TEST REPORT

Lucideon Reference:	174885 (QT-47281/1/GMB)/Ref. 1/CR1
Project Title:	Hygrothermal Testing in Accordance with ETAG 034:2012 Kits for External Wall Claddings
Client:	Telling Architectural Ltd 7 The Dell Enterprise Drive Four Ashes Wolverhampton WV10 7DF
For the Attention of:	Mr Mike Wood
Author(s):	Miss Lisa Cobden
Report Date:	29 January, 2018
Purchase Order No.:	008789
Work Location:	Lucideon UK

This report supersedes the report issued on 16.01.18.

Miss Joanne Booth
Consultancy Team
Reviewer

Miss Lisa Cobden
Consultancy Team
Project Manager

Lucideon Limited
Queens Road, Penkhull
Stoke-on-Trent
Staffordshire ST4 7LQ

T +44 (0)1782 764428
enquiries@lucideon.com
www.lucideon.com

CONTENTS

1 INTRODUCTION

Telling Architectural Ltd required a programme of testing in order to investigate the durability of a Grade 18 Brick Faced GRC panel, proposed for 19 Colville Estate Balcony Soffits for Higgins Construction. The sample was subjected to Accelerated Weathering in accordance with ETAG 034:2012 followed by a Freeze Thaw regime in accordance with TS EN 772-22.

2 TEST PROGRAMME

The test specimen was constructed by the client, submitted as a finished sample and was subjected to the following tests:

- **Hygrothermal performance in accordance with Clause 5.4.6 of ETAG 034**. One full size wall was tested of nominal dimensions 2015mm x 2475mm (h x w).
- **Freeze thaw in accordance with TS EN 772-22**. One full size wall was tested of nominal dimensions 2015mm x 2475mm (h x w).
- **Bond strength test in accordance with Clause 5.1.4.1.1 of ETAG 034** 5 No. Samples were pulled from the full size wall after weathering.
- **Hard body impact tests in accordance with Clause 5.4.4.1 of ETAG 034**. These were undertaken at energy levels of 3 Joules and 10 Joules on the full size wall after weathering.
- **Soft body impact tests in accordance with 5.4.4.2 of ETAG 034**. These were undertaken at energy levels of 300 and 400 Joules on the full size wall after weathering.

3 TEST SAMPLES

1 No. 2015 mm x 2475 mm (h x w) Grade 18P Brick Faced GRC panel, proposed for 198 Colville Estate.

4 TEST METHOD

4.1 Hygrothermal Wall

The wall frame was centrally clamped to the face of a 2.4 m high x 3.0 m test aperture.

Testing was carried out in accordance with the method described for Hygrothermal Performance in ETAG 034 2012 and Freeze Thaw Performance in accordance with TS EN 772-22. The testing involved subjecting the panel to repeated heat-rain cycles followed by repeated heat-cold cycles at controlled humidity conditions designed to simulate naturally occurring conditions followed by Wet Freeze:

4.1.1 Weathering Cycles

The panel was subjected to cyclic heat-rain, heat-cold and freeze thaw cycles according to the following programme.

4.1.2 Heat Rain - 80 Cycles

Heating to 70°C rising over 1 hour and maintaining at 70°C ± 5 at 10-30% RH for a further 2 hours.

Followed by spraying with water (water temp 15 ± 5°C) at 1 l/m^2/min for 1 hour.

Draining for 2 hours.

On completion of the heat rain cycles the wall was conditioned for 48 hours at a temperature between 10 and 25°C with a minimum RH of 50%.

4.1.3 Heat Cold – 5 Cycles

Exposure to 50ºC ± 5 with a rise of 1 hour and maximum 30%RH for 7 hours.

Exposure to -20°C ± 5 with a fall over 2 hours and hold for 14 hours.

The test panel was inspected every 4 heat rain cycles and daily under the heat cold cycles to observe changes in the visual characteristics of the panel.

On completion of the cyclic testing the wall was left to dry for 7 days.

4.1.4 Freeze Thaw – TS EN 772-22

After at least 48 hours of subsequent conditioning at temperatures between 10 and 25°C and a minimum relative humidity of 50%, the same test rig being exposed to a series of 100 cycles of 24 hours comprising of the following phases:

- Exposure to (20 ± 3)°C for 20 minutes.
- Spraying for 2 minutes.
- Exposure to (-15 ± 3)°C for 2 hours.

Visual observation was carried out after 25 and 100 freeze/thaw cycles.

Condition the test wall initially by wetting for 8 hours with water at a temperature of (15 ± 5)°C.

4.2 Bond Strength Testing

Five No. 210 mm x 64 mm brick slips were tested to determine bond strength. A steel plate was bonded to the area with an epoxy resin and allowed to cure for 24 hours. A centralised tensile load was provided to the plate at a rate of 1 to 10 mm/minute through a studded bar attached to a hydraulic ram and load cell arrangement.

Bond strength, σ_B was determined using the tensile load at failure, f and the area of the plate, A, according to the equation below.

$$\sigma_B = f/A$$

4.3 Hard Body Impact Testing

Testing was carried out based on ISO 7892 Vertical building elements - impact resistance tests – impact bodies and general test procedures.

The wall was laid down in the structures laboratory. A 1 Kg steel ball was allowed to impact the face of the panel at a height of 1020 mm to give an impact energy of 10 Joules. A 0.5 Kg ball was allowed to impact the face of the panel from a height of 610 mm to give an impact energy of 3 Joules. Care was taken during the test not to allow the ball to impact the same spot more than once.

Test positions were chosen as to be the most onerous. On completion of each impact using digital callipers, the diameter of the impact area was measured and recorded. The presence of any cracks at the impact point and at the circumference was noted.

4.4 Soft Body Impact Testing

Testing was carried out in accordance with ISO 7892 Vertical building elements - impact resistance tests – impact bodies and general test procedures.

The test wall in a vertical position was restrained around its perimeter against a large steel reaction frame which was bolted to the laboratory floor.

A rigid scaffold framework was constructed to hold the impactor such that the centre of the soft body impactor was aligned with the geometric centre of the Brick Faced GRC panel. The geometric centre was chosen as the most onerous position.

The scaffold framework was then extended to provide a pulley point to retract the impactor.

The soft body impactor consisted of a leather bag containing 50 Kg of glass beads and was suspended from a 3000 mm steel wire. The bag was swung from differing drop heights to give a range of impact energies as given in Table 1.

Table 1 - Impact Energies

Impact Energy (J)	Distance from Face of Wall (mm)	Drop Height (mm)
300	1430	600
400	1600	800

The impactor was pulled back to the desired distance from the face of the wall, using a steel cable, and then released.

5 RESULTS

5.1 Hygrothermal Walls

According to Section 6.4.6 of ETAG 034:2012 and TS EN 772-22 the performance requirements of the large scale hygrothermal test is that the following defects should neither occur during, nor at the end of the test programme:

- Deterioration such as cracking or delamination of the cladding element that allows water penetration to the insulation.
- Detachment of the cladding element.
- Irreversible deformation.

5.1.1 Results

Upon completion of the weathering and freeze/thaw cycles the panel was visually inspected to determine if any deterioration had taken place.

Visual inspection concluded that there was no damage to the Grade 18P GRC Panel.

5.2 Bond Strength Testing

The failure loads and tensile strengths for each of the samples are recorded in Table 3.

Plate 1 shows the failure mode of the brick slips and test locations seen in Plate 7. In all instances failure occurred within the face of the brick slip. This indicates that the bond between the brick slip and substrate is stronger than that of the brick slip itself.

5.3 Hard Body Impact Testing

The results of the hard body impact testing carried out at both 3 Joules and 10 Joules energy are given in the Table 4. Typical damage can be seen in Plate 2 with test locations seen in Plate 7.

According to Table 5 of Section 6.4.4 of ETAG 034:2012 the systems can be categorised as follows:

Catergory III

Category III definition is as follows:

> "A zone not likely to be damaged by normal impacts caused by people or by thrown or kicked objects."

5.4 Soft Body Impact Testing

The results of the soft body impact testing carried out at both 300 Joules and 400 Joules energy are given in Table 2.

Table 2 – Results of Soft Body Impact

Impact Energy (J)	Observations
300	No damage recorded
400	No damage recorded

Visual inspection concluded that there was no damage to the Grade 18P GRC Panel.

BS 8200:1985 Code of Practice for Design of non-loadbearing external vertical enclosures of buildings is a withdrawn standard but is still widely recognised within the construction industry.

When the panel was tested in accordance with ISO 7892 and classified in accordance with BS 8200 the panel achieved a Classification B – Readily accessible to public and others with little incentive to exercise care. Chances of accident occurring and of misuse.

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

END OF REPORT

RESULTS TABLES

Bond Strength Testing

Table 3 - Results of Bond Strength Tests Carried Out on the wall after Subjecting to Hygrothermal Action

Test Specimen	Maximum Failure Load (kN)	Tensile Strength (N/mm^2)	Failure Mode
1	5.38	0.40	Within the face of the brick slip
2	5.29	0.39	Within the body of the brick slip
3	5.17	0.38	Within the body of the brick slip
4	7.13	0.53	Within the body of the brick slip
5	6.87	0.51	Within the face of the brick slip
Mean	**5.97**	**0.44**	**-**

Hard Body Impact Testing

Table 4 - Results of Impact Tests Carried Out on the Wall after Subjecting to Hygrothermal Action

Location	Diameter under 3 Joules Impact Energy (mm)	Cracking	Circumference of Cracking (°)	Diameter under 10 Joules Impact Energy (mm)	Cracking	Circumference of Cracking (°)
1	17.89	Corner of Brick Slip	360	21.67	Corner of Brick Slip	360
2	17.00	Damage to Edge of Brick Slip	360	23.87	Cracking of adjacent mortar joint	360
3	9.82	Damage Corner of Brick Slip	360	11.07	Cracking of adjacent mortar joint	360

APPENDIX 1 - Test Photos

Plate 1 - Typical Failure Modes Bond Strength

Plate 2 - Typical Damage Hard Body Impact Testing

Plate 3 - Face of Panel Prior to Test

Plate 4 - Rear of Panel Prior to Test

Plate 5 - Front of Panel after Test

Plate 6 - Rear of Panel after to Test

Plate 7 - Panel after Impact and Bond Strength Testing