Hoffmann Architects

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JOURNAL

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How To Retrofit a Terrace or Plaza

John J. Hoffmann, AIA and John D. Kennedy

Few building amenities can rival a well designed terrace or plaza, particularly in a dense urban setting. The concept of a terrace or plaza in the form of a roof garden dates back to biblical times, but since the 1960's we have seen an increasing utilization of terraces and plazas over occupied spaces, especially in major urban areas in the United States.

Big Amenity, Big Retrofit Job

As great an amenity as a terrace or plaza can be, when it becomes necessary to rehabilitate or retrofit the area, it can also present immense challenges.

In any horizontal waterproofing project—such as a roof, garage, terrace or plaza—the keys to a quality job include specifying the right system, selecting a capable contractor, and having a quality control representative on the job to assure proper installation.

In terrace and plaza rehabilitations, these requirements take on special meaning because the waterproofing system is typically buried below tons of planters, pavers and other aesthetic elements leaving no room for error and no way to go back in and correct a leak.

The Proper Slope

Before any system is selected, a key requirement is having a substrate which slopes to drain off the surface. 1/4 inch per foot of slope is the minimum. If primary drainage occurs at the paving surface, the slope should be increased to 1/2 inch per foot. Adding slope can present real difficulties in plaza rehabilitation projects.

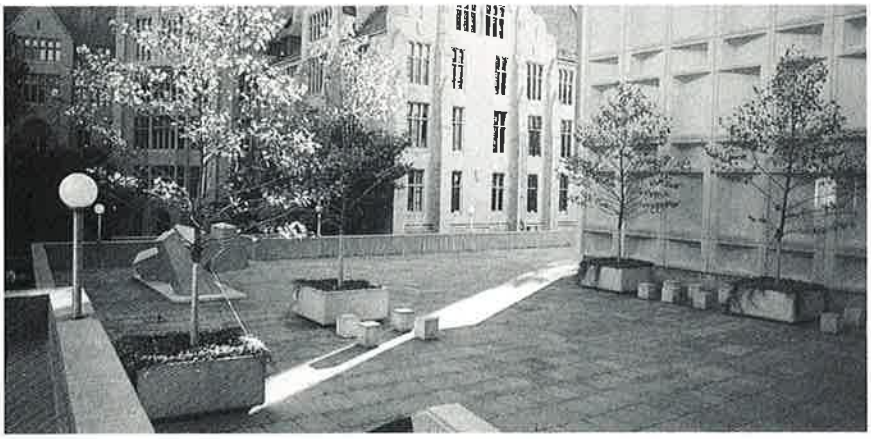
Many original concrete structural slabs and wear surfaces were constructed dead level, leading to waterproofing problems. To correct these problems and provide adequate drainage, a slope fill must be added. This process is very expensive and time-consuming. Even a low moisture content material such as polymer modified concrete requires a curing period, and the occupied space below must be maintained watertight during construction. Edge conditions, flashings, and the load bearing capacity of the structure also limit what can be added over an existing deck.

At the time a slope is added, a drainage system must be constructed as well. There are basically two types of drainage systems used with a fully-adhered system in a terrace or plaza. The first is called an open system; the second, a closed system.

Courtesy / Unilever United States, Inc.

Lever House departed dramatically from the 1952 Midtown Manhattan norm by allotting almost seventy-percent of its air space to a third floor roof terrace which is currently undergoing major renovation.

An authority on the rehabilitation of existing facilities, Mr. Hoffmann is Principal and Founder of Hoffmann Architects. As Project Manager, Mr. Kennedy oversees roof, plaza and facade rehabilitation projects for the firm.



Open Joint: Becton Center Plaza at Yale University designed by Marcel Breuer.

- *The open system.* In this system, the waterproof membrane will either adhere to the substrate or to an insulation layer which may or may not be sloped. There may also be a protection board on top of the membrane, a drainage board, and finally a high density insulation board. Then a wear surface is put in place which may be a unit material with pedestals at the corners of the units. Water runs between the unit pieces and drainage occurs within the cavity. This is an effective drainage system particularly if there is a good slope.

- *The closed system.* In a closed system the waterproofing membrane is adhered directly to the substrate and insulation layer is applied on top of the membrane. In other situations, the insulation layer may be below the membrane. The insulation layer may or may not be sloped. Over the insulation is a drainage layer of a loose and granular material which also acts as a setting bed. On top of the drainage layer is poured concrete or a unit paving system such as quarry tile, stones or even precast concrete.

Drainage to some extent takes place at the surface level, preventing water from draining down into the layers below the wear surface. While drains are required at the surface to remove water, they should also be installed at the membrane level. In many situations, bi-level drains are not specified, creating the equivalent of a dam at the membrane level for water that has moved below the wear surface.

Making the Right Choices

Although many different waterproofing systems are available for horizontal waterproofing projects, in terraces or plazas good waterproofing practice dictates the use of a system fully-adhered to the concrete substrate. Why? If a leak should develop in the membrane—whether it is a split or a pinhole leak—the water will not easily migrate to other areas of the substrate below the waterproofing but will remain localized. This minimizes the number and severity of water leaks that will be experienced in a building.

Using a fully-adhered system, however, somewhat narrows the choice of a membrane from what might be used on other horizontal waterproofing jobs. Environmental factors and owners' requirements make BUR systems (mopped or torch applied) impractical for most plaza rehabilitation projects. This narrows the choice to the two types of single-ply waterproofing which are fully adhered: sheet waterproofing and liquid waterproofing. Here are details on each:

- *Sheet membrane.* The polymer modified sheet has good self-healing properties and adheres well. The sheet membrane can also withstand standing water, although it is best to eliminate any possibility of water collecting.

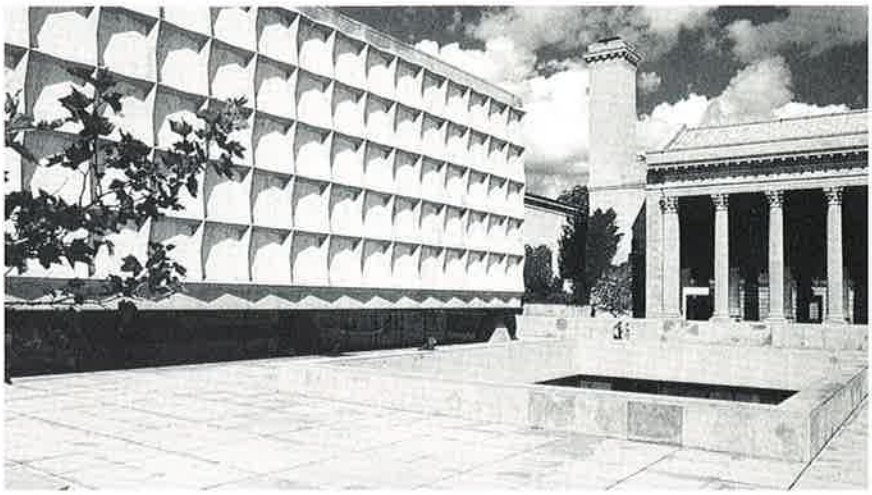
While open joint plazas have many practical and visual advantages, maintenance is important to prevent debris (in this case, pine needles) from clogging the joints and drainage system underneath.

Open joint plaza slabs are relatively easily removed and replaced for inspection, cleaning, and repair. Lack of mortar joints eliminates many maintenance problems common in closed system plazas.

- *Liquid membrane.* The liquid systems (polymer modified bitumen, synthetic rubber, urethane, etc.) can present special problems in a retrofit job because of poor adhesion if the substrate is moist.

Terrace membranes are typically protected by pavers or a cast-in-place concrete wearing surface. Most of these sheet and liquid systems need this protection from ultraviolet exposure and physical impact exposure.

"Few building amenities can rival a well designed terrace or plaza, particularly in a dense urban setting."



Closed Joint: Beinecke Library Plaza at Yale University designed by Skidmore, Owings & Merrill. A Noguchi sculpture garden below the street level plaza is partially visible in the foreground.

The Issue of Planters

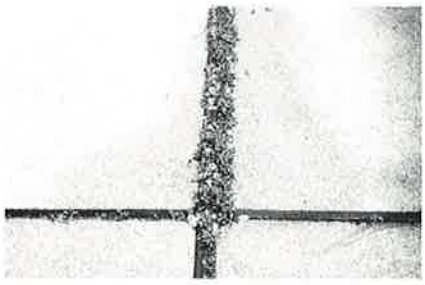
While a flat terrace can pose a challenging problem in a terrace renovation, another issue is planters on the terrace. The planters must be waterproofed, and they must be drained. Sediment must be filtered so that it does not build up and block the drains. Often the existing planters have no slope, although slope is just as essential there as on the deck itself.

In many terrace renovations, drains must be added to the planters because the original plan made no provision for drainage. Within planters, there can be a closed drainage system that ties the planters into a pipe system or an open system that empties onto the deck. Proper drainage of the planters is necessary to assure the success of the waterproofing system as well as the viability of the plants themselves. One major concern with planters is the potential for structural failure due to the weight of a large build-up of water within the planters.

Trend to Terraces and Plazas

The rising cost of land, zoning laws that provide floor area bonuses for public amenities, increasing density of buildings in urban areas and the competition for rental dollars will probably continue to encourage the development of terraces and plazas over occupied space. Along with this increase will come greater challenges on the part of asset managers and owners, architects and waterproofing contractors to keep the building areas below the terraces and plazas dry and protected from the elements. ■

Photographs by Kenneth Labs are reprinted with permission of Progressive Architecture, Penton Publishing.



Resilient fillers were provided in this closed joint plaza to take up thermal movement, but some joints have opened over time–pointing out the need for a secondary drainage system under the plaza surface.

Closed joint plazas are separated into individual watersheds. Increasing the pitch of the surface immediately surrounding the drain can prevent puddles from spreading too far when drains clog, as they often do.

Verdant Roofs

Roofs may be planted with ground cover, shrubs, trees, and other ornamentals. Some designers "roll" the terrain to accommodate differing needs, and sometimes the grade is held level at the greatest depth required. Various lightening devices such as foam blocks and capped void tubes have been used under shallow-rooted plants to reduce the weight and volume of soil required when a level surface is maintained. Lightweight soil mixes are also used, but these may provide inadequate "ballast" for tree roots under windy roof-top conditions.

According to Brian Mitchell, a landscape architect with POD/Sasaki, the weights of landscape materials (overburden" loads) often are not fully appreciated by architects. He recommends that the landscape designer be brought into the project early on and have direct communication with the structural engineer. This sentiment is shared by Theodore Osmundson, a long-time advocate and practitioner of roof garden design.

Excerpt from "Technics: Roofs for Use" by Kenneth Labs, Progressive Architecture.

Mitchell notes that the major share of load from containerized plants is the weight of the soil and planter, both of which are easily determined. Heavy, saturated soils can weigh in excess of 120 pounds per cubic foot, while moist but well-drained soils weigh in around 100 pounds per cubic foot.

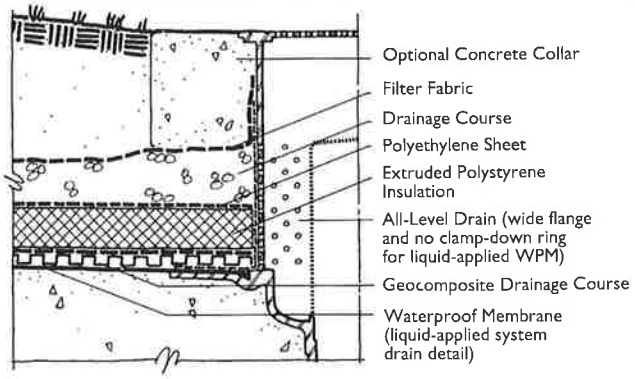
Little information is available about the weight of very large trees, although foresters have developed different means of estimating the biomass of woodland trees. Researchers at the University of Maine, for example, have devised an equation that predicts the live weight of forest trees. How these predictions relate to trees grown in the open is unknown. One would expect lawn trees to be more densely branched and foliated, so the equation may significantly underestimate design loads.

"Browning off" is a very common (and preventable) failure of turf on roofs which occurs when the plant cannot extract sufficient moisture from the soil. Turfgrass is capable of rooting to depths of 12 to 16 inches, but studies have shown that 60 to 80 percent of the roots (by weight) are concentrated in the upper 4 to 5 inches of soil.

While one foot of soil is adequate for most ground covers, this thickness has little water storage capacity to carry plants through drought periods—and there is no subsoil from which to supply moisture by capillary rise. Irrigation is part of—but not entirely—the solution.

Ironically, too much water, poor drainage through the soil profile, and foot compaction can all hinder development of a deep and healthy root system, which is necessary to sustain plants through drought periods. Turf growing in soggy soils, therefore, may brown off sooner during a drought than turf in more ordinary soils.

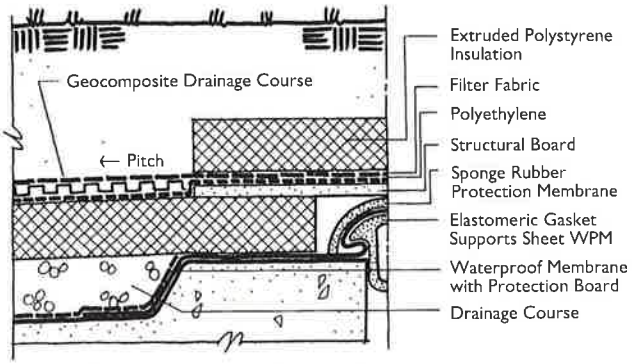
Some lessons can be learned from the design of golf greens, especially for highly trafficked lawns. Greens are typically soilless—the growing medium is



Adapted from NAVFAC DM 1.4 by Kenneth Labs, *Progressive Architecture*

All-Level Drain, Earth-Covered Roof

All-level drains collect water from all strata within the roof section. The grade level inlet is not really necessary, but it helps locate the fixture for maintenance.



Expansion Joint, Earth-Covered Roof

Soil is capable of taking up some deck movement, so expansion joints do not necessarily have to be carried through to the surface.

75 to 80 percent sand, and the balance is an organic amendment such as peat, rice hulls, or sea weed to improve water holding capacity (super-absorbent polymers that hold up to 500 times their weight in water are marketed for horticultural use and could be used as an amendment for roof soils).

This lush, well-manicured roof garden atop the International Building at Rockefeller Center recently underwent major renovation that included restoring the original planting design, resetting stone walls, and installing new sprinkler and drainage systems.

According to Michael Hurdzan, a golf course architect trained as a plant physiologist, the objective is to drain the "soil" section (typically 12 to 14 inches) as quickly as possible, and to supply the necessary moisture as needed by irrigation. The greens surface is pitched 3 percent or more; the "soil" is underlaid with a gravel bed and pipe subdrainage system, and a surface water infiltration rate of 15 percent is desirable—although this is not a hard and fast rule.

There are other, more water conservative approaches to greens design that make use of a subsurface water reservoir to supply moisture. Landscape architect Jake Frankhouser describes

continued on page 6

The Facility Manager's Bookshelf: **Plaza Decks**

Note: This subject includes membrane waterproofing, insulation and pavers installed to form a plaza, promenade deck or roof garden.

A. ASTM

ASTM STP 1084 ***Building Deck Waterproofing*** (1990). Editor: L. E. Gish, 150 pages. $52.00 (no shipping/handling charge for prepaid orders). For ordering from ASTM: PCN 04-010840-10; (215) 299-5585, FAX (215) 977-9679 (Amex, Mastercard, VISA accepted). ASTM, 1916 Race Street, Philadelphia, PA, 19103-1187. For ordering from your local bookstore: ISBN 0-8031-1384-6.

B. CSI

Construction Specifications Institute
Specifier Reprints
601 Madison Street
Alexandria, VA 22314-1791
(703) 684-0300

Cost: $4 each, $10 minimum, VA residents add 4.5% tax.

1. Estenssoro, Luis F. and William F. Perenchio. "Failures of Exterior Plazas." ***The Construction Specifier,*** January 1991, pp. 75–83 (Vol. 44 No. 1).
2. Monroe, David C. "Waterproofing Principles for Concrete Decks." ***The Construction Specifier,*** December 1990, pp. 64–74 (Vol. 43 No. 12).
3. Petersen, Wayne. "Solving Problems with Protected Membrane Roofing." ***The Construction Specifier,*** November 1985, p. 78 (Vol. 38 No. 11).
4. Ruggiero, Stephen S. and Dean A. Rutila. "Plaza Waterproofing Design Fundamentals." ***The Construction Specifier,*** January 1991, pp. 75–83 (Vol. 44 No. 1). Excellent article.

C. For information about standard weight 2' x 2' pavers:

National Precast Concrete Association
825 East 64th Street
Indianapolis, IN 46220
(317) 253-0486

Publication available: ***A Perfect Way to Pave***

D. Miscellaneous Articles

1. Labs, Kenneth. "Technics: Roofs for Use." ***Progressive Architecture,*** July 1990, pp. 35–42.
2. Osmundson, T. "Roof and Deck Landscaping." Section 610, ***Time Saver Standards for Landscape Architecture.*** McGraw-Hill, 1988. Direct inquiries to: (800) 2-MCGRAW.

Compiled by Alan Eddy, Technical Librarian ■

Ten Challenges of Terrace and Plaza Rehabilitation

Terrace and plaza rehabilitation projects present at least 10 special problems and challenges seldom encountered in roof, parking deck or other horizontal waterproofing projects.

Aesthetic requirements. Because terraces and plazas are viewed and used by many people, whether at grade level or roof level, they require great attention to aesthetic detail.

Warranty protection. On a roof project, an owner can get as much as a 20-year system warranty including roof membrane, insulation, and ballast. Most manufacturers do not offer a full system warranty on labor and materials for terraces and plazas.

Exposure to traffic. Terraces are exposed to constant traffic, creating the threat of potential damage to the waterproofing system even if it is a protected system. This damage could come from cigarette butts causing a fire below the pavers or broken glass falling between spaces in the unit material and damaging the system.

Safety factors. Because a roof is exposed to relatively little traffic except from contractors required to work on it, there are few safety hazards to consider. On a terrace or plaza, however, one must constantly look for tripping hazards and anything else that could cause injuries.

Load-bearing systems. Unlike roofs, terraces and plazas require special consideration of load bearing capacity. Typically, terraces must support the weight of people, pavers, planters, and window washing equipment. Additionally, the local fire department often requires that a grade level terrace support fire equipment in an emergency.

Planters. Quite often the aesthetic requirement of a terrace will be fulfilled in part by the addition of planters. These planters could either sit on top of the membrane or paving system or become an element of the terrace structure. Typically, they create waterproofing problems and can affect drainage.

Access to waterproofing layer. Gaining access to the waterproofing layer is much more difficult and expensive in a completed plaza or terrace than in a roof. For instance, a layer of poured-in-place concrete paving applied to the top of a waterproofing layer can make it virtually inaccessible. Although top quality performance is required in all horizontal waterproofing projects, terraces and plazas demand a far more conservative approach than roofs and parking decks.

Flashing. While flashing is a potential weak point on any horizontal waterproofing job, it presents unusual demands in a plaza where it is often expected to occur below the walking surface or be hidden in some other way.

Debris removal. In terrace or plaza renovations, considerably more material must be removed from the site than is normally required for a roof renovation. The paving system, for example, must be removed to access the waterproofing. In a dense urban setting or in an occupied building, noise and dust must be minimized over a considerable period of time, resulting in costs and logistical problems not found in typical roof renovations. If planters need to be waterproofed, all plants and planting materials must first be removed.

Costs. Terraces are usually more than twice as expensive as roofs to rehabilitate. In raised terraces on highrise buildings in dense urban areas, the costs for removals and hoisting can increase the costs dramatically. ■

—John J. Hoffmann, AIA and John D. Kennedy

Verdant Roofs

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how the "PURR-Wick" (plastic under root reservoir with wick action) system for golf greens can be adapted for roof garden applications in the November 1980 issue of *Landscape Architecture*. Soilless greens, however, do require regular fertilizing and a diligent greenskeeper.

Donald Olson, a landscape architect with Sasaki Associates, suggests that overwatering is often more of a problem on rooftop landscapes than drying out and notes that irrigation systems ideally should be triggered by a soil moisture sensor, and not by a timer. He also points out that thought needs to be given to the long-term maintenance of plant materials and whether or not the contractor is knowledgeable enough to spot problems as they develop.

All this concern for maintenance is antithetical to the sympathies of many earth-covered building advocates, who see planted roofs as an environmental conservation strategy. The use of low maintenance and indigenous plant material for roof garden design are described in the University of Minnesota's Earth Sheltered Residential Design Manual. ■

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REPRESENTATIVE PROJECTS

Plaza and Terrace Rehabilitation

Hoffmann Architects specializes in the rehabilitation of the exteriors of existing facilities.

A major portion of the firm's practice involves the diagnosis and solution of deterioration and water infiltration problems within plazas, roof terraces, setbacks, and courtyards over occupied space.

Hoffmann Architects avoids many of the pitfalls usually associated with rehabilitation of plazas and terraces over occupied space by treating them as ROOFS which need special protection from traffic rather than simply as platforms for pedestrian and vehicular traffic.

The firm's architects and engineers pay the same attention to flashings and waterproofing details in rehabilitating plazas and terraces as they do in repairing and replacing roofs.

Hoffmann Architects has provided plaza deck, roof terrace and courtyard rehabilitation services for such prominent facilities as:

Rainbow Room Terrace
Atop GE Building (RCA Building)
New York, New York
(Rockefeller Center Management Corporation)

Cannon and Rayburn House of Representatives Office Buildings
Washington, District of Columbia
(The Architect of the Capitol)

Beinecke Rare Books Library
New Haven, Connecticut
(Yale University)

Ford Foundation Headquarters
New York, New York
(The Ford Foundation)

Albert Einstein College of Medicine
Bronx, New York
(Yeshiva University)

Cadbury Schweppes Headquarters
Stamford, Connecticut
(F.D. Rich Management Company)

Lever House
New York, New York
(Unilever United States)

Mendenhall Center for the Performing Arts
Northampton, Massachusetts
(Smith College)

Atria Complex Plaza
Garden City, New York
(Chase Manhattan Bank, N.A.)

Executive Plaza
Hunt Valley, Maryland
(Prudential Insurance Company of America)

Bank of New England Headquarters
Boston, Massachusetts
(The Prudential Insurance Company of America)

Williams Center Plaza
Tucson, Arizona
(Hartford Insurance Group)

Landmark Square Plaza
Stamford, Connecticut
(F.D. Rich Management Company)

NYNEX Facility
White Plains, New York
(NYNEX Properties Company)

One Champion Plaza
Stamford, Connecticut
(Champion International Corporation)

United States Capitol Terrace
Washington, District of Columbia
(The Architect of the Capitol) ■

Staff News

Publications:

John J. Hoffmann, AIA wrote "The Building Envelope," a chapter for the Building Owners and Managers Institute's RPA Course #1–The Design, Operation and Maintenance of Building Systems. Alan Eddy provided research assistance.

Theodore F. Babbitt, AIA's masonry restoration article, "Repointing Mortar Joints," which appeared as a Technics Feature in the October 1990 issue of Progressive Architecture, tied for first place in reader interest during 1990 in an independent poll conducted for the publication. "Repointing Mortar Joints" was reprinted in the Spring 1991 issue of The Applicator, a publication of the Sealant, Waterproofing & Restoration Institute.

Arthur L. Sanders, CSI contributed to the article, "Hoffmann Architects Does Study for U.S. Capitol Dome Problem," which appeared in the March/April 1991 issue of CSA/AIA News.

Bruce R. Soden's article, "Taking Steps to Preserve Concrete Structures" appeared in the March 1991 issue of Weathervane, a publication of The Western Group.

New Staff:

Hoffmann Architects is pleased to introduce the following new staff members. A former partner at DiSalvo Associates, **Arthur L. Sanders, CSI** has joined the firm as Project Manager. **Anna M. Atocha** has joined Hoffmann Architects as Drafter/Project Representative. **Brenda C. Cummings** serves as Secretary at the firm's New York City office. ■

Hoffmann Architects Conduct Roofing Workshop

On 29 May 1991, Russell M. Sanders, AIA and John C. Butters, AIA conducted a BOMA/NY Roofing Seminar at The Manufacturers Hanover Trust Building in New York City.

Brian W. Schafer introduced the speakers who offered practical advice on the diagnosis, solution and prevention of problems in commercial roofing systems, particularly as they pertain to New York City.

Discussion explored the following topics:

- Causes of Roof Failure
- Asbestos in Roofing
- Reroofing Options
- When and Why to Reroof
- Repair vs. Replacement
- Costs of Reroofing
- Plazas and Terraces
- Alternate Roofing Systems
- Warranties and Guarantees
- Contractor Selection
- Contract Documents
- Bidding Requirements
- Inspection and Maintenance

Members and guests of the Building and Managers Association of New York attended. ■

JOURNAL is a publication of Hoffmann Architects, specialists in investigative and rehabilitative architecture/engineering, including the analysis and solution of problems within roofs, exterior walls, glazing and structural systems of existing buildings, plazas and parking garages.

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For answers to specific questions or for information on the services we offer, please call Brian Schafer at (203) 239-6660.

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