COLD WEATHER ROOFING APPLICATION

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A great deal of roofing application occurs under less than ideal conditions, yet very little information is readily available to specifiers or contractors regarding proper techniques to achieve a quality installation during cold weather. This paper presents information gathered from practical experiences on a number of issues related to the application of various common roofing systems in cold weather, including:

- Safety is a major concern of all who are involved in the roofing industry. The effects of cold weather require special consideration.
- Material storage and handling during cold weather often requires the use of different equipment and techniques.
- Inclement weather requires extra preparation and protection of the substrate to achieve a quality system.
- BUR installation in cold weather requires modification of equipment and some revision of normal application methods. In severe cold weather, the use of tents becomes necessary if work is to proceed.
- EPDM membranes may be successfully installed in extremely cold weather, however, the membrane and adhesives require additional time to relax and flash-off. Special precautions regarding condensation on adhesives is needed.
- Hand tabbing of asphalt shingles should be considered during cold weather application. Wood shingles and shakes may need to be thawed if the temperature is below freezing.

The roofing industry needs to study materials and methods which will allow quality installation in extreme conditions. The findings of these studies should be disseminated throughout the industry in order to provide high quality roofing year-round at reasonable prices.

KEYWORDS

Asphalt and wood shingles and shakes, built-up and modified bitumen roofing, cold weather application, deck preparation, EPDM membrane, material storage and handling, safety, tents and artificial lighting.

COLD WEATHER ROOFING APPLICATION

A great deal of new roof installation occurs during periods of cold weather and very little has been written on the subject. The building construction season in northern areas usually begins with ground breaking when the frost leaves the ground in the spring. In a normal construction sequence, the building is fully enclosed when 50 to 60 percent of the total construction time has elapsed. Therefore for construction of a building which will take 10 to 12 months to complete, the roofing will be installed five to seven months after the frost leaves the ground. In many geographical areas this means roofing will be done in cold weather during the months from September to January.

Some reroofing work is also necessitated in cold weather, due to wind blow-off or other events which require roof replacement prior to the onset of warmer weather.

Roofing contractors have a responsibility to provide the building owner with a quality product at a reasonable price, while often having to perform work under less than ideal conditions.

This paper will concentrate on techniques used and concerns expressed as they relate to the application of quality roofing systems during periods of cold weather.

How Cold Is Cold?

A temperature less than 4°C (40°F) is often considered as "cold." However, it should be realized that different materials have different thresholds where certain warm weather work practices are no longer applicable and therefore must be replaced by different practices. This paper will discuss various roof systems, these thresholds and alternative practices when working in cold weather.

SAFETY

The first concern of a responsible contractor is the safety of his employees and others who may be in the vicinity of his work area.

Safety is basically the exercise of common sense and reasonable caution. Trucks and equipment need to be maintained and inspected regularly, ladders need to be secured, in other words, all the rules of summer still apply during cold weather. The use of heavier, bulkier clothing and gloves requires extra care when climbing ladders or working with equipment. Anyone who must be on the roof should be extremely cautious of snow or frost on deck surfaces. There is no more treacherous footing than fresh snow or frost on a fresh glaze of asphalt, a sheet of polyethylene or steel deck. Guard rails or lifelines may become necessary on projects which might not require their use during warmer weather.

If temporary enclosures ("tents") over work areas are used, they must be well ventilated to prevent the accumulation of fumes from heated bitumen, adhesives or carbon dioxide from space heaters. Larger than normal liquid propane tanks are needed in cold weather to maintain adequate gas for heater or torch operations. Tanks should not be heated or laid on their sides to increase pressure.

Employees need to be aware of the effects and symptoms of cold, wind chill, hypothermia and frostbite. The crew members need to watch out for each other and exercise common sense and reasonable caution.

BUILDING HEAT AND INTERIOR MOISTURE

During cold weather construction, buildings often are pro-

vided with temporary heaters. These heaters often discharge moisture into the building. The building can also have high humidity levels due to curing concrete or drywall. If the roof system does not have a vapor retarder, an excessive amount of interior humidity may drive into the roof system. This moisture may later drip out and be mistaken for a leak, as described at the end of this paper. If this scenario is contemplated, the roof designer should consider the incorporation of a vapor retarder to control moisture drive during the time of construction.

For built-up roofing (BUR), it is preferable that the building is heated during roof application. However, for EPDM systems, it is preferable for the building to be cold during application. Otherwise, it is common for moist air to escape from the interior and condense, thereby causing problems with adhesives. While moist air can escape from the building during BUR application, this does not typically present a problem.

MATERIAL STORAGE AND HANDLING

Warm storage areas may be required for some materials. These may be simple wind breaks with space heaters to maintain minimum temperature of materials on the roof prior to installation. "Hot boxes" (insulated boxes with an internal heat source such as a light bulb or small electric heater) are used to keep adhesives and mastics at usable temperatures. Insulated vans with unit heaters or space heaters will allow roll goods and bulky items to be warmed prior to installation. Depending on ambient temperature, it may be necessary to bring small quantities of warm material to the roof to prevent them from getting too cold before use.

The use of direct fired unit heaters or space heaters must be monitored closely, when used within enclosed spaces, to avoid excessive build up of carbon dioxide and moisture, both by-products of combustion. When using heaters, it is desirable to place the heater outside of the van (or enclosure) and run a flexible duct into the space (Photo 1). This allows combustion gases to vent directly to the outdoors. However if the unit must be placed inside the enclosure, instruments to monitor combustion gas and oxygen levels should be used.

Materials which have been transported to a construction site may have been exposed to moisture and freezing temperatures during shipment and may have to be thawed and dried in a warehouse before use.

With proper care and planning, the materials will reach the roof at temperatures and moisture content to permit quality installation.

TENTS AND ARTIFICIAL LIGHTING

As previously noted, very cold weather may require the use of tents (temporary structures) to provide adequate ambient temperature to allow the roofing operation to continue. When tents are required, they must be large enough to allow the worker adequate room to perform his tasks. Tents may cover the entire roof area (Photo 2), or when using EPDM can be small portable units which cover only seams or areas to be flashed (Figure 1).[1]

All tents must be well ventilated to avoid build up of carbon dioxide, smoke or volatile fumes. If bitumen is used, the tent's interior surface must be frost free, otherwise it will melt and drip as the hot bitumen is applied.

Tents, which are commonly constructed with polyethylene sheets supported by warm air, are typically not very resistant to moderate/high winds. If tents are needed in windy areas, special consideration should be given to their design and construction.

Cold weather work in tents or in arctic and subarctic areas may also necessitate the use of artificial lights due to the very limited number of daylight hours. Adequate lighting is necessary for both safety and to achieve a quality installation.

DECK PREPARATION

The substrate for any roofing system must be adequately clean, dry and at a temperature which will allow the system to be installed properly. Snow can be removed by shoveling, sweeping or with equipment such as a snow blower or compressed air blower. In removing snow, take care to avoid overloading the deck. Ice or frost must be melted with a torch, then the deck is swept and dried with the torch. When drying with a torch, care must be taken to avoid overheating.

Temporary coverings, such as polyethylene or tarps, can be used to protect the deck prior to roofing application. This will reduce the amount of preparatory work required. Temporary heat in the building can be used to increase deck temperatures, facilitating drying and allowing proper adhesion of some systems.

BUILT-UP AND MODIFIED BITUMEN ROOFING

Bitumen

The installation of BUR and mop-applied modified bitumen in cold weather requires the kettle pipes and hot luggers to be insulated to maintain bitumen temperatures. Hot bitumen should never be pumped directly into mop carts or felt layers since the low volume of hot bitumen will lose temperature in the cold pipe. Pumping hot bitumen to insulated luggers moves a much larger volume with less heat loss. The kettle should be set up as close to the point of application as possible.[2] Equiviscous temperature (EVT) should be monitored and maintained. Kettles may have to be run hotter than usual to achieve the EVT. However, special care should be taken to keep kettle temperatures at least 14°C (25°F) below the flash point of the bitumen. The throw of the mop should be within about 1.2m (4 ft.) of the roll, and the roll should be embedded quickly while the bitumen is still hot.

Substrate Temperatures

If bitumen is mopped directly to a dense substrate, such as concrete or gypsum board, the substrate should have a surface temperature of approximately 1.6°C (35°F) or warmer. If bitumen is mopped to plastic foam insulation, the insulation should have a surface temperature of −6.6°C (20°F) or warmer. If bitumen is mopped to denser insulations (such as perlite), the insulation should have a surface temperature of −3.8°C (25°F) or warmer. Because of the rapid loss of temperature, bitumen should not be applied to steel decks.[3]

Temperature of Roll Goods

Rolls of felt or modified bitumen cap sheets should be 1.6°C (35°F) or warmer at the time of application.

Aggregate Surfacing

If fiberglass felts are used, aggregate surfacing could be delayed until warmer weather arrives. Alternatively, aggregate surfacing could be applied in cold weather, but the aggregate should be approximately 10°C (50°F) or warmer at the time of application.

Protected Membrane Roof (PMR) Application

With a PMR, one or more layers of insulation are placed above the membrane. If possible, at least the first layer of insulation should be applied over the membrane the same day the membrane is installed. If this does not happen, the membrane should be about 1.6°C (35°F) at the time the insulation is applied. The warm membrane is desired to avoid breaking the membrane by inadvertently stepping on a void.

General Recommendations

Application should be scheduled so there are no partially completed areas left exposed to the weather.[4] During cold weather, smaller areas of roofing may be installed at one time as it is easier to control the conditions of a 50 square area than one of 100 squares. Always work toward the kettle pipe to avoid unnecessary traffic over completed work areas.

Use of Tents

At temperatures above −6.6°C (20°F) with winds less than about 8.05 Km/h (5 mph), roofing without the use of a tent can be successful if the above guidelines are followed.[5] With lower temperatures or higher winds, work should be performed within a warm tent.

Special Considerations for Modified Bitumen

Because of increased low temperature flexibility, if modified bitumen sheets are used, SBS- rather than APP-modified sheets are preferred in cold weather application.

EPDM MEMBRANES

Low Temperature Threshold in Extreme Situations

EPDM membranes have been applied at temperatures at least as low as −40°C (−40°F) without the use of a tent. However at very low temperatures, the solvents of the adhesives volatilize (flash off) very slowly, hence applicators need to be sensitive to this to achieve quality results. Also, the membrane sheets take longer to relax.

Condensation on Adhesives

The most common problem with EPDM installation in cold weather is moisture contamination of adhesives. This occurs when condensation/frost forms on the adhesive while the solvent of the adhesive is flashing off. The dew point temperature frequently is near the freezing temperature, thus it is common to have condensation form on the surface as the adhesives flash off their solvents. Condensation/frost can often be recognized by the sheen that it gives to the adhesive.

If condensation/frost is observed on lap adhesive, there are two options which the author has used. One option is to close the seam and resume work under a small tent (Figure 1). The other is to resume work when temperature/humidity conditions are such that condensation will not occur. When work begins, the seam that was contaminated needs to be covered with a cover strip of cured EPDM.

Where fully adhering the sheet, if condensation/frost is observed, do not mate the sheet to the substrate. Resume work under a tent or when conditions are such that condensation will not occur, apply additional bonding adhesive.

Temperature of Adhesive

While some manufacturers recommend the adhesive be at room temperature, warm adhesive often presents condensation problems as the solvent flashes off. The author's experience is that condensation/frost is less of a problem if the adhesive is lower than 0°C (32°F). Adhesive may be as low as −9.5°C (15°F) and still be fluid enough to apply.

Heat Guns

Heat guns are useful in molding uncured flashings, however, care is needed to avoid blistering the material.

Special Precautions

Adhesives and cleaning solvents are volatile. When using them within tents, good ventilation is needed. Also, care should be used when operating heaters or a torch to prepare substrates in the vicinity of applied adhesives or near open containers.

ASPHALT AND WOOD SHINGLES AND SHAKES

Low Temperature Threshold

Asphalt and wood shingles and shakes can be applied at temperatures at least as cold as −31.6°C (−25°F). However at temperatures colder than −18°C (0°F), there is more breakage of the shingles or shakes (hence more time is needed for replacement) and greater effort is needed to achieve a successful job.

Fastener Application

When driving fasteners with a pneumatic gun into plywood, oriented strand board or wood decking, the power setting needs to be monitored. If the deck is frozen, it is more resistant to fastener penetration. If the deck warms up during the day, it may be necessary to decrease the power to avoid over driving. Compressors used for pneumatic guns must be fitted with dryers to remove moisture from the pneumatic lines to avoid equipment failure.

Asphalt Shingles

Asphalt shingles (both organic and fiberglass) become brittle at cold temperatures, although the fiberglass shingles are somewhat more susceptible to breakage. Breakage problems can be minimized by storing the shingles in a warm enclosure and loading the roof with a few warm bundles at a time. Also, in cold weather, the self-seal sealant strips will not seal effectively until the surface temperature rises sufficiently (which may not be until the following spring). If the roof is in an area that is likely to receive high or moderately high winds prior to the tabs bonding, the shingles should be hand tabbed to minimize the possibility of blow-off. When hand tabbing, do not apply a continuous strip of sealant, as this will create a dam and could cause leakage. Apply dabs of adhesive (usually four or six dabs per shingle), with sufficient space between dabs for the adhesive to spread, but not

contact the adjacent dab. To achieve a good bond, the adhesive and the shingle should be warm at the time of application.

Modified Bitumen Fiberglass Shingles
These relatively new products remain flexible in temperatures down to approximately −18°C (0°F), thus they present few breakage problems. However, these shingles do not self-seal in cold weather. If high or moderately high winds are expected, these products should also be hand tabbed. Because of their flexibility, if high winds are expected, modified bitumen shingles may provide greater blow-off resistance than typical asphalt shingles.

Wood Shingles and Shakes
These products often contain enough moisture to freeze in extreme cold, and become brittle and split during installation. To minimize this problem, they can be stored in a warm enclosure and, with proper material handling, be installed before they become frozen.

POST-APPLICATION

After the roof has been installed, traffic over it in cold weather should be minimized.

Springtime Leakage
It is common for buildings to experience minor leakage from the roof system the first spring after they are constructed. Often times snow, ice or frost is accumulated in the building envelope and it remains in a frozen state (even in heated buildings) until warmer spring weather arrives. These minor drips may cause minor cosmetic blemishes on interior finishes, but generally do not cause greater problems and typically do not reoccur. When performing cold weather application, these minor drips should be anticipated by the building owner.

CONCLUSIONS

The roofing industry has grown and advanced from the use of all natural materials to today's modified bitumens, thermosets and thermoplastics. The research which has been conducted and published has centered around normal roofing conditions, application temperatures above 4°C (40°F). The extreme conditions, cold or hot, have not been addressed. This paper conveys a brief overview of cold weather roofing application. Manufacturers, specifiers, scientists, technologists and contractors need to address, study and communicate the results of their findings to the entire roofing industry. Thus, the roofing contractor can provide a quality roofing system at a reasonable price to their customers, the building owner.

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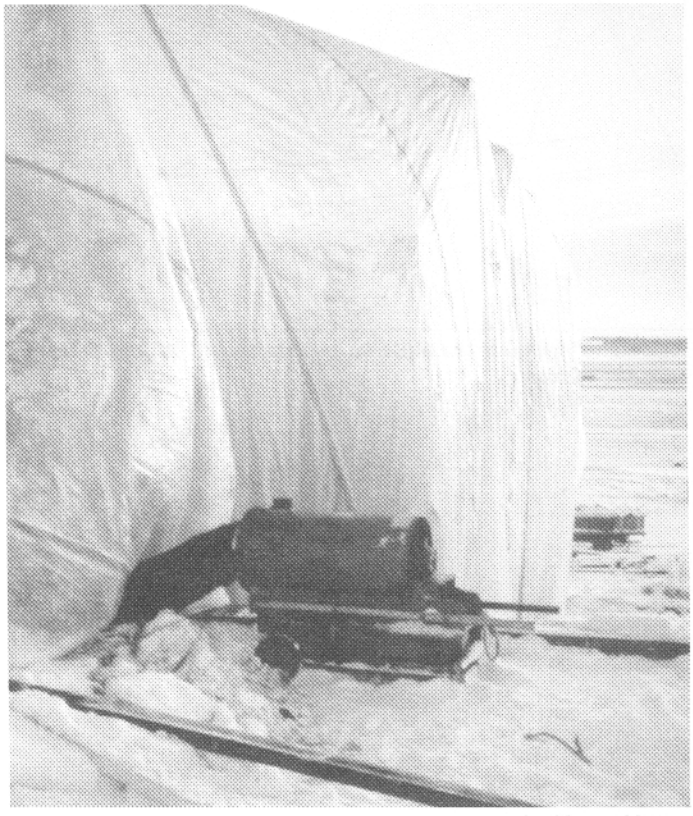

Photo 1 *Warm air supported polyethylene tent over a building addition. Heater is placed outside of the tent. A flexible duct directs warm air into the tent, while combustion gases vent directly to the outdoors.*

Photo 2 *Warm air supported polyethylene tent over the entire roof of a new building being constructed in the winter.*

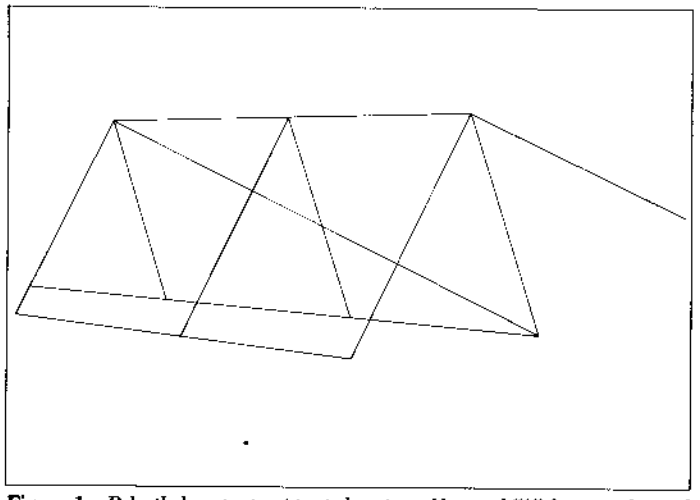

Figure 1 *Polyethylene tent supported on portable wood "A" frames—located over EPDM seam.*