Considerations for Installation of Amenity Spaces on Existing Roofs

By Kelly Cronin, PE; Suzanne Thorpe, PE; and Emmett Horton, EIT

Having an outdoor rooftop amenities space is changing from a luxury to a requirement for most buildings. To meet this need, a popular new trend is arising in the renovation and restoration of existing buildings: converting the traditional, unoccupied roof space into an amenity space for building occupants to share and enjoy. These amenities spaces will often include numerous hardscape and landscape elements, water features, and/or movable building façade assemblies. For many building owners, the benefit of converting a traditional roof space into useable amenity space increases the overall value of the property and can attract new occupants.

While this conversion often increases value and occupancy, it comes with its own set of challenges. Typically, if the original roof design did not include accessible tenant space, the redesign of the in-service assemblies must be evaluated in a completely new context. Adapting a traditional roof space into a useable amenity space requires thoughtful design and consideration of various aspects of the conversion to ensure a successful transformation.

While every project is unique, there are several typical items to consider during the design phase that will improve the overall success of renovating a traditional roof area to a modern rooftop amenity terrace.

STRUCTURAL CONSIDERATIONS

General

A licensed structural engineer should be consulted to determine whether the existing structural framing supporting the roof can accommodate any potential additional loading requirements introduced during the design of the new amenity space. Per ASCE 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, most roofs are designed for wind, snow, and a minimum roof live load, typically 12 to 20 lb./ft.^{2} Amenity spaces, in addition to the wind and snow loads, often require a higher roof live load, typically 60 to 100 lb./ft.^{2} The addition of water features or water-retention planters will increase the loads further and could result in the need for supplemental structural retrofits. These retrofits can become invasive to tenants and cost prohibitive if the installation of supplemental roof framing or modifications to foundations are deemed necessary.

Anchorage

Components such as railings, screen walls, posts, and trellises are all popular features for rooftop amenity spaces. New or modified railings are often necessitated by the *International Building Code* (IBC) to meet safety requirements for an occupied area. All of these components must be properly anchored to structural elements to resist anticipated loading. For example, the anchorage of a large shade umbrella to the structural slab would need to be evaluated for additional wind uplift. As another example, an existing parapet wall would need to be evaluated for the additional rotational force required for the attachment of a handrail. Anchorage of these components may require penetrations through the existing roofing assembly into the structure and necessitate careful detailing to maintain a watertight roof. Further consideration of properly detailed penetrations is discussed below.

Wind

Depending on the height of the roof, the proximity to other buildings of similar or taller height, and existing parapet conditions, wind uplift should be considered when designing rooftop amenity spaces. Wind uplift will impact the hardscape and landscape materials selected for use, particularly at the edges of the roof (Zones 2 and 3 in ASCE 7) where forces are greater. Corner zones often require heavier pavers or paver strapping, greater ballast depths, or higher parapet walls to resist anticipated wind loads on hardscape elements. Any accessory items not anchored to the roof structure (for example, furniture) that are to be used on the rooftop amenity space should be selected with wind considerations in mind.

Figure 1. Core cuts or larger destructive openings into the existing roof assembly can be used to confirm components and condition of the in-service roof system as well as results of non-destructive testing. This information will help the design team and owners define necessary repair or replacement scope criteria early on in a project.

WATERPROOFING CONSIDERATIONS

Existing Roof Assembly

A critical and often overlooked component of any rooftop amenity renovation project is the roof assembly itself. It is important to know the type, age, and thickness of the roof assembly, as well as the location of insulation or any topping slab or overburden that may be a part of the in-service roof. Consideration should be given to surveying the existing roof assembly to document the condition of the roof membrane and base flashings prior to finalizing the new design. Non-destructive testing such as Electronic Leak Detection (ASTM D7877, *Standard Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes*) or Infrared Thermography (ASTM C1153, *Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging*), in combination with limited destructive openings to confirm non-destructive testing results, will help the design team and ownership determine the necessary roof assembly repair or replacement scope of work (**Figure 1**).

If testing and inspection openings confirm there are deficiencies in the existing roof membrane, these should be addressed prior to proceeding with the construction of the new amenity space, as leaks below the overburden can be very invasive and costly to repair. In addition to locating deficiencies, the information gathered through visual inspection and non-destructive testing can be used to evaluate whether the existing assembly is appropriate for the intended change in use to an occupied/accessible area, which may include more pedestrian traffic or overburden than originally anticipated.

Knowing the type and existing condition of the roof assembly will allow for an informed decision on repair strategy and provide insight on the anticipated performance of the existing assembly within the new design. Review of the in-service roof will help guide the decision of whether a full roof replacement is warranted or whether isolated, discreet repairs are sufficient. The age and exposure of the existing roofing assembly should be considered when contemplating a full roof replacement prior to installation of a rooftop amenity space.

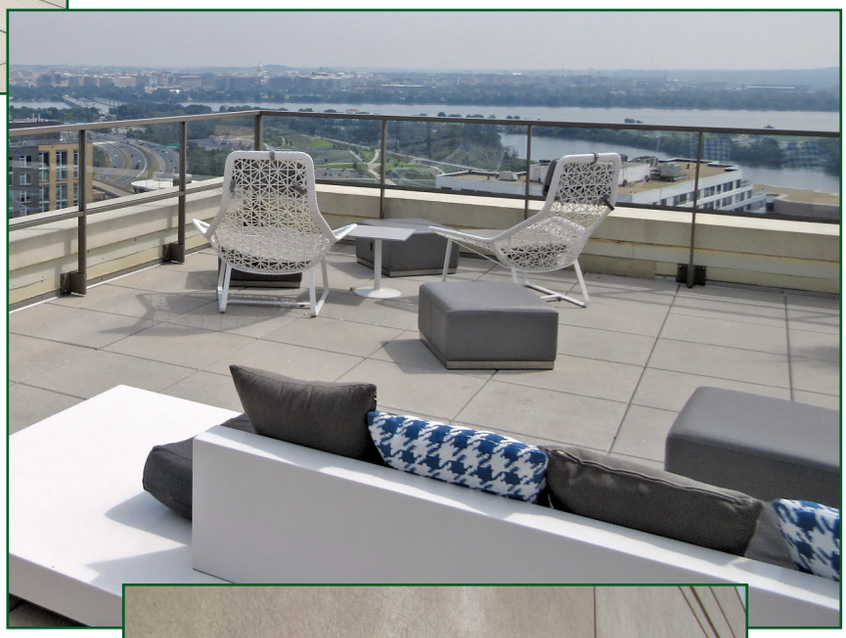
Drains and Drainage

The existing roof should be surveyed to determine if there are any areas of ponding or insufficient drainage (**Figure 2**). In addition to the increase in structural loading that results from ponding water, depending on the roof system (that is, whether it is a low-slope, single-ply membrane such as modified bitumen, TPO, PVC, EPDM, or KEE), ponding water can void the manufacturer's warranty. Ponding water can magnify ultraviolet rays which may accelerate deterioration of the roof system; it can

Figure 2. The functionality of roof drains and overflow drains should be reviewed during the design phase to ensure adequate drainage and limit ponding.

Figure 3. Existing mechanical equipment must often be relocated to make room for new amenities at existing rooftop spaces. Screen walls and planters can be used to hide or restrict access to mechanical areas. Fireplaces and other utilities will require new penetrations through the roof assembly.

Figure 4. Consideration should be given to existing parapet heights and code requirements for guardrails. Existing parapets or guardrails may require modification to meet code requirements.



also collect debris and contaminants, promote algae growth, create areas of ice, and potentially support mosquito breeding.

Moreover, the functionality of all primary roof drains and overflow drains, as well as slope to drain in proposed amenity spaces, should be reviewed and confirmed during the design phase. All roof overburden—inclusive of new support structures and curbs for decks, railings, and the like—should be designed to not impede or otherwise block drainage. Applicable code provisions regarding primary and overflow drainage requirements should be reviewed during the design phase.

Drain assemblies should be regularly cleaned and remain readily accessible during their service life to reduce the potential for ponding water. Indicating the location of drains at the surface of new overburden (with a mark on pavers, an inspection chamber in planters, and the like) is helpful to building engineering staff who must locate and maintain roof drains. Depending on the existing roofing assembly and proposed overburden, consideration should be given to the use of a two-stage drain assembly, with appropriate grates, screens, or strainers, to facilitate drainage at the levels of the existing roofing membrane and new overburden as well as to reduce blockage by debris.

Another important drainage consideration that is often left to field coordination is the elevation of door thresholds with respect to scuppers and overflow drains. It is critical that overflow drainage elevations are set below the level of all thresholds to prevent water that backs up on the roof from undermining doors before evacuating the roof. To that end, it is critical that slope to drain, drain strainers, scuppers, and overflow drains remain unobstructed by new hardscape and landscape elements to promote roof drainage.

Expansion Joints

Depending on the structure, an existing expansion joint assembly may need to be integrated into the design of the new amenity space. Expansion joints are engineered assemblies that accommodate building movements generated by forces due to thermal cycling, wind, seismic events, or live-load deflections. The design team should consider the potential for surface-level movement of overburden elements located above the expansion joint to avoid such things as heaving of pavers or cracking of topping slabs. Prior to covering an existing expansion joint, similar to the existing roof membrane, the joint should be

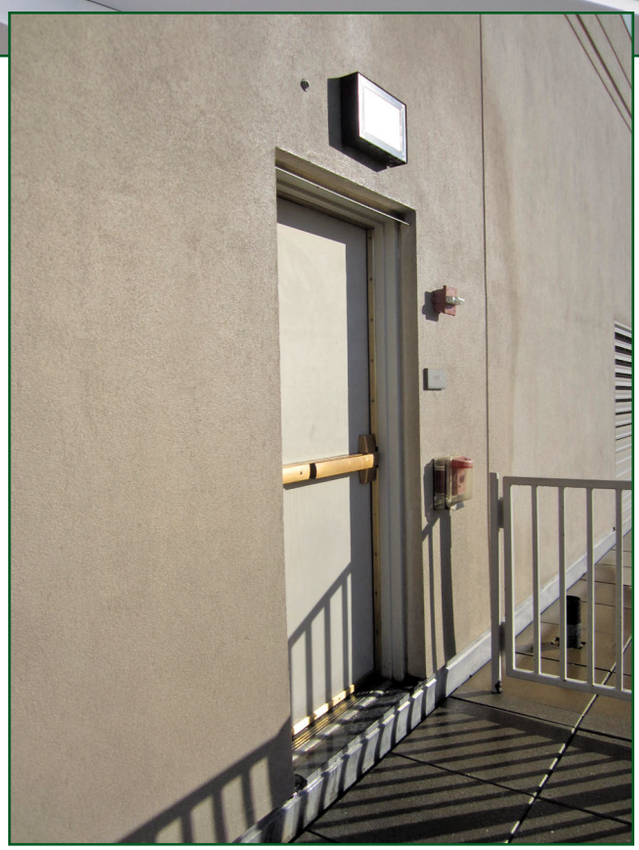


Figure 5. Inswing doors are often required at rooftop amenity spaces to meet code requirements for emergency egress. Inswing doors can pose challenges for maintaining the integrity of the building enclosure.

surveyed to ensure it is watertight; if the existing roof assembly is replaced, any expansion joints integrated into the roof should also be replaced. The expansion joint should be protected from damage both during construction of the amenity space and once completed and exposed to pedestrian traffic.

Penetrations and MEP Equipment

Roofs commonly include vents, fans, HVAC equipment, solar panels, and other mechanical equipment. Consideration should be given to designing around or relocating this equipment as part of the amenity space design phase (**Figure 3**). Screen walls, landscape elements, or security gates may be used to limit access to rooftop equipment or other areas where pedestrian access should be limited. Additionally, many designers will include new features such as gas grills, firepits, or water elements that will require the installation of new utility lines through the existing roof assembly.

Review of the existing roof membrane and any applicable warranty requirements should be considered to ensure that installation of the penetrations and new flashing membranes are performed by a certified installer to avoid water leakage and voiding of existing warranties.

SAFETY CONSIDERATIONS

Railings and Screen Walls

To maintain occupant safety and protect against fall hazards, rooftop amenity spaces may require the addition of railings at their perimeter; full-height glass screen walls may be warranted in areas with high winds to provide comfort to rooftop occupants. While some roofs have existing parapets that meet railing height requirements, other roofs only have low perimeter curbs and will require new railings to meet minimum code requirements (**Figure 4**).

The height of the existing parapet may meet the height requirements for guardrails (42 in. per IBC Chapter 10, Section 1015.3), but if pavers and pedestals are added to the roof, the parapet height may need to increase, or a handrail may need to be mounted to the top of the existing parapet to meet code requirements. The height of the railing should be measured from the top surface of the finished flooring. Building height restrictions and setback requirements should be considered in the location of new railings or screen walls.

Access and Egress

It is not uncommon for traditional roofs to be accessed via a service stairwell or freight elevator. There are also many existing roofs that are not readily accessible, perhaps limiting access to an operable window. Most new amenity spaces must be Americans with Disabilities Act (ADA) compliant, which may require reconfiguring of elevator lobbies or the installation of a ramp. In addition, per IBC Chapter 10, Section 1010.1.2.1, rooftop amenity spaces will require exit doors in the direction of egress travel, resulting in the need for inswing doors at these locations. This often proves challenging in maintaining the integrity of the building enclosure (**Figure 5**). Depending on anticipated occupant load of the roof, multiple means of egress may be required by code.

New access doors should be properly detailed into the existing building enclosure to promote a water-resistant design. Inswing doors are prone to water leakage as the positive pressure from wind gusts during storms reduces the compression of their perimeter gasketing allowing excess water around the operable door panel. Consideration should be given to including diverters at the head of doors, sweeper gaskets face-mounted to the bottom of the doors, robust perimeter gaskets/weather-stripping, and fully sealed door thresholds as strategies for improving the performance of inswing doors.

Figure 6. Pavers come in all shapes, sizes, and materials, and they are a common choice for use as walking surfaces at rooftop amenity spaces.

Additionally, limiting the use of hollow metal doors and using more robust terrace doors that have a water-resistance rating per the American Architectural Manufacturers Association can improve the overall performance with respect to water leakage.

AESTHETIC CONSIDERATIONS

Specialty Doors

There are several specialty doors on the market that allow for large portions of the building wall to be opened to the exterior rooftop amenity space (such as garage-style overhead doors or folding glass walls). Much like in-swing doors for egress, if not carefully detailed, these are often susceptible to water and air leakage. Consideration should be given to installation of a trench drain, either immediately outboard of these assemblies to reduce water sheeting over the walking surface from accessing the flat thresholds, or inboard of these door systems to manage water that may bypass the minimal weather-stripping that often accompanies this style of movable façade. Additionally, the use of moisture-tolerant flooring can prevent water damage to interior finishes when water leakage occurs.

Planters

Planters are popular features for rooftop amenity spaces. Planters can be built in and integrated with the roofing assembly, or independent and placed on the surface of the roof. As noted previously, consideration should be given to the additional loading of the planters and evaluated by a licensed structural engineer.

The location of integral planters, as well as the drainage within and around the planters should be considered to ensure the planters do not block scuppers or prevent drain

Figure 7. New interior conditioned spaces must be properly integrated into the existing primary building enclosure.

Figure 8. Interface details at new fenestration or exterior elements should be considered to maintain a continuous air, water, and thermal plane with the addition of the new features.

maintenance. The types of plantings intended for use, along with any required liners/root barriers, should also be considered and incorporated into the design to avoid damage to the roof assembly from invasive root systems. Consideration should also be given to the amount of work required to remove the planter to facilitate roof replacement or repairs when needed.

Turf

Artificial turf has become more advanced and more natural in its overall appearance. As such, designers are incorporating it more frequently into their designs of rooftop amenities.

Many artificial turf manufacturers have requirements specific to their products. Generally, items to consider when designing and installing an artificial turf assembly include but are not limited to attachment of the turf to the roof, and drainage beneath the turf. Improper attachment can result in wrinkling of the turf assembly or inhibit drainage of large areas of the roof.

Drainage is a particularly important consideration if the turf assembly is intended for use as a pet relief area. If proprietary pet relief roofing systems are not included in the design, consideration should be given to the development of an appropriate care and maintenance plan that may include frequent inspections to review the condition of the roofing/waterproofing membranes as well as adjacent elements such as railing posts and thresholds. part of the plan may require regular rinsing with water to maintain a sanitary space and reduce odors. The roofing manufacturer should also be consulted about effects of pet waste on the roofing assembly and existing warranties.

Pavers

Pavers come in all shapes, sizes, and materials, such as standard concrete pavers, porcelain tiles, stone, and wood. Given the seemingly unlimited options, they are certainly the most common walking surface for rooftop amenity spaces (**Figure 6**).

Pavers are typically positioned above the roof assembly on shims or pedestals of varying heights. It is not recommended that the roofing assembly be directly walked upon, or that pavers be positioned on top of the roof assembly without a protection layer, as this will increase the risk for puncture and other damage.

Finishes and Amenity Structures

Rooftop amenity spaces often include new interior conditioned spaces such as vestibules, lobbies, or shared common space for tenants (**Figures 7** and **8**). Exterior elements, such as permanent canopies or sunshades and trellises or pergolas, can all enhance the outdoor space at the roof. These features all require integration with the existing primary building enclosure, whether that is the roofing membrane or the air and moisture barrier of an existing penthouse structure. Interface details should be considered to maintain a continuous air, water, and thermal plane with the addition of the new features.

SUMMARY

As can be seen in the list of items in this article, there is a lot to consider prior to starting any rooftop-amenity design project. The first step should be to complete a thorough evaluation and condition assessment of the existing roof assembly, inclusive of non-destructive testing and

inspection openings to limit unforeseen conditions and design changes during construction.

Detailed drawings should be produced by a design professional, in the context of the owner's performance requirements and overall project limitations. Engage design consultants to assist with project-specific requirements addressing structural modifications, waterproofing challenges, safety, and design of specialty assemblies.

REFERENCES

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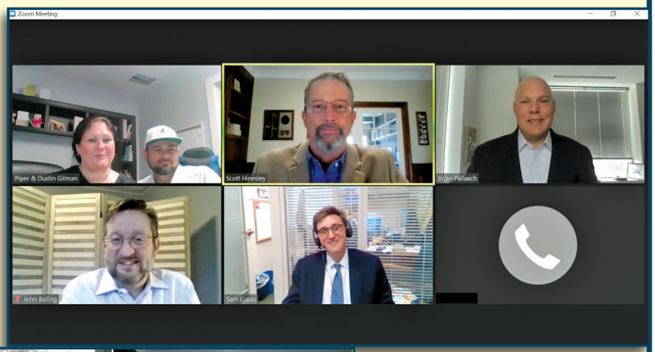
IIBEC Participates in Roofing Day 2021

For the past few years, the National Roofing Contractors Association (NRCA) has organized an annual Roofing Day in DC, and IIBEC has supported and participated in these efforts. Like many events since the pandemic began, this year's event was virtual, and took place on March 23 and 24. Over 300 participants met with their senators and representatives and staff (via Zoom) to discuss federal policies and how they impact roofers. Topics included:

- Increased funding for career and technical education to address workforce shortages;
- A strong buildings component in federal infrastructure legislation—the E-QUIP Act—which would provide an accelerated tax depreciation for upgraded roofs; and
- Immigration reform that meets the roofing industry's workforce needs.

IIBEC's Second Vice President Amy Peevey, Immediate Past President Scott Hinesley, Past President and Advocacy Committee Chair Thomas M. Gernetzke, Industry Liaison Committee Chair Janial Mack, EVP/CEO Brian Pallasch, and Director of Government Relations John Boling joined industry colleagues to meet with members of Congress and their staff to build relationships and discuss how the roofing industry is affected by federal policies.



Representative Madison Cawthorn's (R-NC-11) legislative assistant Keifer Wynn (bottom) spoke with Dustin and Piper Gilman (top left) and Scott Hinesley (top right).

Senator Thom Tillis's (R-NC) legislative correspondents Cirilo Perez (on the phone) and Sam Lupas (bottom center) spoke with Dustin and Piper Gilman (top left), Scott Hinesley (top middle), Brian Pallasch (top right), and John Boling (bottom left).