RAAFT®

RAAFT WIND CERTIFICATION

BS EN 1991-1-4:2005+A1:2010

TEST REPORT

Lucideon Reference:	UK234413 (QT-72325/1/MM)/N25280/Ref. 1
Project Title:	Wind Uplift Testing of Raaft Ltd's Raaft Preventa System
Client:	Raaft ltd Compass Park Staplecross East Sussex TN32 5BS
For the Attention of:	Mr Stuart Bowie
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CONTENTS

1 INTRODUCTION

Raaft Ltd supply Raised Decking Systems.

They required a programme of testing to establish the resistivity to wind uplift of their Raaft Preventa System, incorporating Atria and Farrino Porcelain Tiles.

Raaft Ltd provided Lucideon Ltd with the following materials to construct samples of each of the systems within Lucideon Limited's wind uplift rig:

- Preventa Metal Pedestals.
- Preventa Aluminium Joists.
- Preventa Wind Uplift Clips.
- 4 mm Tile Spacers (4 way).
- Atria 20 mm Porcelain Tiles.
- Farrino 20 mm Porcelain Decking.

Product datasheets for each component supplied can be found within Appendix A, along with installation instructions.

Installation took place between 13 and 14 January 2025 with testing completed between 15 and 17 January 2025 in Lucideon Limited's Structures Laboratory, Queens Road, Stoke on Trent, ST4 7LQ.

Installation was completed by representatives from Lucideon Limited following Raaft Ltd's installation videos and literature.

2 SAMPLE CONSTRUCTION

The sample was constructed such that each system was approximately 1800 mm x 2400 mm as detailed in Figure 1 below.

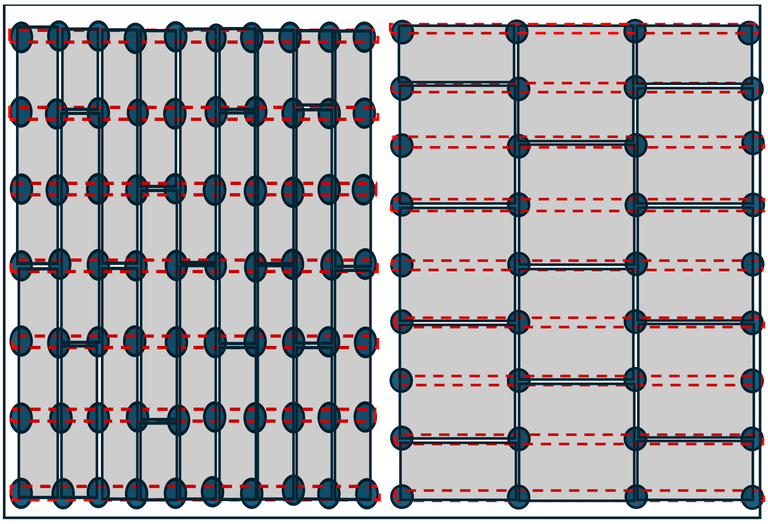


Figure 1 − Sample Construction Layout

The Raaft Preventa System with Atria 20 mm Porcelain Tiles consisted of the following components:

- 600 mm x 600 mm x 20 mm Atria Porcelain Tiles laid in a half bond pattern.
- Preventa Metal Pedestals spaced along the Preventa Aluminium Joists at 600 mm centres.
- Preventa Aluminium Joists set at 300 mm centres.
- Wind uplift clips installed per installation manual of 2 per tile.
- 4 mm tile spacers installed per installation manual (snapped to suit the tile junction).

The Raaft Preventa System with Farrino 20 mm Porcelain Decking consisted of the following components:

- 1200 mm x 200 mm x 20 mm Farrino Porcelain Decking laid in a third bond pattern.
- Preventa Metal Pedestals spaced along the Preventa Aluminium Joists at 200 mm centres.
- Preventa Aluminium Joists set at 400 mm centres.
- Wind uplift clips installed per installation manual of 2 per tile.
- 4 mm tile spacers installed per installation manual (snapped to suit the tile junction).

Linear Voltage Displacement Transducers (LVDT's) were positioned below the tiles to measure the deflection of the tiles during testing per Figure 2 below.

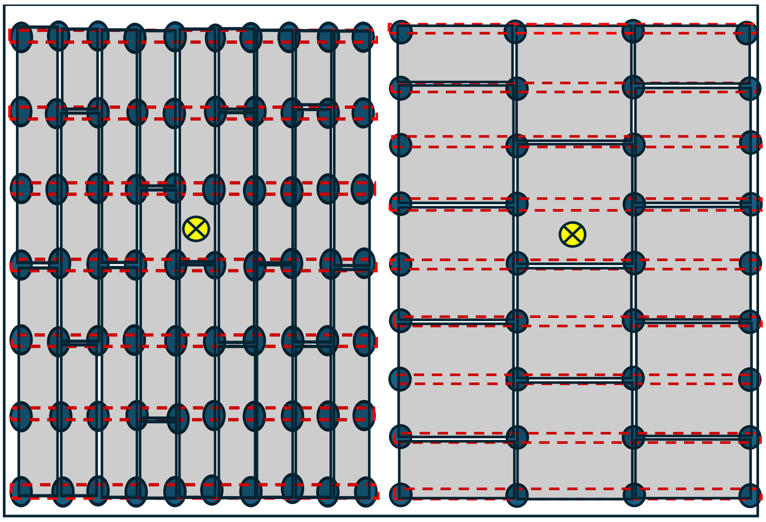


Figure 2 − Transducer Positions

A manometer was positioned within the test rig to measure the air pressure during testing.

The LVDT's and manometer were connected to a Data Logger and laptop to record data during testing at a frequency of 1 Hz.

It should be noted that the pedestals were not fixed in any way to the interior of the test rig and each system was free standing.

Gaps between the systems and gaps between the systems and the edge of the test rig were blanked off using plywood and sealed with silicone sealant to ensure there were no gaps for pressure to escape other than those within the systems themselves.

3 TEST PROGRAMME

A cyclic loading based upon EOTA Technical Report TR005:2003 Determination of the resistance to wind loads of partially bonded roof waterproofing membranes.

4 TEST METHOD

4.1 Cyclic Wind Loading

All samples were subjected to a number of proportional sequential loading cycles in accordance with Table 1 of EOTA TR 005:2003.

All cycles were in accordance with EOTA TR 005 Figure 2 – Proportional Array of Suction Pressures, which can be seen in Figure 3 below.

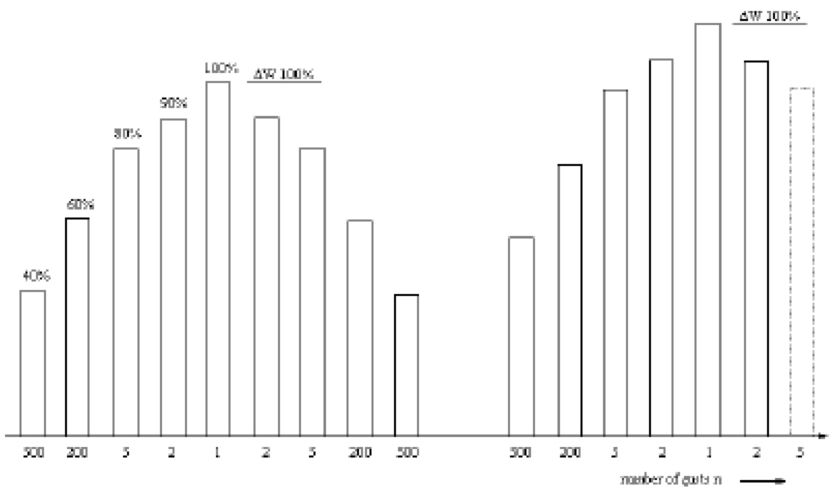


Figure 2 – Proportional array of suction pressures

Figure 3 – EOTA TR 005 Figure 2 – Proportional Array of Suction Pressures

The lapse time for each suction pressure was in accordance with EOTA TR 005 Figure 5 − Time/Suction Pressure Diagram of as seen in Figure 4 below.

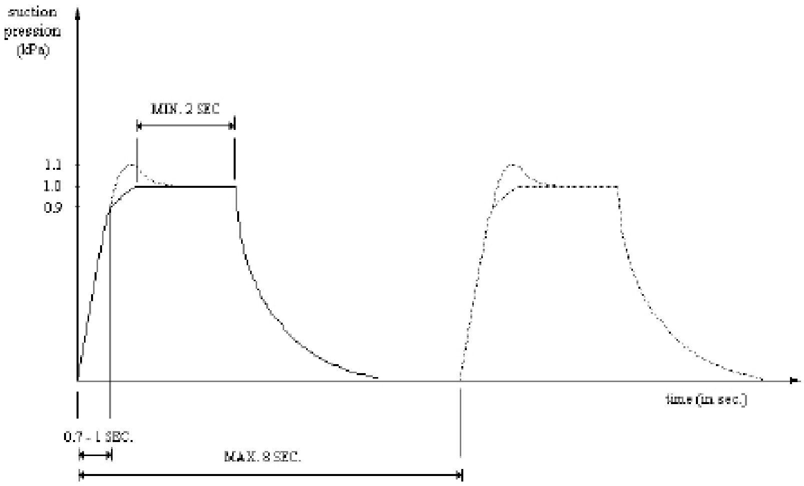


Figure 5 – Time/suction pressure diagram (trapezium)

Figure 4 – EOTA TR 005 Figure 5 – Time/Suction Pressure Diagram

The behaviour of the sample was observed during each cycle.

The loading was set at 6000 Pascals maximum giving the following pulses for the cyclic loading.

Table 1 − Cyclic Wind Loading Pulses

Load %	Load (Pa)	No. of Pulses
40	2400	500
60	3600	200
80	4800	5
90	5400	2
100	6000	1

The system was monitored continuously throughout this testing with deflection and pressure measurements being taken per Section 2 of this report.

Photographs of the test set-up can be seen in the Plates Section of this report.

5 RESULTS

5.1 Cyclic Wind Loading

The sample was taken to a maximum of 6000 Pascals in pulsed cycles as described within Section 4 of this report.

There was found to be no detrimental effects to either system or failures observed during testing.

Table 2 – Deflection of Systems During Cyclic Wind Load Testing

System	Deflection (mm) @ Load (Pa)					
	2400	3600	4800	5400	6000	Residual
Raaft Preventa System with Atria Tiles	0.00	0.06	0.10	0.10	0.12	0.10
Raaft Preventa System with Farrino Decking	0.00	0.25	0.25	0.34	0.77	0.33

We can see from the Chart that there is little uplift from the tiles, as the wind uplift pressure increases there is an increase in the lift of the tiles which does not return to zero.

No tiles came fully loose during testing to a maximum of 6000 Pascals.

Chart 1 gives pressure and deflection against time for the maximum wind load cycles of Raaft Preventa System with Atria Porcelain Tiles.

Chart 2 gives pressure and deflection against time for the maximum wind load cycles of Raaft Preventa System with Farrino Porcelain Decking.

6 DISCUSSION

Wind can approach a building from any direction. It will hit a side elevation, causing it to be directed upwards and accelerated.

Once it reaches the top of the building it can return to its normal course; however, it leaves a void before settling back down over the roof.

This void is an area of negative pressure, which has the effect of trying to pull or suck the roof coverings off the remaining structure.

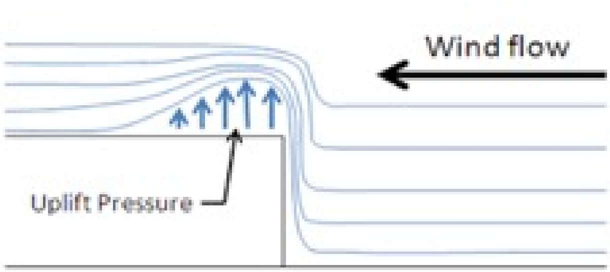


Figure 5 − Edge Zone of a Roof

You can see from Figure 5 above that the edge zone of a roof is the most likely to be affected by wind uplift.

As the wind can come from any direction, all corner and perimeter zones require a greater resistance to the effects of wind load when being secured.

The effect can be worsened if the edges of flat roofs are not correctly fixed, which can allow air to get underneath the roof covering.

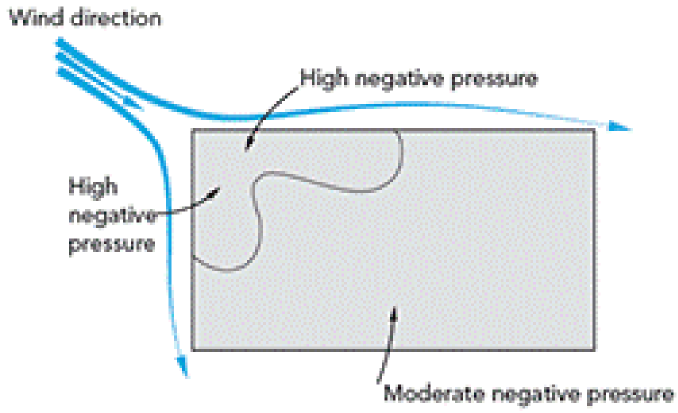


Figure 6 – Wind Striking an Object

When wind strikes a building, it is deflected to generate a positive pressure on the windward face. As it accelerates around the side of the building and over the roof, it creates a reduced or negative pressure in its trail.

The greatest pressures are experienced at the windward corners and edges of the roof, where the negative pressure exerted on the roof, can be several times that experienced in the central areas.

It is also important to consider the location and exposure of the building to determine the effect of Wind Uplift. Northern England, Scotland and Northern Ireland typically will have much higher average wind speeds than those experienced in the South and Southeast.

Wind speed will also be higher in exposed areas such as on the coast and in open, rural, or hilly areas. Tall buildings with no surrounding protection would be more at risk; buildings that are sheltered in a town centre less so.

How does this apply to raised flooring on a flat roof??

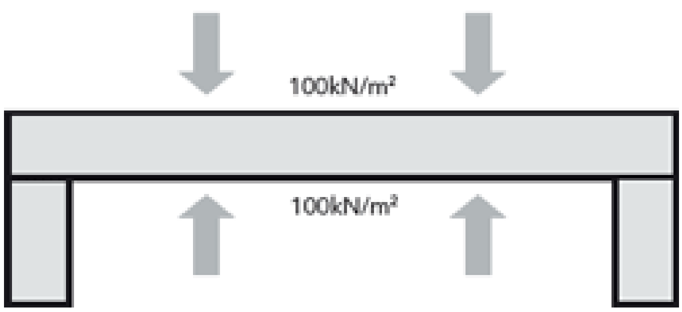


Figure 7 – Pressures in Normal Situations

When there is no wind, the air pressure on the upper surface of a roof system is the same as that on the underside. Wind changes this equilibrium by reducing the atmospheric pressure on the surface of the roof system.

The atmospheric pressure acting on the underside of the roof will remain the same or may be increased if windows or doors are open on the windward side of the building.

The result is a net upward push acting on the underside of the roof. This upward thrust will be exerted on the lowest air impermeable layer in the roof construction, which will be required to stop air flowing further into the system (the diaphragm).

In most roof constructions there is one layer that provides the dominant barrier against the upward thrusting flow of air, and this is referred to as the critical layer.

In roof constructions where the deck is continuous (e.g. screeded concrete) it will be deemed to be the critical layer, but for **air permeable decks (i.e. those with joints)** the critical layer will occur somewhere in the roof system itself, this is because the gaps within the air permeable layer allow the air pressure to equalise below and above and, hence, not act as a diaphragm.

This pressure equalisation is not instant; however, there can be a time of up to a few seconds, dependant on the air flow rate of the air permeable deck (size of the gaps between the slabs for decking), where the pressure differential will act upon the deck itself until pressure equalisation occurs.

It is for this reason, that any surface that is added to the upper face of a flat roof, should be tested for uplift resistance, to establish that under extreme pressures it has the ability to pressure equalise, prior to the wind uplift force causing a failure of that layer, wind uplift prevention systems would need to be implemented should this be the case; however, they would not be required for systems that allow a sufficient air flow rate between them to pressure equalise prior to any failure.

To give some context to the results obtained during testing:

It has been recorded that, gusts of up to 100 mph (44.70 ms^{-1}) occur in the UK on average once every 50 years and as such it was deemed prudent to test beyond this maximum potential wind speed.

Wind Pressure (Nm^{-2}) = ½ x Air Density (kgm^{-3}) x wind speed² (ms^{-1}) x Drag Coefficient.

The air density was taken as 1.25 kgm^{-3}.

The wind speed = 44.70 ms^{-1}.

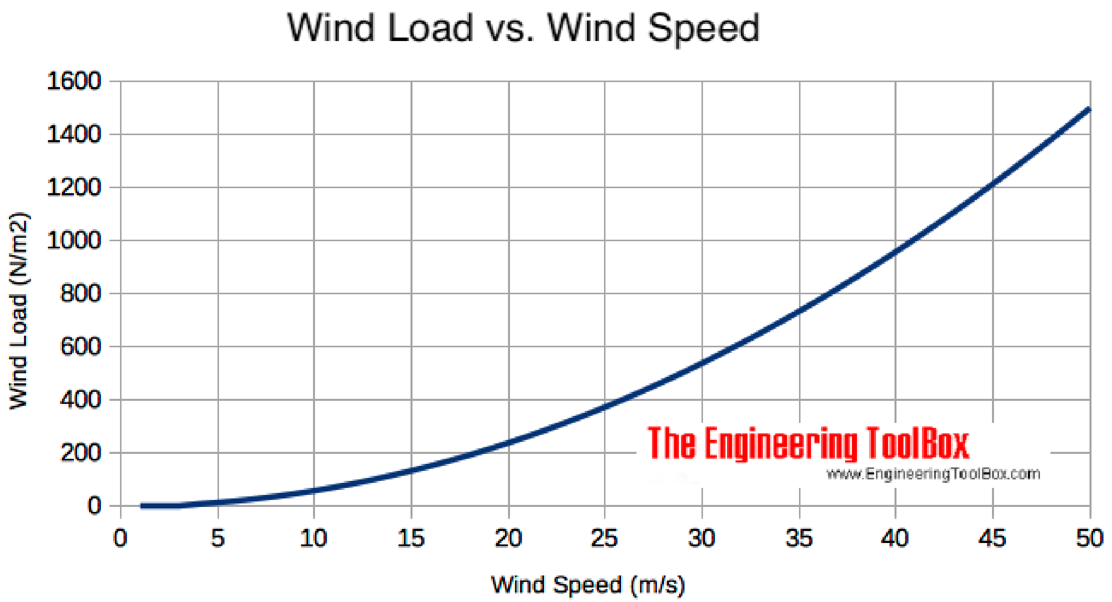
The drag coefficient (taken as 1.0).

This gave a pressure of 1225.73 Nm^{-2} (1.23 kilopascals).

In any particular situation, the wind load, dependant on the basic wind speed (the value of wind speed for a 3 second gust), which varies across the country, the height above ground, the degree of protection from other buildings and also geographic features (e.g. escarpments.) is determined in accordance with BS EN 1991-1-4:2005 +A1:2010 and this is, of course, very specific to the building, its location orientation etc.

To give a feel for this, the pressure from a 3-second gust at 10 m above the ground, would range from around 0.6 kNm^{-2} in a city centre anywhere in England, to 1.4 kNm^{-2} in open country.

To this wind load is applied a partial safety factor which is taken from BS EN 1990, which covers the Basis of Structural Design. These factors can also be complicated to select but a common number used is 1.5. Thus, the wind load for which an element must be designed is defined.



NOTE: The results given in this report apply only to the samples that have been tested.

END OF REPORT

PLATES

Plate 1 – Raaft Preventa Metal Pedestal

Plate 2 – Raaft Preventa Aluminium Joist

Plate 3 – Setting Joists and Pedestals Out

Plate 4 – Farrino Porcelain Decking Installed whilst Installing Pedestals

Plate 5 – Atria Porcelain Tiles Installed

Plate 6 – Sample Complete

Chart 1 - Deflection and Load Against Time Chart for Cyclic Wind Uplift Testing of Raaft Ltd's Preventa System with Atria Porcelain Tiles Restrained on 2 Sides with Wind Uplift Clips

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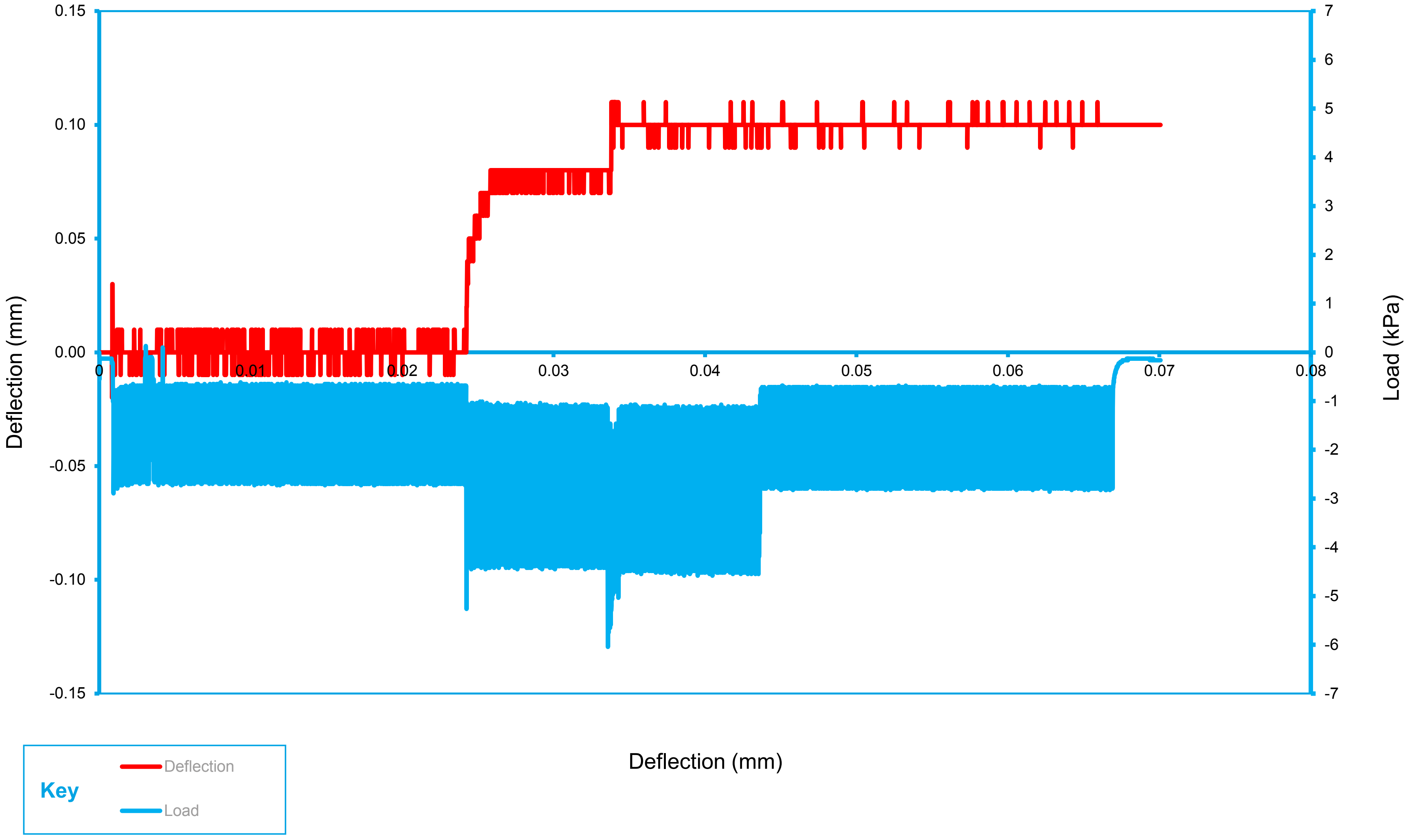

Chart 2 - Deflection and Load Against Time Chart for Cyclic Wind Uplift Testing of Raaft Ltd's Preventa System with Ferrino Porcelain Decking Restrained on 2 Sides with Wind Uplift Clips