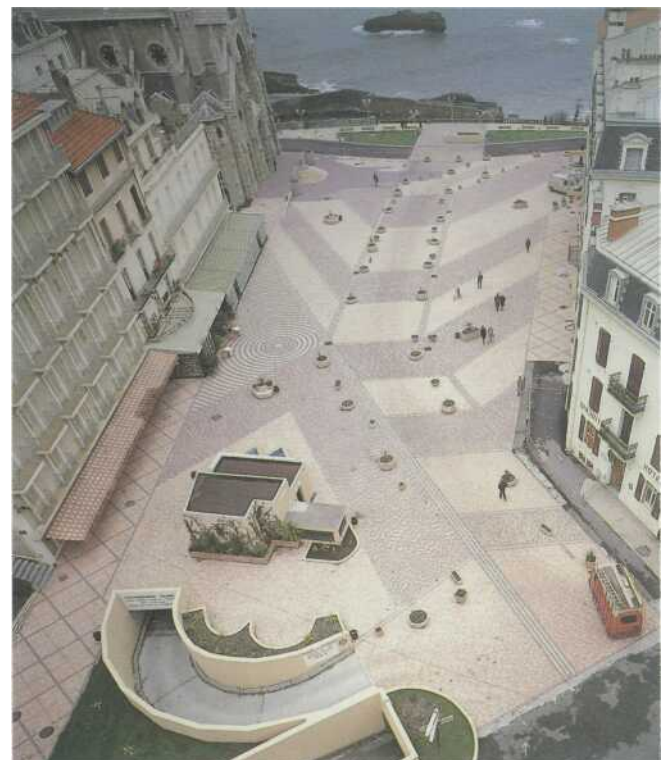


Terraces protected with tiles.

The installation of the protective layer of tiles is usually done by specialists who are not familiar and therefore not too careful with the bituminous membrane.

Therefore, **the qualities of elasticity and strength of the SBS modified membrane** (at least the upper layer with reinforcement of non-woven polyester) is especially recommended.

This system is often used on very large terraces.

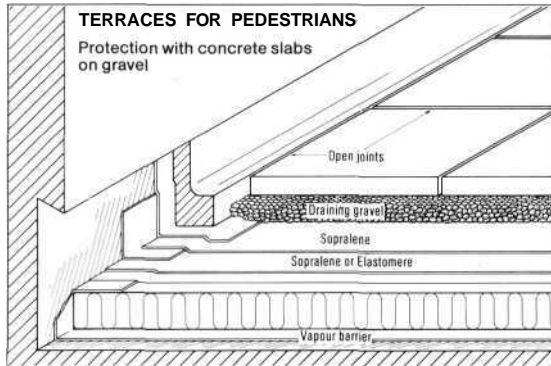


Place Ste Madeleine - Biarritz.

## 2. Concrete slabs

a) Another protection used for large or smaller terraces is composed of concrete slabs, usually 16" by 16" or 20" by 20" wide and 2" thick. They may be applied on a layer of sand, or even better, a layer of fine but sandless gravel (3/8).

The large porosity of the latter provides a good drainage of the water. Around the drainpipe, we put gravel on a distance of 4 to 6", gravel with only larger elements 2/3 to 1", to avoid the smaller stones being flooded down with the downpouring water.



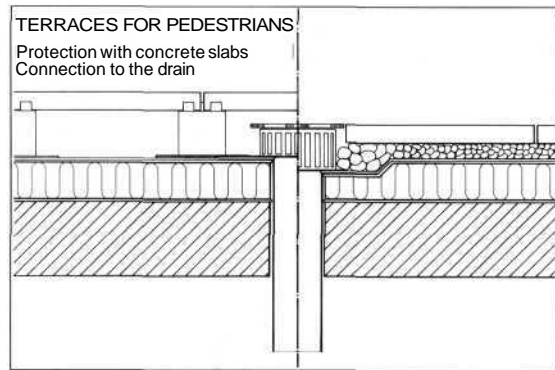
Concrete slabs.

b) the sand or gravel layer may be replaced by a **underseated pavers system**.

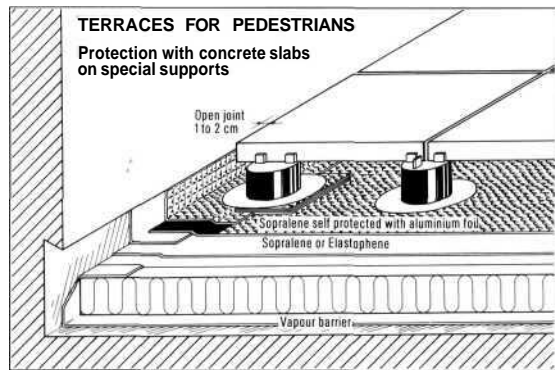
It is largely used in Europe. It can be used on dead level slopes, (to reduce costs), for rainwater does evacuate easily.

It is recommended to conceive easily removable slabs, in order to hose down the surface of the membrane.

Otherwise, smaller objects like leaves, papers, cigarette butts, may glide through the joint of the slabs, and remain, at certain spots, close to the supporting devices, and rot!



Connection to the drain



Underseated pavers system.

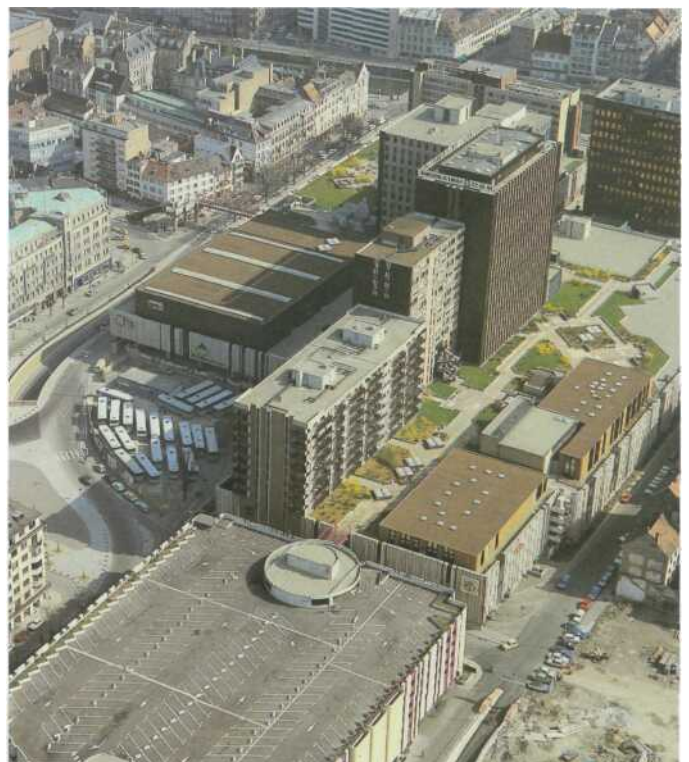
## II. LIGHT TRAFFIC DECKS

The concrete deck is installed with a 1 to 2% slope. The concrete must have a minimum of porosity to avoid the formation of blisters. The surface must be hard and clean. A good bituminous primer; compatible with SBS modified bitumen and solvent providing fast drying, is recommended.

A SBS modified bitumen membrane in one or two layers, the upper layer with non-woven polyester reinforcement 250 or 350 grams/square meter, is welded, or stuck by adequate hot bitumen. The upper sheet is self-protected with mineral granules.

A hot-applied (in one or two layers) bituminous concrete deck, the same as used for road coating, will form the protection of the membrane, about 2" thick, and a good circulation surface for light traffic, (axle weight of 2 tons maximum).

The self-protected membrane, well welded on the upstands, on primerized surfaces can remain without other protection if there are special fences against deterioration by cars or other moving objects.



Carpark deck on top of large shopping centers.

### III. HEAVY TRAFFIC DECKS

Whether it is designed for light or heavy traffic, the problem is the same. The concrete deck should be stronger in case of heavy traffic. The expansion joints at traffic level are often special and strong: this problem exceeds the frame of my talk.

In cold countries where, in winter time, snow and ice is melted with salt, the danger of corrosion of the steel reinforcement of the concrete decks exists. In the Alps tens of thousands of square meters of concrete deck have been replaced by new ones and you can bet than these were covered with a very strong bituminous membrane. We buy special stainless steel foils, here in the States, and manufacture stainless steel protected bituminous membranes, which have already covered hundreds of thousands of square meters of new or old bridge decks, especially in Germany and Switzerland.

These membranes can be covered directly with hot-applied road asphalt.



Station of Strasbourg.

## The roof garden

### A NATURALLY PLANTED GREEN ROOF:

1. Improves the image of the city,
2. Improves the thermal insulation (energy saving), provided by the plantations and the more or less wet earth layer,
3. Improves the phonic insulation - very little noise is transmitted through those layers,
4. The temperature in the waterproofing membrane is moderated - in a self-protected membrane laid on top of a thermal insulation there can be a span of 100° C between the highest and lowest temperature registered. This difference is reduced to a maximum of 35° C in the roofing membrane of a roof garden.
5. Improves the ecological environment through dust fixing, and oxygen production.
6. The downpour of heavy rainfalls doesn't congest the draining system. The water is kept in the different layers: grass, top soil, filters and drain which provide a relatively slow evacuation.
7. It allows people to enjoy nice areas.



Garden terraces in south France.

We have seen horizontal roofs which have lasted 60 to 80 years with a membrane of multi-ply paper and soft coaltar pitch. They were protected by 4 inches of sand and gravel, and a thick wild vegetation. There was always some humidity on the surface of the membrane **avoiding** the temperature in the membrane to rise, and thus the hardening of the coal-tar pitch.



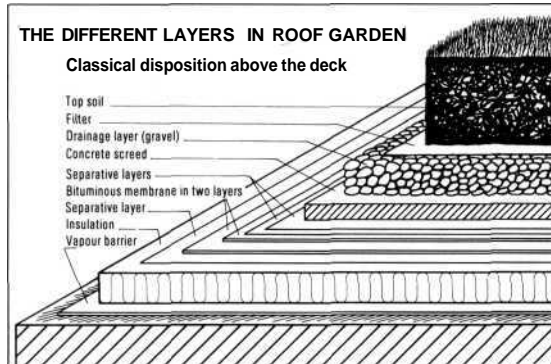
Garden terraces in Monaco.

These conditions, which were good for the preservation of the old fashioned membranes can be provided in a well structured roof-garden, and lessen the ageing of all kinds of bituminous membranes.

A garden roof or a natural green roof must:

- allow the development of the roots,
- provide food for the plants,
- keep enough humidity, however **not too much water**, so that the roots do not rot.

**A. According to the classical roof garden, where an average gardener is competent, the light structure, the most utilized nowadays, is shown in number 2 :**



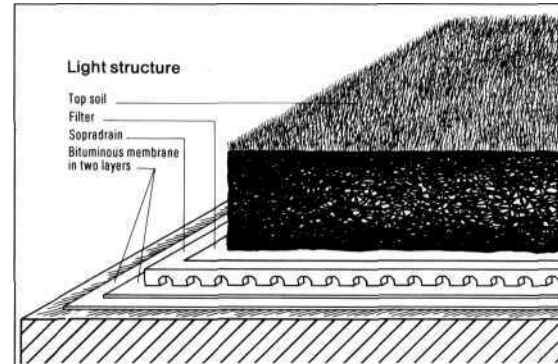
1 Classical roof garden

gives a root repellent quality, in contrast with plastic substances which yield to roots. The root repellent property of products like **SOPRALENE JARDIN** is permanent, the preventol is absolutely stable and constant.

**B. We had considered for many years that an earth layer of 12 to 24" was required for a roof garden:**

But nowadays much lighter structures are available. Certain plants grow easily on 1 inch selected top soil. This is the job of specialized roof gardeners.

But such thin layers of earth can only be stipulated in accordance with the gardener specialized in this field, or by a landscape architect.

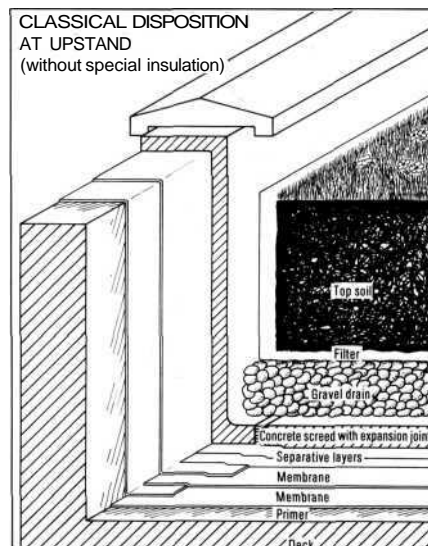


2 Light structure.

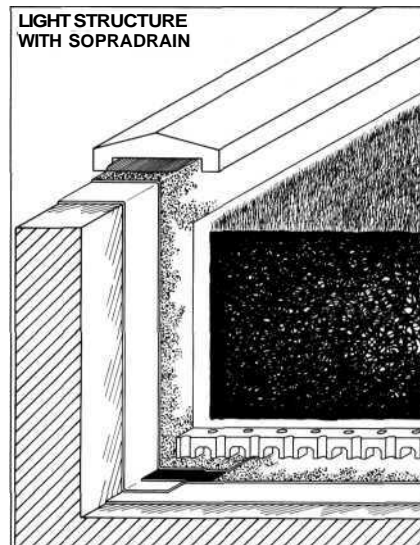
**The membrane shall be proof against root perforation.**

The specific quality of a membrane used as a permanent waterproofing layer under plantation is proof against the perforation of certain roots, which have the possibility of pushing themselves through any normal bituminous membrane or built-up roofing.

Coal-tar pitch was useful because of the excellent barrier against roots. But a problem always occurred at the junction with upstands.



Classical disposition at upstands.



Light structure at upstands.

Everybody has seen flat roofs covered with a green layer of moss, where earth had never been laid. Only a thin gravel protection and the dust brought by the wind or the mould created by leaves of surrounding trees were enough to allow the spreading of a natural green protection. This protection is good for a longer life of the roof. But what nature fulfils easily, in certain cases, can only be achieved correctly by specialists.

It is **therefore** the job of specialized gardeners or landscape architects to design the upper layers of a very light garden roof.

**We, roofers,** can only say that the function to be fulfilled by a garden roof are:

1. To keep the plantation in good health with enough food, good mould and fertilizers.
2. To keep enough water, if necessary with artificial watering disposition avoiding the roots to be drowned and to rot.

This depend on the kind of plants disposed on the roof.

One solution consists in incorporating a root repellent foil, of copper for instance, orterephtalate. In this case the problem lies in the perfect junction of these foils. Certain roots are able to penetrate between the overlaps when the bitumen is not root repellent.

The best solution to these problems, given by producers of roof garden membranes, is to incorporate a special chemical substance, successfully tested since several decades, the **PREVENTOL B 2**. It is not a poison. Its presence in the bituminous membrane repels the roots... In addition the elasticity of the SBS modified bitumen with reinforcement of non-woven polyester fleece also

## To conclude

Classical garden roofs are heavy.  
The deck has to be calculated  
with a margin allowing the overloading  
when the earth must be removed.

The waterproofing membrane must  
be strong enough and chosen for a  
**long lasting time.**

Presently the SBS modified  
bitumen with reinforcement  
of a non-woven (250 gram/square  
meter) polyester mat and a roof  
repellent property, seems  
to be the best way to achieve  
**our goal.**



**BOITE POSTALE121**  
67025 STRASBOURG CEDEX  
FRANCE  
TELEPHONE: (88) 79.99.45  
TELEX: 890.307 F