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Journal

A Reroofing Primer

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No one wants to be caught unprepared by catastrophic roof failure. Emergency roof replacements tend to be more expensive than planned ones, and damage to interiors may mean unrecovered costs and detrimental downtime. But nobody wants to shell out for a new roof when it's not needed, either. So how to know when it's time to replace your roof?

Occasional leaks, especially after major storms, may be resolved with an isolated repair. But when leaks become recurrent and pervasive and the roof approaches the end of the warranty period, it's probably time to consider roof replacement. As preventive maintenance ceases to keep pace with failures, leaks can damage inventory, equipment, and interior finishes, leading to business interruption and closures as repairs are made. Hospitals, laboratories, data centers, libraries, and museums contain sensitive spaces particularly susceptible to water damage. For critical facilities, it therefore may be prudent to replace an aging roof as it approaches the end of its anticipated service life, before problems are observed.

Even for the typical industrial, commercial, or institutional building, planning for roof replacement is likely a better option than is waiting for a major failure before taking action. Not only can early, preventive replacement protect the structural deck and exterior walls from water damage, planned reroofing may also realize cost savings. For example, re-covering an existing roof with a new membrane offers a less expensive alternative to full tear-off and replacement, but it is only possible if the roof assembly is stable and dry. Planning ahead for roof replacement also allows facility dollars to be spent on those areas that need them most. It's generally easier to budget for a phased roof replacement program than it is to find funds for unexpected replacement of a failed roof.

For many building owners and managers, the first step in a reroofing project is to obtain proposals from roofing contractors. But proposals for what? Given technological developments in the roofing industry and changes in building codes over the past 20 years, replacement in kind might not be the best option—or even a possible option. Without a set of specifications and drawings, contractors will often opt for the cheapest possible assembly to make their bottom line more appealing. A better strategy is to get a detailed picture of existing conditions first, then use that information to select the right roofing system for the job.

Planning ahead for roof replacement avoids the unexpected expense of emergency leak remediation.

As Project Architect in Hoffmann Architects' Connecticut office, Deborah J. Costantini, AIA leads project teams in diagnosing and resolving roofing distress and in developing roof maintenance protocols. Project Coordinator Michael S. Pereira, Assoc. AIA provides design documents and specifications for a wide range of roofing systems.

Roof Investigation

If you're planning to replace the roof anyway, it may seem superfluous to conduct a roof investigation. However, without an understanding of the existing roof system and deck conditions, building owners and managers may inadvertently select incompatible systems, neglect to resolve underlying problems, or even replace a roof when it isn't necessary to do so.

Particularly for roof areas installed at different times or exposed to different conditions, a professional investigation can help decide which roofs need maintenance (good general condition), restoration or repair (salvageable condition), or full replacement (poor condition). Evaluating roof conditions assists in prioritizing roof areas for replacement, which allows for accurate budgeting and long-term capital improvement planning. In addition, a comprehensive investigation aids in establishing code compliance and identifying deficiencies at parapet walls, penthouses/bulkheads, copings, and transitions, so that these repairs can be completed concurrently, saving on set-up and construction costs and preventing damage to the newly installed roof system.

A condition survey is also important to evaluate proposed roof replacement systems for compatibility with the existing structure. During the investigation, the design professional will determine the construction type and condition of the roof deck, as well as the adequacy of the existing drainage system. He or she will also consider potentially difficult flashing conditions, such as a large number of roof penetrations, and the structural and waterproofing integrity of roof intersections and terminations. Recommendations for remedial action can then be based on actual roof conditions, rather than on hypotheticals, assumptions, or generalizations.

Roof Design Considerations

Selecting a roof assembly for replacement isn't necessarily as simple as re-installing the same system, nor is it sufficient to select a promising product seen at a conference or used on the building next door. While these strategies can yield fine results, more often than not choosing the right system for the job requires consideration of a number of factors. The top five:

1. Building Characteristics.

A good reroofing option for a one-story, 100,000-square-foot warehouse might be a poor choice for a 50-story skyscraper with multiple roof setbacks. Building height is a major factor in roof system design, particularly as it relates to wind uplift. Siting, too, is key, in that exposure to wind, rain, snow, and sunlight varies depending upon the roof orientation and its relationship to building intersections and exterior walls. A roof laden with mechanical equipment and numerous penetrations demands a very different type of roof system than does one with wide open areas unencumbered by vents, hot stacks, or fan curbs. Skylights and penthouses also play a role. Of critical importance is the deck construction type and load capacity, which can impact re-cover/replace decisions, as well as the selection of insulation, adhesives, and fasteners.

2. Logistics.

Practical considerations for installation can make the difference between a successful reroofing project and one that is fraught with problems. Urban settings, for example, may preclude

^ Roof replacement at a suburban or rural facility may involve use of a crane to facilitate material delivery.

< Reroofing projects in urban areas, such as this setback roof replacement in New York City, demand consideration of roof access as part of the design process.

use of a crane for lifting materials onto the roof. The size and capacity of service elevators then becomes vital to roof system selection, in that the elevators might not accommodate large membrane rolls or insulation boards. Debris removal can likewise face similar obstacles. Coordination of site access and material storage should be considered well before the contractor's arrival on site.

Suburban locations have their own challenges, particularly when it comes to roof areas of excessive width, such as at industrial or manufacturing facilities. Sprawling buildings may require a large crane for delivering materials, and hot-applied products may not maintain the correct temperature by the time crews reach the middle of the roof. For rural areas, material selection can be driven by availability. Choosing a system that's not supplied locally may mean that contractors don't have support from the manufacturer's technical representative, or that materials aren't in stock and must be pre-ordered prior to installation.

3. Roof Configuration.

Here's where a detailed roof investigation really helps: identifying deficiencies in drainage, deck slope, flashing details, and intersections before beginning a reroofing project allows these problems to be corrected in the design phase. Installing a roof membrane without first addressing insufficient drainage or problematic details may leave the owner with a new roof that still leaks.

Roof configuration can also impact choice of assembly. Multiple, interconnected roof areas with changes in roof level or slope can mean that bulkier assemblies, which don't readily accommodate irregular angles or tight spaces, may fall short as a reroofing option. Tying different types of roofing materials together at intersections is also a consideration for these complex roofs.

Cost Calculation and Budgeting

When selecting a roof system for replacement, consider ownership objectives. A resilient roof system with a substantial warranty period is a good investment, but only if you plan to hold on to the building long-term. For a quick sell, a new roof that doesn't leak and meets minimum quality criteria may be sufficient.

Other factors to consider when selecting a roof assembly are future upkeep costs, downtime during the reroofing project, and energy cost savings that might be realized from the new system. The additional expenses that might be incurred by closing the top floor of a hotel or relocating large quantities of inventory could mean that a roof system that can be installed in a day is preferable to one that disrupts operations for weeks.

A roof area that is difficult to access, such as a waterproofing system buried below a rooftop terrace or garden, demands a more resilient, puncture-proof system than does an assembly that's in the open. Where resolving leaks would prove cost-prohibitive, a waterproofing membrane that is initially more expensive might be well worth the investment.

During the investigation phase, the architect or engineer can evaluate these and other cost considerations when preparing recommendations for repair or replacement. Discuss any concerns regarding logistics, maintenance, or performance during design development to avoid any unpleasant surprises. Detailed contract documents enable contractors to provide accurate bids for the full project scope, including any enhanced details necessary to meet warranty, code, or insurance requirements. With the complete scope of services at hand, contractor bids can then be compared as apples-to-apples. ■

A wide, even roof expanse with few penetrations is less likely to encounter the same problems, but without shade from other building areas, it faces greater sun exposure, requiring a system that resists ultraviolet damage.

4. Climate and Exposure.

Roof configuration also plays a role in the weather damage to which a given roof area is subjected. Temperature fluctuations can be more or less dramatic, depending upon whether a roof area is protected by surrounding building facades or exposed continuously to the elements. Snow drifts can build up at roof areas where prevailing winds channel storm precipitation; roof assemblies at these areas should accommodate the long-term presence of moisture and increased loading the weather events create.

Where maintenance staff frequently access rooftop equipment or use snow removal tools during winter months, membrane selection should consider durability and puncture resistance as high priorities. For steep-slope roofs, ice dams at eaves may be a concern, and ice and water shield should be incorporated for buildings in snowstorm-prone locations.

Many roofing products have constraints on temperature ranges for installation. Sealant, caulk, mortar, and adhesives cannot be applied in very cold temperatures, while rubber roofing can soften in high heat. Materials selection and construction scheduling should therefore consider heat and cold tolerance of roofing materials, as well as the building's climate zone.

5. Energy Conservation.

Installing a new roof system is an opportunity to improve the energy efficiency of the building envelope. Many building owners and managers are now opting for roof systems with a high Solar Reflectance Index (SRI), which help to reduce cooling demands on mechanical equipment by reflecting a majority of solar heat. Adding insulation can improve a roof's R-value; however, the additional depth of the assembly may necessitate adjustments in flashings, terminations, and parapet heights, so plan accordingly. Although ecological roofing products may cost more than traditional systems, the higher up-front cost may be defrayed through long-term energy savings.

In addition to thermal performance, exposure, building orientation, construction type, and logistics, the design professional may consider a number of other factors when making a product selection. Experience with a given product, proven performance, and owner's preference might play a role, as can anticipated maintenance demands and roof system life expectancy, among other considerations.

Code Requirements

Depending upon the jurisdiction, even a partial reroofing can trigger compliance with current codes. Researching relevant codes and standards can prevent costly delays and change orders during or after a reroofing project.

Energy

Thermal performance is not only a design consideration; in many locations, it's a code requirement. Most states and many municipalities have adopted a version of the International Energy Conservation Code (IECC), developed by the International Code Council, as part of their building codes. The IECC specifies minimum thermal performance values for building envelope components, including the roof.

Fire and Wind

Building code requirements, often derived from the International Building Code, commonly regulate fire and wind uplift ratings of roof assemblies. Other codes, including the National Fire Protection Association's NFPA 101 Life Safety Code and the International Fire Code, may also be applicable.

In collaboration with the American National Standards Institute (ANSI), FM Global has developed procedures for testing and approving roofing products for wind uplift and fire resistance that may be more stringent than those set by local code. FM Global windstorm classifications require a 2:1 safety factor, with designations dependent upon building height, location, and roof area dimensions, among other criteria.

Volatile Organic Compounds (VOCs)

Recent and forthcoming ecological building standards, including the 2012 International Green Construction Code, have tightened requirements on environmentally harmful chemicals.

Incorporating a light-colored cap sheet with a high SRI into a traditional modified bitumen roof system can improve energy performance.

Schools and hospitals often require roofing products that are free of volatile organic compounds to protect sensitive building occupants.

What's So Cool about Ballasted Roofs?

Plenty. That's according to a recent study by the Oak Ridge National Laboratory in Tennessee, which demonstrated that a ballasted system can reduce peak membrane temperatures and mitigate heat transfer into the building just as well as can a white reflective membrane.

Typical "cool roofs" use a high-albedo membrane or cap sheet to reflect sunlight and radiate absorbed solar heat. Traditional ballasted assemblies, commonly dismissed as dinosaurs of the roofing industry where energy performance is concerned, were tested alongside cool roof membranes over a three-year period. It turns out that roof membranes covered by at least 10 pounds per square foot of 1 ½ inch diameter stone ballast performed as well as—or better than—light-colored membranes. The mass of the stones acted as a heat sink, reducing membrane temperatures and delaying heat flow into the building until the cooler evening hours.

As a result of the study, standards by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and others are undergoing revision to include ballasted systems as a cool roof option. The Environmental Protection Agency is also reconsidering the use of SRI values as the sole metric for heat gain in roof assemblies. When selecting a roof system, building owners may want to talk to their architects about options beyond white roofs, including ballasted assemblies, to improve energy performance.

Note: The size and distribution of stone in this study was selected for heat gain consideration, and does not necessarily reflect requirements for wind uplift as determined by building characteristics. ■

Some projects, particularly at hospitals and schools, cannot tolerate even low VOC levels. However, longer drying times and higher minimum application temperatures for water-based products may impact project schedule. Material selection should therefore aim to balance performance with the needs of building occupants and with code requirements.

Be aware that "no VOC" does not necessarily mean no odor. If chemical smells are a concern, check with the manufacturer to determine the appropriateness of products under consideration. Contractors should take precautions to work downwind of air intakes and to keep operable windows closed during application to protect indoor air quality.

Historic and Landmark Ordinances

If the building is a national or local landmark, or if it is listed on the National Register of Historic Places, additional stipulations for reroofing may apply. Replacement in kind is generally the most acceptable option, but it can also be the most expensive one. Some historic commissions may accept aesthetically compatible alternatives if they resolve a design flaw inherent to the original material.

For example, at a college preparatory school library constructed in the 1920s, persistent water infiltration at a wood- and metal-clad dome was resolved with a liquid-applied roofing product. The school wanted to improve water-tightness and reduce maintenance demands, and the finished look of the dome was consistent with its original appearance. Different municipalities and commissions have different requirements, however; replacement of historical materials with contemporary products may not gain regulatory approval.

Contractor Experience

Even a system that seems ideally suited to a particular application may not be a viable option if there is no contractor in the area qualified to install it. As part of the roof selection process, the architect or engineer should contact manufacturers to identify certified contractors and to determine the training requirements for contractors wishing to become certified installers. Specifying a product without hiring a contractor certified by the manufacturer may preclude issuance of a warranty.

If the nearest experienced contractor for a given assembly is a significant distance from the site, the additional costs of transportation will need to be considered in the project budget. If the building is located in a busy urban area and the contractor is accustomed to working in suburban locations—or vice versa—issues may

The roofing contractor for this project piled materials and equipment in one spot, potentially overloading and damaging the roof structure.

arise in construction for which the contractor is not prepared. At best, an inexperienced contractor's efforts can incur additional expenses for time and materials; at worst, the roof system might be incorrectly installed, leading to premature failure.

The construction team also needs to be well versed in the basics of roof replacement procedures. Heavy materials piled in one area of the roof risk structural damage or even roof collapse, but this practice is all too common. That's why a field representative, generally the architect or engineer, should be available to oversee installation. Too often, "experienced" construction teams adopt practices they've used in the past in lieu of following design specifications, even when their methods are inappropriate for the situation or, even, unsafe.

The Devil Is in the Details

Design professionals often enhance manufacturers' design details to accommodate situation-specific conditions and customize the roof assembly as necessary. Unfortunately, many contractors are inclined to ignore deviations from specifications and install the roof as per their usual practice. The danger in this approach lies in its inability to account for site conditions that demand special provisions, such as unusual configurations of penetrations or strong wind uplift. The field representative should therefore impress upon the construction team the importance of adhering strictly to the contract documents, even where they deviate from the manufacturer's standard details or from the contractor's personal experience.

In cases where the contractor believes that the roof cannot be installed as designed, or that the design is inconsistent with observed site conditions, he or she should be encouraged to meet with the architect or engineer to discuss the perceived inconsistencies. By keeping channels of communication open, the project team will be more likely to achieve the desired outcome.

Details count when it comes to warranty coverage, too. A 10-year and a 20-year warranty may cover the same assembly, but the manufacturer may require more redundancy at flashings, closer spacing between fasteners, or additional leak protection at terminations in order to support a longer warranty period.

To upgrade from a membrane-only warranty to a full system one, enhanced details may also be required. A roof system warranty covers the entire assembly; in the event of a leak, no matter which part of the roof fails, the manufacturer agrees to resolve the problem. Membrane warranties, by contrast, do not cover failures at flashings, intersections, insulation, or fasteners; only damage to the membrane itself is compensated. Although membrane warranties usually come at a cheaper price and don't require the enhanced details of a full-system warranty, they tend to prove disappointingly irrelevant in the event of a failure.

Reroofing Right

Of all the major building envelope elements, the roof usually has the shortest expected service life. With this in mind, building owners and managers must consider whether they intend to be proactive or reactive when it comes to roofing distress and failure: in short, to chase after problems or anticipate and prevent them? Put in those terms, the response seems clear. But given the expense and disruption of a reroofing project, many owners and managers would just as soon put it off as long as possible.

Roof replacement at this corporate headquarters building needed to accommodate changes in roof slope and deck type while maintaining watertight tie-ins with historic building elements.

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representative projects

Roof Rehabilitation

Appropriate design solutions mean lasting results. That's why Hoffmann Architects tailors each roof repair and replacement project to the individual needs of the building and of the client. Our design professionals evaluate underlying sources of leaks and heat loss, and develop contract documents with enhanced details that protect against moisture entry, wind uplift, and premature failure.

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Social Sciences Building
Purchase College
State University of New York
Purchase, New York
Roof Replacement, Cool Roof System

Donald W. Reynolds Center
Smithsonian Institution
Washington, District of Columbia
Copper Roof Investigation and Replacement

Master Clock Building
United States Naval Observatory
Washington, District of Columbia
Roof Leak Consultation

Manhattan House
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Terrace Garden Roof Replacement

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Roof Replacement

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While that's not an unreasonable approach, most building owners and facility professionals will find that planning ahead for roof maintenance and replacement, and responding promptly to signs of deterioration, actually saves money and reduces downtime. By the time a leak is detected at the building interior, water has likely saturated insulation and damaged structural elements, framing, and drywall, to the point that repairing water damage can be more expensive than fixing the leak.

Replacing an aging roof assembly before problems arise might seem an extravagance, but it's actually fiscally responsible. Advance planning allows the prudent building owner or manager time to reflect on the available options, in order to make the best choice for the available budget and for the building's needs. Emergency reroofing rarely affords that luxury. ■

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