Solving the Waterproofing Puzzle: Plaza Decks and Green Roofs

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Learning Objectives

1. Avoiding common pitfalls.
2. Review waterproofing design concepts and industry standards.
3. Review waterproofing fundamentals and integration with various building elements and flashing conditions.
Acknowledgements / Credits

- American Hydrotech, Inc.
- ASTM International
- City of Chicago Energy Code
- National Roofing Contractors Association (NRCA)
- Sika Sarnafil, Inc.
- Siplast
- Soprema, Inc.
Outline

• What is Sustainable Waterproofing?

• LEED Rating Systems

• Examples of Integrated Green Roofs and Plazas

• Waterproofing Concepts for Green Roofs and Plaza Decks

• Conclusions
Sustainable Waterproofing

A waterproofing system that is designed, constructed, maintained, rehabilitated, and demolished with an emphasis throughout its life cycle on using natural resources efficiently and preserving the global environment.

Proceedings of the Sustainable Low-Slope Roofing Workshop
Oak Ridge National Laboratory, October 1996
Waterproofing

Treatment of a surface or structure to prevent the passage of water under hydrostatic conditions.

1” of water = 5.2 Lbs/ft$^2$

Waterproofing must be able to:

- Perform in a constantly wet environment
- Resist mild acids, alkalis, salts, and soil contaminates
- Best applied directly to structure
Roofing vs. Waterproofing

Roofing Systems
- Resist ultraviolet radiation
- Resist temperature variation
- Accessible for maintenance and repair
- Moderate costs to re-cover or replace

Waterproofing Systems
- Resist standing water and hydrostatic pressure
- Usually covered with overburden
- Restricted access for repairs can be costly to replace
Protected Membrane Assembly

- Pavers or rock ballast on extruded polystyrene insulation over waterproofing membrane
- Minimize thermal cycling on membrane
- Protect against UV
- Protect against physical damage

Membrane must resist constantly wet conditions.
Sustainable Waterproofing Concepts

• Extend building and roof life span by improving long term performance
• Conserve energy by improving thermal efficiency of green roofs and plaza decks
• Minimize environmental burden by responsible use of earth’s natural resources

Tom Hutchinson
Hutchinson Design Group
LEED

The Leadership in Energy and Environmental Design (LEED) green building rating system was initiated by the U.S. Environmental Protection Agency and private industry.

Awards program based on points earned for sustainable design:

- Platinum
- Gold
- Silver
- Certified (primarily for new construction)
### Possible LEED Points at Rooftop

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
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<tbody>
<tr>
<td>Storm Water Management (rate and quantity)</td>
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<tr>
<td>Storm Water Management (treatment)</td>
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<tr>
<td>Heat Island Effect (roof)</td>
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<tr>
<td>Innovative Wastewater Technologies</td>
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<td>Recycled Content</td>
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<tr>
<td>Local/Regional Materials</td>
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<tr>
<td>Certified Wood</td>
<td>1</td>
</tr>
<tr>
<td>Low Emitting Materials</td>
<td>2</td>
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<tr>
<td>Innovation in Design</td>
<td>1</td>
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<tr>
<td><strong>Total Possible Points</strong></td>
<td><strong>14</strong></td>
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</table>
Green Roof and Plaza Benefits

- Storm water management
- Reduce rooftop temperatures
- Improve air quality
- Mitigate urban heat island effects
- Aesthetic enhancement
- Community green space
- Enhance ecological balance
Energy Performance

According to the Department of Energy (DOE), energy use by buildings accounts for approximately 40 percent of all energy consumption in the United States.
Millennium Park  Chicago, IL
Types of Plaza’s and Green Roofs

- Plaza Decks and Terrace
  Pedestrian and/or vehicular use

- Extensive
  Low maintenance, non-recreational, with shallow soil depths (integrated or in containers)

- Intensive
  Wide range of vegetation, recreational with deeper soil beds (integrated)
Code Issues

• **IBC Section 1607 Live Loads**: Roof gardens and roofs for assembly to have 100 psf live load, plus dead load.

• **IBC Section 1607.11.2.3 Landscaped Roofs**: Minimum 20 psf live load, in addition to the dead load (saturated soil).

• Fire resistance and protection, and wind uplift ???
Intensive Green Roof and Plaza Deck
Extensive Green Roof/ Plaza Deck
Intensive Green Roof/ Plaza Deck
Sustainable Concepts for Waterproofing Green Roofs and Plaza Decks

• **Design:**
  Materials selection and reference standards
  (ASTM, NRCA, Manufacturers’ Literature, others)

• **Detailing:**
  Improve performance and durability

• **Construction:**
  Protection, sequencing issues, and testing of waterproofing membrane for longevity
Green Roof Waterproofing

- Structural considerations
- High performance waterproofing membrane
- Membrane adhesion (adhered to deck or loose laid)
- Membrane protection (root barriers, protection slabs, etc.)
- Thermal insulation (above vs. below the membrane)
Material Issues

- Robust roof deck
- High performance waterproofing membrane
- Protection course
- Insulation
- Drainage course
- Water retention layer
- Filter layer(s)
- Selection of soil and overburden for green roofs and wearing surfaces for plazas
Green Roof System Components

- Vegetation
- Growing medium
- Filter fabric
- Air/water reservoir
- Water retention layer
- Drainage mat
- Rigid insulation
- Root barrier
- Waterproofing membrane
- Structure
Plaza Deck Waterproofing
Plaza Deck Waterproofing Considerations

- High performance of waterproofing membrane
- Adhered or loose laid waterproofing membrane
- Resistance to standing water and hydrostatic pressure
- Ability to accommodate vehicular and/or pedestrian loading
- Provide access for repairs
High Performance Waterproofing Membrane (Hot Applied Rubberized Asphalt)
High Performance Waterproofing Membrane (Modified Bitumen)
High Performance Waterproofing Membrane (Loose Laid Sheet with Adhered Grid Strip)
Design and Construction Issues

- Establish and coordinate slab elevations and flashing tolerances
- Accommodate movement at walls and structural changes
- Provide slope to drain, or add supplemental drains
- Specify high performance waterproofing membrane
- Elevate vulnerable elements above membrane level
- Maintain flashing clearances
- Provide redundancy in flashing details
- Provide protection for base flashings
- Extend flashing above the wearing or overburden surface
- Provide flashed chases as future raceway for utilities
- Design considerations for planters
- Building code issues

ASTM standards, NRCA Waterproofing Manual, ACI 515, and manufacturers’ literature are all excellent resources!
ASTM Standards to Assist Design and Detailing

• **D 5295** Preparation of Concrete Surfaces for Adhered (Bonded) Membrane Waterproofing Systems

• **D 5898** Standard Details for Adhered Sheet Waterproofing

• **C 981** Design of Built-up Bituminous Membrane Waterproofing for Building Decks

• **C 898** High Solids Content, Cold-Applied Elastomeric Waterproofing Membrane with Separate Wearing Course

• **D 6622** Standard Guide for Application of Fully-Adhered Hot-Applied Reinforced Waterproofing Systems

• **D 6135** Standard Practice for Application of Self-Adhering Modified Bituminous Waterproofing

• **D 6950** Standard Practice for Application of Heat Weldable Attactic Polypropylene (APP) Modified Bituminous Waterproofing Membrane Systems for New Building Decks

• **E 2400** Standard Guide for Selection, Installation, and Maintenance of Plants for Green Roofs
Elevate critical details above the waterproofing membrane and extend the flashing above the finished grade or surface.

Illustration from ASTM C 981
NRCA Standards to Assist Design and Detailing

- NRCA Waterproofing Manual
Slope for Drainage

• Sloped concrete topping slab
• Sloped structural concrete slab
• Supplemental drains
Drains

- Utilize two-stage drains for plaza decks
- Isolate drain from rigid wearing surface
- Filter media should contain fines, sand, and soil
Expansion Joints

• Elevate flashing
• Provide redundant detailing
Walls

- Accommodate differential movement
- Provide sufficient flashing clearance, 8 inches
- Integrate deck flashing with wall system weather barrier
- Redundancy in flashing details
Flashing at Walls

Problem Areas:
- Low Curbs
- Doors and Door Closers
- Integration with Wall Flashing
Doors and Low Height Curbs

- Integration with wall flashing
- Integration with doors
Integration with Walls

• Sufficient base flashing height
• Access for maintenance and future replacement
• Redundant flashing details to accommodate differential movement
Integration with Walls

Problem:
Inadequate coordination between deck and wall system
Access for Future Utilities

FINISHED GRADE

GREEN ROOF ASSEMBLY

REMOVABLE WATERTIGHT LID

UTILITY
ELECTRIC, WATER, SECURITY
WIRING, ETC.

EXTERIOR

INTERIOR
Planters
Planters

07/25/2006
Construction Issues

• Specify temporary membrane to accommodate construction means and methods

• Specify protection of completed high performance waterproofing membrane

• Testing of waterproofing system
  ✓ Flood testing
  ✓ Electronic leak detection using electric field vector mapping (EFVM)

• Third party inspection
Sequencing and Protection

- Temporary membrane
- Initial complete protection followed by flood testing and/or EVFM testing after other trades
Flood Testing

ASTM D 5957
Standard Guide for Flood Testing Horizontal Waterproofing Installations
Electric Field Vector Mapping (EFVM) Testing

High Voltage

Low Voltage
Summary of Water Proofing Design Concepts for Green Roofs and Plaza Decks

Design Issues
- Appropriate Material Selection
- Drainage
- Wall Flashings
- Utility Access
- Anticipating Construction Sequence in the Details
- Maintainability / Future Revisions
- Correct existing deficiencies in related building components and systems

Construction Issues
- Temporary membrane or Ample Protection
- Field Testing of Completed Assembly
  - Flood Testing
  - EFVM (High or Low Voltage)
THANK YOU
Improve Green Roof and Plaza Deck Performance and Durability

- Robust roof deck
- Redundant flashing system and detailing
- Slope and drainage
- Insulation
- High performance waterproofing membrane
- Root barrier
- Filter layers
- Water retention layers
- Soils and plants