Feature

A Project Profile: Benefits of Front-End-Heavy Due Diligence

By Don Kilpatrick

Do building owners and the overall project charter benefit from information derived from a reasonable level of due diligence on the front end? We think so.

This article will impart our recent experience in delivering a multimillion-dollar restorative effort for a student dining facility at the University of Chicago. Bartlett Dining Hall, originally built in 1901, was initially commissioned as a field house, with various sport-related fixtures including a swimming pool, a running track at the mezzanine level, and a basketball court. Previously (in 2002), the facility underwent major renovations that would abandon the sport-centered use in favor of kitchens and student dining (**Fig. 1**).

Figure 1. *In September 2022, the building was fitted with scaffolding, hoisting bays, and monorails prior to roof and skylight replacement work scopes.*

BACKGROUND

The overall project scope was derived from a 6-month period of study that placed an emphasis on all things related to the building enclosure.

By extension, the project charter would come to include the following:

- demolition and reconstruction of mass parapet walls and turrets
- selective removal and replacement of ashlar and custom decorative stones
- 100% grinding and tuckpointing of mortar joints
- removal and replacement of water-damaged wood decking, timber purlin, and beams
- complete reroofing with clay tile (to restore the original design intent)
- completely abandoning the existing roof drainage piping in favor of new components—replaced from drain heads to new structures at grade and confirmation that continuum of drainage to City of Chicago stormwater and individual roof area access improvements
- skylight replacement
- interior painting of all main roof, below-deck components, including steel trusses and exposed ductwork

The project duration was two calendar years, with most of the masonry restoration completed in 2022. The balance of the work scopes were completed during the 2023 construction window (**Fig. 2**).

DUE DILIGENCE

The due diligence (design survey) was executed during an immersive two-week interval in

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Figure 2. *Project was substantially completed prior to the start of the fall 2023 quarter.*

the summer of 2021. Working closely with a masonry service provider and roofing contractor, targeted inspection openings were made in areas of interest to establish the types and condition of the materials, and sequencing, layering, and tolerances (relevant/critical flashing heights) of the as-built conditions. Approximately 8 openings were made in masonry substrates with another 12 made in the existing roof cover. Quotes were secured from prequalified masonry service providers to help facilitate tasks such as creating masonry-related inspection openings, as well as safety-related items such as specialized means of access (that is, mobile elevated work platforms), ground protection, and temporary detours for foot or vehicular traffic. A roofing contractor was engaged to accommodate similar efforts related to the existing roof cover. A summary of the proposed schedule for the due-diligence evaluation and specific areas of interest (locations on the building where we were proposing the openings be made) was submitted to the owner for review and approval.

EXTERIOR WALL INSPECTION

The biggest takeaway from the masonry due diligence was that masonry parapet walls extending over 4 ft (1.2 m) above the stone belt course on the exterior side of the parapet wall would require complete controlled demolition; in this case, *controlled* means a standard of care in the demolition process that preserves the cladding stone for reinstallation. The new wall section would feature a fully grouted, steel-reinforced concrete masonry unit (CMU) backup wall, replacing the original two-wythe brick masonry backup wall. The controlled demolition plan required the creation and maintenance of project record drawings that assigned each stone a unique alpha-numerical identifier that functions as setting and positioning diagrams for the salvaged stone.

Sounding is the practice of lightly tapping the stone cladding to identify localized areas of distress or delamination. It could be compared to dragging chains across concrete hardscapes to locate limits of delamination. As with that process, two quite different rebound noises/tones can be expected with the practice of sounding mass walls. The audible rebound in a mass wall of good condition (that is, with bedding mortar in good condition, which can be seen by visual examination, and a solid collar joint) should result in a relatively clear "ring" on impact. In contrast, a rebound that has dull resonance usually means that the wall section has been compromised in any number of ways. When the response to sounding yields a dull resonance, it can generally be assumed that the wall is *dead*, with mortar bonds compromised, and in some instances having reverted to sand.

When these signatures are derived from sounding, a free hand should be placed on the opposite end of the stone/brick with additional

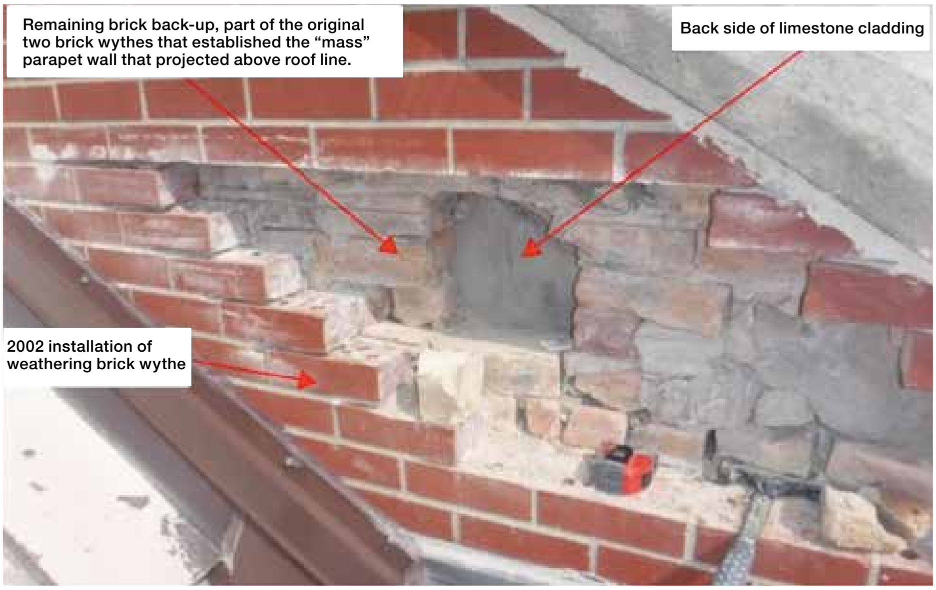


Figure 3. *Through targeted removals it was determined that the exposed brick installed in 2002 as part of the conversion from field house to food services did not include brick ties. In addition, the bedding mortar that was present in the remaining wythe of brick (Chicago pinks) between the weathering wythe and stone cladding on the outboard side of the parapet wall had reverted to sand. A pocketknife could be used to pull brick from that area of the wall.*

Figure 4. *Overall poor condition of existing brick masonry backup wall found to be typical on each of the four turrets.*

blows given to the other end. In most instances, the free hand will feel slight movement, suggesting the bond or attachment (such as carbon-steel straps) between the stone cladding and brick masonry backup and/or collar joint are in poor condition.

A more thorough investigation at these locations is recommended and can be as simple as a visual examination of the entire wall, focusing on evidence of movement in the carved, cut stone cladding.

At the gable end wall parapets, which rise above the roof line, it seemed that the work scope from the 2002 build-out included the introduction of new face brick below the stone coping to the roof line. Beyond the fact that the new brick showed no evidence of a header coursing, visually the brickwork looked great, and it even passed the sounding test. However, with lift access to the opposite side of the parapet wall exterior, sounding suggested a dead wall. A targeted inspection opening was made off the roofline into the otherwise new brick masonry backup wall, and it was determined that the interior parapet wall repairs of 2002 only included the exposed weathering brick wythe. Existing headers were detached, and the new brick wythe was installed without any brick ties at the interface of the brick backup that remained as part of the repair. The bedding mortar of the brick backup that remained from the original construction was compromised and was friable, with no structural integrity (**Fig. 3**).

From there, the team refocused on the limestone cladding on the gable end wall, including pockets of deflection and changes in plane of the limestone cladding. Sounding, paired with visual examinations, determined that most of the stone cladding on the gable end wall (both north and south ends) would minimally require removal and reinstallation, using stainless steel clips, pins, and fasteners.

Demolition and reconstruction of the four turrets were required, from the crenelated top of same, to the stone copings of the adjacent main roof line parapet wall below, including the brick masonry backup (**Fig. 4**).

At locations not subject to complete demolition and reconstruction, the work scopes specific to the exterior walls included 100% grinding and tuckpointing, targeted repairs of locally damaged ashlar and decorative stones, and removal and replacement of all window perimeter sealants.

PROJECT DELIVERY

At the schematic design level, the project team and owner representatives participated in a joint review of the final project charter as an opportunity to develop an understanding of the as-built, present-day conditions and our proposed long-term solution for each of the project-specific challenges. This is the interval at which the client provided critical input on the soft issues that may otherwise go unattended or are unknown to the designer. Those conditions are typically centered on building end use when work is underway, with the building remaining in service, and key parameters of schedule. Specific to the work itself, it is critical that the owner's project management team understands what they are buying, and why. Also addressed at this point are the potential lead-time issues for specialty products like the skylight and replacement timber framing. As the work scopes at this time would be characterized as "broad stroke," our recommended preliminary budget was reported in a manner consistent with the expectations at this level in the process, operating in a range rather than a specific dollar amount with contingencies.

With owner authorization, the team proceeded to the design development level review, where the preferred method of delivery was determined. Given the number of moving parts and the owner's commitment to continuing the occupancy of the building through the spring quarter of 2023, the team chose Construction Manager (CM) at Risk as the preferred method of delivery.

In this method, bid documents and technical specifications (95%) were firstly provided to the selected service providers chosen through a competitive bid process of construction management. The content of the bid documents prepared by the architect were parted out by discipline, by the CM, into "scope sheets" that referenced project-specific trades/bid packages. The architect was afforded the opportunity to (1) review the scope sheets, as well as (2) participate in or attend the varied pre-bid meetings by trade.

The CM assumes responsibility for all trades, including scheduling, lead-time issues, coordination, and the early identification of potential trade conflicts (such as skylight installer to roofer, roofer to mason, painters to carpenters, etc.), maximizing the production rates of the varied trades bookended firm start and end dates imparted by the owner.

BUILDING DRAINAGE

Existing Conditions

The main building's plan view geometry established 11 primary roof drainage zones (**Fig. 5**).

As intended by the original design, wood cribbing below the wood roof deck establishes slope to drain in each zone, which moved water to an array of drain heads servicing each of the zones. The original drain heads were inboard of the parapet wall, passing through the decking carried by the wood cribbing. As is common with vintage structures, the risers trail off toward that portion of parapet wall below the wood cribbing, only to disappear, buried in the mass wall. Unattended leaks at the drain heads provided a direct route for water into the "sponge" that defines the behavior of the vintage mass walls as they are introduced to water. Due to the significant moisture storage capacity of the mortar and Chicago pinks that comprise the brick masonry backup walls (that are 22 in. [560 mm] deep below the parapet wall belt course), the wall components held water against the 4 in. (100 mm) cast drain risers for extended durations, resulting in complete failure of the piping (**Fig. 6**).

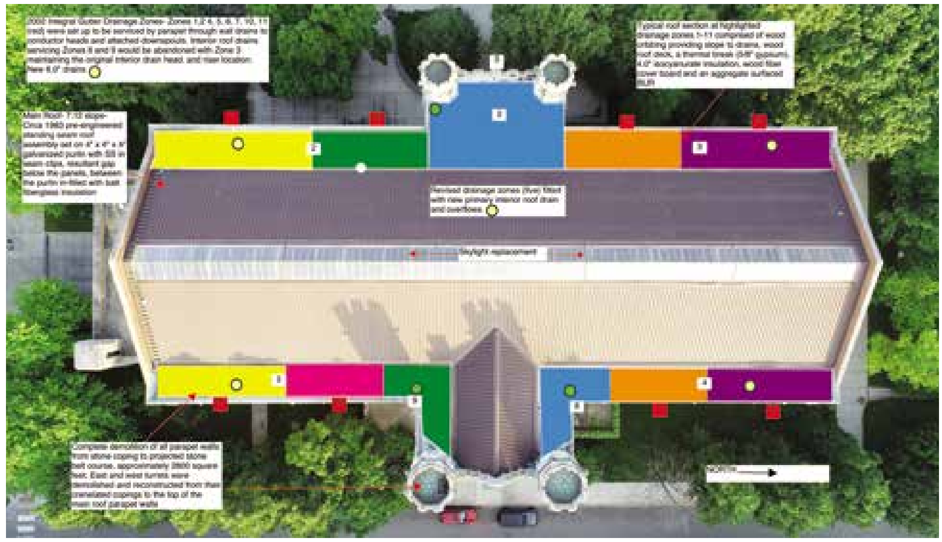


Figure 5. *Graphic showing scope of work.*

Figure 6. *Original drain riser buried in the mass wall. Corrosion of the piping resulted in damage to the stone surrounding the adjacent window opening.*

In addition, the 4 in. (100 mm) risers were choked down to 2 in. (50 mm) at the roof line through the introduction of drain inserts, resulting in a 75% reduction in capacity.

The 2002 build-out would acknowledge the failure of the existing drain risers/bowls at the roof line with the revised roof drainage systems featuring the following:

- At intervals matching the number of existing risers concealed in the mass walls, new primary through-parapet-wall drains were installed and connected to attached downspouts**.**
- The layout of the cribbing, which created low points at the converging sloped roof decks, was used to locate the new through-wall drains, which would leave the new downspouts passing over window openings. To counter or correct that condition, they had to firstly pass through the wall and interface with a conductor head and short lateral that would shift the locations of the new downspouts north or south, centered between window openings; this essentially mirrored the location of the original existing drain

Figure 7. *The introduction of new galvanized steel roof deck and framing members into one of the four primary drainage zones. The line on the back side of the new steel-reinforced, grouted concrete masonry unit backup wall represents the location of the slope to drain feature that was accommodated by the wood cribbing that was original to the building. A fully tapered insulation atop the new steel deck will move water to the new drains at new locations (see Fig. 5).*

risers that were buried in the mass wall (see **Fig. 7 inset**).

- The below-grade laterals carrying roof drainage to the City of Chicago stormwater system were also centered between the windows. This allowed the connection of the new downspouts to the existing subgrade drainage features. The revised condition was prone to significant ice dams (see Fig. 7 inset), which resulted in leakage to the building interior.

Revised Drainage

While not necessarily part of the building envelope, experience has shown that it is prudent to take a close look at building roof drainage features of vintage structures, from the drain heads at the roof line, through all laterals and risers, to the city stormwater management infrastructure. The conditions were summarized in the body of the sustainable development (SD) report, supplemented by some video of the existing below-grade stormwater that suggested the original 8 in. (200 mm) clay drainage tile had collapsed at the laterals that connected the northern half of the building to the City of Chicago stormwater system to the east. The project charter was revised to include the complete replacement of building drainage features from the drain heads to the sidewalk side of the of City of Chicago stormwater system. This was achieved while avoiding the disruption of the sidewalks, as well as recently adopted city mandates for owner participation in pavement restoration that far exceeded the cost of the targeted repairs that would be considered as required for the scope of work.

A mechanical engineer was engaged for assistance with the design of a revised drainage system. Preceding that, our staff performed an in-depth review of the challenges in locating potential routes and conflicts for new drain piping. The owner's only requirement was that they did not want to see new drain piping laterals hanging from or passing through the exposed steel trusses on the building interior.

The SD report summarized the proposed new drain in a circuitous piping route from the main roof drain heads at the third floor down to the basement, and two new catch basins between the building and the City of Chicago stormwater system. At one location, existing casework in the first floor "Trophy Room" required that a new drain piping riser come through the second-floor dining room ceiling and floor (exposed). To make these conditions more palatable, the team promoted the use of a small "load path wall" adjacent to the new piping, which was extended as a pipe chase and finished to match the existing conditions. Otherwise, the risers from the main roof line to the basement were installed in stair chases on the northwest and southeast corners of the building.

SKYLIGHT

The existing skylight frame and curb were believed to be original to the building. The original 2002 rehabilitation required the installation of new, uninsulated safety glass in the existing skylight frame. In the design phase, it became apparent that the previous introduction of a standing-seam metal roof in 1983 left the interface of the skylight curb, sheet metal accessory closures, and metal roof panels in a compromised condition (see the "Roofing: Existing Conditions" section below). The flashing that extended from the skylight curb to the closure at the sheet metal pan heads was left dead flat or slightly back pitched to the skylight curb. Repeated incursions of water occurred at this location to the extent that previous repairs also required the replacement of heavy timber beams that carry the skylight curb. Leakage was additionally reported at locations downslope, assumed to be sourced from this condition.

This project is the second steep-sloped roof on the campus where the design could consider the introduction of above-roof deck insulation. The generous height of the parapet walls easily accommodated *R*-30 insulation above the roof deck with room left for tapered materials in the integral gutters. The introduction of all above-deck roofing components made it necessary to introduce a new skylight curb (**Fig. 8**).

The new skylight rafters were designed to induce "thrusting" loads by using an A-frame shape without the horizontal chord between each rafter end or base plate. The new curb was fitted with horizontally oriented steel angles at regular intervals to accommodate/offset the thrusting loads imposed by the new skylight framing.

ROOFING: EXISTING CONDITIONS

As previously mentioned, in 1983, a new standing-seam sheet metal roof was installed, which was assumed to have replaced the original clay tile roof. The existing conditions are summarized below:

- Steep-Sloped Portion (7:12)
- Structural: Steel trusses oriented east-west, establishing 11 bays, each subdivided into 24 bents by north-south heavy timber beams and east-west purlin
- Structural Roof Deck: 2.5 in. × 5.5 in. tongue-and-groove lumber
- Underlayment: Asbestos, asphalt-coated base sheet
- Z-Girts: 4 in. deep to establish pocket for insulation
- Insulation: 4 in. fiberglass batt with vinyl facer on warm side
- Sheet Metal Panels: Formed Galvalume panels 12 in. wide with 2.5 in. high profile with in-seam stainless steel clips fixed to top flange of 4 in. Z-purlin

ROOFING: NEW SYSTEM

The new roof system for the main gable areas included the following, with an applicable variance for the remaining integral gutters and low-sloped roof areas:

- Thermal Barrier: ⁵⁄₈ in. gypsum-based cover board, mechanically fastened
- Temporary Roof: Asphalt-based self-adhering underlayment
- Insulation: Two layers of 2.6 in. polyisocyanurate
  (1) Cover Board: ¾ in. plywood
- Underlayment: Asphalt-based self-adhering underlayment and two plies of non-perforated organic felt
- Roof: Nail-fastened Ludowici interlocking clay tile
  (1) All components from here to ¾ in. plywood are mechanically fastened per Factory Mutual recommendations

INTEGRAL GUTTERS

The original design intent and existing cribbing for the four integral gutters would be demolished and reconstructed, featuring four new drain heads paired with through-wall overflow scuppers. Eleven drains were present in the existing as-built conditions. New galvanized steel cribbing and decking were introduced to the assembly (**Fig. 7** and **9**), followed by the

Figure 8. *Original 1901 skylight curb on the left side with new curb on the right. Increased height was required to accommodate increased insulation thicknesses.*

Figure 9. *Crew installing the structural steel framing intended to carry the new galvanized decking and hat channels on the roof side of the parapet wall that is the receiving substrate for the plywood sheathing, establishing the substrate for the new flat-lock-seam copper panels. The existing through-wall drain will be closed off and the new parapet wall section will be cored through, establishing provisions for overflow drainage for each of the four roof drainage zones.*

Figure 10. *Overall completed northwest integral gutter drainage zone.*

Figure 11. *Typical condition as encountered in each of the four integral gutters. See Fig. 9 and 12 for additional information related to new design intent and solution for venting of the triangulated, "dead" air space that will be maintained as part of the new as-built condition. New insulation was required from the interface of the parapet wall upslope to the skylight curb.*

Figure 12. *First in-place work of vented parapet wall assembly, including stainless steel insect screen and 32 oz copper hook strip for cap/counterflashing, providing a continuum of protection from above receiver for the through-wall flashing.*

introduction of thermal break, temporary roof using asphalt-based self-adhered underlayment, tapered insulation, cover board, and a new three-ply torched styrene-butadiene-styrene (SBS) modified bitumen membrane (**Fig. 10**).

To address the triangulated, "dead" air space between the new steel roof deck of the integral gutter and continuum of the 7:12 slope of the main roof (**Fig. 11**), the interior parapet wall was designed to function as a vent, offering the opportunity for air changes/movement by convection from the otherwise "closed" space (**Fig. 12**).

Full-scale mock-ups of the design intent were required in advance of full production, including the sheet metal work specific to the parapet wall interiors, the transition to the skylight curb, and the SBS modified bitumen membrane system in the integral gutters.

INTERIOR PAINTING

In the second year of production (2023), the building was taken completely offline after the spring quarter to accommodate loading from the interior scaffolding used for access to the underside of the deck/trusses and ductwork for surface preparation and painting. The upper limits included a floor that would carry four rolling scaffold towers between the trusses that would allow workers hands-on access to all decking, timber beams, and purlins.

CARPENTRY

The inspection of the wood beams, purlins, and decking was undertaken topside as the existing roof cover was removed (**Fig. 13**).

Concurrently, timber beams, purlins, and decking were visually examined and probed, working off the rolling scaffold set up on the work platforms established just below the bottom chords of the steel trusses. About one dozen north-south wood beams and purlins were removed and replaced due to water damage (**Fig. 14**).

The bid form included provisions for replacement of over 2,500 square feet of 2.5 in. (64 mm) tongue-and-groove wood decking.

LESSONS LEARNED

Most design professionals engaged as designers of record, deriving their income from the rehabilitation of existing buildings, would agree their chosen vocation is fertile ground for unexpected conditions and scope creep resulting from unforeseen conditions. Summarized below are key parts of the whole where the experience on this project suggests that efficiencies and investments in the process

Figure 13. *Inspection and identification of bad decking (2.5 in. thick and 5.5. in. wide tongue and groove) was performed topside after the removal of the existing standing-seam roof, insulation, and underlayment.*

upfront and concurrent with the work played a key role in the project being delivered on time and under budget.

Project Charter and Due Diligence

The framing of a project charter is driven by existing conditions that are discoverable in the presence of an immersive due-diligence exercise that places an emphasis on putting the team in the "best position to know." The intimate knowledge derived from targeted removals at inspection openings is critical to the design process. This investment at the front end of the project accommodates the development of an all-encompassing scope of work, removes barriers (real or imagined), and minimizes the potential for costly change orders due to unforeseen conditions.

Bid Form

The bid form provides additional opportunities to acquire costs for specific tasks and unit-price-based information that can later be leveraged to accommodate additions and reductions in overall work scopes. Assigned unit-cost quantities are based on counts (for example, visibly compromised stones), which was increased by a factor of 20%.

Stone counts (units), and quantities (square feet) of wood deck, timber beam, and purlin replacement are tracked by elevation/roof area and measured against bid-form values.

Lump-sum values are typically associated with work scopes that will be required with minimal chances of not being fully realized as part of the work (such as scaffolding, skylight, skylight curb, reroofing, demolition, and reconstruction of integral gutters).

Delivery Method

It is our opinion that projects with multiple disciplines, hard start/end dates, and lead times for products/assemblies can benefit from the CM at Risk method of delivery. Those interested in fulfilling the CM role are forced to take ownership at a more granular level than they would in a more traditional procurement process.

Key Personnel

If possible, the firm providing the engineering services should try to staff the project with personnel that will remain part of the project from the due-diligence phase to project close-out. That may be an unrealistic expectation in some circumstances, but the benefits of continuity cannot be understated. Similar consideration should be given to the on-site presence of key firm personnel assuming the CM's role.

Ownership Project Management

Another critical component is the presence of a project manager/staff that works for the owner, has a working knowledge of the key project parameters, and, moreover, fulfills the role of liaison between their client (the building end user, which in this case was food services) and the construction team. The client looks at the work through a quite different lens than the construction team. The owner's staff project manager is in an improved position to engage this and other stakeholders for any concerns that may arise during the work.

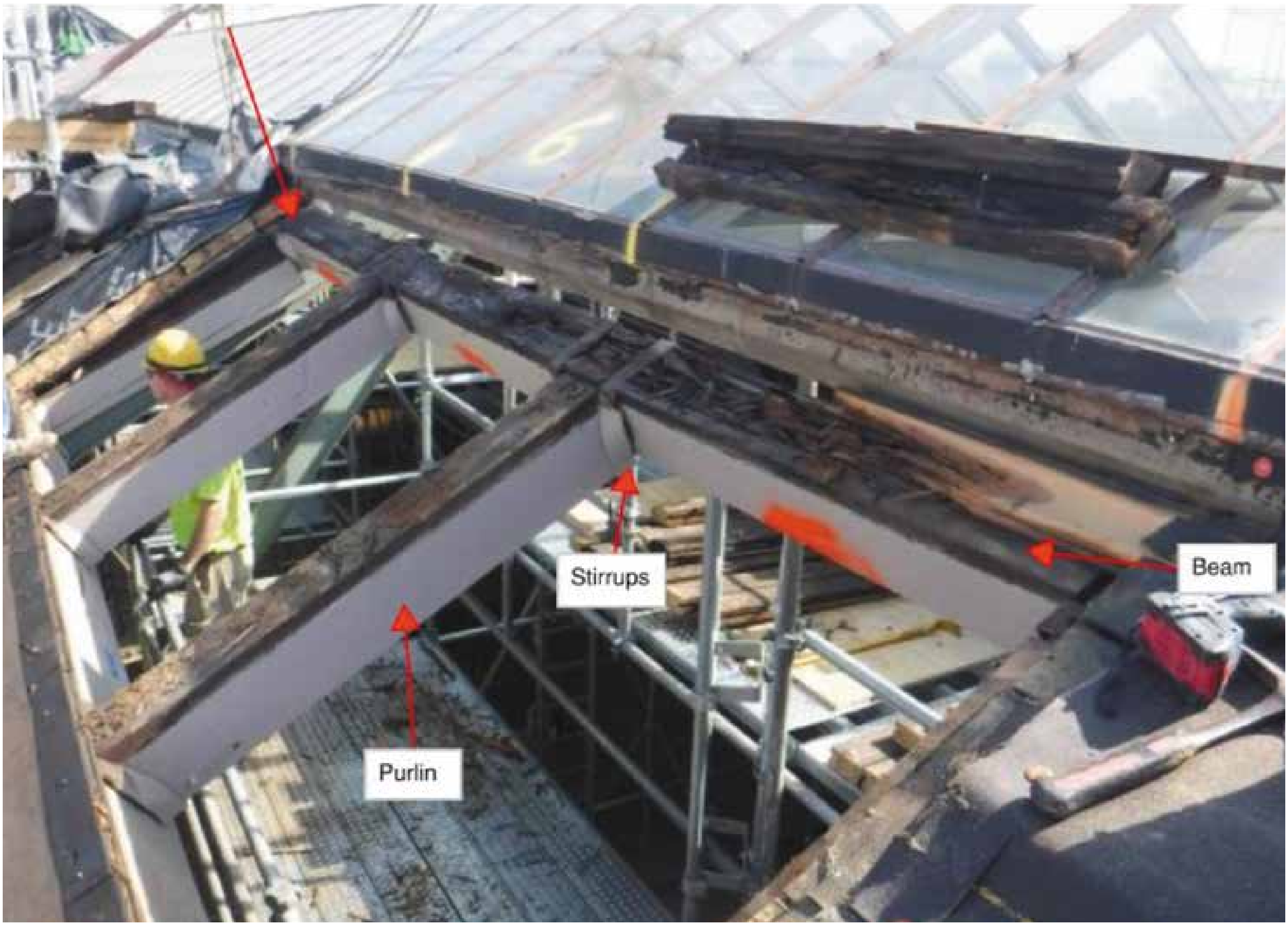


Figure 14. *Decking removed, exposing water-damaged timber beam framing at base of original skylight curb. The beams ran north-south, intersecting with east-west purlin at regular intervals between the steel trusses. The purlin had to be removed to facilitate the replacement of the north-south beam.*

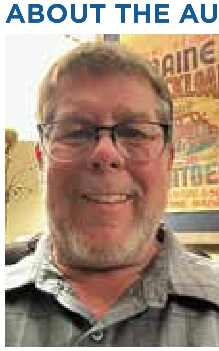
SUMMARY

In summary, the design of repairs for existing buildings and, moreover, vintage structures can be characterized as an immersive experience. These efforts require careful attention to detail, and an appropriate level of due diligence/discovery can offer the owner some protection from what could become an onslaught of change orders for unforeseen conditions. Experience suggests that more favorable outcomes are derived from a bid package that acknowledges the potential for unforeseen conditions, preparing for the worst, and hoping for the best.

Owners are more receptive to credits than a spate of change order additions. Each project/client brings a new set of challenges that fosters the continued evolution of processes that are of mutual benefit to the project charter, the owner, and the designer of record in delivering a quality project within the key parameters of budget and schedule.

We are grateful for the opportunity and level of trust that the University of Chicago, Capital Projects Department (CPD) team afforded us with this challenging project. Special thanks to Berglund Construction for their efforts and assembling their dedicated team of subcontract service providers successfully bringing the project in on schedule and well under budget.

ABOUT THE AUTHOR



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