

# THE MODIFIED BITUMEN ONE-LAYERS IN ITALY AND EUROPE: ORIGINS AND GROWTH

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## INTRODUCTION

The bituminous-core, single-ply sheet has proven an acceptable answer to a tangled web of social and economic problems extending far beyond the purely technical problems of designing and constructing a water-tight roof. With a solid record of 10 years' field experience behind it, this modified bituminous product has flooded the Italian roofing market and is steadily invading the other European nations, its widespread market success testifying both to its technical performance and economy.

## THE CRISIS OF THE BUILDING CONTRACTING INDUSTRY

Social evolution, with its goal of an ever-rising standard of living, constantly shrinks the available pool of manual labor. In addition to better wages, manual laborers are demanding better working conditions and a more comfortable working environment (air-conditioning, dust, smoke, noise and general pollution control) and more incidental services (locker rooms, meeting rooms, cafeterias, and recreational programs). In the competition for the steadily declining number of manual workers, industrial enterprises have a tremendous advantage over the building industry in this incidental services competition, which is gaining steadily on wage competition in relative importance. Thus there is a steady decline of manual workers willing to perform the often onerous job of working on roofs, exposed to extreme heat or cold, without social services, and often at inconvenient distances from home. The result of this social trend for the roofing industry is easily deduced: fewer, and less skilled laborers. Throughout Europe, manual workers from the Third World are replacing domestic workers.

Associated with this worsening labor problem is a worldwide trend toward the flat roof. The flat roof offers faster construction, space-saving economy, and adaptability to modular construction. As its major disadvantage, the flat roof is, of course, much more difficult to waterproof than a pitched roof. It requires greater workmanship care and quality. And its success or failure is more dependent on weather conditions, especially temperature and humidity.

As a consequence of this dual-faceted problem – declining availability of skilled field labor coupled with the need for greater skills to construct dependably weather-resistant flat roofs – the roofing industry, like other segments of the building industry, is turning to prefabrication. Prefabrication offers the following advantages:

- More waterproofing work at the factory, where it is easier to attract labor.
- Reduced quantity and quality required of site work, which can then be carried with fewer, less skilled workmen.
- Reduced dependence on good weather for quality work (since a greater proportion of the total fabrication is performed indoors).

The industry's first response – plastic sheet membrane materials, originally conceived for uses other than roofing – was a failure. Instead of less field labor skill, these plastic sheets required greater labor skill for dependable, watertight field application than the conventional bituminous materials they replaced. And instead of a wide range of suitable weather conditions during application, they required an even narrower range – low humidity, low dust levels, relatively constant temperature. Consequently, some products that appeared promising during the testing period proved a disaster in practice.

## WHAT THE MARKET REQUIRES

From the foregoing, we conclude that the market needed a product satisfying the following requirements:

- High degree of prefabrication, reducing site work to the minimum, allowing fast application and high rate of field labor production by relatively few workmen.
- Easy application, even for unskilled workmen.
- Insensitive to application conditions, assuring good performance even when applied under poor field conditions.
- Service life of 10 years or so.

## THE ANSWER

So far, the modified bituminous sheet has proved the right answer to these market requirements. Its enormous market first in Italy, and now throughout Europe, testifies to its suitability. The bituminous sheets that entered the Italian market 10 years ago developed slowly at first, and then rapidly. Today the modified bituminous sheet accounts for nearly 65% of the Italian waterproofing market, with a total area of nearly 120 million square meters of these prefabricated sheets in place.

The membrane is a typical Italian product, created in connection with the great availability of large quantities of atactic polypropylene in Italy. This product filtered into nearby foreign markets. Our exports extend a distance of about 2,000 km, into Europe and Africa, and even Asia. Similar products have been developed in France, Germany, England and Spain. The use of the membrane has spread into all Mediterranean countries.

## THE MODIFIED BITUMINOUS-CORE SHEET

The bituminous sheet is modified with synthetic products and usually reinforced with a non-woven fiber. This modification is necessary because it is impossible to produce, with bitumen only, a sheet able to withstand handling - from manufacture to application - at the different temperatures occurring throughout the year, or even at daily temperature cycling.

The modification is performed by plastic materials compatible with the bitumen.

Bitumen was chosen as the base material because it is widely known, economical, and effective. As a byproduct of oil, it is compatible with several polymers having the same matrix; it has good workability at relatively low temperatures, requiring only relatively simple machinery, thus permitting high-rate output at acceptable production cost. Moreover, it has always been the premier material used for waterproofing, so it is familiar to workmen.

The bituminous core sheet is normally black-colored, 4-mm thick, prefabricated in rolls of 10m x 1m, feeling like hard rubber or soft leather to the touch. It generally allows single-ply application, performed with the aid of a liquid-gas torch. The torching operation melts the upper surface to obtain good adherence to the substrate and the overlapped joints to the contiguous sheets.

Overlapped joints are normally treated with the same torch to assure a good, strong seal. Remaining operations (preparation, beadings, outlets, protection) are performed as in traditional bituminous systems.

To prepare these modified bituminous sheets, you can use several synthetic products, such as vinyl-acetate ethylene, butadiene-styrene, styrene-butadiene-styrene copolymer, and regenerated rubber obtained from old tires. Best results, however, have been achieved with the atactic-polypropylene (APP) base sheet. This APP sheet offers easy mixing of the bitumen with the plasticizer, good workability during application, long service life, and low cost.

The APP core sheet has been marketed for 10 years, a time span that provides field data on its durability. This bituminous sheet deteriorates less than any other known bitumen, even when directly exposed to ultraviolet rays. Moreover, its elasticity and its mixed properties - essentially plastic, but partially elastic - make the sheet adaptable to different kinds of bases, and under stresses that normally would preclude bitumen.

These desirable properties have promoted the use of the sheet in other fields, particularly for the decks of bridges, to protect them from corrosion caused by anti-freeze salts (DIAPO).

The most interesting application of the bituminous sheet has been proved to be for hydraulic structures and especially for irrigation and water-treatment. The sheet has been successfully used in South Italy for coverings of irrigation canals, for water collecting or decantation basins, and in North Italy as well, in purification tanks, (when not attacked by oils), on concrete, bituminous conglomerates, lean-cement underlayers, or simply on rolled ground (DIAPO).

This versatile product has performed well, displaying good mechanical resistance, durability, impermeability to vegetation, and economy. Quick application, light weight, and easy transportability, added to easy application, make the sheet attractive to developing countries, where the water shortage represents a very serious problem.

## TECHNOLOGY OF A BITUMINOUS SHEET

The machinery for the manufacturing of bituminous sheets has evolved from that used to produce bituminous felts. Apart from the equipment for mixing of bitumens and resins, the machinery essentially comprises:

- An impregnation tank, for dipping the two reinforcements (non-woven fiberglass base, and the synthetic fiber reinforcement polyester + polyamide). Fiberglass provides thermal stability throughout the processing, and at laying as well.
- A nebulized water-cooling system, integrated with a rolling-cylinders-contact cooling; featuring closed-circuit circulation. To produce 1000 sq. m. per hour, 4 mm. in thickness, the heat quantity to be dissipated is about 600,000 Cal/hour - about 1 cu.m. of evaporated water or practically 1 litre/sq.m.

- A surface-spraying system with the powder sized to allow adhesion between sheets or to the base throughout the torching operation. The powder is used to facilitate detachment of the continuous packing sheet, especially in summertime, and to allow pounding throughout laying as well.
- A compensation system allowing the winding machine to stop at every roll without stopping or snagging production.
- A winding machine able to roll compact thicknesses (5 or 6 mm) of a slightly adhesive material, coupling it to a continuous polyethylene sheet separating the turns and functioning as a package (stamped with thickness and quality).
- A packing machine, preferably using sheets of thermoshrinkable polyethylene, able to provide further information (trademark, date, plant identification).
- A palletizing machine.

However, the newest and the most important part of a bituminous sheet plant concerns production of the mixture, in the quantity and quality necessary for a continuous output. It consists of two separate sections:

- a) The melters, for proportioning the resin, bitumens, and other ingredients.
- b) The mixers, where the melted mix is homogenized and kept at controlled temperature, comprising conveying (pumping) and filtering systems.

Temperature control poses a problem. High temperature accelerates production, melting the resins quickly. But this temperature must be controlled - to avoid depolymerization or other chemical degradation of the mix and to control the cooling to a manageable level.

### CONCLUSIONS

The bituminous-core, single-ply membrane satisfies not only the technical, but the economic requirements. It offers these advantages to the various concerned parties:

- The manufacturer produces the whole waterproofing component, not merely some elements, without a proportional rise in investment.
- The contractor has fewer problems of supplying and stocking, requiring less storage space and field equipment.
- The field workman has an easier job, with less physical risk, less pressure for skilled workmanship standards, and less pressure from the contractor.
- The customer feels reassured because he can verify beforehand the characteristics of the product that will be applied, and he feels protected by the product trademark, guaranteeing him quality that he could not obtain with a jobber team.