Weathertightness testing of Solar Slate Plate to MCS012

Prepared for:

Michael Share

Solar Slate Plate

24th June 2014

Test report number 296-964

Prepared by

Name Mr Devinder Athwal

Position Laboratory technician, Building Technology Group

Date 24th June 2014

Signature

Approved on behalf of BRE

Name Dr Paul Blackmore

Position Associate Director, Building Technology Group

Date 24th June 2014

Signature

BRE
Garston
WD25 9XX
T + 44 (0) 1923 664000
F + 44 (0) 1923 664010
E enquiries@bre.co.uk
www.bre.co.uk

Executive Summary

This report describes tests carried out to determine the weathertightness performance of the Solar Slate Plate PV mounting system when tested in accordance with MCS012.

The main conclusions from this study are:

- During the testing the Solar Slate Plate system did not leak and did not cause any leaks of the surrounding roof slates at roof pitches between 15º and 22.5º when subjected to the deluge conditions specified in MCS012.
- The Solar Slate Plate system as described and tested in this report meets the weathertightness requirements of MCS012 and will be suitable for use on roof pitches up to 75º (the maximum recommended pitch for natural, fibre cement or concrete slates)

Contents

1 Introduction

This report describes testing carried out on the Solar Slate Plate PV fixing system to the MCS 012 test method for weathertightness [1].

The MCS012 standard specifies the test procedures which shall be used to demonstrate the performance of PV modules and solar thermal collectors and/or their installation kits under the action of:

• Wind loads – resistance to wind uplift forces.

• Fire – resistance to external fire

• Rainfall and wind driven rain – weathertightness.

These test methods apply to 'in roof' and 'above roof' systems fixed to pitched roofs. They do not apply to systems mounted inclined above flat roofs or mounted on vertical walls.

This report presents the results from the weathertightness tests; the results from the wind uplift tests are reported separately.

2 Details of the test specimen and installation

The weathertightness performance of the Solar Slate Plate system intended for installing above-roof PV systems was investigated using a purpose-built monopitch test roof of nominal size 2m x 2m. On the underside of the test roof, and central to it, a 1.8m wide x 1.6m long shallow Perspex box (open area 2.88m^2) was mounted. This test rig fully complies with the requirements laid down in EN 15601:2009 and has been calibrated to give the required uniformity of wind speed and rain flow across the test specimens. Results of the calibration tests on the BRE test rig are presented in Annex A.

The Solar Slate Plate system is intended for use with either 600mm x 300mm or 500mm x 250mm natural or man-made slates. For these tests the Solar Slate Plate was installed with 500mm x 250mm natural slates with 100mm headlap. This size Solar Slate Plates were chosen for the test as they are the smallest size in the range and so have more joints per square metre of roof and could represent the worst case installation. The Solar Slate Plates were installed on the BRE test rig by Solar Slate Plate personnel (following instructions in the installation manual).

For these tests, two off of the Solar Slate Plates were tested, one had an 'L' bracket fitted and the other had a 'Z' bracket fitted. Figure 1 shows the fixings installed on the roof ready for testing.

Figure 1 A general view of the test rig showing the installed Solar Slate Plates

3 Details of the tests carried out

The tests were carried out with the test roof mounted at the exit of BRE's No.3 Boundary Layer Wind Tunnel. A schematic diagram of the test arrangement is shown in Figure 2 and Figure 3 shows the products under test.

A spray nozzle was mounted above the roof, so that water could be sprayed down onto the roof to provide deluge rain. The wind tunnel was not running during deluge rain testing.

To simulate a typical 7 metre rafter length, a sparge bar was mounted across the top edge of the roof. The sparge bar was used to provide the quantity of runoff water that could be expected from a further 5 metre run of roof up to the ridge.

The test conditions represent the worst case wind and rain combination likely to occur in Northern Europe during any 50-year period.

In Clause 6.2.1.1 of MCS012 it is stated that only Test D (deluge) is mandatory where the system does not create any unprotected gaps larger than those existing on the surrounding roof covering and providing that there is no reason to believe that the gapping will not increase due to wind. As the Solar Slate Plates do not create any unprotected gaps then only the Deluge test (Test D) is required. The applied deluge conditions are described below and full details of the calibration of the BRE test facility are included in Annex A.

Deluge Test – Maximum rainfall with no wind (prEN 15601 Test D)
Water was sprayed onto the roof, with no wind, at a rate equivalent to a rainfall of 225mm/hour over the whole roof. The run-off sparge bar at the top of the test section simulated additional rainfall of 225mm/hour over the rest of a typical 7m roof. The test lasts for two minutes with an observer, beneath the box, checking for leaks. This represents conditions that on average will only occur once in any 50 year period in Northern Europe.

The weathertightness tests were all carried out at roof pitches of 15º and 22.5º.

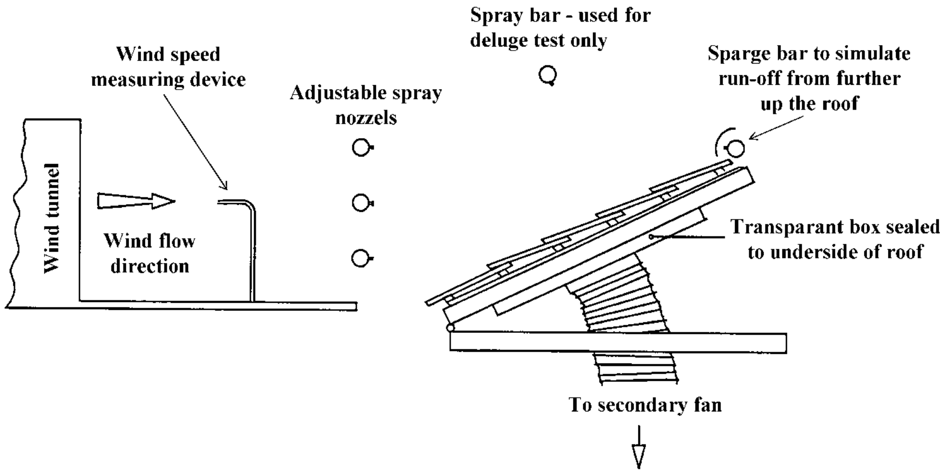

Figure 2   Schematic view of the BRE Rain Penetration Test Rig

Figure 3 Solar Slate Plates under test installed with 500mm x 250mm natural slates

4 Test results

The Solar Slate Plates were tested at roof pitches of 15º and 22.5º. The results from these tests are given in Table1 below.

Test : 1 Deluge Test with Solar Slate Plate and 500mm x 250mm natural slates			
Rainfall rate : 225mm/hr		Wind speed :0m/s	
Date of test: 16/6/2014			
Roof pitch (º)	Pressure difference (Pa)	Water collected (g)	Comments:
15	0	0	No Leakage Visible
22.5	0	0	No Leakage Visible

Table 1 Results from the deluge tests

The results from the deluge tests show that there were no leaks observed around the Solar Slate Plates or adjacent natural slates during the testing.

5 Conclusions

This report describes tests carried out to determine the weathertightness performance of the Solar Slate Plate PV mounting system when tested in accordance with MCS012.

The Solar Slate Plates were subjected to deluge rain conditions representative of the worst case rain conditions that would be expected during a 50 year period anywhere in Northern Europe.

The conclusions from this study are:

- The Solar Slate Plate system does not cause any leaks of the surrounding roof slates at roof pitches between 15º and 22.5º when subjected to the deluge conditions specified in MCS012
- The Solar Slate Plate system as described and tested in this report meet the weathertightness requirements of MCS012

The weathertightness performance of slate roofs improves with increasing roof pitch. Although the maximum roof pitch used in these tests was 22.5º, it is expected that the Solar Slate Plates, when installed with the appropriate headlap, will perform satisfactorily under deluge rain conditions at steeper roof pitches of up to 75º, which is the maximum recommended pitch for natural, fibre cement or concrete slates given in BS5534.

The Solar Slate Plates were tested with 500mm x 250mm natural slates at 100mm headlap. It is expected that the 600mm x 300mm Solar Slate Plates will perform similarly with 600mm x 300mm natural slates.

6 References

1 MCS012; Microgeneration Certification Scheme, Roof performance tests for solar thermal collectors and PV modules, March 2012.

Annex A - Calibration results for the BRE test rig

FprEN 15601 requires details of the rig calibration to be included in the test report. The following information provides a brief description of the calibration of the BRE test rig.

FprEN 15601 has specific calibration requirements for the test facility to ensure that the distribution and magnitude of the wind speed, driving rain and runoff water are all within required limits. The requirement for the wind speed generation is a fan system capable of generating wind blowing parallel to the rafters of the test specimen with a spatial variation of the wind speed over the specimen of not more than 10%. This is achieved by measuring the wind speed at not less than 9 positions uniformly distributed at a height of 200 ± 10 mm over a flat boarded area which replaces the test specimen, at the relevant roof pitch. The calibration wind speed shall be 10 ± 0.5 m/s at the centre of the test specimen. Figure A1shows the end of the BRE wind tunnel and Figure A2 shows the wind speed calibration of the BRE test rig using ultrasonic anemometers.

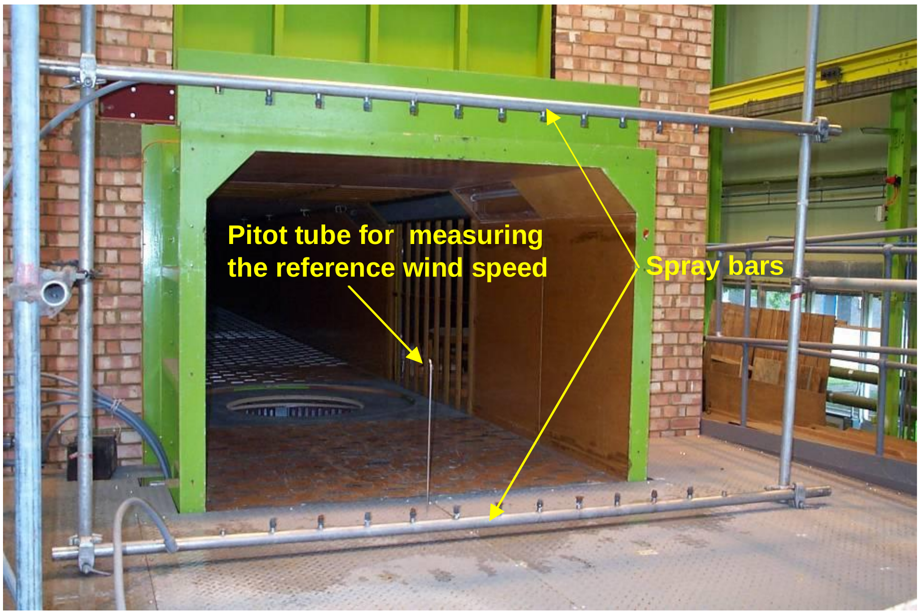

Figure A1 The end of the BRE wind tunnel

Figure A2 Calibration of the wind speed over the test specimen area

The standard requires the turbulence intensity (*t*) in the oncoming wind to be less than 10 %. The turbulence intensity *t* (%) is expressed as t = 100u/U, where *u* and *U* are the RMS and mean wind speeds respectively, measured over a duration of not less than 5 minutes. *u* and *U* are defined as shown below:

RMS (root mean square) wind speed $u = \sqrt{\dfrac{\sum_{i=1}^{n}(v_i^2 - U)}{n-1}}$

Mean wind speed $U = \dfrac{\sum_{i=1}^{n} v_i}{n}$

Where v_i is the individual wind speed measurement over the specimen;

n is the number of measurements

Table A1 shows the calibration measurements. The maximum turbulence intensity across the specimen is 5.57% and occurs at location 5 in the centre of the specimen. In all cases the turbulence intensity is within the limit of 10% allowed by the draft standard.

10m/s nominal speed

	mean wind speed			Variation from mean %	Turbulence intensity		
Location	U	V	W	U	u'	v'	w'
1	9.83	0.90	-0.69	-0.98	0.03	0.01	0.02
2	10.21	1.29	-0.30	2.85	0.03	0.02	0.02
3	9.56	0.10	0.83	-3.67	0.03	0.02	0.02
4	9.64	1.44	-0.26	-2.88	0.03	0.02	0.02
5	10.48	1.68	0.02	5.57	0.03	0.01	0.01
6	9.66	0.87	0.85	-2.69	0.03	0.02	0.03
7	9.86	1.02	0.60	-0.71	0.03	0.02	0.02
8	10.14	1.40	0.48	2.14	0.04	0.02	0.02
9	9.96	0.32	0.31	0.37	0.03	0.02	0.03
Mean	9.93	1.00	0.21				

locations (facing tunnel)

1	4	7
2	5	8
3	6	9

Table A1 Calibration measurements of wind speed in the BRE wind tunnel facility

The requirements for the rain generating device are a capability for generating a stable rain fall rate for the roof pitch under test. The spatial variation of rainfall must be not more than ±35% over the area of the test specimen during a time period of 5 min±10s. During the same time period of 5 min ±10s the rainfall rate shall vary by not more than ±2%. The actual rainfall rate that should be applied depends on the geographical location. Rainfall conditions are given in the draft standard for three climates: Northern European Coastal, Central Europe and Southern European. In all cases the rainfall rain varies with pitch angle. This means that the test rig must be calibrated for every pitch angle that is likely to be used. The variation in rainfall rate with pitch angle can be very small, for example in the Northern European climate Sub-Test A the rainfall rate varies between 124mm/hr and 130mm/hr for pitches between 15° and 45°. In practice it is not possible to control the rainfall rate on the roof to such small tolerances. The degree of variation in rainfall rate allowed by the draft standard is ±35% which is generally much wider than the range of rainfall rates specified for each pitch angle.

Figures A3 to A6 show the calibration of the driving rain in the BRE test rig. The results of the calibrations for Sub-Tests A, B and C for the Northern European Coastal climate are shown in Table B2. From Table B2 it can be seen that the degree of variability in Sub-Tests A, B and C is close to but just within the allowable limit of ±35%.

% variation of water collected in buckets			
Bucket No	Test C	Test B	Test A
1	-3	-11	-7
2	-3	-21	-26
3	14	9	-22
4	-29	9	26
5	11	-2	22
6	16	-9	24
7	34	24	19
8	29	28	29
9	-17	-15	5
10	-22	3	-1
11	-8	7	-16
12	30	13	-4
13	-21	-29	-21
14	-18	-2	-28
15	-5	-5	-21
16	-9	3	23
Maximum %	34	28	29
Minimum %	-29	-29	-28

Table A2 Calibration of driving rain variability


Figure A3 Bottom spray bar


Figure A4 Top spray bar


Figure A5 View of the test rig at the end of the tunnel


Figure A6 View of the 16 rainfall collection buckets on the test rig

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