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TEST REPORT

Manthorpe dry fix systems - testing to BS8612:2018 and high-speed wind tunnel testing

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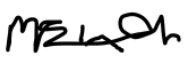
Signature	

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1.Executive summary

Dry fix verge testing was carried out on Manthorpe's MBP_GU_GPPV-TLE Dry Fix Verge System using the procedures set out in BS8612:2018.

A summary of the results are documented in Table 1.

Table 1: Summary of results of dry fix verge testing.

Test	Annex	Result
Mechanical resistance	E	314 N
Vertical load with tile sidelocks	F	2.28 kPa
Vertical load with tile sidelocks removed	F	3.19 kPa
Rain drainage	G	Pass

Bespoke high-speed wind tunnel testing was carried out on the following products:

- MBP_GU_GPPV-TLE Dry Fix Verge System
- GDRR-ULTRA Roll-out Ridge System
- GPPV-END-R Round Ridge End Cap
- GBAT Ridge Roost bat conservation roost

They were installed onto the BRE test rig with Marley Edgemere tiles and subjected to wind speeds of up to 48 m/s. No damage to the products was recorded.

The high-speed wind tunnel testing does not rate products in relation to general reference wind speeds. A tunnel wind speed that is used as part of this work can be related to a site-specific peak gust wind speed that a product may be subjected to in a particular location. Site specific peak gust wind speeds can be higher than associated general reference wind speeds and may be influenced by local terrain and surrounding buildings.

Products can be subjected to a range of wind pressures in any given scenario depending on the objects surrounding them. The pressures that a product is subjected to during this work may not necessarily be representative of the applied wind pressures in a specific situation that the product is used in.

The wind speed being applied during this work is of low turbulence intensity (approximately 5%) and is not representative of real-life fluctuating wind gusts that could affect dynamically sensitive products.

It is the responsibility of the customer or the customer's representatives to consider the actual wind speeds, wind pressures and turbulence that a product may be subjected to in a given situation and satisfy themselves that the product is fit for purpose.

This work does not warranty the performance of the product in use and BRE accepts no liability for any loss or damage arising from its use.

2. Introduction

At the request of Ben Hales, Product Designer at Manthorpe Building Products, BRE issued proposal number P127035 and BRE Standard Terms and Conditions of Business on the 21 of November 2023. The proposal and terms and conditions were accepted by Ben Hales on the 21 of November 2023.

The proposal covered testing of dry fix verge systems to BS 8612:2018 and bespoke high speed wind tunnel testing for dry verge and ridge systems.

The specimens were provided and delivered to the test lab by the client on the 15 December 2024.

The BS 8612 tests on the specimens were carried out at BRE during the week commencing 19 February 2024. The high speed wind tunnel testing was carried out on 08 January 2024. This report provides details of the testing carried out and results obtained.

Dry fix verge testing was carried out on Manthorpe's MBP_GU_GPPV-TLE Dry Fix Verge System to BS 8612:2018 Annexes E, F and G.

Bespoke high-speed wind tunnel testing was carried out on the following products installed onto the BRE test rig with Marley Edgemere tiles.

- MBP_GU_GPPV-TLE Dry Fix Verge System
- GDRR-ULTRA Roll-out Ridge System
- GPPV-END-R Round Ridge End Cap
- GBAT Ridge Roost bat conservation roost

3.Test details

3.1 Dry fix verge testing to BS 8612:2018

This testing was carried out on Manthorpe's MBP_GU_GPPV-TLE Dry Fix Verge System using Marley Edgemere tiles. Further details can be found in the next section of this report.

3.1.1. Mechanical resistance tests for verges to Annex E

This testing was carried out following the procedure given in Annex E.10 of BS 8612. The purpose of this testing was to establish the resistance of the verge units to horizontal wind action.

In this test, the verge unit was subjected to horizontal load via a hydraulic ram and the load was measured by a load cell. The load was gradually increased until failure occurred:

a) in verge unit(s);

b) in verge fixing(s);

c) in tiles held by verge;

d) where the verge unit disengaged from the tiles, or in the case of discontinuous verges, disengaged from each other, with or without damage to the verge units.

The testing was repeated three times.

The instruments used in the testing are given in Table 2.

Table 2: Instrument table.

Instrument number	Description	Last Calibrated
IN6333	Novatech load cell	30 May 2023
IN5492	Tape measure	5 Oct 2022

3.1.2. Vertical load tests for wind uplift resistance of verges to Annex F

This testing was carried out following the procedure given in Annex F of BS 8612. The purpose of this testing was to establish the uplift resistance of the verge units when subjected to simulated wind uplift forces.

The tiles were initially laid without fixings to determine the test load FVO required to lift the tail of the tile by 10mm. This test load included the self-weight of the tiles, fixing clamps and loading equipment.

A trial test was then carried out to establish the expected failure load FV,test. This value was then used to establish the loading increments which were < FV, test/5.

The loads were applied as specified in BS 8612 Annex F. Each load increment was applied and then removed. This was repeated until failure occurred, where failure was defined as one of the following:

a) the verge unit broke;

b) the verge unit fixing pulled out;

c) either the roof tiles broke; or

d) the verge unit disengaged from the verge unit below or from the tile.

This testing was conducted with standard tiles and with modified tiles where the sidelocks were removed under client instruction. The testing was repeated three times for each variation using new verge units for each test.

The instruments used in the testing are given in Table 3.

Table 3: Instrument table.

Instrument number	Description	Last Calibrated
IN2477	Mecmesin force gauge	16 Dec 2023
IN5492	Tape measure	5 Oct 2022

3.1.3. Rain drainage from verges test to Annex G

The purpose of this testing was to establish if the verge units satisfactorily discharged rainwater away from the face of a building.

The tiles, slates, and verge units were installed on a test rig complying with the requirements of BS 8612 Annex G. The pitch of the test rig was 22.5°, the water flow rate was set to 2 litre/min, and the water outlet was at 35° to the horizontal. See Figure 1 for a diagram of the test set up.

The testing was repeated three times. A visual assessment of the drainage performance of the verge was made.

The pass / fail criteria for this test is stated in Clause 7 of BS 8612

> Verge systems, when tested in accordance with the test method in Annex G, shall not allow water to discharge in one or more concentrated, continuous or intermittent streams on the wall. Random splashes which do not form intermittent streams are acceptable.

The instruments used in the testing are given in Table 4.

Table 4: Instrument table.

Instrument number	Description	Last Calibrated
IN3294	Timer	12 Sept 2022
IN3767	Inclinometer	6 Dec 2023

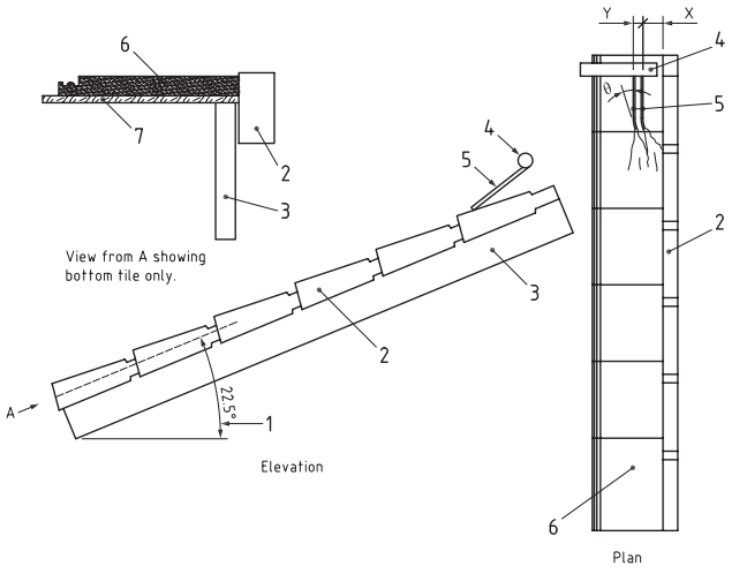


Figure 1: Test setup as described in Figure G.1 of BS 8612.

3.2 High speed wind tunnel testing

Bespoke high-speed wind tunnel testing was carried out on the following products installed onto the BRE test rig with Marley Edgemere tiles. Further details can be found in the next section of the report.

- MBP_GU_GPPV-TLE Dry Fix Verge System
- GDRR-ULTRA Roll-out Ridge System
- GPPV-END-R Round Ridge End Cap
- GBAT Ridge Roost bat conservation roost

The test specimen was mounted at the outlet of the BRE wind tunnel. It was tested in 8 orientations, in each orientation the wind speeds were incrementally increased up to 48 m/s. Any damage was noted and recorded.

4.Specimen details

4.1 Dry fix verge testing to BS 8612:2018

The dry fix verge system used for this testing was Manthorpe's MBP_GU_GPPV-TLE. The individual verge units were secured with one No.8 x 1 ½" pan head stainless steel coarse self-tapping screw.

The verge units were installed according to the installation manual provided by Manthorpe.

The tiles used with the verge units were Marley Edgemere tiles. Details are given in Table 5 below.

Table 5: Marley Edgemere tile details.

Material:	Concrete
Width:	330 mm
Length:	420 mm
Gauge	345 mm
Head-lap:	75 mm
Fixing	Clamped to hinged batten.

Annex F testing was conducted with standard tiles (Type A) and with modified tiles (Type B) where the sidelocks were removed under client instruction. For both types a notch was also added to allow the tile to freely rotate on the test rig.

- Type A: Sidelock notched.
- Type B: Sidelocks removed and the tiles notched.

These modifications can be seen in Figures 2 and 3.

Figure 2: Type A with sidelock notched.

Figure 3: Type B with sidelock removed and tile notched.

4.2 High speed wind tunnel testing

The specimen for the high-speed wind tunnel testing was built using the following products on the BRE test rig. The test rig is 2 x 2 m box with a 22.5° duo-pitch roof, see Figure 4.

- Marley Edgemere concrete tiles.
- MBP_GU_GPPV-TLE Dry Fix Verge System.
- GDRR-ULTRA Roll-out Ridge System.
- GPPV-END-R Round Ridge End Cap.
- GBAT Ridge Roost bat conservation roost.

All the products were installed by Manthorpe employees.

Figure 4: Products installed on BRE test rig.

4.2.1. Marley Edgemere tiles

The battens, underlay, tiles and fixings used were all laid in accordance with British Standards BS 5534:2014 'Code of Practice for slating and tiling' and in accordance with the tile manufacturer's guidelines. Details of the products used are given in Table 6.

Table 6: Marley Edgemere tile details.

Material:	Concrete
Width:	330 mm
Length:	420 mm
Gauge	310 mm
Head-lap:	110 mm
Battens:	25 x 50 mm
Fixings:	• No.5 x 50mm woodscrews (in place of 50mm aluminium clout nails). • Marley Solofix Edgemere Tile Clips utilized for central tiles not affected by the verge unit as a secondary fixing. • Eaves course supplemented by Marley Edgemere Eaves Clip & Nail (code 30297).
Bond:	Broken bond. Left-hand half tile cuts bonded to adjacent tiles with Soudal Fix All High Tack Polymer Adhesive.
Pitch:	22.5°
Underlay:	Danelaw LR120

4.2.2. Verges and ridge

The dry fix verge system used for this testing was Manthorpe's MBP_GU_GPPV-TLE. The individual verge units were secured with one No.8 x 1 ½" pan head stainless steel coarse self-tapping screw.

The ridge products used are listed below.

- Marley third round segmented ridge tiles
- Manthorpe GDRR-ULTRA roll-out ridge system
- 1 no. GPPV-END-R round ridge end cap
- 1 no. GBAT Ridge Roost bat conservation roost

5.Test Results

5.1 Dry fix verge testing to BS 8612:2018

The following sections detail the test results for dry fix verge testing to BS 8612:2018.

5.1.1. Mechanical resistance tests for verges to Annex E

All tests ended when criteria d was met, this is a serviceability criteria. It was not possible to continue the test to an ultimate failure mode as the verge units did not re-engage when the load was removed.

> d) where the verge unit disengaged from the tiles, or in the case of discontinuous verges, disengaged from each other, with or without damage to the verge units.

The results from the load tests on the verge unit are given in Table 7. They are given per verge unit. The results were within 15% of the mean so no further testing was required. Photos from before and after the test are shown in Figures 5 and 6.

Table 7: Annex E results.

Test Number	$F_{v,s}$ (N)	Failure mode
Test 1	307	Right verge unit unclipped from right verge unit
Test 2	294	Right verge unit unclipped from right verge unit
Test 3	339	Left verge unit unclipped from right verge unit

Characteristic resistance: 314 N

The verge unit disengaged with no damage, a serviceability failure with a partial safety factor, γ_M =1.0 (Table C.2 of BS 8612). Further details of the calculation can be found in Appendix A.

Design resistance: 314 N

Figure 5: Before test.

Figure 6: After test showing failure mode.

5.1.2. Vertical load tests for wind uplift resistance of verges to Annex F

This testing was carried out twice on two variations of the tiles.

5.1.2.1 Tile with sidelock notched (Type A)

All tests ended when criteria d was met. It was not possible to continue the test to an ultimate failure mode as the verge units did not re-engage when the load was removed.

> d) the verge unit disengaged from the verge unit below or from the tile.

The results from the load tests on the verge unit are given in Table 8. The results were within 15% of the mean so no further testing was required. Photos from before and after the test are shown in Figures 7 and 8.

Table 8: Annex F results for tiles with sidelock notched.

Test Number	$F_{v,s}$ (N)	F_{v0} (N)	R_{si} (N)	Failure mode
Test 1	303	44	259	Verge unit disengaged without breaking. Verge unit can be reengaged and is still serviceable
Test 2	343	44	299	Verge unit disengaged without breaking. Verge unit can be reengaged and is still serviceable
Test 3	266	44	222	Verge unit disengaged without breaking. Verge unit can be reengaged and is still serviceable

The verge unit disengaged with no damage, a serviceability failure with a partial safety factor, γ_M =1.0 (Table C.2 of BS 8612). Further details of the calculation can be found in Appendix A.

Characteristic resistance, $R_{kx,s}$: 260 N

Design resistance, R_s: 2.28 kPa

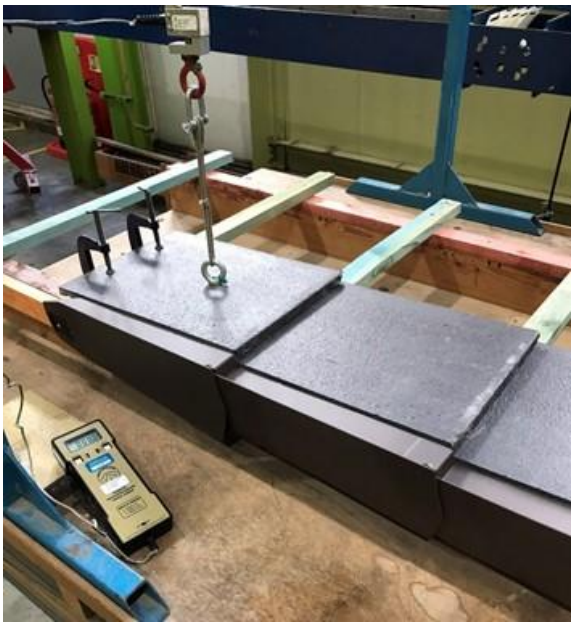


Figure 7: Before test.

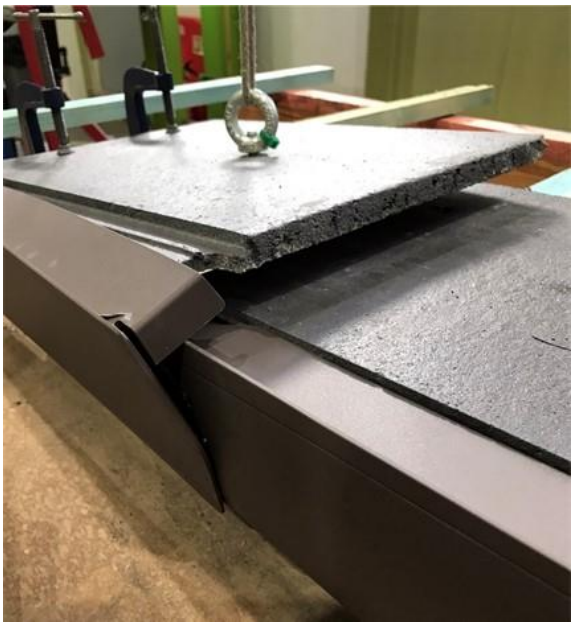


Figure 8: After test showing failure mode.

5.1.2.2 Tile with sidelock removed and tile notched (Type B)

All tests ended when criteria d was met. It was not possible to continue the test to an ultimate failure mode as the verge units did not re-engage when the load was removed.

d) the verge unit disengaged from the verge unit below or from the tile.

The results from the load tests on the verge unit are given in Table 9. The results were within 15% of the mean so no further testing was required.

Table 9: Annex F results for tiles with sidelock removed and tile notched.

Test Number	$F_{v,s}$ (N)	F_{v0} (N)	R_{si} (N)	Failure mode
Test 1	389	41	348	Verge unit disengaged without breaking. Verge unit can be reengaged and is still serviceable
Test 2	370	41	329	Verge unit disengaged without breaking. Verge unit can be reengaged and is still serviceable
Test 3	339	41	298	Verge unit disengaged without breaking. Verge unit can be reengaged and is still serviceable

The verge unit disengaged with no damage, a serviceability failure with a partial safety factor, γ_M =1.0 (Table C.2 of BS 8612). Further details of the calculation can be found in Appendix A.

Characteristic resistance, $R_{kx,s}$: 325 N

Design resistance, R_s: 3.19 kPa

5.1.3. Rain drainage from verges test to Annex G

In the rain drainage tests none of the verge units allowed water to discharge in concentrated continuous or intermittent streams on to the fascia board in any of the 3 tests. Figure 9 shows the verges under test.

The Manthorpe MBP_GU_GPPV-TLE dry verge unit meets the rain drainage performance requirements of Annex G.

Figure 9: Manthorpe dry verge under the rain drainage test.

5.2 High-speed wind tunnel testing

Table 10 shows the results of the testing as well as any observations noted, with the test rig being rotated at various angles for the test. Figures 10 and 11 below showcase the test rig at BRE with the test rig rotated to show both sides of the test rig with the tiles and verge units installed.

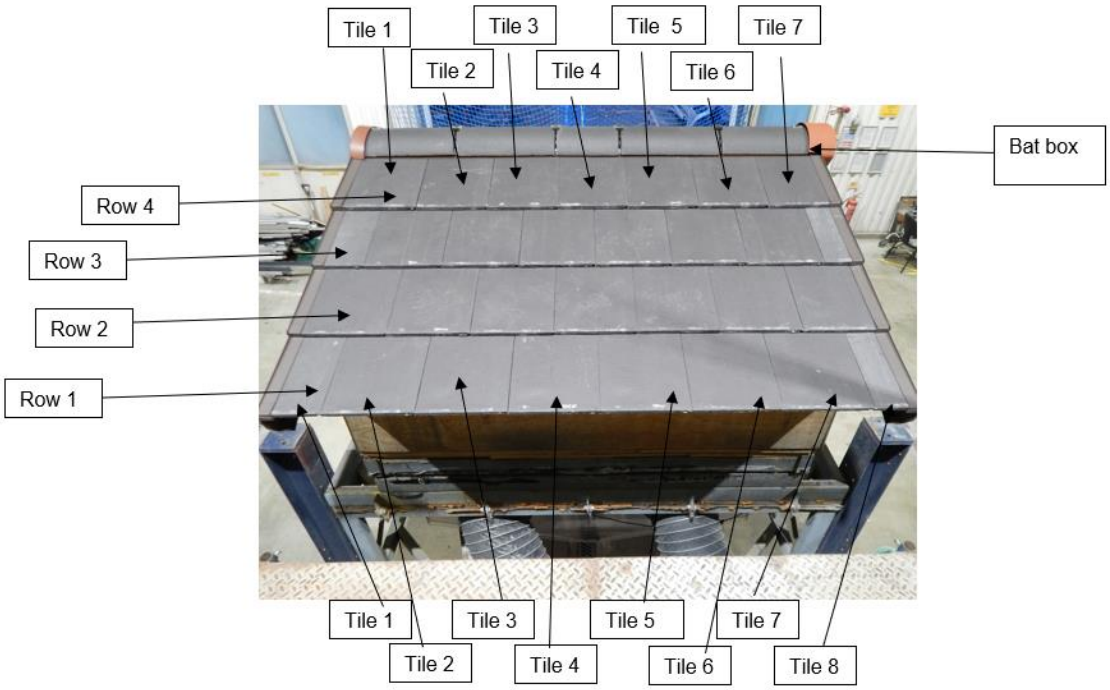


Figure 10: Image to show the test set up with corresponding tiles & rows for side A (bat box on the left when facing the wind tunnel).

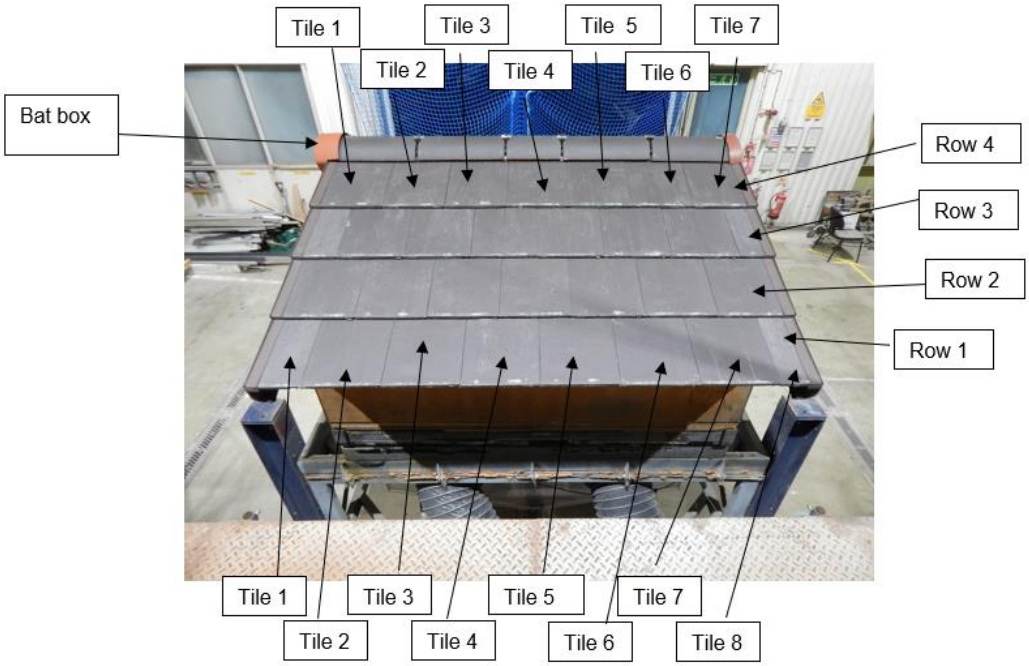
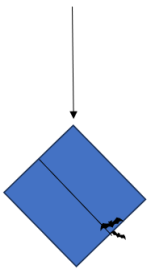
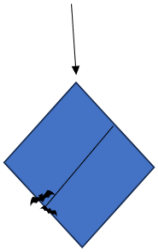
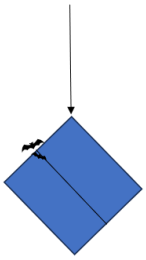
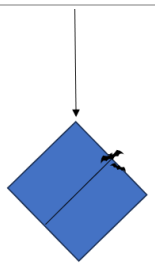
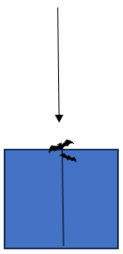
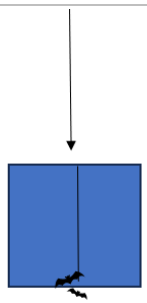
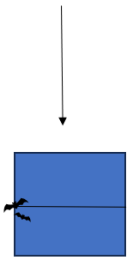
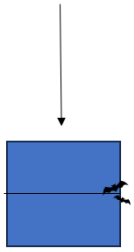


Figure 11: Image to show the test set up with corresponding tiles & rows for side B (bat box on the right when facing the wind tunnel).

Table 10: Results of the high-speed wind tunnel testing with observations.

Box Angle	Image Representation	Wind speed (m/s)	Row	Tile	Observations
0°		25	-	-	-
		30	-	-	-
		35	-	-	-
		40	-	-	-
		45	-	-	-
		48	-	-	-
90°		25	-	-	-
		30	-	-	-
		35	-	-	-
		40	-	-	-
		45	3 1	1 2 2 3 4	Chattering Chattering
		48	1 3 2	1 2 3 4 2 3 4 1	Chattering Chattering Chattering
180°		25	-	-	-
		30	-	-	-
		35	-	-	-
		40	2	7	Chattering
		45	2	7	Chattering
		48	2	7	Chattering
270°		25	-	-	-
		30	-	-	-
		35	-	-	-
		40	-	-	-
		45	1 2	1 2 3 1	Chattering Chattering
225°		25	-	-	-
		30	-	-	-
		35	-	-	-
		40	-	-	-
		45	-	-	-
		48	-	-	-

Box Angle	Image Representation	Wind speed (m/s)	Row	Tile	Observations
45°		25	-	-	-
		30	-	-	-
		35	-	-	-
		40	-	-	-
		45	-	-	-
		48	-	-	-
135°		25	-	-	
		30	1	3	Chattering
		35	1	2 3 4 5	Chattering
		40	1	1 2 3 4 5 6 7	Chattering
		45	1 3	1 2 3 4 5 6 7 2 3 4	Chattering Chattering
		48	1 2 3	1 2 3 4 5 6 7 7 1 2 3 4	Chattering Chattering Chattering
315°		25	-	-	-
		30	-	-	-
		35	-	-	-
		40	1	1 2 3 4 6 7	Chattering
		45	1 3	1 2 3 4 5 6 7 1 2 3	Chattering Chattering
		48	1 3	1 2 3 4 5 6 7 1 2 3	Chattering Chattering

No damage was recorded.

6. References

1 BS 8612:2018, “Dry Fixed ridge, hip and verge systems for tiling – Specification”, BSI Standards Limited.

2 BS 5534:2014 + A2:2018, “Slating and tiling for pitched roofs and vertical cladding – Code of practice”, BSI Standards Limited.

Appendix A

A.1 Calculations to Annex E

The calculations have been carried out in accordance with E.6 of BS 8612.

E.6 Derivation of characteristic and design values

Derive the characteristic value as the mean value of the test results for the maximum number of specimens tested.

Derive the design value of resistance as the characteristic value divided by the appropriate value of γ_M for ultimate failure or serviceability failure.

In the case of tests on discontinuous verges which might disengage with each other or with the roof tiles, failure by serviceability or ultimate limit states shall be identified in accordance with the classification given in Table C.2.

Table C.2 from BS 8612 is re-produced below.

Table C.2 — Load safety factors γQ and material safety factors γ_M.

Mode of resistance failure	γ_Q	γ_M
Ultimate strength (including discontinuous verges which disengage and are damaged)	1.5	1.1 for metals; 1.3 for timber, plastics, roof tiles and slates
Serviceability (including discontinuous verges which disengage but are otherwise undamaged)	1.0	1.0

A.2 Calculations to Annex F

The calculations have been carried out in accordance with F.5 of BS 8612.

F.5 Expression of test results

F.5.1 Combined uplift resistance of the verge unit and tile head fixings

Calculate the combined uplift resistance due to the verge plus head fixings from the individual test loads, for the ultimate limit state and serviceability limit state using equations (F.1) and (F.2).

$$R_{ui} = (F_{v,max} - F_{v0}) \quad (F.1)$$

$$R_{si} = (F_{v,s} - F_{v0}) \quad (F.2)$$

F.5.2 Characteristic value of the uplift resistance of the verge unit and tile head fixings

Derive the characteristic value as the mean value of the test results for the maximum number of specimens tested. Calculate the characteristic value for both ultimate limit state failure, $R_{kx,max}$, and serviceability limit state failure, $R_{kx,s}$.

F.5.3 Design combined uplift pressure resistance of the verge unit and tile head fixings

Derive the design values of the combined resistance (expressed as a pressure) for ultimate limit state failure (R_u) and serviceability limit state failure (R_s) as the characteristic value divided by the appropriate value of γ_M for ultimate and serviceability (see Table C.2) and by dividing by the verge tile area A_t.

$$R_u = R_{kx,max} / \gamma_M \times A_t \quad (F.3)$$

$$R_s = R_{kx,s} / \gamma_M \times A_t \quad (F.4)$$

Where A_t is the area of the verge tile calculated as the full width of the tile (including any sidelock) multiplied by the exposed length of the tile for the head-lap simulated.

The higher γ_M value shall be adopted where failure occurs in more than one material.

For the calculations in this report the value of A_t used has been calculated below.

A_t = width x gauge

Type A tiles:

A_t = 330 mm x 345 mm

A_t = 0.114 m^2

Type B tiles:

A_t = 295 mm x 345 mm

A_t = 0.102 m^2

Report ends