CYCLONE TESTING STATION

SCHOOL of ENGINEERING and PHYSICAL SCIENCES

James Cook University

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Concentrated Load Testing and Cyclic Strength Wind Load Testing of Everbright E610 Cladding

By

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for

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1 Introduction

This Report No. TS799 Revision A is to replace the original document Report No. TS799.

The aim of this test program was to perform concentrated load testing and cyclic strength simulated wind load testing of *Everbright E610* roofing and walling system, manufactured by *Everbright Roofing Systems*. The test roof panels were loaded in accordance with the *AS 4040.1* concentrated load and *AS 4040.3* cyclic strength test regimes. The testing was performed with the use of new test materials, supplied by the client.

The wind load tests were conducted in the airbox testing facility located in the Wind Tunnel Building and the concentrated load tests were conducted on the Structures Floor, both at James Cook University. The Cyclone Testing Station is a NATA accredited testing laboratory. All trials for this testing program were performed in accordance with NATA requirements.

2 Test Program

A program of cyclic strength wind load testing and concentrated load testing was conducted. A summary of the test program is provided in Table 1.

Table 1: Test Program Summary

Trial No.	Cladding Thickness (mm)	Span Length (mm)	Span Type	Test Regime
1	74.0	2385	Double	Cyclic Strength Wind Load
2		1855		
3		4380	Single	Serviceability & Strength Concentrated Load

3 Cladding, Fastener, Support and Installation Details

3.1 Everbright E610 Cladding

The *Everbright E610* coextruded triple skinned polycarbonate roofing and walling system was stated to have been made from *Makrolon 1243* high impact resin from *Bayer Material Science*. The panel system is assembled from individual modules, each with a cover width of 100 mm that interlock with adjacent panels. Each panel has an upper and lower skin and a central horizontal vein that runs along the length of the created cavity. The panels were supplied pre-assembled with six modules per panel. Hence, the panel cover width is 600 mm and the total panel width is approximately 615 mm. The module rib height is approximately 74 mm; all five internal ribs of each panel have 6060 aluminium alloy with T5 temper locking bars inserted that run along the entire length of the panel. The lapped ribs have polycarbonate locking bars inserted after adjacent panels have been interlocked; these polycarbonate bars are made from the same resin as the panels. Each module has an end cap fitted to close of the opening at each end of the panel. Figure 1 is a photograph that shows the assembled panel profile. For detailed drawings of panel components including dimensions, refer to Appendix A.

Figure 1: Photograph of *Everbright E610* cladding profile

3.2 Cladding Fasteners

The fasteners used to fix the cladding to the supports were 14-10 x 110 mm self-drilling metal screws. The cladding was crest fixed to the supports at every rib in accordance with the client's installation manual. 7 mm diameter holes were drilled through the cladding and locking bars prior to screw installation. Figure 2 shows a photograph of a typical cladding screw.

Figure 2: 14-10 x 110 mm self-drilling metal screw

3.3 Aluminium EL 154 Washers

Aluminium washers were fitted to all cladding screws. The washers are made from 6060 aluminium alloy with T5 temper, measured to be 50 mm long, 20 mm wide and 12 mm high. The thickness varies with the curvature of the internal washer profile. The central hole for the screw was drilled to be approximately 7 mm in diameter. Figure 3 shows a typical aluminium washer, for detail drawings refer to Appendix A. A foam seal was fitted to the washer surface in contact with the cladding panels.

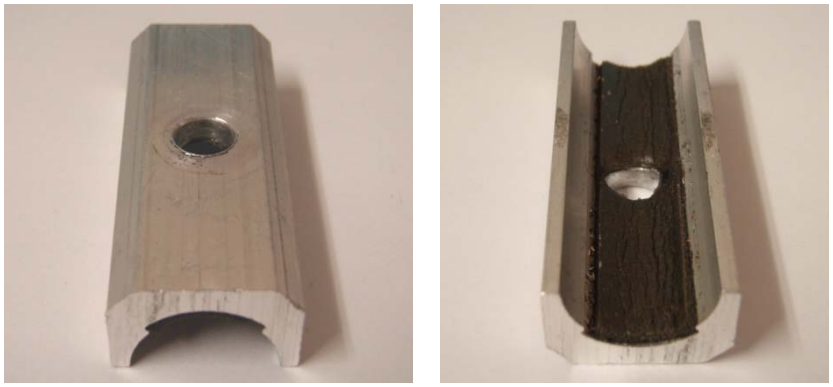

Figure 3: Aluminium washer top (left) and inside (right) views

3.4 Support Details

The supports used for all trial in this test program were 1.5 mm BMT Z15015 purlins. Note that the strength of these supports was not being tested in this program.

4 Test Apparatus and Procedure for Concentrated Load Tests

4.1 Test Set Up on Structures Floor

A test roof, two sheets wide was installed in a single span arrangement below a loading frame. A hand operated hydraulic ram was attached to the loading frame to allow the concentrated loads to be applied to the test roof panel. The test load was applied to the top surface of the roof cladding through a circular rubber loading pad with a diameter of 100 mm.

Both serviceability and strength concentrated load testing were performed in accordance with *AS 4040.1-1992, "Methods of Testing Sheet Roof and Wall Cladding – Method 1: Resistance to Concentrated Loads"*.

4.2 Concentrated Load Testing

For non-trafficable roofs with a slope of up to 35 degrees, the design concentrated load is specified as 1.1 kN applied in any position to the roof.

The cladding was loaded at two different locations; once at mid span and another adjacent to a support. The former is expected to exhibit the maximum residual deflection while the latter is expected to sustain the maximum permanent deformation. At both locations, the load was applied directly above a panel joint (polycarbonate locking bar).

4.2.1 Concentrated Load Serviceability Testing

The serviceability test load of 0.92 kN is calculated by multiplying the design load by a load factor, specified as 0.7 and a factor for variability of 1.2 when only one test is performed.

When the serviceability point test load is applied, Clause 5.4.2 of *AS 1562.1-1992* specifies that there shall be no de-indexing, unclipping, permanent local deformation, fracture or any failure on the cladding or failure of the fastener shall occur. Also the residual deflection shall not exceed Span/1000, directly under the point where the load is applied.

Three digital dial gauges (DGs) were arranged on the test roof panel to measure deflections of the cladding. Two of the DGs (Nos. 1 & 2) were installed with their measuring shafts located on the underside of the two supports. The remaining DG3 was installed on the underside of the cladding, directly below the point of load application.

4.2.2 Concentrated Load Strength Testing

The Strength Limit State test load of 2.5 kN is calculated by multiplying the design load by a load factor, specified as 1.5 and a factor for variability of 1.5 when only one test is performed.

Clause 5.4.3 of *AS 1562.1-1992, "Design and Installation of Sheet Roof and Wall Cladding – Part 1: Metal"* specifies that when the strength point test load is applied, for not less than one minute, it shall be sustained, irrespective of any permanent deformation that may occur.

5 Test Apparatus and Procedure for Wind Load Tests

5.1 Test Set Up in Airbox Test Facility

The test roof panels were installed in the Cyclone Testing Station's airbox test facility. The airbox is an open-topped pressure chamber with a maximum test width of 2050 mm and an adjustable length of up to 10 m. For this testing program, the cladding supports were set up to run across the width of the airbox and the spacing between supports varied according to the span length that was being tested at the time.

The cladding was installed to become the top (horizontal) surface of the chamber. The test roof panels comprised three full cladding panels and a part edge sheet panel covering the total width of the airbox. The roof cladding was installed according to the manufacturer's instructions.

5.2 Wind Load Testing

A uniform pressure was applied to the internal face of the cladding by a large centrifugal fan blowing air into the airbox chamber. This pressure simulated the combined effect of both the outward pressure (suction) and the internal positive pressure acting on the cladding. A pressure transducer measured the applied load on the test roof panels.

5.3 Cyclic Wind Load Strength Testing

5.3.1 General

Clause 5.2.3 of *AS 1562.3-1992, "Design and Installation of Sheet Roof and Wall Cladding – Part 3: Plastic"* states that cladding systems to be used in cyclone regions shall be tested for their capacity to resist low-cycle fatigue loading. The cyclic strength testing was performed in accordance with *AS 4040.3-1992, "Methods of Testing Sheet Roof and Wall Cladding, Method 3: Resistance to Wind Pressures for Cyclone Regions*". Cyclic loading was achieved by opening and closing pressure dump valves.

5.3.2 AS 4040.3 Fatigue Loading Sequence

The cyclic loading sequence used in this test program was performed in accordance with the cyclic testing regime specified in the *AS 4040.3-1992, "Methods of Testing Sheet Roof and Wall Cladding, Method 3: Resistance to Wind Pressures for Cyclone Regions*". The test pressure (P_t) for strength limit state is specified as being equal to the design pressure for strength limit state divided by a material capacity reduction factor. A material capacity factor of 0.9 was adopted (as recommended by *AS 4040.3-1992*). The loading sequence is presented in Table 2, where P_t is the test pressure.

Table 2: *AS 4040.3* Fatigue Loading Sequence

No. of Cycles	Load
8000	0 to 0.40 P_t
2000	0 to 0.50 P_t
200	0 to 0.65 P_t
1	0 to Ultimate Load

For one test sample, *AS 4040.3-1992* specifies an Ultimate Load of 1.30 P_t for the Single Load Cycle. If either two or three identical tests are performed, then the Single Load Cycle value to be applied reduces to either 1.20 Pt or 1.00 Pt, respectively, but all of the tests must support the smaller load. Note that the single load test cycle must be supported for 1 minute. For this test program an Ultimate Load of 1.30 P_t was used for the Single Load Cycles.

5.3.3 Acceptance Criteria

The cladding system shall remain substantially in position, notwithstanding any permanent distortion, fracture or damage that might occur in the sheeting and fastenings.

6 Results

6.1 Concentrated Load Serviceability Testing

The results of the concentrated load serviceability tests are summarised in Table 3; all stated deflections are relative to the deflections measured at the supports.

Table 3: Concentrated Load Serviceability Testing Results

Trial No.	Date Tested	Loading Location	Loading Applied		Loading Removed		Results and Observations
			Load Applied (kN)	Relative Deflection (mm)	Residual Deflection Limit (mm)	Relative Residual Deflection (mm)	
3-1	15 Dec 2010	On panel lap at midspan	0.92	34.07	4.38	0.50	**Pass**. No permanent deformation.
3-2	15 Dec 2010	On panel lap next to support	0.92	1.69	4.38	0.14	**Pass**. No permanent deformation.

6.2 Concentrated Load Strength Testing

The results of the concentrated load strength tests are summarised in Table 4.

Table 4: Concentrated Load Strength Testing Results

Trial No.	Date Tested	Loading Location	Load Applied (kN)	Results and Observations
3-1	15 Dec 2010	On panel lap at midspan	2.50	**Pass**. Cladding sustained load for 1 minute. No damage.
3-2	15 Dec 2010	On panel lap next to support	2.50	**Pass**. Cladding sustained load for 1 minute. No damage.

6.3 Wind Load Cyclic Strength Testing

A summary of the test results and observations is provided in Table 5.

Table 5: Wind Load Cyclic Strength Testing Results

Trial No.	Date Tested	Target Design Pressure P_d (kPa)	Test Pressure P_t (kPa)	Ultimate Load 1.3 P_t (kPa)	Results and Observations
1	13 & 14 Dec 2010	3.00	3.33	4.33	**Pass**. No visible damage.
2	15 & 16 Dec 2010	5.00	5.56	7.22	**Pass**. No visible damage.

7 Limit State Design Wind Capacities

7.1.1 Recommended Cyclonic Ultimate Strength Limit State Design Capacities

Target design capacities were nominated by the client for the spans tested in this program. As the cyclic strength tests were successful, these design pressures can be adopted and are summarised in Table 6

Table 6: Recommended Cyclonic Ultimate Strength Limit State Design Wind Capacities

Double Span Length (mm)	Recommended Cyclonic Ultimate Strength Design Wind Capacity (kPa)
2385	3.00
1855	5.00

8 Recommended Maximum Spanning Capacity for Foot Traffic

The concentrated load test demonstrated that this roof system is adequate to support the load specified in *AS 4040.1* on any position on the cladding system for the particular arrangement tested. Therefore, the recommended maximum single span for incidental foot traffic on roofs is 4380 mm.

9 Conclusions

A program of concentrated load testing and cyclic strength simulated wind load testing was performed on *Everbright E610* roofing and walling system manufactured by *Everbright Roofing Systems*.

The methods of testing (in accordance with *AS 1562.1*, *AS 1562.3, AS 4040.1* and *AS 4040.3*) have been presented.

Section 8 provides recommended maximum spanning capacity for incidental foot traffic, for the particular arrangement tested in this test program.

The cyclic strength wind load test results can be used to determine the Ultimate Strength Limit State design wind capacities for cyclonic regions. Table 6 provides the recommended Ultimate Strength Limit State design wind capacities for cyclonic regions, for the particular arrangements tested in this test program.

Prepared by	Checked	
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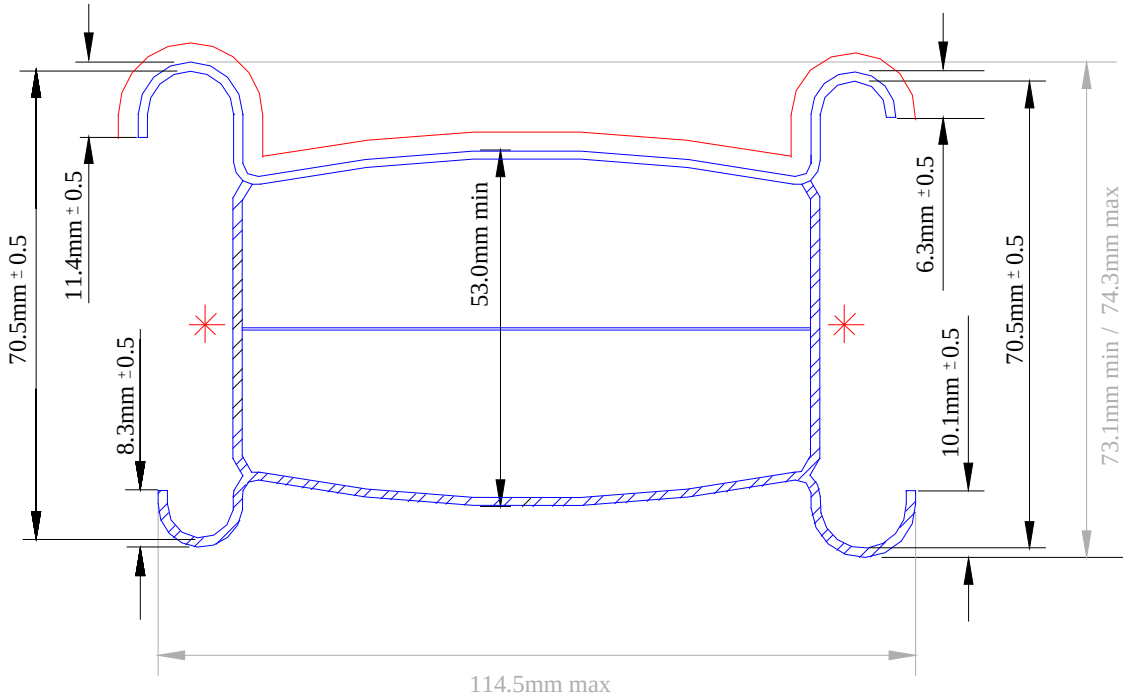
Appendix A – Panel Component Detail Drawings (Provided by Client)



NOTES:

Wall thickness: *1.2 - 2.0mm*
1.4 - 1.8mm

Profile sides to be straight (1.0mm/M)

End cap functional fit required.
Center vein must be intact.

UV layer thickness 0.050mm minimum

Figure 4: Detail drawing including dimensions of panel module (provided by client)

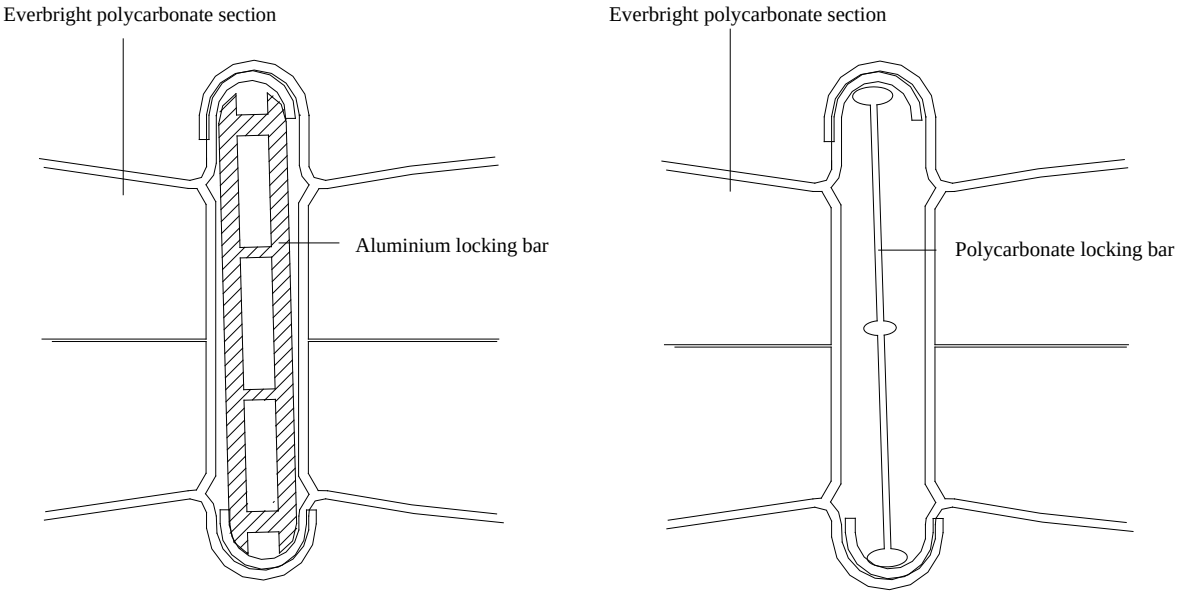


Figure 5: Detail drawings of aluminium (left) and polycarbonate (right) locking bar installations (provided by client)

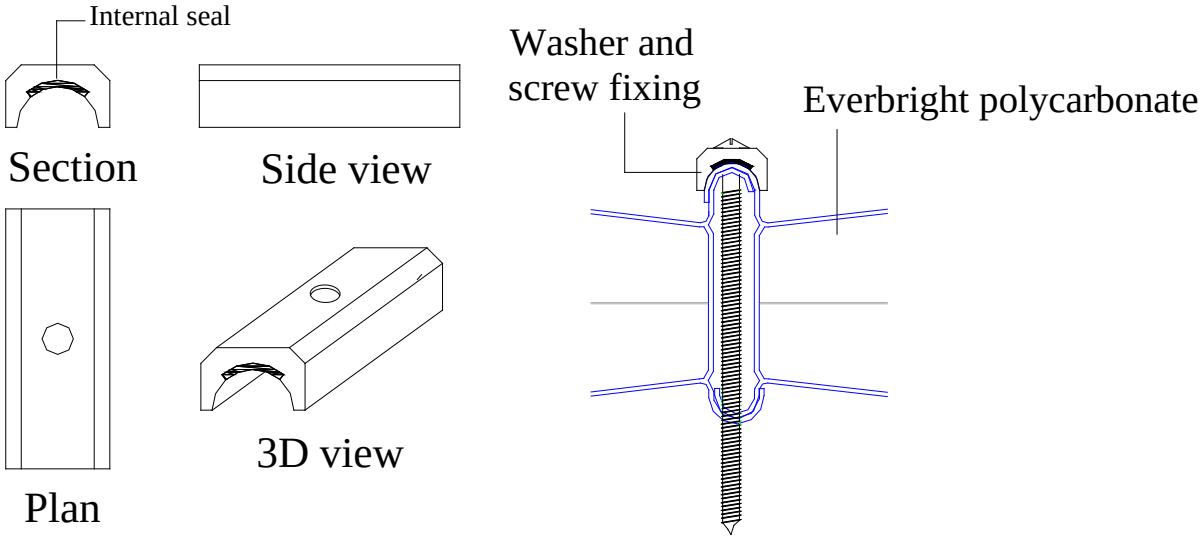


Figure 6: Detail drawings of aluminium washer and fixing installation (provided by client)