3 Built-up Roofing

3.1 MATERIALS

INTRODUCTION

Almost all forms of flat roof are suitable to receive built-up roofing, and it is also widely used for bridge deck waterproofing before the application of protection and wearing courses such as sand asphalt carpet, hot rolled asphalt and coated stone.

Built-up roofing is formed on site from two or more layers of roll roofing. The vast majority of materials available consist of a reinforcement base of glass or polyester coated with oxidised or modified bitumen. The continued development and popularity of roll roofings is due to the waterproofing and adhesive properties of bitumen, but it is the nature of the reinforcing base which dominates the strength and fatigue resistance of the membrane.

Rag, wood or asbestos fibre were originally used to form the base reinforcement for all built-up roofing. These bases were saturated with a penetrating bitumen and coated with oxidised bitumen. They achieved only limited success and are not now recommended for built-up roofing. They are withdrawn from British Standards, other than for underslating felt.

Glass tissue reinforcement was introduced during the 1950's. Being composed of solid fibres held together with a resin this base requires only a coating of oxidised bitumen. No breakdown of the glass through weathering has been observed in service and the ageing and weathering process has little effect on the reinforcement provided by the glass tissue, but the strength of glass tissue and oxidised bitumen combined is now considered insufficient for specifications to be entirely composed of standard glass base roofing. It is still used as a component in specifications, however, to provide lap security where strength is not required.

HIGH PERFORMANCE ROOFING

High performance specifications are now always recommended for built-up roofing and should completely displace lesser specifications from the market.

Most high performance felts are made on a polyester fibre base which is more than strong enough for roofing purposes, and has a high elongation at break which exceeds all demands likely to be met in service. Past problems with built-up roofing, before the use of polyester, were almost all concerned with splitting of the membrane due to an inherent lack of strength. Such splitting is now a thing of the past, and split polyester base roofing specifications are practically unknown.

Polyester roofing has been in regular service for some 25 years and there appears to be no report of failure through ageing. Reported defects have been due to design faults or workmanship faults, for example at outlets or pipes.

Polyester felts were originally made with oxidised bitumen coatings, but the majority are now made with modified bitumen coatings. These have further improved performance under test, and have improved handling characteristics on site, particularly in cold weather.

The polyester itself is manufactured in one of two different methods which produce materials with differing characteristics. Needled polyester forms a relatively thick material with an open structure. Spun bonded material is more densely compacted, and tends to be stiffer and stronger. Both forms of polyester are equally suitable and roofing manufacturers make a choice to best suit there own process and economies and achieve a good balance of handling characteristics and performance on test.

The addition of a polymer to the bitumen improves its properties as a roofing material in almost all respects, and in particular the flexibility, strength and fatigue resistance. Polymer modified bitumens are usually applied to a base of polyester or glass.

The most commonly used modifying additives are SBS (styrene butadiene styrene) and APP (atactic polypropylene).

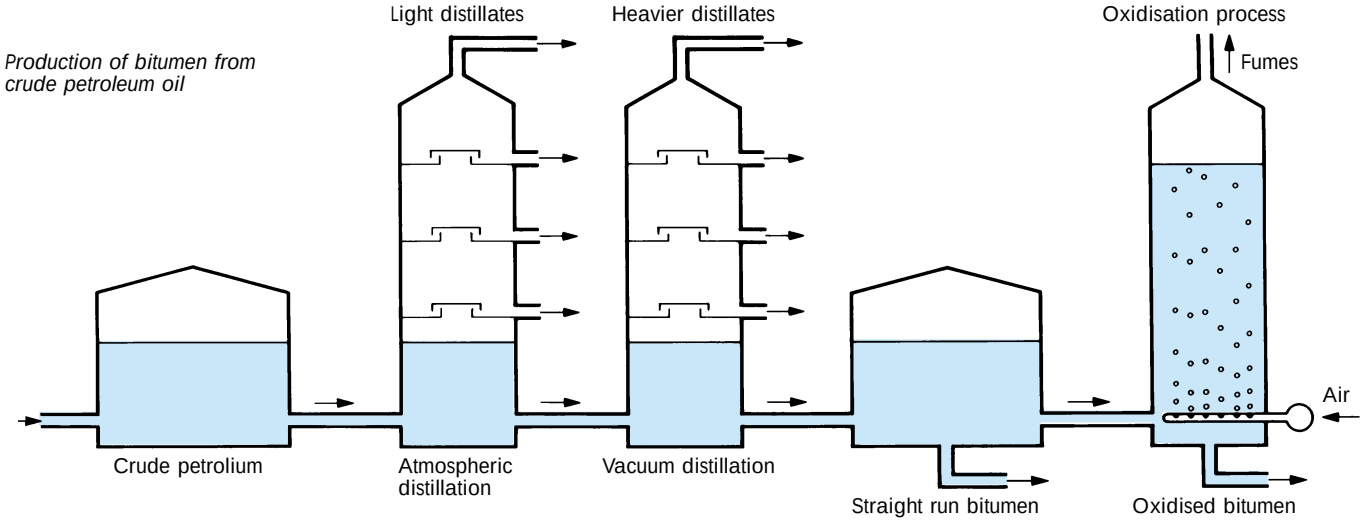
The addition of SBS to bitumen makes the bitumen more rubber like. The finished roofing material is more flexible at low temperatures, with greater elasticity than those manufactured from oxidised bitumen. The softening point of SBS modified bitumens is in the order of 110°C. Felts using SBS modified bitumen can be manufactured for application either by bonding in hot bitumen or by torching, depending on manufacturers recommendations.

Adding APP to bitumen improves its high temperature performance and can give improved weathering characteristics. The softening point of APP modified bitumens is approximately 150°C. An effect of this high softening point is that hot bitumen used on sites to bond felts is not hot enough to melt and fuse the APP modified bitumen, and therefore these materials are not suitable for bonding in hot bitumen. They are primarily for application by torch.

As there is no British Standard for SBS or APP modified bitumen roofing, designers and specifiers may refer to certificates issued by the British Board of Agrement.

The quality of roofing is measured by laboratory testing and manufacturers all make test data available. This makes a useful basis for judging and comparing the quality of a product but test methods are not yet standardised. European tests are being developed for publication in European Standards. When published, these tests will allow manufacturers published test data to be comprehensive and strictly comparable. They will also form the basis of a CE mark.

Napier University, Edinburgh, have carried out research with government funding to establish the performance of flat roofs, including polyester specifications, and to report on aspects of flat roofing which show any cause for concern. The roofs which formed the basis of the investigation, include roofs which were studied by the Building Research Establishment, BRE, in 1986/87 in association with the British Flat Roofing Council, BFRC. This gave a useful two- stage assessment. The Napier College report, published in 1994, indicated a satisfactory performance of all the roofs in the study.



BITUMEN MANUFACTURE

Bitumen is a component of crude oil and is separated by the refinery process of fractional distillation. Heat is applied to the crude oil in a distillation column until the lighter constituents vaporise and rise to condense on a series of trays within the column, with only the lightest remaining as vapours. A temperature difference between the top and bottom of the column ensures that the trays contain successively lighter fractions of the oil.

At atmospheric pressure the high temperature needed to vaporise some constituents would degrade the products. The distillation process is therefore carried out in at least two stages, one at atmospheric pressure and the other at reduced pressure or vacuum to lower the boiling point of the heavier constituents.

Bitumen remains as an end product of fractional distillation after other products such as naphthas, white spirit, kerosene, diesel oil and light, medium and heavy lubricating oils have been driven off. Bitumens obtained by this method are generally called penetration or straight run bitumens. They flow easily at high temperatures and are susceptible to cracking at low temperature. For roofing work it is necessary to make the bitumen firmer and less temperature sensitive. These types of bitumens are known as oxidised bitumens and are made by passing a regulated stream of air through a soft bitumen under controlled temperature conditions.

BONDING BITUMEN

Oxidised bitumens are used by the roofing trade as bonding and coating bitumens and are identified by a two figure system, for example 95/25 bitumen. The first figure refers to the softening point of the bitumen in degrees centigrade when subject to a ring and ball test. The second figure refers to the result of a penetration test.

The softening point is measured in accordance with Institute of Petroleum test method IP 58/82 or BS 2000:Part 58:(1995). Melted bitumen is poured into a tapered brass ring and allowed to cool. A 9.53mm diameter steel ball is placed centrally on the ring of bitumen and the apparatus is heated in a suitable liquid, the temperature of which is increased at a rate of 5°C per minute.

The softening point is the temperature at which the bitumen has softened sufficiently for the steel ball to fall through the ring for a distance of 25mm and is an indication of temperature susceptibility.

The penetration is measured in accordance with Institute of Petroleum test method IP 49/72 or BS 2000:Part 49:(1983). The penetration is the distance in tenths of a millimetre by which a standard needle penetrates into the bitumen under a total load of 100 grammes in 5 seconds at 25°C.

Both figures in the classification give an assessment of hardness, one at 25°C and the other at the softening point, which will be at a much higher temperature. Together they provide a good indication of the performance of the bitumen.

Modified bitumens do not have a standard classification as their properties depend on the grade and quantity of modifier. Softening point and penetration values should be obtainable from individual manufacturers. Whilst widely used in the manufacture of bitumen felts, SBS modified bitumen is not widely used as a hot bonding bitumen on site as ordinary oxidised bitumen is considered adequate for all normal purposes. APP modified bitumen is not suitable for use as a hot bonding compound.

The bonding bitumens in normal use are listed below:

TABLE 1.27 Oxidised bitumen

Grade	Softening point °C	Penetration at 25°C
95/25	90 - 100	20 - 30
105/35	100 - 110	30 - 40
115/15	110 - 120	10 - 20

95/25 is the conventional general purpose oxidised bitumen for bonding. It is normally supplied in block form to be remelted on site in a heated boiler but may also be supplied hot for bulk delivery by tanker.

105/35 bitumen is used by most leading manufacturers as a coating bitumen for roll roofing, but is not normally used as a bonding bitumen on site.

115/15 is the hardest roofing bitumen and a strong adhesive in hot conditions. It is used as a general purpose bonding bitumen for roofs with a slope of 20° or more and is sometimes used on lesser slopes when improved bonding and resistance to slipping are required.

THE MANUFACTURE OF ROOFING FELTS

The manufacture of roofing felt is a continuous process involving the impregnation and coating of the base with bitumen, bitumen and filler, or modified bitumen.

The bases are first impregnated by passing them through a bath of molten bitumen to fill the voids between fibres with bitumen to exclude air and moisture. Oxidised bitumen or polymer modified bitumens are generally used to impregnate polyester bases. Glass fibre bases do not normally require impregnation.

The impregnated base is then coated with a layer of oxidised bitumen and filler, or polymer modified bitumen, usually containing filler, to provide the waterproofing layer. The thickness of the coating is controlled by nip rollers

Sand or talc surfacing is next applied to the coating to prevent sticking to the machinery during manufacture and within the finished roll of roofing felt. For mineral surfaced roofing a range of coloured mineral aggregates is applied to the upper surface of the felt in place of sand or talc. Correct control of manufacturing conditions is necessary to achieve good adhesion of the mineral surfacing to the roofing felt.

The felt is then cooled by passing over cooling rollers so that the felt can finally be reeled and wrapped without blemishing and sticking.

The oxidised bitumen coatings used in the manufacture of roofing felts are normally made from 105/35 bitumen mixed with filler to give a stable and relatively firm material.

SBS modified bitumen coatings are made from selected grades of straight run, not oxidised, bitumen and SBS rubber. The latter, in granule or powder form, is mixed with the molten bitumen under carefully controlled conditions. Filler is usually added to increase the stiffness of the coating. The type and amount of SBS rubber, the composition of the bitumen and the mixing conditions all affect the properties of the final coating and must be controlled.

APP modified bitumen coatings are made in a similar manner to the SBS modified coatings. The type and amount of APP polymer, the composition of the bitumen and the control of mixing conditions again critically affect the properties of the final coating and must be controlled.

FELTS MANUFACTURED TO BS 747

BS 747:1994 Specification for roofing felts, classifies felts according to base and surface finish by a number and letter system. The number refers to the base material: class 3 is glass fibre base, and class 5 is polyester base. Class 1 and 2 have been superseded and withdrawn, other than type 1F, a reinforced felt for underslating.

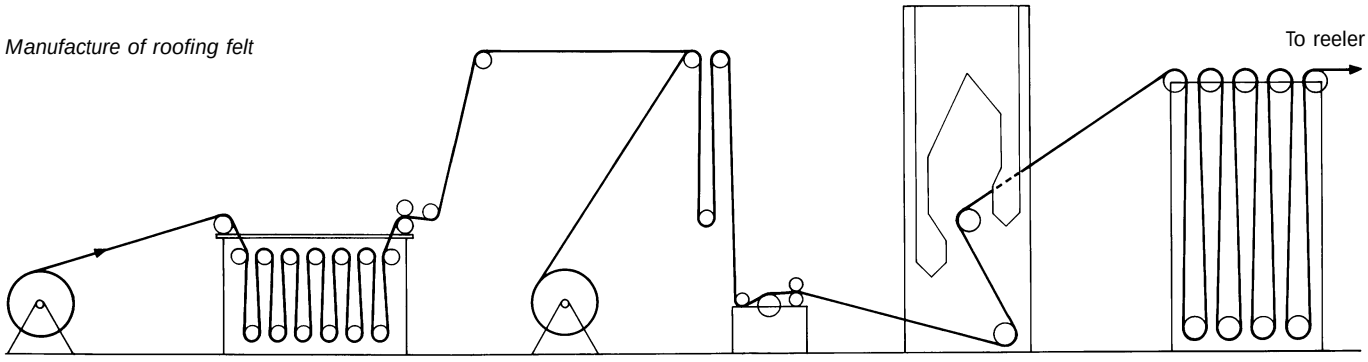
The letter refers to the type or finish of the felt. Type U is for underlay only and type B is general purpose sand finished felt. Type E is mineral surface felt and type G is a perforated felt. Each class of felt can be identified by the coloured sand strip which is applied to one edge during manufacture. An additional class, class 4, includes black sheathing felt which is used as an underlay to isolate mastic asphalt from the substrate material.

CLASS 3 - GLASS FIBRE BASE

Glass fibre base roofing has excellent weathering qualities but is not strong enough to be recommended for built-up roofing in its own right. Type 3B is used as a low cost component to provide a base for polyester roofing, or to provide lap security as an additional layer. Type 3E is sometimes used as a cap sheet to protect polyester felts beneath.

Class 3 felts are coated in manufacture with oxidised bitumen.

Manufacture of roofing felt



Felts to BS 747:1994

TABLE 1.28

Felt type	Surface finish	Weight/roll
Class 1 Fibre base (colour code white)		
1F	Hessian reinforced base with fine granule surface	22.5kg/15m x 1m
Class 3 Glass base (colour code red)		
3B	Fine granule surface	36kg/20m x 1m
3E	Mineral surface	28kg/10m x 1m
3G	Mineral surface underside Fine granule surface topside	26kg/10m x 1m
Class 5 Polyester base (colour code blue)		
5B	Fine granule surface	33.6kg/8m x 1m
5E	Mineral surface	37.6kg/8m x 1m
5U	Fine granule surface	28.8kg/16m x 1m

CLASS 5 - POLYESTER FIBRE BASE

Polyester base roofing is recognised as the leading material for built-up roofing. Type 5U is a sand finished bonding felt for a fully bonded first layer, or for application on type 3G perforated roofing to achieve a part bonded specification. The base weight of type 5U is nominally 125g/m² (minimum 118g/m², maximum 150g/m²).

Type 5B is also a sand finished bonding felt and can be used for the top layer in a specification provided it is protected by stone chippings or other surfacing. The base weight of type 5B is nominally 350g/m². It makes an extremely thick roofing which is normally used as a top layer over a layer of type 5U.

Type 5E is the mineral surfaced version of type 5B, again on a nominally 350g/m² polyester base.

Class 5 felts are coated in manufacture with oxidised bitumen.

ROOFING IN ADDITION TO BS 747

A wide range of roofing felt is available which is not described in British Standards. The main types are listed below, and are grouped according to the type of coating; oxidised bitumen, SBS modified, APP modified and pitch polymer.

ROOFING WITH OXIDISED COATING

All felts which are coated with oxidised bitumen are suitable for application in hot bonding bitumen, and are not normally suitable for torch application.

Glass base

BS 747 type 3B and 3E roofing is made on a 60g/m² glass tissue base. An improved quality is available on a heavier glass base, for example 100g/m². It is used as an alternative to type 3B where increased strength is required.

Polyester base

BS type 5U felts are considered by many to be rather thin and light, and types 5B and 5E rather thick and heavy. However, an alternative range of different base weights are regularly used to form polyester base roofings including 180g/m², 200g/m² and 250g/m². These are easier to handle than the type 5 roofings and yet make for specifications with comparable performance.

Glass/polyester base

Glass and polyester fibres can be mixed together in a single glass/polyester base material, which can have a wide variety of compositions, weight and structure. The polyester fibres add flexibility and toughness to the base. The glass fibre helps provide dimensional stability and resistance to high temperatures, such as those experienced during manufacture of the roofing membrane or when the membrane is torch applied. Glass/polyester based roofing is suitable for nailing to timber decks.

ROOFING WITH SBS MODIFIED COATING

Felts which are coated with SBS modified bitumen are suitable for application in hot bonding bitumen, and a number of special grades are manufactured for torch application.

Glass base

SBS coatings greatly improve the performance of felts made on a glass tissue base, and these are sometimes used to form a built-up roofing system without the addition of polyester, but the stronger systems incorporating polyester are normally recommended.

A woven glass base is used to form a torch applied quality, and can be used where no significant stress will be imposed on the membrane. Woven glass material will mould into place on awkward shapes and is sometimes used for the formation of details.

Polyester base

The full range of polyester base material is used with SBS modified coatings. This improves the properties of flexibility and elongation to give much improved handling characteristics, the ability to conform to more complex shapes, and generally improved test results. The material can become sticky in hot weather, when a little extra care is required on application. For a torch applied roofing an extra thickness of coating is put on the underside of the membrane so that it can provide the bonding bitumen when heated with a gas torch.

Glass/polyester base

Again an SBS coating improves the flexibility of glass/polyester base materials, and maintains temperature stability. These materials are bonded in bitumen on site and may also be nailed to timber decks.

ROOFING WITH APP MODIFIED COATING

Felts manufactured with APP modified coatings are intended only for torch application and will not bond satisfactorily in hot bitumen.

Glass base

Glass base is suitable for APP and is used when the material is not likely to be under significant stress in service.

Polyester base

Polyester base APP modified torch-on material is widely used. The high melting point of APP makes it a very firm material at high temperature, with good slip resistance. It is very suitable for single layer application on existing built-up roofing or asphalt for repair or renewal.

In areas where a naked torch flame is an unacceptable fire risk, it is possible to bond some specialised APP coated materials with a cold bituminous adhesive, but the laps will require to be sealed by torching or hot air welding.

PITCH POLYMER ROOFING

The addition of special polymers to pitch or bitumen can make a material which is more like a stiff rubber, and is manufactured by a calendering process as a homogeneous material with no base to form a reinforcement or carrier. Pitch polymers are resistant to chemical attack and root growth, and exhibit extremely good retention of properties after weathering. These specialised materials are normally used for applications where chemical resistance is important, or for buried work such as roof gardens where toughness and root resistance is required.

METAL FOIL SURFACED FELTS

High performance materials with a polyester or woven glass base are available with aluminium or copper facings. Metal facings give an extremely effective protection to the membrane, as they exclude ultra violet light, oxygen and ozone - the factors which are most instrumental in the ageing and hardening of bitumens. Aluminium also has good reflective properties and effectively reduces the temperature of the bitumen in service.

Foil faced felts are suitable for nailing but on sloping roofs the metal facing can slip or slide at the interface with the bitumen backing unless mechanically fixed. Most manufacturers indicate a maximum sheet length in the order of 2 to 2 1/2 metres. Slope lengths which exceed this dimension should have nailing battens at intervals down the slope to allow nailing at the top of each length of material.

Aluminium faced roofing can be used for the formation of detail work and is also sometimes applied to flat areas of roof. In this case the drainage must be efficient to prevent corrosion from standing water and chemical pollution. Aluminium faced roofing should not be used for roofing or detail work near cement works or in similar alkaline atmospheres.