EVALUATION REPORT

Mbrico Tile Decks Wind Uplift System for Rooftop Tiles

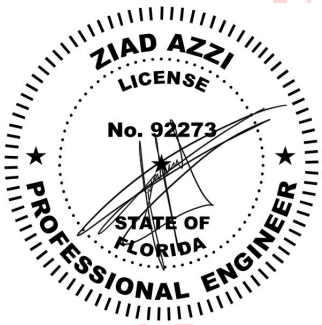
MANUFACTURER:

MBRICO TILE DECKS
P.O. BOX 1108
BETTENDORF, IA 52722

FLORIDA BUILDING CODE APPROVAL

Florida Building Code 8th Edition

Per Rule **61G20-3**
Method: **2-B**
Category: **Roofing**
Sub-category: **Roofing accessories that are an integral part of the Roof System**



Digitally signed by Ziad Azzi, PhD, MBA, PE, CGC, CCC, PMP
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Scope of "Limitations and Conditions of Use" for this evaluation:

This report was prepared at the request of MBrico to present the methodology, observations, results and conclusions gathered from the wind tunnel testing and wind-performance experiments of a paver system performed on 11/6/2024 at the NSF NHERI Wall of Wind Facility, located at the Engineering Center, at Florida International University. The report was written by Ziad Azzi, PhD, MBA, PE, with the help of Research Scientist Manuel Matus, PhD, EIT.

This summary report was prepared for MBrico by Ziad Azzi. Any other use is prohibited without the express, written consent of MBrico and Ziad Azzi. Our services are performed using the degree of care and skill ordinarily exercised by members of the subject profession practicing under similar circumstances at the same time and in the same locality. This report makes no warranties, expressed or implied, in connection with this service.

This report summarizes the test methodology, model configurations, and experimental results for a series of wind-performance experiments conducted on a raised pedestal paver system. The pedestal system is designed by MBrico, which encompasses all the different components used in the construction of the system. The system was installed on a large-scale building model and tested under simulated wind conditions at the Wall of Wind (WOW) Experimental Facility (EF) at Florida International University (FIU). The porcelain tiles (pavers) were installed on a pedestal system that consists of the following:

- A standard pedestal called "threaded pedestal" with an adjustable height.
- Aluminum track called "tongue & groove L-Track."
- Aluminum track called "tongue & groove T-Track."
- Aluminum MBrico cross-bracing.
- MBrico adhesive used to adhere the pavers to the pedestal system. On top of the MBrico adjustable height pedestal and aluminum track system, the porcelain tiles were mechanically attached to the track system and glued using an adhesive compound. More details about the pavers, the pedestal system, and the installation mechanism are discussed later in the report.

This raised pedestal paver system forms a self-ballasted roof decking system designed to avoid penetration into or adhesion with the roof membrane. This series of tests investigated the behavior and performance of the system, under simulated wind loading conditions generated by the WOW EF using 12-fan system. Based on visual observations and the measured wind speed time histories recorded during the tests, this report identifies: 1) the nominal wind speed at which initial lifting of the pavers system was observed, and 2) the highest nominal wind speed attained for a 60-sec test duration before pavers blow-off occurred, unless the maximum WOW wind speed was achieved before any paver blow-off. For the scope of this project, "lifting" is defined as a vertical displacement of one or more pavers without any paver(s) dislodging out of position. Paver "blow-off" is defined as one or more pavers becoming dislodged or moving out of position due to the wind loading. Additional information on the wind simulation capabilities of the WOW EF, and the relationship between wind speeds defined by the Saffir Simpson Hurricane Scale and the ASCE 7-22 Standard is provided in Appendices A and B, respectively.

For this series of experiments, the different test configurations involved the presence of parapet as well as a ledger board along the building's parapet walls to help secure the edge pavers. The test configurations covered in this report are identified as follows:

- Test Case 1 – Adhered Pedestals + Paver + Molding + Raised Parapet (not discussed in this report).
- Test Case 2 – Pedestals + Paver + Molding + Raised Parapet.
- Test Case 3 – Pedestals + Paver + No Molding + Raised Parapet.

Further details on each of these configurations can be found in Section 2 of this report.

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Tile Rooftop Pedestal System Installation Notes

1. Verify roof is waterproof and clean for installation.
2. Verify height clearance is at least 2-5/8" or higher (contact salesperson for lower clearance alternatives)
3. Verify slope of roof deck and all adjoining floors & doorways to ensure correct pedestals were ordered to reach desired finish floor height. Refer to provided Mbrico project shop drawings for pedestal key and color-coded pedestal layout map.
4. Place first row of pedestals, per provided project layout, at your designated starting edge. Refer to provided Mbrico shop drawing suggested control/starting point for your project. Place pedestals 30" on center.
5. Adjust pedestal height to meet desired finish floor height (remember to account for the 1-5/8" rack and tile thickness).
6. Place your Mbrico Offset L-Track into click-adapter on top of pedestal. Press down until track "clicks" into pedestal click adapter.
7. To join two pieces of tracks together, attach an 8" aluminum sleeve connector with provided stainless screws. Pre-drill and place one screw on each side of 8" sleeve connector. The sleeve connector is used to connect two pieces of 12' tracks end to end as needed. Note: a pedestal needs to be place at this connection.
8. Place the next row of pedestals per your layout at designated location. Offset row of pedestals 50% from previous row so each row of pedestals are staggered. This eliminates any possible deflection in the system.
9. Adjust pedestal height to reach desired finish floor elevation. Each pedestal is threaded for adjustment up or down.
10. Place Mbrico T-Track into click-adapters and press down to "click" tracks into the top of each pedestal. Refer to Step 7 for sleeve connectors attachment as needed.
11. Slide your Mbrico T-Track and row of pedestals into position. The gap between the 2 prepared tracks should be ½" wider that the width of your ordered tile. For example, if using 24x24" tile, the tracks will be 24.5" apart for this step until fully secured.
    a. Verify the 2 rows of tracks are level prior to installing tiles. Make any final adjustments to pedestals as needed.
12. Using a 1/8" drill bit, pre-drill track and crossbrace before attaching with provided stainless screws. Repeat attaching crossbrace under the track every 6 foot on center. One stainless screw will be used at each intersection of 12' track and 12' cross brace channel. Cross brace channels are installed under the tracks running perpendicular and maintain perfect spacing and gaps in tiles over time.
13. Place a dab of the provided noise dampening adhesive onto the tracks where all four corners of the tile will sit on each track. The adhesive dab should be approximately the size of a quarter.
14. Place a row of Mbrico tiles at the designated location in between both rows of track and pedestals.
15. Using a rubber mallet or dead blow hammer, slide the Mbrico tile, track, and pedestals towards your previous track until all tile grooves are fully seated in the track and your two tracks are snug and parallel. Verifying each tile is snug and tongue and groove is fully engaged allows you to easily maintain perfect spacing as you continue.
16. Verify with a laser or level that all tiles are sitting level and free from movement before moving to next row.
17. Attached 12' crossbrace channel to T-Track. There will be only one screw per intersection of track and crossbrace. Remember to pre-drill track and crossbrace for easier fastening.
18. Repeat Steps 8 through 17 until you reach the final row of tile.
19. Place final row of pedestals in position and verify all heights and level. Allow for 1 5/8" track and tile thickness for appropriate final system finish floor elevation.
20. At final row of tile, cut final offset L-Track ½" shorter than the length of 2-3 tiles and place track on top of final row of pedestals. Press down until the track "clicks" into place in the pedestal click adapters.
21. Using 1 provided screw, pre-drill and attach your final row of tracks to cross brace channel underneath the track.
22. Place dabs of provided Mbrico adhesive onto the track where all four corners of tiles will sit on tracks.
23. Slide tile from track end into designated location. Repeat previous 3 steps to complete this segment of tracks.
    a. Repeat steps 20-23 until you reach the final tile.
24. Cut the bottom lip of the last tile with a porcelain blade. Remove the bottom lip of a grooved edge of a tile.
25. After applying 4 adhesive dabs on the tracks, slide the final tiles grooved edge into your T- track and gently place down cut edge onto offset L-Track.
26. Install ledger/base around entire Mbrico system perimeter. Ledger/base supplied by others. Materials example: Aluminum, Composite, Masonry. Contact your Mbrico salesperson for details.

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Porcelain Tile Product Notes

1. MBRICO's porcelain tiles installed on the MBRICO frame system consists of an impervious, vitreous porcelain tile that is abrasion, freeze / thaw, chemical, and stain resistant installed on an aluminum track system that is self-aligning, guarantees consistent gaps throughout the system and can be adjusted to any height. It requires no grout work, and it is intended for exterior use.
2. Features and Benefits include:
   a. Warranty – lifetime warranty on MBRICO tiles
   b. Self-Aligning – subframe system aligns tiles consistently through field, and will not allow movement after installation
   c. Color Options – 75+ colors in stock, more available upon request
   d. Through Color – Through color porcelain rather than color body tiles
   e. Zero Maintenance – tiles require no special or seasonal maintenance
   f. Impervious Product – tiles have a water absorption rate of .05%, far less than standard 5% requirements
   g. Minimal Weight – Lighter weight tiles for easier installation and future access below tiles. Approx. 10.6 lb/sf per tile
   h. Skid Resistant – tiles are ADA skid resistant approved
   i. Wind Uplift – tiles on track system are approved to Miami Dade Wind Uplift standards
   j. LEED Compliant – up to 10 LEED credits are available using MBRICO system
   k. Load Capacity – up to 4,500 lbf breaking strength

Tile Technical Data:

DATA	STANDARD	INT STANDARDS	MBRICO VALUE
WATER ABSORPTION	ASTM C373	.5%	.05%
FLEX RESISTANT	ASTM C648	>250 lbf	>4,500 lbf
RESIST THERMAL FREEZE/THAW	ASTM C484	Pass	No Damage
FROST RESISTANCE	ASTM C1026	As Reported	No Damage
ABRASION RESISTANCE	EN ISO 10545-6	<175mm	<175mm
RESISTANCE TO CHEMICALS	ASTM C650	As Reported	Not Affected
RESISTANCE TO STAINS	ASTM C1378	As Reported	Not Affected
SKID RESISTANCE (DRY)	ASTM C1028	>.60	>.90
SKID RESISTANCE (WET)	ASTM C1028	>.60	>.70

Threaded Pedestal & Aluminum Frame Product Notes

1. The adjustable pedestals are suitable for installing the MBRICO paver system in outdoor applications. The pedestals are resistant to UV rays, weathering, and chemicals, and are made from 100% recycled material. The top of the pedestal is self-leveling and utilizes a multitude of head adapters and extension rings. Accessories needed are dependent on the paver system being used. Wind Up-Lift requirements are subject to alternate types and styles.
   a. Assembly Height - 1"-39"
   b. Load Bearing Capacity - 3,300 lbs
   c. Slope Compensation - 0-1%
2. The aluminum subframe system is utilizes an extruded profile designed to work with the tongue and groove system of the MBRICO tile system. It is always dimensionally stable and straight, and utilizes system connectors that extend the profiles easily and endlessly.
   a. Material – Aluminum
   b. Gage / weight – included in system weight of 10.6lbs / sf
   c. Size – 13.3ft
   d. Shape – extruded aluminum profile
   e. Grade - 6560

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Mbrico Tile Decks Wind Uplift System for Rooftop Tiles

COMPONENTS AND ASSEMBLY

Mbrico Tile
(Sizes Vary by Project)

T-Track

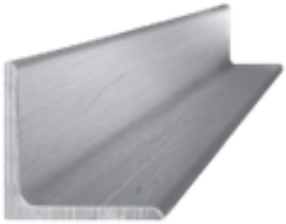
Offset L-Track

#8 x 1 1/4” Self Drilling Stainless Screws

Pedestal Click Adapter

Pedestal

12’ Cross Brace Channel



8” Sleeve Connector

Mbrico Field Slotter Router Bit

20oz Adhesive Tube

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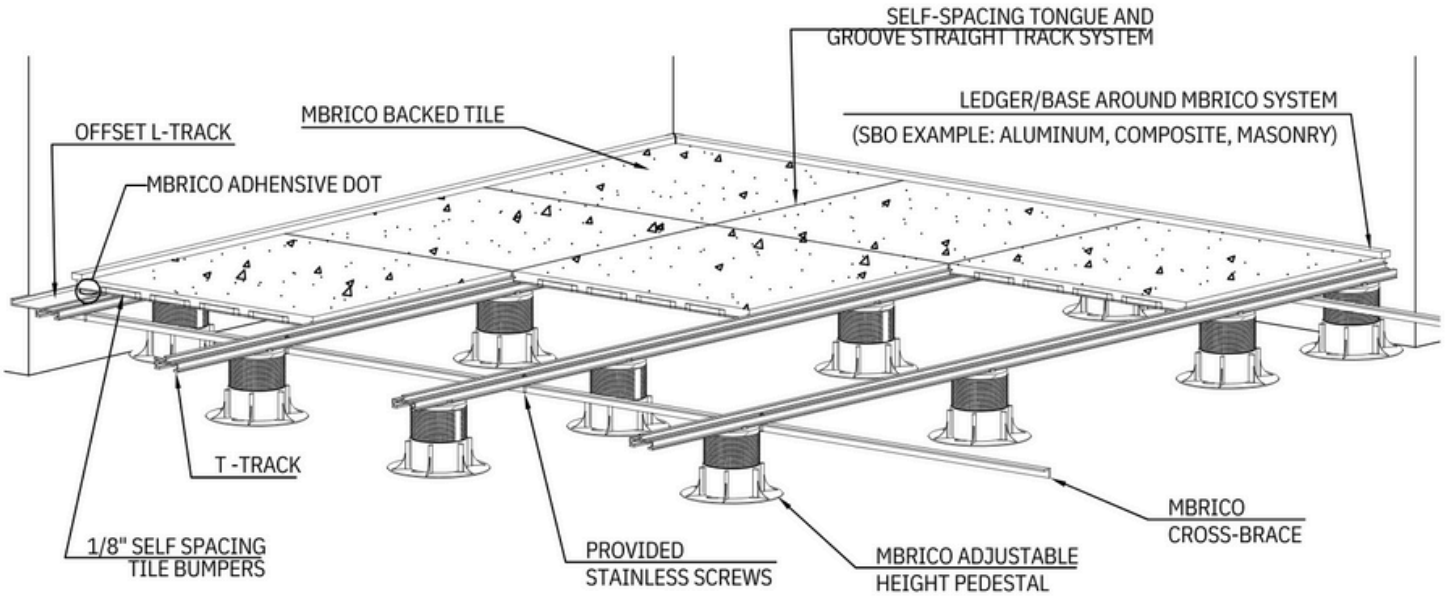
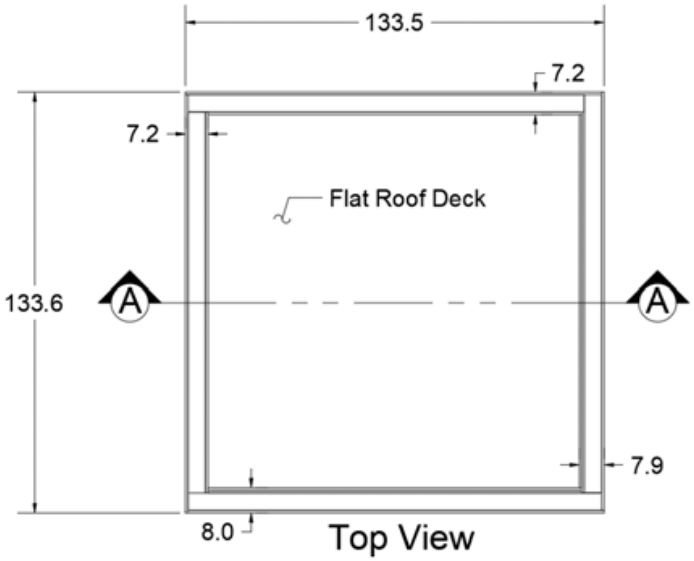
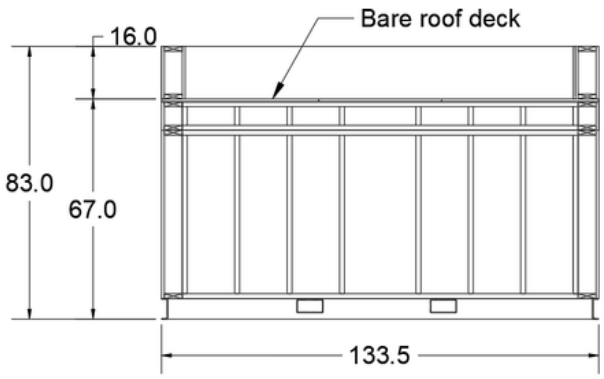


MBRICO DETAIL

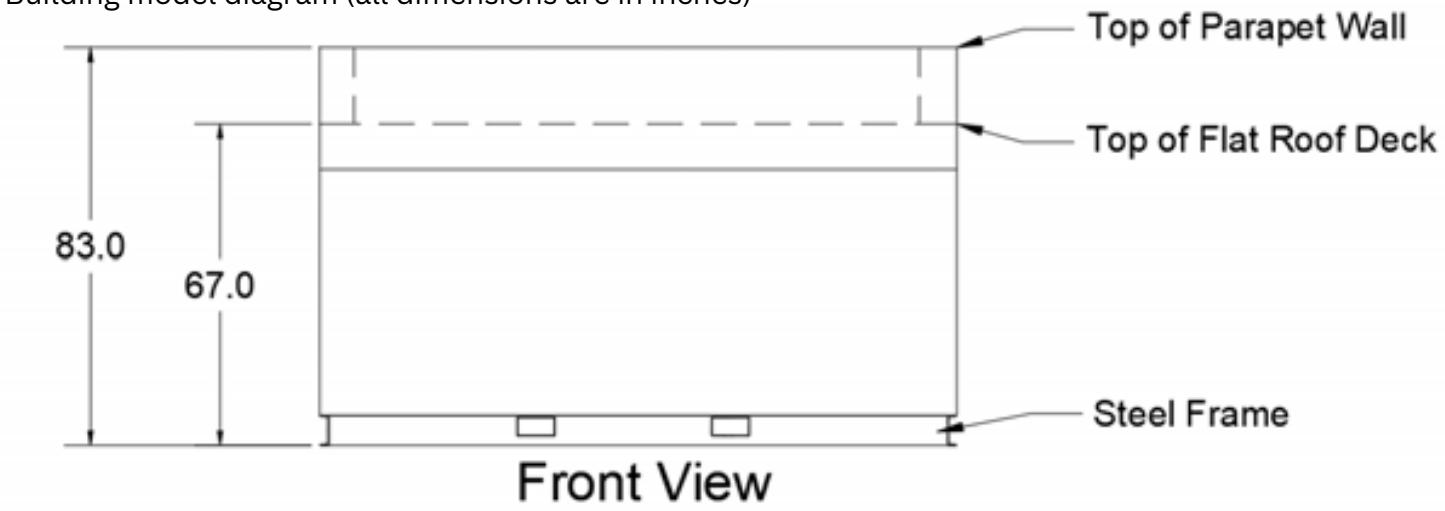
MBRICO: ROOFTOP TRACK WIND UPLIFT SYSTEM



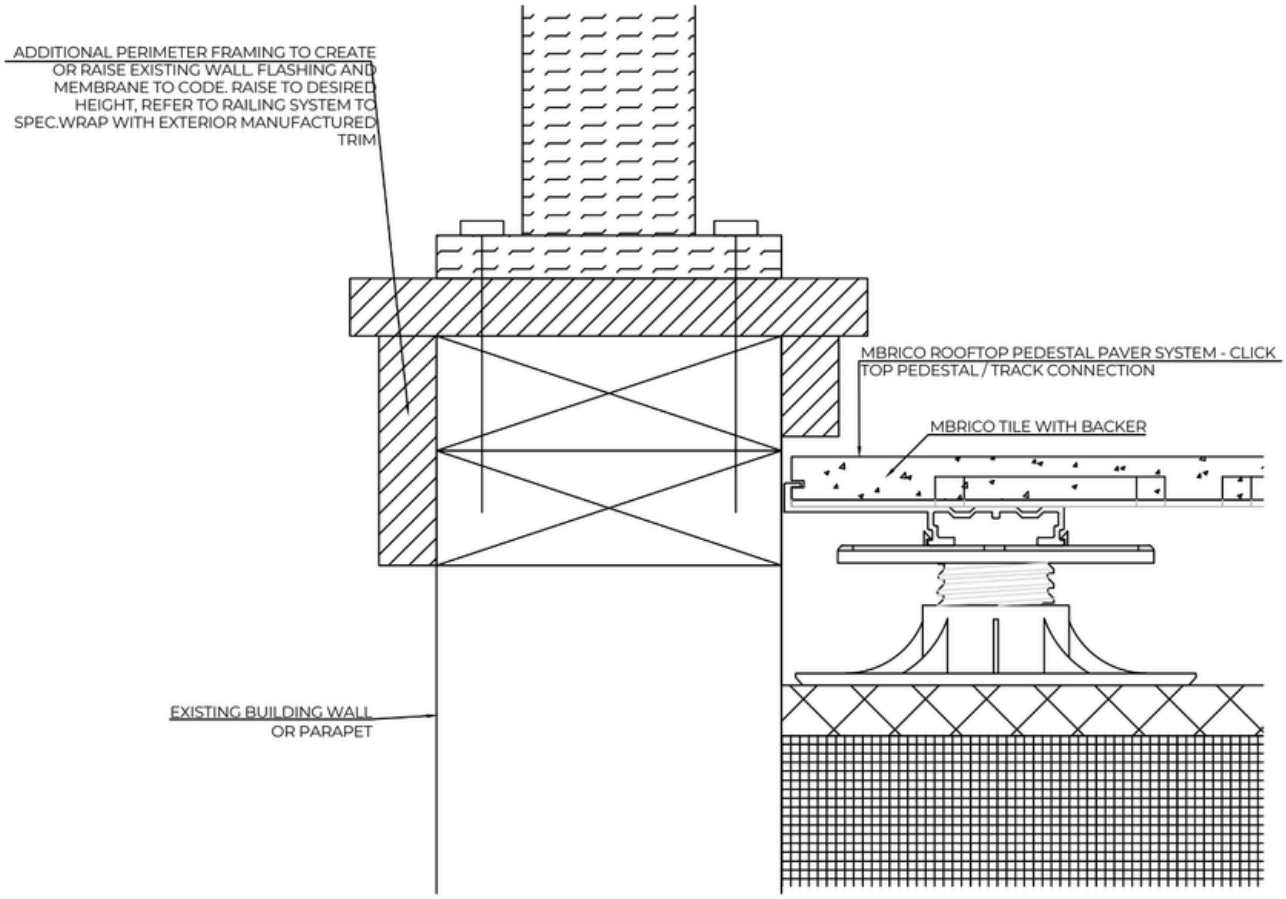


Section view of building model (all dimensions are in inches)

Building model diagram (all dimensions are in inches)



Building model diagram (all dimensions are in inches)



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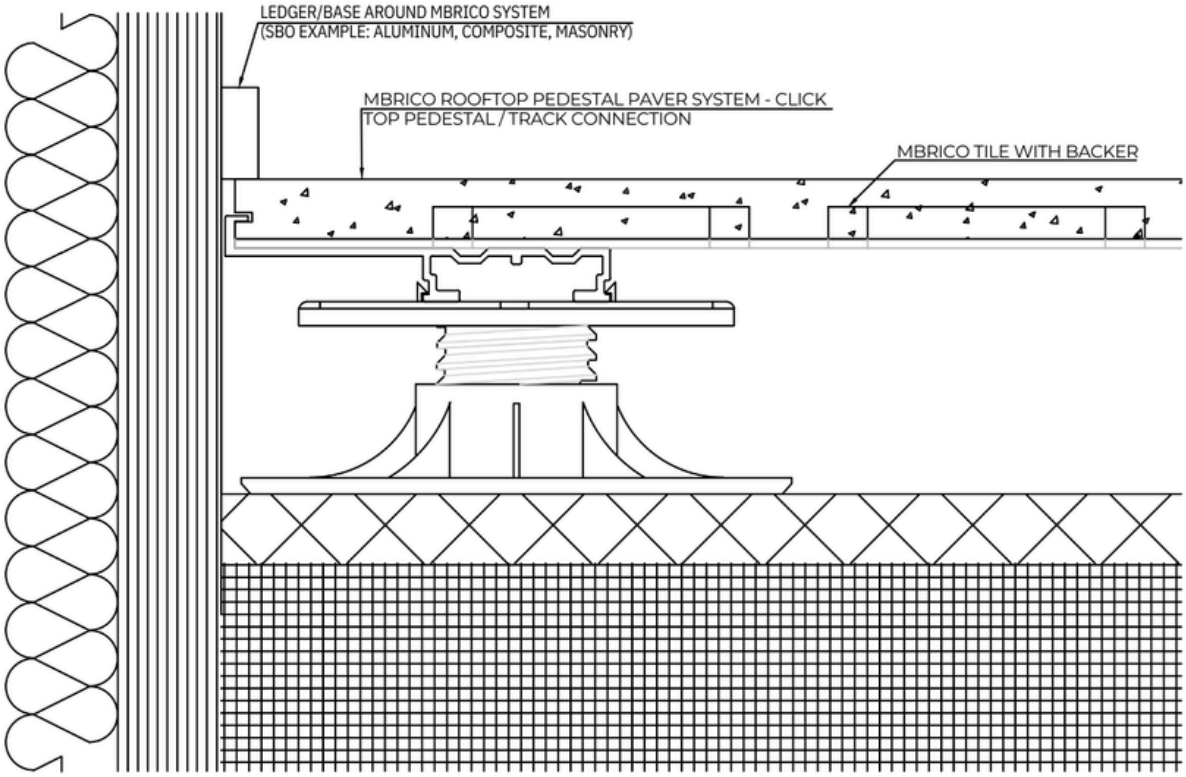
MBRICO: ROOFTOP DETAIL - CURB AND HANDRAIL ATTACHMENT OPTION



DETAIL VIEW

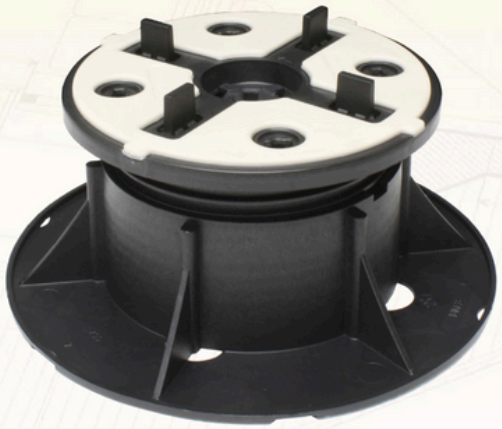
MBRICO DETAIL

MBRICO: ROOF WIND UPLIFT OFFSET L-TRACK & TILE PERIMETER DETAIL

NM Series Pedestal Paver Supports

FEATURES

- Adjustable height from 1" - 39" (with NM
- extension)
- Bi-material self-leveling head offers anti-noise
- & anti-slip
- Made from 100% recycled material
- Smooth base with pre-cut lines
  Resistant to weathering, acids and UV rays
  Removable spacer tabs



SPECIFICATIONS

Height Range: 1"-39"
Base Diameter: 8"
Head Diameter: 6"
Tab Height: 1/2"
Tab Width: 5/32"
Load Capacity: 3,300 lbs
LEED Certified

P NM Extension

OPTIONS

- Wood joist head for joist applications
- Aluminum joist head for aluminum joist applications
- Pins for IPE deck tiles
- Locking piece for lighter tiles
- Adjustment key to raise or lower support
- Slope compensator (0-1%)

3310 North Benzing Road
Orchard park, NY 14127
Ph: 800-828-8424
Web: www.mrpsupports.c om
Email: mrp@mrpsupports.com

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Nominal Wind Speed (mph)	60	70	80	90	100	110	120	130	140	150	157
60-sec mean wind speed at CP1 during the paver tests, $U_{cp1,test,60s}$ (mph)	58.8	68.2	78.7	88.3	99.4	108.7	118.0	127.4	138.5	148.2	155.9

Exposure Category	R_1	R_2	R_3
B	1.129	1.082	0.886
C	1.103		
D	1.089		

Exposure Category	Nominal Test Wind Speed (mph)										
	60	70	80	90	100	110	120	130	140	150	157
	3-sec gust wind speed calculated from measured WOW data V3-sec at roof height (mph)										
B	50.7	58.8	67.9	76.2	85.8	93.8	101.8	109.9	119.5	127.9	134.5
C	51.9	60.2	69.5	78.0	87.8	96.0	104.2	112.5	122.3	130.9	137.7
D	52.6	61.0	70.4	79.0	88.9	97.2	105.6	114.0	123.9	132.6	139.5

Exposure	**B**	**C**	**D**
Roof Height (ft)	**K_z**		
150	1.059	1.362	1.545
120	0.997	1.301	1.486
90	0.924	1.227	1.413
60	0.829	1.129	1.317
50	0.790	1.088	1.276
40	0.744	1.040	1.228
30	0.689	**0.980**	1.168
20	0.619	0.903	1.088
10	0.573	0.851	1.035

Figure 1

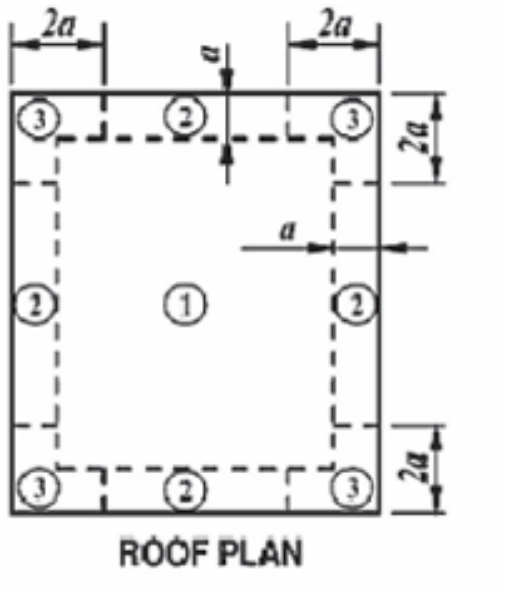
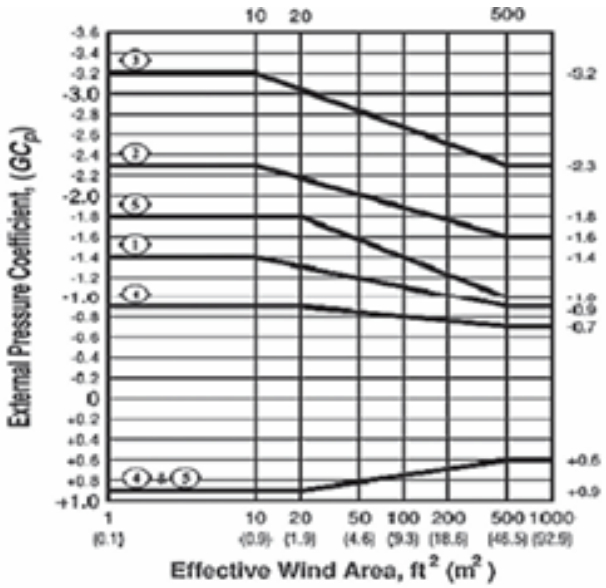


Figure 2



Allowable Uplift Wind Pressures (psf)				
USD / ASD	Zone 1'	Zone 1	Zone 2	Zone 3
USD	N.A.	-53.9	-84.6	-115.3
ASD	N.A.	-32.3	-50.7	-69.1
Allowable Uplift Wind Pressures (KPa)				
USD / ASD	Zone 1'	Zone 1	Zone 2	Zone 3
USD	N.A.	-2.6	-4.1	-5.5
ASD	N.A.	-1.5	-2.4	-3.3

Table 2

Figure 2. Allowable uplift wind pressures for Case 2 for mean roof height > 18.3 m (60 ft) -3.3 The following notes need to be stated with respect to Figure 1 and Figure 2:

- As an alternative to the Velocity vs Height values presented in Table 1, allowable uplift pressures for roof zones 1', 1, 2 & 3 as shown in Table 2 may be utilized for the tested paver size at the WOW provided the building and component wind load calculations comply with the criteria below. For clarity, both USD and ASD allowable uplift pressures are provided:
  - Basic Wind Speed is determined based on Risk Category and local requirements.
  - Exposure Category 'B', 'C', or 'D' is determined based on location and local requirements.
  - Building is an enclosed building with GCpi = 0.18 such as to produce the highest uplift pressures on the paver system. The system is not rated for open, partially enclosed, or partially open buildings.
  - Topographic Factor, Kzt, as required for local conditions.

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Case 2 – raised pedestal paver system with molding

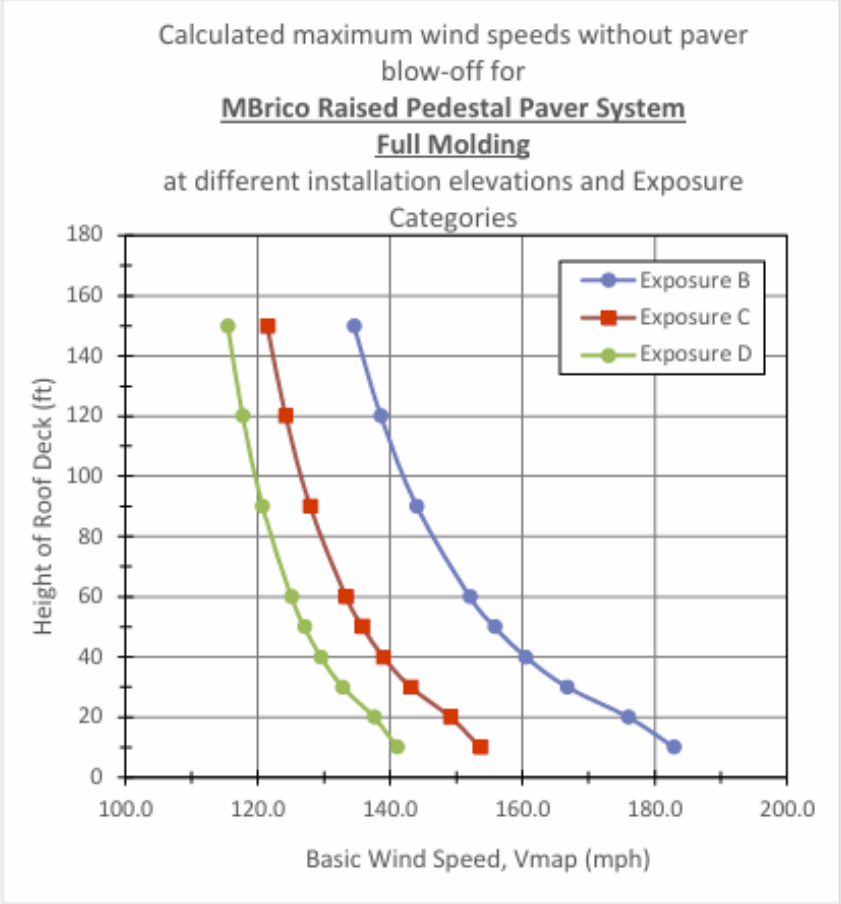
The performance observations of case 2 are summarized below:

- Tile lifting was not observed for all the wind directions considered, and therefore the nominal maximum wind speed was taken as 157 mph.

Below shows the calculated maximum wind speeds without paver blow-off based on the highest nominal 60-sec wind speed achieved for the worst-case wind direction tested for this configuration.

Map wind speeds for case 2 at different roof deck elevations and Exposure Categories

CALCULATED MAXIMUM WIND SPEEDS WITHOUT PAVER BLOW-OFF			
BASED ON EXPERIMENTAL DATA			
ROOFS			
Case With Molding			
Map Wind Speed			Elevation of
At height of 33 ft			Roof Deck
(mph)			(ft)
Exposure			
B	C	D	
134.5	121.4	115.5	150
138.6	124.2	117.7	120
144.0	127.9	120.7	90
152.0	133.3	125.0	60
155.7	135.8	127.0	50
160.5	138.9	129.5	40
166.7	143.1	132.8	30
176.0	149.1	137.6	20
182.9	153.6	141.0	10



Calculated maximum wind speeds for case 2 without paver blow-off at different roof deck elevations and Exposure Categories, based on the worst-case wind direction tested

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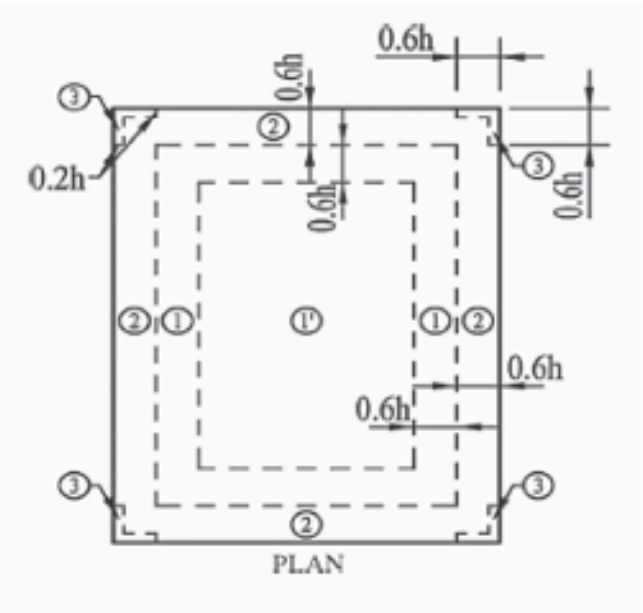

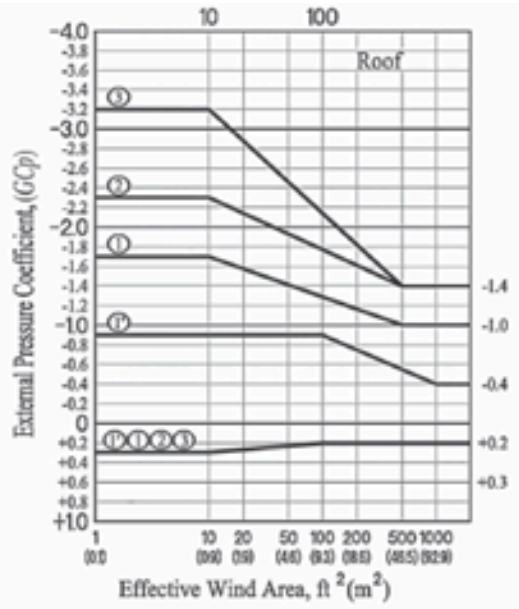

Allowable Uplift Wind Pressures (psf)				
USD / ASD	**Zone 1'**	**Zone 1**	**Zone 2**	**Zone 3**
USD	-43.2	-75.2	-99.2	-135.3
ASD	-25.9	-45.1	-59.4	-81.0
Allowable Uplift Wind Pressures (KPa)				
USD / ASD	**Zone 1'**	**Zone 1**	**Zone 2**	**Zone 3**
USD	-2.1	-3.6	-4.8	-6.5
ASD	-1.2	-2.2	-2.8	-3.9

Figure 3. Allowable wind uplift wind pressures for Case 2 for mean roof height ≤ 18.3 m (60 ft)

The following notes need to be stated with respect to Table 1 & 1A:

- Table 1 & 1A shall be utilized for a paver size having the following dimensions: 60 cm x 60 cm x 2 cm (23.6” x 23.6” x 0.79”) (L x W x T).

- The variables ‘V’ and ‘h’ limits provided in Table 1 & 1A area based upon the following:

1. Basic Wind Speed ‘V’ is determined based on Risk Category and local requirements. Exposure Category ‘B’, ‘C’, or ‘D’ is determined based on location and local requirements.
2. Roof deck surfaces are consistent with low-slope (flat) and monoslope roofs with a pitch less than or equal to 3 degrees.
3. Building is an enclosed building with GCpi = 0.18 such as to produce the highest uplift pressures on the paver sy stem. The system is not rated for open, partially enclosed, or partially open buildings.
4. Site conditions as well as shape and location of host building are representative of a Topographic Factor, Kzt = 1.0, a Ground Elevation Factor, Ke ≤ 1.0, and a Directionality Factor Kd = 0.85.

- For N.A. values, the raised pedestal paver tray system is not adequate at any height ‘h’ for the noted Exposure Cate gory and Wind Speed ‘V’.
- Values of ‘h’ or ‘V’ beyond those shown in Table 1 are outside the scope of these documents and the tests con ducted at the WOW.

Case 2 – raised pedestal paver system with molding Table 1. Maximum height at which pavers can be installed with respect to basic wind speed for case 2 (in SI and US customary units)

Table 1

Basic Wind Speed 'V' (mph)	Maximum Height 'h' (feet)		
	Exp. B	Exp. C	Exp. D
≤ 100	1,387	1,004	783
≤ 105	962	622	447
≤ 110	679	395	262
≤ 115	486	255	157
≤ 120	353	168	96
≤ 125	260	113	60
≤ 130	194	77	38
≤ 135	146	53	25
≤ 140	111	37	16
≤ 145	85	26	N.A.
≤ 150	66	19	N.A.
≤ 157	47	12	N.A.

Table 1A

Basic Wind Speed 'V' (m/s)	Maximum Height 'h' (m)		
	Exp. B	Exp. C	Exp. D
≤ 45	423	306	239
≤ 47	293	190	136
≤ 49	207	120	80
≤ 51	148	78	48
≤ 54	108	51	29
≤ 56	79	34	18
≤ 58	59	23	12
≤ 60	45	16	8
≤ 63	34	11	5
≤ 65	26	8	N.A.
≤ 67	20	6	N.A.
≤ 70	14	4	N.A.

The following notes need to be stated with respect to Table 1:

- Table 1 shall be utilized for a paver size having the following dimensions: 60 cm x 60 cm x 2 cm (23.6” x 23.6” x 0.79”) (L x W x T).

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The following notes need to be stated with respect to Figure 1, 2 and Table 2:

- As an alternative to the Velocity vs Height values presented in Table 2 & 2A, allowable uplift pressures for roof zones 1', 1, 2 & 3 may be utilized for the tested paver size at the WOW provided the building and component wind load calcu lations comply with the criteria below.

1. Basic Wind Speed is determined based on Risk Category and local requirements.
2. Exposure Category 'B', 'C', or 'D' is determined based on location and local requirements.
3. Building is an enclosed building with GCpi = 0.18 such as to produce the highest uplift pressures on the paver sy stem. The system is not rated for open, partially enclosed, or partially open buildings.
4. Topographic Factor, Kzt, as required for local conditions.
5. Effective Wind Area = 10 square feet.
6. Directionality Factor, Kd = 0.85.
7. Ground Elevation Factor, Ke, as permitted for local conditions.
8. Parapet Height = 30 cm (1 ft). Load ratings are not applicable for loads reduced due to parapet height.
9. Roof deck surfaces are consistent with low-slope (flat) and monoslope roofs with a pitch less than or equal to 3 degrees.
10. Mean Roof Height ≤ 18.3 m (60 ft) with GCp from Figure 3 and reference Figure 1 for Allowable Uplift Wind Pressures.
11. Mean Roof Height > 18.3 m (60 ft) with GCp from Figure 30.4-1 and reference Figure 2 for Allowable Uplift Wind Pressures.

- The allowable uplift pressures noted herein shall be greater than a building's roof component design pressure

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