APPLICATION CONSIDERATIONS AND PRODUCT DEVELOPMENT OF MODIFIED BITUMEN

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Modified bitumen roof membranes, in various industry studies, have been forecasted to be the fastest growing segment in the roofing industry. No longer are modified bitumens considered to be the dark horse in the business. With their ever-increasing market share and their excellent in-service track record, it's not surprising that these systems have gotten high marks from roofing contractors, architects, and owners.

While modified bitumen membranes are total roofing systems, they are also very important components for built-up roof BUR systems. Their BUR usage takes place in a roof system's most critical area: base and wall flashings. They have no equal, as there is no other BUR flashing material in the marketplace that has the versatility and strengths of the modified bitumen membrane.

The first portion of this paper will deal with application consideration for both torched-on and mopped-on modified bitumens. The second portion of this paper will cover the European viewpoint of product development and formulation technology of atactic polypropylene modified bitumen materials.

TORCHED-ON MODIFIED BITUMENS

First, the paper will cover torching equipment, application guidelines, and safety considerations.

Equipment

The following is a description of some of the equipment required by a torching crew during the application of modified membranes.

Torches This portion will include single-headed, double-headed, and trolley wagons. The purpose of the torch is to activate the modified bitumen on the roll. Single-headed or double-headed torches are primarily used on small projects and for flashing work. A trolley wagon is an apparatus with a torching head, usually consisting of a minimum of five burners, mounted on a wheeled trolley. It is generally used for field application on large or open roofs. It is also possible for applicators to use the torching head part for the torch-and-flop flashing method.

LP gas hose This hose must be UL-listed for use with LP gas. This insures the gas will not cause the hose to deteriorate, and also guarantees certain required performance characteristics. The hose should be a minimum of 25 feet long to allow for sufficient working efficiency. A maximum of 50 feet is recommended.

Regulators It must be supplied with a torch to insure that the proper working pressure is maintained for the type of torch equipment being used.

Spark lighter This is the simplist, safest and only approved way to ignite a torch. Use of a match or pocket lighter has caused many an unnecessary burn to an applicator, and is not recommended.

LP gas The type of liquified petroleum gas used with roofing torches is propane, in either a liquid or a vapor state.

Fire extinguisher It is absolutely essential that every torching crew have a fire extinguisher (20-pound type ABC) close to the work area. The fire extinguisher should not be next to a propane cylinder, as it is possible to have a fire at the head of the cylinder caused by old or improperly mounted fittings. If working around wood shingles, a water fire extinguisher is an excellent safety precaution and is highly recommended.

Field installation patterns

There are primarily two good patterns used to install the product on a low-sloped roof. The first is a staggered pattern. (This means the) second roll of material is shorter or longer than the first roll; this insures that the end laps of each roll are offset or staggered from the one immediately adjacent to it. An advantage is that it offers good production rates, as it allows the crew considerably more working space. This pattern is most productive on a direct overlay application.

The second installation pattern is referred to as the perpendicular sheet layout. For the first series of horizontal courses of material, all of the rolls are installed full length, with the ends of the rolls in a straight line. After laying these rolls out to the width of the building (or as wide as needed), a gap of 31 inches is left with substrate exposed. The next set of horizontal material is then installed, also full length. After this part of the pattern is complete, a roll of membrane approximately 39 inches wide is laid perpendicular or vertical to the previously installed rows of membrane, sidelapping the end laps of each row by 4 inches. This is an excellent pattern for a new project that requires insulation, or for an application over insulation in a recovery situation. On new construction, where it is necessary to complete the installation of the insulation, base felt and modified bitumen daily, this pattern results in an easier and more secure end-of-day tie-off.

A third pattern is often referred to as a "straight butt" application. It is neither the quickest nor the best application, because of the lap joints that are four layers high. There may, however, be areas on certain roofs where this type of application is the only one feasible.

On slopes of 3 inches in 12 inches or greater, the "strapping method" is the one recommended. The rolls are run vertically up the slope in this pattern. Experience has indicated that a horizontal pattern on a slope this steep is quite difficult to keep running straight and true. The vertical application pattern also reduces the potential for membrane slippage. Further, it's easy to apply, which results in reduced labor costs and renders better membrane performance.

Field installation guidelines

A roofer must see the flow of modified bitumen in front of the roll, and out to the sides of the lap, with both the torching trolley or with hand-torching. To repeat, it is very important to ensure full

adhesion; the applicator needs to see bitumen flow.

It is also important to check and seal the laps while the membrane is being installed. It is a lot safer that way. It has been estimated that completing the lap operation later can increase costs by three times the man hours. In addition, the roof is not really tied off at this point, and remains susceptible to damage from the elements. Not all torch-on systems require this, but for those that do, make sure it's done soon after the roll is torched down, or it can prove to be expensive. Some manufacturers do not require troweling of the laps, but do require that modified asphalt be visible beyond the lap.

Base flashing installation

The two most common ways to install base flashings are the torch-in-place method, or the torch-and-flop method.

Regardless of the flashing operation used, the fire extinguishers will not do any good if you get wood fiber cant on fire. You can take wood fiber cant and put it in a bucket of water, pull it out, and in all probability it will still be ignited. When using torch-application techniques, it is strongly recommended that either Perlite or other non-combustible cant strips be used, and then only with a base felt covering them.

Torch-in-place method

With the torch-in-place method, the piece is precut and held in place with a 3-inch lap on the side, and a minimum of 4 inches on the deck. The area that runs along the base of the parapet is then torched. The sheet is worked in by hand, and the rest of the material is solid-torched.

This is a common application method, and its primary benefit is that the roofer should be able to heat the wall substrate and torch the membrane at the same time. This process should eliminate any non-adherence problems, as the membrane is at its hottest and the bitumen is in its most fluid state. This procedure is not recommended if flammable materials or an open joint in either the deck or the wall are nearby.

Torch-and-flop method

In this case, the torching surface of the membrane is heated and flopped into place, which solidly welds it to the receiving surface. The torch-and-flop method is suggested for any application that has potential for a smoldering fire, or in any situation where the flame may not be visible.

The primary limitation of the torch-and-flop method is the potential for non-adherence during the installation of wall flashings. Lack of adherence occurs if the receiving surface has not been sufficiently warmed, or if the flashing membrane has been allowed to cool before installation. The solution for the first is to preheat. A successful solution for the other is a bit more detailed.

The first requirement is to have a four-wheeled cart, such as a little giant trailer, with a 4-foot-by-8-foot piece of plywood bolted to it. This renders a movable, flat platform on which to torch and stock pieces of membrane. The mobility of the torching platform is important. It's easy for the roofers to stay opposite the wall that is to receive the next piece of flashing membrane; this maintains the shortest distance possible. This mobile platform also insures that the flashing membrane is not being torched when lying directly on the finished membrane roof surface, thus avoiding degradation to the surface by overheating.

The type of torch equipment being used is also very important to the torch-and-flop method. A skilled workman can use either two single-headed torches, two double-headed torches, or the torching handle with a multi-burner head, part of a dragon wagon torch trolley, to heat the flashing membrane. A three-or four-man crew is recommended for this type of wall flashing procedure. This allows the flashing piece to be installed while much hotter and more fluid, which reduces the potential chill problem, and the ensuing non-adherence.

Think safety

All documents on roofing applications should include the subject of safety. This is true for all types of systems-built-up, modified bitumen, and single ply. While the toxicity and flammability of single-ply adhesives is a real concern, so too is the potential for fire with torched-on products. Safety recommendations always seem so self-evident, but on the roof, obvious and fundamental safety requirements can sometimes be overlooked by well-intentioned roofers. The answer to this problem is having better educated and trained mechanics.

The Midwest Roofing Contractors Association has published a comprehensive training document on torch welding entitled, "Safety in Torch-Welded Roofing." With this training program now available, it is possible for every applicator to be certified and exprienced in this type of roofing application.

The Asphalt Roofing Manufacturers Association (ARMA), in conjunction with the National Roofing Contractors Association, Owens-Corning Fiberglas Corp, and the United Union of Roofers, Waterproofers and Allied Workers, also produced an excellent videocassette, titled, "A Guide to Safety: Torch-on Modified Bitumens."

The purpose of the safety document and the videotape is to teach roofing applicators the proper techniques for personal and building safety. Another purpose is to demonstrate to building owners, specifiers, code officials and the insurance industry, that torch-applied modified bitumens are viable, well-performing systems that can be installed safely by professional, qualified roofers.

MOPPED-ON MODIFIED BITUMENS

General guidelines

For the application of mopped-on modified bitumens, the same technology and equipment, such as tankers, kettles and mops, would be used as would be with the conventional built-up roof system. From an installation standpoint, the closest thing to a granulated mopped-on modified bitumen product would be a product like the granulated fiber glass cap sheets used with built-up roofing.

If the rolls become slightly deformed, whether they are in the warehouse or on the jobsite, it is possible before application to lay the material out on a roof and allow the sun to relax them, making them usable again. One of the more important things to remember is not broom, or use a heavy roller, when applying a granule-surfaced modified bitumen. Also, it is imperative that you avoid foot traffic until the material has cooled.

The mopped-on modified bitumen should not be applied in such a manner that, at any point, the flow of water is against the laps. This requirement is just as appropriate for this system as it is for conventional built-up roofs. While there are some manufacturers of APP torched-down modifieds that allow installation over a dead-level surface, the manufacturers of SBS-granulated mopped-on membranes do not guarantee or recommend their product if positive drainage of roof surfaces does not occur. However, some mopped-on manufacturers state that occasional ponding water is acceptable.

Field installation considerations

In field application, the shingle method has been found to be the

best from a quality and efficiency standpoint. It is also recommended that mopping take place no farther than 4 feet in front of the roll. It is sometimes necessary to unroll or cut the granule-surfaced modified material to allow it to flatten and warm up prior to application. This overcomes the wrinkling problem.

The application temperature of the asphalt is even more critical here than with built-up roofing. Temperatures need to be at the highest EVT (equiviscous temperature) range. This allows the best marriage between the two types of asphalt, and minimizes the potential of a poor bond between plies. The interply moppings of asphalt should consist of an appropriate amount of asphalt to obtain a continuous film sufficient to render the proper adhesion between plies. The use of ASTM Type III or Type IV asphalt for the application of this product is the requirement.

As in all roofing applications, the adherence of the laps is very important. It is essential to mopped-on modifieds that the laps be totally adhered in asphalt with no void areas. End laps on a mopped-down membrane should overlap the underlying sheet by a minimum of 6 inches. Side laps of the membrane should be about 4 inches, consistent with factory selvedge.

The protrusion of asphalt from the end lap and side laps is acceptable and desirable, and provides a check point for the proper application of the material. If a dressed-up finish is required, sprinkle granules into the hot asphalt showing beyond the lap. About 5 gallons of granules for every 10 squares will be required. This granule application must be done immediately after the roll has been laid to ensure proper adhesion.

Base flashing installations

The flashing system usually consists of a fiber glass base layer installed in hot asphalt, as the substrate. This would be followed by a layer of the modified membrane, also mopped in hot Type III or IV steep asphalt. The flashing membrane is side-lapped approximately 6 inches and should reach approximately 6 inches out onto the deck as well. This criteria is different from other single-plies, including torched-on modifieds, and it is a point that needs to be made evident to the roofers installing the product.

Although this is not required, flashing cement with 4- to 6-inch-wide asphalt-saturated fabric can be used to seal the flashing laps. If asthetics are not a consideration, this is an excellent addition to the mopped-on modified membrane system.

European product development

The final portion of the paper will provide the roofing contractor and other interested parties with a fundamental understanding of the main aspects of manufacturing a quality atactic polypropylene modified bitumen membrane.

What can be seen in Fig. 1 is a picture of an atactic polypropylene (APP)-modified bitumen mixture taken through a fluorescent microscope, enlarged 125 times. One side of the picture represents 80 mils in real size. The white on Fig. 1 represents the continuous phase and consists of the APP swollen by the maltenes of the bitumen; the black spots are the heavier parts of the bitumen, the asphaltene. The continuous phase can be compared to a sponge: it is a network stabilizing the maltene phase of the bitumen and in which the asphaltenes are widely dispersed.

Seeing this continuous phase of APP, you can better understand why, with only 30 percent of APP versus 70 percent of bitumen, many characteristics of the mixture are dramatically influenced by the APP alone. For example, the ring-and-ball tests (ASTM D36) or softening point, shows a temperature of 300°F for the APP alone, 115°F for the bitumen used in the mixture and 300°F for the mixture itself.

To obain this continuous phase and these characteristics it is essential that bitumen and APP are compatible. With 70 percent of the mixture, the bitumen is the main component. Two bitumens coming from the two different sources and sold under the same brand name, for example, bitumen 80—100 pen, can be very much different one from the other. Mixing these two bitumens with the same APP formulation can give totally different characteristics to the final mixture. The Corbett[1] method helps the membrane manufacturer to precisely analyze the composition of the bitumen, percentage of asphaltene, and the percentage of the different maltenes present in the bitumen. The manufacturer can then determine what bitumen best suits his atactic polypropylene and the bitumen maltenes.

One important point to mention is that the Corbett method is time-consuming (almost one week long), and therefore daily supplies cannot be fully controlled following this method. Also, the manufacturer must trust his bitumen supplier.

The polypropylene atactic is the other main component in the mixture. Polypropylene is a generic name; it regroups many different products with many different characteristics. The distillation of crude oil renders propane. After a crackling of the propane, propylene is obtained. Through polymerization, polypropylene is obtained. It is a polymer. The word polypropylene in our industry regroups two main families of polymers: the polypropylene homopolymer, where the molecular chain is composed of identical propylene elements, and the ethylene propylene copolymer, where the molecular chain is composed of propylene and ethylene elements. They have different physical and chemical characteristics, but they are both usually called polypropylene.

The construction of the molecular chain determines the atactic classification. When the elements are randomly placed on both sides of the molecular chain in an amorphous and supple configuration, it is called atactic configuration, versus the rigid and crystalline configuration, called isotactic, where the elements are placed on one side of the molecular chain.

The atactic polypropylene coming from homopolymer or copolymer is a waste product of the isotactic polypropylene manufacturing process. There is no guaranteed specification for it. It is up to the membrane manufacturer to make his own classification following his own methods. Some atactic polypropylene is not compatible with bitumen and will not give a good mix. This results in the product aging faster. It is vital to closely control the atactic polypropylene supply and be sure it still fits the classification the manufacturer has decided for it.

The manufacturer can seldom be sure that the atactic polypropylene received is exactly what was anticipated. An APP formulation usually regroups four to five different atactic polypropylene. Several companies are now working on manufacturing and supplying atactic polypropylene by following rigid specifications to guaranteed minimal variance. As actual world spot supplies decrease, these companies will become more and more important on the market.

When a manufacturer of membrane must choose a reinforcement for his product, he usually chooses between three; single reinforcement of non-woven polyester mat, double reinforcement of fiber-glass mat and non-woven polyester mat, polyester scrim bonded to a fiber-glass mat or non-woven polyester mat. With the first technique, the reinforcement must have the best possible dimensional stability at high temperature. Indeed, the reinforcement is pulled through an impregnation tank full of modified bitumen heated at around 375°F. That can generate much stress in the reinforcement and can cause stability problems during production

and in use. That is why rigid and heavy non-woven polyester mats generally are preferred for these products, although these heavier mats are more difficult to impregnate and can limit production speed.

With double-, glass- and non-woven polyester reinforcements, the glass fiber mat ensures dimensional stability during production and while the product is in use. The problem here is to fully impregnate both mats and place them in the product so that there is enough modified bitumen between them to avoid delamination problems. Also, if there is too much modified bitumen between the mats, it can generate aesthetic problems, i.e., creasing of the roll, etc.

Finally, the third choice offers an easier solution for the manufacturer as far as the production technique and production speed are concerned.

This reinforcement is easier to impregnate, but can sometimes cause delamination problems. The manufacturer must see that the reinforcement is well located in the product, leaving enough modified bitumen for an easy and safe application.

As can be discerned from the previous product development review, the manufacturing process is similar to the application process; both fall in the category of being more of an art than a science. The key ingredient to the selection of a product manufacturer is similar to the selection process of a roofing company for its installation. Simply put, that requirement is for a long-term performance record of quality installations for satisfied customers. This is the important requisite, worldwide, for both aspects of the roofing process.

REFERENCE

[1] Corbett, L. W. *Analytical Chemicals*, 1969, pp. 41, 576.

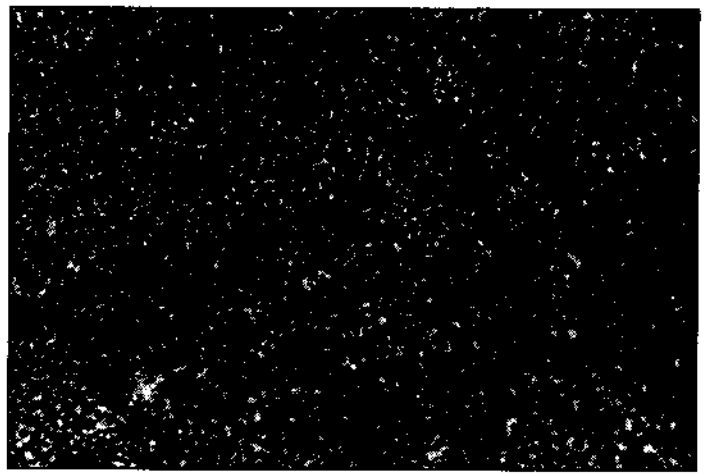

Figure 1