



bre

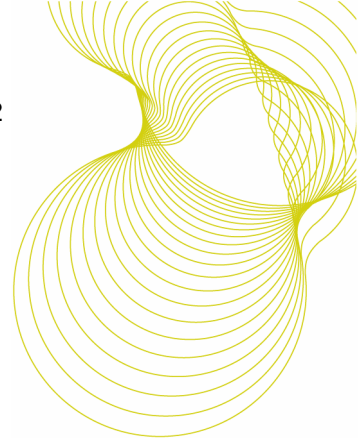
**Wind loading and impact
testing on Navitas Solar
Thermal Collector to
EN12975-2**

Prepared for:
Ronan Ginnell

Joule

8th September 2010

Test report number 264-584/1



Prepared by

Name Dr P Blackmore
Position Associate Director, Building Technology Group

Signature 

Approved on behalf of BRE

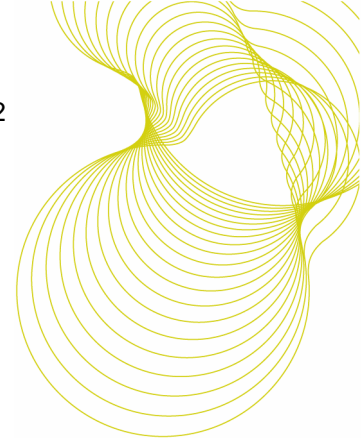
Name Mr D Richardson
Position Director, Building Technology Group
Date 8th September 2010

Signature 

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

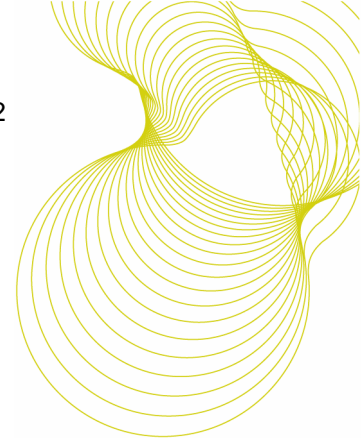
This report may only be distributed in its entirety and in accordance with the terms and conditions of the contract. Test results relate only to the items tested. BRE has no responsibility for the design, materials, workmanship or performance of the product or items tested. This report does not constitute an approval, certification or endorsement of the product tested.

This report is made on behalf of BRE. By receiving the report and action on it, the client – or any third party relying on it – accepts that no individual is personally liable in contract, tort or breach of statutory duty (including negligence).



Contents

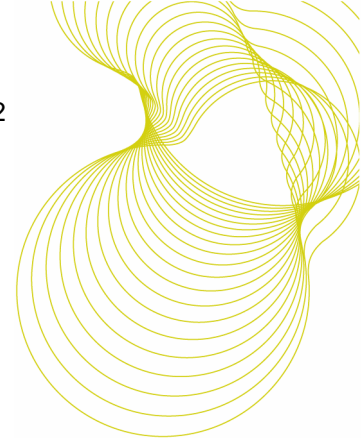
1	Introduction	4
2	Details of the test specimens and the testing	5
2.1	Clause 5.9.1 Positive load test	5
2.2	Clause 5.9.2 Negative load test	5
2.3	Clause 5.10 Impact resistance test	7
3	Test results	8
3.1	Positive pressure loading test	8
3.2	Negative pressure loading test	10
3.3	Impact tests	12
3.3	Impact tests	12
5	Conclusions and Discussion	13
4	References	14
Annex A	Installation instructions for Navitas solar collectors	15



1 Introduction

This report describes mechanical load testing carried out to EN12975 to assess the wind loading and impact resistance of the Joule Energy Navitas above-roof solar thermal collector.

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



2 Details of the test specimens and the testing

BRE were supplied with three Joule Energy Navitas above roof solar thermal collectors and the associated mounting kits. The serial numbers of the three collectors tested are:

Module 1: 201030 -11 Used for upwards acting pressure testing

Module 2: 201030 -12 Used for downwards acting pressure testing

Module 3: 201030 -13 Used for hard body impact testing

Details of the module and fixing kit are included in the installation instructions for these collectors are given in Annex A.

The testing was carried out according to the requirements of Clause 5.9 and Clause 5.10 of EN 12975-2 as follows:

2.1 Clause 5.9.1 Positive load test

Positive loading was applied to a single solar thermal collector using pneumatic rams with suction cups attached in accordance with 5.9.2.2. Loads were applied in increments not exceeding 250Pa. The deflection of the centre of the collector was measured during and after each load increment. The testing continued until failure of the collector occurred; which could be breakage of the cover glass or where the permanent deflection of the collector or fixings exceeds the specified limit, or where the limitation of the test rig is reached. No fixings are used for this test (as specified by EN 12975). The specimen was laid horizontally on an even ground for the tests. Figure 1 shows the specimen on the BRE test rig.

2.2 Clause 5.9.2 Negative load test

Negative loading was applied to a single solar thermal collector using pneumatic rams with suction cups attached in accordance with 5.9.2.2. The deflection of the mid point of the long and short sides of the collector frame were measured during and after each load increment. Testing continued until failure of the collector occurred; which could be breakage of the cover glass or where the permanent deflection of the collector or fixings exceeds the specified limit, or where the limitations of the test rig are reached. The collector was attached to the roof using the supplied fixings, see Annex A for details of the fixings. Figure 2 shows the specimen on the BRE test rig.

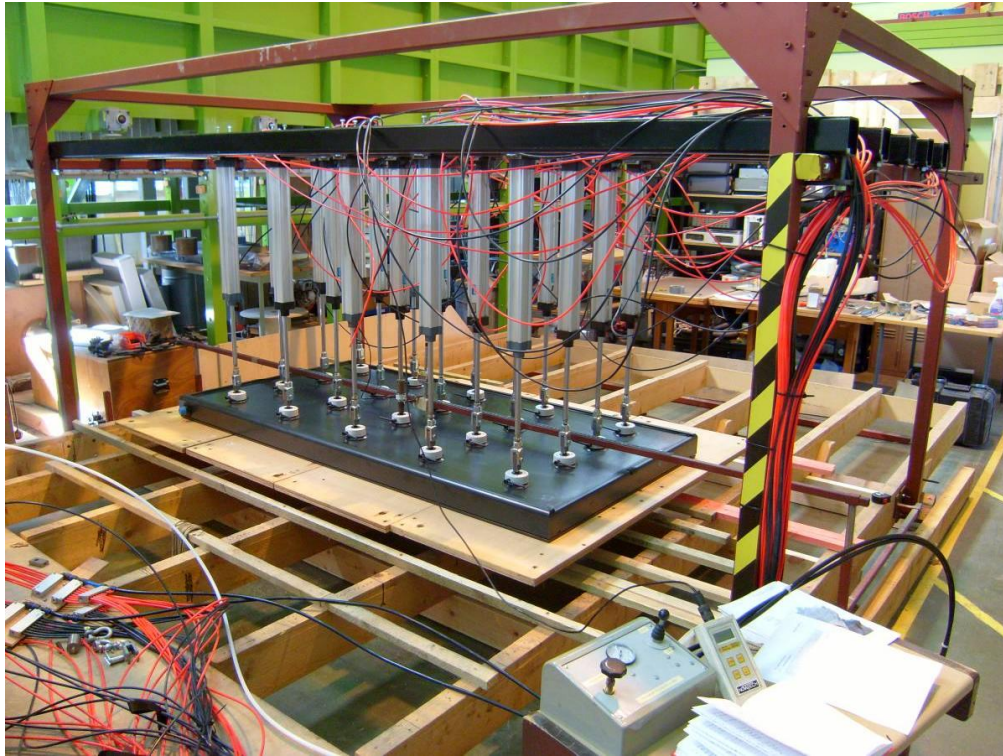
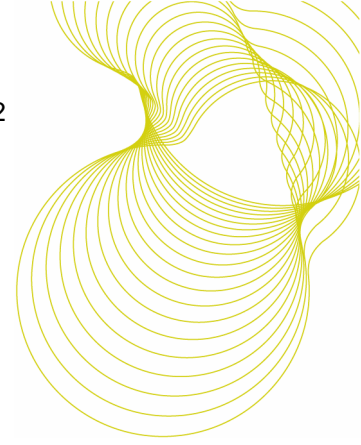


Figure 1 View of the BRE test rig and the test specimen ready for the positive pressure test

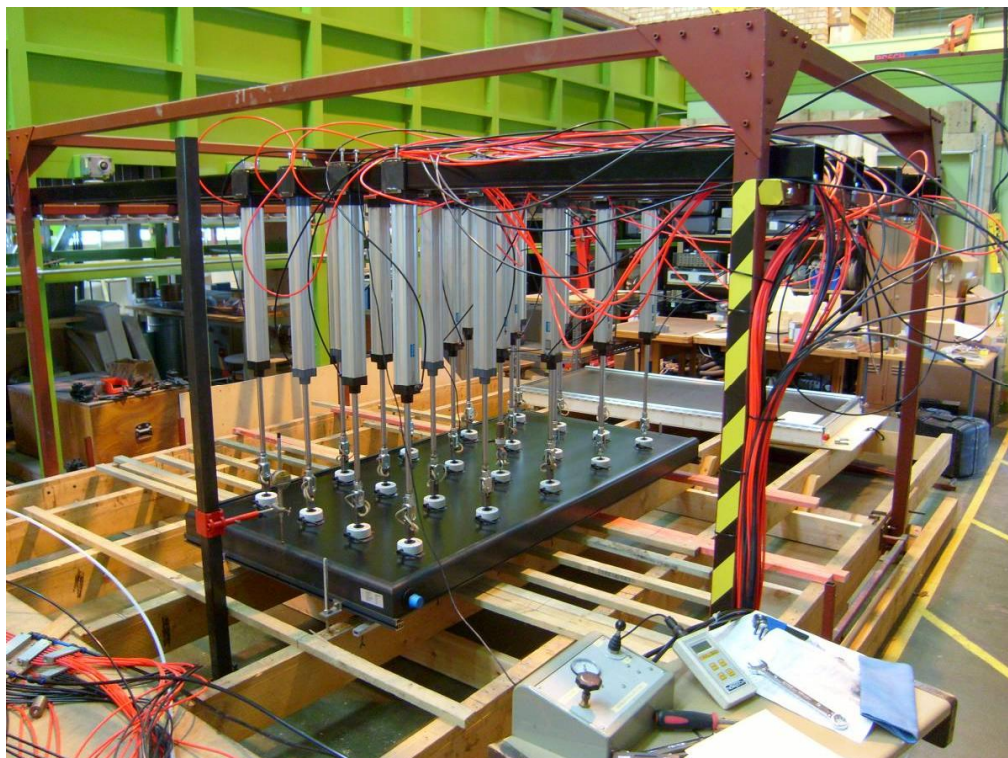
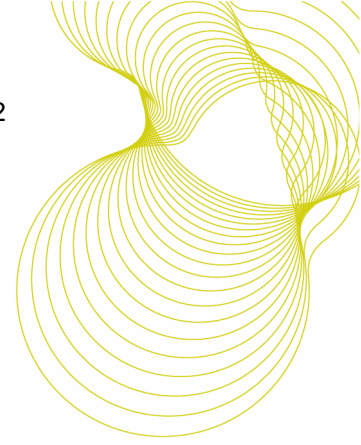
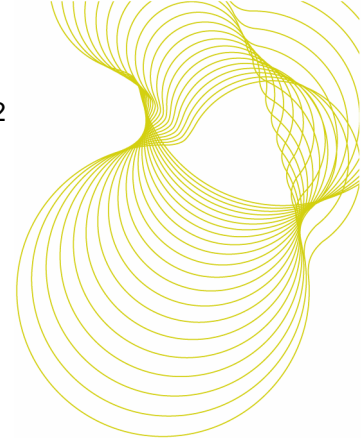


Figure 2 View of the BRE test rig and the test specimen ready for the negative pressure test



2.3 Clause 5.10 Impact resistance test

Tests were carried out using Method 1 of Clause 5.10. This method requires a steel ball of mass $150\text{g} \pm 10\text{g}$ to be dropped on to the cover plate of the collector at a distance of no more than 5cm from the edge of the collector cover and no more than 10cm from the corner of the collector cover. The ball is moved a few millimetres between each impact. Impact drop heights of 0.4m, 0.6m, 0.8m, 1.0m, 1.2m, 1.4m, 1.6m, 1.8m and 2m were used, or until the specimen was damaged. The steel ball was dropped 10 times at each drop height and the impacts were distributed randomly around the four corners within the distance limitations described above. Figure 3 shows the device used to drop the steel balls on to the collector.



3 Test results

3.1 Positive pressure loading test

The results from the positive pressure tests on Navitas solar thermal collector are shown in Table 1 and Figures 4 and 5 for the maximum and residual displacement respectively.

Table 1 Load displacement results for Navitas solar thermal collector under positive loads

Load (Pa)	Maximum Displacement (mm)	Residual Displacement (mm)
227	3.07	0
453	13.82	0.21
680	17.7	0.33
907	20.19	0.41
1046	22.18	0.45
1273	24.45	0.57
1500	27.15	0.64
1727	29.41	0.79
1866	30.71	0.88
2093	32.75	0.87
2320	34.27	0.92
2546	36.42	0.99
2773	37.95	1.11
2912	39.99	1.11
3052	41.17	1.12
3279	42.7	1.13
3505	44.45	1.14
3732	46.98	1.16
3941	47.98	1.22
4168	49.09	1.23
4308	49.72	1.35
4534	51.89	1.36
4761	53.3	1.37
5040	55.1	1.39
5319	58.4	1.45

The Navitas solar collector withstood a positive pressure of 5319Pa. This was the limit of the BRE test rig. At this pressure there was no damage to the collector and it is likely that the collector will withstand higher pressures than this without damage. The maximum load is divided by a safety factor of 1.5 to obtain the permissible load under positive wind loading as specified in Clause 5.9.1.4

The permissible positive pressure for wind loads is $5319/1.5 = 3546\text{Pa}$

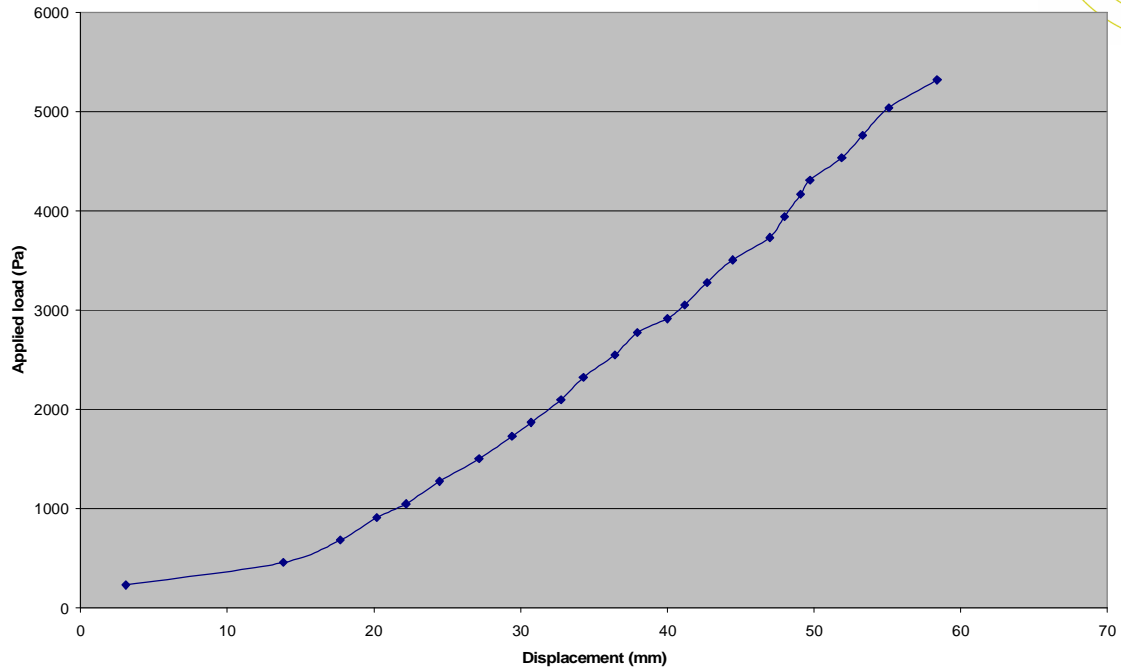
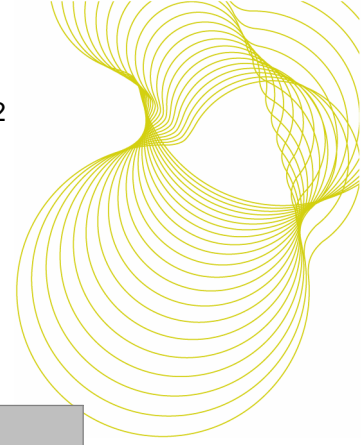


Figure 4 Plot of load versus maximum displacement for Navitas solar collector under positive loading

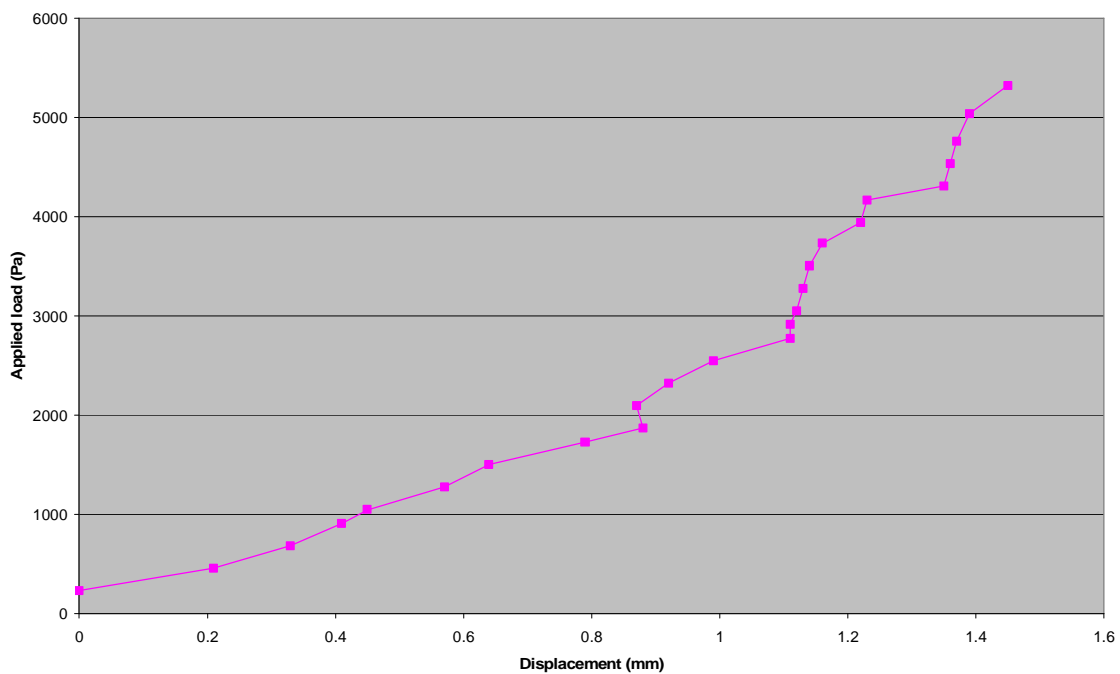
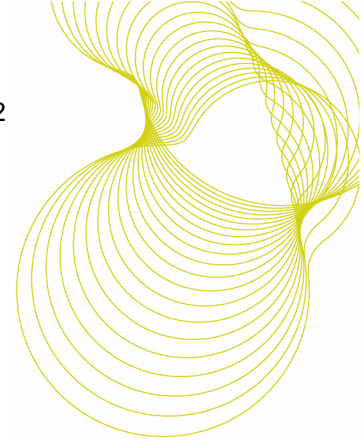


Figure 5 Plot of load versus residual displacement for Navitas solar collector under positive loading



3.2 Negative pressure loading test

The results from the negative pressure tests on the Navitas solar thermal collector are shown in Table 2 and Figures 6 and 7 for the maximum and residual displacement respectively.

Table 2 Load displacement results for Navitas solar thermal collector under negative loads

Load (Pa)	Maximum Displacement (mm)	Residual Displacement (mm)
227	1.07	0.43
453	1.66	0.44
680	2.03	0.49
907	2.34	0.53
1134	3.2	0.62
1360	4.02	0.76
1587	4.45	0.78
1814	5.23	0.79
2040	5.6	0.86
2267	6.48	0.93
2494	7.33	1.04
2721	8.06	1.06
2947	8.77	1.23
3174	9.71	1.32
3401	10.22	1.47
3628	11.51	1.62
3854	13.01	1.76
4081	14.82	1.99
4308	16.23	2.41

The Navitas solar collector withstood a maximum negative pressure of 4308Pa. This was the limit of the BRE test rig, at suction pressures above this value the curvature of the glass cover sheet was such that the suction cups became detached. At this suction pressure there was no damage to the collector and the residual deflections were within the specified limits. It is likely that the collector will withstand higher suction pressures than this without damage. The maximum load is divided by a safety factor of 2.0 to obtain the permissible load under positive wind loading as specified in Clause 5.9.2.4

The permissible negative pressure for wind loads is $4308/2 = 2154\text{Pa}$

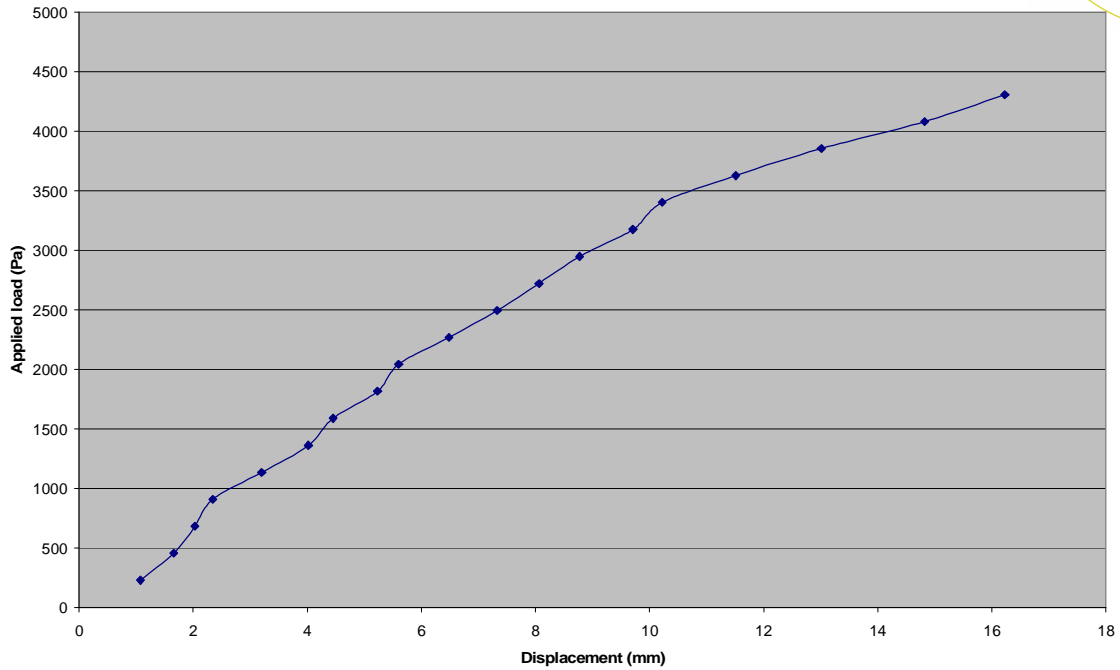
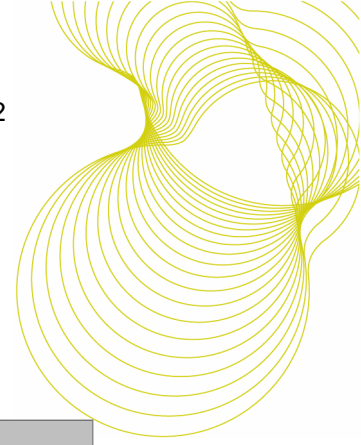


Figure 6 Plot of load versus maximum displacement for Navitas solar collector under negative loading

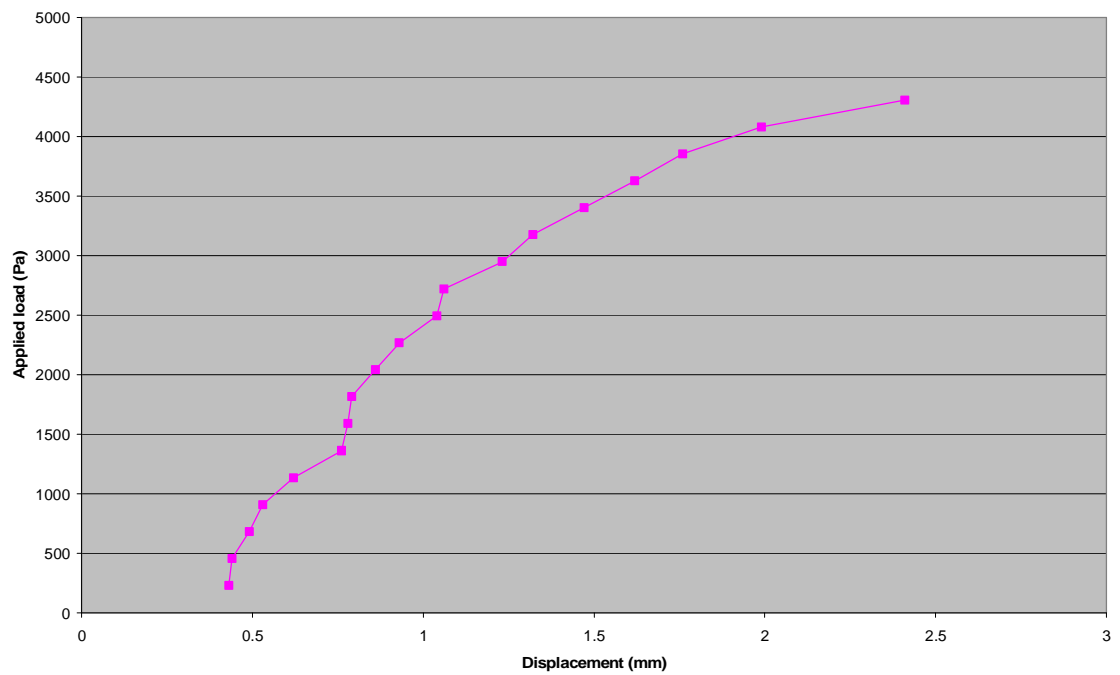
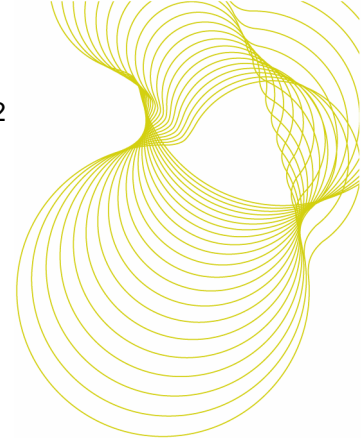


Figure 7 Plot of load versus residual displacement for Navitas solar collector under negative loading



3.3 Impact tests

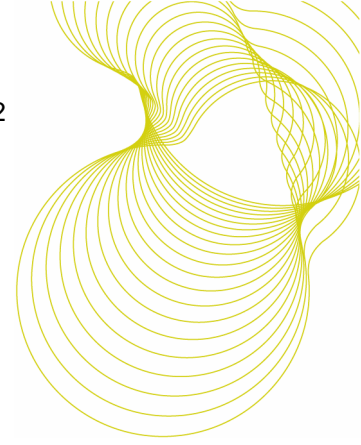
The solar collector was impacted 10 times at each of the drop heights of 0.4m, 0.6m, 0.8m, 1.0m, 1.2m, 1.4m, 1.6m, 1.8m and 2m. The impacts at each drop height were randomly distributed around each of the four corners.

The collector survived all drop heights up to and including the maximum drop height of 2m. At the end of the testing there was no visible sign of any damage to the collector.

Figure 8 shows the test specimen after completion of the impact testing.



Figure 8 View of the collector after all impact testing has been completed

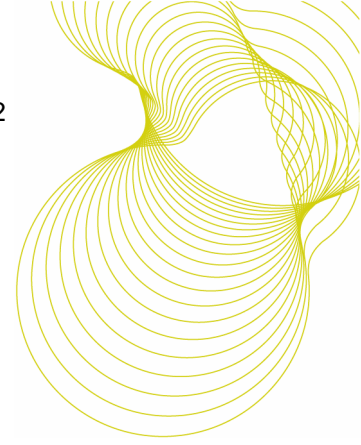


5 Conclusions and Discussion

This report describes tests carried out to assess the performance of the Navitas solar thermal collectors under simulated wind loading (downwards and upwards acting wind loading) and impact loading carried out in accordance with the requirements of EN 12975-2.

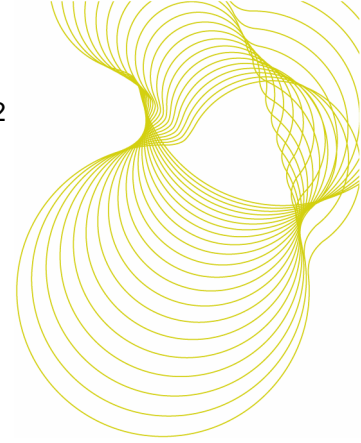
The main conclusions from this study are as follows:

- i. Under positive (downwards acting pressure) the solar collectors will withstand a wind load of at least 5319Pa. The permissible downward acting wind pressure is 3546Pa (based on a factor of safety of 1.5).
- ii. Under negative (upwards acting pressure) the solar collectors will withstand a wind load of at least 4308Pa. The permissible upward acting wind pressure is 2154Pa (based on a factor of safety of 2).
- iii. The Navitas solar thermal collector will withstand hard body impacts from a 150g \pm 10g steel ball dropped 10 times from a height of 2m.



4 References

- 1 EN 12975 Part 2; Thermal solar systems and components — Solar collectors — Part 2: Test methods, 2006.

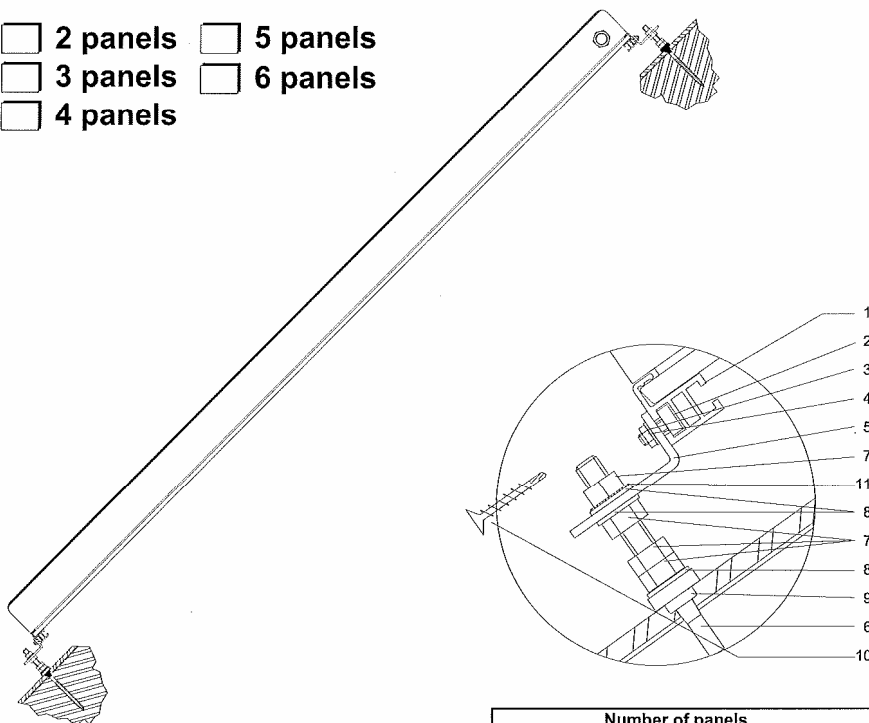


Annex A Installation instructions for Navitas solar collectors

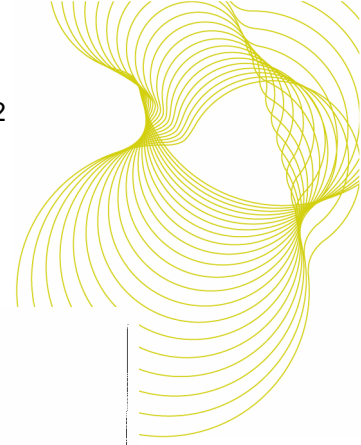


Mounting set with special screws for type vertical

- 2 panels 5 panels
- 3 panels 6 panels
- 4 panels



Pos	Code	Designation	Number of panels				
			2	3	4	5	6
			310012	310013	310014	310015	310016
1	09150	Support profile (1.070+60 mm)	2	2	2	2	2
-	09717	Alu connecting piece 15x6x200 mm	2	2	2	2	2
2	29510	T-headed bolt M8x20	6	8	10	14	16
3	29206	Disk for M 8 - 8.4 mm DIN 125 A2	6	8	10	14	16
4	29272	Nyloc nut M8 DIN 985 A2	6	8	10	14	16
5	03908	Mounting angle for special screws	6	8	10	14	16
6	29042	Special screw M12x350 mm	6	8	10	14	16
7	29237	Nyloc nut M12 DIN 934 A2	24	32	40	56	64
8	29211	Disk for M12 - 13.0mm DIN 125 A2	18	24	30	42	48
9	08929	Sealing	6	8	10	14	16
10	29526	Self-tapping screw 5,5x32mm	4	6	8	10	12
11	29175	Fan disk M12 - 13.0mm DIN 6798 I A2	6	8	10	14	16



Assembly instruction for special screw-on-roof fastening set



Tools required:



tape measure



hammer



powerdrill with
screwdriver bit



19mm spanner, 27mm
spanner, 38mm spanner

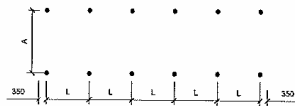


Drive ratchet with
19mm and 13mm
socket



13mm ring
spanner

Table: positioning of the screws

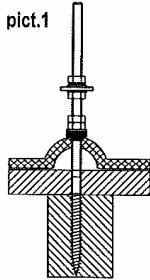


Standard format:

number of panels	2	3	4	5	6
A mm	2180				
L mm	750	877	940	815	860

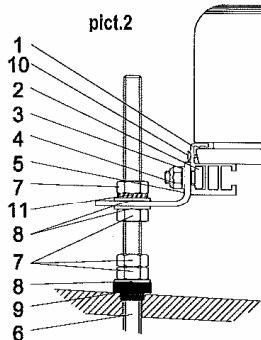
Horizontal format:

number of panels	2	3	4	5	6
A mm	1153				
L mm	1187	1144	1126	1116	1109



pict.1

- For finding the optimal position of the collectors, you have to measure the distance between the highest and the lowest special screw (type vertical = 2180 mm; type horizontal = 1153 mm) on the roof. The holes should be settled in the middle of the tiles, so that only one tile has to be drilled.
- Mark the lowest row with impact cord and a spirit level and determine so the right positions of the lowest screws. The distance between the screws depends on the rafter distance of the roof. Please note, to fix the special screws on the wave mountain on a firm underground (rafter) pict.1.
- Drill a hole with \varnothing 14 mm for the special screw and sealing into the tile (do always drill in the wave mountain pict. 1), then drill a hole of \varnothing 7 mm (at firm undergrounds like f.e. concrete, drills and pegs with \varnothing 14 mm are needed). To achieve the necessary firmness, the hole should have at least 120 mm, that the screw can be screwed in with the whole shank (min 110 mm).
- Screw the special screws into the hole by screwing a nut against the special screw. Use this nut as flat. Subsequently take apart the nuts. Pull the seal (9) and the disk (8) into hole with \varnothing 14 mm and fix it with a nut (But do not tighten it too much, otherwise the tile could break) and place a second nut against. Then install the next nut and disk (7,8), that serve as surface for the assembly angle. The distance between the two nuts depends on the type of tile (recommendation about 30 mm) pict.2.
- Place the assembly angle (5) at the special screws on the backside of the collector and bolt it with the nut, the disk and the fan disk (7,11,8) on. With the slotted hole eventual disalignments of the screws can be adjusted.



pict.2

- Install the support profile (1) with the „T“ headed bolt (2) and selffixing nut (3) and disk (4) on the assembly angle pict.2.
- Practise the items 5 and 6 for the upper profile, but don't screw the nut (7) too firm.
- Installation of the collectors:**
Put the collectors on the lowest support profile. Pull the upper support profile into the planned nut on the collector.
- The hydraulic connection between the collectors happens through the union fittings. First of all tighten the union fittings (with spanners) at the collectors for achieving the correct distance between the collectors. **ATTENTION! It's necessary to pull against while screwing otherwise the collecting pipe could be rotated!**
- After this, fix every collector by using a self-tapping screw (10) (also look at page nr. 1) on the support profile (the holes have already been drilled).
- Now screw the upper nuts (7) with the upper support profiles.

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