www.bre.co.uk

BRE Test Report

Determination of the uplift resistance of the Innovast MyDek Tile Clip System Following the Test Principles of BS EN 14437:2004

Prepared for: Paul Reeves

Date: 18th February 2023

Report Number: P124492 -1000 Issue 1

BRE
Watford, Herts
WD25 9XX

Customer Services 0333 321 8811

From outside the UK:
T + 44 (0) 1923 664000
F + 44 (0) 1923 664010
E enquiries@bre.co.uk
www.bre.co.uk

Prepared for:
Paul Reeves
Innovast
11 Arkwright Road
Reading
RG2 0LU

Prepared by

Name Mr Simon Croucher

Position Wind Engineering Technician

Date 18th February 2023

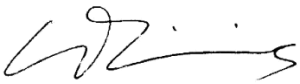
Signature 

Authorised by

Name Gary Timmins

Position Head of Construction, Assurance Division

Date 18th February 2023

Signature 

bre

Table of Contents

1 Introduction

At the request of Paul Reeves, Innovast, BRE issued Proposal P124492 on 17th October 2022. This was accepted on 3rd November 2022. The tests on the specimens were carried out under the BRE Standard Terms and Conditions of Business under BRE project P124492-1002 on 8th February 2023.

We are unaware of any test method specifically for assessing the wind uplift resistance of flooring tiles or associated fixings. The principles of a test method intended for assessing the wind uplift resistance of roof tiles was used. The principles of the test method outlined in BS EN 14437:2004[1] (Determination of the uplift resistance of installed clay or concrete tiles for roofing. Roof system test method) was combined with the results from Mooneghi et al (2016)[2] to create a bespoke testing strategy. This allowed the wind uplift resistance of the fixing system to be determined.

This report provides details of the testing carried out and results obtained.

2 Details of Specimen

The system as tested is shown in Figure 1 and is composed of:

CF02 base cleat

60mm BoxRail section

J-Clip fixings

600mm x 600mm x 20mm (nominal dimensions) porcelain pavers

Each tile was fixed using four J Clips one fixed to each corner via a 5mm nominal width slot 5.5mm from the lower surface within the edge of the tile.

Figure 2 shows a close up of the box section/J Clip/paver interfaces with Figure 3 highlighting the installation of the system prior to test.

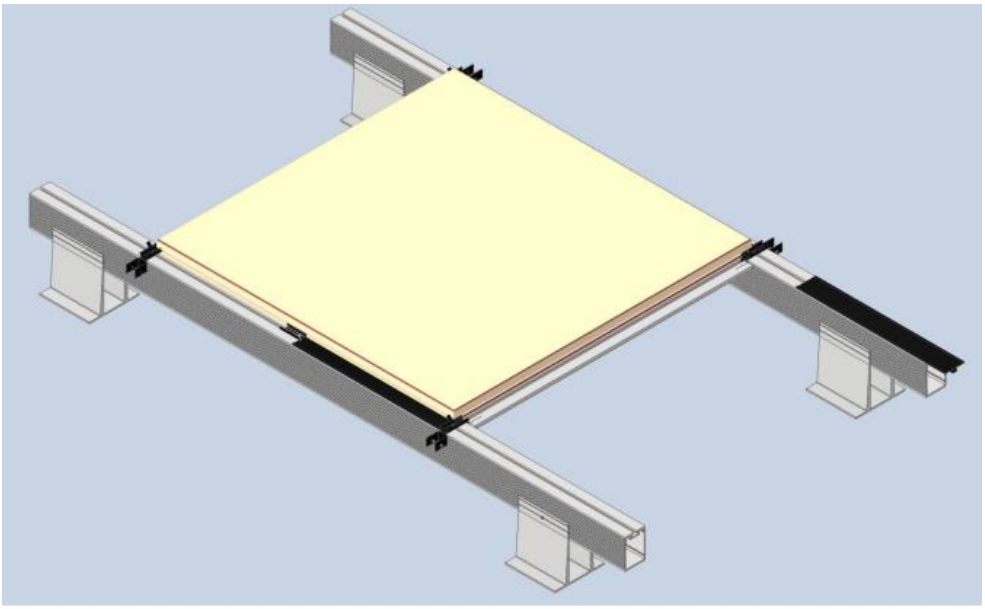


Figure 1. CAD depiction of the MyDek system as tested.

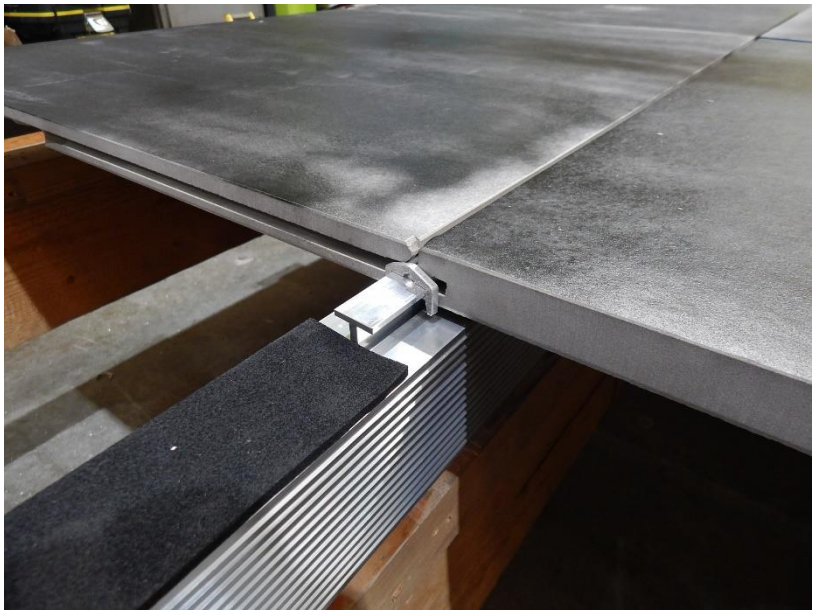


Figure 2. Close up of beam, J Clip, paver connection.

Figure 3. Installation of the paver system.

3 Details of Test Procedure

The testing process itself was carried out following the principles outlined in BS EN 14437:2004[1] and was used to establish the failure limit of the system.

The tests were carried out on a simulated floor structure at a pitch of 0º. Cleats were fixed to the test rig which were used to fix five beams in place at 600mm centres. The pavers were mounted to the beams via the J Clip system. The system was installed by BRE staff under the supervision of Innovast staff following the installation guide provided by Innovast (Design Guide MYD-00011 v5).

Four pneumatic rams with suction cups per tile to be loaded were attached to apply a uniform uplift force to simulate wind uplift loads. To aid the suction, each tile was spray painted.

Initially, the tiles were loose laid on to the joists in order to determine the test load required to lift the unfixed tile, F_{TO}. This load included the self-weight of the tiles and loading equipment.

The specific configuration tested was based upon the experimental work of Mooneghi et al (2016)[2] who investigated the pressure distribution on a roof paver system. The testing confirmed high suction pressures generated by the effects of conical vortices under cornering winds.

As a result, a 4 x 3 array of pavers was installed with a 3 x 2 array of pavers loaded, to simulate the potential vortex system, as shown in Mooneghi.

Testing was repeated five times with damaged tiles replaced and new clips used for each test. The loads were applied slowly to reach the failure load $F_{T,max}$.

Failure was defined as one of the following:

- Breakage or pull-out of the mechanical connection between the aluminium joist and the tile.
- Breakage of the tile.

Figure 4 shows the specimen prior to test.

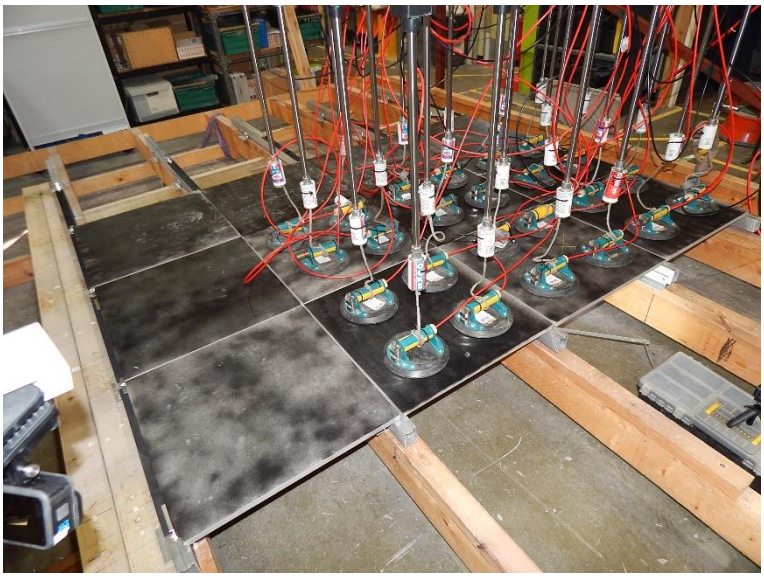


Figure 4 Set up of the test.

4 Test results

4.1 Calculation procedure

EN 14437:2004 requires the characteristic uplift resistance R_k to be determined from equation 1:

$R_k = R_x - k_n s_x$ … (1)

Where

R_x is the mean uplift resistance determined from $R_x = \frac{1}{n}\sum R_i$

s_x is the standard deviation of the resistance determined from $s_x = \sqrt{\frac{1}{n-1}\sum (R_i - R_x)^2}$

k_n is a statistical factor = 3.37 for a sample size of 3 or 2.33 for a sample of 5 from Table D.1 in EN 14437

R_i is the individual measured value from each test

EN14437 requires that the coefficient of variability given as s_x / R_x be <0.1 after each batch of three tests. If this value exceeds 0.1 then at least two additional tests must be carried out.

4.2 Results of MyDek System

Table 1 gives the calculated values of R_k, R_x, s_x and s_x/R_x and the individual failure loads from each of the initial three tests on the MyDek system.

Test configuration	Test number	Self weight (N), F_{ro}	Measured force (N), F_n	Net Force (N)	Net Force per clip (N)	Failure mode
MyDek 0.6m x 0.6m tile system	1	152.1	1251.8	1099.7	275	Fracture of slot within tile
MyDek 0.6m x 0.6m tile system	2		1106.6	954.5	239	Fracture of slot within tile
MyDek 0.6m x 0.6m tile system	3		1326.3	1174.3	294	Fracture of slot within tile

Mean force (N)	269.0
Standard deviation (N)	27.9
Coefficient of variability	0.10
Characteristic wind uplift force (N)	174.9

Table 1. Failure load data for the MyDek system after three repeats.

The coefficient of variability (s_x/R_x) is =0.1 so the result is valid.

At the request of the client, an additional two tests were completed to confirm the failure modes. Table 2 gives the calculated values of R_k, R_x, s_x and s_x/R_x and the individual failure loads from the five tests completed.

Test configuration	Test number	Self weight (N), F_{TO}	Measured force (N), F_{Ti}	Net Force (N)	Net Force per clip (N)	Failure mode
MyDek 0.6m x 0.6m tile system	1	152.1	1251.8	1099.7	275	Fracture of slot within tile
MyDek 0.6m x 0.6m tile system	2		1106.6	954.5	239	Fracture of slot within tile
MyDek 0.6m x 0.6m tile system	3		1326.3	1174.3	294	Fracture of slot within tile
MyDek 0.6m x 0.6m tile system	4		1169.4	1017.3	254	Fracture of slot within tile
MyDek 0.6m x 0.6m tile system	5		1345.9	1193.8	298	Fracture of slot within tile

Mean force (N)	**272.0**
Standard deviation (N)	**25.5**
Coefficient of variability	**0.094**
Characteristic wind uplift force (N)	**212.6**

Table 2. Failure load data for the MyDek system after five repeats.

The coefficient of variability (s_x/R_x) is <0.1 so is a valid result.

The failure mode in each test was the fracture of the tile where the J Clip inserted into the slot cut in the side of the tile, Figure 5. This is an ultimate failure state. The location of failure for each test varied. Figure 6 shows the location of the initial failure of the system for each of the five tests.

Figure 5. Example of failure mode of the MyDek system.

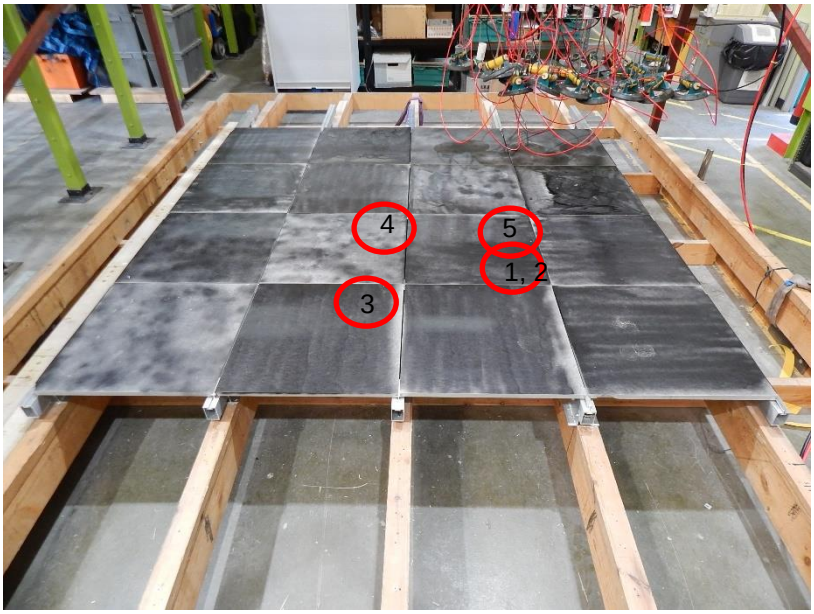


Figure 6. Location of initial failure of the system for each of the five tests completed.

Based upon the five tests completed, the characteristic wind uplift force per clip is **212.6N.** Please note**,** no partial safety factors have been applied

4.3 Indicative Calculation of Characteristic Wind Uplift Resistance

The characteristic wind uplift force per clip is 212.6 N (as measured).

With 4 clips per 0.6m x 0.6m tile (nominal tile dimension) , the characteristic wind uplift force per tile = 212.6 x 4 = 850.4 N.

Tile area (as measured) = 0.595m x 0.595m = 0.354m^2.

Therefore, the characteristic wind uplift resistance of the fixings = 850.4 N / 0.354m^2 = 2402.1 Pa

The mass of the tile is an additive effect on the uplift pressure. Therefore, weight of single tile (as measured) = 15.5kg x 9.81 = 152.1N.

Wind uplift resistance of the tile = 152.1N / 0.354m^2 = 429.7Pa

Therefore, the effective characteristic wind uplift pressure of the fixing and tile = 2402.1 Pa + 429.7 Pa = 2831.6 Pa

Note. This calculation is indicative only and does not include the mass effects of the rails, cleats or clips.

5 Conclusion

This report describes tests carried out to determine the characteristic wind uplift resistance of the MyDek clipped system to fix 600mm x 600mm x 20mm porcelain pavers mounted on 60mm BoxRail section and four J Clips per tile. The testing followed the principles of BS 14437 and data by Mooneghi et all (2016). The following results were obtained:

- Five tests were completed with a coefficient of variability <0.1 so the results are valid.
- The calculated characteristic strength per clip is **212.6 N**
- An indicative effective characteristic wind uplift resistance of the fixings and tile is **2831.6 Pa** (this ignored the dead weight of the rails, cleats or clips)

No partial safety factors have been applied.

6 References

1 BS EN 14437:2004 Determination of the uplift resistance of installed clay or concrete tiles for roofing – Roof system test method, BSI, December 2004

2 M. Asghari Mooneghi, P. Irwin, and A. Gan Chowdhury (2016). “Towards Guidelines for Design of Loose-Laid Roof Pavers for Wind Uplift.” Wind and Structures. Vol. 22, No. 2, 133160.