



# ROOF REPLACEMENT DESIGN FOR TODAY'S ROOF: *ART MEETS SCIENCE*

BY MICHAEL HENSEN, RRC, PENG

**A**s many building restoration consultants and contractors will attest, roof replacement designs and construction have evolved substantially in the last 20 years. No longer can contractors or roof designers rely on habitually selecting favorite roof solutions, no longer can one roof system or assembly be considered suitable for all buildings, and no longer is there one material manufacturer that can supply all the solutions. Roof designs now have increased demands brought on by building owners to provide roofs that offer complete solutions and not just a waterproof protection.

Up to the mid-1970s, roof construction was typically a very predictable practice. Roofing crews would leave their place of business for projects where the only installation instruction required was how many squares of built-up roofing were expected to be completed that day. There was no question as to what type of roof system was to be installed, no concern about how much or what type of insulation was required, and no thought of how to ensure continuity of air barrier, vapor retarder tie-ins, adhesive rates, mechanical fastening patterns, shop drawings, and so on.

The practice worked well, with roofers installing watertight solutions that would typically provide long-lasting, effective results. Roofing technicians/mechanics were craftsmen, often trained through apprentice-type programs. They were successful in their trade in large part due to the predictable and repetitive nature of working

with built-up roof assemblies that had few variables and whose sole objective was to keep precipitation out. There was very little thought of using roofing materials for anything but waterproofing.

Modern roofing construction practices have altered substantially since that time. The current emphasis is on providing better thermal separation between the interior and exterior climates in an attempt to improve interior comfort and reduce energy costs. No longer are we putting umbrella-type covers over our buildings. We are now installing impermeable solutions and eliminating thermal, moisture, and air flow.

Early attempts with revolutionary materials, including new membranes and insulations designed to provide improved roof performance, had mixed results. As an industry, roofers and designers alike experienced roof system failures—often due to a lack of understanding of how to detail and install the roof with the new products and from uncertainty over how to incorporate building science principles on roofing installations.

The early versions of insulated roof systems brought other issues to the front, including vapor drive and thermal bridging. This resulted in uncontrolled deterioration and premature failures of roofs. The moisture-related deterioration included reduction in thermal resistance values, mystery leaks, emulsifying adhesives, corrosion of metals, and mold issues.

Membrane technology also changed, with new membrane types being developed to improve performance and (hopefully)

provide reliability in an insulated roof system. Roof membrane system types included single- and multi-ply assemblies that were incorporated in either built-up (membrane over insulation) or inverted (membrane under insulation) formats. The unfortunate part of the new membrane and insulation trend was that many in our industry were not completely certain how to install and detail the new roof assemblies. Roofing contractors sometimes relied on workers with traditional built-up roof training, habits, and equipment to install new single- or multi-ply systems without sufficient training. As time progressed, most membrane manufacturers worked in conjunction with contractors to determine best-practice methodology and attain a reasonable confidence in providing long-term solutions.

There is no denying that historically, owners' roof replacement decisions have been swayed by persuasive salespeople offering extraordinary solutions and services, the attempt to economize by selecting the least expensive proposal, or even by chasing a warranty. The bottom line is that not all sales pitches guarantee success, the best price does not ensure an optimum solution, and a warranty has never improved the performance of a roof assembly. A well-designed and installed roof system deserves a warranty issued by the contractor and membrane manufacturer as a gesture of quality, but a warranty won't guarantee the system is a suitable solution to waterproofing and energy management, nor can it guarantee that the roof meets building code requirements.



*When it comes to roof, wall, and parapet detail, how does one transition and detail the vapor retarder, air barrier, insulation, and waterproofing? Expectations of roof solutions = zero air and energy loss with zero moisture infiltration.*

Modern design thoughts are evolving to concentrate more on the difficulty of installing roofs (the art) to meet with our raised

expectations of building performance (the science)—all, of course, within building code requirements. The practicality of installing membrane and insulation continuity can sometimes resemble a game of Twister™, requiring coordination between the roofing contractor and other trades, including mechanical, electrical, plumbing, fenestration, cladding, and insulation contractors. Roofing contractors are often hired as general contractors, subcontracting other trades within a roof replacement project contract as the only way to successfully complete roofing details.

Prior to designing a roof replacement, it is important to understand how the existing building has been constructed. The type of structure and roof deck, existing mechanical and plumbing systems, parapet

and adjacent wall construction, rooftop equipment, and more must all be considered. There is no use designing a roof that is not compatible with existing materials or building detailing, as the connections could fail, allowing for air and moisture infiltration (leaks and energy loss). Removing wall parapet claddings to ensure continuous barrier membrane and insulation transitions, lifting mechanical units to complete curb detailing, and ensuring sufficient drainage capacity and strategy must all be detailed and installed with purpose to ensure roof replacement success.

On a roof replacement project, relying on the roofing technician/mechanic to bridge the transition between adjacent wall and parapet detailing, building materials, and roof accessories without professional direction opens up the possibility that the technician's installation does not meet with building code and building science



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best practices. This is in no way meant to disparage modern roofing technicians' abilities, but rather to emphasize the cooperative approach that roof replacement work should take between the roofing contractor and the design professional.

In turn, the designer must be mindful of the difficulties, limitations, and obstacles of roof construction and understand that what may look good on paper may not be possible or practical to install. Weather conditions, safety, accessibility, and material limitations could all turn what looked like a good design idea into failure.

Today's roofing contractors have, for the most part, adapted to the modern ways of roofing. They send their crews to project sites armed with material safety data sheets, safety and rescue equipment and plans, shop drawings for scaffolding and hoarding, building and road closure permits, and tapered insulation drawings. Today's roofing technicians/mechanics are trained in how to install multiple types of roof membranes and how to incorporate them with insulation in a variety of roof system configurations. How they incorpo-



*Shown here is a roof replacement design incorporating green technologies, including a permanent insulation system, resurfaceable roof membrane, water retention capabilities, and rooftop landscaping. Complexities of rooftop safety and access are overcome with extensive scaffolding and walkways.*




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rate their ability to work with the specified roofing materials into the entire building envelope is where accurate contract document detailing and site review of work in progress by the design professional lead to successful roof installations.

With more municipalities requesting building permits for roof replacement work, we as designers are reminded of our obligation as professionals to implement current building code and municipal bylaw requirements in the design. Considerations for structural loading, wind uplift resistance, roof drainage, insulation values, building occupancy, etc., have always been required; however, they are often not accurately analyzed nor calculated.

In recent years, increased demands have emerged concerning how we use our roofs. Roofs are viewed by some as wasted space and prime opportunities to imple-

ment landscaping, additional building mechanical operating equipment, storm-water retention, and energy production equipment. Some of these have become requirements and are included in municipal bylaws as a measure to “green” the roofs and reduce the negative aspects of large low-slope roof spaces. How roofing design and construction are to cope with these increased demands is a new hurdle. Providing viable solutions to roofing contractors to overcome these innovations should be the objective of the roof designer.

As we look to the future of roof replacement construction practice, designers must be able to continuously identify solutions to meet the growing demands of balancing roof installation with sound building science principles. 



Michael Hensen

*Michael Hensen is an executive director of IRC Building Sciences Group and works out of the company's London, Ontario, office. His duties include manager of IRC's London office and technical leader for the company's initiatives in building envelope and waterproofing consulting engineering and forensic science services. He is a graduate of Concordia University and has completed the Building Science Certificate Program at the University of Toronto. Hensen is a member of RCI's Technical Advisory Committee and its RCI Interface Editorial Board.*

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