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Factors to Consider in Developing Conceptual Scopes of Repair for Common Low-Slope Roofing Assemblies

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Abstract

Forensic engineers are commonly asked to develop conceptual scopes of repair as part of their work. Many factors impact these recommendations, including building codes, construction feasibility, manufacturer assessment, and installation requirements. In addition, the conditions present on and within the existing roof surfaces can limit the repairability of a commercial roof assembly such that removal and replacement of the entire roof section is the appropriate or only feasible repair option. This paper will focus on common limitations to be considered when developing a conceptual scope of repair for common commercial roof systems, including single-ply membranes, built-up roofing, metal panel roofing, spray polyurethane foam roofing, and the application/maintenance of roof coatings. It will also discuss an assessment methodology that can assist in developing a broader understanding of the condition of the roof surfaces.

Keywords

Forensic engineering, roofs, roofing, repairability, commercial roofing, conceptual scope of repair, repairs, roof sections, built-up roofing, modified-bitumen built-up roofing, ethics, feasible, feasibility, life safety, low slope, single-ply

Introduction

Forensic engineers are commonly engaged to determine the cause and extent of damage to various roofing systems, and then asked to develop conceptual scopes of repair for identified damage. Developing a conceptual scope of repair requires significant knowledge about and experience with the construction of roof assemblies and how any proposed repair would interact with other building components and perform over an extended period. These determinations require careful consideration and the ability to properly assess not only the entire roofing system, but also its geographic location, exposure to chemicals or oils, and other factors that dictate the types of roof assemblies used. Many proposed conceptual scopes of repair do not fully consider the existing conditions that would limit or prohibit the completion of repairs. This understanding is imperative for developing effective repair recommendations because minute details can impact the entire layout and structure of the roofing system.

This paper offers observations and recommendations commonly associated with low-slope roof assemblies, including built-up roofing, modified-bitumen cap sheets, various types of single-ply roof membranes, and others. These roofing systems collectively are referred to as "commercial roofing." The discussion of materials compatibility and manufacturer or industry practices related to repairs would also apply to metal panel roofing assemblies, asphalt-composition shingles, and others.

Finally, damage can occur to roof surfaces from numerous causes. It is not the intent of this paper to discuss the assessment of the specific causes of damage or the establishment of the extent of the damage but rather to focus on determining what factors can limit the overall repairability of a roof assembly upon which damage was identified.

Conceptual Scopes of Repair Objective

Conceptual scopes of repair for roof assemblies are commonly developed to provide broad guidance for the work necessary to repair or replace the assembly. This guidance must comply with applicable building codes, industry and manufacturer's standards or recommendations, and (as necessary) to protect the health, welfare, and safety of the general public. They are typically used to assist with the development of cost estimates and are not intended to represent complete construction

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documents. Since conceptual scopes of repair are not final, signed, and sealed construction documents, they should not be used by contractors or owners to obtain a building permit or complete necessary repairs.

Code References and Definitions

The 2018 edition of the "International Building Code" (2018 IBC) and the 2018 edition of the "International Existing Building Code" (2018 IEBC) are referenced herein. A review of the specific language of the applicable building code for a specific building is recommended, as the specific references indicated may not apply to all buildings.

A. General Code Provisions

When considering repair options, it is necessary to consider general code provisions.

2018 IBC Section 101.2: General: Scope states:

> *"The provisions of this code shall apply to the construction, alteration, relocation, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures."*[1]

2018 IBC Section 114.1: Unlawful Acts states:

> *"It shall be unlawful for any person, firm or corporation to erect, construct, alter, extend, repair, move, remove, demolish or occupy any building, structure or equipment regulated by this code, or cause same to be done, in conflict with or in violation of any of the provisions of this code."*[2]

2018 IBC Section 1503.1: Weather Protection: General states:

> *"Roof decks shall be covered with approved roof coverings secured to the building or structure in accordance with the provisions of this chapter. Roof coverings shall be designed in accordance with this code, and installed in accordance with this code and the manufacturer's approved instructions."*[3]

B. Health, Welfare, and Safety of the Public

As discussed previously, when developing a conceptual scope of repair, it is essential to keep the health, welfare, and safety of the public at the forefront when considering repair options. Not only is this in keeping with the morally accepted duties and obligations of being an engineer, but it is also codified in engineering canons.

The 2018 IBC Section 101.3: General: Intent states:

> *"The purpose of this code is to establish the minimum requirements to provide a reasonable level of safety, public health, and general welfare through structural strength, means of egress facilities, stability, sanitation, adequate light and ventilation, energy conservation, and safety to life and property from fire, explosion, and other hazards, and to provide a reasonable level of safety to fire fighters and emergency responders during emergency operations."*[4]

2018 IEBC, Section 101.3: General: Intent states:

> *"The intent of this code is to provide flexibility to permit the use of alternative approaches to achieve compliance with the minimum requirements to safeguard the public health, safety, and welfare insofar as they are affected by the repair, alteration, change of occupancy, and relocation of existing buildings."*[5]

The National Society of Professional Engineers (NSPE) Code of Ethics for Engineers Section I Fundamental Canons states (in part):

> *"Engineers, in the fulfillment of their professional duties, shall: 1. Hold paramount the safety, health, and welfare of the public…"*[6]

While obviously inherent to all engineering practices, it bears repeating and emphasis: Inadequate repairs can lead to health and safety issues associated with failure, microbial growth, water incursion, hazardous or toxic exposures, and the like. The recommendations resulting from a conceptual scope of repair — like all other aspects of engineering — require deliberate care and consideration to ensure safe spaces for human occupancy.

C. Roofing Cover and Assembly

It is common for the top weathering surface of a building to be referred to as the "roof." As defined in the 2018 IBC, the visible roof covering is but one component of the broader roof assembly.

1) Roof covering as:

IBC 2018 defines "Roof Covering"

"The covering applied to the roof deck for weather resistance, fire classification, or appearance."[7]

2) Roof assembly

IBC 2018 defines "Roof Assembly" as:

"A system designed to provide weather protection and resistance to design loads. The system consists of a roof covering and roof deck or a single component serving as both the roof covering and roof deck. A roof assembly can include an underlayment, a thermal barrier, insulation, or a vapor retarder."[8]

Similarly, the National Roofing Contractors Association (NRCA) has a definition for a roof assembly that resembles that of the IBC:

"An assembly of interacting roof components including the roof deck, air or vapor retarder (if present), insulation and membrane or primary roof covering designed to weatherproof a structure."[9]

When evaluating roofing damage and developing a conceptual scope of repair, the full construction of the roof assembly should be considered — not just the condition of the roof covering.

D. Roof Repair and Replacement

The terms "roof repair" and "roof replacement" are frequently used interchangeably when discussing or evaluating repair methods. However, it is important to keep the distinction clear as the scale of work associated with each definition is vastly different. The following definitions emphasize the differences between the two.

1) Roof repair

IBC 2018 defines a "roof repair" as:

"Reconstruction or renewal of any part of an existing roof for the purpose of its maintenance."[10]

2018 IEBC defines a "roof repair" as:

"Reconstruction or renewal of any part of an existing roof for the purposes of correcting damage or restoring the predamaged condition."[11]

2) Roof replacement

Both IBC 2018 and IEBC 2018 share the same definition for the term "roof replacement":

"The process of removing the existing roof covering, repairing any damaged substrate, and installing a new roof covering."[12,13]

It is important to note that neither the IBC nor the IEBC includes a definition for the term "damage"; however, distinguishing when damage is a result of an unexpected action versus when it is the result of natural aging or environmental conditions may be requested. The presence of natural and ongoing weathering is often a factor that can limit the overall repairability of a roofing assembly.

E. Roof Section

When developing a conceptual scope of repair, it can be beneficial to demarcate the roof area by mapping it into discrete roofing sections. While there is no specific definition of a "roof section" included within the 2018 IBC, 2018 IEBC, or from the NRCA, the 2020 edition of the Florida Building Code defines a roof section as:

"A separating or division of a roof area by existing expansion joints, parapet walls, flashing (excluding valley), difference of elevation (excluding hips and ridges), roof type or legal description, not including the roof area required for a proper tie-off with an existing roof system."[14]

If the damage can be contained to individual roof sections, developing a conceptual scope of repair for unaffected portions may not be necessary. In some cases, however, this may not always be possible. Smaller buildings may not have physical characteristics that allow for the division or designation of individual roof sections.

Primary Repairability Limitations

The following discussions include common issues that are encountered with commercial roof assemblies. The conditions addressed are not intended to represent every possible issue or situation that may be present. In addition, multiple conditions may exist. In some situations, these conditions may occur simultaneously. As such, the forensic engineer should seek any additional information regarding the site-specific conditions that may affect or

limit the overall repairability of the roof.

A. Roof Assembly Configuration/Construction

When damage is identified to a commercial roofing system and a forensic engineer is requested to develop a conceptual scope of repair, it may be necessary for the engineer to open the roof section to identify the layers and overall construction of the roof assembly. This process is commonly referred to as "coring."

Coring a roof typically consists of drilling a small (2-inch) cylindrical core through the roof assembly to the roof deck or opening a rectangular section to view larger portions of the roof assembly. The roof core can provide an understanding of the type and number of layers present within the roof assembly, the presence of moisture as well as the condition of roof assembly components. Roof core material composition, dimensions, condition, and the presence of moisture should be documented.

When examining the core or section of a roof assembly, it is important to consider any code constraints. For example:

IBC 2018 Section 1511.3.1.1: Reroofing: Exceptions states (in part):

> *"A roof recover shall not be permitted where any of the following conditions occur:*
>
> *3. Where the existing roof has two or more applications of any type of roof covering."*[15]

In these cases, a roof replacement would need to be advised, and, in accordance with the IBC, the replacement would require the full removal of all existing layers.

IBC 2018 Section 1511.3: Reroofing: Roof replacement states (in part):

> *"Roof replacement shall include the removal of all existing layers of roof covering down to the deck."*[16]

Therefore, the presence of two or more roof coverings on an existing roof system represents a repairability limitation.

While the building code would prohibit the recommendation of a third layer of roof covering in these situations, some jurisdictions have adopted local amendments to the building code and permit the construction of a third layer. However, in these situations, a professional engineer must verify the building framing to ensure it can continue to carry the necessary loads. In circumstances where it is permissible to construct a third roof, not only is it recommended to consider the overall structural capacity of the roof framing, but it is also important to consider and assess the interaction of the new roof relative to existing roof drains and other appurtenances.

B. Moisture within the Roof Assembly:

Moisture within the roofing assembly is another common issue that should be assessed. The presence of moisture is a multifaceted concern. Not only does water present issues resulting in the degradation of roof assembly materials, but it can also impact the underlying structure. In addition, entrapped water can increase the weight of the roof assembly. Finally, there are issues associated with bacterial or fungal growth, thereby potentially compromising the air quality within the building.

All of these issues can have a cascading effect over the life of the system, potentially resulting in further water intrusions or failure of the roofing assembly.

IBC 2018 Section 1511.3.1.1: Reroofing: Exceptions states (in part):

> *"A roof recover shall not be permitted where any of the following conditions occur: ...*
>
> *1. Where the existing roof is water soaked or has deteriorated to the point that the existing roof or roof covering is not adequate as a base for additional roofing."*[17]

The 2018 IBC and previous editions do not provide a specific definition for "water soaked." Nevertheless, the analysis of the existing roof system should attempt to identify areas where free water may be present or where the localized moisture contents exceed representative "dry" baselines for the subject roof. Determining the presence of moisture within the roof assembly may include non-destructive assessment methods, including electrical impedance moisture meters or infrared evaluations. However, it is also recommended that direct readings be taken through surface or pin moisture meters from core sampling when possible and in accordance with the manufacturer's instructions. Additional considerations related to obtaining moisture readings are discussed in ASTM International standard D7954, "Standard Practice for Moisture

Surveying of Roofing and Waterproofing Systems Using Non-Destructive Electrical Impedance Scanners."

It is important to note that the building code limitations, as referenced in IBC Section 1511.3.1.1, do not address the causes or potential sources of moisture within the roof assembly. Consequently, the presence of moisture from any cause within a given roof assembly represents a repairability limitation that must be considered.

C. Surface Drainage

Failures related to ineffective surface drainage to modified roof assemblies have been observed. Section 705.1 of the IEBC regarding reroofing states that the re-covering or replacing of an existing roof covering shall comply with the requirements of Chapter 15 of the IBC with the following exception:

> *"Roof replacement or roof recover of existing low-slope roof coverings shall not be required to meet the minimum design slope of one-quarter unit vertical in 12 unit horizontal (2 percent slope) in Section 1507 of the International Building Code for roofs that provide positive roof drainage…"*[18]

This code provision does not indicate that roof drainage during repairs or reconstruction of commercial roofing can be ignored. While the term "positive roof drainage" is not defined in the 2018 IEBC, it is in the definitions section of the IBC.

> *"The drainage condition in which consideration has been made for all loading deflections of the roof deck, and additional slope has been provided to ensure surface drainage of the roof within 48 hours of precipitation."*[19]

Thus, applying the exception from IEBC's Section 705.1 should be viewed relative to IBC's definition of "positive roof drainage." While the IEBC provides flexibility in completing building repairs and alterations, it also emphasizes the need to safeguard public health, safety, and welfare. IEBC Sections 101.3 and 701.2, respectively, underscore these points:

> *"The intent of this code is to provide flexibility to permit the use of alternative approaches to achieve compliance with minimum requirements to safeguard the public health, safety, and welfare insofar as they are affected by the repair, alteration, change of occupancy, addition, and relocation of existing buildings."*[20]

> *"An existing building or portion thereof shall not be altered such that the building becomes less safe than its existing condition."*[21]

To safeguard public health, safety, and welfare, forensic engineers should consider if drainage issues are present in the given roof assemblies and ensure that the conceptual scope of repair resolves such issues. This includes the prolonged presence of water following rain events, the resulting degradation of the roof surface in areas of accumulated water, and issues related to inadequate or ineffective drainage at inlets, scuppers, and roof perimeters.

The paper "Foreseeable Failure: Roof Collapses and Roof Drainage Deficiencies" by Stewart M. Verhulst, P.E., and Travis G. Ebisch, P.E., presents case studies where modifications to buildings resulted in drainage failures, which ultimately contributed to the partial collapse of roof framing and assemblies. In the final part of their paper, Verhulst and Ebisch concluded:

> *"The authors have worked on numerous other collapses caused or contributed to by inadequate roof drainage. Based on these experiences and on conditions that we have observed throughout the built environment, it is clear that roof drainage and the water loads on roof framing resulting from deficient drainage are not properly considered in the design, construction, maintenance, and repair of buildings…"*

> *"Based on the prevalence of dangerous drainage deficiencies and the repeated occurrences of resultant roof collapses, it is the authors' opinion that roof drainage should be treated as a critical life safety issue."*[22]

D. Material Availability or Obsolescence

Decades may pass between the construction of a building and its ultimate demise. However, removing and replacing roof sections for these decades-old buildings is common. In fact, manufacturers often make such changes every few years, including the types of materials produced, the manufacturing processes, and the dimensions in which materials are manufactured. This is especially common with metal roofing panels and decking but has also been noted in other building products. These changes can affect the chemistry of the materials, the colors available, shapes, etc.

When developing a conceptual scope of repair, it is

necessary to confirm if the existing roof's materials are still manufactured or compatible with the current inventory. The lack of material compatibility, such as that occurring from the change in the shape of metal roof panels, may represent a repairability limitation that would need to be considered and resolved as part of the development of a conceptual scope of repair.

E. General Condition of the Roof Assembly

Ongoing degradation is inherent to roofing assemblies; therefore, it is necessary to consider the general condition of the roof assembly and its ability to sustain a durable repair.

General surface degradation of built-up roof systems, including blistering or surface flaking and wearing of the exposed asphalts, is of concern as these conditions allow moisture to enter the roof assembly. Therefore, when surface flaking, wear, or degradation of the seams is noted on the surface of a built-up roof, these conditions represent a repairability limitation.

The side and end laps for commercial roofing systems are susceptible to wear from long-term exposure to the elements and issues potentially related to the original construction. When separations in the form of seam welds or adhesion failures are apparent, this can allow for accelerated degradation of the roofing assembly. Such conditions reduce the ability to conduct a localized repair successfully due to the inability to tie into the system. Furthermore, when a roofing assembly has a history of previous repairs or age-related deterioration, the general condition of the roof assembly may be a repairability limitation.

The condition of roof appurtenances, including wall and cap flashing, HVAC or plumbing boots, and other roofing components, will also degrade over time. Therefore, it is necessary to consider the condition of the roof appurtenances and their tie-ins to the roof assembly as part of determining the overall repairability of the roof assembly.

Finally, the safety of accessing the roof to complete the necessary repairs should also be considered. For example, in cases where metal roof decking is corroded with section loss or water-logged poured gypsum roof decking is present, accessing the roof surfaces to complete repairs may place roof repair personnel at risk of injury or death. As such, it is necessary to consider whether or not the existing roof assemblies have conditions present that would represent a safety risk to those accessing the roof.

F. Construction Defects

Construction defects relative to this section are those defects or deviations from manufacturer requirements that can contribute to water or air intrusions into the roof assembly. Such defects can reduce the capacity of the roof assembly to resist wind and other design loads, and can accelerate weathering of the roof covering.

These types of defects can be present in numerous ways, including incomplete seam bonds/welds, wrinkling of the roof membrane during construction, and many others. However, when such construction defects are present, the consequences of these defects should be assessed to determine if they will contribute to (or result in) the failure of an intended repair. Construction defects contributing to the roofing assembly's failure or subsequent repairs should be resolved before or as part of the conceptual scope of repair.

G. Material Defects

Material defects for commercial roofing will vary depending on the type of roof assembly. For example, modified-bitumen cap sheet material defects may include areas of focused granule loss in reoccurring patterns or locations or linear strips. For single-ply membranes, material defects include, but are not limited to, areas of failure of the membrane surface. The presence of material defects within roof assemblies can allow water to seep through the roof surfaces over time and contribute to accelerated degradation of the roof assembly, which can also contribute to failure of the attempted repairs.

If material defects are present within roofing assemblies, the implications of such conditions should be considered to determine if the noted defects represent a repairability limitation that should be resolved prior to developing repair recommendations.

H. Surface Contamination and Degradation

External contamination can degrade the surface conditions of roof membranes. General Aniline & Film (GAF), a commercial roofing manufacturer, discusses the chemical resistance of thermoplastic polyolefin (TPO), polyvinyl chloride (PVC), and polyvinyl chloride ketone ethylene ester (PVC KEE) membranes in the article, "Chemical Resistance: an 'Engineered' Approach."

> *"In general, roofs should be protected from exposure to chemicals that can damage the roofing system. However, GAF recognizes that leaks from*

grease traps, occasional releases of chemical mists, and other chemical attacks on the roofing system may occur. Strong acids of any type, oxidizers, and most strong bases are known to cause issues with most roofing membranes regardless of type."[23]

(Note: PVC KEE membranes are a chemically resistant PVC blend.)

GAF further addresses chemical degradation to TPO, PVC, and PVC KEE membranes from de-icing salts, dilute acids, strong acids, grease, oils, vegetable fats, animal fats, diesel and jet fuel, and solvents.

In addition, a discussion of surface contaminates appears in a 2017 NRCA article, "Chemical Considerations" (Fester, 2017), in which similar cautions and concerns are echoed:

"A roof membrane, whether it is built-up, polymer-modified bitumen or single-ply, can prematurely age when there is not chemical compatibility with its surroundings. Sources of chemicals that may be incompatible with roof membranes can be found in all sorts of places from exhausts to cleaning supplies to other roofing materials."[24]

Modified-bitumen cap sheets are also susceptible to degradation from exposure to surface contaminants. The Asphalt Roofing Manufacturers Association (ARMA) addresses this in the article "Potential Effects of Contaminants on Modified Bitumen Sheet Materials":

"Modified bitumen roof membranes may be adversely affected by exposure to cooking oils (animal or vegetable) and greases. Unprotected membrane may experience degradation around exhaust vents, where the roof membrane has repeated contact with these contaminants. The organic substances contained within oils and greases may weaken and eventually break down the polymer-bitumen network, causing premature failure of the roof."[25]

The ARMA also addresses other forms of surface contamination, including petroleum-derived products, bacteria, and fungi, and their ability to contribute to the degradation (e.g., swelling, softening, and slumping) of the bitumen compounds.

These conditions, therefore, necessitate the need to identify and consider the presence of surface contamination in a conceptional scope of repair — as they can either limit the ability to complete repairs or reduce the anticipated service life of these repairs.

Primary Repairability Limitations Checklist

The following checklist provides an itemized synopsis of the topics discussed above. It is a general guide of considerations when assessing roof assemblies and developing a conceptual scope of repair. While the concerns listed here are often applied to individual roof sections, there may be situations where they apply universally to a roof assembly, depending on its construction. As in all engineering aspects, there may be additional concerns or considerations beyond what has been addressed here, so it is incumbent upon the forensic engineer to apply due diligence when using this checklist.

The presence of any of the items listed below indicates a repairability limitation that needs to be considered and addressed when developing a conceptual scope of repair.

Primary Repairability Limitations:

- The presence of two or more layers of roof assemblies.
- Elevated moisture or free water is present throughout the roof assembly.
- Elevated moisture or free water present in isolated portions of the roof assembly.
- Indications of poor surface drainage resulting in the accumulation of water, sediments, or debris.
- Suitable and/or compatible building materials are not available to complete repairs.
- Existing roof assemblies exhibit age-related deterioration and/or degradation.
- Construction defects that detrimentally impact the condition or drainage of the roof systems.
- Indications of previous repairs to the existing roof assemblies.

- Indications of previous repairs that have subsequently failed.
- Indications of corroded, waterlogged, or otherwise compromised roof decking.
- Indications of oils, chemicals, or other surface contaminants or related degradation present on the roof surfaces.
- The presence of damage to underlying insulation or other roof assembly components.

If one or more of the factors listed are present and cannot be resolved to meet life safety, building code, and/or manufacturer requirements, then the conceptual scope of repair should include the recommendation for replacing the given roof or roof section.

Additional Repairability Considerations

A. Energy Conservation Codes

Energy conservation codes and the insulation required within roofing assemblies have changed over time. In some locations, jurisdictions will require repairs to comply with current energy conservation codes. When replacing only one area of a roof or roof section and bringing that area up to code, the resulting insulation thickness can result in uneven roof surfaces that will detrimentally affect roof drainage. When it is necessary to construct a roof repair in compliance with current energy codes that are incompatible or do not align with the surrounding roof sections, the removal and replacement of the given roof section is recommended.

B. Roof Coatings

Roof coatings are commonly proposed as an alternative to roof replacement. However, using these coatings introduces additional factors that need to be addressed before recommending the application of such a coating within a conceptual scope of repair.

The IBC does allow for the application of a protective coating over an existing roof covering:

> *"The application of a new protective coating over an existing roof coating, metal roof panel, built-up-roof, spray polyurethane foam roofing system, metal roof shingles, mineral surfaced rolled roofing, modified bitumen roofing, or thermoset and thermoplastic single-ply roofing shall be permitted without tear off of the existing roof coverings."*[26]

However, the code does not waive the specific installation requirements of respective coating manufacturers — nor does it waive the necessity of the proposed repair coating to meet appropriate fire code or other building code requirements[27]. Therefore, it is incumbent on the engineer to ensure all applicable conditions and repair criteria are met.

The primary concern when considering the use of coatings as part of a repair is bonding of the proposed coating to the existing roof coverings or any existing roof coatings. The composition of the numerous types of roof coatings will vary significantly among manufacturers and can change over time. In addition, it is important to follow manufacturer recommendations, as some coating manufacturers will limit the use of their respective products when surface corrosion, standing water, or contamination is present. Additional factors, such as the conditions of the existing roof surface and the potential for surface moisture, should also be considered. In these situations, some coatings will not perform well over an extended period when chronically exposed to standing water.

It is necessary to determine not only the type of existing coatings present on a roofing surface but also to evaluate their condition to ensure they can be safely and effectively used with the proposed repair coating. It is also recommended that any testing necessary to establish proper bonding (e.g., a pull test) be completed per the manufacturer's requirements before including a coating recommendation. Given the numerous coating variations, it is recommended that the forensic engineer discuss proposed repairs with the respective technical or manufacturing representatives.

C. Cost Considerations

While cost considerations can be a weighty influence on any repair or replacement recommendation, professional engineers are obligated to consider this aspect of their recommendation only after ensuring the proposed repairs meet life safety considerations, applicable building codes/industry standards, environmental considerations, and manufacturer's recommendations and guidance.

Conclusion

Forensic engineers are commonly requested to develop conceptual scopes of repair as part of their work. Identifying the potential damage associated with commercial roofing systems is a complex process. It is not simply a matter of specifying existing roofing materials or methods but requires careful analysis of the present conditions. Therefore,

it is important for the forensic engineer to consider the factors listed herein and other provisions specific to their given situation. Failure to wholly assess the conditions impacting the roof assembly and subsequent supporting structure can not only compromise the recommended repair, the roofing assembly, and the structure, but it can also unnecessarily place the health, welfare, and safety of the public at risk.

It is understood that conceptual scopes of repair are at times developed by individuals other than forensic engineers. The repairability limitations indicated herein should be considered by anyone considering a scope of repair or developing a conceptual scope of repair.

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