CYCLONE TESTING STATION

COLLEGE of SCIENCE and ENGINEERING

James Cook University

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Simulated Wind Load Strength Testing of Apex Apdeck Cladding

By

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for

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NATA Accredited Laboratory Number 14937
Accredited for compliance with ISO/IEC 17025 - Testing.

1 Introduction

The aim of this test programme was to perform static simulated wind load strength testing of Apex Apdeck cladding, manufactured by *Apex Building Products (NSW) Pty Ltd.* The test sheeting was loaded in accordance with the *AS 4040.2* static wind load strength test regime. The testing was performed with the use of new test materials, supplied by the client.

The wind load strength tests were conducted in the airbox testing facility located in the Wind Tunnel Building at James Cook University. The Cyclone Testing Station is a NATA accredited testing laboratory. All trials for this testing programme were performed in accordance with NATA requirements.

2 Test Programme

A programme of static simulated wind load strength testing was conducted. A summary of the test programme is provided in Table 1.

Table 1: Test Programme Summary

Trial No.	Cladding Base Metal Thickness (mm)	Span Length (mm)	Span Type	Test Regime
SS13	0.42	900	Equal Triple	*AS 4040.2* static wind load strength
SS14a		1,800		
SS15		2,700		
SS16	0.48	900		
SS17		1,800		
SS18		2,700		

3 Cladding, Fastener, Support and Installation Details

3.1 *Apex Apdeck* Cladding

The two *Apex Apdeck* roof cladding products were stated to have been rolled from 0.42 mm and 0.48 mm Base Metal Thickness (BMT) G550 steel with a painted finish, into a “stacked trapezoid rib” profile with four ribs per sheet, with the two outer ribs being over lapped and under lapped. The ribs were approximately 40 mm high and 233 mm apart. The pans have two longitudinal mini ribs along the length of the pan. The total sheet width was approximately 728 mm and its cover width was approximately 700 mm. A Total Coated Thickness (TCT) average of 0.48mm and 0.54 mm was measured for the 0.42 mm and 0.48 mm BMT materials respectively. Figure 1 is a photograph that shows the cladding profile.

Figure 1: Photograph of *Apex Apdeck* cladding profile

3.2 Fixing Clips

The brackets used to fix the cladding to the supports were manufactured from 0.78 mm TCT steel in strips approximately 775 mm long with 3 clips per bracket. The clips were manufactured from 1.24 mm TCT steel and have a trapezoidal shape with a rolled hook either side to engage the contour edges of the internal profile of the cladding ribs. The strip was approximately 40 mm wide with a 11 mm wide × 4.5 mm high stiffening bead along each side. The ends of the strips interlock to form a continuous strip. Figure 2 shows a photograph of a typical clip bracket.

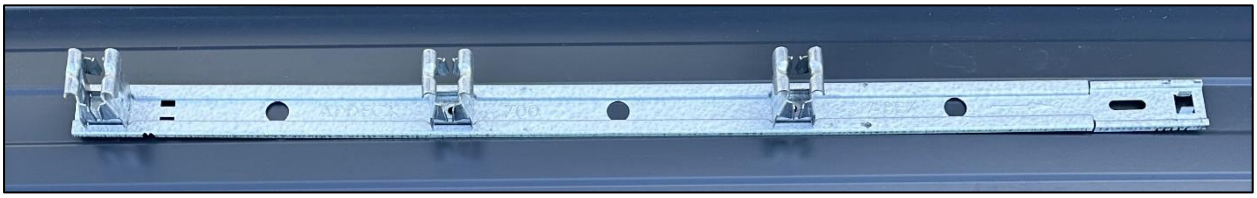

Figure 2: Typical clip bracket

Figure 3 shows detail photographs of a typical fixing clip.

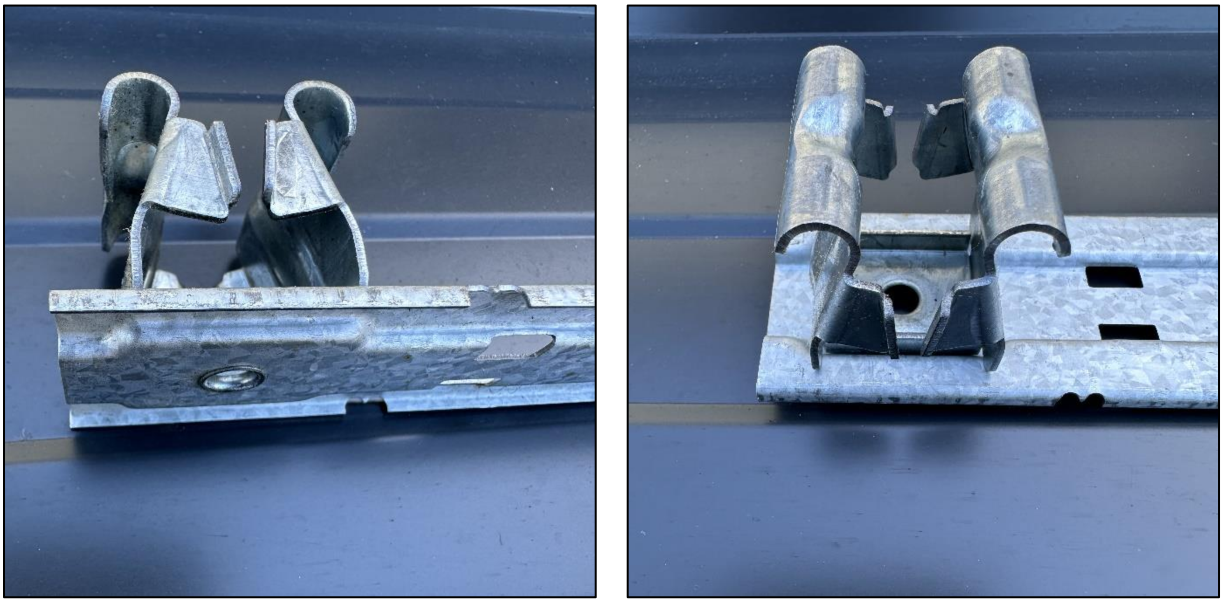

Figure 3: Typical fixing clip used in this testing programme

3.3 Clip Fasteners

The fasteners used to fix the clips to the supports were 5.5 mm, 11 threads per inch self-drilling batten zips with a length of 40 mm (M5.5-11 × 40 mm) and a 14 mm circular integral washer under an 8 mm hex drive head. The brackets were fixed to the supports at every clip in accordance with the client's installation manual. Figure 4 shows photographs of a typical clip fastening screw and a clip with fastener installed.

Figure 4: M5.5-11 × 40 mm self-drilling batten zip (left) and clip fastened to batten (right)

3.4 Stitch Screws

No side lap stitching screws were used in this testing programme.

3.5 Support Details

The supports used for all trials in this test programme were 40 mm high 0.75 mm BMT G550 steel top hat battens. Note that the strength of these supports was not being evaluated in this programme.

4 Test Apparatus and Procedure for Simulated Wind Load Tests

4.1 Test Set Up in Airbox Test Facility

The test specimens 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 2040 mm and an adjustable length of up to 10 m. For this testing programme, 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 specimens comprised two full central cladding sheets and two part edge sheets covering the total width of the airbox. The cladding was installed according to the manufacturer's instructions.

4.2 Simulated Wind Load Testing

A uniform pressure was applied to the internal face of the cladding by one or two large centrifugal fan(s) 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 sheeting.

4.3 Static Simulated Wind Load Strength Testing

4.3.1 General

The static simulated wind load strength testing was performed in accordance with *AS 4040.2-1992 (Incorporating Amendment No. 1), "Methods of Testing Sheet Roof and Wall Cladding, Method 2: Resistance to Wind Pressures for Non-Cyclone Regions"* as stipulated in Clause 5.5.2 of *AS 1562.1, "Design and installation of sheet roof and wall cladding, Part 1: Metal"*. The test specimen was subjected to increasing pressures in appropriate increments and each pressure was held constant for a period of 1 minute. This procedure was repeated until failure of the test specimen, or the maximum capacity of the airbox test rig was reached.

4.3.2 Acceptance Criteria

Clause 6.3 of *AS 4040.2* requires that the test pressure must be held for 1 minute. However, as the test method is for an Ultimate Limit State design criteria, the test specimen can show signs of distortion and permanent deformation and still be considered a successful outcome.

The last reading at which the test specimen was able to support the load for 1 minute was used to calculate the Ultimate Limit State design pressure.

5 Results

5.1 Static Simulated Wind Load Strength Testing

Six static simulated wind load strength tests were performed. A summary of the test results and observations is provided in Table 2. For photographs of damage see Appendix A.

Table 2: Static Simulated Wind Load Strength Testing Results

Trial No.	Date Tested	Test Pressure P_t (kPa)	Results and Observations
SS13	07 Jul 2023	2.70	Cladding disengaged at lap at internal supports
SS14a	23 Jun 2023	2.40	Cladding disengaged at lap on all supports. One clip fastener pulled out of batten at internal support
SS15	27 Jun 2023	2.20	Cladding disengaged at lap at end supports
SS16	07 Jul 2023	4.35	Cladding disengaged at lap at internal supports
SS17	22 Jun 2023	3.30	Cladding disengaged at lap at internal supports
SS18	27 Jun 2023	2.30	Cladding disengaged at lap at end support

6 Limit State Design Wind Capacities

6.1 Determination of Non-Cyclonic Ultimate Limit State Design Wind Capacities

The recommended Ultimate Limit State design wind capacities for the cladding for non-cyclonic regions can be determined by using an approach based on that specified in the Australian standard *AS 4040-1992, "Methods of Testing Sheet Roof and Wall Cladding"*. This standard specifies that the test pressure to be supported shall be equal to the Ultimate Limit State design wind pressure multiplied by the material variability factor from Table 5.1 in the Australian standard, *AS 1562.1-2018, "Design and Installation of Sheet Roof and Wall Cladding, Part 1: Metal"*. The material variability factor was dependent on the coefficient of variation of structural characteristics (V_{sc}) and the total number of units to be tested. An increase in the number of units to be tested results in a reduction of k_t and an increase in the final design capacity.

As the tests were to evaluate the strength of metal cladding a coefficient of 10% may be assumed for the roof cladding strength testing, as recommended in Note 2 of Table 5.1.

For roof cladding test sheeting, each full cladding sheet (including both side laps) and each internal row of fixings can be counted as a "unit to be tested". For this test programme, the triple span test specimens were set up with two full cladding sheets and two internal rows of fixings. Therefore, a total of four (4) "units to be tested" can be counted for each of three (3) span lengths and the maximum number of "units" that can be counted is ten (10). Hence, the material variability factor adopted was 1.21.

6.1.1 Recommended Non-Cyclonic Ultimate Limit State Design Wind Capacities

The Ultimate Limit State design wind pressure capacities can be back calculated from the static test results by dividing the lowest of the highest test pressures held for 1 minute by each specimen by the material variability factor. The recommended Ultimate Limit State design capacities for non-cyclonic regions are summarised in Table 3. Note that these design capacities are only applicable for the cladding profile, geometry, fastener types and support details, as used in this testing programme.

Table 3: Recommended Non-Cyclonic Ultimate Limit State Design Wind Capacities

Base Metal Thickness. (mm)	Equal Triple Span Length (mm)	Recommended Non-Cyclonic Ultimate Limit State Design Wind Capacity (kPa)
0.42	900	2.23
	1,800	1.98
	2,700	1.82
0.48	900	3.60
	1,800	2.73
	2,700	1.90

7 Conclusions

A programme of static simulated wind load strength testing was performed on *Apex Apdeck* cladding manufactured by *Apex Building Products (NSW) Pty Ltd*.

The methods of testing in accordance with *AS 4040.2* have been presented.

The static simulated wind load strength test results can be used to determine the Ultimate Limit State design wind capacity for non-cyclonic regions. Table 3 provides the recommended Ultimate Limit State design wind capacities for non-cyclonic regions, for the particular arrangements tested in this test programme.

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Appendix A – Photographs of Damage after Static Simulated Wind Load Strength Testing

Figure 5: Typical damage after Trials SS13, SS16 and SS17

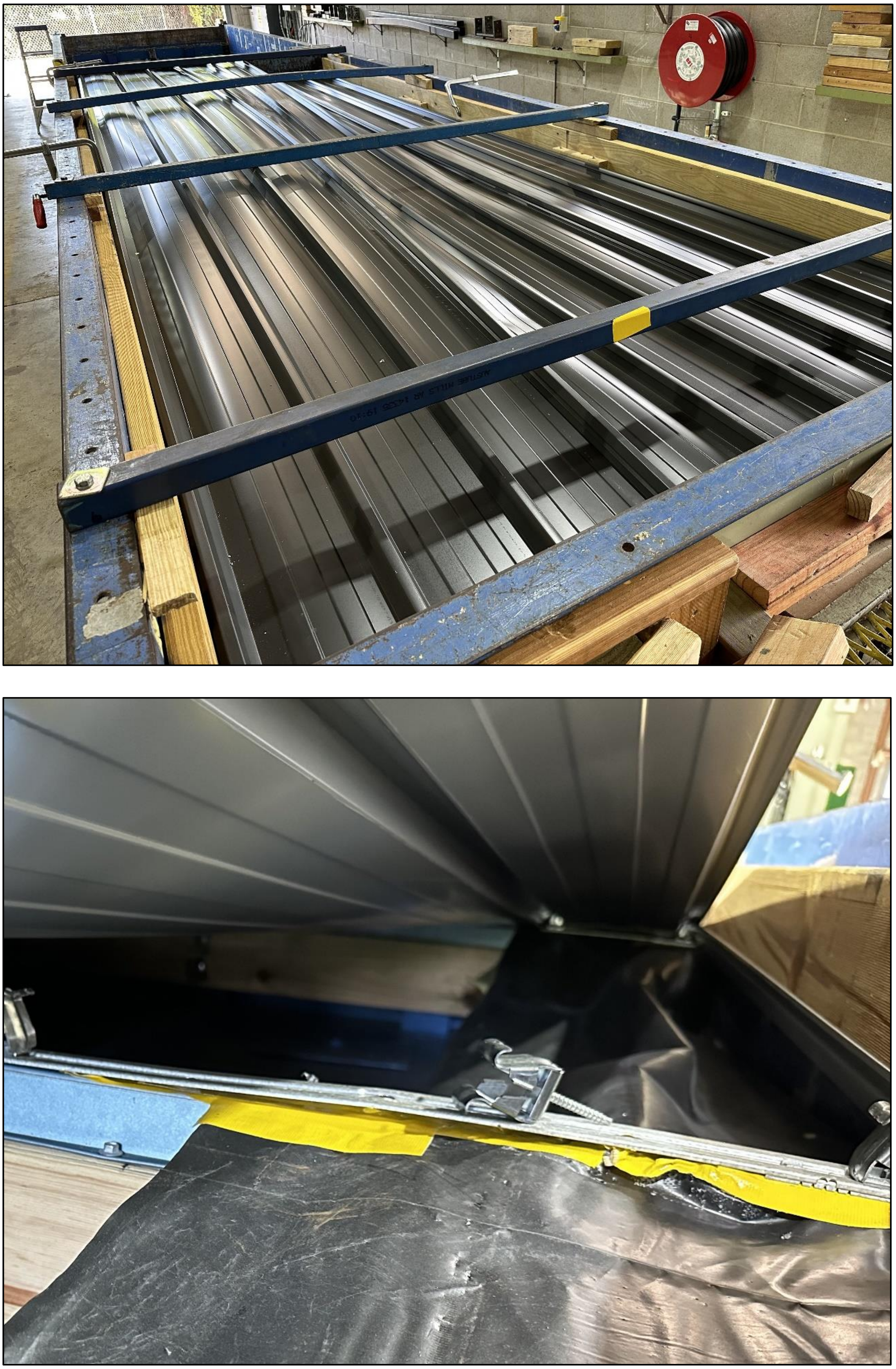

Figure 6: Typical damage after Trial SS14a

Figure 7: Typical damage after Trials SS15 and SS18