HR Wallingford
Working with water

Kitemark Testing of Building Aperture Products

Kayron - Small barrier - Test results

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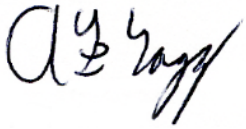

Summary

Kayron

The following report gives the results from the testing of an external flood barrier produced by Kayron, in accordance with BSI PAS 1188-1:2014. The sample is a type 1 building aperture product designed by the company. Testing was carried out between 12/04/2017 and 26/04/2017 at HR Wallingford test facility.

This test report has been prepared for BSI (BSI number: 8593414).

Confidential to BSI.

This report contains:

1. Static test results in accordance with section B.5.2 of PAS 1188-1:2014.
2. Current test results in accordance with section B.5.3 of PAS 1188-1:2014.
3. Wave test results in accordance with section B.5.4 of PAS 1188-1:2014.

Notes:

The test procedure assigns the specimen tested with a test code in the form: K-01-P2-01. Where ‘K’ indicates Kayron, the first number refers to the Test Series, ‘P1’ to the product being tested, in this case the small barrier. The final number indicates the Test Part being run (01-03 are static head tests, 04 are wave tests and 05 are the current tests).

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1. Introduction

1.1. General layout

Tests have been carried out on a flood product which is designed to prevent water ingress during external flooding.

The product is an externally fitted flood barrier which was provided and fitted by Kayron. The product consists of a solid fibreglass structure fitted to the outside of the building, as shown in Figure 1.1. A number of metal screws attach the product over the building aperture and fitting into several previously inserted threaded ‘rivnuts’ as shown in Figure 1.2

Figure 1.1: Kayron flood product in HR Wallingford test rig.

The inner edge of the barrier consisted of a dual seal. The seals were attached to a timber frame allowing for a secure fixture to the building aperture. This meant that any leakage through the barrier could be recorded around the inner seal. The set up for this is shown in Figure 1.3.

Figure 1.2: Threaded ‘rivnuts’ used to mount product to frame.

Figure 1.3: The dual seal used in Kayron's Small Flood product which is subsequently attached to a timber frame.

1.1. Flood Barrier Installation

Flood Barrier Frame Installation

Ron Grover and his colleague from Kayron attached the frame to the test rig in the HR Wallingford test facility. The method of installation was as follows:

- In real-world use, holes are drilled into the outside of the building, however for this testing the holes were drilled into a timber frame in the test rig.
- A threaded ‘rivnut’ was added to each hole to allow screws to be fixed to the frame.
- The structure is added and attached with the screws until tight.
- A small sheet of plywood was added to the top of the product to prevent overtopping during wave and current testing Figure 1.4.

Figure 1.4: Plywood attached above product to prevent overtopping from wave overtopping.

2. Test Schedule

The test schedule followed Section B.5 of PAS 1188-1:2014 for reusable building aperture flood protection products. This schedule has been summarised in Table 2.1, giving details of the test type, test duration, water depth and the related sections in PAS 1188-1:2014.

The Test Series and Test Part numbers are taken from PAS 1188-1:2014 where a Test Series is defined as a complete set of tests between installation and removal of the flood products. A Test Part is a single test with a specified water depth and test duration.

NB Due to time constraints on the project, testing on this Type 1 barrier was undertaken at the same time as that on a Type 4 product. Both products were designed for a DMWD of 600mm. However, due to allowances in the Type 1 specification for entrance threshold level, the water depths are measured at a point 60mm above the threshold. This means that for the tests reported here the product underwent testing at water depths 60mm greater than those required by the PAS. Since the product passed all tests in terms of leakage rate being below the allowed maximum, this procedure was deemed to be acceptable. The values in the table below refer to the actual depths used.

Table 2.1: Test schedule

Test Series	Test Type	Test Part	Water depth above invert (mm)	Test duration (hours)
B.5.1.3	Static B.5.2	B.5.2.3	200	1.0
		B.5.2.4	400	1.0
		B.5.2.5	600	18.0
	Waves B.5.3	B.5.3.3	450	0.5
	Currents B.5.4	B.5.4.2	500	1.0
B.5.1.4	Static B.5.2	B.5.2.3	200	1.0
		B.5.2.4	400	1.0
		B.5.2.5	600	18.0
	Waves B.5.3	B.5.3.3	450	0.5
	Currents B.5.4	B.5.4.2	500	1.0
B.5.1.5	Static B.5.2	B.5.2.3	200	1.0
		B.5.2.4	400	1.0
		B.5.2.6	600	48.0

Source: BSI PAS 1188-1:2014

3. Kayron Small Flood Barrier

3.1. Test Series 1 (B.5.1.3)

The barrier frame was installed in the HR Wallingford facility on 13/04/2017 by Kayron representative Ron Grover and his colleague. Testing did not commence until 14/04/2017.

3.1.1. Static Tests (PAS 1188-1:2014 Section B.5.2)

The static tests were performed in order of increasing water depth in accordance with BSI PAS 1188-1:2014 section B.5.2. Leakage rates for all tests are given in Table 3.1.

Test Part B.5.2.3 K-01-P2-01: 1/3 DMWD (200mm)

The test facility was filled to a depth of 200mm above the invert of the barrier. A total volume of water passing through the seal of 0.0 litres gave a leakage rate of <0001 l/h/m (an aperture width of 1.780m was measured for this product) so the product was successful in meeting the requirements for this test

There was no observable deformation of the product during this test part.

Test Part B.5.2.4 K-01-P2-02: 2/3 DMWD (400mm)

The test facility was filled to a depth of 400mm above the invert of the barrier. A total volume of water passing through the seal of 0.005 litres gave a leakage rate of 0.004 l/h/m (an aperture width of 1.160m was measured for this product) so the product was successful in meeting the requirements for this test. A photograph for this test demonstrating water on the seal of the product is shown in Figure 3.1. As the leakage rate was so small, it was recorded by weight. through mopping up the water on the seal

There was no observable deformation of the product during this test part.

Figure 3.1: Water on seal of product demonstrating low leakage.

Test Part B.5.2.5 K-01-P2-03: 3/3 DMWD (600mm)

The test facility was filled to a depth of 600mm above the invert of the barrier. A total volume of water passing through the seal of 0.008 litres gave a leakage rate of 0.007 l/h/m (an aperture width of 1.160m was measured for this product) was found to pass the seal in the first hour and 0.001 litres in the final hour, giving a leakage rate of 0.001 l/h/m . The product was therefore successful in meeting the requirements for this test. Observations indicated that the seal was leaking gradually throughout the test at an extremely low rate.

There was no observable deformation of the product during this test part.

Table 3.1: Test Series B.5.1.3 – Static Test Results

Test Part	Water Depth (mm)	Duration (hours)	Aperture Width (m)	Volume of water collected (l)	Leakage Rate (l/h/m)
B.5.2.3	200	1.0	1.16	0.0	<0.001
B.5.2.4	400	1.0	1.16	0.005	0.004
B.5.2.5 (First Hour)	600	1.0	1.16	0.008	0.007
B.5.2.5 (Last Hour)	600	1.0	1.16	0.001	0.001

Maximum allowable leakage rate 0.5 l/h/m

3.1.2. Wave Tests (PAS 1188-1:2014 Section B.5.3)

The wave leakage tests were performed with one of HR Wallingford's multi-element paddles. HR Wallingford's software (HR Merlin) was used to control the paddles and the wave data was recorded using an array of four calibrated twin-wire wave gauges which measured changes in the surface elevation of the water. These measurements were recorded using HR DAQ software, which is capable of calculating wave information such as mean wave period and significant wave height. An overall view of the wave generator is shown in Figure 3.2.

Waves were measured by recording the average significant wave height at each of the four wave gauges, this was then adjusted using a reflection coefficient, calculated by the software, to generate the incident significant wave height.

Figure 3.2: HR Wallingford wave generator.

Test Part B.5.3.2 K-01-P2-04: 450mm

The basin was filled to a depth of 450mm above the invert of the aperture and the waves with a JONSWAP spectrum with significant wave height 100±10mm and mean wave period of 1.03s were generated at a direction perpendicular to the face of the building aperture. A total volume of 0.002 litres was recorded passing through the seal giving a leakage rate of 0.003 l/h/m aperture width (an aperture width of 1.16m was

recorded for this product). The product was therefore successful in meeting the requirements for passing this test.

There was no observable deformation of the product during this test part.

Table 3.2: Test Series B.5.3 – Wave Test Results

Test Part	Water Depth (mm)	Duration (hours)	Aperture Width (m)	Volume of water collected (l)	Leakage Rate (l/h/m)
B.5.3.3	454	0.5	1.16	0.002	0.003

Maximum allowable leakage rate 0.5 l/h/m

3.1.3. Current Tests (PAS 1188-1:2014 Section B.5.4)

The current flows for the tests were generated via a pumping system built into the test facility and controlled by in-house software. The software controls four pumps whose discharge rate can be controlled to produce the desired flow velocity at the location of the test specimen.

To control the flow, guides were installed between the pump outlet and the test specimen to form a channel for the water to flow through. Several of the guides previously used to control the waves in front of the product were used to create the necessary channel in front of the product as can be seen in Figure 3.3 and Figure 3.4.

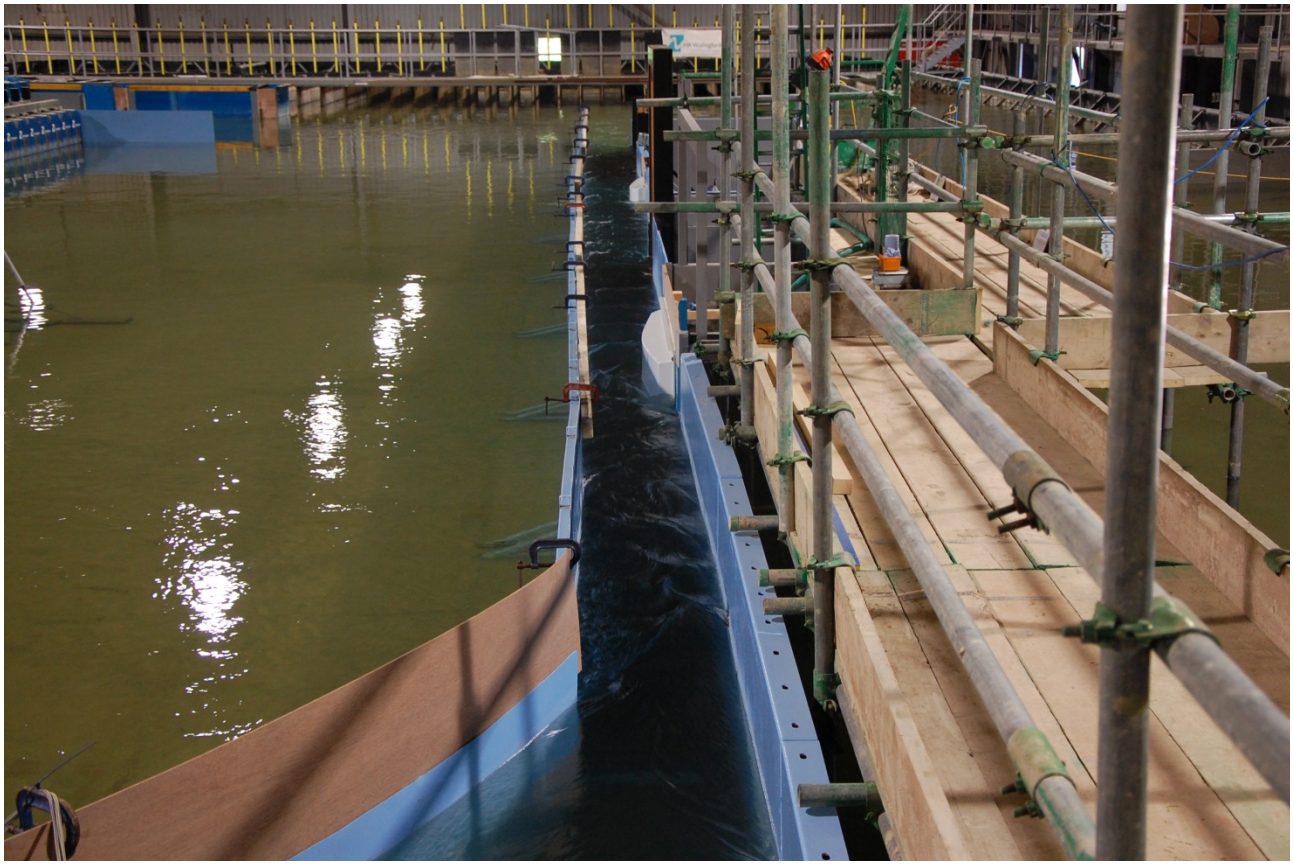

Figure 3.3: Current testing setup showing wave guide positions and flow direction.

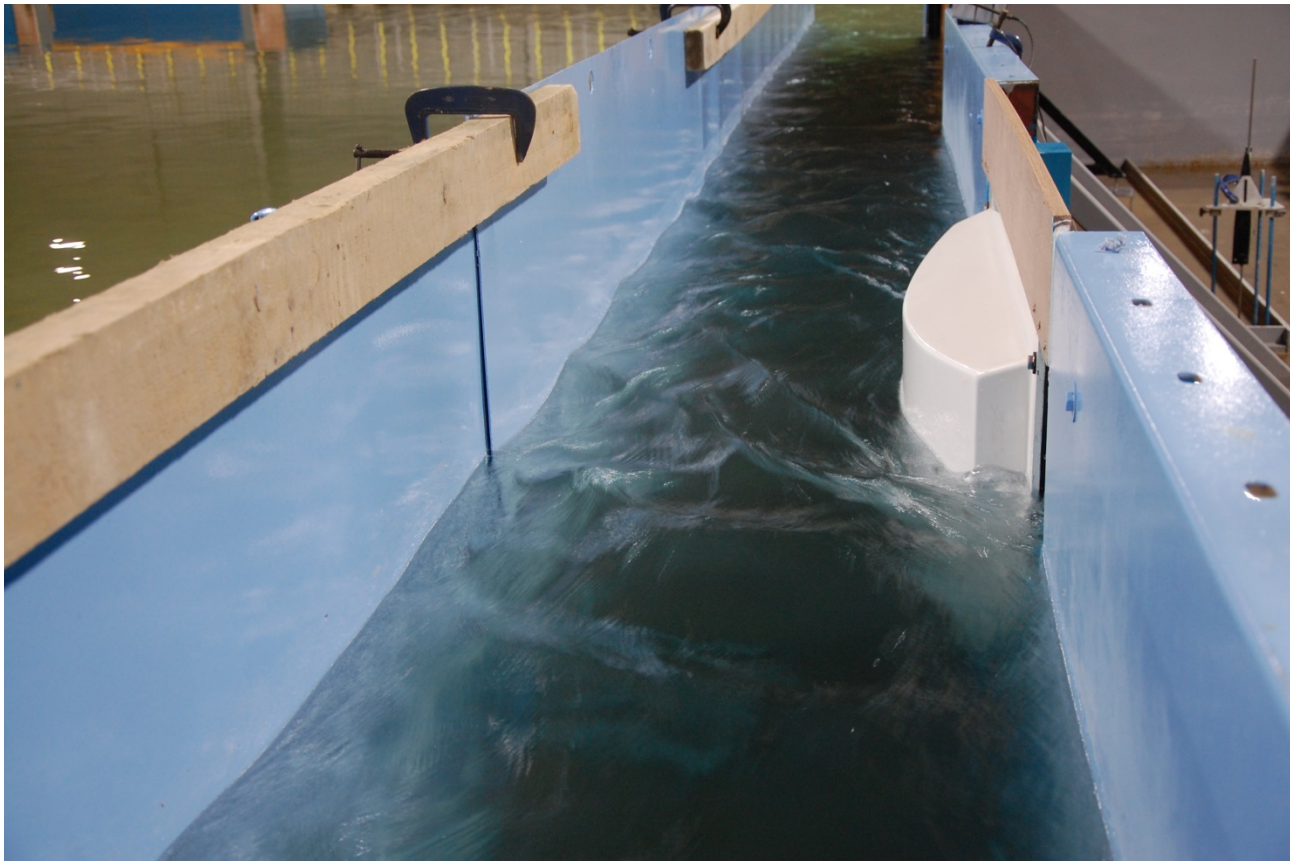

Figure 3.4: View downstream during current testing.

Test Part B.5.4.2 K-01-P2-05: 500mm

The test facility was filled to a depth of 500mm above the invert of the barrier. A total volume of water passing through the seal of 0.002 litres gave a leakage rate of 0.002 l/h/m (an aperture width of 1.16m was measured for this product) so the product was successful in meeting the requirements for this test.

There was no observable deformation of the product during this test part.

Table 3.3: Test Series B.5.1.3 – Current Test Results

Test Part	Water Depth (mm)	Duration (hours)	Aperture Width (m)	Volume of water collected (l)	Leakage Rate (l/h/m)
B.5.4.2	504	1.0	1.16	0.002	0.002

Maximum allowable leakage rate 0.5 l/h/m

3.2. Test Series 2 (B.5.1.4)

Once Test Series B.5.1.3 had been completed the basin was drained, the product removed and the seals were dried and checked for damage. The product was then remounted to its frame and test series B.5.1.4 started.

3.2.1. Static Tests (PAS 1188-1:2014 Section B.5.2)

The static tests were performed in order of increasing water depth in accordance with PAS 1188-4:2014 Section B.5.2. Leakage rates for all the static tests are given in Table 3.4

Test Part B.5.2.3 K-02-P2-01: 1/3 DMWD (200mm)

The test facility was filled to a depth of 200mm above the invert of the barrier. A total volume of water passing through the seal of 0.0 litres gave a leakage rate of <0001 l/h/m (an aperture width of 1.780m was measured for this product) so the product was successful in meeting the requirements for this test

There was no observable deformation of the product during this test part.

Test Part B.5.2.4 K-02-P2-02: 2/3 DMWD (400mm)

The test facility was filled to a depth of 400mm above the invert of the barrier. A total volume of water passing through the seal of 0.0 litres gave a leakage rate of <0001 l/h/m (an aperture width of 1.780m was measured for this product) so the product was successful in meeting the requirements for this test

There was no observable deformation of the product during this test part.

Test Part B.5.2.5 K-02-P2-03: 3/3 DMWD (600mm)

The test facility was filled to a depth of 600mm above the invert of the barrier. A total volume of water passing through the seal of 0.0 litres gave a leakage rate of <0001 l/h/m (an aperture width of 1.160m was measured for this product) was found to pass the seal in the first hour and 0 litres in the final hour, giving a leakage rate of 0 l/h/m. The product was therefore successful in meeting the requirements for this test.

There was no observable deformation of the product during this test part.

Table 3.4: Test Series B.5.1.4 – Static Test Results

Test Part	Water Depth (mm)	Duration (hours)	Aperture Width (m)	Volume of water collected (l)	Leakage Rate (l/h/m)
B.5.2.3	197	1.0	1.16	0.0	<0.001
B.5.2.4	400	1.0	1.16	0.0	<0.001
B.5.2.5 (First Hour)	596	1.0	1.16	0.0	<0.001
B.5.2.5 (Last Hour)	596	1.0	1.16	0.0	<0.001

Maximum allowable leakage rate 0.5 l/h/m

3.2.2. Wave Tests (PAS 1188-1:2014 Section B.5.3)

Test Part B.5.3.3 K-02-P2-04: 450mm

The basin was filled to a depth of 450mm above the invert of the aperture and the waves with a JONSWAP spectrum with significant wave height 100±10mm and mean wave period of 1.03s were generated at a direction perpendicular to the face of the building aperture.

Leakage rates for the wave test are given in Table 3.6.

A total volume of 0.0 litres was recorded passing through the seal giving a leakage rate of <0001 l/h/m aperture width (an aperture width of 1.16m was recorded for this product). The product was therefore successful in meeting the requirements for passing this test.

There was no observable deformation of the product during this test part.

Table 3.5: Test Series B.5.1.4 – Wave Test Results

Test Part	Water Depth (mm)	Duration (hours)	Aperture Width (m)	Volume of water collected (l)	Leakage Rate (l/h/m)
B.5.3.3	452	0.5	1.16	0.0	<0001

Maximum allowable leakage rate 0.5 l/h/m

3.2.3. Current Tests (PAS 1188-1:2014 Section B.5.4)

Test Part B.5.4.2 FA-02-2P-05: 500mm

The test facility was filled to a depth of 500mm above the invert of the barrier. A total volume of water passing through the seal of 0.0 litres gave a leakage rate of <0001 l/h/m (an aperture width of 1.16m was measured for this product) so the product was successful in meeting the requirements for this test.

There was no observable deformation of the product during this test part.

Table 3.6: Test Series B.5.1.4 – Current Test Results

Test Part	Water Depth (mm)	Duration (hours)	Aperture Width (m)	Volume of water collected (l)	Leakage Rate (l/h/m)
B.5.4.2	502	1.0	1.16	0.0	<0001

Maximum allowable leakage rate 0.5 l/h/m

3.3. Test Series 3 (B.5.1.5)

3.3.1. Static Tests (PAS 1188-1:2014 Section B.5.2)

Once test series B.5.1.4 had been completed the basin was drained, the product removed and the seals were dried and checked for damage. The product was then remounted to its frame and test series B.5.1.5 started.. Leakage rates for all the static tests are given in Table 3.7

Test Part B.5.2.3 K-03-P2-01: 1/3 DMWD (200mm)

The test facility was filled to a depth of 200mm above the invert of the barrier. A total volume of water passing through the seal of 0.0 litres gave a leakage rate of 0.0 l/h/m (an aperture width of 1.78m was measured for this product) so the product was successful in meeting the requirements for this test.

There was no observable deformation of the product during this test part.

Test Part B.5.2.4 K-03-P2-02: 2/3 DMWD (400mm)

The test facility was filled to a depth of 200mm above the invert of the barrier. A total volume of water passing through the seal of 0.0 litres gave a leakage rate of 0.0 l/h/m (an aperture width of 1.78m was measured for this product) so the product was successful in meeting the requirements for this test.

There was no observable deformation of the product during this test part.

Test Part B.5.2.6 K-03-P2-03: 3/3 DMWD (600mm)

The test facility was filled to a depth of 600mm above the invert of the barrier. A total volume of water passing through the seal of 0 litres gave a leakage rate of 0 l/h/m (an aperture width of 1.160m was measured for this product) was found to pass the seal in the first hour and 0 litres in the final hour, giving a leakage rate of 0 l/h/m overall. The product was therefore successful in meeting the requirements for this test.

There was no observable deformation of the product during this test part.

Table 3.7: Test Series B.5.1.5 – Static Test Results

Test Part	Water Depth (mm)	Duration (hours)	Aperture Width (m)	Volume of water collected (l)	Leakage Rate (l/h/m)
B.5.2.3	197	1.0	1.78	0.0	<0001
B.5.2.4	400	1.0	1.78	0.0	<0001
B.5.2.6 (First Hour)	596	1.0	1.78	0.0	<0001
B.5.2.6 (Last Hour)	596	1.0	1.78	0.0	<0001

Maximum allowable leakage rate 0.5 l/h/m

4. Conclusions

A series of tests were carried out in accordance with the BSI PAS 1188-1:2014 to investigate the performance of the flood products designed and manufactured by Kayron. The products were designed to withstand a design maximum water depth of 600mm above the aperture threshold level. Three test series were carried out, separated by the removal of the products from the frames, allowing them to be dried and reinstalled.

Test Series 1 and 2 tested the product under static water, waves, and current conditions at varying water levels and durations as laid out in sections B.5.1. of BSI PAS 1188-1:2014. Then followed test series 3 where the products were tested under a set of increasing static heads culminating in a 48 hour test at the design maximum water depth (600mm).

The product passed all tests within the acceptable leakage rates for this standard.

The seal demonstrated a small leak throughout much of the testing, however it was very minor. Using a paper towel to absorb and measure the weight of water leaking through the seal proved effective and efficient. It was not clear from where on the seal the leakage occurred.

The maximum recorded leakage rates for each test type were:

- Static Test: 0.007 l/h/m – During test part K-01-P2-03
- Wave Test: 0.003 l/h/m – During test part K-01-P2-04
- Current Test 0.002 l/h/m – During test part K-01-P2-05.

- These rates are well within the maximum allowable leakage rates for this standard of 0.5 l/h/m.

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HR Wallingford, Howbery Park, Wallingford, Oxfordshire OX10 8BA, United Kingdom
tel +44 (0)1491 835381 fax +44 (0)1491 832233 email info@hrwallingford.com
www.hrwallingford.com

FS 516431
EMS 558310
OHS 595357