Commercial Roofing

Jean Wamsley, CR

January 1988

INTRODUCTION

The information contained in this paper is regarding Commercial Roofing.

It will be referring mainly to the construction content of Built-up-Roofing Systems , with a brief reference to the Single-Ply roofing System.

There is also some related damages to roofing systems that we as Restoration Service People may encounter.

As I have had limited experience involving Commercial Roofing , this paper has led me to extensive reading and research in furthuring my own education.

I hope that after reading this paper,you the reader, will have some knowledge of Commercial Roofing. And, that it will , at least, peak your interest enough to further your own studies on the subject.

We, as restorers, need to have a working knowledge regarding all fields of our profession and I feel it should be top priority to us , at all times, to continually further our education by any and all means presented to us in our day to day lives and be wise enough to persue that knowledge.

Respectfully presented :

Jean Wamsley

Jean Wamsley

Vice - President
Restoration Services Manager
SECURITY/AMIRKHANIAN
1776 Tennessee Avenue
Cincinnati , Ohio 45229

Commercial Roofing

One of the most common coverings used in commercial roofing is a laminated arrangement consisting of a vapor-barrier membrane, insulation, layers of felt and a top ballast of gravel or slag, all of which are attached to each other and to the roof deck or substrate with asphalt.

This type of roofing system is referred to as a built- up roof or BUR System.

The built-up roofing system grew out of an invention in 1844, by Samuel Warren in Cincinnati , Ohio. Warren coated paper with pine resin and found it would weatherproof the near- flat industrial roofs that were coming into use at that time. Word that Warren's discovery of tarpaper worked spread rapidly.

The nailing of layers of tarpaper over the wood decking was only the beginning. Over the years, roof evolution continued. Wood decks gave way to the more durable metal and concrete decks. Vapor barriers were installed over the decking to prevent moisture infiltration. Insulation boards were added to keep heat in its proper place. Multi-ply felt membranes laminated with asphalt made the original paper coated with tar resin, by Warren , in 1844, obsolete.

There are three basic types of built-up roofing systems.

1. Smooth Surface
2. Gravel Surface
3. Mineral Surface

1. Smooth Surface Roof System

This type of built-up roof system has several advantages. In addition to being light in weight, the absence of a top ballast of gravel or mineral chips, makes for easier inspection for damage and then making the necessary repairs. Patching takes less time as there is no gravel to scrape away and then replace after repairs are made. Therefore, maintence is simpler.

A smooth-surface roof is usually less expensive than a gravel- surfaced roof with the same design life.

2. Gravel Sruface Roof System

This system is similar in construction to the smooth surface roofing except for the final coating. A heavier application of tar or asphalt coating is used then a layer of gravel is applied.

3. Mineral Surface Roof System

Cap sheets form the last ply in the roof system. The mat is saturated and coated with weathering grade asphalt into which is embedded opaque- non-combustible mineral granules.

This type of system yields a white roof that will enhance the appearance of the building.

Gravel or mineral surfacing on built-up-roofing systems provide protection to the membranes below.

Smooth surface roofs have been found to be more susceptible to damage and possible leaking from severe hail or impact than other conventional aggregate surfaced roofs.

Proper quantities of clean, dry gravel, slag or chips be used and firmly embedded into the asphalt coating.

Gravel and chips should be spread at a rate of 400 pounds per square. Slag due to its lower density should be spread at a rate of 300 pounds per square.

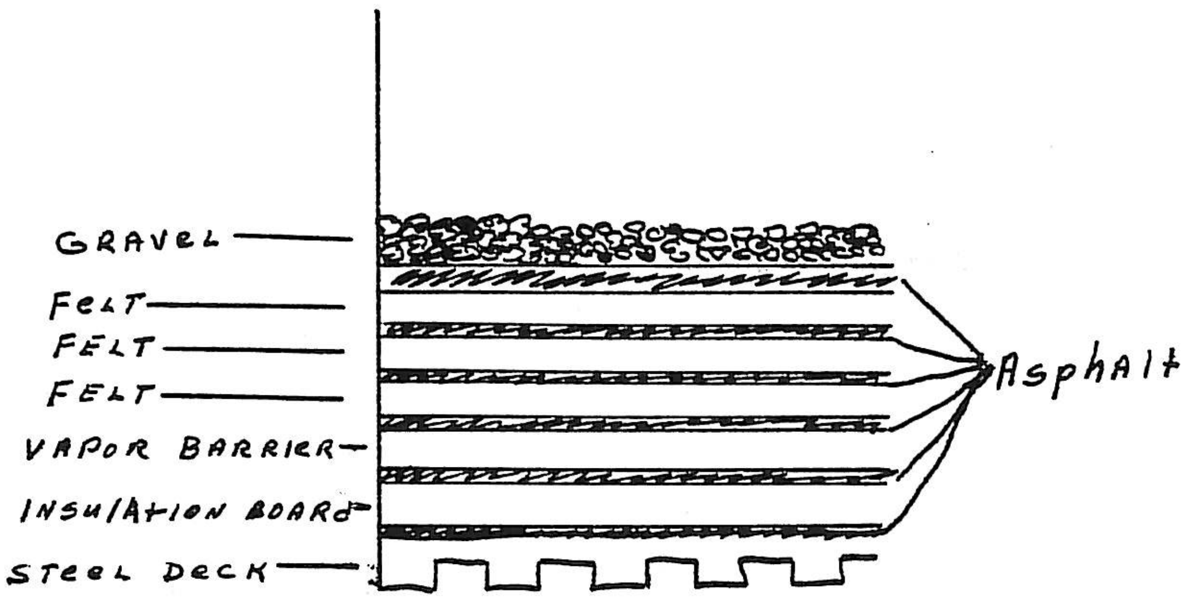
Approximately 75 per cent of the aggregate coating should be adhered to the top pouring of tar or asphalt.Any bare spots will accelerate oxidation of the asphalt along with alligatoring and exposure of the underlying built-up roof to moisture and premature weathering.

Very low density aggregates are to dusty to provide adequate attachment and are frequently blown or washed away during heavy rainfalls.

The aggregate should have no more than 3 per cent moisture by weight and particle size should range about 1/4 inch to 3/4 inch.

Gravel-surfaced roofs should be limited to sloped of 3 inches or less to minimize gravel loss.

BUILT-UP ROOF SYSTEM



Roof Decking or Sub-Strates

The roof deck is the structural foundation upon which the roofing assembly is installed.

The primary function of a roof deck is to provide support for the roofing system.

Some decks are selected for inside appearance and even sound control.

There are several types of acceptable roof deck materials.

1. Steel
2. Wood
3. Plywood
4. Structural wood fiber
5. Poured concrete
6. Pre-cast concrete slab
7. Pre-stressed concrete
8. Poured gypsum
9. Monalithic gypsum concrete

Roof decks are referred to as nailable or non-nailable decks, depending upon construction materials.

Steel decks are the most common type employed in the commercial construction market today.

When constructing the decking system there are a number of important considerations vital to the proper performance of the total roofing system.

The deck should be constructed in accordance with the manufacturers specifications. It should be designed to support the maximum anticipated loads. Provisions should be made for expansion and contraction. The deck must be rigid, smooth and free of large cracks,holes or sharp changes in the elevation of the surface.

Roof Drainage

Design and installation of the deck and or the substrate has to result in the roof draining properly. The drain outlets should be located so as to remove water promptly and completely.

Roof installation should provide a minimum 1/4 inch per foot slope under such conditions that the roof drain freely throughout the life of the building.

Areas where water ponds for more than 24 hours are not acceptible. Water ponded on a roof induces breeding of pests such as mosquitoes and will pose a serious threat of damage to the structure and its contents in the event of the roofing or the flashing rupturing while covered with water and in cold weather areas when covered with snow and ice.

No bituminous roof is completely free from moisture penetration. Minute cracks in the top coating, bare spots or blisters all will permit moisture to enter the top plies when the roof is covered with water. This penetration of moisture can promote the growth of bacteria and fungi,which, along with the moisture itself, will tend to weaken the membranes. It is important that this moisture be allowed to evaporate within a short period of time and this requires a dry roof.

Roof Insulation

Insulation is a vital part of the total built-up roof assembly. It serves as a base for the roofing membrane and retards the flow of heat in and out of the building.

Roof insulation depends on the type of decking used, the incline, building codes, degree of insulating factor and insurance classification required.

Proper attachment of the roof insulation is as important as the installation of the roofing and flashing systems.

The method used to attach the insulation to the deck can be a decisive factor in built-up roofing failure or success. Insulation boards that are not securely fastened can be affected by stresses in the membranes which can result in the lateral transfer of the insulation with resultant splitting of the membrane, wind uplift or blow-off of the roof.

Roof Vapor Barrier

A vapor barrier is used to retard the passage of water vapor into the roofing assemblies. Thus, preventing condensation which could result in damage to the structural materials, the roofing insulation or the roofing membranes.

The use of a vapor barrier usually depends upon occupancy conditions and whether the outside winter weather conditions will result in a January temperature of 40°F or less.

The vapor barrier is placed on the predominantly warm side of the roofing assembly.As water vapor tends to migrate from warm to cooler areas.

Roofing Asphalt

Roofing asphalts or butumens are derived from various crude oil sources.

It is applied by mopping,brooming or squeegee.

Usual requirements for interply mopping asphalt is 30 pounds per 100 square feet with a variation of 15% plus or minus. This also applies to top pourings.

Thirty pounds of asphalt is easier to obtain for the moppings if the mopping temperatures for the asphalt is kept at or near the following temperatures.

Steep Asphalt 375°F-400°F

Flat Asphalt 360°F-390°F

The following information is necessary when appling the asphalt.

1. Softening Point (SP)

   The temperature range of the asphalt.

2. Minimum Flash Point (FP)

   The flash point of the asphalt.

3. Minimum Finished Blowing Temperature

   The minimum temperature at which the blowing of the asphalt has been completed.

4.Equiviscous Temperature (EVT)

The temperature at which a viscosity of 125 centistokes is attained

Roofing asphalt should be applied in the roofing system within 25°F of the EVT temperature and not be heated to the minimum flash point, or be held beyond the minimum finished blowing temperature for more than four hours.

Roof Damage

Roof failures are often the result of a complex interaction of a number of causes. However, there are a number of common or fundamental causes and effect relationships in the evaluation of roofing failures.

A recent consideration developed for roofing failures is " thermal shock ". Thermal shock is defined as " a stress-producing phenomenon resulting from sudden temperature change in a roof membrane".

Splitting in the built-up roof system membrane is among the most common complaints which occur during cold weather.

This can occur after the occurence of below- zero temperatures with ice and freezing rain conditions.

Splitting is more common in the colder climates and on larger roofing systems. It will typically occur above the continous longitudinal points of board insulation.

The membrane splits will always be parallel to the long direction of the felts. This is for two reasons:

1. The thermal coefficient for a built-up membrane is higher than in the transverse direction.
2. Built-up membranes are typically weaker in the transverse direction than in the longitudinal direction.

Splitting can be caused by one or more of the following:

1. Thermal contraction
2. Insulation movement
3. Water content in felts
4. Shrinkage of drying felts
5. Shrinkage cracking of poured decks
6. Deflection
7. Stress concentrations

The most common cause of splitting is usually excessive movement of the insulation on the roof. A major function of the insulation is to transfer the stresses which affect the membrane down to and through the insulation. If the insulation is not adhered to the deck, the membrane will undergo higher stress and will frequently result in splitting.

The importance of proper installation of roofing insulation cannot be overemphasized. The effect of loose insulation is so severe that it can cause splitting even if there are no other problems within the roofing assembly.

The other causes listed can all contribute to splitting of built-up roofs either singly or in combination.

The correct interpretation of splitting may not be simply "thermal shock" but instead thermal constraction in combination with faulty or loose insulation and weak, moist felts.

Wind Damage

Many such roofing systems are damaged each year by wind.

Of all the various loads a roof has to carry, wind is unique with its uplift forces,which creates a suction effect that is more difficult to resist and than constant pressure.

In most cases, the initial point of failure was started at the edge of the roof.

This can be a result of one or more of the following:

1.Astrong uplift force near or at the edge of the roof.

2.Poor application of the adhesive at the roof edge.

3.Delamination of the insulation.

4.Weak installation of the flashing.

The extent of injury to roofing by wind is not readily determined without a careful survey. In all cases, when practical, the inspection should be made on the roof instead of from the ground. A roof that appears undamaged from ground level may show extensive damage upon close inspection.

When damage occurs over several square feet or more or scattered over one side of the roof, it may be advisable to recover the entire side of the roof.

Hail Damage

The extent of damage to roofing by hail depends largely on the age of the roof,type of material used in the roofing system, and the size of the hailstones.

Built-up roofing assemblies surfaced with gravel or slag is much is much less susceptible to hail damage than smooth top roofing.

However, no roofing material is completely safe in storms involving hailstones as large or larger than golf balls.

This type of damage should be observed at close range as the small pocks or holes caused by hail are not always easy to observe from ground level.

Fire Damage

Damage by fire to a roof is in most cases a result of a fire which originated within the structure itself.

It can char or otherwise damage the frame and decking to the extent replacement is necessary or the fire actually breaks through the roof.

The roof is often damaged by holes chopped in the roof by firemen to ventilate or extinguish the fire.

Wood and asphalt products while combustible, the degree of heat required to ignite asphalt is relatively high.The principal value of asphalt roofing products are their longer resistance to ignition.

Sparks and embers from exposure fires,while failing to ignite the roofing, can cause scorching and mar the roofing surface. This scarring due to embers is sometimes sufficient to require complete roof replacement.

Snow Damage

A large snowfall is not necessary to produce damage to a roof. In most cases the damage is created by drifting, rain and snow combined.

The actual signs of damage can range from a small leak to a total collapse of the roofing assembly.

A total collapse will rarely be the result of an overload of snow. The overload of snow will usually contribute to other reasons for the collapse. Among which are:

1. Numerous layers of roofing
2. Poor maintenance
3. Undersized connections
4. Deterioration of members and connections

Freshly fallen snow weight is approximately .1 inch of precipitation per inch of snow depth or 8 pounds per cubic foot. This can increase to 20 pounds per cubic foot by wind-driven snow or thaw-freeze cycles.

Damage to built-up roofing, when replacement is not necessary, can be repaired in one of the following ways:

1. Spot- patch

   This method is used for small or medium size breaks in the surface involving one or more plies. The area is cut out and removed. All moisture should be throughly dried out. New felts are laid and mopped. A coating of asphalt is then applied to the patch surface.

2. Patch-mop

   This repair is used where large patches or many small patches are made. The patching is done in the same manner as in spot-patching. When the patches are complete, the entire surface of the roof is given a coat of asphalt.

3. Cap-sheet and mop

   When the roof has been badly dented or perforated by hailstones, repair can be made by cleaning off the surface of the roof needing repairs, lay down a 30 pound cap-sheet and apply 25-30 pounds of asphalt.

4. Resurfacing with Gravel or Slag

   In wind damage, frequently, no greater damage occurs to a built-up roof than the loose gravel or slag will blow around or off the roof. In most cases , replacement of the gravel or slag is all that is required. Some cases, it will be necessary to clean off the areas and mop coat with sufficient asphalt to hold the new gravel or slag.

Single-Ply Roofing Systems

As the built-up roof system has been used for many years in commercial roofing, there is another type of roofing that is being used in the commercial market. After being in use in Europe it was started in this country approximately fifteen years ago.

It is a single-ply roofing system. It may be installed as a mechanically fastened, ballasted,or bar anchored system for either a new roof or for re-roof applications.It can be used over a variety of commonly used roof deck types and insulation materials.

Basically it consists of a thin sheet of material that has been formulated to afford the high strength properties and flexibility values required for consistent long life performance. It resists most tears, impacts and punctures.

Properly installed, this system can withstand extreme temperature fluctuations with no loss to seams or surface. It will remain water-tight in temperatures as low as minus 60 F.

A single piece or overlapping rolls of manufactured sheet material loosely laid or fully adhered to form the roof membrane. The material is elastomeric, that is. it consists of a synthetic polymer material with elastic properties.

The sheets are fastened with adhesive. The membrane can be attached mechanically with clip type fasteners,with bar anchors or with a top ballast of gravel.

Credits

Zero - Breeze Co. Cincinnati , Ohio

Ron Pinkerton - Roofing Estimator

General Adjustment Bureau Cincinnati , Ohio

Fred Naeve- General Adjustor

Grange Insurance Co. Cincinnati , Ohio

Tom Britton- Claims Supervisor

Manville Roofing Systems Denver,Colo.

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Celotex- Roofing Products Division , Tampa. Fla.

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Systems Engineering Assoc. Inc., Columbus, Ohio

1983

National Roofing Contractors Assoc. , Chicago , Ill.

Roofing Spec, June, 1983

RSI,Duluth Minn. , July, 1983

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Dec. 1983

Carlisle Tire & Rubber - Carlisle, Pa.

Construction Materials Div.

Single-Ply Membrane System Manual