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# Outdoor Amenity Space Surfacing Materials and Systems

Hubbard Place, Chicago, IL. Photo: Daniel Weinbach & Partners

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# Outdoor Amenity Space Surfacing Materials and Systems

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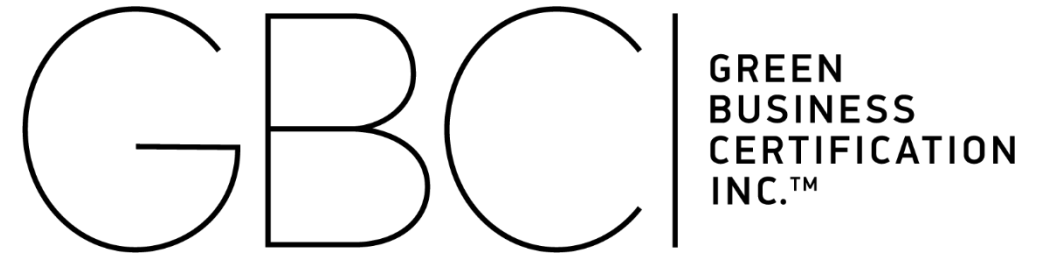
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# Purpose and Learning Objectives

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## **Purpose:**

Over the past few decades, exterior building spaces and roofs have significantly transformed from utilitarian ballasted roof systems to roof systems with highly programmed, environmentally conscious, people-friendly amenities that promote healthier lifestyles. A variety of products and materials can be utilized in the design and construction of roof gardens and decks. This course reviews the construction of basic types of roof systems and the range of hardscaping products that are available to designers.

## **Learning Objectives:**

At the end of this program, participants will be able to:

- identify key sustainability criteria (SITES® and LEED® rating systems) for roof decking systems and outdoor amenity spaces and discuss how the arrangement of hardscape and planting on the roof deck can achieve a harmonious connection to the interior building amenities
- review the basic types of roof systems and evaluate the materials used in roof deck design in terms of their structural performance, durability, and sustainability
- explain the evolution of ballasted roof systems to outdoor amenity spaces and discuss how these areas can benefit the environment and human health and well-being, and
- examine the available customization options for concrete tiles and slabs on roof decks and outdoor amenity spaces.

# Contents

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Introduction

Roof Deck Systems

Installation Options

Material Selection

Wall Systems

Case Studies

Conclusion







# INTRODUCTION

# Outdoor Amenities in Urban Areas

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Real estate studies show that urban housing demands are on the rise. Members of the baby boomer generation looking to retire seek smaller residences that are easier to maintain and desire being in urban areas where they can readily access public transit, quality medical care, and other lifestyle preferences.

Members of the millennial generation want the convenience of living and working in urban areas that offer a wealth of amenities and a variety of transportation or walkable options.

As the demand for urban housing increases, developers are expected to provide more and better amenities that add value to housing properties and entice potential renters and urban home and condominium buyers.

# Roof Decks and Terraces: Must-Have Amenity Spaces

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Roof decks and terraces are now a must-have amenity space in urban environments and are easily added without increasing the building footprint by building out underutilized roof space. Roof decks provide outdoor spaces that are easily accessible to residents and can be designed to accommodate social and recreational needs.

New outdoor roofs incorporate a wide variety of site amenities, including patios, dining and bar areas, putting greens, pools, garden spaces, and grilling areas.

# Benefits of Shared Amenity Spaces

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Business owners are also looking for office spaces that offer additional features such as outdoor amenity spaces as they help to increase usable space. Other benefits include contributing to employee well-being by providing the opportunity for employees to get outside and walk or stretch, reinforcing the culture/corporate brand identity of the integration of work and life. With large tech companies, the creation of a professional, creative, and collaborative environment is conducive to better business. Commercial building owners now understand the importance of shared amenities as an attraction for high-quality office tenants, improving their tenant retention and increasing the overall building value.

# Mitigation of Urban Heat

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A roof deck surface can comprise both hardscape materials and green planting areas. Green roof deck areas can benefit the environment and human health and well-being. In doing so, they can contribute to points (a building project achieving certification under the SITES® and LEED® rating systems). The SITES and LEED rating systems are complementary and can be used independently or in tandem.

In large part, roof decks with vegetated and nonvegetated areas can help to reduce the effects from urban heat through the use of light-colored pavement surfaces and planting areas rather than the traditional roof surfaces of dark gravel and asphalt materials.

# Sustainable SITES Initiative®

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Some SITES rating system criteria applicable to a roof deck system include:

## Site Context

- 1.6: Project located in an existing developed area
- 1.7: Project connects to multimodal transit networks

## Site Design: Soils and Vegetation

- 4.9: Reduce urban heat island effect with lighter colors on roof

## Site Design: Materials Selection

- 5.3: Design for adaptability and disassembly
- 5.5: Use recycled content materials
- 5.8: Support transparency and safer chemistry
- 5.9: Support sustainability in materials manufacturing
- 5.10: Support sustainability in plant production

## Site Design: Human Health and Well-Being

- 6.4: Support mental restoration
- 6.5: Support physical activity
- 6.6: Support social connection

# LEED

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Some LEED criteria applicable to a roof deck system include:

## Sustainable Sites

- 5.2: Maximize open space
- 7.2: Heat island effect

Energy and Optimization: Optimize energy performance through reduction of energy demand

## Materials and Resources

- Recycled content
- Regional material



## ROOF DECK SYSTEMS



# Evolution of Roof Deck Systems

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In the evolution of roof deck systems, there are five common types of systems currently used on commercial and large residential buildings. These include:

- conventional ballasted (single-ply) roof systems
- extensive roof gardens
- intensive roof gardens
- pedestal roof systems, and
- outdoor amenity roof spaces.

# Conventional Ballasted Roof Systems

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Conventional ballasted roof systems are the earliest types of flat roof systems and are still in use today. Their design requires a flat roof with slopes of no more than two inches height over 12 inches length (a ratio of 1:6).

These systems commonly consist of a single-ply membrane or a membrane and a substrate material that is loose-laid over a deck, with ballast used to hold the system in place. The ballast is usually a crushed stone meeting ASTM D448, “Standard Classification for Sizes of Aggregate for Road and Bridge Construction.” ASTM D448 stone ranges between 1½ inches to 2 inches.



Lightweight interlocking pavers with integral cementitious coating can also be used as the ballast material. The interlocking pavers provide a smoother walking surface and are more aesthetic than the crushed stone, but in general, these ballast systems are not intended for use other than for servicing of buildings.

# Extensive Roof Gardens

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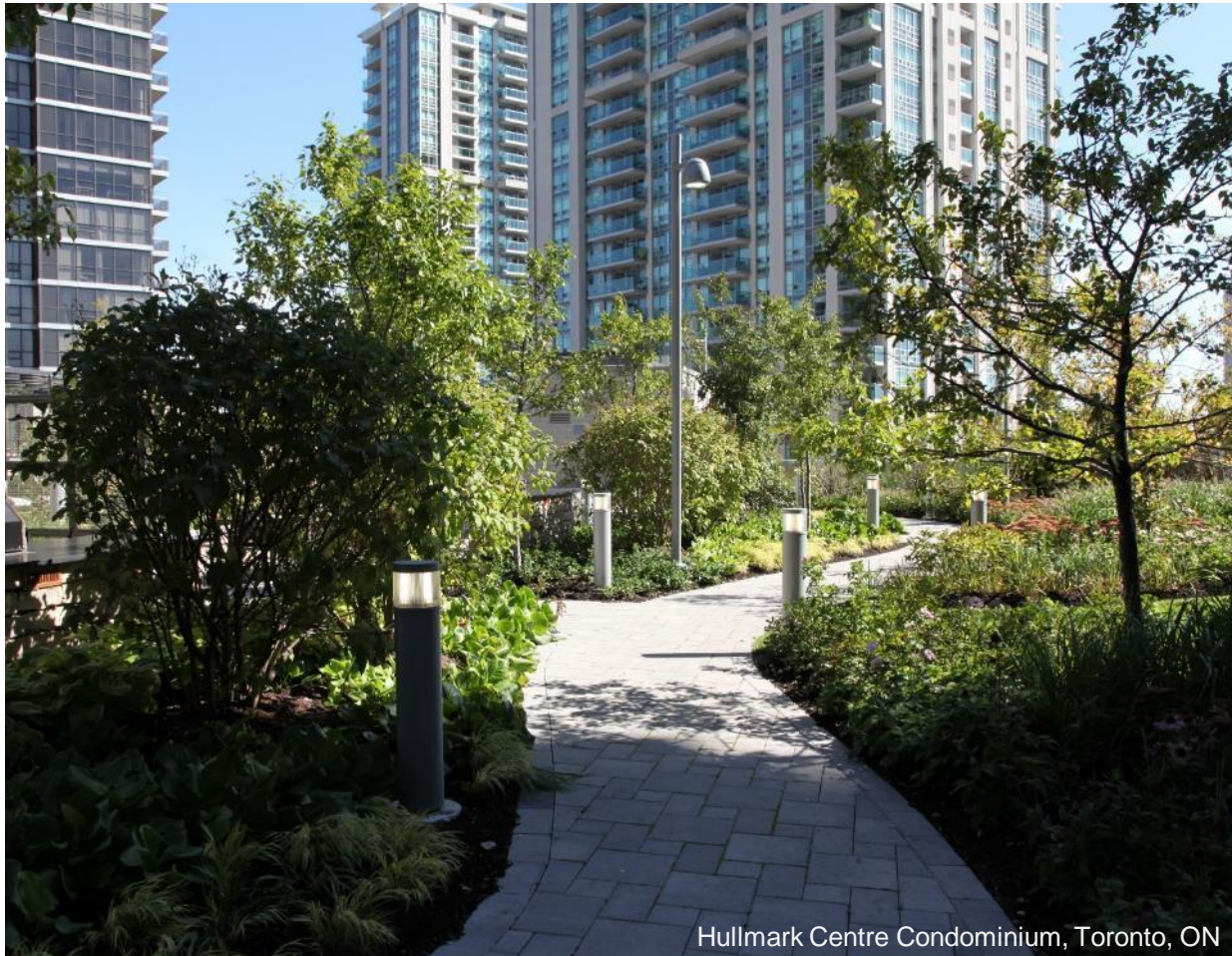
Lake Point Tower, Chicago, IL (1969)

Extensive roof gardens were popular in the late 1960s and early 1970s. They provided many benefits but were very expensive. These green roofs commonly have plants growing in low-profile planting media placed over almost the entire roof. Plantings usually comprise various types of sedums and hardy wildflowers all of which are self-sustaining, have shallow root systems, and do not require artificial irrigation. The plants are grown in a prepared, shallow soil medium within modular trays that are placed on top of a waterproof roof membrane.

Access to and around the roof is provided through small walking paths, so these roofs are not designed for extensive foot traffic. They do provide an energy savings as they help to insulate the building. They also reduce the heat effect of traditional dark asphalt or ballasted roof systems.

# Intensive Roof Gardens

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Hullmark Centre Condominium, Toronto, ON

Intensive roof gardens are similar to extensive green roof gardens in that they are composed of both hardscape and plantings. However, soil depths for plantings on intensive green roofs can range from eight inches up to several feet. The greater soil medium depth allows intensive green roofs to accommodate a wider variety of plant types and species, including large trees.

As these buildings and roof systems are usually designed to accommodate more weight, larger hardscape areas can also be included in the design. With the combination of larger hardscape surface areas and deeper planting areas, intensive green roofs have the potential to provide more outdoor amenities and additional living space on the roof deck.

# Pedestal Roof Systems

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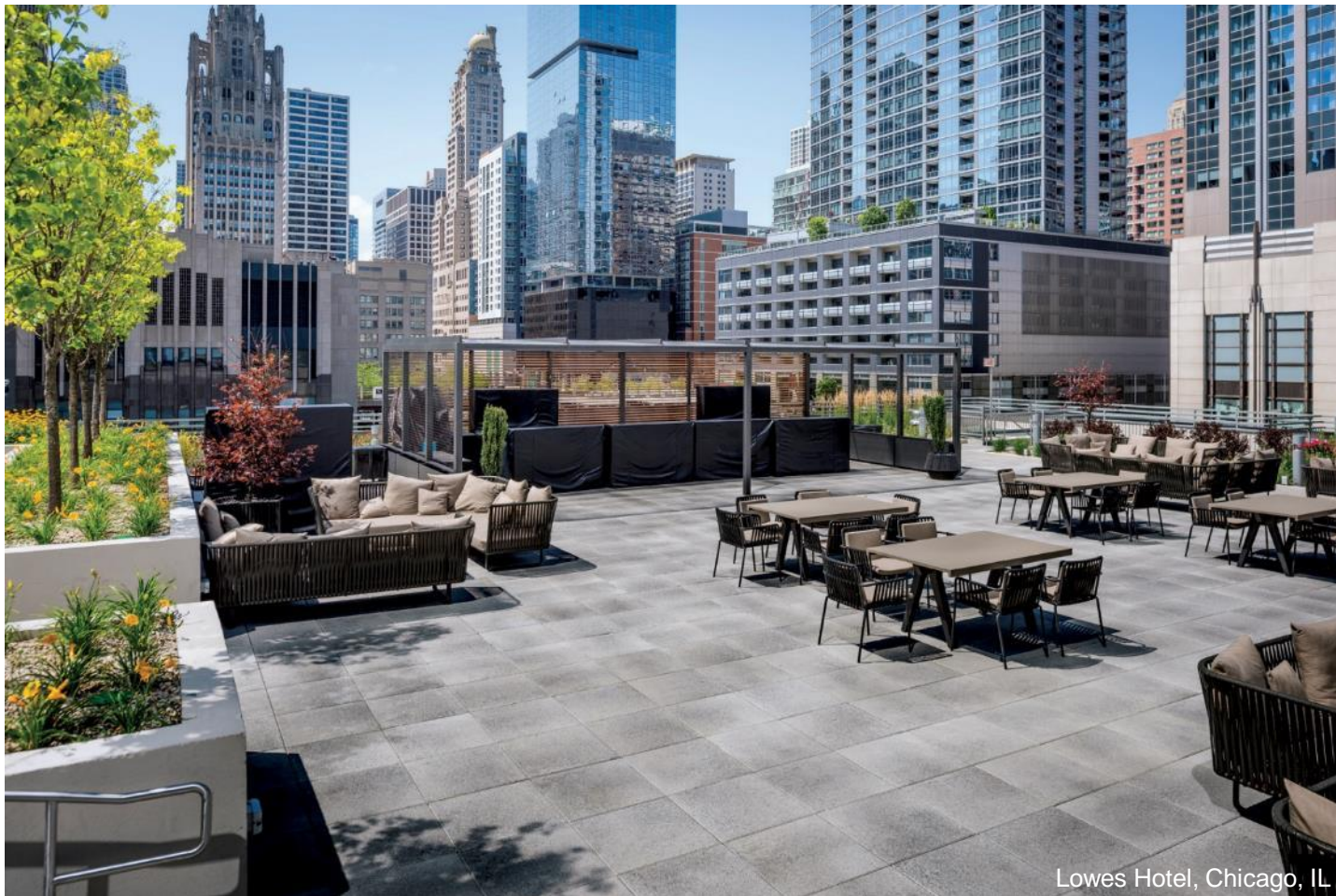


Pedestal roof systems provide a means of creating a level deck space on top of pitched or uneven roof surfaces that would otherwise not be usable. The pedestal deck systems can also conceal roof extrusions and other obstructions, such as pipes, vents, and anchor points.

Pedestal systems allow wood units, stone units, porcelain tiles, natural stone slabs, or concrete slab tiles to be placed on top of a grid of pedestals. For lighter products susceptible to wind uplift, additional fasteners are required to ensure the units stay in place.

# Pedestal Roof Systems

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The placement of a deck surface utilizing a pedestal system allows space between the deck surface and the roof membrane for added insulation as well as room for utilities and irrigation lines for planting areas.

The preferred layout for this type of system is orthogonal. Curvilinear layouts require significantly more pedestals, which can increase cost. The distance between the pedestals can also be constrained by the size and strength of the slabs or panels that they support.

# Combination Roof Systems

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Cuyahoga County Headquarters, Cleveland, OH (early 2000s)

Here is an example of a green roof and a stackable pedestal roof slab ballast system. It has a tray system for live plant material while providing concrete slab walkways and gathering areas with bench seating. It could be more user friendly if it had moveable furniture and key vertical elements to better define space.

# Outdoor Amenity Roof Spaces

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The fifth type of roofing system is in high demand, as it provides owners and developers with greater options for providing outdoor amenities in the multifamily and commercial building markets.

In the past, most outdoor amenity spaces such as patios, grilling areas, and gardens were for large commercial and residential units and located on the ground level. More frequently, these outdoor amenities can now be found on the roof, as developers wish to enhance the marketability of their projects by capitalizing on roof views while also utilizing roof space that would have previously remained as a mechanical space.



# Outdoor Amenity Roof Spaces

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Outdoor amenity roof systems need to be more than just open spaces or large expanses of green roofs, as developers are looking for the opportunity to program these spaces for a wide range of components, such as hardscape patio areas, planting areas, walkways, pet play spaces, fire pits, pools and spas, kitchens, dining and bar spaces, and putting greens.

Real estate market studies have shown that projects offering enhanced outdoor amenity roof spaces may cost more to construct, but they are easier to market, bring in higher rental and sales prices, and retain renters for a longer time frame. The construction of these systems requires careful design and coordination, but developers are seeing potential one-year returns on their investments by including outdoor amenity roof spaces on buildings.

# Outdoor Amenity Roof Spaces

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John G. Shedd Aquarium, Chicago, IL (2009). Photo: Robert Gigliotti

The outdoor amenity space provides the best combination of the intensive roof garden, green roof, and hardscape while still providing water protection for the roof. These are aesthetically pleasing and functional designed spaces.

Design professionals such as landscape architects have experience in the design and arrangement of hardscape and softscape balance to achieve harmonious connection to the interior building amenities.

## Review Question

What is the difference between intensive and extensive roof gardens?



## Answer

Intensive roof gardens are similar to extensive green roof gardens in that they are composed of both hardscape and plantings. However, soil depths for plantings on intensive green roofs can range from eight inches up to several feet. The greater soil medium depth allows intensive green roofs to accommodate a wider variety of plant types and species.





## INSTALLATION OPTIONS

# Construction Options

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There are primarily three construction systems used for amenity roof applications:

- slab on a pedestal system
- slab on a granular base system
- slab on a permeable base system

Although these three are the most commonly used, there are additional methods including mortar set or sand over concrete, rigid insulation, and self-leveling concrete that can be used in the appropriate applications.



College of DuPage Culinary and Hospitality Center, Glen Ellyn, IL (2011)  
The paver on the roof deck was matched with the paver used on-grade.

# Slab-on-Pedestal System

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The slab-on-pedestal system is easy to install and maintain, and provides a system for leveling uneven roofs. Pedestal systems, however, can have size limitations due to load limitations, their limited size, and the required spacing of the pedestals.

These systems start with the concrete structure of a building over which a waterproof membrane is placed. A protection board is then placed on top of the waterproof membrane and insulation is placed on top of this protection board. The support pedestals sit on top of the insulation and the roof slab tiles or units either sit on or are anchored to the pedestals.

The roof slab tiles or units can be made of wood, concrete, stone, or porcelain tile depending on the design intent. It must be noted that some tile or paver products may require a full base tray to support the product against breakage or cracking as a result of impacts or heavy loads.

# Pedestal Options

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There are three basic types of pedestals: fixed height, adjustable, and stackable. The adjustable pedestal systems are the most commonly used as they provide the greatest flexibility.



# Advantages of Adjustable Pedestals

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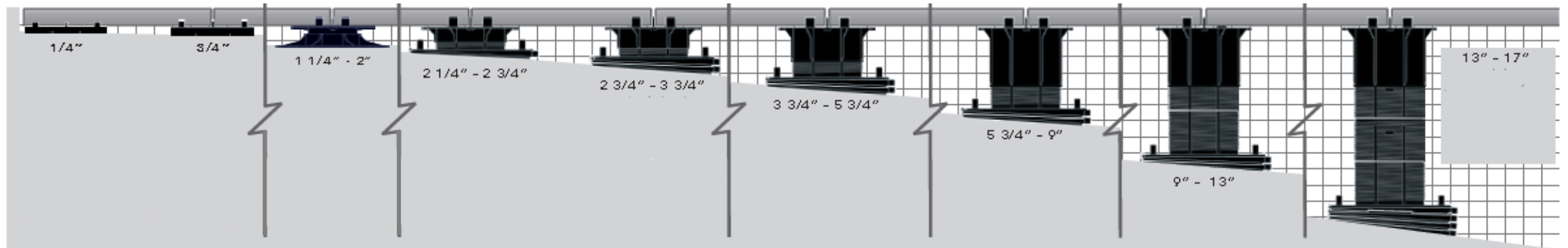
The pedestals can be fabricated of a high-density copolymer polypropylene containing 20 percent postindustrial recycled material. They are impervious to water, mold, and freeze/thaw. They can support loads of 1,250 pounds per pedestal.



# Advantages of Adjustable Pedestals

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The height adjustment can range from 2¼ inches up to 36 inches, and the integrated leveler can accommodate a 0 to 0.5 inch/foot slope.



# Slab-on-Pedestal System

## Conventional or Inverted Roof Membrane Assembly (IRMA) Pedestrian use only

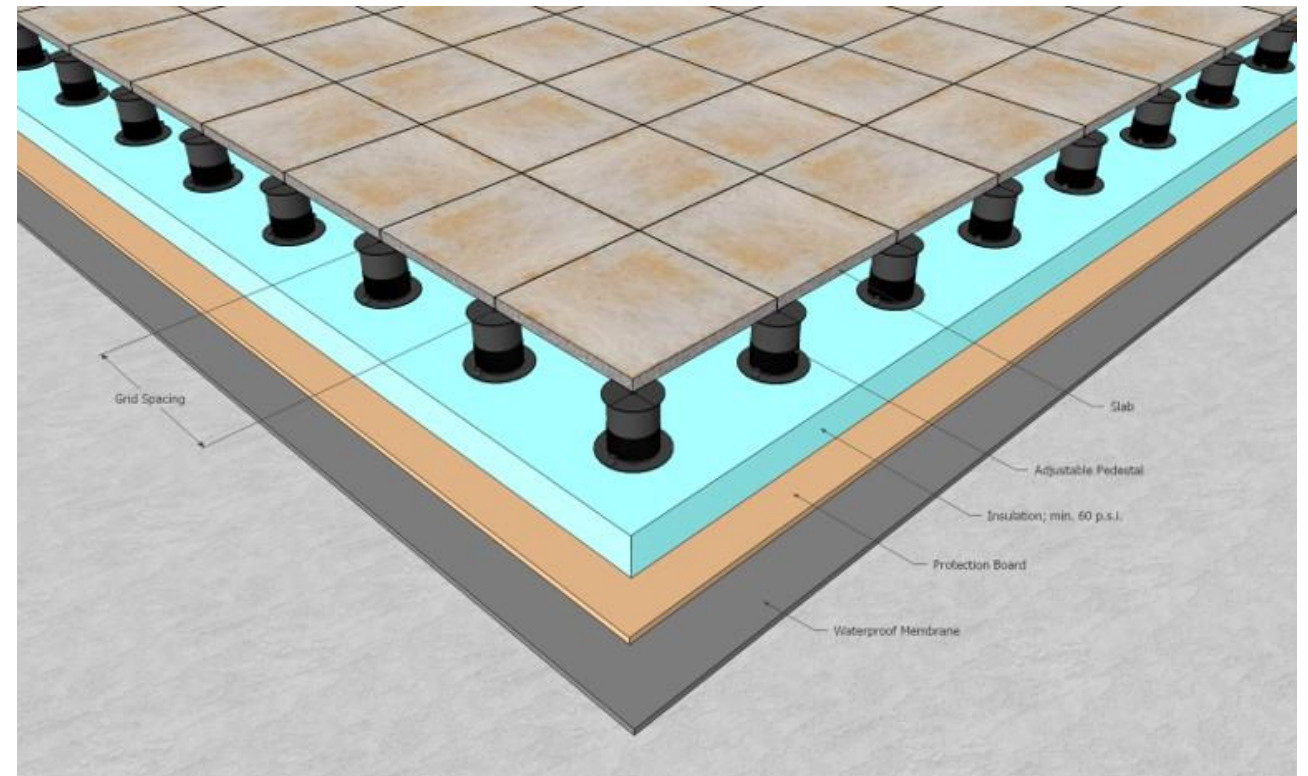
### Level System

The level system is used for a dead level paver surface. This system allows for installation of a level paver surface over various sloping substrates. Pedestals adjust, often by turning on a thread, to create the level slab surface.

### Sloped System

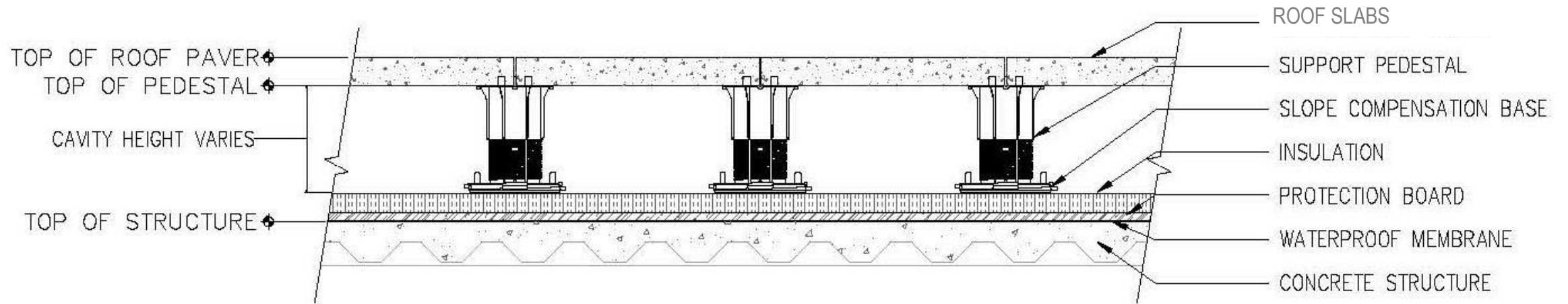
The sloped system can be used when a dead level paver surface is not necessary. Pedestal height is adjusted to accomplish a sloped slab surface when desired.

Pedestals are loose-laid and not attached to the roof assembly. If insulation is used, refer to the insulation manufacturer for psi requirements.



# Example: Cross Section of Slab-on-Pedestal System

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# Pedestal Systems

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# Slab on Granular Base System

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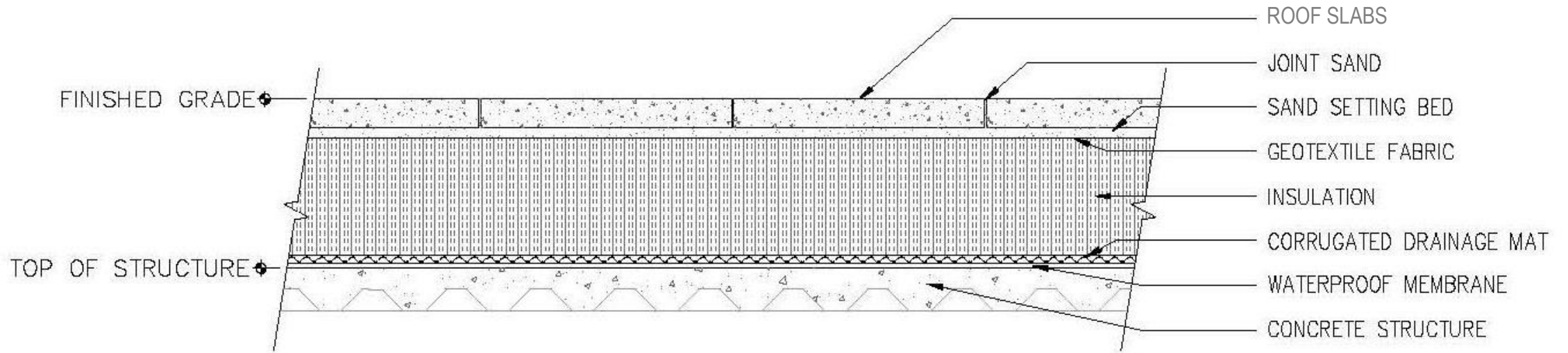


A slab on granular base system is the oldest and most widely used system and is easy to install. There are no size or shape limitations so these roofs can cover large areas. However, slab on granular base can be the most expensive system to install and can be costly if repairs to the membrane are necessary.

The system starts with the building's concrete slab over which a waterproof membrane is placed. A drainage mat is then placed over the membrane, followed by any insulation if required. The drainage mat or roof drain has a geotextile fabric covering to prevent setting bed fines from clogging the drainage area. Roof tiles or pavers are placed on the sand setting bed and held in place with joint sand. In some newer systems, the insulation is placed on top of the waterproof membrane, providing more protection to the membrane from extreme temperature changes and physical damage.

# Example: Cross Section of Slab on Granular Base System

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Slab on sand over insulation

# Slab on Permeable Base System

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A roof system with slabs on a permeable base (chips) can accommodate heavier loads than the pedestal systems. This system also provides optimum drainage, as the permeable chips or aggregates maximize water penetration.

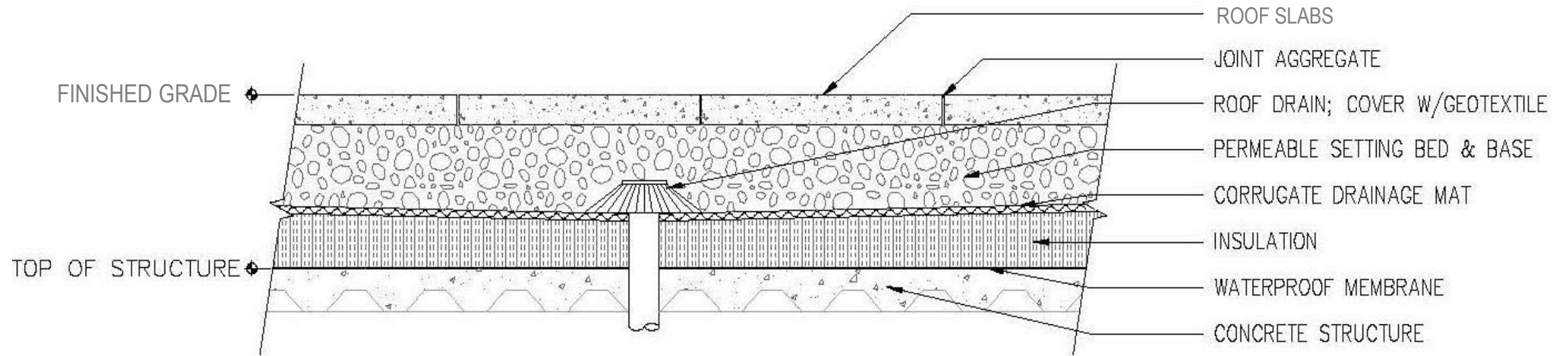
The construction for this system consists of the building's concrete structure, a waterproof membrane, insulation, and a permeable setting bed and base, and is finished with the roof slab tiles or unit pavers.

Existing wood roof structures can also be retrofitted with a roof deck system by adding a structural underlayment to the existing joist and beam structure. Spacer tabs of  $\frac{1}{8}$ -inch thickness are set on the structural underlayment, and the roof tile units (porcelain, stone, concrete) are anchored on top.



# Example: Cross Section of Slab on Permeable Base System

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# All Systems Use a Waterproof Membrane

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Whether the slabs are set on a permeable base roof system or on a pedestal system, the top surface of the roof is still “permeable.” The roof deck shown here is permeable by way of 12-inch x 12-inch and 24-inch x 24-inch set slabs with ¼-inch spacers.

Note: all the systems use a waterproof membrane in their construction to keep water from penetrating through the roof into the building.

# Opportunities and Limitations in Design

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There are opportunities and limitations with each paving system. With the elevated roof slabs on pedestals, utilities can be hidden under the slabs, and the system allows easy access to roof drains and other maintenance. For some buildings, a pedestal system can be a very economical way to transform any exterior roof space. The main limitation of elevated pedestal slab systems is regarding layout. The most efficient size is on a 24-inch grid. However, this grid reduces the design flexibility.

In contrast, the slab on granular base systems and slab on permeable base systems allow for a more dramatic use of material sizes, shapes, and layouts. These systems expand the landscape architect's creative abilities to work off the grid by designing more natural, curvilinear spaces. Certainly, with base material comes an increased cost, but the weight per square foot can also be a limiting factor. Confirming the structural loads is an essential step in the design process.

## Review Question

Which systems require the use of a waterproof membrane?



## Answer

Whether the slabs are set on a permeable base roof system or on a pedestal system, the top surface of the roof is still “permeable.” All the systems use a waterproof membrane in their construction to keep water from penetrating through the roof into the building.





## MATERIAL SELECTION

# Hardscaping Products

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There are four popular products used as slab or paver units in roof deck systems:

- concrete slab tiles
- natural stone
- porcelain tile, and
- wood decking (panel).

Today's wide range of paver products can provide designers with an array of colors, sizes, and finishes for rooftops and pedestal systems. They can transform elevated and sloped roof surfaces into gathering spaces, gardens, plazas, green roofs, pool decks, amenity spaces, and terraces that are not only functional but aesthetically beautiful.

# Concrete Slabs

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Concrete slabs provide a variety of sizes, colors, and finishes. They range in price from \$3.50 to \$11 per square foot depending on the size and finish.

Concrete slab tiles must meet ASTM C1782, “Standard Specification for Utility Segmental Concrete Paving Slabs.”



# Concrete Slabs

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The primary method for determining suitability for spanning between two pedestals spaced 24 inches apart is the product's flexural strength, measured by its modulus of rupture, which places a load in the center of a slab supported only on the corners. According to ASTM C1782, a product in this application must support a minimum load of 650 psi.

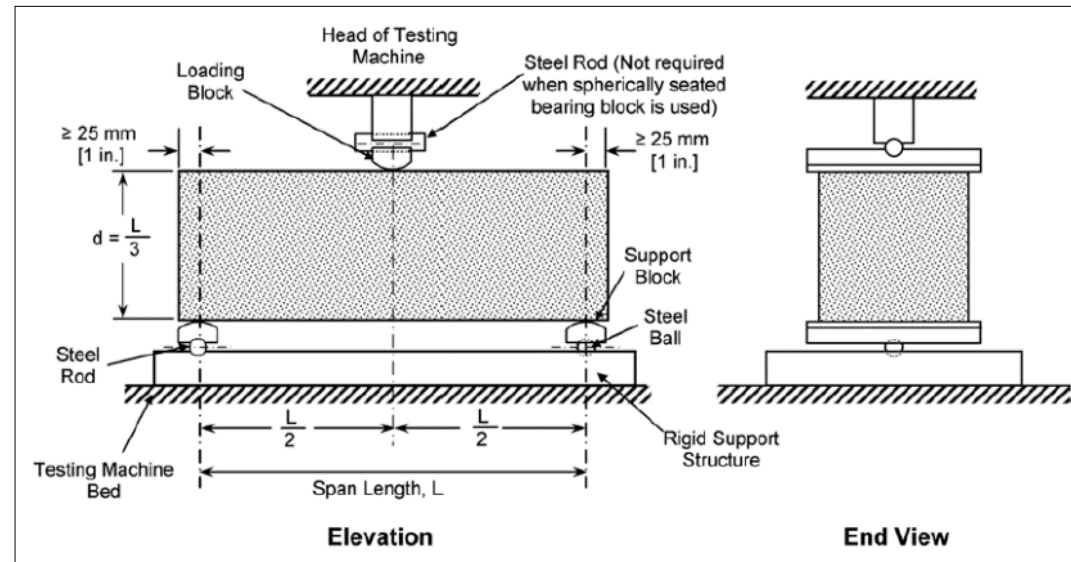
In addition, slabs must comply with ASTM C1645, "Standard Test Method for Freeze-Thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units," and ASTM C418, "Standard Test Method for Abrasion Resistance of Concrete by Sandblasting."

Pavers that are set on a granular base and are 101 square inches or less need to meet ASTM C936, "Standard Specification for Solid Concrete Paving Units."



# Concrete Slabs

The concrete slabs have quality controls that limit the modulus of rupture to an average of 725 psi. Concrete slab height tolerances are allowed to +/- 3 millimeters. The height tolerance ensures uniformity of the slabs and makes the installation easier, as the uniform height or thickness means less time is required during installation. The weights of these concrete slabs vary depending on the slab thickness. Units that are 1¾ inches thick weigh 19 pounds per square foot. Units that are 2 inches thick weigh 22 pounds per square foot. Units that are 2¾ inches thick weigh 31 pounds per square foot. Units that are 4 inches thick weigh 46 pounds per square foot.

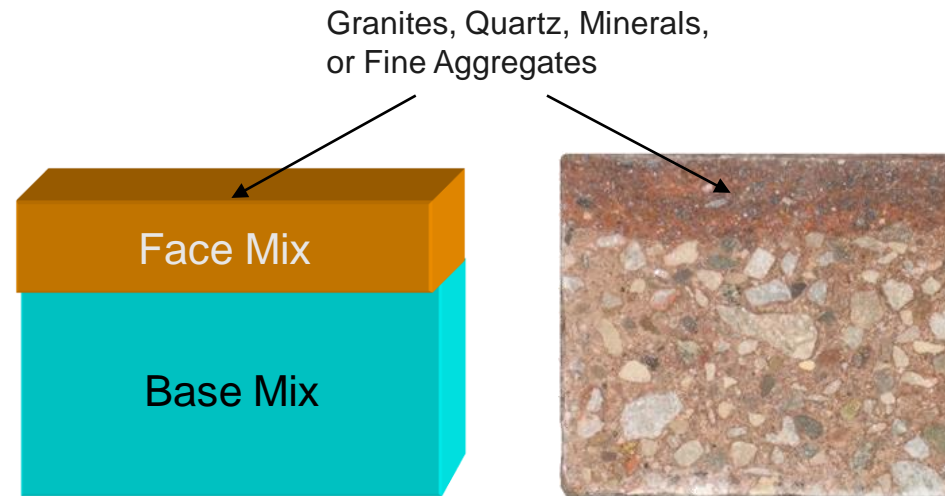


# Concrete Slabs

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Concrete slabs and pavers can be manufactured in the standard through-mix where the same aggregates are used throughout the slab. The only drawback is that over time the concrete and pigment will wear, showing the large aggregate at the surface, and the slabs will appear faded and worn.

A newer two-step manufacturing process combines a base of coarser aggregates for high strength and durability, while concentrated color and wear-resistant finer aggregates form the top. This results in a surface that is UV resistant and almost fade proof.



# Concrete Slabs

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The aesthetic options for concrete slab tiles and pavers include many technologies and surface finishes such as standard, smooth, brushed, exposed aggregate, blasted, speckled, mottled, and more.



# Concrete Slabs

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Additional processing can be added to the face-mix process. This results in unique, distinctive, and very durable, even easier-to-clean, pavers and slabs.

## Face Mix – Plus



Mottled Finish



Exposed Aggregate Finish



Heritage Brick Finish



Cobblestone Finish



Flagstone Finish



Flamed Finish



Sandblasted Finish

# Concrete Slabs

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These slabs and pavers can also be treated with an easy-to-clean, stain-resistant finish during the manufacturing process, eliminating or reducing the need to use aftermarket sealers. This makes the pavers easier to clean with water (hose) and perhaps a mild soap as required.



Before cleaning



After cleaning

# Concrete Slabs

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The available color palette is extensive. Shown here are just a few of the hundreds of options. Consult individual manufacturers for additional information.



# Concrete Slabs

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While slabs have more commonly been used in roof deck environments, traditional concrete unit pavers that are used on the ground are gaining popularity in roof deck spaces. This allows designers to further extend their creativity and create continuity from the ground level to the amenity spaces while enhancing the flow, patterning, privacy, and division of amenity spaces.



# Concrete Slabs

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# Concrete Slabs

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99 Davisville, Toronto, ON

Natural stone tiles for amenity spaces are available in three classification categories:

- igneous
- metamorphic
- sedimentary

With each classification, there are a variety of stone options, with the most popular being granite, sandstones, and limestones. Many are available in a range of colors and textures as well as sizes. Natural stone pricing can range from \$8 to \$44 per square foot depending on the stone variety, finish, and thickness.

# Natural Stone

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Sawn



Riven – a surface with the texture of natural breakage



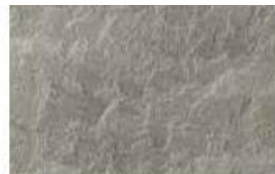
Antiqued – a timeworn, aged appearance



Flamed – a weathered, texture finish



Honed – a smooth, matte finish



Flamed & Clearblasted – a weathered, softened texture



Fine Picked – a stippled, granular texture



Leathered – a lightly textured finish with a soft sheen



Shotblasted & Brushed – matte finish with sandy texture



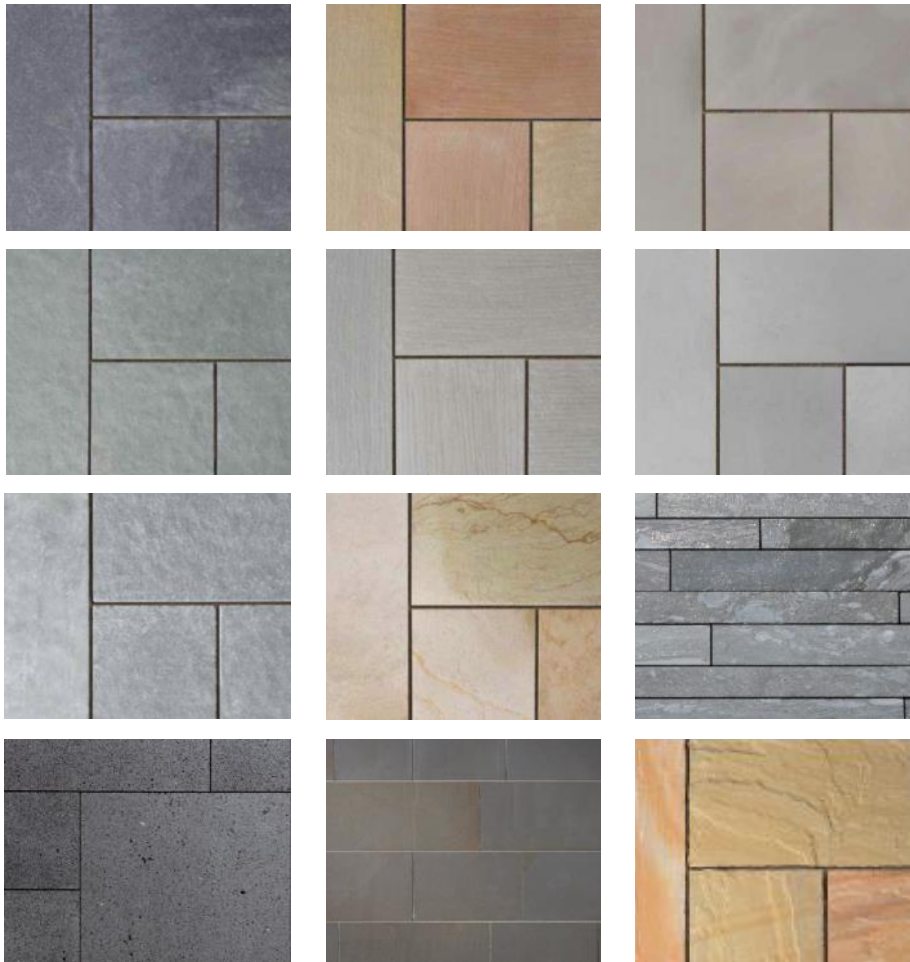
Sandblasted & Brushed – a slightly bumpy, soft feel texture

Natural stone finishes include polished, honed, water jet, riven, sandblasted, leathered, flamed, combed, riven, and antiqued. Sizes range from 12 inches by 24 inches up to 24 inches by 36 inches. Stone tiles are available cut into natural edge steps, natural edge copings, full nose copings, and stone pillar caps.

Stone thickness ranges from  $\frac{7}{8}$  inch to  $2\frac{1}{2}$  inches or thicker if necessary. This low-profile thickness makes it well suited for many applications but in particular for a concrete or wooden deck overlay where there are constraints on the height or weight of the material. The thickness will be determined by the span of the stone between supports if not placed on grade. For granite materials, the Marble Institute of America recommends a minimum flexural strength of 1,200 psi per ASTM C880, “Standard Test Method for Flexural Strength of Dimension Stone,” with compressible strength of 19,000 psi per ASTM C170, “Standard Test Method for Compressive Strength of Dimension Stone.”

# Natural Stone

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Sources for natural stone include countries in Asia such as India, where you may wish to validate the ethical standards of the quarry. There are suppliers in North America aligned with quarries that only process to the strict standards of ethical trading initiatives, ensuring that no child labor is used, fair wages are paid, and safe working conditions are maintained.

Quarried stone varieties from India and other countries in Asia, North America, South America, and Europe include sandstone, limestone, granite, basalt, and quartzite.

# Natural Stone

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# Porcelain Tiles

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Porcelain tiles also provide a wide selection of colors and finishes. They are available in a variety of sizes; however, three sizes are commonly used for roof decks: a 24-inch by 24-inch square, a 16-inch by 48-inch rectangle, and a 16-inch by 32-inch rectangle.

Porcelain tiles are also uniformly thick at  $\frac{3}{4}$  inch, and this low profile makes them ideally suited as overlay products, particularly where installations have height or weight constraints. The tiles can be used as an overlay application on new and existing concrete decks, porches, balconies, stairs, and wood decks.

# Porcelain Tiles

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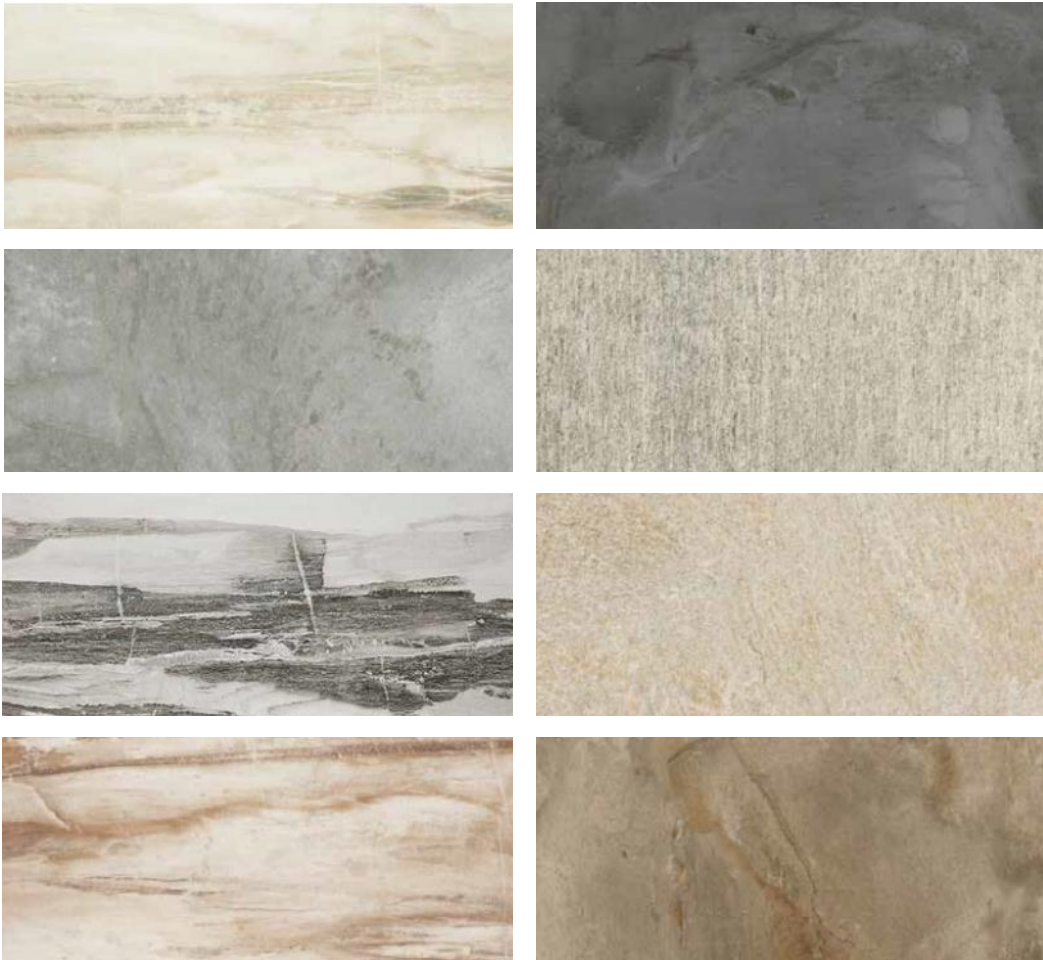


Porcelain tiles meet the following standards:

- ASTM C373, “Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products,”
- ASTM C1026, “Standard Test Method for Measuring the Resistance of Ceramic and Glass Tile to Freeze-Thaw Cycling,”
- ASTM C648, “Standard Test Method for Breaking Strength of Ceramic Tile,” and
- ANSI A137.1, “American National Standard Specifications for Ceramic Tile.”

# Porcelain Tiles

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Finishes include stone finish, and wood grain finish and edge treatments can be specified as sawn or pressed.

Pressed edge (other names include cushion edge, round edge, and soft edge) tiles have been manufactured using standard pressing processes in molds that result in a slight curving on the sides. The amount of curving will vary between manufacturers and processes.

First quality tiles with pressed edges have batches with an allowable variation in size. Thus, a wider grout joint should be used to allow for this tile size variation.



# Porcelain Tiles

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Porcelain tiles are designed for pedestrian use only but are ideal for commercial applications.

The colors are nonfading for long-term wear performance. They are priced on average \$8 per square foot.

Porcelain tile is manufactured worldwide. The tiles are manufactured to size and well packaged to protect them during shipment. Porcelain tile and natural stone may, in some cases, require additional securing to prevent against wind uplift.

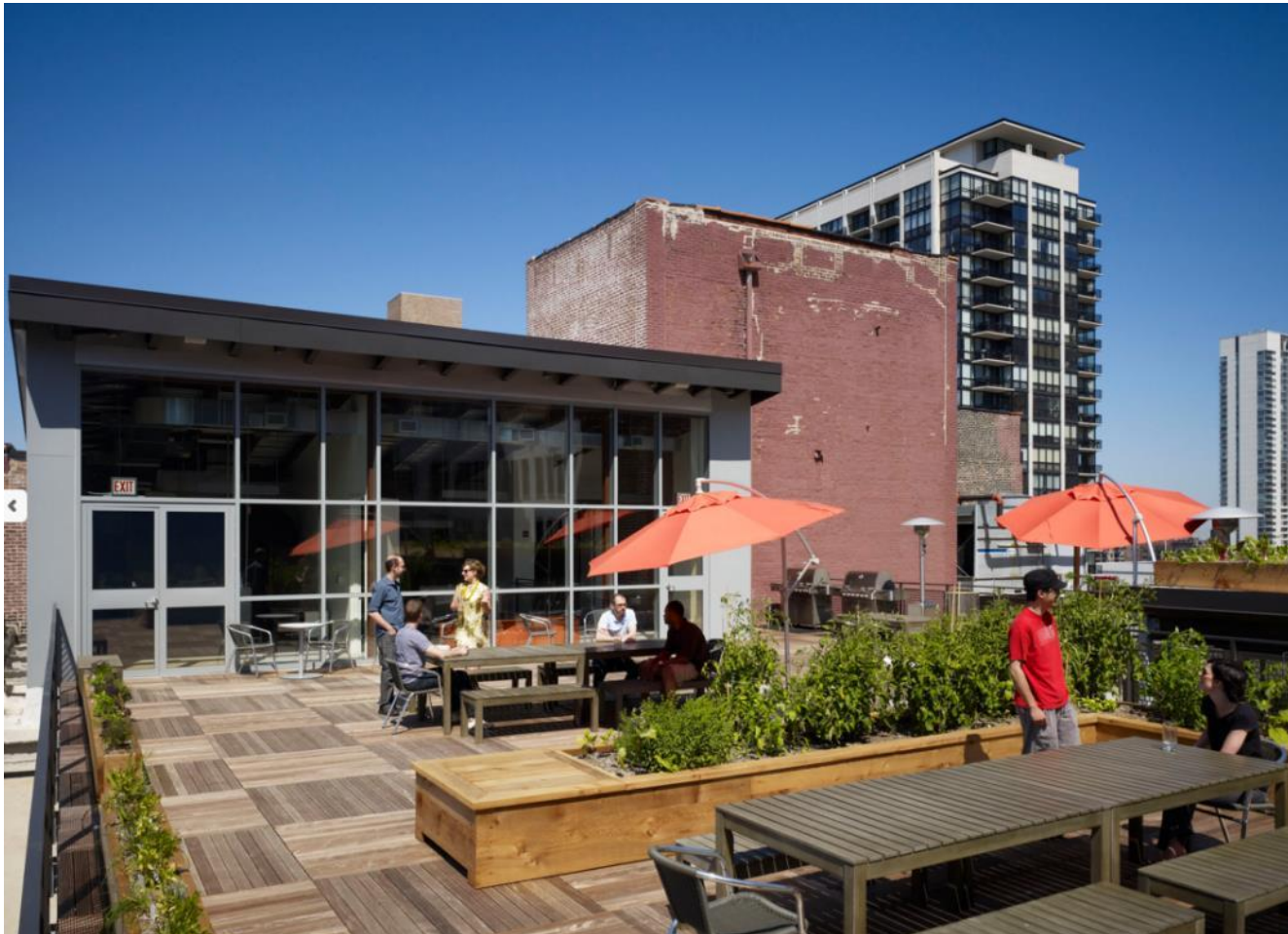
# Porcelain Tiles

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# Wood Decking

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Wood decking units or panels are usually square and have minimal size variations. Structural wood tiles are available to provide decking on roofs where designers are looking for a different texture. Wood tiles or panels can be fabricated from foreign woods, such as ipe, cumaru, and garapa.

It is important to make sure that these products are harvested using environmentally responsible methods designed to preserve rainforest hardwoods or are certified by the Forest Stewardship Council® (FSC®). Wood tiles can also come from thermally modified North American hardwoods.

# Wood Decking

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Wood decking panels can have hardness ratings ranging from 1,630 to 3,680.\* They can be nominal 24-inch square panels that weigh 24 pounds and nominal 24-inch by 48-inch rectangular panels that weigh 48 pounds. Look for wood panels that have a Class A fire rating. Pricing typically ranges from \$12 to \$14 per square foot. Even though these products resist fire, some restrictions may apply with local fire building codes.



\*Hardness rating derived from the universal rating system known as the Janka Hardness Scale. The system is widely used in the flooring industry to compare products and determine whether a particular wood is suitable for a specific application.

# Wood Decking

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Many thermally modified North American hardwoods are domestically sourced from red oak and ash trees that are currently harvested in Wisconsin. Red oak and ash are the preferred species because of their consistency in durability and color.

The natural durability of the red oak and ash is enhanced through the thermal heating process, creating a product that is a Grade A wood with a 25-year Class 1 durability level and a resistance to decay that is comparable to South American hardwoods.

# A Broad Palette of Materials

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The variety of available slabs and tiles for roof deck systems provides designers with an extensive palette of materials for designing urban outdoor spaces on roofs. The variety of products to create amenities on building roofs extends vertically as well as horizontally.

The next section looks at vertical design elements in outdoor urban environments.

## Review Question

How does through-mix concrete differ from face-mix concrete?



## Answer

Concrete slabs and pavers can be manufactured in the standard through-mix where the same aggregates are used throughout the slab.

The face-mix manufacturing process combines a base of coarser aggregates for high strength and durability, while concentrated color and wear-resistant finer aggregates form the top.







## WALL SYSTEMS

# Vertical Design Elements Create Semiprivate Spaces

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Adding vertical elements into the outdoor amenity space will enhance the aesthetic of the space. Instead of a waist-high handrail separating the user from the building edge, seat walls and plant material are used to buffer the edges of the space.

A creative design uses these vertical elements to create semiprivate spaces on the amenity roof.

# Wall Systems

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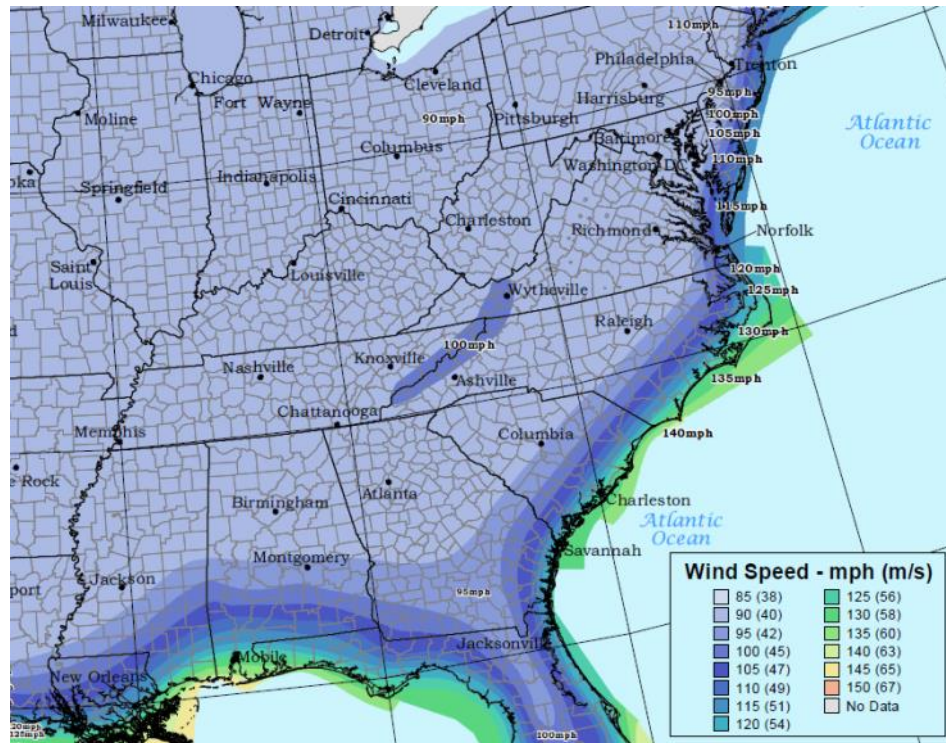


Larger trees provide shade and wind blocking in some cases. Smaller shrubs, grasses, and perennials enhance and focus views toward adjacent desirable sight lines for bodies of water and sunsets while screening undesirable views and building glare.

With the demand for a greater variety of outdoor amenities on urban roof systems, segmental interlocking wall systems are available to create raised planters, seat walls, and privacy screens. These wall systems are composed of segmental block units that are available in a range of sizes and styles, from contemporary linear to a more traditional dry stack, and a variety of textures and colors, thus providing designers with a broad palette of materials.

# Wind Uplift

Most wall systems are heavier than pavers and fit the weight requirements to counter wind uplift.



**Results:**

This table shows the calculated W/0.9 values acting on a loose-laid, elevated paver system in Zone 1 of the roof based on the testing conducted under PRI Project No. MGC-001-02-01.

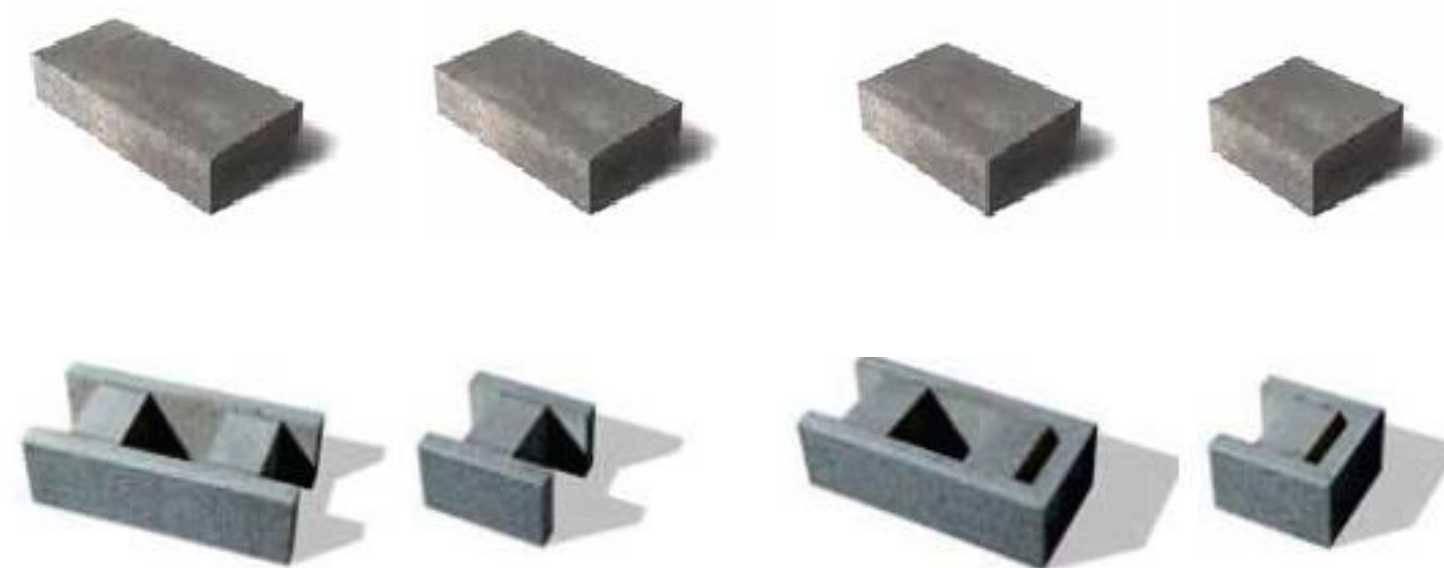
		Flat Roofs (Slope 0:12 – 1.5:12)										
Building Type	Exposure	Mean Roof Height (ft)	Basic Wind Speed (mph)									
			120	130	140	150	160	170	180	190	200	
Enclosed or Partially Enclosed	B	20	-0.18	-0.20	-0.23	-0.27	-0.31	-0.34	-0.39	-0.43	-0.48	
		25	-0.18	-0.20	-0.23	-0.27	-0.31	-0.34	-0.39	-0.43	-0.48	
		30	-0.18	-0.20	-0.23	-0.27	-0.31	-0.34	-0.39	-0.43	-0.48	
		40	-0.19	-0.22	-0.26	-0.29	-0.33	-0.38	-0.42	-0.47	-0.52	
		50	-0.20	-0.23	-0.28	-0.31	-0.36	-0.40	-0.44	-0.50	-0.56	
		60	-0.21	-0.24	-0.29	-0.32	-0.38	-0.42	-0.48	-0.52	-0.58	
	C	20	-0.22	-0.26	-0.30	-0.34	-0.39	-0.44	-0.50	-0.56	-0.61	
		25	-0.23	-0.28	-0.31	-0.36	-0.41	-0.47	-0.52	-0.58	-0.64	
		30	-0.24	-0.28	-0.32	-0.38	-0.42	-0.49	-0.54	-0.61	-0.67	
		40	-0.26	-0.30	-0.34	-0.40	-0.46	-0.51	-0.58	-0.64	-0.71	
		50	-0.27	-0.31	-0.37	-0.42	-0.48	-0.54	-0.60	-0.68	-0.74	
		60	-0.28	-0.32	-0.38	-0.43	-0.49	-0.56	-0.62	-0.69	-0.78	
	D	20	-0.27	-0.31	-0.36	-0.41	-0.48	-0.53	-0.60	-0.67	-0.74	
		25	-0.28	-0.32	-0.38	-0.43	-0.49	-0.56	-0.62	-0.69	-0.77	
		30	-0.29	-0.33	-0.39	-0.44	-0.51	-0.58	-0.64	-0.71	-0.79	
		40	-0.30	-0.36	-0.41	-0.47	-0.53	-0.60	-0.68	-0.76	-0.83	
		50	-0.31	-0.37	-0.42	-0.49	-0.56	-0.62	-0.70	-0.78	-0.87	
		60	-0.32	-0.38	-0.44	-0.50	-0.58	-0.64	-0.72	-0.81	-0.89	

The magnitudes of all above calculated wind loads are below the 3.25 psf minimum dead load of the paver system. Thus, the loose-laid paver system will resist wind uplift for conditions specified above.

# Hollow Units and Solid Units

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Some wall systems are hollow; however, the majority of wall systems use solid units, as these units provide a more stable wall system. Many hollow walls require a back fill of granular material or rebar and concrete. This increases the labor component on the project. Solid walls reduce the extra labor.



# Wall Systems

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## CASE STUDIES

# Residential and Commercial Roof Deck Gardens

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Residential condominium and commercial roof deck gardens can utilize a variety of systems and slabs in their construction. The following are some examples of successful designs that incorporate a number of different site amenities within the roof deck space.



Please remember the **test password GARDEN**. You will be required to enter it in order to proceed with the online test.



# Illinois Center Plaza, Chicago, IL

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The Illinois Center Plaza's south section has undergone a series of innovative architectural changes to its roof deck space located at 233 N. Michigan Ave. Wolff Landscape Architecture Inc. of Illinois designed a roof deck space with built-in benches, flower beds, tables and recliner chairs, and a centrally placed green space. The roof deck is in the center of residential and commercial building units.

This is a high-traffic pedestrian plaza that needs to be extremely durable and also permeable. The square concrete slab tiles and pavers were used in combination with permeable spacers to meet both pedestrian traffic demands and the need for permeability. A slab on permeable base roof system was used for construction. The paver colors were selected to complement the building structure and its surroundings with a mottled finish that looks like granite and includes a treatment added during the manufacturing process that makes them easier to clean and maintain.

# Hubbard Place, Chicago, IL

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Located in the River North neighborhood of Chicago, the Hubbard Place roof deck provides occupants with an inviting atmosphere that includes comfortable seating areas, private outdoor grills for solitary dinners or large group parties, an outdoor fire pit, a sundeck, a dive-in pool, a landscaped dog run, and a variety of garden spaces, all with stunning city views.

The designer was Daniel Weinbach & Partners, who constructed the roof deck using a variety of concrete pavers and slabs with exposed washed aggregate and a mottled granite-like finish in different colors to delineate spaces and flow.

Concrete segmental wall blocks are used for seat walls and garden walls, which effectively create private spaces for residents and their guests.

# Hullmark Centre, North York, ON

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Hullmark Centre is a signature condominium development in North York, Ontario, Canada. The development includes a prime office component, premium retail spaces fronting onto a public plaza, and the tallest condominium towers in the North York skyline. The outdoor roof terrace includes a swimming pool, cabana, pavilion garden, fireplace, and barbequing stations. The designers at MBTW Group used concrete pavers to unite the surroundings.

This design uses semiprivate settings rather than one large open-concept roof deck. The second-floor amenity space is an urban oasis with lush landscape planting to complement the numerous amenities, which include a 150-foot-long trellis that bisects the amenity area and connects several small seating niches to the exterior fireplace and lounge, acting as the focal point at the terminus of this feature.

The exterior spaces of the podium are unified by a common palette of materials that includes aluminum and stainless steel, granite, limestone, and patterned unit paving. The predominant product on the amenity terrace is 70-millimeter-thick concrete pavers in granite blend and dark charcoal colors in a variety of sizes that coordinate with the paving at ground level.

# Fuse, Cambridge, MA

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The Fuse condominium project in Cambridge, Massachusetts, set out to create an outdoor living room or public backyard for the residential community. “Residents in urban settings strive to find a balance between the excitement of the city and the vast social opportunities while trying to carve out a little serenity and relationship to nature/seasons/etc.,” says Robert Adams of Halvorson Design Partnership.

The courtyards and open spaces in this residential community provide many desired qualities of life: sunshine, nature, social spaces, etc. There are two amenity roof spaces on this project designed to provide a variety of different scaled spaces to appeal to a variety of users and uses. One has a pool, lounging, and dining area, and conversational zones created with pergola-type structures and furniture groupings. This space used a 24-inch by 24-inch concrete slab and a wood deck tile on pedestal system to create a harmonious and beautiful design.

# Fuse, Cambridge, MA

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The second space has a large green area with medium-sized patios and dining rooms with grills, tables, chairs, and side tables, with intimate spaces tucked into the edges of the large central lawn. Using the same traditional permeable pavers that were used on the ground level, the designer was able to continue the hip and energizing paver design in this amenity space over a permeable base.

Both spaces borrowed from the surrounding Alewife Reservation, utilizing a glass railing to make the edge as porous as possible and using the same plant types found in the borrowed landscape to tie them together.

Adams points out that “creating open space that provides social interaction at a variety of scales and activities, open space that connects to the context/larger natural environment, and open spaces that somehow enhance the seasons/natural systems” was essential on this project.



On roof deck



On grade

# One Federal, Boston, MA

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Located in the financial district of Boston, One Federal is a skyscraper that is noted for its outstanding height of 38 floors. Architects CRJA-IBI Group worked with the project architects to improve the existing underutilized roof top garden space on top of the ninth floor.

The goal of this renovation effort was to create a usable indoor/outdoor space for the tenants of this office building. The outdoor space was redesigned to accommodate a variety of programmable uses, including casual lunch gatherings, awards ceremonies, cocktail parties, and weddings. The landscape architects used a square concrete slab paver to meet the design requirements. Varied colors in a mottled finish that looks like granite were used to detail the building entrance. Colors were selected for their low solar reflectance value and to complement the greenscape and water features. As part of the manufacturing process, an additive was included for surface protection that will make the area easier to clean and maintain.

# One Federal, Boston, MA

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The roof deck on One Federal utilizes a pedestal installation. Structural evaluation of the existing concrete deck was undertaken to determine its load-bearing capacity for new landscape elements that included new paving, walls, curbs, planting loam, and plantings. The existing drainage system was evaluated by a mechanical, electrical, and plumbing (MEP) engineer to ensure that modifications/replacement could occur simultaneously with landscape enhancements.

To achieve these flexible garden uses, the final design provides for universal access, a large open space for gathering, pedestrian scale paving zones, and a strong, simple planting palette that can be easily maintained.

# Prudential Plaza, Chicago, IL

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Prudential Plaza in Chicago presents an elevated project with amenities that include a lounge space with a fire pit, an outdoor bar area, and views of Lake Michigan and Michigan Avenue. Wolff Landscape Architects used 2,300 square feet of custom concrete slabs for this roof deck. The design balances the landscape and hardscape elements to create an oasis in the heart of Chicago.



# Loews Chicago Hotel, Chicago, IL

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Another Chicago roof deck project is at the Loews Chicago Hotel, which was constructed in 2015 and also designed by Wolff Landscape Architecture.

This project has two expansive rooftop spaces, one a pool deck amenity and the other a social and entertaining space that includes two restaurants.

This outdoor amenity roof deck includes a grassy lawn area for lounging or games, planting areas with seasonal flora and greenery, a two-level terraced area, and cabanas, providing guests and visitors with views of the downtown and the lake in a park-like setting. Installed on a pedestal system, the 24-inch by 24-inch square concrete slab pavers in two shades cover over 18,000 square feet of pedestrian terraces.



## CONCLUSION

# In Conclusion...

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With the continued growth in both residential and commercial developments in urban centers, the demand for outdoor urban amenity spaces will not only continue but will be expected. And with the variety of products and systems available, the sky is the limit in terms of the design possibilities for outdoor amenities for roof deck projects.

Prudential, Chicago, IL.  
Photo: Tim Benson

# Conclusion

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