# Wind load and impact testing of a sample of Rainscreen Cladding using a TI-Tracking Carrier Frame

Report No. N950/10/16184

Presented By

**Technology Centre**

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# Technical Report

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|---|---|
| **Title** | **Wind load and impact testing of a sample of Rainscreen Cladding using a TI-Tracking Carrier Frame** |
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| **Distribution** (confidential) | - 1 copy to TC central area for archive<br>- 1 copy to TC project file<br>- 1 copy to T. I. Tiles International | |
| **Abstract** | | |



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UKAS TESTING
0057

TECHNOLOGY CENTRE

## CONTENTS

## 1. INTRODUCTION

This report describes tests carried out at the Technology Centre at the request of T.I. Tiles International Limited, Westview House, Devro Campus, Gartferry Road, Moddiesburn, Glasgow G69 OJE.

The test sample consisted of a Rainscreen Cladding sample on a Ti-tracking carrier frame.

Technology Centre is accredited by the United Kingdom Accreditation Service as UKAS Testing Laboratory No.0057 and is also approved with BSI Management Systems for ad-hoc in-service inspections and tests to ISO 9001.

The tests were carried out in April 2010 and were to determine the weathertightness of the test sample. The test methods were in accordance with the CWCT Standard Test Methods for building envelopes, 2005, for:

Wind resistance – serviceability, cyclic loading & safety.

The sample was also subjected to the following non UKAS accredited tests in accordance with the Technology Centre Quality System:

Impact resistance (BS 8200)

The testing was carried out in accordance with Technology Centre Method Statement C3468/MS rev 0.

This test report relates only to the actual sample as tested and described herein.

The results are valid only for the conditions under which the tests were conducted.

The tests were witnessed in part by:

Phil Harwood - T.I. Tiles International

# 2. DESCRIPTION OF TEST SAMPLE

## 2.1 GENERAL ARRANGEMENT

The sample was as shown in the photo below and the drawing included as an appendix to this report.

The test sample comprised of an array of rainscreen panels 1500mm wide by 600mm high and 1200mm wide by 600mm high set in a landscape style.

The panels from bottom to top were three number black polished Aerolite Granite panels 15mm thick c/w fiberglass reinforced backing 1500mm wide by 600mm high; followed by three number white Urban Glass panels 15mm thick c/w fiberglass reinforced backing 1500mm wide by 600mm high.

The next two rows of panels were white Fibreform G (GRC) panels 15mm thick c/w aluminium fixing channel insert 1500mm wide by 600mm high; the next row up comprised of two number Urban Glass panels as above and one number Aerolite Granite panel as above.

The next two proceeding rows up comprised of eight number Engineered Ston CB panels 15mm thick c/w fiberglass reinforced backing 1200mm wide by 600mm high; the top and last product on the test rig was four number Engineered Ston panels 15mm thick 1200mm wide by 600mm high.

The panels had special rebated longitudinal edges that enabled them to engage into the horizontal TI-Tracking carrier rail which were spaced at 600mm module (see dwg in appendix).

The horizontal Ti-Tracking carrier rails were tek screw fixed to vertical spanning 1.6mm galvanized steel inverted top-hats 30mmx30mmx80mmx30mmx30mm at 600mm centres which were tek fixed through to an appropriately designed backing structure. This comprised vertical spanning channel sections faced with 20mm thick plywood externally.

PHOTO 3160041

TEST SAMPLE ELEVATION

PHOTO 7010014

CARRIER FRAME FIXINGS INTO VERTICAL TOP-HAT SUPPORT

PHOTO 7010015

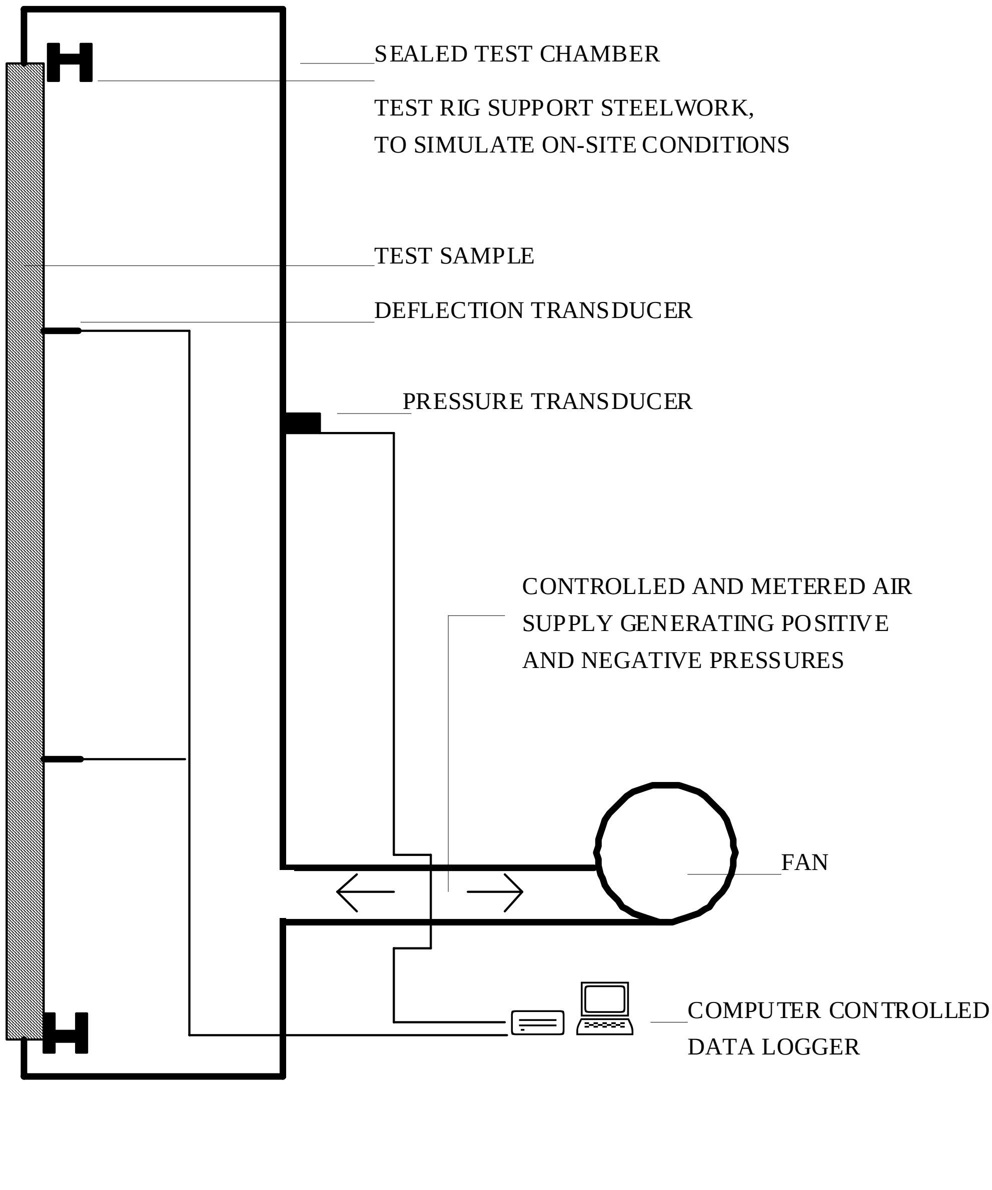
GROOVE IN EDGE OF TILE RESTING ON CARRIER FRAME

## 3. TEST RIG SCHEMATIC ARRANGEMENT

The test sample was mounted on a rigid test rig with support steelwork designed to simulate the on-site/project conditions. The test rig comprised a well sealed chamber, fabricated from steel and plywood. A door was provided to allow access to the chamber. Representatives of T.I. Tiles International installed the sample on the test rig. See Figure 1.

FIGURE 1

TYPICAL TEST RIG SCHEMATIC ARRANGEMENT




*SECTION THROUGH TEST RIG*

## 4. TEST SEQUENCE

The test sequence was as follows:

(1) Wind resistance – serviceability

(2) Wind resistance – cyclic loading

(3) Wind resistance – safety

(4) Impact resistance

# 5. SUMMARY AND CLASSIFICATION OF TEST RESULTS

The following summarises the results of the tests carried out. For full details refer to Sections 6 and 7.

## 5.1 SUMMARY OF TEST RESULTS

TABLE 1

| Date | Test number | Test description | Result |
|---|---|---|---|
| 7 April 2010 | 1 | Wind resistance – serviceability | Pass |
| 7 – 8 April 2010 | 2 | Wind resistance – cyclic loading | Pass |
| 8 April 2010 | 3 | Wind resistance – safety | Pass |
| 17 April 2010 | 4 | Impact resistance | *Pass |

*Please see results on page 25 for pass categories.

## 5.2 CLASSIFICATION

TABLE 2

| Test | Standard | Classification / Declared value |
|---|---|---|
| Wind resistance | CWCT | ±2400 pascals serviceability<br>±3600 pascals safety |

# 6. WIND RESISTANCE TESTING

## 6.1 INSTRUMENTATION

### 6.1.1 Pressure

One static pressure tapping was provided to measure the chamber pressure and was located so that the readings were unaffected by the velocity of the air supply into or out of the chamber.

A pressure transducer, capable of measuring rapid changes in pressure to within 2% was used to measure the differential pressure across the sample.

### 6.1.2 Deflection

Displacement transducers were used to measure the deflection of principle framing members to an accuracy of 0.1 mm. The gauges were set normal to the sample framework at mid-span and as near to the supports of the members as possible and installed in such a way that the measurements were not influenced by the application of pressure or other loading to the sample. The gauges were located at the positions shown in Figure 2.

### 6.1.3 Temperature

Platinum resistance thermometers (PRT) were used to measure air temperatures to within 1°C.

### 6.1.4 General

Electronic instrument measurements were scanned by a computer controlled data logger, which also processed and stored the results.

All measuring instruments and relevant test equipment were calibrated and traceable to national standards.

## 6.2 FAN

The air supply system comprised a variable speed centrifugal fan and associated ducting and control valves to create positive and negative static pressure differentials. The fan provided essentially constant air flow at the fixed pressure for the period required by the tests and was capable of pressurising at a rate of approximately 600 pascals in one second.

## 6.3 PROCEDURE

**Note:** For the following three wind load tests the joints between the tiles were sealed over with tape. This was then taken off for the water and impact tests.

### 6.3.1 Wind Resistance – serviceability

Three positive pressure differential pulses of 1200 pascals were applied to prepare the sample. The displacement transducers were then zeroed.

The sample was subjected to one positive pressure differential pulse from 0 to 2400 pascals to 0. The pressure was increased in four equal increments each maintained for 15 ±5 seconds. Displacement readings were taken at each increment. Residual deformations were measured on the pressure returning to zero.

Any damage or functional defects were recorded.

The test was then repeated using a negative pressure of -2400 pascals.

### 6.3.2 Wind Resistance – cyclic loading

The following cyclic load tests were carried out on the sample.

| No of cycles | Applied pressure (pascals) |
|---|---|
| 1 | 0.9 x $W_P$ = -2160 |
| 960 | 0.4 x $W_P$ = -960 |
| 60 | 0.6 x $W_P$ = -1440 |
| 240 | 0.5 x $W_P$ = -1200 |
| 5 | 0.8 x $W_P$ = -1920 |
| 14 | 0.7 x $W_P$ = -1680 |

Where $W_P$ = design wind load

The sequence above was repeated for a total of five times and then a single pulse of $W_p$ (-2400 pascals) was applied.

The frequency of oscillation was seven seconds between loading, with loading applied in a sinusoidal manner.

Deflection readings measured at the locations shown in Figure 2 were taken at regular intervals.

### 6.3.3 Wind Resistance – safety

Three positive pressure differential pulses of 1200 pascals were applied to prepare the sample. The displacement transducers were then zeroed.

The sample was subjected to one positive pressure differential pulse from 0 to 3600 pascals to 0. The pressure was increased as rapidly as possible but not in less than 1 second and maintained for 15 ±5 seconds. Displacement readings were taken at peak pressure. Residual deformations were measured on the pressure returning to zero.

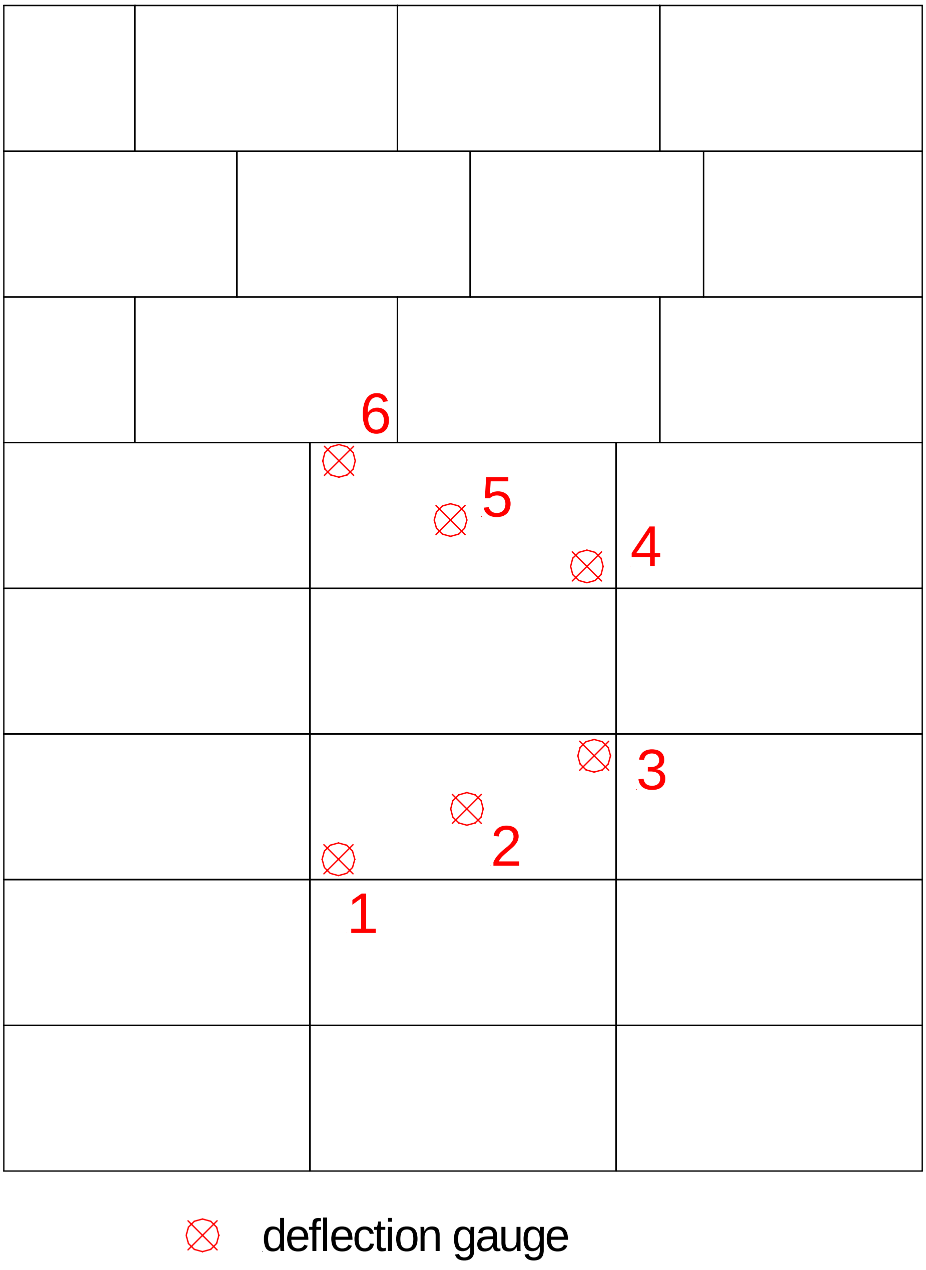
Any damage or functional defects were recorded.

The test was then repeated using a negative pressure of –3600 pascals.

FIGURE 2

DEFLECTION GAUGE LOCATIONS

External View



## 6.4 PASS/FAIL CRITERIA

### 6.4.1 Calculation of permissible deflection

| Gauge number | Member | Span (L) (mm) | Permissible deflection (mm) | Permissible residual deformation |
|---|---|---|---|---|
| 2 | Panel | 1500 | L/360 = 4.1 | 1 mm |
| 5 | Panel | 1500 | L/360 = 4.1 | 1 mm |

## 6.5 RESULTS

**Test 1 (serviceability)** Date: 7 April 2010

The deflections measured during the wind resistance test, at the positions shown in Figure 2, are shown in Tables 3 and 4.

**Summary Table:**

| Gauge number | Member | Pressure differential (Pa) | Measured deflection (mm) | Residual deformation (mm) |
|---|---|---|---|---|
| 2 | Panel | 2399<br>-2411 | 0.0<br>-0.6 | 0.0<br>0.1 |
| 5 | Panel | 2399<br>-2411 | 0.6<br>-1.0 | 0.0<br>0.2 |

No damage to the test sample was observed.

Ambient temperature = 8°C
Chamber temperature = 10°C

**Test 2 (cyclic wind)** Date: 7 -8 April 2010

The deflections measured towards the end of the cyclic load test, at the positions shown in Figure 2, are shown in Table 5.

No damage to the test sample was observed.

Ambient temperature = 8 - 12°C
Chamber temperature = 9 - 14°C

**Test 3 (safety)** Date: 8 April 2010

The deflections measured during the structural safety test, at the positions shown in Figure 2, are shown in Table 6.

No damage to the sample was observed.

Ambient temperature = 12°C
Chamber temperature = 14°C

TABLE 3

WIND RESISTANCE – POSITIVE **SERVICEABILITY** TEST RESULTS

| Position | Pressure (pascals) / Deflection (mm) | | | | |
|---|---|---|---|---|---|
| | 600 | 1201 | 1821 | 2399 | Residual |
| 1 | 0.5 | 0.9 | 1.2 | 1.5 | 0.0 |
| 2 | 0.5 | 1.0 | 1.4 | 1.8 | 0.0 |
| 3 | 0.6 | 1.1 | 1.6 | 2.2 | 0.1 |
| 4 | 0.5 | 1.1 | 1.7 | 2.4 | 0.1 |
| 5 | 0.6 | 1.2 | 1.9 | 2.5 | 0.1 |
| 6 | 0.3 | 0.7 | 1.0 | 1.4 | 0.1 |
| 2 * | 0.0 | -0.1 | 0.0 | 0.0 | 0.0 |
| 5* | 0.2 | 0.3 | 0.5 | 0.6 | 0.0 |

* Mid-span reading adjusted between end support readings

TABLE 4

WIND RESISTANCE – NEGATIVE **SERVICEABILITY** TEST RESULTS

| Position | Pressure (pascals) / Deflection (mm) | | | | |
|---|---|---|---|---|---|
| | -593 | -1204 | -1820 | -2411 | Residual |
| 1 | -0.6 | -1.2 | -2.1 | -3.0 | -0.2 |
| 2 | -0.8 | -1.8 | -2.9 | -4.0 | -0.1 |
| 3 | -0.8 | -1.7 | -2.7 | -3.8 | -0.3 |
| 4 | -0.6 | -1.4 | -2.3 | -3.3 | -0.3 |
| 5 | -0.8 | -1.8 | -3.1 | -4.3 | -0.1 |
| 6 | -0.6 | -1.4 | -2.3 | -3.3 | -0.3 |
| 2 * | -0.1 | -0.4 | -0.5 | -0.6 | 0.1 |
| 5 * | -0.2 | -0.5 | -0.7 | -1.0 | 0.2 |

* Mid-span reading adjusted between end support readings

TABLE 5

WIND RESISTANCE – CYCLIC TEST RESULTS

| **Position** | **Pressure (pascals) / Deflection (mm)** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **-2164** | **-960** | **-1461** | **-1215** | **-1950** | **-1678** | **Residual** |
| **1** | -2.5 | -1.1 | -1.9 | -1.7 | -2.6 | -2.3 | -0.3 |
| **2** | -3.6 | -1.7 | -2.5 | -2.2 | -3.5 | -3.1 | -0.3 |
| **3** | -3.5 | -1.7 | -2.7 | -2.4 | -3.5 | -3.1 | -0.6 |
| **4** | -2.9 | -1.4 | -2.3 | -2.1 | -3.1 | -2.8 | -0.7 |
| **5** | -3.5 | -1.5 | -2.0 | -1.9 | -3.5 | -3.1 | 0.0 |
| **6** | -2.5 | -1.0 | -1.6 | -1.4 | -2.3 | -2.0 | 0.0 |
| **2 *** | -0.6 | -0.3 | -0.2 | -0.2 | -0.4 | -0.4 | 0.1 |
| **5 *** | -0.8 | -0.3 | -0.1 | -0.2 | -0.8 | -0.7 | 0.3 |

* Mid-span reading adjusted between end support readings

TABLE 6

WIND RESISTANCE - **SAFETY** TEST RESULTS

| **Position** | **Pressure (pascals) / Deflection (mm)** | | | |
|---|---|---|---|---|
| | **3599** | **Residual** | **-3603** | **Residual** |
| **1** | 2.3 | 0.1 | -4.8 | -0.4 |
| **2** | 2.9 | 0.2 | -6.2 | -0.4 |
| **3** | 3.4 | 0.2 | -5.8 | -0.5 |
| **4** | 3.8 | 0.3 | -4.9 | -0.4 |
| **5** | 3.9 | 0.3 | -6.6 | -0.3 |
| **6** | 2.5 | 0.4 | -5.2 | -0.6 |
| **2 *** | 0.0 | 0.0 | -0.9 | 0.1 |
| **5 *** | 0.8 | -0.1 | -1.6 | 0.2 |

* Mid-span reading adjusted between end support readings

# 7. IMPACT TESTING

## 7.1 IMPACTOR

### 7.1.1 Soft body

The soft body impactor comprised a canvas spherical/conical bag 400 mm in diameter filled with 3 mm diameter glass spheres with a total mass of approximately 50 kg suspended from a cord at least 3 m long.

### 7.1.2 Hard body

The hard body impactor was a solid steel ball of 50 mm or 62.5 mm diameter and approximate mass of 0.5 kg or 1.0 kg.

## 7.2 PROCEDURE (BS 8200:1985)

### 7.2.1 Soft body

The impactor almost touched the face of the sample when at rest. It was swung in a pendular movement to hit the sample normal to its face. The test was performed at the locations shown in Figure 3. The impact energies were 120, 350 and 500 Nm.

### 7.2.2 Hard body

The impactor almost touched the face of the sample when at rest. It was swung in a pendular movement to hit the sample normal to its face. The test was performed at the locations shown in Figure 4. The impact energies were 3, 6 and 10 Nm.

## 7.3 PASS/FAIL CRITERIA

### 7.3.1 At impact energies for retention of performance

There shall be no failure, significant damage to surface finish or significant indentation.

### 7.3.2 At impact energies for safety

The structural safety of the building shall not be put at risk, no parts shall be made liable to fall or to cause serious injury to people inside or outside the building. The soft body impactor shall not pass through the wall. Damage to the finish and permanent deformation on the far side of the wall may occur.

## 7.4 RESULTS

**Test 5** Date: 17 April 2010

### 7.4.1 Soft body

**Impact location 1**

120 Nm – No damage was observed.

350 Nm – No damage was observed.

500 Nm – No damage was observed.

**Impact location 2**

120 Nm – No damage was observed.

350 Nm – No damage was observed.

500 Nm – No damage was observed.

**Impact location 3**

120 Nm – No damage was observed.

350 Nm – No damage was observed.

500 Nm – A small chip in the top left-hand corner was observed.

**Impact location 4**

120 Nm – No damage was observed.

350 Nm – No damage was observed.

500 Nm – No damage was observed.

**Impact location 5**

120 Nm – No damage was observed.

350 Nm – No damage was observed.

500 Nm – The panel broke.

Ambient temperature = 7°C

### 7.4.2 Hard body

**Impact location 1**

3 Nm – No damage was observed.

6 Nm – No damage was observed.

**Impact location 2**

3 Nm – No damage was observed.

6 Nm – A very small indent was observed.

**Impact location 3**

3 Nm – No damage was observed.

6 Nm – No damage was observed.

**Impact location 4**

3 Nm – No damage was observed.

6 Nm – No damage was observed.

**Impact location 5**

3 Nm – No damage was observed.

6 Nm – No damage was observed.

10 Nm – No damage was observed.

**Impact location 6**

10 Nm – A small indent was observed in the panel.

**Impact location 7**

10 Nm – No damage was observed.

**Impact location 8**

10 Nm – A small indent was observed in the panel.

**Impact location 9**

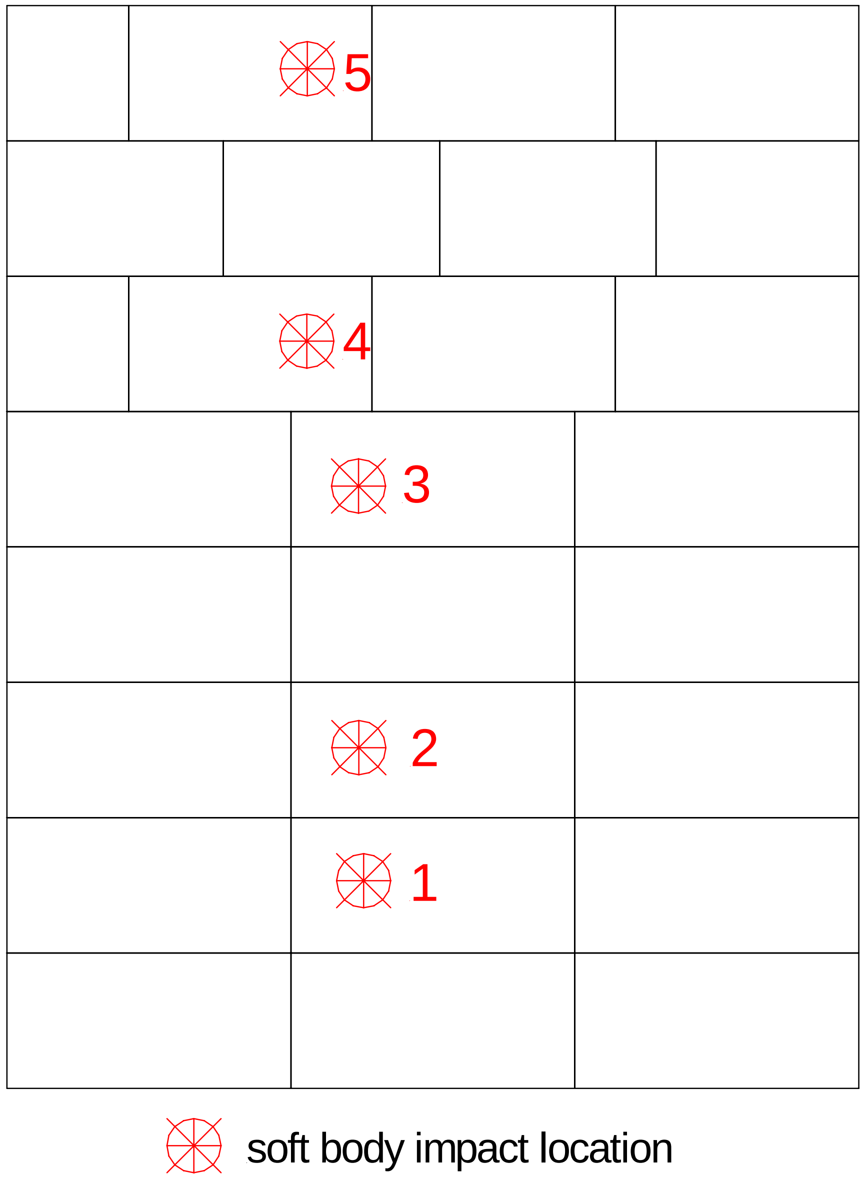
10 Nm – No damage was observed.

Ambient temperature = 7°C

FIGURE 3

SOFT BODY IMPACT TEST LOCATIONS

External View



SOFT BODY IMPACT TEST LOCATIONS

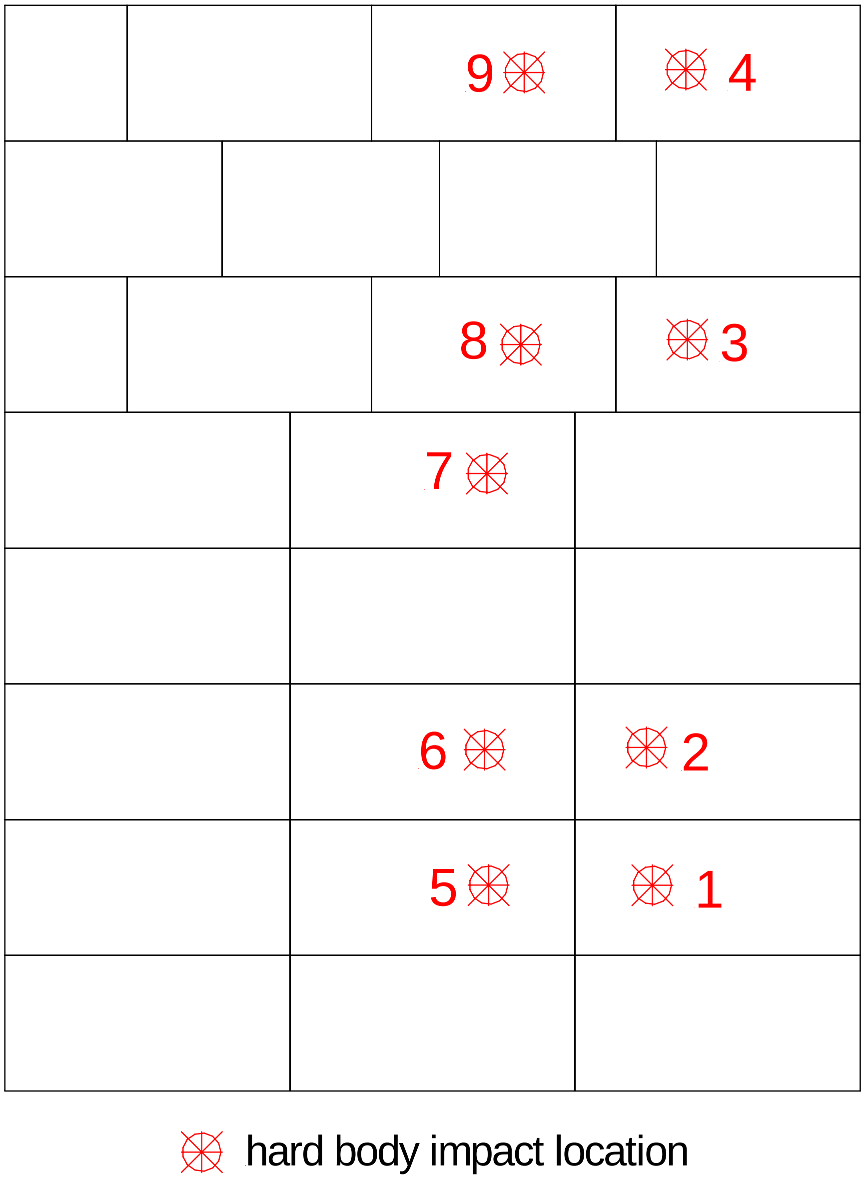
External View

○ Soft body impact location

FIGURE 4

HARD BODY IMPACT TEST LOCATIONS

External View



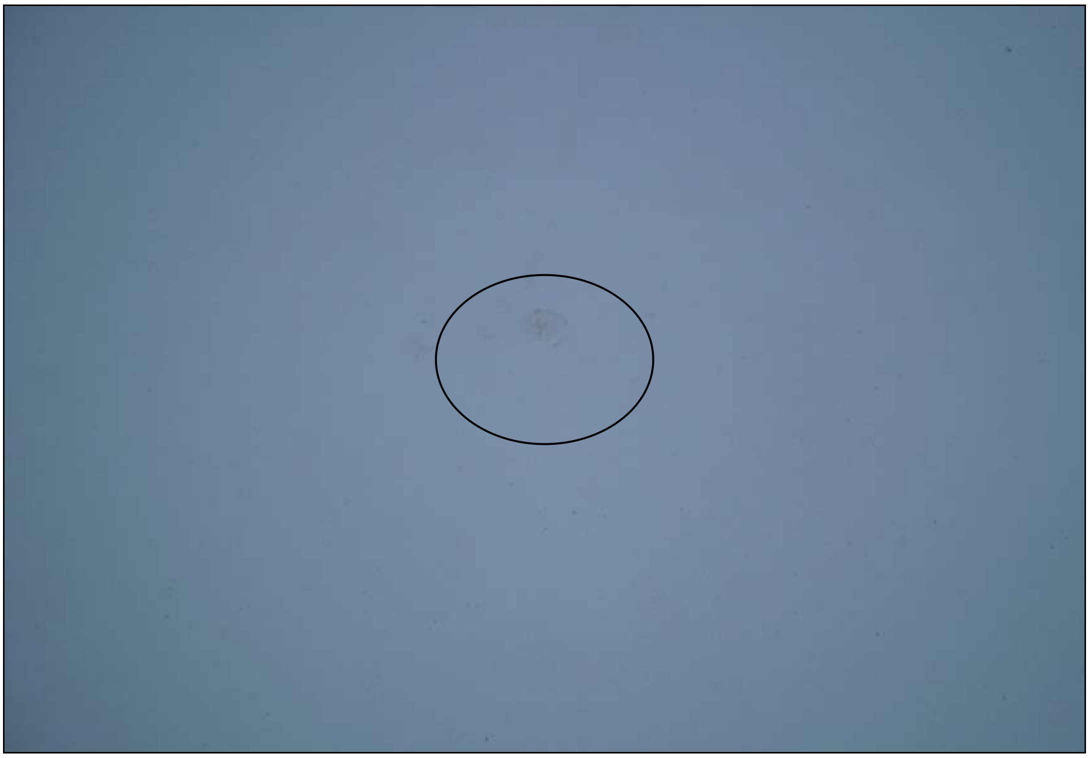
HARD BODY IMPACT TEST LOCATIONS

External View

○ Hard body impact location

PHOTO 3260016

TILE AFTER 10 Nm HARD BODY IMPACT AT LOCATION 6



## 7.5 SUMMARY OF IMPACT TEST RESULTS

### 7.5.1 Soft body

| Impact location | Impact energies (Nm) | Result |
|---|---|---|
| 1 | 120, 350, 500 | Pass |
| 2 | 120, 350, 500 | Pass |
| 3 | 120, 350, 500 | Pass |
| 4 | 120, 350, 500 | Pass |
| 5 | 120, 350, 500 | Fail at 500 Nm |

### 7.5.2 Hard body

| Impact location | Impact energies (Nm) | Result |
|---|---|---|
| 1 | 3, 6 | Pass |
| 2 | 3, 6 | Pass |
| 3 | 3, 6 | Pass |
| 4 | 3, 6 | Pass |
| 5 | 3, 6, 10 | Pass |
| 6 | 10 | Pass |
| 7 | 10 | Pass |
| 8 | 10 | Pass |
| 9 | 10 | Pass |

### 7.5.3 Pass Categories

The top panel achieved a Category E pass in accordance to the BS8200:1985 Standard.

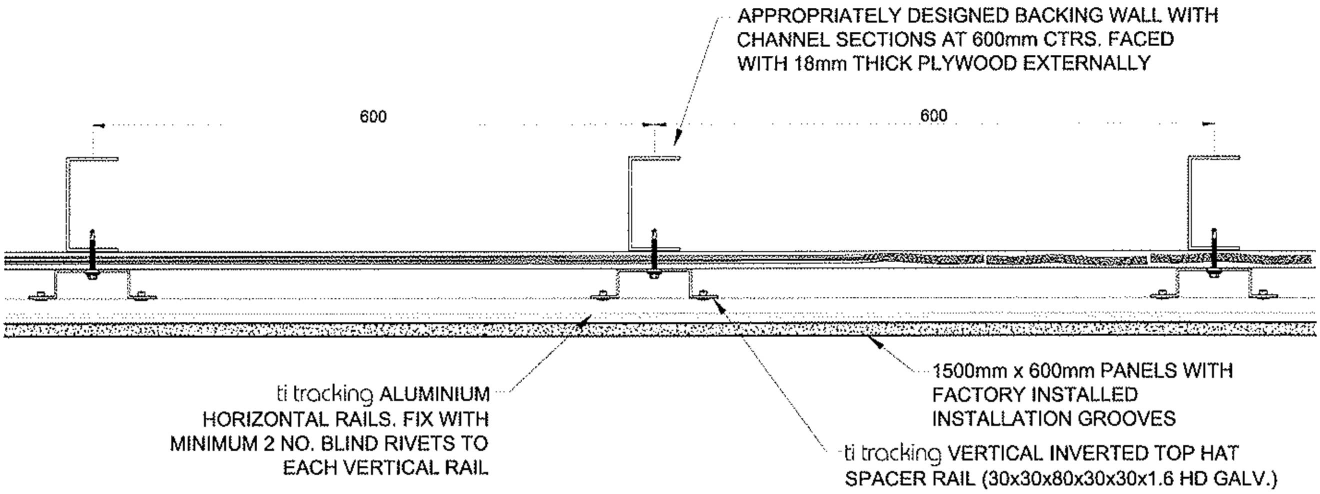
All the other panels tested achieved a Category B pass in accordance to the BS8200:1985 Standard.

## 8. APPENDIX - DRAWING

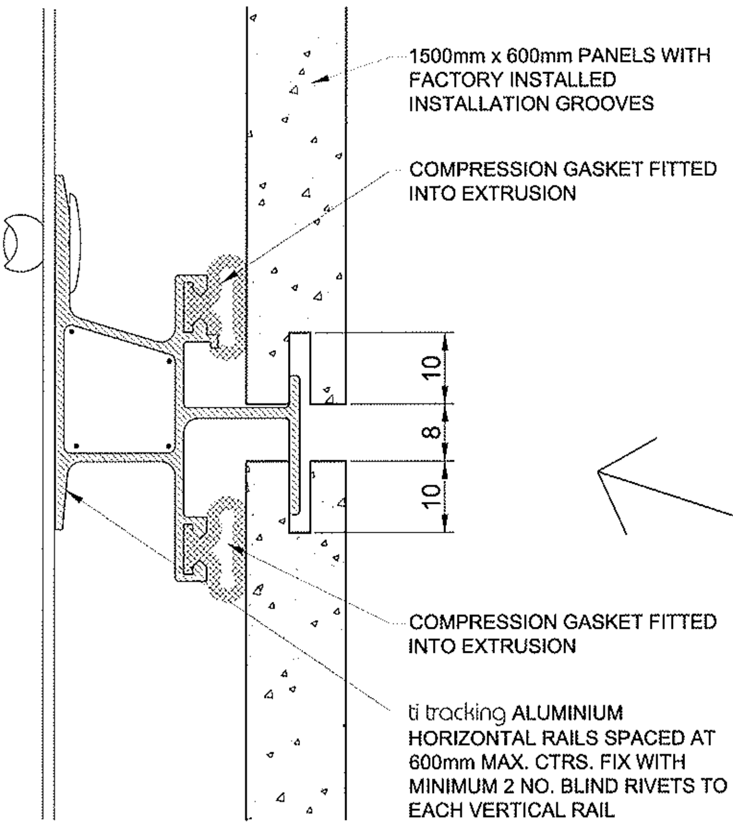
The following unnumbered page is a copy of T. I. Tiles International drawing numbered:

TI-001 rev0.

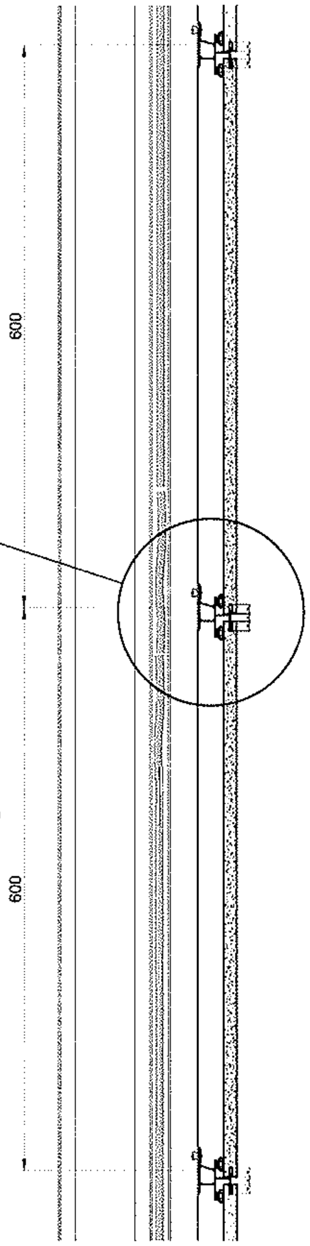
END OF REPORT




SECTIONAL PLAN




HORIZONTAL JOINT DETAIL




SECTION

***NOTES:***

CWCT TEST GUIDELINES STANDARD BUILDING ENVELOPES 2005:-
WIND SERVICEABILITY :- 2400Pa
WIND SAFETY:- 3600Pa
CYCLIC WIND LOADINGS
IMPACT RESISTANCE BS8200 DISCLAIMER

PLEASE CHECK WITH DYNAMIC SUPPORT FOR EXACT TEST CRITERIA. THE VERTICAL RAILS MUST BE INSTALLED AT A MAXIMUM OF 600mm TO ENSURE COMPLIANCE WITH THE TEST CRITERIA. THE RAIL & BRACKET CENTRES SHOULD BE CALCULATED BY THE CLADDING CONTRACTOR FOR EACH INDIVIDUAL BUILDING LOCATION

FREQUENCY AND TYPE OF FASTENERS SHOULD BE CALCULATED BY THE CLADDING CONTRACTOR FOR EACH INDIVIDUAL BUILDING LOCATION

THE SYSTEM MUST BE ATTACHED TO A SUITABLY DESIGNED BACKING STRUCTURE

| | | | |
|---|---|---|---|
| Drawing Title | GENERIC CONSTRUCTION DETAILS<br>TI TACKING HORIZONTAL CARRIER<br>MULTI-PRODUCT TESTING | | |
| Scale | 1:5,2 at A4 | Date Drawn | Sept. 2010 |
| Drawing Number | TI-001 | Revision | 0 |

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