The Modern Plaza: Making More from Less

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The Modern plaza must be durable, waterproof, structurally sound, and aesthetically pleasing. Understanding how plazas perform is essential to their successful repair.

Introduction

In the postwar decades of the 1940s, 1950s, and 1960s, high-rise buildings adopted a Modernist architectural vocabulary. Often, a key component of these designs was the notion that the tower would be seen as a free-standing object, rather than as a facade defining traditional urban fabric. A paved plaza surrounding the tower was one way to create a setting for the building in an urban environment. The exterior paved plaza often included occupied interior spaces below; thus, the plaza surface needed to function both as a load-bearing surface and a waterproof roof. The basic plaza design therefore became a blend of materials and systems: a waterproofing membrane, derived from traditional coal tar pitch built-up roofing systems, and stone paving, a traditional material used in a non-traditional thin-paving installation. The exterior paved plaza is part of the iconic aesthetic of Modern architecture, but the very features that make these plazas architecturally distinctive have presented particular challenges in their maintenance and repair. Preservation of Modern architecture requires that designers reconcile performance improvements with the designers' original intent for the plaza's appearance.

Fig. 1. 860–880 North Lake Shore Drive, Chicago, Illinois, constructed 1950-1952, photograph June 5, 2007. The exterior plaza extends around the twin apartment towers. All images by WJE unless otherwise noted.

Since these plazas must function as a roof over lower-level interior spaces, the key considerations in plaza design relate to management of water. The primary opportunity to mitigate moisture infiltration in the plaza system is to provide for drainage at the surface in order to remove water as quickly as possible; surface drainage significantly affects the performance of the plaza system. Without adequate surface drainage, water ponding on the plaza surface will encourage staining and deterioration of the plaza materials and will increase the volume of water entering the paving system. The second layer of defense is typically a waterproofing membrane concealed within the plaza construction. The original designs of 1950s and 1960s plazas usually included traditional built-up waterproofing membranes to protect the building structure. In many cases, these waterproofing membranes were installed on flat structural slabs, and the system included no horizontal pathway for water on the waterproofing membrane to be drained. With the benefit of hindsight, it is easy to see the flaw in these types of designs. Water that reaches the waterproofing membrane must be able to drain, or it will degrade the paving materials. It can be expected that some water will reach the waterproofing membrane; after all, if the paving surface were impermeable, no waterproofing membrane would be necessary. Removing water from the surface level and getting water out of the system at the subsurface waterproofing level — slope and drainage — are the keys to performance.

In addressing the repair or upgrading of a Modernist plaza today, the critical dimension for the designer is the distance from the top of structural deck to the top of the existing paving surface. The existing building structure usually cannot be altered except at great cost, and the top of the paving surface typically aligns with adjacent public ways and interior floor levels, which also cannot be altered. Another key question facing the designer of any plaza-repair project is defining what failure means for the project. Water leakage into the lower-level interior is almost certainly considered a failure, so the design, detailing, and installation of a robust waterproofing system must be given a high priority. For the stone paving system, the definition of failure may be based on a variety of problem conditions: individual pavers that shift and create tripping hazards, cracking of isolated pavers or of many pavers across the plaza, or a variety of other distress conditions.

Two recent plaza-reconstruction projects in very different climates illustrate the challenges of bringing historic Modernist plazas up to contemporary expectations of performance, as well as how the availability of recently developed materials and detailing strategies can provide additional options for consideration by designers. Combining various current design strategies and repair materials enabled the project team to improve the performance of the plazas while maintaining the historic appearance. Although both projects ultimately received new plaza systems essentially matching the original design, there were multiple opportunities to make incremental improvements to increase the durability and performance of the systems.

The Case Studies

860–880 North Lake Shore Drive, Chicago, Illinois. These apartments were designed in the late 1940s by Ludwig Mies van der Rohe and constructed from 1950 to 1952 (Fig. 1). The innovative design features two rectangular towers oriented perpendicular to each other, with identical exteriors of steel cladding and aluminum-framed windows, united by a travertine-paved plaza that conceals an underground two-level parking garage. For Mies, the plaza served as a plinth from which the towers would rise. The desire to present the plaza as a freestanding base even led him to provide a small offset between the level of the travertine paving and the adjacent concrete sidewalks. Travertine paving was also used on the interiors of the lobbies, creating a sense of seamless space from interior to exterior. The building is a City of Chicago Landmark. For this project, Wiss, Janney, Elstner Associates, Inc., served as a subconsultant to Krueck + Sexton Architects of Chicago.

At 860–880 North Lake Shore Drive, the lobby-level storefront glazing was set back from the perimeters of the towers, and a steel canopy provided a covered walkway between the two towers; thus, the majority of the exterior plaza surface was covered. The remaining uncovered zone of the plaza between the towers was routed to a single area drain. In keeping with the concept of the plaza as a pristine plane from which the towers rose, almost no surface slope was provided to direct water toward the edges of the plaza. The paving material was 42-inch-square, $1^1/4$-inch-thick travertine pavers. These pavers were laid on a 1-inch mortar setting bed over the waterproofing membrane, for a nominal overall system thickness of only $2^1/2$ inches. Since contemporary standards recommend a minimum of 2 inches for the mortar setting bed alone, it was clear from the outset that the new plaza design would be a challenge.

The original plaza paving system was substantially reconstructed in the early 1980s. The entire system was removed down to the structural slab; new waterproofing was installed; and the original stone pavers were reinstalled, generally matching the original design and details. Reportedly, the original travertine units were reversed, with the original bottom surface rehoned to serve as the new finished surface. Although documentation of this previous repair project was limited, the decision to reuse the travertine implies that the stone pavers had survived their first 30 years of service with minimal cracking. By the 1990s, however, cracking of the pavers was widespread, leading to a series of localized paver-replacement efforts using travertine that did not match the color or veining of the original material. By the start of the present investigation in 2007, less than 20 percent of the original travertine remained uncracked. Leakage into the structure had caused corrosion expansion of the steel framing under the lobby storefront walls, distorting the glazing framing and cracking the glass. With leakage to the interior growing worse and given the lack of success from previous, localized repairs, the homeowners' association made the decision to pursue complete reconstruction of the plaza.

Lyndon B. Johnson Presidential Library and Museum, Austin, Texas. This complex on the campus of the University of Texas at Austin was designed in the mid-1960s by Gordon Bunshaft of Skidmore, Owings & Merrill (Fig. 2). The building complex as completed in 1971 included an eight-story museum and library tower and a three-story academic office wing, linked by a plaza paved with travertine and terrazzo. Beneath the plaza, the plinth portion of the building included lecture halls, seminar rooms, archival storage for the museum, and mechanical and unfinished spaces. Although not a designated landmark, the LBJ Library is considered eligible for listing in the National Register of Historic Places, and the project was therefore reviewed by the Texas Historical Commission. For this project, Wiss, Janney, Elstner Associates, Inc., served as a subconsultant to Overland Partners of San Antonio, Texas.

At the LBJ Library plaza, the waterproofing was applied to the plaza's deck structure. Above the waterproofing was concrete fill of varying thickness that created surface slope: the high point was the library and museum tower, and the low point was the perimeter guardrail of the plaza, with a relatively consistent surface slope of about $3/32$ inch per foot. Above the sloping concrete was a 2-inch-thick mortar setting bed and the paving materials, which included a field

Fig. 2. Lyndon B. Johnson Presidential Library and Museum, Austin, Texas, completed in 1971, photograph Oct. 6, 2004. The library and museum tower is at left. Monumental exterior stairs descend to the lower level, where an exterior entrance leads to the classroom and lecture-hall spaces.

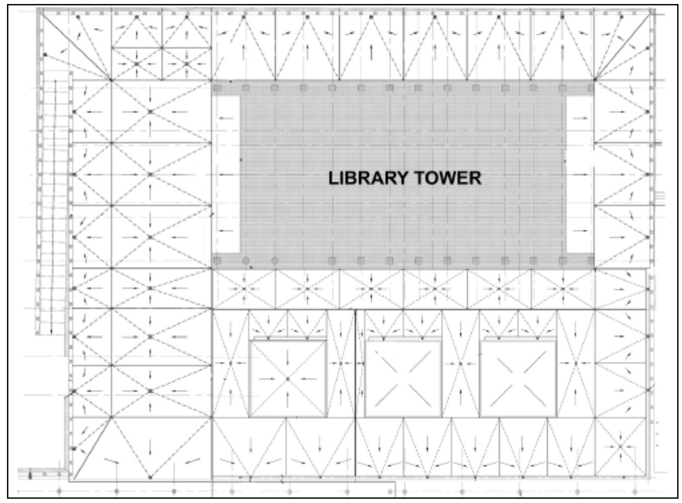

Fig. 3. Plan of the LBJ Library plaza at the subsurface (waterproofing) level, showing the slope of the new bonded overlay added atop the original structure. Each rectangular area is drained to an individual drain body.

of $1\frac{1}{2}$-inch-thick travertine pavers of varying sizes up to 30 inches square, with inset panels of dark green terrazzo paving. The total system thickness varied from 7 to 13 inches. A distinctive feature of the original plaza design at the library was the use of an open perimeter trench drain beneath the wide travertine-clad solid balustrade. The trench drain was lined with precast concrete units, and the travertine pavers rested atop the edge of the precast concrete drain. The edge of the paving system was unrestrained. Since the trench drain units were placed on top of the waterproofing system, no drainage from the waterproofing level was possible.

The original, expansive LBJ Library plaza concealed a variety of structural and interior conditions below the plaza. Oddly, one quadrant of the plaza, consisting of a reinforced-concrete structure over unfinished and mechanical spaces, lacked waterproofing entirely. Unsurprisingly, water leakage to the interior at this area was substantial. The rest of the plaza incorporated a mixture of steel, precast concrete, and cast-in-place concrete framing. The plaza system was divided by multiple control joints and a few expansion joints where these different structural systems met. The coal tar pitch waterproofing system was generally watertight; however, under the hot sun of a Texas summer, the waterproofing softened and flowed into the expansion joints, dripping tar to the interior spaces below in some places. In other areas, the tar erupted through the paving, forming black pools on the light-colored stone surface. In addition, the unrestrained edge of the travertine pavers adjacent to the perimeter trench drain allowed units to shift and displace outward, due to thermal expansion of the paving system. As a result, the pavers were pushed up at the drain, and a trough-like depression that collected standing water was formed adjacent to the trench drain. Prior to our involvement, the client had decided on complete reconstruction of the plaza in conjunction with an expansion and renovation of the educational facilities housed below the plaza. The client also selected granite, as opposed to travertine and terrazzo, for the new paving system. Although it was understood that the original paving materials contributed to the architectural character of the historic plaza, long-term maintenance needs of travertine and terrazzo, as well as the desire to improve slip resistance of the plaza for pedestrians, which could not be achieved with the original materials, contributed to the client's decision to use a different paving material.

Challenges of Renovating a Modern Plaza

The performance of plaza systems is dependent on several factors, including loading from pedestrians and vehicles; the durability of the paving materials; the ability of the plaza to drain quickly at both the surface and, perhaps more importantly, at the level of the waterproofing; and the ability to install the system successfully while accommodating irregularities in the field.

Loads on the plaza can come from pedestrians, bicycles, wheeled carts, maintenance vehicles such as scissors lifts or snow-removal equipment, and even car and truck traffic. The design of the plaza must accommodate these concentrated live loads and transmit the forces to the underlying structure without degrading the paving system. Other distributed live loads, such as snow loads, must be considered but are generally less of a constraint on the plaza design.

The nature of the paving materials is also a key performance criteria. The surface texture of the material must be considered, since a surface that will receive pedestrian traffic in all weather conditions should provide appropriate slip resistance. Some natural stones, even if initially installed with a relatively rough surface texture, tend to be polished over time by the action of pedestrian traffic. The paving material must also be resistant to the effects of weather, especially water. As with other building-envelope materials, such as roofing, plaza paving can be expected to deteriorate over time; however, the paving material should provide sufficient

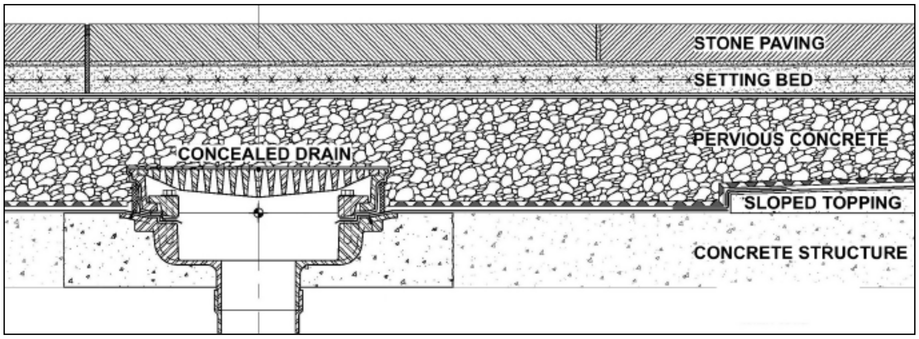

Fig. 4. General cross section of the LBJ Library plaza, showing components of the new system.

resistance to fading, crazing, or cracking such that a reasonable service life is obtained.

Water is the most likely source of deterioration in the plaza system, especially the freezing and thawing of water trapped within the system. For this reason, the ability of the plaza system to shed as much water as practical at the surface is the first step in providing durable performance. The surface slope and locations of drainage are the key design parameters. However, even the most rigorously maintained plaza paving will allow some water to infiltrate the surface and reach the underlying waterproofing materials. Water trapped within the system will degrade the plaza materials and can lead to staining, efflorescence, or freeze-thaw damage. Therefore, long-term durability requires an effective way to allow moisture below the finished surface to drain out of the system. This effect can be achieved by sloping the waterproofing surface and providing drainage outlets at low points.

Finally, plaza systems must be able to be installed successfully. Since plaza systems typically involve the integration of multiple components installed by multiple trades, the involvement of a general contractor and a design professional to ensure quality control is critical at each stage in the process. Also, the design of the system must allow for the variability of the underlying structure and variations in the thickness and dimension of the plaza materials (for example, extra thickness of the waterproofing at membrane laps or minor variations within tolerances of the size and thickness of the pavers).

A wide variety of paving options exists. Monolithic paving materials, such as cast-in-place concrete or asphalt topping, can be considered for new construction but do not meet historic-preservation standards as substitute materials for stone pavers. Paving blocks (typically clay bricks or precast concrete blocks) can be set on a sand bed for leveling or can be installed on a mortar or asphalt bed. In practice, a sand-set system is most effective when the individual pavers are relatively small and thick. As the sand bed experiences heaving and settling due to shifting sand and freezing and thawing, the need to lift up, relevel, and reset displaced paving blocks should be expected.

Natural-stone paving is usually installed as either a mortar-set system or a pedestal-set system (and, less frequently, moderately sized stone pavers are set in sand, as mentioned above). In a mortar-set system, the stone pavers are bonded to a mortar bed to form a composite. The combined strength of the stone-mortar composite is available to support the loading. The mortar-set system was the original design for both 860–880 North Lake Shore Drive and the LBJ Library. A pedestal-set system consists of individual stone pavers supported at their corners by plastic blocks or shims, with open joints and a hollow space below allowing moisture to flow to concealed drains at the waterproofing level. In a pedestal-set system, the stone itself must support the loads. The stone acts a simple structural member spanning the points of support, the pedestal blocks.

As noted, any plaza system must also consider dimensional tolerances to accommodate minor variations in the underlying structure and the pavement material itself during installation. Monolithic materials, such as cast-in-place concrete, are placed while plastic and can be easily formed around any structural irregularities. In a sand-set system, the sand depth varies as needed to accommodate any fluctuations in the structural deck or paving units. In a mortar-set system, the mortar itself becomes the variable element, since the fabricated thickness of the paver will inevitably vary slightly. In a pedestal-set system, the pedestal blocks become the variable elements; the blocks under each paver must be shimmed and adjusted to create a stable, level finished surface.

All of these considerations and options are further complicated during the renovation of an existing plaza. The new design must meet the loading and paving-finish requirements, provide appropriate drainage, and be successfully installed, while working within the confines of the existing structure. These constraints may limit the designer's options. The overall system thickness — the distance from the top of the structural deck to the finished surface elevation — is usually fixed. Loading requirements may be determined by the existing usage of the building, and it may not be possible to change users' habits to reduce the loads. The location of drains, the total slope from building entrances to the perimeter of the plaza, and the location of sidewalks and other adjacent features already are determined and may not be readily changed without significant expense. Many existing plazas were originally built with poor slope at the surface and a limited number of drains. In addition, many plaza systems were not built to be able to let water weep out at the waterproofing membrane, consequently trapping water that penetrated the surface in the system.

Finally, many Modern plazas are highly visible and architecturally significant elements of the building composition; thus, the underlying challenge of any repair program is how to preserve the original design — its materials, details, and character. As the various factors involved in a plaza renovation are identified, preservation of the character-defining features is always an overarching consideration.

Structural Performance

The repair design for these two plaza systems began with a consideration of the loading design criteria. Due to the need to accommodate occasional truck loading for university maintenance vehicles, a pedestal-set system could not be considered for the LBJ Library plaza. At 860–880 North Lake Shore Drive, the plaza needed to accommodate only pedestrian loading, along with occasional hand-cart loads for deliveries (an adjacent concrete-paved service drive accommodates vehicular traffic). Therefore, both the mortar-set and pedestal-set systems were studied.

The pedestal-set system was initially an appealing concept for 860–880 North Lake Shore Drive. Since the joints are left open and drainage occurs below the surface, the finished paving could be completely level. The level surface would have matched the intended aesthetic of the original design. The first study concept used 1¼-inch-thick travertine pavers at a 21-inch-square size, that is, half the original module. Although a technically sound solution, the aesthetic change produced by the smaller paver module was unacceptable. The use of 42-inch-square, 1¼-inch-thick pavers was evaluated structurally; as feared, the thin travertine was too weak to span from pedestal to pedestal, even for the light pedestrian traffic. Increasing the thickness of the paver to 3 inches would have provided sufficient strength; however, there was not enough depth available between the structural deck and the finish elevation to use a 3-inch paver. Also, installation would have been very difficult, as each 3-inch-thick paver would weigh 460 pounds, making the shimming and adjustment needed to align the pedestals a challenge.

An alternate possibility was the reinforcement of a thinner stone paver to meet the design loading while meeting the paver size and thickness constraints. It is possible to reinforce a thin-stone paver with another material to provide improved structural performance. Specifically, since natural stone is strong in compression but relatively weak in tension, the reinforcement should provide greater tensile strength, in much the same way that steel reinforcing provides tensile strength for a reinforced concrete slab. The reinforcement material must form a true composite system with the stone paver. Therefore, bonding reinforced concrete to the back face of the stone will not achieve the intended result; in precast construction, a slip sheet is typically used to prevent such a bond, as the shrinkage of the concrete during curing could warp the stone if the concrete were directly bonded. The use of a steel plate below the stone will also not provide appropriate performance. Although sufficiently strong, steel will deflect more than the stone under plaza design loading, likely leading to cracking of the stone. However, one material that is sufficiently strong, can be fully bonded to a stone paver, and can match the elasticity of stone is carbon fiber. Carbon fiber has been developed as a repair and strengthening material for concrete structures. Cracked or overstressed elements are wrapped in the carbon-fiber fabric, which has a very high tensile strength and is bonded using epoxy adhesives to create composite structural action.

Table 1. Travertine Flexural Strength as Determined by *ASTM C 880, Standard Test Method for Flexural Strength of Dimensional Stone*

Test 1: Parallel to Veining		Test 2: Perpendicular to Veining		Test 3: Carbon-fiber Reinforcement	
Sample	Failure (psi)	Sample	Failure (psi)	Sample	Failure (psi)
Dry 1	808	Dry 1	1229	Dry 1	3409
Dry 2	743	Dry 2	1387	Dry 2	3144
Dry 3	623	Dry 3	1336	Dry 3	4230
Dry 4	636	Dry 4	1233	Dry 4	3240
Dry 5	946	Dry 5	1248	Dry 5	3240
Wet 1	823	Wet 1	1387	Wet 1	3308
Wet 2	802	Wet 2	1390	Wet 2	3482
Wet 3	956	Wet 3	1113	Wet 3	3938
Wet 4	606	Wet 4	1404	Wet 4	3201
Wet 5	758	Wet 5	1167	Wet 5	3774

To test the concept of using carbon fiber on stone pavers, mock-ups of composite pavers were tested using *ASTM C 880, Standard Test Method for Flexural Strength of Dimension Stone*.[1] The flexural-strength test closely mimics the real-world situation of a pedestal-set system, with supports at either end of the unit and a load applied at the center. When tested according to *ASTM C 880*, travertine pavers typically have average test values of 1,200 psi in the axis perpendicular to the veining and 700 psi in the axis parallel to the veining. These average values conceal relatively wide variation in values from specimen to specimen; due to the high variability of the material, the designer must make relatively conservative assumptions regarding strength when designing with travertine. With carbon fiber bonded to the pavers, the test values increased to more than 3,000 psi. No variation was seen between the parallel and perpendicular direction (Table 1).

As a result of these tests, a design concept utilizing reinforcement was proposed for the 860–880 North Lake Shore Drive project, consisting of pavers 42 inches square by 2 inches thick, reinforced with carbon-fiber fabric and set level on pedestals with all joints left open. Since drainage would be concealed beneath the surface, as many drains as needed could be added to overcome the lack of slope in the original structure. Unfortunately, cost estimates for this system revealed an increase in the project budget of 40 percent, due to the cost of the carbon-fiber fabric. Also, although accelerated-weathering testing gave the project team some confidence in the durability of the system, no warranty would be available for the carbon-fiber and stone composite pavers. Therefore, this option was not pursued further.

Although both 860–880 North Lake Shore Drive and the LBJ Library would receive new plaza systems essentially matching the original designs, there were multiple opportunities to make incremental improvements that would increase the durability and performance of the system. In both plazas, these improvements included adding slope at the waterproofing level; adding drains and providing slope to the drains; using improved contemporary materials, such as hot-applied rubberized asphalt waterproofing and latex-modified setting mortar; and ensuring quality control during construction.

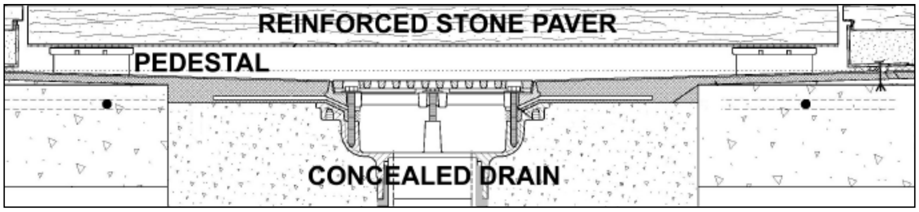

Fig. 5. Section detail at new concealed drain at the 860–880 North Lake Shore Drive plaza, showing use of pedestal-set reinforced paver. Drawing by Krueck + Sexton Architects.

Slope for Drainage

The first improvement considered for both projects was to add slope at the waterproofing level. As noted above, in both buildings the waterproofing was originally applied directly to the flat building structure. By providing slope, the design would ensure that water penetrating the plaza surface had positive slope for drainage and that the buildup of water in the paving system would be minimized.

At 860–880 North Lake Shore Drive, the system depth was a significant constraint but the goals were the same; to increase slope to provide better drainage at both the surface and at the level of the waterproofing. The challenge was to pick up fractions of an inch wherever possible to create positive slope, although the slope could never be as steeply pitched as would normally be recommended. While investigating the potential structural repairs required to address the result of past water leakage, it was discovered that the top reinforcing steel of the structural slab had excess concrete cover. Therefore, it was possible to remove 3/4 inch of concrete from the top surface of the structural slab. A concrete-milling machine was used to scarify the concrete surface and remove the excess cover. A thin bonded overlay was added to the new surface to create slope. A proprietary polymer-modified cementitious overlay was used to allow the material to be feathered to zero thickness at the desired low points. With the combination of scarification and a thin overlay, the desired slope at the waterproofing level was achieved.

At the LBJ Library, which had a relatively thick system depth, it was possible to add a bonded concrete topping slab over the existing structure to create the desired slope and still leave room for the paving-system installation. The waterproofing could then be installed over the sloped topping slab to quickly weep away water that penetrated the paving surface. However, changes to the slope at the paving-finish elevation, which ran from a high point at the building and a low point at the perimeter drain that surrounded the building, were not possible without changing the geometry of the plaza. Therefore, to provide positive (and rapid) drainage at the waterproofing level, a "pin cushion" pattern of sloping topping slabs and intermediate drains was designed (Fig. 3). Since this solution resulted in a steeper pitch at the waterproofing level than that at the finish elevation, a layer of pervious concrete was installed to create a uniform bed for the mortar-set granite paving stones. Also referred to as "no fines" concrete, the pervious mix consisted of only small aggregate and cement binder. This layer is intended to allow water to flow freely to the subsurface level, while providing a robust base for the paving system to accommodate the intended loading (Fig. 4).The paved surface still matches its original slope, so the variability of the subsurface condition is concealed.

Increased Drainage

The next improvement considered for both projects was the addition of drainage at both the subsurface waterproofing level and at the surface paving level in order to accommodate the increased slope in these surfaces.

At 860–880 North Lake Shore Drive, the limited depth meant that the plaza needed to slope to multiple new drainage locations; there was insufficient depth to allow for the long travel distances at a given slope to match the original design with all drainage to the perimeter landscaping. The subsurface and surface slopes were designed to be equal, which meant that each drain location needed to accommodate both subsurface and surface drainage. A uniform zone along the perimeter of the plaza about 10 feet 6 inches wide was able to be drained to the perimeter landscaping at both the subsurface and surface levels. For the remainder of the plaza, area drains were needed. Aesthetically, however, it was not desirable to add drains at the surface beyond the one original drain inlet. Therefore, the carbon-fiber-reinforced pedestal-set concept was revived to allow for concealed drains. At the drain location, the typical paving system was interrupted. One reinforced paver was set on plastic shims over a low-profile drain body, with the perimeter joints left open to allow for surface drainage (Fig. 5). The added cost

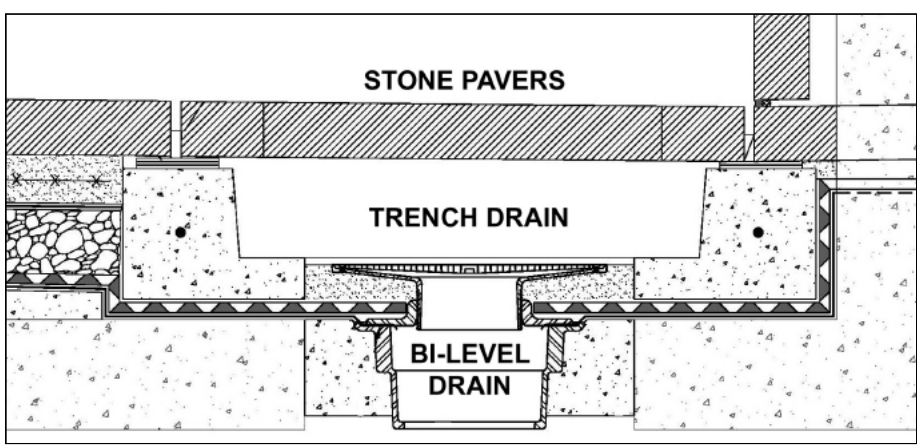

Fig. 6. Section detail at new perimeter trench drain at the LBJ Library plaza, showing a pedestal-set paver atop precast-concrete trench unit. Within the precast concrete trench, bi-level drain bodies were used.

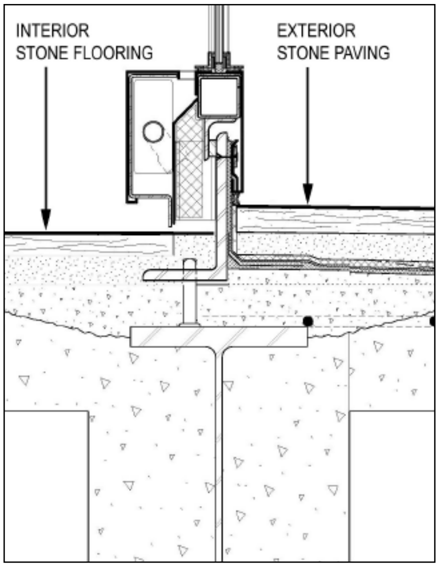

Fig. 7. Section detail at lobby storefront at 860–880 North Lake Shore Drive, showing new offset between interior and exterior paving. Drawing by Krueck + Sexton Architects.

and lack of warranty were acceptable for the single paver at each of ten drain locations to preserve the overall appearance of the plaza. A premolded-plastic drainage mat was also incorporated throughout the plaza to facilitate the lateral movement of water at the waterproofing membrane.

For the LBJ Library plaza, the design for the sloped topping slab required that new drains be added to remove water that reached the waterproofing layer. However, the originally designed surface slope provided adequate drainage, and changes in the slope of the surface paving for additional drains was considered undesirable. Therefore, the new drains were detailed as concealed, subsurface drains buried within the plaza construction. Above the waterproofing, a preformed-plastic drainage mat was installed to facilitate the lateral movement of water beneath the mortar setting bed.

At the perimeter, a variation of the original trench-drain design was used. New, wider precast trench units were fabricated, with better cross slope to individual drain bodies. Bi-level drain bodies were used within the trench drain, so that each individual drain would accept surface water from the trench drain, as well as subsurface drainage at the waterproofing level. Finally, since the wider trench drain now extended beyond the limits of the guardrail, a slotted, pedestal-set stone paver was used to cover it (Fig. 6).

Elevation Constraints and Quality Control

For both plazas, an initial constraint on the new design was the need to align the elevation of the new finished paving surface with adjacent interior thresholds and site paving.

At 860–880 North Lake Shore Drive, matching the original surface level while still creating even marginal slope proved impossible. Therefore, a compromise solution was adopted. At the glazed storefront areas of the lobby, the exterior paving surface was installed 1 1/2 inches higher than the original interior floor level (Fig. 7). Although obvious in a section drawing, the storefront curb and integral fin-tube radiator obscures this transition to the casual observer, and the interior and exterior paving still “read” as a continuous plane, as envisioned by Mies. At the primary exterior-door openings to the lobby, some of the desired slope was sacrificed to allow for a level transition across the threshold; at service areas, the interior floor was sloped up to meet a raised threshold.

At the LBJ Library, the relatively large overall system depth and the adequate original surface slope meant that the new paving surface could readily follow the original plaza contours and drainage patterns and that no additional drainage at the surface would be required.

Since plaza paving systems are dependent on the quality of the installation for their durability and performance, both projects included on-site testing and observation during the construction phase to ensure that the as-built plaza matched the design intent. Of particular concern was the bond between each stone paver and the mortar setting bed. Since the stone unit on its own is not sufficiently strong to support the required loading, the setting mortar must fully bond to the stone to provide composite structural action. Unbonded corners or zones of the stone paver would be susceptible to cracking. The quality control included load testing, as well as destructive investigation of mock-ups, to reveal whether the procedures followed by the contractor were successful in achieving complete bond.

Conclusion

For both plazas, the new installations benefit from contemporary materials, as well as rigorous quality control in the field during construction. Improved materials, such as hot-applied rubberized asphalt waterproofing and latex-modified setting mortars, provide improved long-term durability and more robust in-service performance beyond the materials available during the original mid-twentieth-century construction. Although the travertine paving at 860–880 North Lake Shore Drive has known limitations and would not necessarily be recommended today for a new installation in the Chicago climate, the careful selection and detailing of the other materials in the plaza construction improved the durability of the system while preserving the original design intent and material selection. Other new materials, such as the carbon-fiber reinforcing, were selected to meet specific detailing needs and improve performance. For both projects, the use of new detailing and new materials for the concealed portions of the system enabled the project team to achieve a durable plaza while preserving the original aesthetic intent of these Modernist icons.

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Note

1. American Society for Testing and Materials, *ASTM C 880, Standard Test Method for Flexural Strength of Dimension Stone* (West Conshohocken, Penn.: ASTM International, 2009).

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