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Fundamentals of Roof Inspections

by William M. Easterly

When the condition of a plant roof is ignored, it can be expected to fail before it reaches half its designed life. Deficiencies in the roofing system can result in wet insulation, which causes loss of insulating quality, damage to decking, and leakage. The economic burden of such neglect is generally many times the cost of an ongoing roof maintenance program, especially if the program includes regular inspections.

The roof should be inspected in the spring and in the fall after the leaves have fallen, when it is dry and surface temperatures are less than 80 F. It also should be checked after any severe wind, rain, hail, or snow storm.

INSPECTION PROGRAM

The intent of roof inspection is to find irregularities that make the roof susceptible to damage. The investigation should cover roof history, design, current problems, testing, and evaluations.

DESIGN DETAILS

Improper or careless design creates areas of special vulnerability on the roof. Shoddy details are the weak link in roof system performance and should not be tolerated. Typical examples of poor design details include lack of adequate expansion joints; inferior light gauge structural steel decks; penetrations through roof for equipment (vents, fans, etc.) without proper flashing; change in direction of structural decking without adjustment in flashing; and inadequate slope designed into a flat roof.

Loose Flashing

Drains and scuppers should be placed at the proper location and height and should not be clogged. The drain assembly, including the clamping rings, should be in good condition and have a clear waterflow path. The flashing of drains, downspouts, gutters, and scuppers should be in good condition.

Vents and projections should have flashings and counterflashings secured in place and intact. Counterflashings should slope to prevent ponded water. Projections such as stacks, vents, hoods, domes, and umbrellas may be conductors of water because of design or deterioration; they should be in good condition and properly anchored.

Areas near mechanical equipment should be checked for leakage, vapor condensation, inadequate walkways, and deteriorated or improper curbing. Pitch pockets should be examined for filling.

Flashings and counterflashings at parapet walls and around roof edges and projections should not sag, separate from the wall, buckle, crack, or show signs of weathering.

Cant strips also should be checked for any signs of deterioration.

Parapet walls should be checked for cracks, open coping joints, or deteriorated or porous mortar joints.

Built-up roofing systems should be checked for these additional items:

Surface gravels should be firmly adhered to the roofing membrane. Alligatoring or cracking of the smooth roof surfaces, or exposed felts should be noted. The roof membrane should also be examined for curling, buckling, fishmouthing, and blistering. Blistering and ridging indicate serious problems.

Cracks and splits allow moisture into the roofing system. Evidence of previous repair in a problem area should be noted, as well as the nearest expansion joint and its direction relative to the troubled area.

Expansion and control joints should be in good condition, as well as seam laps, flashing, cant strips, and membrane. In addition, it is good practice to check for any dryness, brittleness, or splitting of bellows material.

Lap seams should be inspected for dried and brittle edges and felt ends. Loss of aggregate coverage and loss of mineral surfaces on organic felts occur with dryness.

Bare felts and wrinkles indicate a generally poor surface condition. Spots where the membrane shows through the gravel and the edges of roofing felts are no longer bonded together or are raised should be carefully checked.

CURRENT PROBLEMS

The condition of the roof system is also indicated by more obvious signs of deterioration:

Falling objects such as tree limbs, debris blown from high to low roofs, copings and capstones falling from parapets, and materials or tools dropped by workers can perforate the roof's surface.

Debris on the roof may include sawdust, grain dust, sand, oil, grease, chemicals, solvents, vegetation, tree limbs, branches and leaves, or other materials that can contribute to the degradation of the system.

Taking a Roof History —

The condition of a roof can best be evaluated with a complete inventory of its components. The roof's history can be assessed with these questions:

Is the existing roof the original installation?

Has the roof been resurfaced?

Is there more than one roof system on the building?

How old is the roof?

What material is the roof deck (for example, steel, gypsum, lightweight fill, concrete, wood)?

Does the roof system have a vapor barrier?

What type of insulation was used (fiber glass, urethane, wood fiber, perlite, polystyrene)?

What is the thermal value of the existing insulation?

What material is the existing surface membrane (coal tar pitch, asphalt, asbestos, fiber glass, one of the newer systems of modified bitumen, single ply, or polyurethane foam/coating)?

What is the top surface of the roof system (slag, smooth asphalt, fiber glass and emulsion, aluminum coating, white crystal spar, rock, ballast, mechanical fasteners, smooth surface single-ply membrane, foam coating, metal)?

Is the air space below the roof deck heated, unheated, cooled, insulated, dead air space, or a return air plenum?

Erosion occurs where water falls continuously on the roof, such as around any open downspouts and open-ended condensate drains from the cooling equipment. The condition includes the displacement of aggregate and the wearing of cap sheet and felts.

Ponding and drainage problems, typically evidenced by standing water, result in softness or sponginess of the roof materials. In addition, ponding encourages growth of fungus or discoloration of the stone and degradation of the surface.

Leakage problems should be tracked with a log that outlines the location, intensity, and weather conditions during the leakage. In evaluating and correcting current problems, the following questions can help pinpoint the source of the problem:

Has the roof leaked in the past?

Where does it leak now?

What preventive maintenance or repairs have been done on the roof recently?

Does the leak occur as soon as the rain starts, despite wind intensity or direction?

Does it occur after the rain starts but while it is still raining?

Does the leak stop immediately after it rains, or does the roof continue to leak for extended periods of time?

The interior of the building should be checked for the following:

Leaks on the underside of roof decking, along vertical walls, around columns, and around equipment attached to or extending through the roof

Discolored ceiling tile, rust spots, peeling paint, warped or spalling deck material

Straightness of walls, columns, and ceilings

Sagging roof structure.

The building's exterior perimeter should be checked for the following:

Cracks, openings, deterioration, and loose mortar in coping and joints

Separation of termination points

Splits or tears in flexible expansion or control joints

Cracks in mortar, brick, or masonry
Plumbness of walls
Unnatural configuration and looseness of overhangs, fascias, cornices, gutters, and downspouts.

TESTING

If the roof is leaking internally, it is advisable to test for moisture content of roof insulation. Nondestructive testing equipment scans the roof surface to monitor the condition of the insulation. Infrared or nuclear testing is most reliable for base scanning; other methods can be used for detailed verification.

Once a roofing system has been properly installed, it must be inspected and maintained. When inspections are regular, small defects can be detected and repaired before they turn into major failures.

Destructive testing typically involves cutting into the roofing system for physical analysis of insulation, barrier, and decking. The extent of water damage, deck deterioration, and structural dead load capacities can be determined from the examination. It is a good idea to use independent service companies for testing roof systems rather than those associated with roofing manufacturers or contractors.

EVALUATION

If there are no leaks, the condition of the flashing system is good, and the overall appearance of the roof reveals no serious problems, proper maintenance will allow continued good service. As long as the insulation is dry and the substrate sound, only minor repairs and maintenance are required.

If the surface condition of the roof looks bad, but there is no evidence of leaks, the roof may be nearing the end of its effective life. Expert advice should be sought as soon as possible for analysis.

A roof that shows evidence of ridging, but does not leak, will soon leak.

If the flashings are in questionable condition, but other conditions are acceptable and there is no wet insulation or leaks, flashing should be repaired immediately to keep water from entering the roof system.

If the roof leaks, wet insulation must be replaced. If the wetness is confined to a small area, or if a large wet area is confined to one location, the insulation can be replaced in those spots only.

Split

If the flashings are water tight and the roof shows signs of degradation from previous repairs, or if the roof leaks and the flashings are in bad condition, the insulation is probably wet and must be replaced.

If flashings are open and ridging and splits are in evidence, the roofing system may need complete replacement. The stresses that cause splitting and subsequent damage usually cannot be corrected through repairs. If blistering of the membrane is severe, again the only solution may be total replacement. Other conditions that require immediate attention include loss of the roof systems insulating value and dead load design violations. Under these conditions, the roof membrane must be replaced even if the insulation retains its thermal integrity.

And if the roofing system is approximately 20 years old, it should be evaluated by an expert. Complete replacement may be required.

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When Is It Safe To Re-Cover An Existing Roof?

by Karen L. Warseck

Most roofing systems manufacturers state in their sales literature that their product can be used, in some cases, to re-cover an existing roof. At first look, the advantages appear overwhelming. The owner saves the cost of tear-off. The noise, dirt and inconvenience of tear-off are eliminated. The building remains somewhat watertight during the installing of the new roof. Normal operations are less disturbed by the roofing work.

All these are very compelling arguments.

However, the realities of the situation require careful consideration. First of all, the reason roof replacement is under consideration is because the existing system leaks. Almost never is a roof considered for major work simply because it has exceeded its projected life span. More likely, it has leaked and been patched on many occasions over a long period of time. This means that water has entered the existing system and is probably being retained in the insulation.

Thus, in a typical re-roofing situation, there are various degrees of wet insulation under a membrane of dubious integrity. Logically, this is not the best substrate in which to attach a new and expensive roof.

Furthermore, manufacturers will not warranty an installation over a wet or faulty substrate. Unfortunately, "faulty" is usually not defined until warranty repairs are required.

LIFE SAFETY PROBLEMS

The water entrapped in the existing system can do a lot worse than void a warranty. If the deck is steel, wood, wood fiber or gypsum, the moisture can cause potential life safety problems due to rusting through a steel deck or rotting of wood or wood fiber.

Gypsum decks will turn into powder when constantly exposed to moisture. Composite decks of gypsum mechanically fastened to steel are especially susceptible to moisture damage. The gypsum will deteriorate when wet, the fasteners corrode, and, because the steel deck in these systems is extremely thin, it will rust through that much more quickly.

Ponding and Heavy Blistering

Even concrete decks, although less susceptible to damage, are not immune. Since wet insulation has no insulating value, the concrete deck below can be subjected to freeze/thaw damage. Any cracks in the concrete can let water into the reinforcing steel, causing corrosion and possibly spalling the deck. Lightweight insulating concrete fill will deteriorate rapidly under freeze/thaw cycling, with the result that it becomes the consistency of beach sand. Because there is no way of fastening to such deteriorated fill, complete removal is required, at a premium cost.

Unless the existing roof is removed, there is virtually no way of knowing the condition of the deck underneath it. Simply looking at the deck from below may not uncover the hazards — decks deteriorate from water coming in from *above*, not below. Think of the potential liability if someone should fall through a deteriorated deck!

INHERITED MOISTURE PROBLEMS

In addition to life safety hazards due to deck deterioration, moisture in the existing roof can cause problems with the new system. The new roof may appear to be leaking, when in fact, the moisture is trapped in the old one and finding its way through the deck. Impervious re-cover membranes such as built-up, modified bitumen or coated polyurethane foam will blister if installed over a moisture-laden substrate. These blisters are easily broken by foot traffic, allowing water into the new roof.

Because adhesion of roofing materials is adversely affected by dampness, existing moisture may prevent any adhered system from bonding to the substrate. The weight of the water trapped in the existing insulation may also cause the new re-cover to exceed the design load of the roof assembly, eventually causing structural failure.

Re-cover recommendations generally require either removal of gravel on a built-up roof and installation of a re-cover board or insulation over the existing surface. If the roof mem-

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Glossary of Roofing Terms

Aggregate — (1) Crushed stone, crushed slag, or water-worn gravel used for surfacing a built-up roof. (2) Any granular mineral material.

Air Lance — A device used to test, in the field, the integrity of field seams in plastic sheeting. It consists of a wand or tube which compressed air is blown.

Alligatoring — The cracking of the surfacing bitumen on a built-up roof, producing a pattern of cracks similar to an alligators hide; the cracks may not extend through the surfacing bitumen.

Asphalt — A dark brown to black cementitious material in which the predominating constituents are bitumens which occur in nature or are obtained in petroleum processing.

Backnailing — The practice of blind-nailing roofing felts to a substrate in addition to hot-mopping to prevent slippage.

Ballast — Paving blocks or rounded river bottom stones used to hold down a loose laid or IRMA roof.

Base Flashing — A flashing used to cover the end of a membrane.

Bitumen — (1) A class of amorphous, black or dark-colored, (solid, semi-solid, or viscous) cementitious substances, natural or manufactured, composed principally of high molecular weight hydro-carbons, soluble in carbon disulfide, and found in asphalts, tars, pitches, and asphaltites. (2) A generic term used to denote any material com posed principally of bitumen. (3) In the roofing industry, there are two basic bitumens: asphalt and coal-tar pitch. Before application, they are either; (a) heated to a liquid state; (b) dissolved in a solvent; or (c) emulsified.

Blister — An enclosed pocket of air mixed with water vapor, trapped between layers of felt, foam or other impermeable layers.

Brooming — Embedding a ply by using a broom to smooth it out and ensure contact with the adhesive under the ply.

BTU — (British Thermal Unit) The heat energy required to raise the temperature of one (1) pound of water one (1) degree Farenheit.

Built-Up Roofing — (BUR) A continuous, semiflexible membrane consisting of plies of saturated felts, coated felts, fabrics or mats assembled in place with alternate layers of bitumen, and surfaced with mineral aggregate, bituminuous material, or a granule surfaced sheet.

Calender — A precision machine used for preparation of highly accurate continuous sheeting or plying up of rubber compounds and frictioning or coating of fabric with rubber or plastic compounds.

Cap Sheet — A granule-surfaced coated felt used as the top ply of a built-up roofing membrane.

Cant Strip — A beveled strip used under flashings to modify the angle at the point where the roofing or waterproofing membrane meets any vertical element.

Capillarity — The action by which the surface of a liquid (where it is in contact with a solid) is elevated or depressed, depending upon the relative attraction of the molecules of the liquid for each other and for those of the solid.

Caulking — A composition of vehicle and pigment, used at ambient temperatures for filling joints, that remains plastic for an extended time after applications.

Chlorinated Polyethylene — (CPE) Family of polymers produced by chemical reaction of chlorine on the linear backbone chain of polyethylene. CPE can be vulcanized but is usually used in a nonvulcanized form.

Chlorosulfonated Polyethylene — (CSPE) Family of polymers that are produced by polyethylene reacting with chlorine and sulfur dioxide. They are used in both vulcanized and nonvulcanized forms. Most membranes based on CSPE are nonvulcanized. ASTM designation for this polymer is CSM.

Cigar — A long tubular wrinkle in a single ply membrane.

Coal Tar — A dark brown to black cementitious material produced by the destructive distillation of coal.

Coated Fabric — Fabrics which have been impregnated and/or coated with a plastic material in the form of a solution, dispersion, hotmelt, or powder. The term also applies to materials resulting from the application of a preformed film to a fabric by means of calendering.

Coated Sheet — (Or Felt) (1) An asphalt felt that has been coated on both sides with harder, more viscous asphalt. (2) A glass fiber felt that has been simultaneously impregnated and coated with asphalt on both sides.

Cold Patch — To repair a roof leak by using prepared roofing or membrane and plastic cement.

Cold-Process Roofing — A continuous, semiflexible membrane consisting of plies of felts, mats, or fabrics laminated on a roof with alternate layers of roof cement and surfaced with a cold-applied coating.

Collar — Metal flashing for a vent pipe.

Condensation — The conversion of water vapor or other gas to liquid as the temperature drops or atmospheric pressure rises.

Coping — A covering on top of a wall exposed to the weather, usually sloped to carry off water.

Counterflashing — Formed metal or elastomeric sheeting secured on or into a wall, curb, pipe, roof-top unit, or other surface, to cover and protect the upper edge of a base flashing and its associated fasteners.

Creep — The dimensional change with time of a material under load, following the initial instantaneous elastic deformation. Creep at room temperature is sometimes called cold flow.

Cricket — A small false roof used to throw off water from behind an obstacle such as a chimney.

Cure — To change the properties of a polymeric system into a more stable, usable condition by the use of heat, radiation, or reaction with chemical additives.

Cutback — Solvent-thinned bitumen used in cold-process roofing adhesives, flashing cements, and roof coatings.

Cutoff — A detail designed to prevent lateral water movement into the insulation where the membrane terminates at the end of a day's work, or used to isolate sections of the roofing system. It is usually removed before the continuation of the work.

Dead Level — Absolutely horizontal, or zero slope.

Dead Loads — Non-moving rooftop loads, such as mechanical equipment, air conditioning units, and the roof deck itself.

Deck — The structural surface to which the roofing or waterproofing system (including insulation) is applied.

Degradation — A deleterious change in the chemical structure, physical properties, or appearance of a plastic.

Delamination — Separation of the plies in a membrane of separation of insulation layers after lamination.

Drain — A device that allows for the flow of water from a roof area.

Edge Stripping — Application of felt strips cut to narrower widths than the normal felt-roll width to cover a joint between flashing and built-up roofing.

Elastomeric — The term used to describe the elastic, rubber-like properties of a material.

Embedment — The process of pressing a felt, aggregate, fabric mat or panel uniformly and completely into hot bitumen or adhesive to ensure intimate contact at all points.

Envelope — A continuous edge seal formed by extending one ply of felt beyond the edge of the assembly. After other plies or insulation are in place, the extended ply is turned back and adhered.

EPDM — A synthetic rubber based in ethylene, propylene, and a small amount of non-conjugated diene to provide sites for vulcanization. EPDM features excellent heat, ozone and weathering resistance, and low temperature flexibility.

Expansion Joint — A structural separation between two building elements that allows free movement between the elements without damage to the roofing or waterproofing system.

Exposure — (1) The transverse dimension of a roofing element not overlapped by an adjacent element in any roofing system. The exposure of any ply in a membrane may be computed by dividing the felt width minus 51mm (2 in.) by the number of shingled plies; thus, the exposure of a 914mm (36 in.) wide felt in a shingled, four-ply membrane should be 216mm (8 1/2 in.). (2) The time during which a portion of a roofing element is exposed to the weather.

Fabric Reinforcement — A 'fabric, scrim, etc., used to add structural strength to a two or more ply polymeric sheet. Such sheeting is referred to as "supported."

Factory Mutual — (FM) An organization which classified roof assemblies for their five characteristics and wind-uplift resistance for insurance companies in the United States.

Fishmouth

Alligator

Factory Square — 108 ft.^{2} (10 M^2).

Fallback — A reduction in bitumen softening point, some times caused by refluxing or overheating in a relatively closed container.

Felt — A flexible sheet manufactured by the interlocking of fibers through a combination of mechanical work, moisture, and heat, without spinning, weaving, or knitting. Roofing felts are manufactured from vegetable fibers (organic felts), asbestos fibers (asbestos felts) or glass fibers (glass-fiber felts).

Fishmouth — A half-cylindrical or half-conical opening formed by an edge wrinkle or failure to embed a roofing felt.

Flashing — The system used to seal membrane edges at walls, expansion joints, drains, gravel stops, and other places where the membrane is interrupted or terminated. Base flashing covers the edges of the membrane. Cap or counter-flashing shields the upper edges of the base flashing.

Flashing Cement — A trowelable mixture of cutback bitumen and mineral stabilizers including asbestos or other inorganic fibers.

Flood Coat — The top layer of bitumen used to hold the aggregate on an aggregate-surfaced, built-up roofing membrane.

Fluid-Applied Elastomer — An elastomeric material, fluid at ambient temperature, that dries or cures after application to form a continuous membrane. Such systems normally do not incorporate reinforcement.

Fully Adhered — An application technique where the membrane is completely attached to the substrate by means of adhesive or bitumen.

Glass Felt — Glass fibers bonded into a sheet with resin and suitable for impregnation in the manufacture of bituminous waterproofing, roofing membranes, and shingles.

Glaze Coat — (1) The top layer of asphalt in a smooth-surfaced built-up roof assembly. (2) A thin protective coating of bitumen applied to the lower plies or top ply of a built-up membrane, when application of additional felts, or the flood coat and aggregate surfacing are delayed.

Granules — The mineral particles of a graded size which are embedded in the coating.

Gravel — Coarse, granular aggregate, with pieces larger than sand grains, resulting from the natural erosion of rock.

Gravel Stop — A flanged device, frequently metallic, designed to prevent loose aggregate from washing off the roof and to provide a continuous finished edge for the roofing.

Gutter — Metal or wood trough at edge of roof to drain rain water.

Headlap — The minimum distance, measured at 90 degrees to the eave along the face of a shingle or felt as applied to a roof, from the upper edge of the shingle or felt, to the nearest exposed surface.

Heat Seaming — The process of joining two or more thermoplastic films or sheets by heating areas in contact with each other to the temperature at which fusion occurs. In dielectric seaming, the heat is induced within films by means of radio frequency waves.

Holiday — An area where a liquid-applied material is missing.

Hydroscopic — Attracting, absorbing, and retaining atmospheric moisture.

IRMA — (Inverted Roof Membrane Assembly) A roofing system where the membrane is applied first then the insulation is laid over it and ballasted.

Leader — Another term for down-spout.

Lift — The layer of polyurethane foam resulting from a single pass of the spray gun, normally ranging from $^1/_2$ to $^3/_4$ inch in thickness.

Mechanically Fastened — An application technique where the membrane is fastened to the building by penetrating fasteners which are then sealed, or by non-penetrating fasteners such as disks or tracks which are attached to the building under the membrane.

Membrane — Applies to a continuous sheet of material whether it is prefabricated as a flexibly polymeric sheeting or is sprayed or coated in the field.

Metal Flashing — Frequently used as through-wall, cap- or counter-flashing.

Mineral-Surfaced Sheet — A felt that is coated on one or both sides with asphalt and surfaced with mineral granules.

Mole Run — A meandering ridge in a membrane not associated with insulation or deck joints.

Mop-and-Flop — A procedure in which roofing elements (insulation boards, felt plies, cap sheets, etc.) are initially placed upside down adjacent to their ultimate locations, are coated with adhesive, and are then turned over and ad hered to the substrate.

Mopping — The application of hot bitumen with a mop or mechanical applicator to the substrate or to the plies of a built-up roof. There are four types of mopping: (1) *solid* —

A continuous coating; (2) *spot* — bitumen is applied in roughly circular areas, generally about 460mm (18 in.) in diameter, leaving a grid of unmopped, perpendicular areas; (3) *strip* — bitumen is applied in parallel bands, generally 200mm (8 in.) wide and 300mm (12 in.) apart; (4) *sprinkle* — bitumen is shaken onto the substrate from a broom or mop in a random pattern.

Neoprene — (Polychloroprene) Generic name for a synthetic rubber based primarily on chloroprene. Vulcanized generally with metal oxide. Resistant to ozone and aging and to some oils.

Ninety-Pound — A prepared roll roofing with a granule-surfaced exposure that has a mass of approximately 4400 g/m^2 (90 lb./108 ft.^{2}).

Nylon — Used as a scrim in fabric reinforced sheeting.

Orange Peel — A finished polyurethane foam surface very moderately textured approximating the appearance of an orange peel.

Overhang — That portion of roofing extending beyond the deck.

Overspray — Minute droplets of foaming mixture that become windborne, foaming in transit and becoming deposited to other than the intended surface.

Parapet — The part of a wall that extends above the roof line.

Partially Adhered — An application technique where the membrane is adhered only to mechanical fasteners which are prefastened to the substrate.

Penetration — The measurement of the hardness or plasticity expressed as the distance that a standard needle vertically penetrates a sample of the material under known conditions of loading, time, and temperature.

Permeability — (1) The capacity of a porous medium to conduct or transmit fluids. (2) The amount of liquid moving through a barrier in a unit time, unit area, and unit pressure gradient not normalized for but directly related to thickness.

Permeance — The rate of water vapor transmission per unit area at a steady state through a membrane or assembly, expressed in ng/Pa-s-m^2(grain/ft.^{2}-h-in. Hg).

Phased Application — The practice of applying the felt plies of a built-up roofing membrane in two or more operations, separated by a delay normally of at least one (1) day (not a recommended practice).

Picture Framing — A rectangular pattern of ridges in a membrane over insulation or deck joints. Also called photo-graphing.

Pinholes — Minute cylindrical holes in the surface of urethane foam resulting from irregular expansion. Not suitable for coating without correction as the coating material will not bridge the void under pressure application. May also occur in the coating system.

Pitch or Slope — The angle of inclination that a roof forms with a horizontal. The incline or slope of the roof, usually referred to as a quarter pitch, third pitch, etc.

Pitch Pocket — A flanged, open-bottomed metal container placed around a column or other roof-penetration, and filled with hot bitumen or flashing cement to seal the joint.

Plastic — A material that contains as an essential ingredient one or more organic polymeric substance of large molecular weight, is solid in its finished state and at some stage in its manufacture or processing into finished articles, can be shaped by flow.

Plasticizer — A plasticizer is a material, incorporated in a plastic or a rubber to increase its ease of workability, flexibility, or extensibility.

Ply — Each layer in a roofing membrane; four-ply built-up roof membrane has at least four plies of felt at any vertical cross section cut through the membrane.

Point of Felt — Weight in pounds per 480 square feet of dry felt. Example: 50 point dry felt weighs 50 pounds per 480 square feet.

Polyester Fiber — Generic name for a manufactured fiber used for fabric reinforcement.

Rusting

Perforations

Polyisobutylene — (PIB) The polymerization product of isobutylene. It varies in consistency from a viscous liquid to a rubber-like solid with corresponding variation in molecular weight from 1,000 to 400,000.

Polyvinyl Chloride — (PVC) A synthetic thermoplastic polymer prepared from vinylchloride. PVC can be compounded into flexible and rigid forms through the use of plasticizers, stabilizers, filler, and other modifiers, rigid forms used in pipes, flexible forms used in manufacture of sheeting.

Pond — A surface which is incompletely drained.

Popcorn — A heavily textured finished polyurethane foam surface approximating the appearance of a caramel popcorn ball. Too heavily textured for coating.

Primer — A thin liquid bitumen applied to a surface to improve the adhesion of heavier applications of bitumen and to absorb dust.

Puncture Resistance — Extent to which a material is able to withstand the action of a sharp object without perforation.

Reentrant Corner — An inside corner of a surface, producing stress concentrations in the roofing or waterproofing membrane.

Reglet — A groove in a wall or other surface adjoining a roof surface for the attachment of counterflashing.

Reinforcement — A strong inert material bound into a plastic to improve its strength, stiffness and impact resistance. Reinforcements are usually long fibers of glass, sisal, cotton, etc. in woven or non-woven form. To be effective, the reinforcing material must form a strong adhesive bond with the resin.

Ridge or Hip — The horizontal line where two opposite sides of a roof join at the apex of the roof.

Ridging — An upward, tenting displacement of a membrane, frequently over an insulation joint.

Rise — The direction of volumetric growth in the polyurethane foaming process.

Roof Assembly — An assembly of interacting roof components (including the roof deck) designed to weatherproof and, normally, to insulate a building's top surface.

Roof System — A system of interacting roof components (NOT including roof deck) designed to weatherproof and, normally, to insulate a building's top surface.

Rubber — A polymeric material which, at room temperature, is capable of recovering substantially in shape and size after removal of a deforming force. Refers to both synthetic and natural rubber. Also called an elastomer.

Rust — A rust colored discoloration of foam surface resulting from exposure to air and ultra-violet.

Saddle — A ridge in the roof deck, whose top divides the elevation of the roof so that water will be diverted to the drainage heads.

Scrim — A woven, open mesh reinforcing fabric made from continuous filament yarn. Used in the reinforcement of polymeric sheeting.

Scupper — A device that allows for the flow of water from a roof area through a wall or other perimeter obstruction.

Seam Strength — Strength of a seam of material measured either in shear or peel modes. Strength of the seams is reported either in absolute units (e.g., pounds per inch of width) or as a percent of the strength of the sheeting.

Shingling — The procedures of laying parallel felts so that longitudinal edge of each felt overlaps the adjacent felt. Normally, felts are shingled on a slope so that the water flows over rather than against each lap.

Silicone — A two-part, chemically cured, liquid-applied material which will cure to a silicone rubber membrane.

Slippage — Relative lateral movement of adjacent components of a built-up membrane. It occurs mainly in roofing membranes on a slope, sometimes exposing the lower plies or even the base sheet to the weather.

Slope — The tangent of the angle between the roof surface and the horizontal. It is measured in inches per foot. The Asphalt Roofing Manufacturers Association (ARMA) ranks slope as follows:

Level Slope	Up to $1/2$ inch per foot
Low Slope	$1/2$ inch per foot to 1 $1/2$ inches per foot
Steep Slope	Over 1 $1/2$ inches per foot

Smooth — A finished polyurethane foam surface with virtually no texture approximating the appearance of deep, freshly fallen snow.

Smooth Surfaced Roof — A built-up roof without mineral aggregate surfacing.

Softening Point — The temperature at which a bitumen becomes soft enough to flow as determined by and arbitrary, closely defined method.

Softening Point Drift — A change in the softening point during storage or application.

Split — A membrane tear resulting from tensile stress.

Square — A term used by roofers to indicate an amount of roof area equal to 100 square feet (92.2m²). Sufficient roofing material to cover 100 square feet of roof area.

Stack Vent — A vertical outlet in a built-up roofing system to relieve the pressure exerted by water vapor between the roofing membrane and the vapor retarder or deck.

Strawberry — A small bubble or blister in the flood coating of a gravel-surfaced membrane.

Stress Plate — A flat disk used at the head of a fastener to resist downward punching through a membrane or insulation.

Stripping — (Strip Flashing) (1) The technique of sealing a joint between metal and built-up membrane with one or two plies of felt or fabric and hot- or cold-applied bitumen. (2) The technique of taping joints between insulation boards or deck panels.

Substrate — The surface upon which the roofing or water proofing membrane is placed (structural deck or insulation).

Superimposed Loads — Loads that are added to existing loads. For example, a large stack of insulation boards placed on top of a structural steel deck.

Surfectants — Chemical additives used in foam systems to make the cell structure uniform and fine grained.

Tear Strength — The maximum force required to tear a material, the force acting substantially parallel to the major axis of the test specimen. Values are reported in stress (e.g. pounds) or stress per unit of thickness (e.g. pounds per inch).

Tensile Strength — The maximum tensile stress per unit of original cross sectional area applied during stretching of a specimen to break; units — SI–metric Megapascal or kilo pascal, customary pound per square inch.

Termination Bar — A strip of metal or plastic used to fasten and protect the edge of a membrane or flashing.

Thermal Resistance — (R) An index of material's resistance to heat flow; it is the reciprocal of thermal conductivity (k) or thermal conductance (C). The formula for thermal resistance is:

$$R = 1/C \quad \text{or} \quad R = 1/k \quad \text{or} \quad R = \text{thickness in inches}/k\,.$$

Thermal Insulation — A material applied to reduce the flow of heat.

Thermal Shock — The stress-producing phenomenon resulting from sudden temperature drops in a roof membrane when, for example, a rain shower follows brilliant sunshine.

Thermoplastic — Capable of being repeatedly softened by increase of temperature and hardened by decrease in temperature. The thermoplastic form allows for easier seaming both in the factory and in the field.

Through–Wall Flashing — A water–resistant membrane or material assembly extending totally through a wall and its cavities, positioned to direct any water within the wall to the exterior.

Tree Bark — An unacceptable foam surface very heavily textured in ridges approximating the appearance of the bark of an oak tree.

Ultimate Elongation — The elongation of a stretch specimen at the time of break. Usually reported as percent of the original length. Also called elongation at break.

Underwriters' Laboratories — A non-profit organization maintained in the interest of insurance companies to determine fire resistance of various materials.

Valley — The place of meeting of two slopes of a roof, forming a depression that carries water to an outlet or drainage head.

Vapor Migration — The movement of water vapor from a region of high vapor pressure to a region of lower vapor pressure.

Vent — An opening designed to convey water or other gas from inside a building or a building component to the atmosphere.

Vent or Vent Pipe — Small iron pipe outlet extending up through the roof.

Verge of Popcorn — A finished foam surface, moderately textured, approximating the appearance of the surface of a cracker without holes.

Vulcanization — An irreversible process during which a rubber compound, through a change in its chemical structure (e.g., crosslinking), become less plastic and more resistant to swelling by organic liquids, and elastic proper ties are conferred

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Roof Re-Cover

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brane or insulation are to be directly adhered to the substrate, incomplete removal of gravel, or dirt left on the substrate, can interfere with adhesion and increase the opportunity for a blow-off.

In most cases, however, the new insulation or re-cover board is mechanically fastened to the substrate. Mechanical fasteners, piercing through wet insulation, will eventually rust. Even if they are specially coated to resist rusting, steel deck at the fastener holes is not. As the steel around the fasteners rusts away, the hole enlarges. Whether it is the deck or the fastener that rusts, the fasteners will no longer be held in place by the deck. As a result, they can easily be pulled out, thereby vastly increasing the opportunity of a roof blow-off.

In any case, fasteners penetrating the substrate on a re-cover provide a channel for entrapped moisture through the deck into the occupied space.

With all the problems that can result from wet insulation, logic dictates the removal of the moisture from the existing substrate. One popular way is to attempt to dry out the insulation by the installation of roof vents. Unfortunately, roof vents do virtually nothing to remove trapped water from saturated insulation. While they don't dry wet insulation, they may be helpful (and this has not been proven) in relieving vapor pressure in damp insulation. If the moisture is trapped between plies in a built-up roof, or in open cells in a closed cell insulation, vents will do no good at all because they rely on vapor migration to relieve pressure.

SELECTIVE TEAR-OFF

Another way is to selectively tear off parts of the roof. However, this can cause more problems than it helps solve. By doing *any* tear-off, the building interior is *still* exposed to the weather, noise, dirt and cost of tear-off. Thus, the original reasons for not contemplating tear-off are negated. Another potential problem is that a clear determination of what should selectively be torn off often can not be established. The reason for this is that there is no commonly accepted definition of what is meant by "wet" insulation. A contractor, for example, may remove only what is damp to the touch. If the new roof fails shortly thereafter, is the contractor wrong? Not necessarily. He or she may be using a different standard of "wetness".

At first look, the advantages seem overwhelming. But if the issue is not carefully thought out and the ramifications thoroughly considered, the situation can be deadly.

Obviously, completely saturated materials must go. But what about that which is merely damp to touch, or that which feels dry but moisture readings indicate to be damp? How do you determine where damp insulation stops and dry insulation begins? Part of the confusion results because different insulation materials have different tolerances to moisture, and different membrane systems also have different tolerances to moisture content. What may be "wet" in one situation may not be a problem in another.

The problem of determining where to stop ripping is complicated further because the various types of moisture detection equipment do not work equally well on all types of roofing. For instance, no detection system works well on a Protected Roof Membrane Assembly (PRMA) roof or lightweight insulating concrete. Capacitance meters have little or no value in evaluating ethylene propylene diene monomer (EPDM) membranes or extruded polystyrene and sprayed-on urethane foam insulations. Nuclear meters do not respond on either of those, or with foamed glass. They also will give anomalous readings near walls, parapets or thick membranes. Infrared scanners will give false or misleading readings over extruded polystyrene, all concrete, and foamed glass insulations. Infrared scanners cannot be used on ballasted systems (unless the rock is removed) and may give anomalous results in areas that have been shaded from the sun all day. So, even if the roof is tested to evaluate

Ridges

insulation conditions, there are no guarantees of accuracy.

If a partial tear-off is done, you must consider also that, unless the insulation height of the existing roof is matched exactly by the new insulation, the difference in elevation may cause ponding (standing water) in low areas or near high spots where the higher areas interfere with drainage. In addition to causing premature breakdown of most membranes, standing water — at best — encourages leaks even at minor flaws. At worst, the extra weight of the pond can overload the structural system and cause a roof collapse.

Existing Moisture

PROBLEMS ASSOCIATED WITH ADDING LAYERS OF INSULATION

Simply adding insulation layers on top of the existing roof can cause other problems. Most manufacturers require a minimum six-inch vertical flashing leg to warranty the roof. When the roof elevation is raised, reglets may become too low above the finished roof height to provide this minimum vertical flashing. As a result, a wall may have to be taken apart and new through-wall flashing installed above the higher roof flashing. If this is not done, water from within the wall will run down *behind* the roof flashing into the new roof. Mechanical unit curbs, drains, vents and other penetrations may have to be raised due to the change in elevation. Minimum flashing heights may not be attained if this is not done, resulting in a non-warrantied roof — and increasing the potential for water flowing over the tops of the flashings and causing leaks.

In addition, extra long fasteners will be needed to fasten the new insulation to the deck. These long fasteners are prone to bending and metal fatigue. If this happens, the fastener can break off and puncture the membrane; or, if enough fasteners break, allow the roof to blow off. To combat this problem, extra large diameter fasteners must be used — but they cost a premium price.

Existing moisture could possibly prevent any adhered system from bonding to the original substrate.

Careful selection of roofing systems is important in general, and careful selection of a re-cover membrane and insulation is essential. Severe failures can result when the specified material for the new insulation or the re-cover membrane are chemically incompatible with the existing materials on the roof. Also, the weight of the new materials to be added must be carefully calculated. An engineering study that includes all code mandated snow and live loads must also be completed to assure that the added weight of the new roof does not overload the structural capability of the building.

IS YOUR ROOF INSURABLE?

Finally, your re-covered roof may not be insurable. If your insurer requires an Underwriters Laboratories (UL) listed or Factory Mutual (FM) rated roof, the re-cover may not qualify. FM and UL ratings are based on roof assemblies, and, in order to qualify for the listing, the roof must contain only the materials listed. There are no listings for re-cover assemblies. Code violations may also occur, as some of the model building codes require rated roofs in fire districts.

The question becomes, then: When is it safe to re-cover a roof at all? If the issue is not carefully thought out and all of the ramifications are not fully considered, the situation can be deadly. Ask yourself these questions: Is the roof generally in good condition? Have the leaks in the roof been localized and of short duration ? Is the roof younger than its expected life, span? Will the structural system support the extra load of the new roofing system? Has the condition of the insulation been tested and verified? Is this building located in a fire district that requires a rated roof? Is an FM or UL listing required? If you can't answer any of these with a "yes", or if you don't know for certain, consult a building diagnostics specialist. He or she can help you determine which way to go.

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Karen L. Warseck is director of the Southeastern Region Office of Hoffmann Architects. She is an associate member of the American Institute of Architects.

Representative Projects

Hoffmann Architects provides a wide variety of architectural services on existing buildings and buildings under construction, from pre-mortgage surveys to remedial architecture. A few examples, illustrating the breadth of Hoffmann Architects assignments, include:

FACADE REHABILITATION

Hoffmann Architects prepared plans and specifications, and will administer construction, for the rehabilitation of an historic manufacturing facility in Bridgeport, Connecticut. The General Electric Bridgeport Facility was built in 1915 for a predecessor of Remington Arms Company, specifically for the manufacture of arms for the Czar of Russia. General Electric bought the plant in 1922, and has manufactured consumer products there ever since. Hoffmann Architects is working on the rehabilitation of balconies that grace the end of the many symmetrical bays that distinguish this facility.

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The limestone walls are being repointed and window sealant is being replaced on the 40-story International Building in New York City. Work is proceeding under the architectural direction of Hoffmann Architects for the Rockefeller Center Management Corporation.

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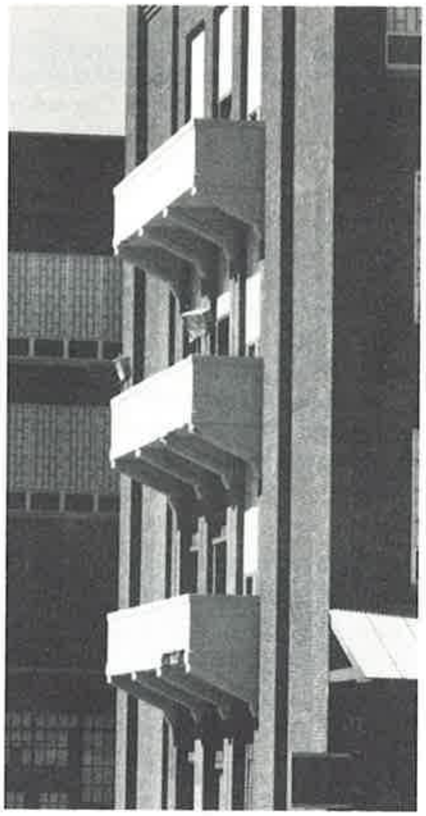
Hoffmann Architects recently conducted a survey of the condition of the exterior walls, courtyard and roofs of the Mendenhall Center for the Performing Arts at Smith College in Northampton, Massachusetts.

Limestone planting boxes will be repaired; and paving and a canopy roof will be replaced at the Warner Communications Building at Rockefeller Center in New York City. Hoffmann Architects is providing the architectural direction for this project.



Balconies on this GE facility are being rehabilitated by Hoffmann Architects.

ROOFING PROJECTS

The condition of the roof of the Mid-Manhattan Branch of the New York Public Library was investigated by Hoffmann Architects. Proposals have also been made to the New York Public Library for the general inspection of roof and cellar wall conditions at two additional branches.

The State of Connecticut Department of Public Works recently engaged Hoffmann Architects to prepare plans and specifications for the re-roofing of South Central Community College in New Haven.

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The town of North Haven, Connecticut has retained this firm to survey the condition of roofs at the Junior and Senior High School buildings.

REMEDIAL ARCHITECTURE

Remedial Architectural services being provided by Hoffmann Architects on an inn and conference center in Maryland include: replacement of waterproof membrane on courtyards and walkways; waterproofing of exterior masonry surfaces and foundation walls; installation of a state-of-the-art replacement fire alarm system throughout the hotel.

PLAN REVIEW

The Weitz Corporation is Hoffmann Architects' client for a Plans and Specifications Review, and construction monitoring services, for Essex Meadows, a life care center being constructed in Essex, Connecticut.

While Hoffmann Architects/Journal attempts to provide the most accurate information on general subjects, it is not intended to be a substitute for professional architecture/engineering services. We strongly urge you to consult a qualified rehabilitation architecture/engineering firm (ours) for answers to specific questions.

staff news

New Staff

Hoffmann Architects is pleased to introduce two new members to the staff: **project architect, James M. Eads, AIA** and **senior architect/engineer, Allan H. Gold, AIA, PE.** Eads comes to us from Texas where he gained broad experience in commercial, institutional and residential construction. Gold, also from Texas, has twenty-three years of comprehensive experience as practitioner, educator, building code official and researcher.

PROFESSIONAL ACCOMPLISHMENTS

Theodore F. Babbitt, AIA is on the Board of Directors of The International Center. It is a private, community-based, non-profit corporation, formed to assist foreign students, medical personnel at local hospitals and business trainees with their adjustment to life in the United States. The International Center Residence, which houses foreign and American students, is on historic Prospect Street in New Haven, Connecticut.

Peter H. Borgemeister, Hon. AIA, has been appointed to the Development Committee of the Peabody Museum at Yale University.

Amy C. Kilburn, AIA has also been appointed to a second year of a 3-year term as a Director of The Connecticut Society of Architects/AIA Board of Directors.

Harwood W. Loomis. AIA recently addressed the Hartford chapter of the National Association of Corporate Real Estate Executives on building envelope problems. He also spoke to the Connecticut Chapter of the American Institute of Plant Engineers in Danbury, Connecticut about architects' services to facilities engineers. Harwood was named to the Board of Directors of Phenix Society International, a non-profit group founded to improve the quality of the last one-third of life.

Russell M. Sanders recently represented Hoffmann Architects in a presentation of typical New York City roofing projects to the winners of the British Flat Roofing Design Competition.

Marian McFarland is serving as Executive Secretary of the Board of Directors, and President-elect for 1988, of TEAM, Inc. TEAM is a Community Action Agency which provides services to low income and elderly residents in a 18-town region. Among the programs are Meals-on-Wheels, Headstart pre-school, and the MANNA elderly nutrition program.

Susan Hauser, Hoffmann Architects' Controller, recently joined the auxiliary of the Hospital of St. Raphael, a major teaching hospital in New Haven, Connecticut. Susan is also a Trustee on the town of Hamden Pension Board of Directors.

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