reroofing primer

IN-DEPTH ADVICE FROM THE EXPERTS

PHOTO: HOFFMANN ARCHITECTS, INC.

Building owners and operators need to plan ahead for roof replacement in order to avoid the unexpected expense of emergency leak remediation.

LEARNING OBJECTIVES

Based on the information presented in this course, you should be able to:

+ IDENTIFY roof design considerations and explain how these factors influence roof system selection and installation to optimize building sustainability and improve occupant health and welfare.
+ EVALUATE reroofing costs in terms of ownership objectives, upkeep, and occupancy demands to determine an appropriate scope of work that meets budget needs and long-term facility goals.
+ APPLY code requirements for energy conservation, fire protection, wind uplift, environmental contaminants, and historic and landmark preservation to roof repair and replacement projects.
+ COMPARE traditional ballasted roof assemblies with newer cool roof technologies in terms of heat gain and energy performance, beyond consideration of solar reflectance index (SRI) alone.

BY DEBORAH J. COSTANTINI, AIA, AND MICHAEL S. PEREIRA, ASSOC. AIA
HOFFMANN ARCHITECTS, INC., HAMDEN, CONN.

No building owner 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. On the other hand, no one wants to shell out for a new roof when it's not needed. So how can design and construction professionals know when it's time to advise clients to replace their roofs?

Occasional roof 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

Roof replacement at a suburban or rural location may involve the use of a crane to facilitate delivery of materials.

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

PHOTOS: HOFFMANN ARCHITECTS, INC.

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 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.

START WITH A ROOF INVESTIGATION

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.

If the client is 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, copings, penthouses/bulkheads, 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. The design professional 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 reinstalling 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 sometimes 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; 2) logistics; 3) roof configuration; 4) climate and exposure; and 5) energy conservation.

1. BUILDING CHARACTERISTICS

A good reroofing option for a one-story, 100,000-sf 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 the 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. Sprawling buildings may require a large crane for delivering materials. 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. A wide, even roof expanse with few penetrations is less likely to encounter these 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. Snowdrifts can build up at roof areas where prevailing winds

REROOFING FINANCIAL BASICS: Calculating Costs, Developing a Budget

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 the client plans 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 to the client's needs.

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 few days may be 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 on an apples-to-apples basis.

PHOTO: HOFFMANN ARCHITECTS

channel storm precipitation; roof assemblies at these areas should accommodate the long-term presence of moisture and increased loading created by such weather events.

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

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 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 upfront cost may be defrayed through long-term energy savings.

In addition to thermal performance, exposure, building orientation, construction type, and logistics, design professionals 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.

GETTING CODE REQUIREMENTS UNDER CONTROL

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 requirements. 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 considerations. 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.

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

PHOTOS: HOFFMANN ARCHITECTS, INC.

Schools often require roofing products that are free of volatile organic compounds (VOCs) to protect indoor air quality for students, teachers, and other building occupants. The same caution applies to hospitals.

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 (IgCC), have tightened requirements on environmentally harmful chemicals. 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 the demands of local building codes.

Caution: 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.

Caution: Historic preservation and landmark requirements can vary widely from one municipality or commission to another. Replacement of historical materials with contemporary products may not always gain regulatory approval.

ENGAGING A QUALIFIED CONTRACTOR

Even a system that seems ideally suited to a particular application may not be a viable option if there is no qualified roofing contractor or general contractor in the area 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—problems may 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. One all too common practice is to pile heavy materials in one area of the roof, thereby risking structural damage or even roof collapse. That's why a field representative, generally the architect or engineer, should be on hand to oversee installation. Too often, "experienced" construction teams adopt practices they've used in the past in lieu of following the design specifications, even when their methods are inappropriate for the situation or, in some cases, patently unsafe.

GETTING DESIGN DETAILS RIGHT

Design professionals may enhance manufacturers' design details to customize the roof assembly to accommodate situation-specific conditions. Unfortunately, contractors often ignore such deviations from standard specifications and install the roof as per their usual methods. The danger in this approach lies in its inability to account for site conditions that demand special consideration, such as unusual configurations of penetrations or strong wind uplift. The field system, building owners may want to talk to their architects about ballasted assemblies as yet another option 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.

WHAT'S SO COOL about ballasted roofs?

Plenty. According to a 2008 study by Oak Ridge National Laboratory, Carlyle SynTec, and the Single Ply Roofing Industry (SPRI), a ballasted system can reduce peak membrane temperatures and mitigate heat transfer into the building just as well as can a white reflective membrane. (See "Evaluating the Energy Performance of Ballasted Roof Systems," ORNL Report Number UF-04-396, at: http://www.spri.org/pdf/Thermal%20Performance%20of%20Ballast%20Study%20Final%20Report%2005%2008%20.pdf.)

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 lb/sf of 1½-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

PHOTO: HOFFMANN ARCHITECTS, INC.

A ballasted roof can serve as a heat sink, lowering the peak temperatures of the roof membrane, according to a study by Oak Ridge National Laboratory, CarlyleSynTec, and the Single Ply Roofing Industry.

PHOTO: HOFFMANN ARCHITECTS, INC.

The roofing contractor for this project piled materials and equipment in one spot on the roof, a practice that could potentially overload and damage the roof structure.

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 where the design is inconsistent with observed site conditions, the contractor should 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 the longer warranty period.

To upgrade from a membrane-only warranty to a full system warranty, 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.

MAKING THE TOUGH DECISION ON REROOFING

Of all the major building envelope elements, the roof usually has the shortest expected service life. On the advice of design and construction professionals, 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 off such a job as long as possible.

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. +

Deborah J. Costantini is Project Architect with Hoffmann Architects, leading project teams in diagnosing and resolving roofing distress and developing roof maintenance protocols. Michael S. Pereira, Project Coordinator with Hoffmann Architects, provides design documents and specifications for a wide range of roofing systems.

PHOTOS: HOFFMANN ARCHITECTS, INC.

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.

> EDITOR'S NOTE

This completes the reading for this course.
To earn **1.0 AIA/CES learning units**, study the article carefully and take the exam posted at **www.BDCnetwork.com/ReroofingPrimer.**