LABORATORY REPORT

R&D 34 9th August 2010

Improvement in Flood Resilience from the use of Stormdry

The objective of this piece of work was to determine the extent of flood resilience improvement from the application of Stormdry.

Stormdry cream reduces the absorption of water into brick and mortar materials (1) and the question was therefore asked as to whether Stormdry could be of benefit in flood protection. In the test method used to assess water absorption (BS EN ISO 15148:2002), the test piece is placed face down in contact with a small head of 5 mm of water. This is a much less severe case than that found in flooding where a 0.6 metre head of water is more representative (2). An alternative test was devised to reproduce a flooding situation.

Method

In order to conduct the test a small 0.5 x 0.7 m single-skin brick wall was built. The bricks chosen were standard Flettons and the mortar used comprised 5:1 sand:cement with plasticiser as typically used in modern masonry construction. The wall was left for 12 months before test work was started to allow for cement hydration and stabilisation of the structure.

A large scale water pressure tube was constructed to simulate a flood situation as shown in Photo 1. This was built from 12 cm diameter drainage tubing and clear polycarbonate. The tube was then attached to the surface of the wall using a water proof sealant.

The test was started by quickly pouring in water into the tube to a height of 0.6 metres. The flow of water through the wall was then measured by monitoring the reduction in height of the head of water. A series of photographs were taken to record the observations.

Three tests were undertaken;

Test 1 – Untreated wall
Test 2 – Stormdry treated but without repointing
Test 3 – Stormdry treated with Repointing Mortar Additive No.2

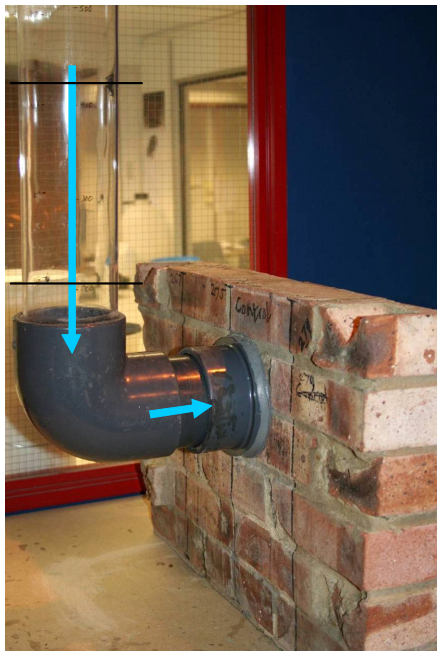


Photo 1: Experimental set-up

Results - Test 1

In the first test water was seen to quickly penetrate the wall. In five seconds water droplets were visible on the rear side. After a few minutes, water could be seen emerging at other locations not necessarily close to the point where the pipe was attached. This indicates the internal passage of water within the wall. Appendix 1 shows some of the pictures taken. Most of the flow of water appeared to be through the brick and mortar interface.

As the head of water was reduced, the flow rate began to slow down consistent with a relationship between flow and pressure. For example, the data obtained in Table 1 shows that the time for the water level to drop from 600 to 500 mm was 208 seconds, and from 300 to 200 mm was 503 seconds.

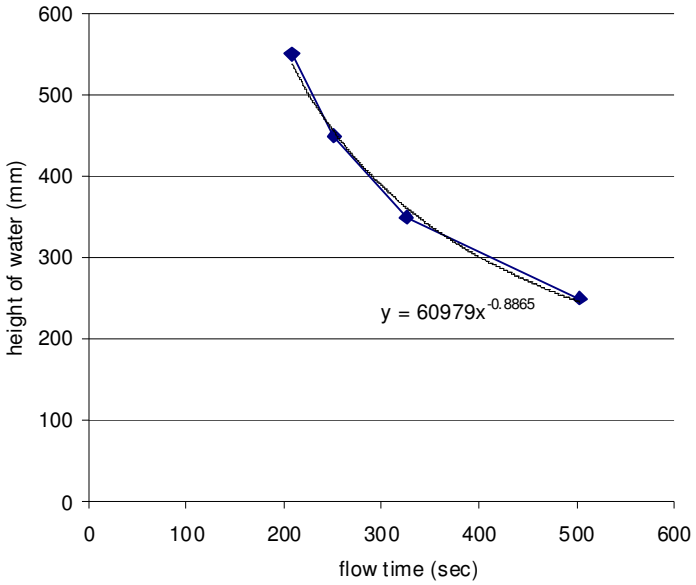
Knowing the dimensions of the tube, it is then possible to calculate the volume flowing into the wall as shown in the table

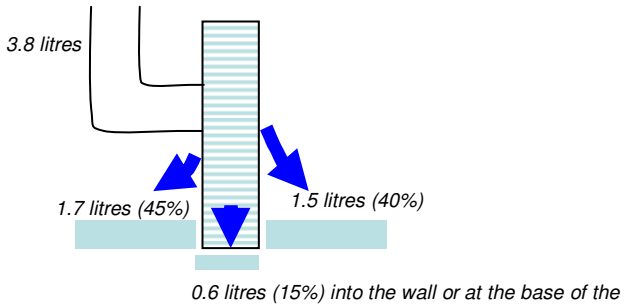
Table 1: Results from the Untreated Wall Test

Height of water(mm)	Time (sec) for water level to reach this height	Flow Rate litres/min	Flow Rate litres/min 40% of this	Flow Rate Litres/min/m2
600	0			
500	208	0.25	0.10	12.5
400	251	0.21	0.08	10.4
300	326	0.16	0.06	8.0
200	503	0.10	0.04	5.2

During the test, not all of the water passed through the wall. Some was observed to come through the front face and bottom of the wall as shown in Figure 1.

Figure 1: The Reduction in Flow with Decreasing Head of Water with a Diagram of Flow Distribution





Bearing in mind that 40% of the water passed through the wall, we can then calculate the volume flow rate. At an average head of 0.55 metres, the flow rate was found to be 12.5 litres/minute/m^2 of wall. Hence, in the case of a flood of height of 0.6 m and a detached house of perimeter of 40 linear metres, the rate of water passing through the wall into the house is 24 x 12.5 = 300 litres/minute. This is for a single skin masonry wall.

Results - Test 2 and 3

After the setting-up test had been completed further testing was done following Stormdry application and repointing with Stormdry Repointing Additive No.2. The results obtained are shown in Table 2.

Table 2: Flood Test Results after Treatment with Stormdry and Repointing No.2

Height of water(mm)	Time for water level to reach this height (seconds)			Flow Rate (litres/min/m2)		
	Untreated	Stormdry alone	Stormdry with Repointing No.2	Untreated	Stormdry alone	Stormdry with Repointing No.2
600	0	0	0			
500	208	214	90000	12.5	12.2	0.03
400	251	302		10.4	8.6	0.03
300	326	529		8.0	4.9	0.03
200	503	1115		5.2	2.3	0.03

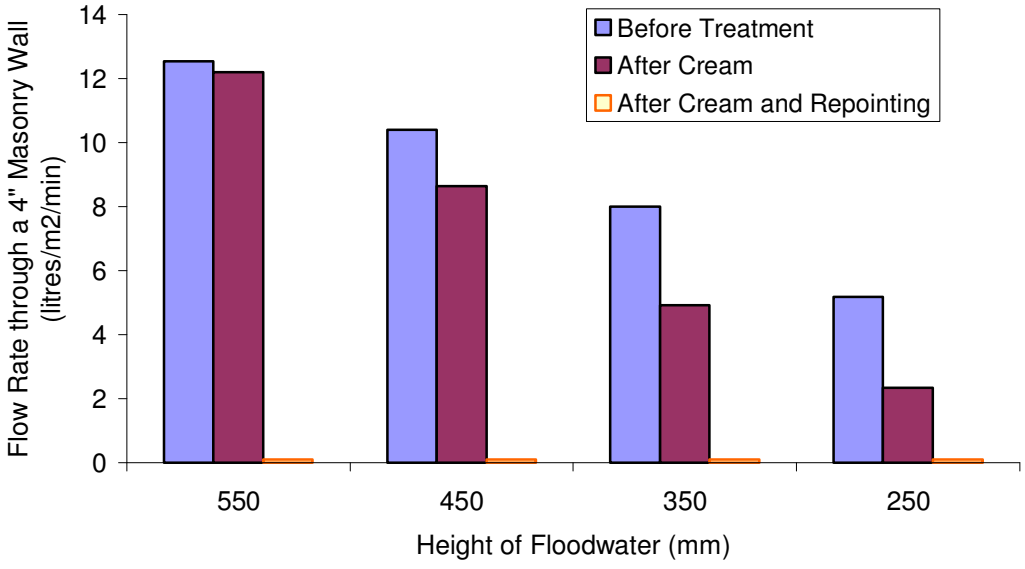
It can be seen from the data that;

(i) Stormdry alone results in some benefit at low flood water heights of 0.2 to 0.4 metres. At higher pressures, there is little effect.

(ii) Stormdry with Repointing Additive No.2 makes a significant difference at all heights. Nearly no water passes through the wall after this treatment even at the high pressures of 0.6 metres. This indicates that much of the passage of water is through the mortar-brick interface.

This is shown graphically in Figure 2.

Figure 2: The reduction in water flow through a wall after treatment with Stormdry Masonry Cream and Repointing Additive



Discussion and Conclusion

The work has shown that water penetrates very quickly through a 4" standard Fletton brick wall. The predominant flow appears to be through the brick and mortar interface, especially at the straight joint at the lower face of the brick. There was less evidence of water flow through the frogged joint which has a more complex profile and would be expected to be the more robust of the two joints.

It is known that shrinkage of mortar is a long term process. Irreversible drying shrinkage in cement occurs by more than one mechanism but is generally associated with reduced spacing in the cement gel (see Soroka reference below*). This effect is diluted by the addition of sand to the mortar but still exists. The small shrinkage results in stress at the interface with the brick, eventually leading to debonding.

The application of Stormdry Cream alone gives some improvement to the position. However, the cream is unable to provide an effective seal to the interfacial cracks that dominate the situation. After repointing the flood resistance improves as the interfacial cracks are now sealed and water flow is effectively eliminated.

The work demonstrates that it is possible to significantly reduce the flow of floodwater into a property. The repointing additive used here is a polymer modified mortar and has been formulated to provide good adhesion to brick surfaces.

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6/8/2010

Copies:
Safeguard Internal

** "Portand Cement Paste and Concrete" I. Soroka MacMillan Press - London 1979*

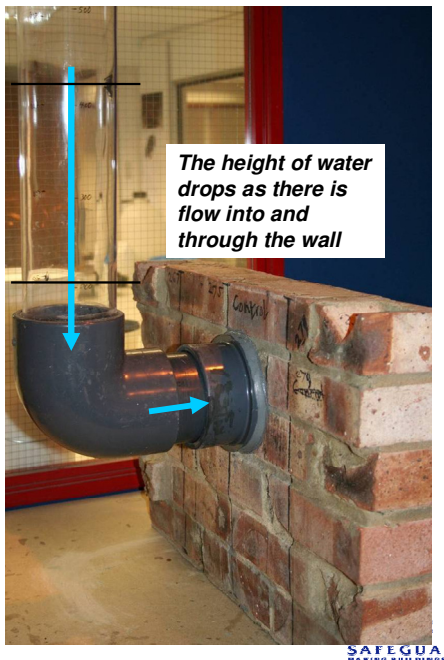
Appendix 1: Powerpoint Slides Showing the set-up and Results

Flood Resistance Tests – Test set-up and results on a brick wall

The idea of the test was to measure the extent of flood water flow through a wall and determine how this can be reduced

A 100mm diameter tube was attached to a brick wall (Flettons with brick-laying mortar 5:1 sand:cement)

A clear plastic pipe was attached. Water was filled to a height of 0.6m



er 14/1/10 file: flood resistance test set-up

Flood Resistance Tests – Test set-up and results on a brick wall

Water penetrates through the wall in a few seconds

After a few minutes, leaks spread into new areas away from where the pipe was.

er 14/1/10 file: flood resistance test set-up

Flood Resistance Tests – Test set-up and results on a brick wall

Although the joint looks sound, water penetrates at the lower brick-mortar interface. This is the weak **point** as this is a flat interface at the bottom of the brick (no frog)

Water also penetrates through cracks in the bricks

er 14/1/10 file: flood resistance test setup

View of wall and repointing after dismantling at the end of the test

Appendix 2: Comparison between Treated and Untreated at Different Test Times

Untreated	Treated	
		1 min
		5 mins
		12 mins
		35 mins