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Please note

Since earliest times the most satisfactory roofing for buildings has been a series of sloped overlapping units to shed water. The waterproofing, preservative and cementing qualities of natural bituminous material were also known by ancient peoples, but bitumens were not used as roofing until comparatively recently. The use of built-up roofing, consisting of alternate layers of bitumen and felt, extends back over little more than a century. Roofing of this type is now often used on roofs with little or no slope, and depends for its effectiveness on its waterproofing properties. Organic felts, most commonly used in this system, can absorb moisture with consequent dimensional changes and deterioration. Bitumens oxidize from exposure to air, moisture, heat and ultraviolet light, and the oxidation products are water soluble and volatile. They also become very brittle when exposed to low temperatures. The quality of the finished built-up membrane depends on workmanship and weather conditions during application. Such roofing, therefore, has not always given good service, and a great deal of attention is being given at present to the problems of roof systems by various agencies in Canada and elsewhere.

During the past decade, research groups in industry have devoted considerable effort to the search for new roofing products. This has been partially as the result of problems with conventional bituminous roofing, but is also due to changes in architectural design. Designers have developed many new roofs of unusual contours - curved shells, domes, hyperbolic paraboloids, folded plates - that are not easily roofed with conventional materials.

The search by industry for new materials for these special applications bas resulted in the development of many new roofing systems. Some of these still use bitumens as an adhesive and waterproofing element but with few exceptions thin films replace the old multiple-ply systems. Although a few systems are applied in a manner somewhat similar to that used for conventional roofing, others are sprayed, brushed or rolled on.

A number of the new systems, while not originally intended as alternatives for conventional roofing, are now being offered for such applications. In addition to the primary function of protecting a building against penetration of water, most of the new roofing systems claim secondary advantages such as lightness, high elasticity, high reflectivity, resistance to traffic, and even easy removal of atomic fallout. Although still comprising a small percentage of the total number, the percentage of roofs finished with these new systems is increasing despite the limited field experience in their application, performance and limitations. This Digest is intended to acquaint the reader with some of the systems now being used.

Bituminous Systems

Cold-applied asphalt emulsions and cold-applied coal tar pitch are bituminous-type systems that appear to offer some advantages over conventional hot-applied bituminous roofs. Emulsions are very small droplets of bitumen in water and are stabilized by the addition of a material with small plate-like particles that orient at the interfaces between the bitumen droplets and the water. Curing of the emulsion takes place by the evaporation of water, and the particles form a honeycomb network throughout the remaining film. This gives the material excellent stability and permits the use of soft asphalts with characteristics most desirable for roofing. Bentonite clay is the principal stabilizing additive used for asphalt roofing emulsions. The weathering characteristics are good because oxidation is limited by the filler material.

Most roofing systems that use these emulsions start with a base membrane of coated asphalt felt applied over the roof deck or over the roofing insulation, with either a hot or cold asphalt adhesive. In some instances, where application is directly to a concrete deck, it is claimed that the base membrane is not necessary. This is only possible if adequate reinforcing is provided within the emulsion coating. In one system that utilizes a spray technique, asphalt emulsion and chopped glass fibres are applied simultaneously by means of a special spray gun. About 1 pound of glass fibre is used to 3 gallons of emulsion, and is intended to reinforce the resulting layer of asphalt. The effectiveness of the glass fibres as reinforcing depends on the distribution within the mass, with fibre lying across fibre to form a continuous mat of micro-reinforcing. When fibres fall in bundles leaving "skipped" areas, the strength and moisture resistance of the material will be reduced. In other systems asphalt emulsion is brushed on over the base membrane and an open glass fibre mat is embedded by brushing to bring the applied emulsion up through the mat. Additional emulsion is then brushed on as the final coating.

Asphalt emulsions do not require the protective covering that is essential to ensure reasonable life of hot applied bitumens. Weathering characteristics, however, are improved by a light reflective coating to reduce surface temperatures and thermal movements. White and pastel shades are preferable, and these are often required for decorative considerations on roofs exposed to view. Such decorative coatings will have a limited life, generally much shorter than the life of the material, and may have to be renewed about every five years. Damage to and deterioration of such roofs are readily discernible and relatively easy to repair with cold materials. There are, however, application limitations related to the nature of asphalt emulsions: because of the water carrier, the emulsions can only be used when temperatures are above freezing; and since the material cures to a stable condition slowly, there is danger of wash-off by rain during the first day after application.

Cold-applied coal tar roofing bas been under development for a number of years in the United States. It was recently put on the market, but has now been temporarily withdrawn. This system consists of an asbestos or glass fibre felt impregnated with coal tar pitch, to which a coal tar based adhesive is applied. The unique feature of the system is this 35-mil factory-applied pressure-sensitive adhesive, which will eliminate the need for either hot or cold adhesives during application. The surface of the adhesive is covered with a disposable release paper that prevents sticking in the roll. During application the release sheet is peeled back as the membrane is laid out on the roof deck. When the membrane is in place on the roof, the application is completed with a top coating of coal tar pitch emulsion. Colour and light reflection is obtained by the application of a sprayed paint-type coating. Adhesion between felts has apparently been excellent, but some difficulties have been experienced with adhesion to substrates, where success depends on the smoothness and cleanliness of the substrate.

Fluid-Applied Elastomers

Several systems have been developed for application in a fluid state to build up a continuous thin membrane. Most of these fluid-applied systems utilize synthetic rubbers or similar elastomers as the basis of the system. One of the earliest coatings of this type was a vinyl copolymer developed at the end of World War II for use in protecting surplus military equipment from rust and deterioration. Combined with plasticizers, stabilizers and pigments in appropriate proportions, this material bas been used as a decorative protective coating and to some extent as roofing for a number of years. A more recent development in liquid vinyl systems is an epoxide vinyl polymer that combines the adhesion properties of the epoxy family with the abrasion resistance, weatherability and colour retention of the vinyls. This is a hot-sprayed system with a finished thickness of 60 mils.

The fluid-applied coating system enjoying the greatest popularity at this time is a neoprene and hypalon combination. The basic raw materials were developed by the chemical industry, and the roofing coatings have been formulated by a large number of manufacturers. Neoprene, which was introduced in 1932, was one of the first synthetic rubbers to be produced on a commercial scale. It has been used extensively as cable covering and is reported to have a history of good resistance to, sunlight, temperature extremes, weather, ozone, and oil and grease. Hypalon has the chemical name of chlorosulphonated polyethylene, and is produced by treating a solution of polyethylene with gaseous chlorine and sulphur dioxide. It is reported to have the same desirable properties as neoprene, and can in addition be tinted to produce stable colours. Its ozone and oxidation resistance are greater than that of neoprene. Although they may be used singly, neoprene and hypalon are usually used in combination. Heavier base coatings use neoprene; thinner coatings of the more costly hypalon are used as decorative, more weather-resistant top coatings. Neoprene may also be applied in sheet form, but this is a much more costly application. The most common technique is to apply it in solution, using the conventional methods of brushing, rolling or spraying. The pressure-fed roller is reported to be the most satisfactory and economical. Several coats have to be applied to build up a cured thickness of at least 20 mils (0.02 inch) for the finished membrane.

The weathering characteristics of neoprene and hypalon systems on applications as old as ten years appear to be very good, if the material is applied in sufficient quantities over suitable substrates. Defects have shown up, however, on some jobs. There has been blistering of material applied directly to concrete decks, cracking of membranes caused by deck movement and by the membrane sagging into joints in the substrate, and occasionally poor adhesion to the substrate. Small blisters may occur in individual coatings due to bubbling caused by improper rolling, but this is usually of no great consequence. Larger blisters, which have occurred in the membrane over concrete decks, are believed to be due to, the trapping of solvent in the voids at the surface of the concrete. The solvent condenses in the voids during application, but later vapourizes and expands from solar heat, causing bubbling or blistering. It therefore appears necessary to, seal the concrete surface before applying the coating. Chlorinated rubber and a mixture of sand and neoprene have been used for this purpose.

Poor adhesion may result if the material is applied. over damp surfaces, and all manufacturers recommend application only over dry decks. Some manufacturers describe a dry deck as one that does not contain more than 16 per cent moisture by weight. Concrete curing compounds have been suspect in certain cases of adhesion failure, and most manufacturers recommend application only to concrete cured without surface additives.

The fluid-applied systems will not, in general, bridge structural cracks or joints in roof decks or insulation, and it is necessary to caulk and tape all such openings. Glass fibre, nylon and cotton tapes applied with neoprene have been used for this purpose. Certain companies have experimented with a spraying technique, using chopped glass fibres sprayed simultaneously to get better bridging characteristics from the material to avoid taping the joints. When the material has sagged into joints, particularly on flat roof applications, a combination of water and dirt in the depression and flexing of the membrane has caused fairly rapid deterioration.

Single-Ply Felts

Two systems have recently been developed that utilize a very thin film of elastomer over an asbestos felt as a support or carrier. One system bas a 2-mil-thick polyvinyl fluoride film, factory laminated with an adhesive to a latex-impregnated asbestos felt. For use as roofing this single-ply membrane is applied using conventional hot or cold asphalt as the adhesive. The material is 36 inches wide, as for conventional roofing, and has a 2-inch selvage edge to allow for side lapping. Caution is required on the part of the applicator to avoid contamination of the adjoining sheets with asphalt, although the surface may be readily cleaned with solvents. The laps are finally secured with a pressure-sensitive tape of polyvinyl fluoride film 2 inches wide, so it is not necessary to bring the asphalt adhesive exactly to the edge. It is claimed that this roofing can be applied to surfaces from level to vertical. The high coefficient of solar reflectivity, particularly of the white film, considerably reduces surface temperatures and consequently the possibility of slippage on steep surfaces is greatly reduced. A coated asphalt base sheet applied by conventional hot or cold methods is used for most applications, but for some jobs it may be possible to use the material without a base sheet.

The other system of this type has a 30~m thick polyisobutylene rubber film, factory-laminated to a latex-impregnated asbestos supporting felt for the membrane, and to a woven glass fibre felt for flashing material. A thicker unsupported polyisobutylene sheet material is also supplied for special flashing operations. The membrane is applied with a liquid polyisobutylene adhesive, spread in ribbons by a special dispenser, and the laps are sealed with a special polyisobutylene lap cement. A third polyisobutylene cement is used for flashing applications. As it is black in colour, a decorative and reflective treatment may be obtained by a sprayed or rolled-on coating. An acrylic latex coating is used for this purpose. A coated asphalt base sheet is used on most applications, but some may be made without this precaution.

The few years of experience with these materials on limited applications in the United States indicate good weathering characteristics. With the polyvinyl fluoride system, there has been some indication of shrinkage in the vicinity of laps sealed with pressure sensitive tape. For the polyisobutylene system, which bas a top-coating, recoating may be required every four or five years.

Sheet Rubber

Butyl rubber, a co-polymer of isobutylene and isoprene, is also being used in sheet form for single-ply roofing. One or two companies have been pioneering this use in the United States and similar material is now being manufactured in Canada, in southeastern Quebec. The Canadian company is manufacturing white butyl as well as the black manufactured by other companies. Sheet rubber is applied by adhering it to the substrate with rubber type adhesives. Material 36 inches wide, as for conventional roofing, is placed with a 4-inch-wide side lap. It appears, however, that it might be practical to produce and apply much wider material, thus greatly reducing the number of field joints in the roofing. The principal problem with the earlier production of this material was its poor resistance to cracking from ozone attack. The more recent formulations produced by the raw material suppliers and the manufacturers appear to have solved this problem. Application tools are paint rollers for spreading adhesive and a sharp knife or scissors to cut the material. Partial adhesive coverage is said to be satisfactory, but full coverage is desirable for easy application with contact adhesives. If large movement is expected at joints in the substrate, the joint should first be taped with a wax-surfaced masking tape about 2 inches wide. The adhesion of the membrane to the masking tape will be low, thus providing a free slide area and allowing movement stresses to be spread over the width of the tape. It is reported that some of the butyl adhesives recommended for use with butyl roofing can be applied at temperatures as low as -20° Test applications of roofing have been performed under fairly ideal conditions, but indications are that the system may be very good.

Conclusion

Many new roofing systems appear to have considerable advantages over conventional bituminous roofing, but most have not yet been extensively field tested. Unlike conventional roofing, which from the beginning was largely the utilization of waste products, most of the new systems have been developed specifically for roofing. Gravel as a protective covering has been dispensed with entirely in the newer systems, so that inspection and maintenance during and after application is greatly simplified. Imperfections and damage can easily be seen and repaired. Reflective and decorative coatings are easily applied. Most systems are light in weight and have much greater elasticity than conventional systems. Promoters, however, in their enthusiasm tend to forget or ignore some of the factors that cause failure such as building movement, trapped moisture and poor workmanship. These factors still exist with the new as well as the old systems. These systems also introduce new factors such as dependence on thin layers of adhesive to provide water-tightness at narrow joints, and bridging characteristics of fluid systems over rough surfaces and joints, as well as the need to adhere strictly to recommended materials and procedures. Despite any new problems that may arise, it is certain that the percentage of roofing using these new systems will increase during the next decade.