LIQUID APPLIED AND COLD APPLIED ROOFING AND WATERPROOFING SYSTEMS IN THE UNITED STATES:

An Independent Overview of their Performance Characteristics, Material Analysis and Solutions for Proper Application

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Abstract:

Cold process and liquid applied roofing and waterproofing systems have been available on the U.S. roofing and waterproofing market for over 50 years. These systems were primarily designed to eliminate concerns associated with hot bitumen application by substituting asphalt cutbacks for the hot mopped bitumen as the interply and surfacing bitumen. Although variations of these systems have been used in the United States for many years, they have never seriously contended with hot applied built-up systems for market share. Their predominate use has been restricted to repair and maintenance of hot applied built-up systems.

In recent years, the market share of these systems has expanded due to increased environmental regulations of hot applied systems, new material developments and technology and an ascent of situations where conventional systems prove impractical. This growth trend is expected to continue into the new millennium.

This paper will analyse the performance characteristics of these types of systems based on independent testing and available historical data. The main characteristics analysed will be waterproofing capabilities, anticipated service life, strength characteristics and durability. Independent testing will be conducted on samples removed from existing applications in different U.S. geographic locations and a range of system ages. The criteria testing established to determine the waterproofing ability of these systems will be; visual observation, microscopic examination, tensile and elongation tests, test cut analysis, water tests and accelerated water tests.

The advantages and disadvantages of these systems will be presented with recommendations and solutions for proper application procedures.

INTRODUCTION

Briefly defined, cold process systems are described as a waterproofing or roofing application that utilises a cold adhesive (solvent based or water based) in the adherence or fusion of the felt. It generally refers to any application that is not torched or mopped down. The adhesives take the place of hot mopping or torching down the membrane plies in the field of the roof.

The first built-up roof systems were actually contrived of a cold process system. In these early applications pine tar was applied to glue the roofing fabrics together. These applications were also prominent in the United States of the early 1900's during the height of the railroad expansion. Solvent based asphalt adhesives were sent on rail cars to remote areas for application of roofing felt with trowels and brushes. In later years, mineral surfaced sheets were applied in medium viscosity asphalt mastics, which produced a roofing system, which was capable of providing weatherproofing for a number of years.

In the past fifty years the market share of cold process systems has rarely risen above five percent compared to hot applied built-up systems. Due to their low volume of full system applications, cold process materials have been predominantly regulated to – and thought of as – repair and maintenance materials. Their low market share compelled the major manufacturers to emphasise the larger market driven systems and materials.

Although market gains were made in these applications in the 1970's, the removal of asbestos from the mastics in the early to mid 1980's squandered the growth cycle. The removal of the asbestos forced the manufacturers to use substitute fibres, which resulted in deficiencies such as slippage of the reinforcing sheets and fire-rating problems. These deficiencies, coupled with the advent of modified bitumen and single ply roof systems in the U.S. market at the same time, propelled cold process materials back to the status of repair materials.

It should be pointed out, that although the market share of these systems has been minimal, there are several "smaller" roofing and waterproofing manufacturers in the U.S. market that have manufactured cold process materials which are applied in system configurations. Many of these manufacturers - still in existence today – have provided these materials (with variations) in full system applications for the past fifty years. This may speak to the longevity capabilities of these types of systems.

In recent years, the market share of these systems has expanded due to increased environmental regulations of hot applied systems, new material developments and technology and an ascent of situations where conventional systems prove impractical. This growth trend is expected to continue into the new millennium.

This growth spurt has resulted in an increased use of these systems by contractors who were more accustomed to built-up and torch applied applications. It has also led to increased attention from manufacturers to provide materials to meet the market demands. In some cases, both of these parties are entering uncharted territories. As with all roofing and waterproofing applications, it is important that the proper materials be applied within the proper application requirements.

ADVANTAGES OF COLD PROCESS SYSTEMS

The increased attention that cold process systems have generated recently in the United States has led to a plethora of industry and manufacturer articles and papers outlining the advantages of these systems. The true intention of this paper is too analyse the performance characteristics of these systems in relationship to their waterproofing capacity as their true validity, and is not based on their advantages promoted by the industry. However, in the context of background regarding these systems the following outline of advantages as presented by manufacturers and contractors is outlined:

- Minimal application equipment
- Easy delivery and storage at the job site
- Smaller crews that can be easily trained are all that is required. Resulting in lower labour costs

- Reduced set-up time – no pre-melting of bitumen
- Equipment take down is minimal
- Higher safety rates – no open flames or hot kettles
- More forgiving of application errors - no overheating of bitumen, cure time allows re-positioning of sheets
- More tolerant of weather conditions
- Ease of application in complicated, equipment-laden areas
- Environmentally safe application

DIFFERENCES BETWEEN COLD ADHESIVES AND HOT BITUMEN

In built-up roof systems the hot bitumen is the waterproofing agent and the felt is the stabiliser. In contrast, the adhesives used in cold process systems provide little waterproofing capacities and require either a waterproof base layer or a waterproof membrane. The basic difference of these materials is in their chemical properties.

Asphalt is a thermoplastic material, which changes properties with an increase in temperature. The material turns to a liquid state as the temperature increases. Further temperature increases result in the decrease of viscosity, which thins out the material. As the membrane is applied to the hot asphalt the asphalt cools and solidifies and the curing process – and subsequent waterproofing protection – begins immediately. Total cure time is approximately two to three hours.

Cold applied adhesives contain solvents that must evaporate to provide a solid or cured state. The solvent evaporation process - or flashing as it is commonly refereed to – depends in a large degree to the rate of material application and ambient weather conditions over time. The system adhesion increases as the solvent evaporates. The most important aspect of a cold process system is that it must properly cure. Once cold process materials cure there is no change in their properties. In theory, once the material cures and the volatiles are out of the product it forms a continuous layer that does not change it properties and should not wear out. Asphalt, on the other hand, crystallises over time as the oils dissipate and the material becomes brittle reducing its waterproofing ability. If properly formulated, a cold process adhesive can achieve a significant set of qualities over hot bitumen.

The manufacturing process of modified bitumen adhesive (SEBS) is similar to the emulsion process except polymers – such as rubber – are added to the asphalt. The modified asphalt blend is mixed with the water and clay stabilisers.

It has been determined that water borne adhesives do not perform well with fibreglass felts due to the facts that these sheets do not saturate well. Water borne products should be applied over synthetic, non-woven, mats –- such as polyester – which will allow for the water to properly migrate through the porous mats allowing for proper curing to take place.

Successful cold process adhesives - solvent based and water based - require a good asphalt bitumen blend to manufacture a good product, providing that the manufacturer also adds a good polymer. The asphalt used is refinery crude oil asphalt that has multiple blends of materials. The adhesive manufacturer can control the type of asphalt they obtain from the refinery by specifying the properties that they want the crude oils and blend asphalts too meet. The important physical properties are softening point, penetration, and ductility. Higher penetration asphalts and modified asphalts are softer than low penetration asphalts. Asphalt testing can be completed by conducting ASTM D-36; The Ring and Ball Test.

APPLICATION TEMPERATURES

The name – cold applied process – is derived from the fact that no torches or hot bitumen's are required for application. It does not suggest that the material can be applied in cold temperatures. Obviously, the water borne products are temperature sensitive and should not be stored in freezing climates or applied in temperatures lower than 50°F (10°C). These requirements should not be a surprise to any roofing professionals.

The surprise may be in the fact the same limitations generally apply to solvent-based adhesives. The viscosities of the adhesives vary with temperature and the more the adhesive's temperature drops the thicker (more viscous) it becomes. The thickness of the material will not allow proper coverage and will have deteriorating effects to the performance of the system and add cost to the project. (The contractor will ultimately spend

more money to do a bad job.)

Unlike waterborne adhesives, which can not be installed in cold temperatures due to the freeze element of the water, solvent based adhesives can be applied in lower temperatures if the product is properly stored in a heated location just prior to application. As always, a contractor should follow the material manufacturers requirements regarding material application in cold weather.

PROPER APPLICATION PROCEDURES

Because cold process adhesives have different physical properties then hot applied bitumen, their application procedures are divergent. Cold process adhesives cannot be perceived as a cognate substitution for hot asphalt or torch installations. The differences in application requirements and techniques must be examined carefully to ensure a quality installation.

Applying the adhesive at the proper application rate is the most important criteria of a successful installation. It is also the most common application problem, if the applicator applies too much or too little adhesive material. When the adhesive is applied at rates below the recommended coverage, the material may cure too quickly. In this case, the adhesion strength of the material is weakened and the performance of the system decreases.

Applying the adhesive at rates above the recommended coverage results in a membrane that may not fully adhere to the substrate because it substantially slows the curing process. In effect, the thick material will cause the membrane to 'float' on the uncured adhesive rather than fully adhere to the substrate. This is essentially the same effect as applying the adhesive at lower than specified temperatures. Solvent based adhesives become thicker at lower application temperatures.

Controlling the coverage rate of the adhesive produces the desired thinner, more uniform and continuous adhesive application. Controlling the materials temperature is also critical in achieving a uniform and proper coverage. For instance, if the required coverage rate of the material is 1.5 gallons per square (0.61 L/m per square) and the applicator applies the adhesive at

a rate of 2 gallons per square (0.81 L/m per square), the adhesive use is increased by 25 percent. This will not only add substantial costs to the project, it will add approximately 50 percent more time to the proper cure of the material.

To ensure that the material is applied at the proper coverage rate the application area should be measured, calculate the amount of material that is required to cover the area, and then apply that amount of material.

For instance, if the required coverage rate is 1.5 gallons per 100 square feet (0.61 L per square meters) and the application area is 50 by 20 feet (15 m by 6 m) or 1000 square feet (93 square meters), the amount of material required is 15 gallons (57 L).

Application Area:	1000 sq. ft. / 100 sq. ft. = 10
Coverage Rate:	1.5 gallons x 10 = 15 gallons

As the applicator gains experience with the use of the material they will obtain a visual appearance of the proper coverage rate. However, until the familiarity of the application rates become apparent it is recommended that they follow this time proven application technique. Referring back to the above example, the applicator should divide an area into three equal parts, place one 5-gallon (19-L) pail in each area and apply the full contents of each pail into each area. The adhesive should be applied in a continuous even application throughout each area leaving no voided areas in the substrate. The membrane is then fully embedded into the adhesive in accordance with the material manufacturers latest printed requirements.

The application of the membrane is also slightly different than in hot mopped or torched systems. The initial adhesion strength, commonly referred to as 'green strength', of the adhesive is not as strong as the initial adhesion strength of hot bitumen. It takes a significantly longer period for the volatiles to flash off from the cold adhesive than it takes for hot bitumen to cool off and set, which is almost instantaneous. Due to this fact, it is imperative that the applicator avoid walking and trafficking over the newly applied membrane for a significant time period, in some instances it may be a couple of days.
The detrimental effects of trafficking over a wet and uncured cold process system may be displacement of the membrane or

displacement of the adhesive, leaving voids within the system. Ironically, the slow cure rate of the adhesive can be advantageous, as displaced or improperly installed membrane sheets can be easily re-positioned to their proper place within the system for a long period after the initial application.

As with all roofing and waterproofing projects, it is recommended that the applicator meet with the project designer and material manufacturer prior to the application procedure. All of the system component materials and application procedures should be reviewed to ensure that all parties are familiar with the system criteria. It is important that all of the parties agree with all application procedures and detail requirements prior to system installation. The difference in material manufacturers requirements and specific project constraints warrants that these meetings occur prior to all projects. Unnecessary delays and/or confrontations during the project can be avoided through this meeting.

Cold process adhesives can be applied using spray equipment's, squeegees, brushes and trowels. The proper application procedure for the specific manufacturers material should be agreed upon at the outset of the project. If spray equipment is authorised for use, the applicator should train the work crew in the proper use of the equipment. It may be beneficial to have the work crew complete a test area – over the existing system – in the presence of the required parties. This will give all parties the opportunity to visually inspect proper coverage rates and rectify problems with the equipment

The work crew should be properly trained in all aspects of cold adhesive system applications. Most importantly, the coverage rates for the project manufacturers materials, particularly over different substrates, and how to control the rates should be reviewed. The coverage rate recommended varies with the different manufacturers; the coverage rate also varies based on the substrate. Typically, a perlite or wood-fibre insulation will require more adhesive than a smooth base sheet, polyester or fibreglass felt or polyisocyanurate insulation.

The work crew should be trained in the proper method of membrane application, weather the sheets must be cut and allowed to relax prior to the application into the adhesive, how

the roll should be set in the adhesive and if the roll must be broomed in place. The work crew must also be trained in proper seam adhesion. With multiple plies of polyester or fibreglass felts, the adhesive forms a continuous seamless application. Some modified bitumen manufacturers require heat welding or torching to fuse the membrane seams, where as some only require adhesive application at the seams. Due to the temperature constraints of the materials, the work crews should also have knowledge in how to store and handle the material.

During the course of the project quality control can be conducted by monitoring the daily temperature and the coverage rates of the adhesive. It should be stressed that foot and equipment traffic be avoided at new application areas and strict housekeeping measures should be implemented. In particular, there should be no storage of material or equipment in new areas. When using modified bitumen sheets all of the seams should be inspected for proper adhesion.

PERFORMANCE CHARACTERISTICS

For the sole purpose of this paper extensive testing was conducted too establish the long term waterproofing capabilities of cold process systems. Seven manufacturers system components (adhesive and membrane) – chosen at random – were analysed by the following testing methods:

1. Visual observation of existing systems (age and geographic location varied)
2. Microscopic analysis of adhesive materials and membrane
3. Tensile testing
4. Peeling resistance at different temperatures
5. Extensibility at expansion rate
6. Peeling resistance after immersion in water

TEST ANALYSIS AND FINDINGS

Note: At the time of this writing (August, 2000) the tests are still being conducted. Analysis and findings will be presented at the XIth International Waterproofing & Roofing Conference in Florence, Italy 4 – 6th October 2000.