CYCLONE TESTING STATION

COLLEGE of SCIENCE, TECHNOLOGY and ENGINEERING

James Cook University

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Simulated Windborne Debris Impact Testing of Astroguard Impact Protection Screen Assembly System

by

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for

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1 Introduction

The aim of this testing programme was to perform simulated windborne debris impact testing of *Astroguard* impact protection screen assembly system, provided by *Cyclone Protection Australia*. The test screen assemblies were tested in accordance with the debris impact test criteria specified in *AS/NZS1170.2*:*2011*. The testing was performed with the use of new test materials, supplied by the client.

The impact tests were conducted using the windborne debris simulator located in the CTS Building Research Facility at James Cook University.

2 Test Programme

Three (3) simulated windborne debris impact tests were conducted. A summary of the test programme is provided in Table 1.

Table 1: Test Programme Summary

Test No.	Overall Screen Size (mm)	Screen Layers	Screen Underlap (mm)	Missile	Impact Location	Target Impact Velocity (m/s)
I1	2900 × 2300	3	400 each side edge	4 kg timber member with 100 × 50 mm cross-section	Geometric centre	43.6
I2					Corner	43.6
I3				2 g steel spheres with 8 mm diameter	Various (five in total)	43.6

3 *Astroguard* Screen, Clips, Fasteners and Support Frame

3.1 *Astroguard* Screen

The *Astroguard* screen tested was stated to have been made from a non-porous ballistic nylon fabric with a 20 × 20 weave and overall dimensions of about 2900 × 2300 mm. The fabric is stated to have a mass 33.91 g per square-metre. Figure 1 shows the *Astroguard* screen fabric.

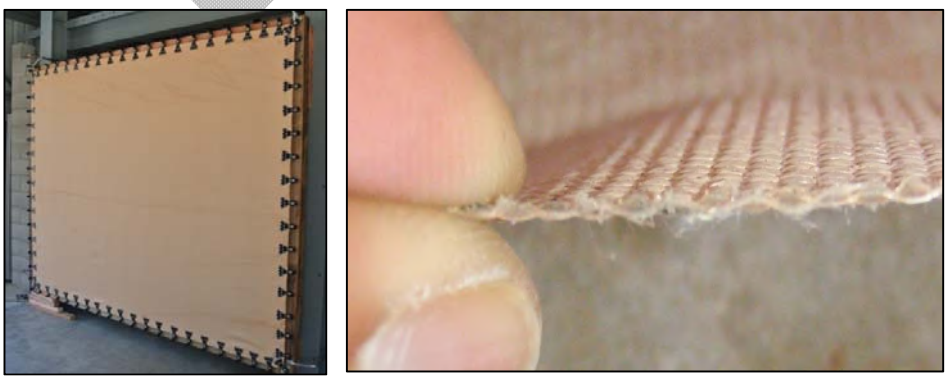

Figure 1: *Astroguard* screen fabric: general view with clips attached (left) close-up view (right)

3.2 Clips

Each clip used to connect the screen fabric to the frame comprise two parts – a male part and a female part, both made from nominal 2.5 mm thick plastic and joined together to form a clip assembly. Both the parts have a triangular shape with a 75 mm wide base and an extended apex with a nominal width of about 25 mm with an upturned end about 40 mm high. Figure 2 is a detail drawing, provided by client, of a typical clip. Figure 3 shows a photograph of a typical assembled clip installed on the *Astroguard* screen fabric.

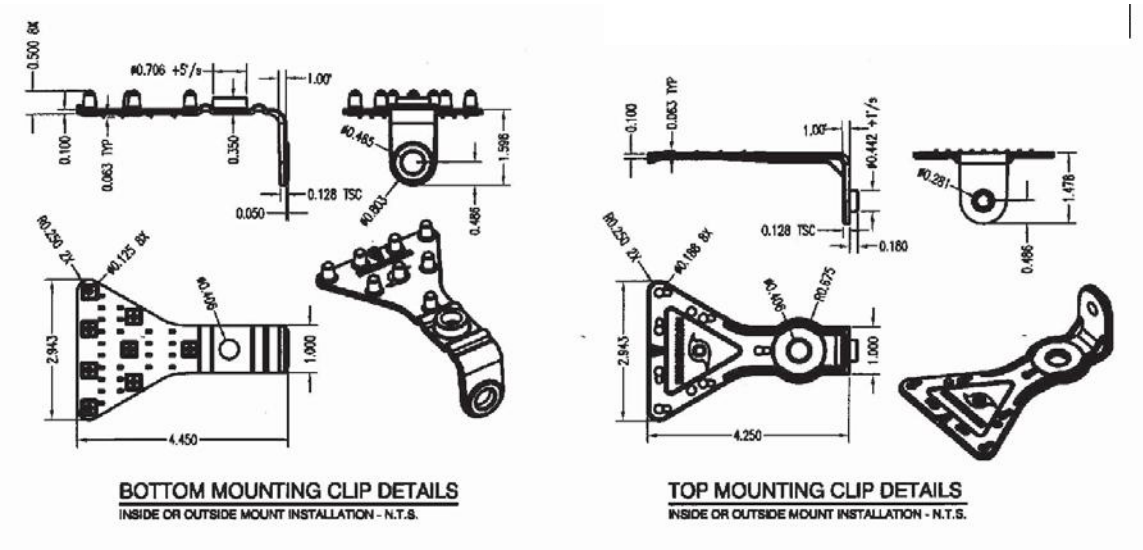

Figure 2: Detail drawing of a typical clip (provided by client)

Figure 3: Typical assembled clip installed to *Astroguard* screen fabric

The clips were spaced at about 150 mm around the perimeter of the specimen with one clip in each corner. In addition the first clips adjacent to the corner clips was spaced at 100 mm (see Figure 1).

3.3 Fasteners

3.3.1 Clip Fasteners

During the assembly of the clip, the male part is clipped over the female part with the screen fabric located between the male and female parts and connected together with eight 10-14 × 20 mm screws. Figure 4 is a photograph of a typical clip fastener.

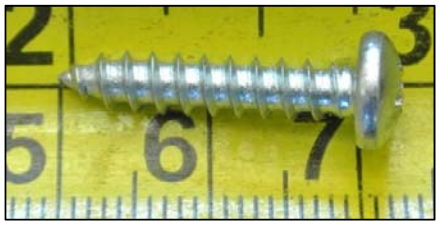

Figure 4: Typical clip fastener

3.3.2 Anchor Screws

Each clip is screwed to the frame with a 14-20 × 30 mm steel screw, referred to in this report as an anchor screw. Figure 5 is a photograph of a typical anchor screw.

Figure 5: Typical anchor screw

3.4 Support Frame

The support frame used in this test programme comprised a 3000 × 2400 mm rectangular frame made from 100 × 100 mm hardwood timber. The frame had screw inserts pre-installed at 150 mm centres and one screw insert in each corner with the adjacent inserts at 100 mm to allow the clips to be screwed to the frame.

Note that the strength of the support frame itself was not tested in this testing programme.

3.5 Installation

Each specimen was installed with three (3) layers of *Astroguard* screen fabric and both side edges folded over creating an underlapped section. The underlapped section extended approximately 400 mm from each side edge toward the centre of the screen. Figure 6 shows the test specimen setup with multilayer fabric and underlapped section.

Figure 6: Test setup showing multilayer fabric (left) and underlapped section of fabric (right)

4 Test Criteria

Clause 2.5.8 of *AS/NZS 1170.2:2011 (Incorporating Amendment Nos 1, 2 and 3), "Structural design actions – Part 2: Wind Actions"* states:

Where windborne debris impact loading is specified, the debris impact shall be equivalent to-

a) timber member of 4 kg mass with a nominal cross section of 100 mm x 50 mm impacting end on at 0.4 V_R for horizontal trajectories and 0.1 V_R for vertical trajectories; and
b) spherical steel ball 8 mm diameter (approximately 2 grams mass) impacting at 0.4 V_R for horizontal trajectories and 0.3 V_R for vertical trajectories.

where V_R is the *Regional Wind Speed*.

For this test programme the horizontal trajectory criteria were used.

The client specified that the mesh be tested for structures located in Cyclonic Region D areas of Australia. The client also specified using a *Regional Wind Speed* which specifies an *Annual Recurrence Interval* of 10,000 years. Therefore the *Regional Wind Speed* for Region D, for this test programme is $V_{10,000} = 99 \times F_D$, where F_D is the factor for Region D of 1.1. Therefore the target missile impact velocity for this test programme is calculated to be:

$\mathbf{0.4 \times V_R = 0.4 \times V_{10,000} = 0.4 \times 99 \times 1.1 = 43.56\ m/s}$ (For both the timber missile and steel spheres)

5 Test Apparatus and Procedure for Impact Tests

The test specimens were tested using the Cyclone Testing Station's wind driven debris simulator located in the Cyclone Testing Station's Building Research Facility. The wind driven debris simulator incorporates cylinders, which are pressurised by an air compressor. Once the required air pressure is reached a solenoid valve is triggered to instantaneously release the air and the missiles are fired through the barrels and accelerate to the required velocity.

The test specimens were mounted on a target support frame located about 1,100 mm away from the exit opening of the barrels. Digital velocity meters are installed at the exit of the barrels to measure the velocity of the missile, at their tail ends, before they impacted the target.

6 Results

A summary of the test results and observations is presented in Table 2. Photographs of damage are provided in Appendix B.

Table 2: Impact Testing Results

Test No.	Date Tested	Impact Location	Measured Impact Velocity (m/s)	Results and Observations
I1	18 Aug 2014	Geometric centre	45.4	**Pass**. No penetration of fabric. All clips remained intact and undamaged. No visible damage to specimen. On inspection after removal of test specimen some anchor screws had been bent.
I2		Corner	45.8	**Pass**. No penetration of fabric. Four clips broke off at connection, but corner clips remained intact with no opening created. On inspection after removal of test specimen some anchor screws had been bent.
I3a-e		Various (five in total)	52.6, 54.9, 55.5, 55.5, 52.0	**Pass**. No penetration and no visible damage.

7 Conclusions

A programme of simulated windborne debris impact testing was performed on an *Astroguard* impact protection screen assembly system supplied by *Cyclone Protection Australia*.

The methods of testing, using the debris impact test loads specified in Clause 2.5.8 of *AS/NZS 1170.2:2011 (Incorporating Amendment Nos 1, 2 and 3)* have been presented.

These results demonstrate the performance of this particular impact protection screen assembly, for the geometry and test assembly details described in this report, when subjected to simulated windborne debris impacts.

Note that the screen assembly when mounted in front of a window may not eliminate the damage that potentially could be caused as the deflections form the screen upon impact have not been assessed.

Prepared by Checked by

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Appendix A – Photographs of Damage

Trial I1

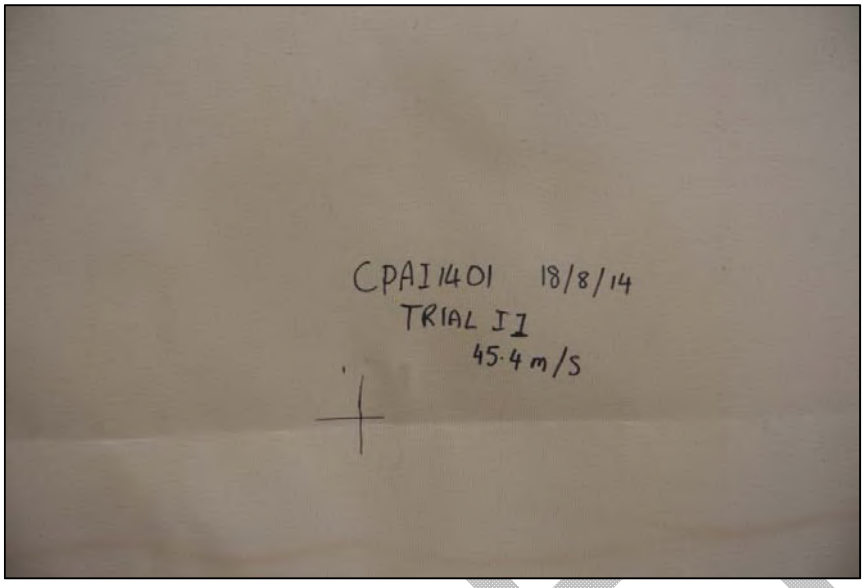

Figure 7: Detail view of impacted area

Trial I2

Figure 8: General view of impacted area

Figure 9: Detail view of impacted area; front view (left) and rear view (right). Note no opening created as corner clips and adjacent clips remain undamaged.

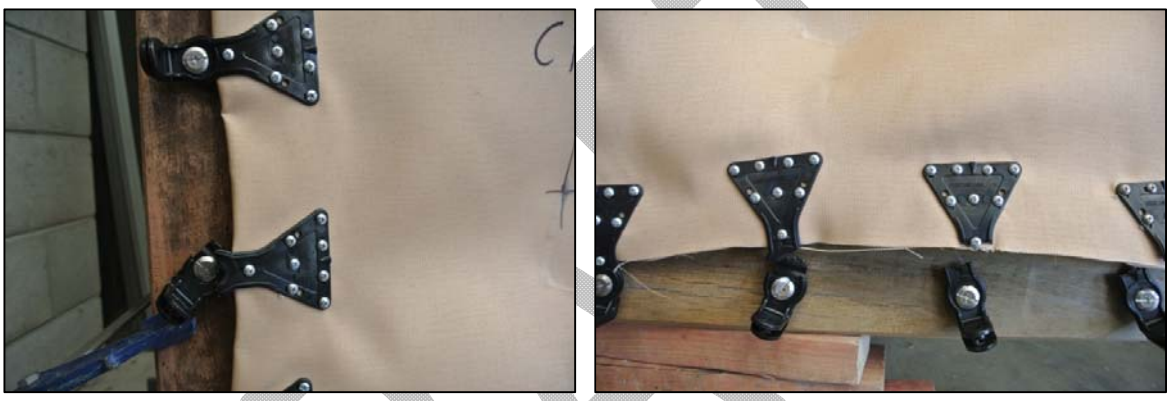

Figure 10: Detailed view of damage to clips

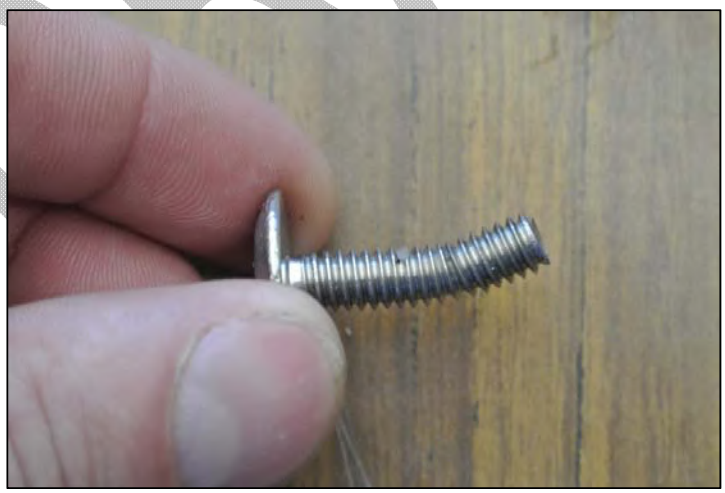

Figure 11: Typical bent anchor screw

Trial I3a-e

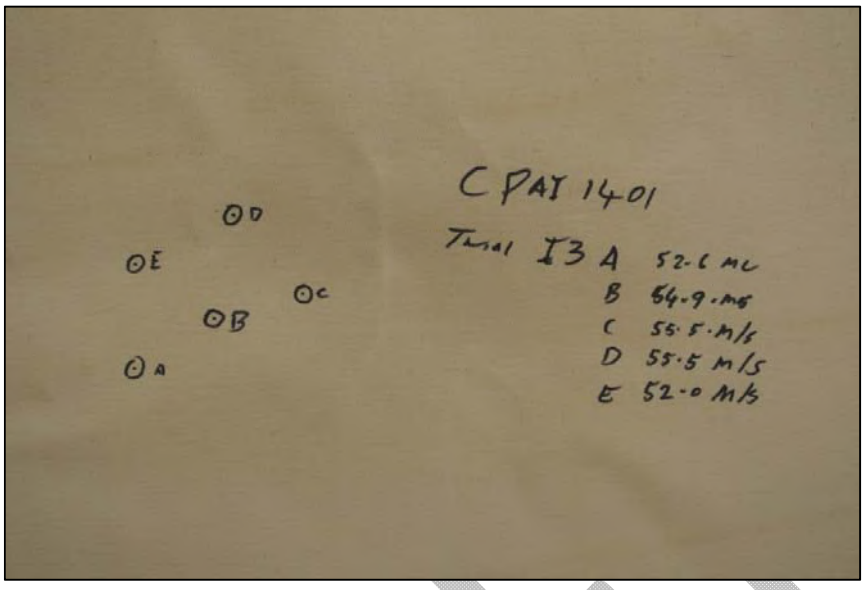

Figure 12: Impact locations