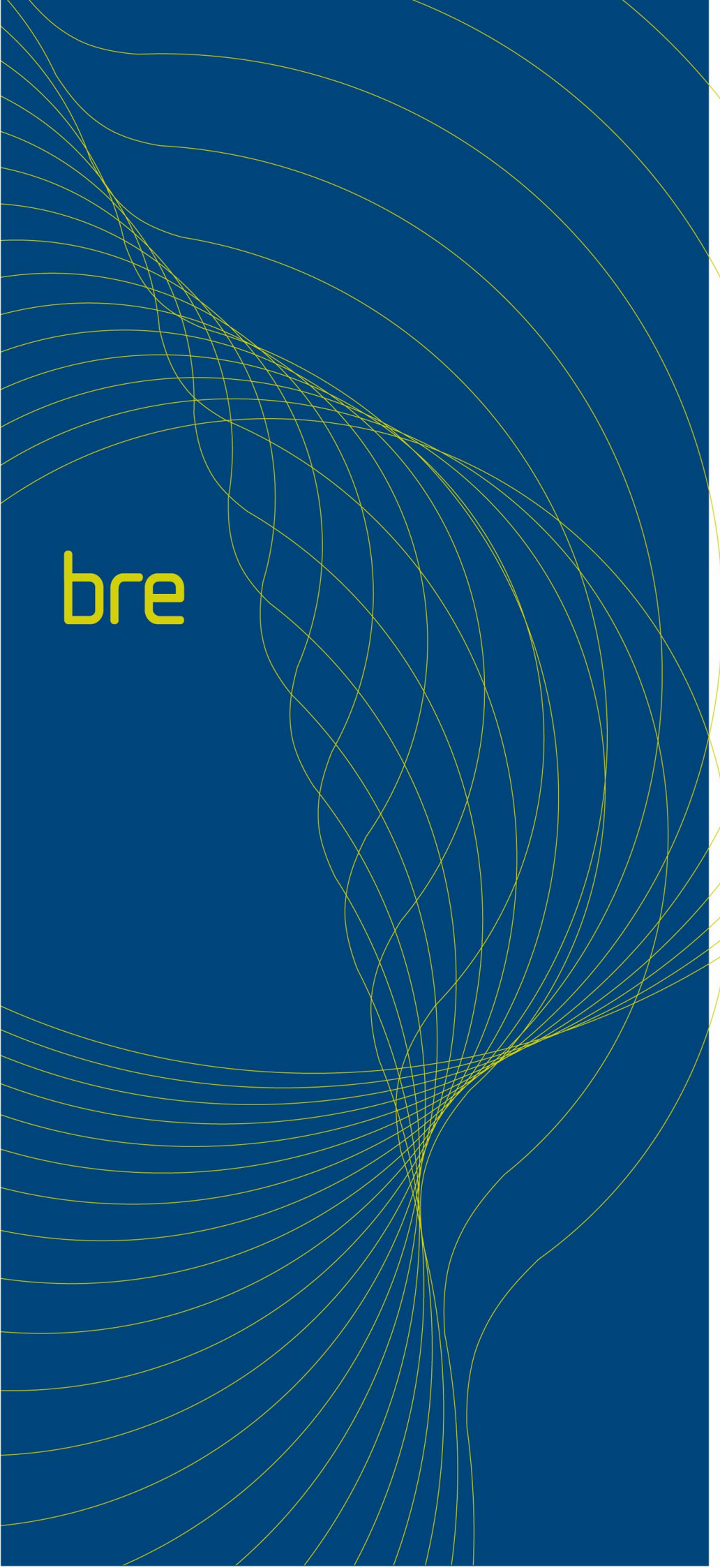


High speed wind tests on the Manthorpe SmartVerge® Linear Dry Verge System (Code: GLV)

Prepared for: Ranulph Pack
Manthorpe Building Products

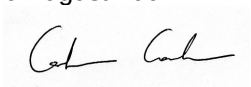
6th August 2007

Test report number 237-548

Prepared by

Name	Dr P Blackmore
Position	Associate Director, Building Technology Group
Date	6 August 2007
Signature	

Approved on behalf of BRE

Name	Mr G Couchman
Position	Director, Building Technology Group
Date	6 August 2007
Signature	

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Contents

1 Introduction

This report details testing undertaken on 20th July 2007 to assess the performance of the Manthorpe SmartVerge® Linear Dry Verge System (Code: GLV) under high windspeed conditions. The testing was carried out at BRE, Bucknalls Lane, Watford, WD25 9XX, UK. The client for these tests was Manthorpe Building Products Ltd, Manthorpe House, Brittain Drive, Codnor Gate Business Park, Ripley, Derbyshire, DE5 3ND.

This testing is based on BRE Proposal No. 120172 dated 17th May 2007, which was accepted by Mr Ranulph Pack of Manthorpe Building Products on 31st May 2007.

The testing was carried out at BRE as project CV1831 under the BRE Terms and Conditions for Testing. This report describes the work carried and the results obtained.

2 Details of tests carried out

The objective of the testing was to assess the performance of the Manthorpe SmartVerge® Linear Dry Verge System (Code: GLV) under high wind speed conditions. The Linear Dry Verge System was installed on a 2m x 2m (plan dimensions) 35° pitch test roof which was mounted at the end of the BRE wind tunnel. The verges were installed as they would be in practice, as detailed in the product information sheets and fixing instructions in Annex A. Two types of roof tile were used with the Linear Dry Verge System; a plain concrete tile and a fibre cement slate.

There is no defined procedure for testing verge systems such as these under wind loading. The advice given in BS5534:2003 is for users to pay particular attention to the resistance to wind load of dry roofing products (Note 2 Clause 4.16.7) but no guidance is given on how to do this. Consequently it was decided that the most appropriate approach would be to subject the verges to high windspeeds to observe how they respond. This was done by mounting the test roof at the end of the BRE high speed wind tunnel. The roof was placed on a turntable so that it could be rotated to subject it to winds from all directions. For each wind direction tested, the wind speed was increased in increments until the maximum speed of the wind tunnel was reached. The wind speed was held at a constant value for a period of approximately 5 minutes at each step increment. A video of the testing was also produced.

3 Details of the test products

In order to maximise the amount of testing a single test rig was used but with each verge having a different tile/slate and verge configuration. The free tile/slate edge in the middle of the roof was sealed to prevent wind getting beneath the tile or slates. Details of the verge details are given in Table 1.

Table 1 Verge fixing details

Verge number	Details of verge and fixings	Tile/slate details
Verge 1	Refurbishment build - left hand linear dry verge units with verge union clip and fixing clips. Units fitted to a counter batten. Top 2 sections of verge have integral clips. The lowest section butting onto the middle verge section is a kick up feature to accommodate tile kick up. The clip is screwed on.	LaFarge (Redland) Cambrian slates, nailed and clipped. Batten gauge: 240mm.
Verge 2	New-build installation - right hand linear dry verge units. No verge unions, fixing clip at base, no counter batten.	LaFarge (Redland) Cambrian slates, nailed and clipped. Batten gauge: 240mm.
Verge 3	Refurbishment build - left hand linear dry verge units with fixing clip and counter batten.	Marley Ashmoor plain tiles nailed and clipped. Batten gauge: 170mm.
Verge 4	New-build installation - right hand linear dry verge units with fixing clips, additional fixing clips at 375mm centres (approx) no counter batten.	Marley Ashmoor plain tiles nailed and clipped. Batten gauge: 170mm.

The ridge tiles were Marley round concrete ridge tiles fitted with the Marley Modern dry ridge system with fixings as per manufacturers fitting instructions. A Manthorpe DGV-END-R Round Ridge End Cap was fitted to the gable end with the slates (verges 1 and 2) and a Manthorpe DGV-END-A Angled Ridge End Cap fitted to the gable end with the plain tiles (verges 3 and 4).

Figures 1 and 2 show the completed roof with plain tiles (Figure 1 - verge detail 3) and slates (Figure 2 - verge detail 1) on the test rig at the end of the wind tunnel. Further photographs of the verges are included in Annex B.

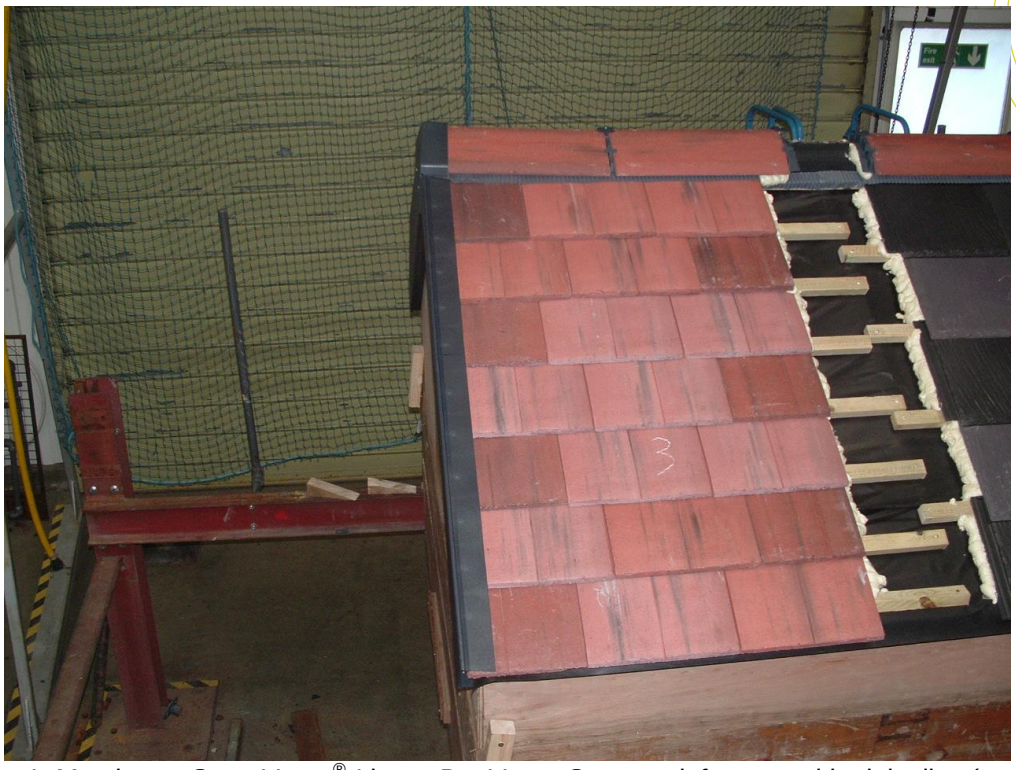


Figure 1 Manthorpe SmartVerge® Linear Dry Verge System - left verge with plain tiles (verge 3)

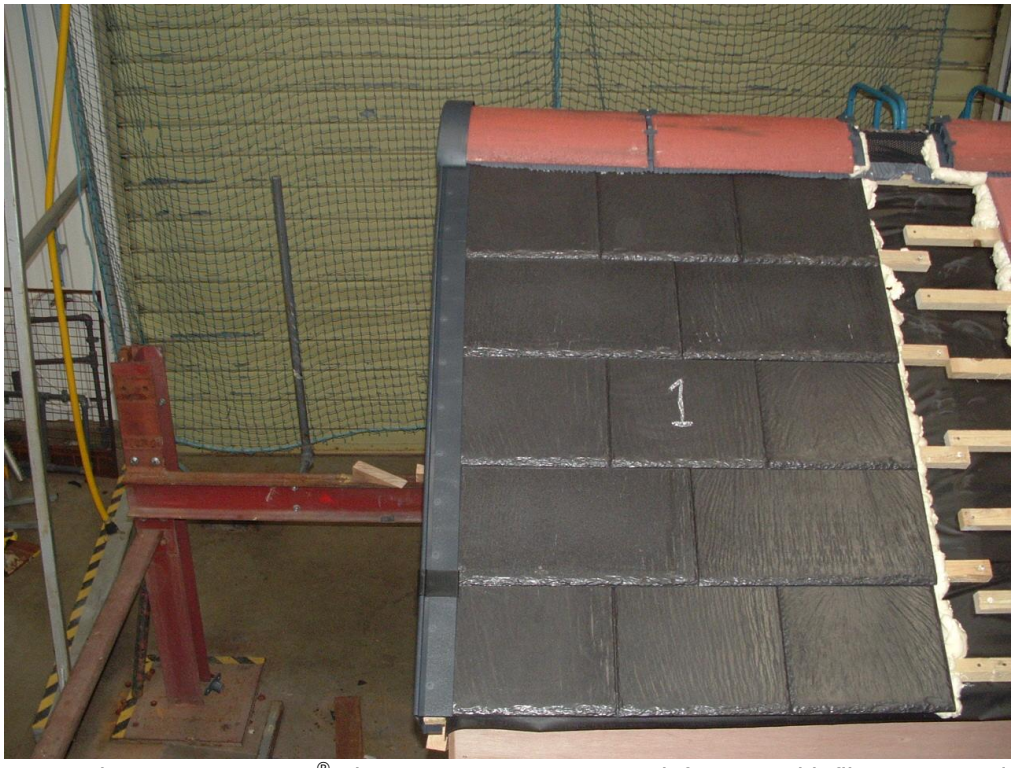


Figure 2 Manthorpe SmartVerge® Linear Dry Verge System - left verge with fibre cement slates (verge 1)

4 Test results

The verges were tested with wind approaching from a range of wind direction. A total of 14 tests were carried out as shown in Annex C. Log sheets of the tests are also given in this Annex. In all of the tests the Manthorpe SmartVerge® Linear Dry Verge System verges resisted the wind tunnel's maximum wind speed of 48.5m/s (108mph) without showing any signs of distress or damage. At the higher windspeeds the verges vibrated slightly under winds from certain directions but none of the fixings worked loose. At the completion of the testing the verges and their fixings were visually inspected and all components and fixings were found to be in good order and completely undamaged .

To put a wind speed of 48.5m/s into context, from BS6399: Part 2 (the British Standard for wind loading on buildings) the design wind speed to be expected on a two-storey house in the London area in a fifty year design life would be of the order of 25m/s to 35m/s (depending on factors such as the roof height, distance to sea and distance from the edge of the town and the heights and spacing of surrounding buildings). For a similar house in a town in Scotland the design wind speed would vary from about 35m/s to 45m/s. These examples exclude the effects of topography and ground altitude. If the building is on the top of a steep hill then the wind speeds can be increased by up to 36%, wind speeds also increase by about 10% for every 100m increase in ground level. To determine the actual design wind speed at any particular site it is necessary to follow the procedures given in BS6399-2.

5 Summary

The results from these tests on the Manthorpe SmartVerge® Linear Dry Verge System show that the verges when fixed according to the manufacturers instructions will resist wind speeds of at least 48.5m/s without failing or demonstrating any other visible signs of distress. It is very likely that this verge system will be able to withstand significantly higher wind speeds than the maximum applied during the testing, although this was not demonstrated in the testing because the maximum speed of the wind tunnel was reached.

Annex A - Details of the Manthorpe Dry Verge System

Manthorpe Building Products

Product Information Sheet

SmartVerge® Linear Dry Verge System - Overview CODE GLV

Description:

The Manthorpe SmartVerge® Linear Dry Verge System is a fast and effective, maintenance free method for finishing the verge of a roof.

The Linear Dry Verge System can be mechanically fixed in all weather conditions without the need for mortar. It is compatible with many types of roof coverings including Fibre Cement Slates, Natural Slates and Interlocking Plain Tiles.

The Angled or Round Ridge End Cap can be used to protect the end of the ridge while the Fixing Clips and Verge Unions allow shorter sections of the Linear Verge Units to be fixed to the verge and joined together.

The sleek appearance of the product maintains the clean line of the verge while remaining unobtrusive to the original roof design.

Features:

Easy to fix and maintenance free.

Compatible with all fibre cement slates, natural slates and interlocking plain tiles.

Also compatible with many other plain tiles and concrete interlocking tiles.

Secures tiles to the roof, preventing wind uplift problems.

Mortar-free solution allows fixing in all weather conditions.

Long term UV resistance prevents discolouring from exposure to sunlight.

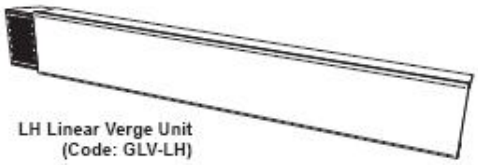
Prevents entry of birds and large insects.

Suitable for new build or refurbishment situations on roofs of 15° to 55° pitch.

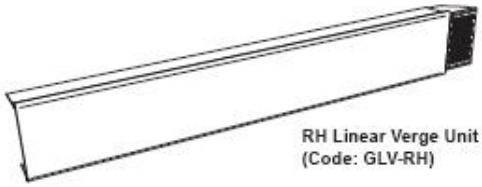
Wind Tunnel Tested to comply with BS 5534 requirements for mechanical fixing.

References:

BSI: British Standard 5534:2003
BSI: British Standard 6399-2:1997
NHBC Standards Chapter 7.2



LH Linear Verge Unit
(Code: GLV-LH)

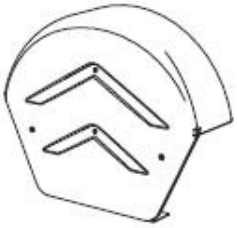


RH Linear Verge Unit
(Code: GLV-RH)

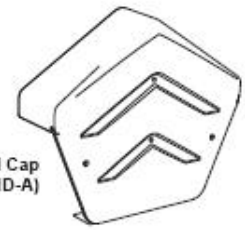
Nails & Screws

Verge Union
(Code: GLV-VU)

Fixing Clip
(Code: GLV-FC)



Round Ridge End Cap
(Code: GDV-END-R)



Angled Ridge End Cap
(Code: GDV-END-A)

MANTHORPE BUILDING PRODUCTS LTD MANTHORPE HOUSE BRITTAIN DRIVE CODNOR GATE BUSINESS PARK RIPLEY DERBYSHIRE DE5 3ND	TEL: 01773 514 200 FAX: 01773 514 262 EMAIL: sales@manthorpe.co.uk WEB www.manthorpe.co.uk	DRN R.P / Date 05.06.07 The company maintains a policy of continuous development of its product range and reserves the right to amend the specification without notice.	DRG No MBP 8252	Issue A

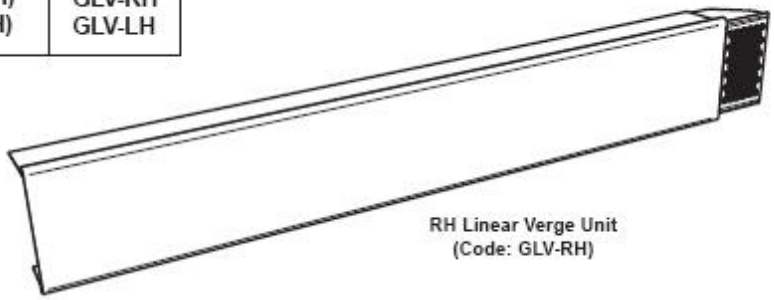
Manthorpe Building Products

Product Information Sheet

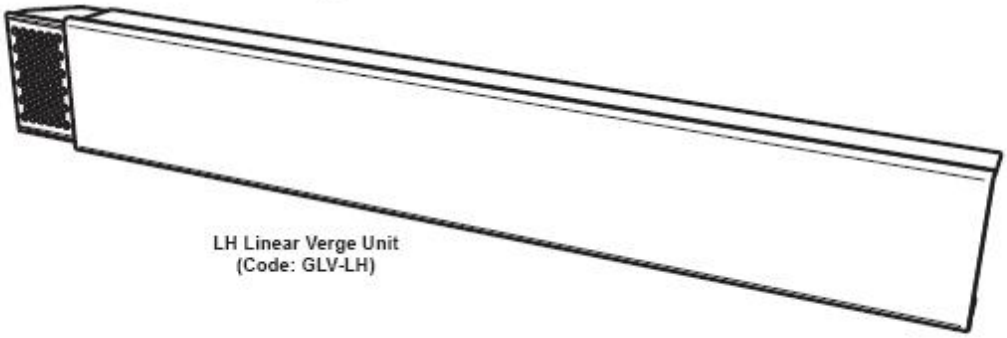
SmartVerge® Linear Dry Verge System - Verge Units

CODE GLV-RH/LH

Product Codes:	
Linear Dry Verge Unit (RH)	GLV-RH
Linear Dry Verge Unit (LH)	GLV-LH



RH Linear Verge Unit
(Code: GLV-RH)



LH Linear Verge Unit
(Code: GLV-LH)

Description:

The Manthorpe SmartVerge® Linear Dry Verge System provides a secure mechanical fixing solution for many types of roof coverings including Fibre Cement Slates, Natural Slates and Interlocking Plain Tiles.

The Linear Verge Units can be easily fitted to the verge of the roof in succession, locking the tiles in place to prevent wind uplift problems. The system is mortar-free and can be fixed in all weather conditions. Once fitted they are completely weatherproof and maintenance free.

Each Verge Unit is manufactured from a high grade of uPVC, providing long-term resistance against plastic degradation and 'colour bleaching'.

The SmartVerge® Linear Dry Verge System is available in Slate Grey, Black, White, Terracotta and Dark Brown to compliment any variation of roof design. The Linear Dry Verge System preserves the continuous line of the verge, providing a neat and attractive finish.

Left & Right Hand:

Right Hand Verge

Left Hand Verge

Illustration shows left and right hand verge units as viewed from outside the building. Note: careful attention should be taken when specifying 'left' and 'right'.

References:

BSI: British Standard 5534:2003
BSI: British Standard 6399-2:1997
NHBC Standards Chapter 7.2

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DRG No: MBP 8253

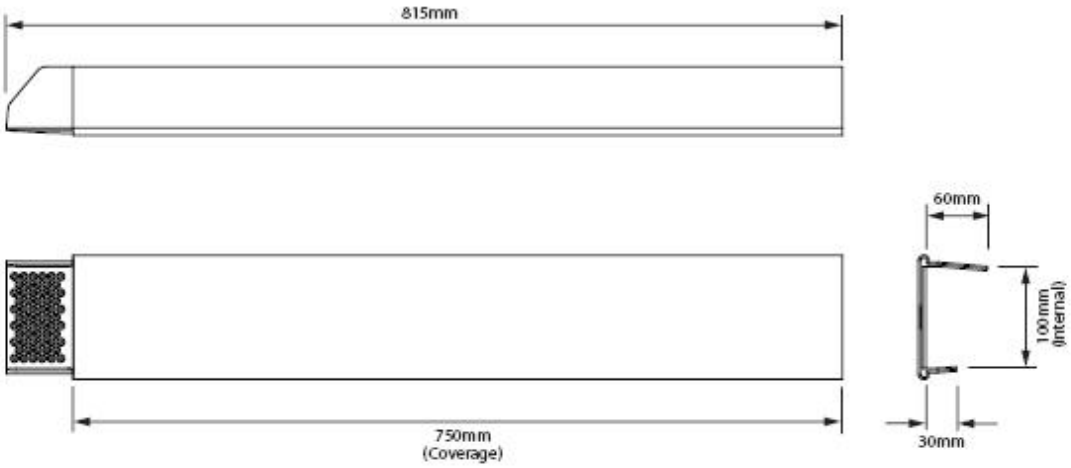
Issue: A

Manthorpe Building Products

Product Information Sheet

SmartVerge® Linear Dry Verge System - Verge Units

CODE GLV



Guidance:

Each Linear Verge Unit should be fixed using aluminium or stainless steel, 3.35mm shank diameter spiral roll or annular shank nails, 38mm in length (these are not provided).

The Linear Verge Units should be used in conjunction with an additional **25mm x 38mm** batten strip securely fixed along the verge of the roof. Alternatively, they can be fixed directly onto the ends of the tiling battens if these are in good condition (may require sawing each Linear Verge Unit to align with batten ends).

At the eaves, the initial Verge Unit should be secured using an additional Fixing Clip (Product Code: **GDV-FC**). For roofs where the bottom course tiles are tilted upwards, a joint can be made with an additional Verge Union (Product Code: **GDV-VU**).

At the ridge, the Angled or Round Ridge End Cap (Product Code: **GDV-END-A** or **GDV-END-R**) should be used to prevent the ingress of birds and large insects.

MAX THICKNESS OF VERGE	100mm (Inc. 38mm Batten Strip)
ROOF PITCH COMPATABILITY	15° to 55° Pitch
PACKING DETAILS	Linear Dry Verge Pack contains 10 Left or Right Linear Dry Verge Units plus Fixing Instructions. 3 Packs per Box.
WEIGHT	X.XX Kg per Box
MATERIAL	Unplasticized Polyvinyl Chloride (uPVC)
MANUFACTURING PROCESS	Injection Moulded
COLOUR VARIATIONS	Slate Grey (GR), Black (BL), White (WH), Terracotta (TR), Dark Brown (BR)

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DRG No: MBP 8253

Issue: A

Manthorpe Building Products

Product Information Sheet

SmartVerge® Linear Dry Verge System - Fixing Clips

CODE GLV-FC

Product Codes:	
Fixing Clip	GLV-FC

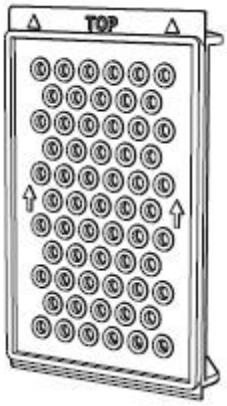
Description:

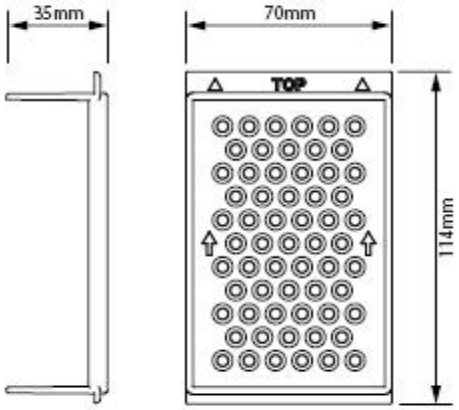
The Manthorpe SmartVerge® Linear Dry Verge Fixing Clip can be used to provide additional fixing points along the verge when fixing the **GLV-LH** or **GLV-RH** Linear Verge Units.

The **GLV-FC** Fixing Clip can be nailed to an additional batten strip fixed to the underside of the verge. The first Linear Verge Unit is then clipped securely over the Fixing Clip providing a strong fix to the eaves.

For roofs where the bottom course tiles are tilted upwards, two Fixing Clips can be used to secure a cut section of Linear Verge Unit to the verge, a third Fixing Clip should then be used to start the continuous run.

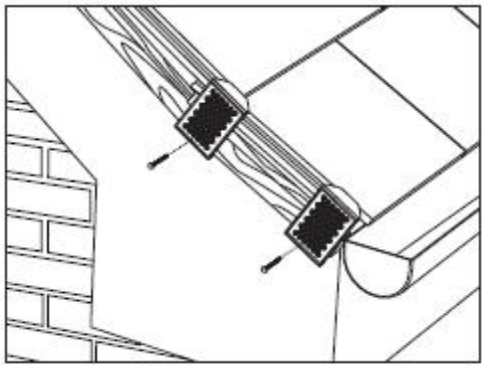
The design can be used on both the left and right hand verges and is completely concealed after installation of the system.





PACKING DETAILS	Fixing Clip Pack contains 2 Fixing Clips, 2 Nails and Fixing Instructions. 10 Packs per Box.
WEIGHT	X.XX Kg per Box
MATERIAL	Unplasticized Polyvinyl Chloride (uPVC)
MANUFACTURING PROCESS	Injection Moulded
COLOUR VARIATIONS	Slate Grey (GR) (not visible when installed)

Fixing:



References:

BSI: British Standard 5534:2003
BSI: British Standard 6399-2:1997
NHBC Standards Chapter 7.2

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DRG No: MBP 8253

Issue: A

Manthorpe Building Products

Product Information Sheet

SmartVerge® Linear Dry Verge System - Verge Unions

CODE GLV-VU

Product Codes:	
Verge Union	GLV-VU

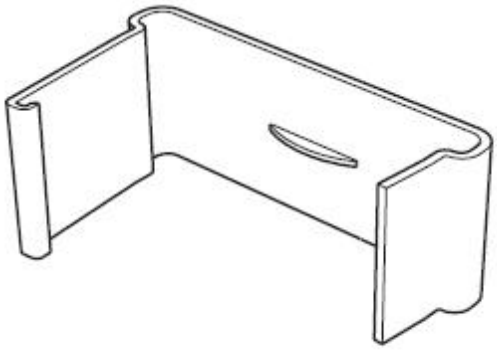
Description:

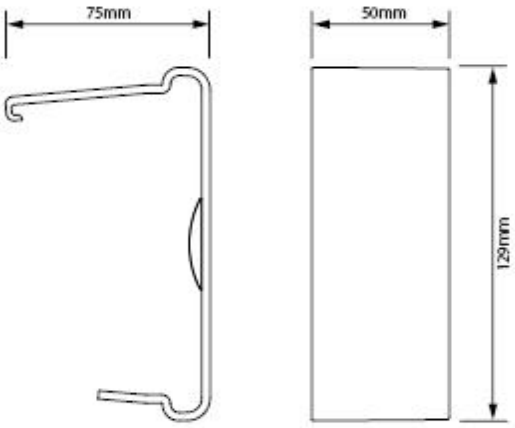
The Manthorpe SmartVerge® Linear Dry Verge Verge Union can be used to cover a joint where two **GLV-LH** or **GLV-RH** Linear Verge Units abut each other.

For roofs where the bottom course tiles are tilted upwards, a **GLV-VU** Verge Union Clip should be used to join two Linear Verge Units abuting at different angles.

Each Verge Unit is manufactured from a high grade of uPVC, providing long-term resistance against plastic degradation and 'colour bleaching'.

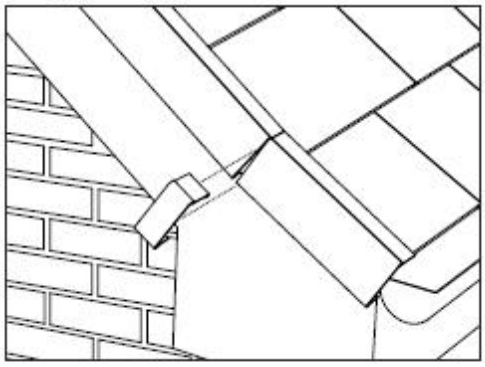
The Manthorpe SmartVerge® Verge Union is available in Slate Grey, Black, White, Terracotta and Dark Brown to compliment the full range of Linear Verge Units.





PACKING DETAILS	Verge Union Pack contains 2 Verge Unions plus Fixing Instructions. 10 Packs per Box.
WEIGHT	X.XX Kg per Box
MATERIAL	Unplasticized Polyvinyl Chloride (uPVC)
MANUFACTURING PROCESS	Injection Moulded
COLOUR VARIATIONS	Slate Grey (GR), Black (BL), White (WH), Terracotta (TR), Dark Brown (BR)

Fixing:



References:

BSI: British Standard 5534:2003
BSI: British Standard 6399-2:1997
NHBC Standards Chapter 7.2

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DRG No: MBP 8253

Issue: A

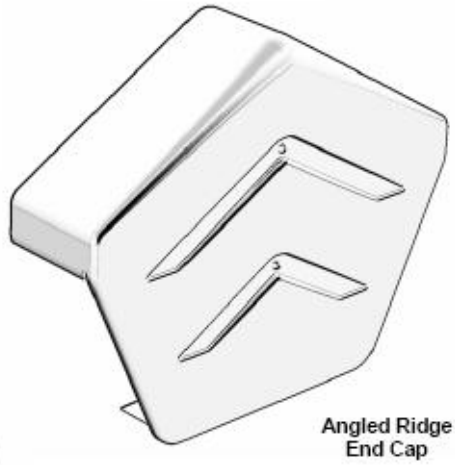
Manthorpe Building Products

Product Information Sheet

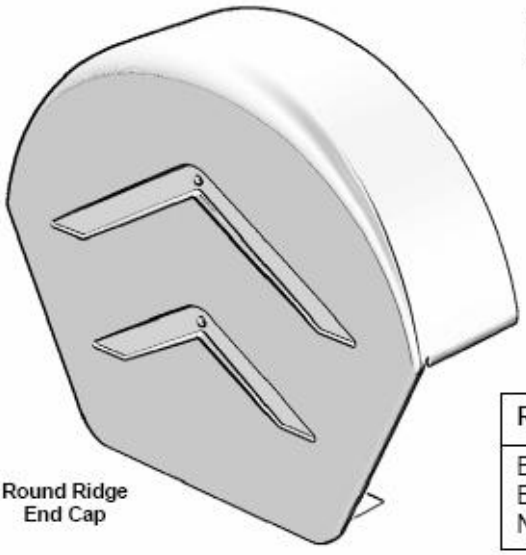
SmartVerge® Dry Verge Systems – Ridge End Caps

CODE **GDV**

Product Codes:	
Round Ridge End Cap	GDV-END-R
Angled Ridge End Cap	GDV-END-A



Angled Ridge End Cap



Round Ridge End Cap

References:

BSI: British Standard 5534:2003
BSI: British Standard 6399-2:1997
NHBC Standards Chapter 7.2 Pitched Roofs

Description:

The Manthorpe Ridge End Caps work in conjunction with the Manthorpe SmartVerge® Dry Verge System and SmartVerge® Linear Dry Verge System to provide a neat and attractive finish for most makes of Round and Angled Concrete Ridge Tiles.

The Ridge End Caps provide durable protection at each end of the ridge, eliminating problems caused by water penetration and wind uplift whilst preventing the entry of birds and large insects into the roof cavity.

Each Ridge End Cap is supplied with fixings and fitting instructions and can be quickly and easily fixed directly to the Ridge Batten(s) in all weather conditions.

The Ridge End Caps are manufactured from a high grade of uPVC, providing long-term resistance against plastic degradation and 'colour bleaching'.

Features:

Easy to fix and maintenance free.

Mortar-free solution allows fixing in all weather conditions.

Long term UV resistance prevents discolouring from exposure to sunlight.

Suitable for new build or refurbishment situations on roofs of 15° to 55° pitch.

Prevents entry of birds and large insects into the roof cavity.

Suitable for most makes of half round, segmental, universal angle & modern ridge tiles.

Complies with BS 5534 requirements for mechanical fixing.

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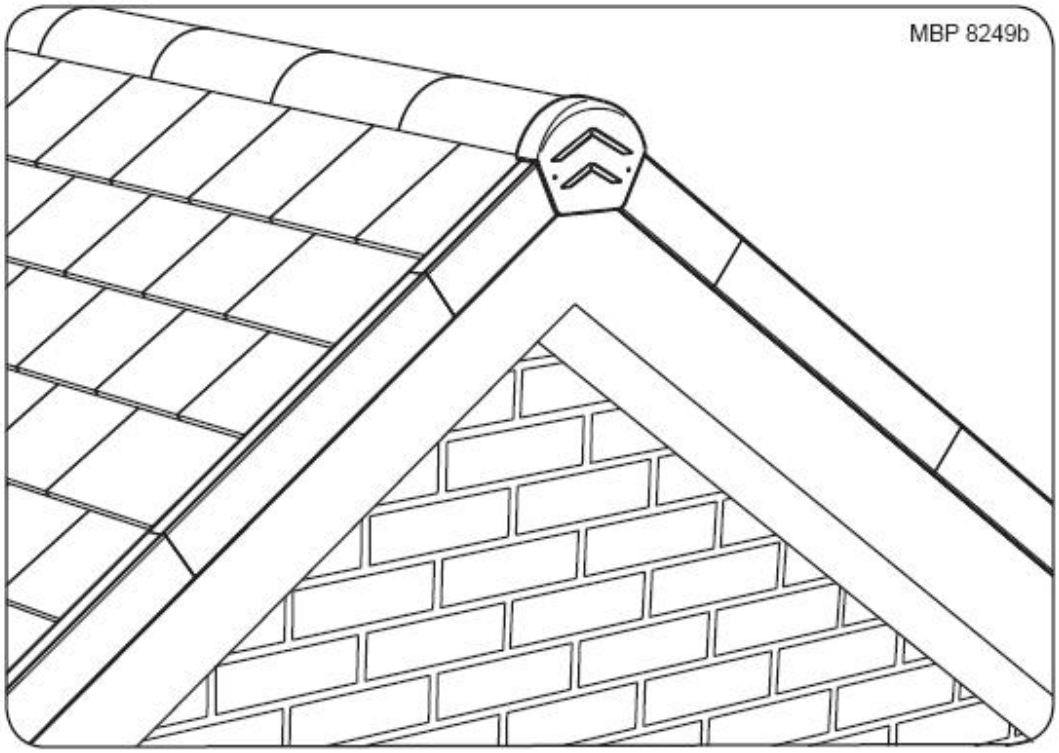
DRG No **MBP 8227** (PAGE 1 OF 2)

Issue **B**

MANTHORPE
BUILDING PRODUCTS

SmartVerge®
Linear Dry Verge System

Fixing Instructions



Typical Verge Details

Fig A. Flush Verge Detail

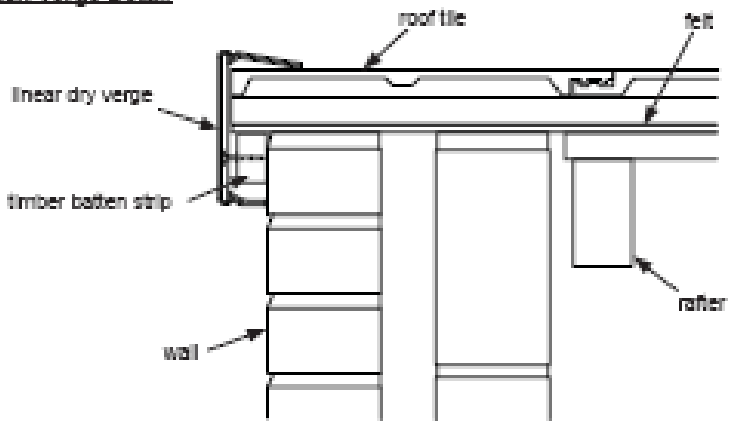
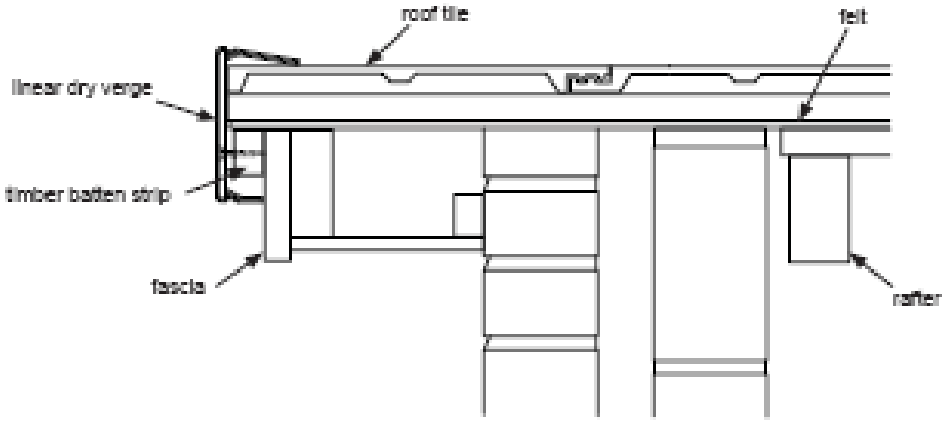


Fig B. Overhanging Verge Detail



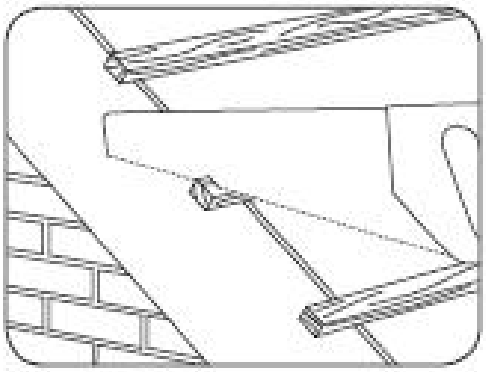
Compatibility

The SmartVerge® Linear Dry Verge System is compatible with most Fibre Cement Slates, Natural Slates and Interlocking Plain Tiles including: -

Marley Rivendale, Blkdale, Garsdale, Thrutone, Edgemere, Duo Edgemere, Melbourn, Marquess, Duo Marquess, Monarch Slates & Ashmore Interlocking Plain Tiles.
Lafarge Cambrian, Landmark, Saxon, Richmond, Natural Slates & DuoPlain Interlocking Plain Tiles.
Sandtoft Cassius, Balmoral, BritLock, BritSlate, Pennine Slates & 20/20 Interlocking Plain Tiles.
Forticrete Minislate Slates & Gemini Interlocking Plain Tiles.
Lagan Elite Slates.

For all other tile enquiries please contact us.

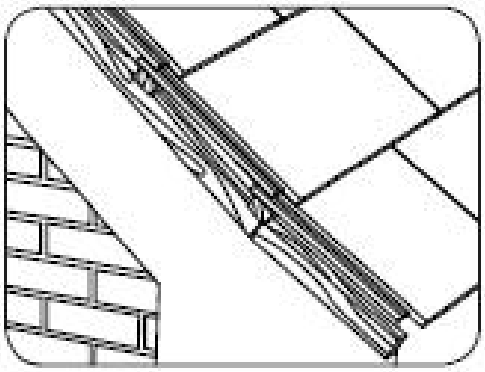
Installation



1. In a new build situation, saw the tiling battens off square so that they overhang the gable wall or bargeboard by 30mm.

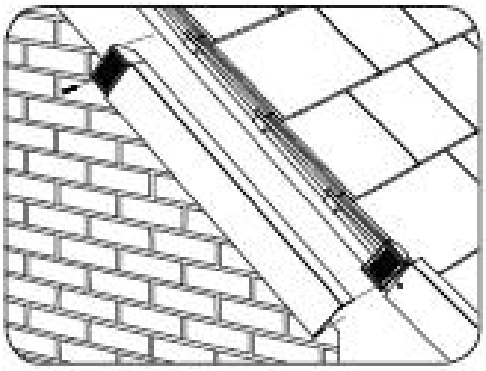
Lay the right hand and left hand tiles flush with the end of the battens.

For refurbishment situations, continue to step 2.



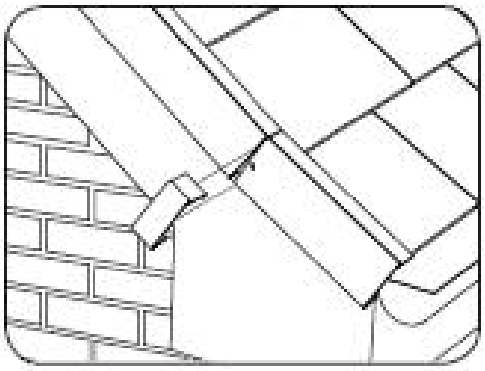
2. Securely plug and screw as necessary *(at approx. 500mm centres)* a length of 25mm x 38mm timber batten to the brickwork or bargeboard as shown in Fig A and Fig B overleaf.

Continue this on both sides of the roof running from the eave to the ridge. This is used for nailing each Linear Verge Unit to the verge of the roof.



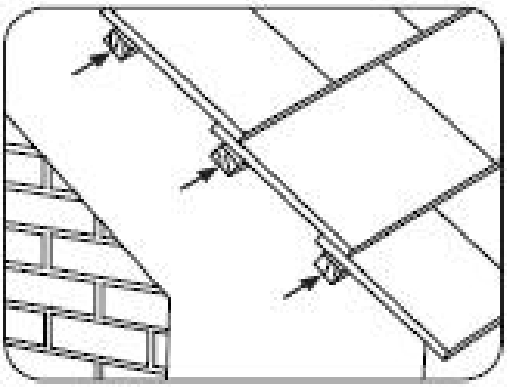
7. Hook the next Linear Verge Unit over the top of the Fixing Clip then push it on until the clip of the Verge Unit engages with the Fixing Clip.

While pressing the Linear Verge Unit down firmly against the tiles, nail the tail end of the Linear Verge Unit through an appropriate hole so that the nail penetrates the centre of the batten strip or batten end.



8. For roofs where the bottom course tiles are tilted upwards, cover the nail head and joint using a Verge Union.

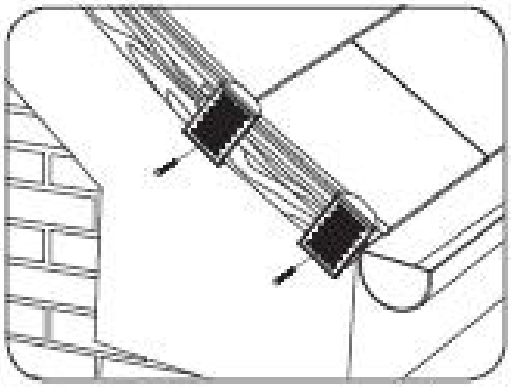
Hook the Verge Union around the top flange between the Linear Verge Unit and the tiles, then firmly push the Verge Union onto the joint until the clip engages with both Linear Verge Units.



3. Alternatively, each unit can be nailed to the ends of the tiling battens.

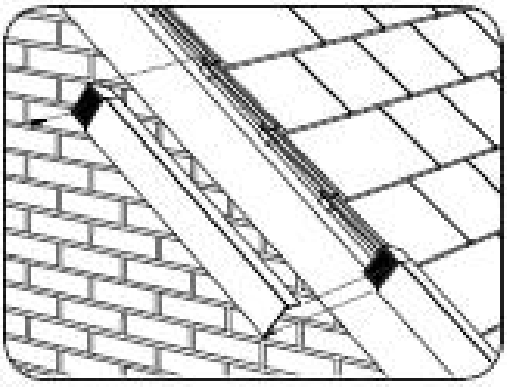
To achieve this, each Linear Verge Unit may have to be shortened so as to allow the nail holes to line up with the ends of the tiling battens.

Saw each unit square using a hacksaw or fine tooth saw then debur with a scraper.



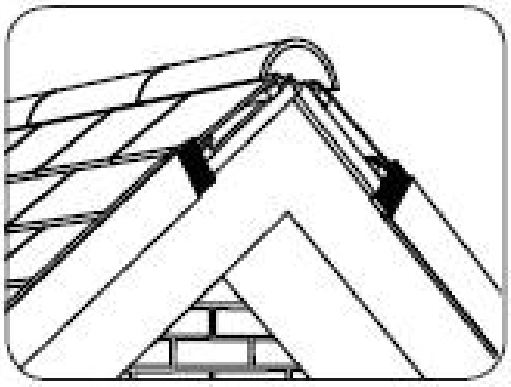
4. For roofs where the bottom course tiles are tilted upwards, securely fix two Fixing Clips at each end of the tile with the annular ring shank nails provided. (*Important: Ensure that the flange labelled "top" faces upwards*). Nail through an appropriate hole so that the nail penetrates the centre of the batten.

For straight verges, continue to step 6b.



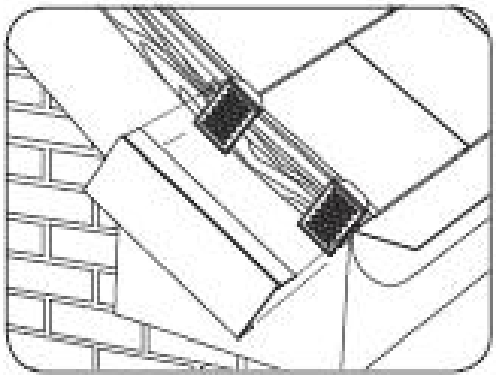
9. Continue up the verge, clipping and fixing each Linear Verge Unit consecutively.

Leave a 2mm gap between each Linear Verge Unit to allow for expansion of the product in warmer temperatures.



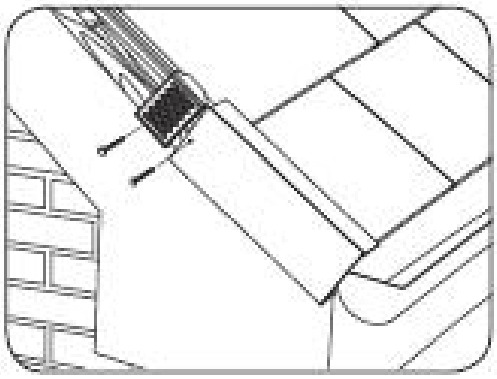
10. Repeat this process up the verge until all tiles have been covered.

Once the left hand verge is completed repeat steps 1 to 9 on the opposing verge, this time using the Right Hand Linear Verge Units.



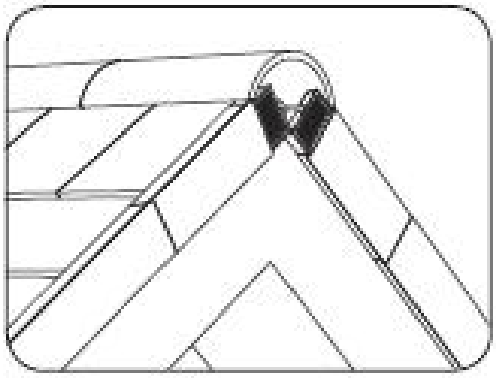
5. Saw a length of the Linear Verge Unit down to cover the full length of the tilted section of the verge.

Hook the shortened Linear Verge Unit section over the top of both Fixing Clips and then push it on to the verge until it engages with both clips.



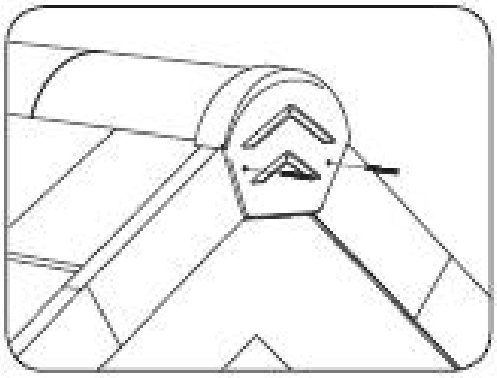
6. To prevent the shortened Linear Verge Unit from sliding down the verge, drill and nail the unit **10mm** from the edge into the batten strip as shown above.

b) Secure a **Fixing Clip** at the start of the straight run of verge. With the fixings provided, nail through an appropriate hole so that the nail penetrates the centre of the batten strip.



11. At the apex of the verge, shorten the last two Linear Verge Units as shown above to fit the remainder of the verge.

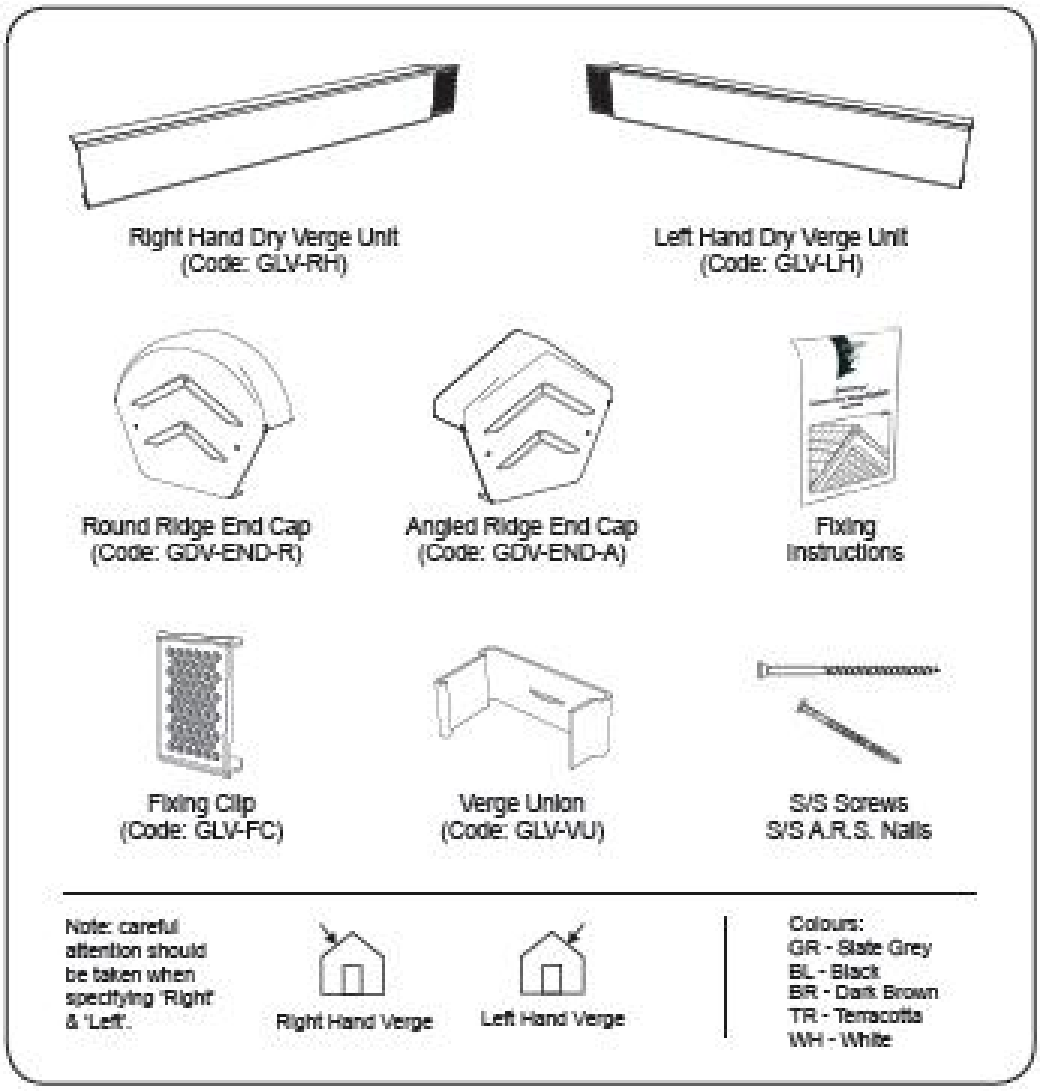
To shorten the Linear Verge Units, measure and saw each unit square using a hacksaw or fine tooth saw then debur with a scraper.



12. To finish the roof at the apex, place a **Ridge End Cap** over the end of the ridge tile so that it sits over both Linear Verge Units.

Using the screws provided, screw into the Ridge End Cap through the desired blind nail hole and into the end of the ridge batten, or, if this is not available, into the top tiling battens.

The Complete System



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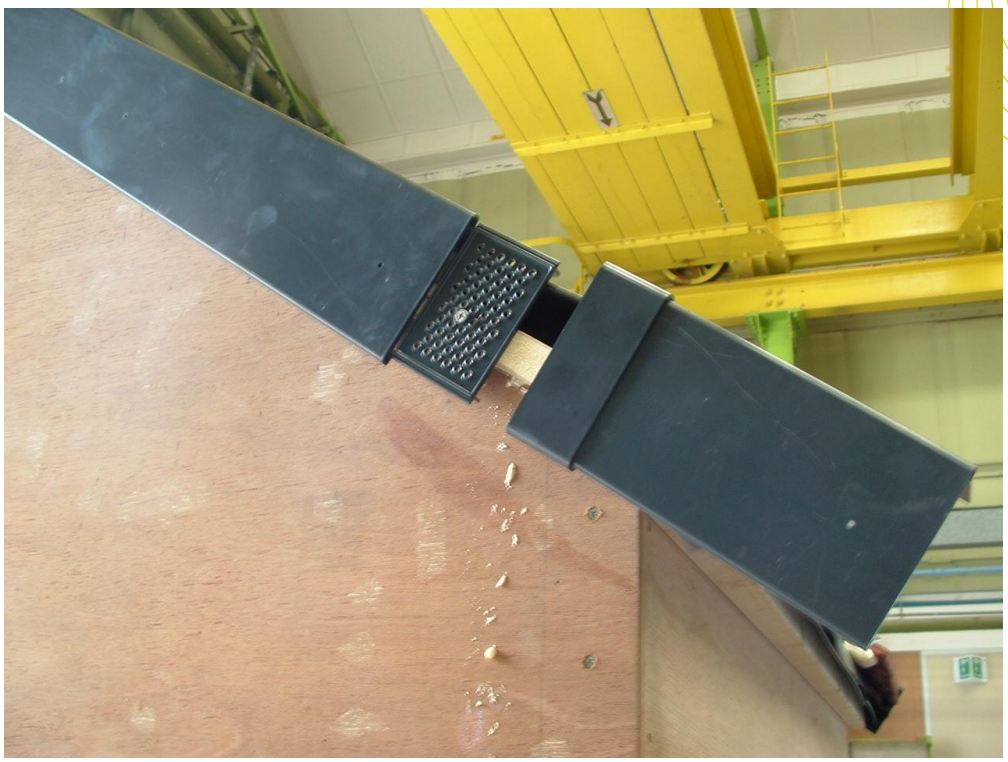
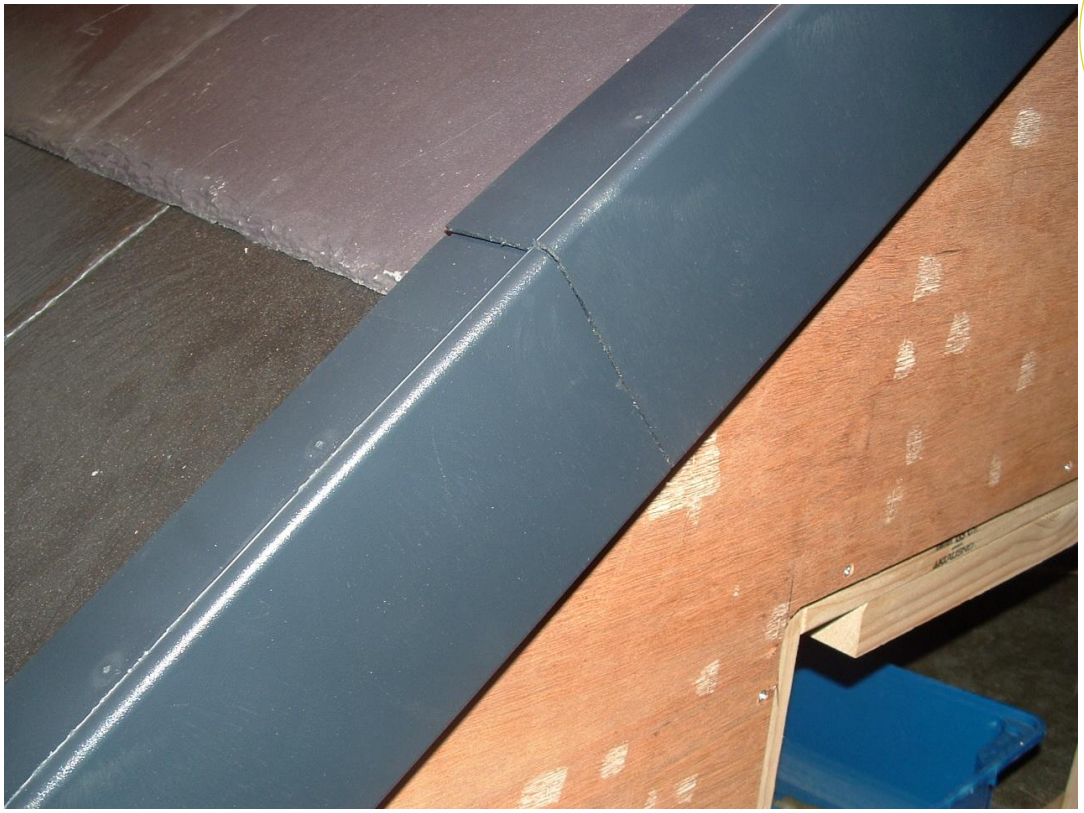
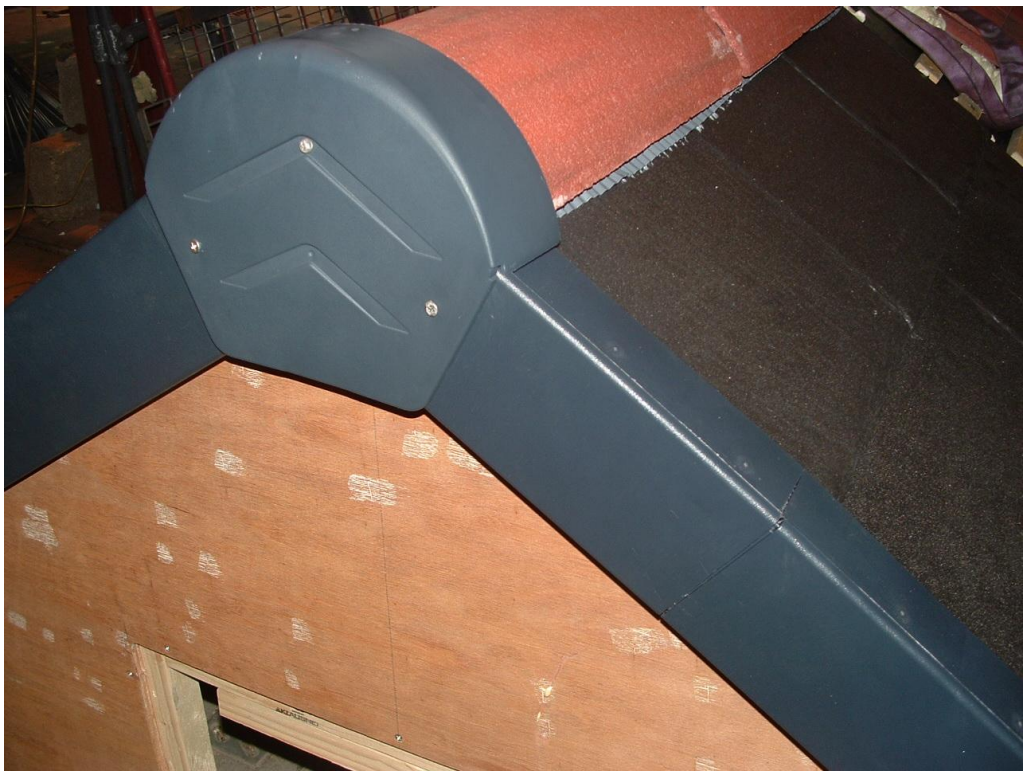
Annex B - Additional photographs of the test specimens



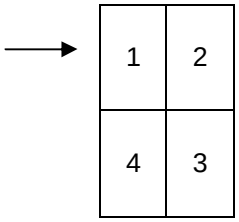




Annex C - Test Results

Test 1.

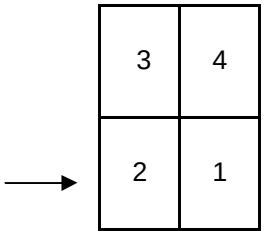
Side1, side on to wind. Arrow indicates wind direction.



Wind speed (m/s)	DVD chapter	Observations
0 to 30	2	No movement observed.
30 to 40	3	Very slight vibration is side of verge, slight tile chatter.
40 to 45	4	Vibration of whole verge a little worse than previous.
45 to 48.5(max)	5	Middle section of verge bowing out from gable end slightly, very little movement overall.

Test 2.

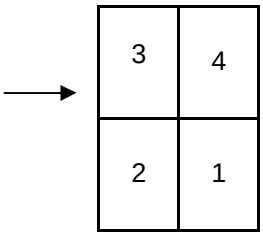
Side 2, side on to the wind. Arrow indicates wind direction.



Wind speed (m/s)	DVD chapter	Observations
0 to 30	6	No movement observed.
30 to 40	7	Very slight vibration is side of verge, slight tile chatter.
40 to 45	8	Vibration of whole verge a little worse than previous.
45 to 48.5(max)	9	Vibration a little worse especially lower end of top verge section. Second tile down right hand side chattering 10 to 15mm.

Test 3.

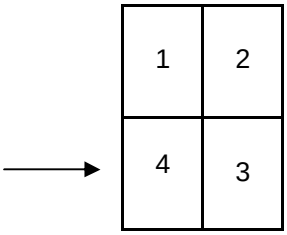
Side 3, side on to the wind. Arrow indicates wind direction.



Wind speed (m/s)	DVD chapter	Observations
0 to 30	10	No movement observed.
30 to 40	11	Slight vibration in side of verge, lower section lifting slightly.
40 to 45	12	Vibration a little more severe. Top surface of lowest verge section lifting from the surface of the roof.
45 to 48.5 (max)	13	As above all a little worse. 3rd course down next to verge a little tile chatter

Test 4.

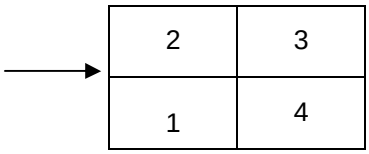
Side 4 side on to the wind. Arrow indicates wind direction.



Wind speed (m/s)	DVD chapter	Observations
0 to 30	14	No movement observed.
30 to 40	15	Slight vibration of verge unit. Lowest section of verge unit lifting from the tiles a little.
40 to 45	16	Lowest end of verge unit lifting a little more. Whole of lower section vibrating a little.
45 to 48.5 (max)	17	As above a little worse.

Test 5.

Side1 & 2, gable end to the wind. Arrow indicates wind direction.



Wind speed (m/s)	DVD chapter	Observations
0 to 48.5 (max)	18	All verges no movement observed. Tile on side 2 chattering quite badly, tiles on side 1 chattering a little.

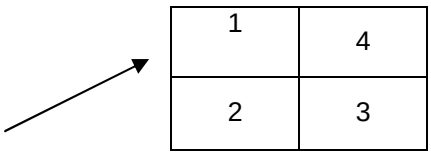
Test 6.

Side 3 & 4 gable end to the wind. Arrow indicates wind direction

Wind speed (m/s)	DVD chapter	Observations
0 to 300 to 48.5 (max)	19	Very little movement in any verge, slight tile chatter.

Test 7.

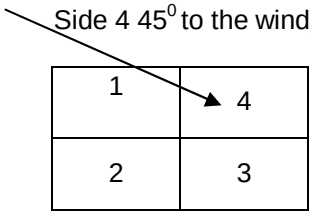
Side 1 45^0 to the wind. Arrow indicates wind direction.



Wind speed (m/s)	DVD chapter	Observations
0 to 48.5 (max)	20	Very slight movement of the verge.

Test 8.

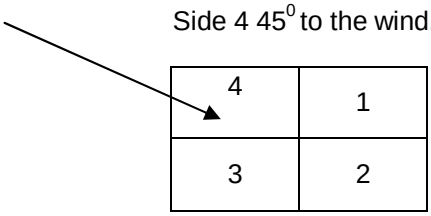
Side 4 45^0 to the wind, wind blowing across the roof. Arrow indicates wind direction.



Wind speed (m/s)	DVD chapter	Observations
0 to 48.5 (max)	21	No movement of the verge observed. 3rd course down right hand side tile chattering a little.

Test 9.

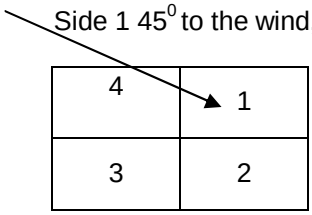
Side 4 45^0 to the wind. Arrow indicates wind direction.



Wind speed (m/s)	DVD chapter	Observations
0 to 48.5 (max)	22	Very slight movement of the verge.

Test 10.

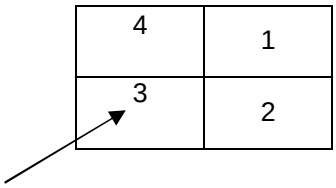
Side 1 45^0 to the wind, wind blowing across the roof. Arrow indicates wind direction.



Wind speed (m/s)	DVD chapter	Observations
0 to 48.5 (max)	23	Very slight movement of the verge.

Test 11.

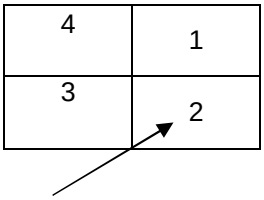
Side 3 45^0 to the wind. Arrow indicates wind direction.



Wind speed (m/s)	DVD chapter	Observations
0 to 48.5 (max)	24	Very slight movement of the verge.

Test 12.

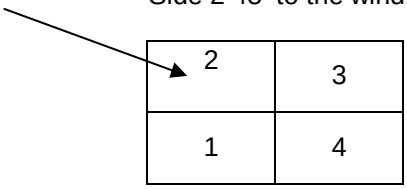
Side 2 45^0 to the wind, wind blowing across the roof. Arrow indicates wind direction.



Wind speed (m/s)	DVD chapter	Observations
0 to 48.5 (max)	25	Very slight movement of the verge. 2nd and 4th course tiles chattering, 4th course worse.

Test 13.

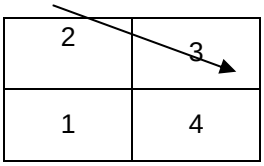
Side 2 45^0 to the wind. Arrow indicates wind direction.



Wind speed (m/s)	DVD chapter	Observations
0 to 48.5 (max)	26	Very slight movement of the verge. 4th course tile chattering.

Test 14.

Side 3 45^0 to the wind, wind blowing across the roof. Arrow indicates wind direction.



Wind speed (m/s)	DVD chapter	Observations
0 to 48.5 (max)	27	Very slight movement of the verge.

==========REPORT ENDS==========