Wind Uplift.

Critical Factors and Mitigation

Archatrak

What You Need to Know About Wind Uplift

Roof systems are exposed to higher wind induced loading than any other building element. Suction forces on the roof can loosen and lift both roof sheathing and roof coverings, such as tiles, shingles, and roof pavers.

How Does This Happen?

Where the net uplift force is higher than the individual weight of the pavers, dislodgement may occur, causing failure of the roof paver system and potentially causing pavers to become windborne.

It's important to note you do not need hurricane force winds to see uplift occur. When wind is blowing over the corner of an elevated deck, conical vertices (tight wind tornados) are formed and can be sufficient to produce the force needed to dislodge pavers.

What Effects Net Uplift?

Building or Site Scale

- Exposure of the building
- Orientation of the building to incoming wind
- Height of the building
- Shape of the building
- Size of the roof
- Height of any parapet
- Details at roof corners
- Roof top structures such as elevator housings, stairwell covers, cooling towers

Paver Scale

- Width of the gap between two adjacent pavers
- Height of any pedestals supporting the pavers
- Paver dimensions
- Paver weight
- Ratio of paver gap to pedestal height
- Distance of the paver from the roof corner
- Air flow resistance underneath the pavers (e.g. by wide pedestals)

Most Critical Factors

Angle of Incoming Wind

Incoming wind angle is critical. Most research studies have concluded that wind coming into the corner of a building at 45° is most critical. However one notable study using a larger number of pressure taps indicated that 22.5° and 67.5° wind angles produced the most intense uplift at the windward edges of the perimeter.

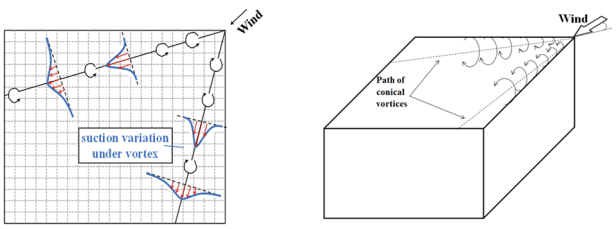

Fig. 1 Conical vortices; Suction variation on roof under corner vortices

Paver Gap Width

The width between pavers can impact the speed at which pressure equalization occurs. Larger gaps allow for faster equalization.

Cavity (Or Pedestal) Height

The more uniform cavity pressure occurring at greater pedestal heights reduces the pressure equalization effect.

Ratio of Paver Gap to Cavity Height

The higher the ratio, the less the net uplift pressure on the paver and the higher the wind speed before uplift occurs.

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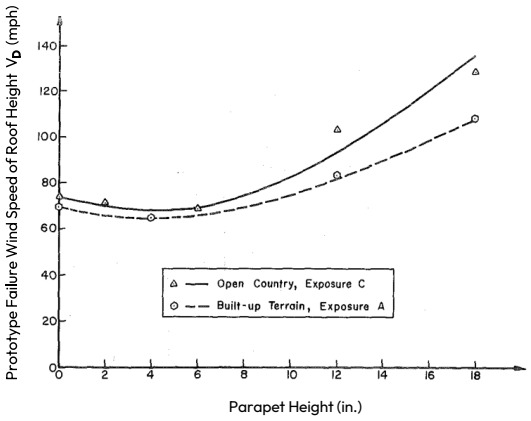


*Bienkiewicz et al. (Wind Effects on Roof Ballast Pavers).

Solid vs 'Porous' Parapets

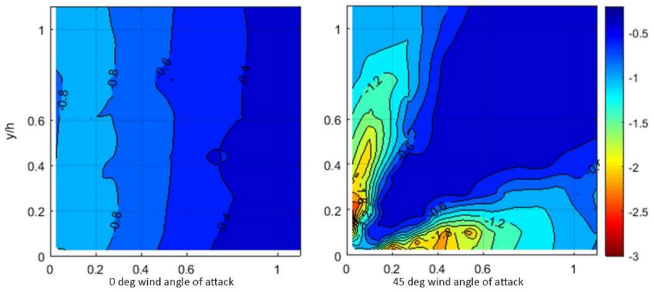
Both have some benefit in reducing uplift. Solid parapets move the core of the wind vortices away from the roof deck perimeter and porous parapets can disrupt the formation of vortices and weaken them.

Parapet Height

Heights up to about 6" can actually cause uplift to occur at a lower wind speed than a zero height parapet. Increasing parapet heights above about 6" provides a gradually increasing resistance against wind uplift.

Most Vulnerable Areas On A Roof Deck

As stated above, there are numerous factors that influence the formation of conical vortices and the subsequent wind uplift. In an installation where the wind is coming at an angle, the most vulnerable pavers are on the perimeter of the roof. And of these, the initial failure is most likely to occur 4' from the corner.



*Birhane et al (Air-Permeability Factor for Wind Loads on Loose-Laid Pavers on Flat Roofs)

How To Mitigate Wind Uplift

The most effective way to mitigate wind uplift in a porcelain paver system is to install an interconnected, contiguous lockdown system. Archatrak offers systems for mitigating wind uplift on both T20 2cm porcelain pavers and T30 3cm porcelain pavers. Both systems use a screw and washer assembly in conjunction with our steel Incendio pedestals. In the 2cm paver system, the washer locks down the corners of steel trays onto which the pavers are adhered while in the 3cm system, slots are cut into each corners of the pavers to accommodate the hold down washers.

Maximum Allowable Wind Pressures:

The two Archatrak lock down systems were tested in accordance with ASTM E 330 (Determining structural performance of exterior building surface elements under uniform static air pressure difference). The pavers were tested to failure. The average pressure at which failure occurred was:

- 2cm paver system 183 psf.
- 3cm paver system 280 psf.

The structural performance of the two systems has been certified by Engineering Express of Boca Raton FL. A copy of the certification document is available on request from Archatrak.

2cm Pavers on Incendio Pedestals
183 psf.

3cm Pavers on Incendio Pedestals
280 psf.