CYCLONE TESTING STATION

**SCHOOL of ENGINEERING and PHYSICAL SCIENCES**

**James Cook University**

# REPORT NO. TS868

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

**By**

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**For**

## Cyclone Protection Australia

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## 1 Introduction

The aim of this testing program 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 air cannon located in the CTS Building Research Facility at James Cook University.

## 2 Test Program

Three windborne debris impact tests were conducted. A summary of the test program is provided in Table 1.

**Table 1:** Test Program Summary

| Test No. | Overall Screen Size (mm) | Missile | Impact Location | Target Impact Velocity (m/s) |
|---|---|---|---|---|
| 1 | 1200 × 1800 | 4 kg timber member with 100 × 50 mm cross-section | Corner | 27.7 |
| 2 | | | Geometric centre | 27.7 |
| 3 | | 2 g steel spheres with 8 mm diameter | Various locations (five in total) | 27.7 |

## 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 1200 × 1800 mm. The fabric is stated to have a mass 33.91 g per square-metre. Figure 1 shows two photographs of 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.

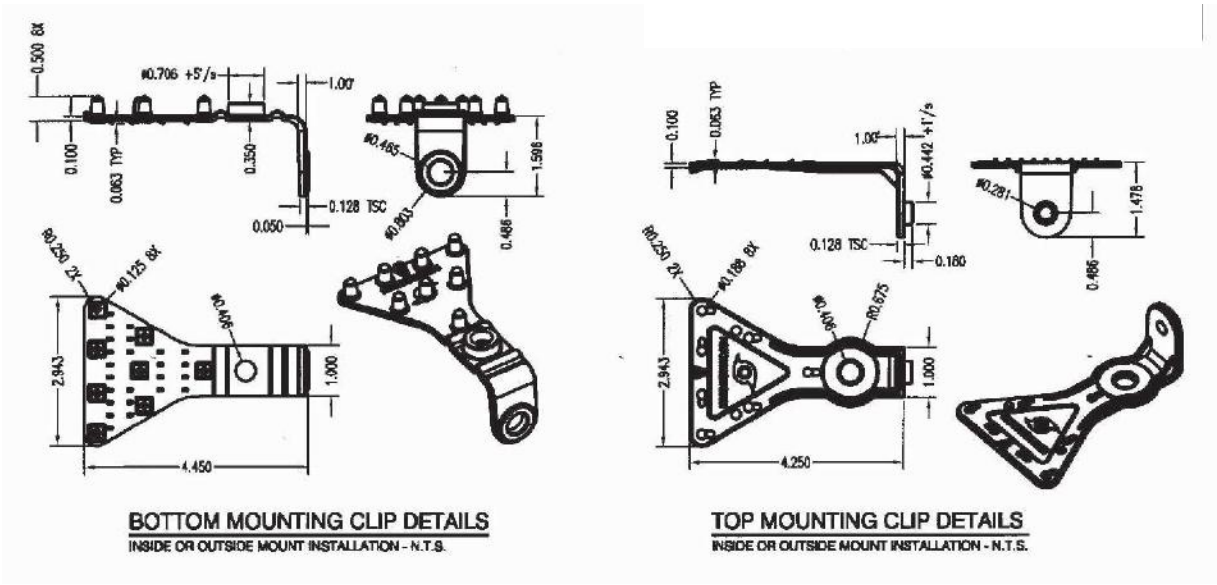


**Figure 2:** Detail drawing of a typical clip

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

The clips are spaced at about 200 mm around the perimeter of the frame with one clip in each corner (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 10-20 × 30 mm screws. Figure 4 is a photograph of a typical clip fastener.

**Figure 4:** Typical clip fastener

### 3.3.2 Frame Fasteners

Each clip is screwed to the frame with a 14-20 × 30 mm steel screw. Figure 5 is a photograph of typical frame fastener.

**Figure 5:** Typical frame fastener

### 3.4 Support Frame

The support frame used in this test program comprised a 1300 × 1900 mm rectangular frame made from 90 × 90 mm hardwood timber. The frame had screw inserts pre-installed at 200 mm centres and one screw in each corner 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 program.

## 4 Test Criteria

Clause 2.5.7 of *AS/NZS 1170.2:2011, "Structural design actions – 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 × 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 program the horizontal trajectory criteria were used.

## 5 Target Impact Velocity

The client specified that the target impact velocity be calculated using the regional wind speed ($V_R$) with an average recurrence interval of 500 years for cyclonic Region C as specified in Section 3 and Table 3.1 of *AS/NZS 1170.2:2011*. This value is calculated to be 69.3 m/s.

Therefore, in accordance with Section 4, the target impact velocity for all of the tests described in this report is calculated to be 27.7 m/s ($0.4V_R$).

## 6 Test Apparatus and Procedure for Impact Tests

The test specimens were tested using the Cyclone Testing Station's air cannon; two air cannons of different size were used to fire the timber missile and the steel sphere(s). Both air cannons incorporate a cylinder, which is pressurised by an air compressor. Once the required air pressure is reached a solenoid valve is triggered to instantaneously release the air and the missile is fired through the barrel and accelerates to the required velocity.

The test specimens were assembled according to client's installation instructions, mounted vertically on a target support frame about 1900 mm away from the exit opening of the barrels

The test specimens were assembled according to client's installation instructions, mounted vertically on a target support frame about 1900 mm away from the exit opening of the barrels and bolted securely. Photographs showing a test specimen mounted on the target support frame are included in Appendix A. Digital velocity meters were installed at the exit of the barrels to measure the velocity of the missile, at their tail ends, before they impacted the targets.

## 7 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 |
|---|---|---|---|---|
| 1 | 3 Oct 2012 | Corner | 29.6 | **Pass**. No penetration. Tearing of fabric around one clip. Another clip pulled out. |
| 2 | | Geometric centre | 28.6 | **Pass**. No penetration. One screw started to pull out. |
| 5 | 9 Oct 2012 | Various (five in total) | 34.2, 32.9, 31.2, 34.2, 31.1 | **Pass**. No penetration and no visible damage. |

## 8 Conclusions

A program 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, in accordance with Clause 2.5.7 of *AS/NZS 1170.2:2011* 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.

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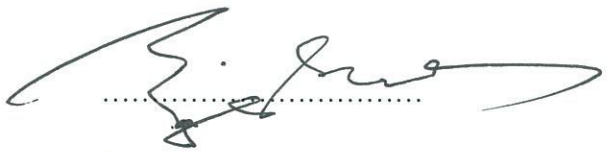

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# Appendix A – Photographs of Test Set Up

**Figure 6:** Test specimen mounted on target support frame: front view

**Figure 7:** Test specimen mounted on target support frame: rear view

## Appendix B – Photographs of Damage


**Figure 8:** General view of damage after Test 1 (Note: Test 1 was labelled “Trial I2” during testing)

**Figure 9:** Tearing of fabric around a clip (left) and one clip pulled out (right) after Test 1

**Figure 10:** No penetration after Test 2

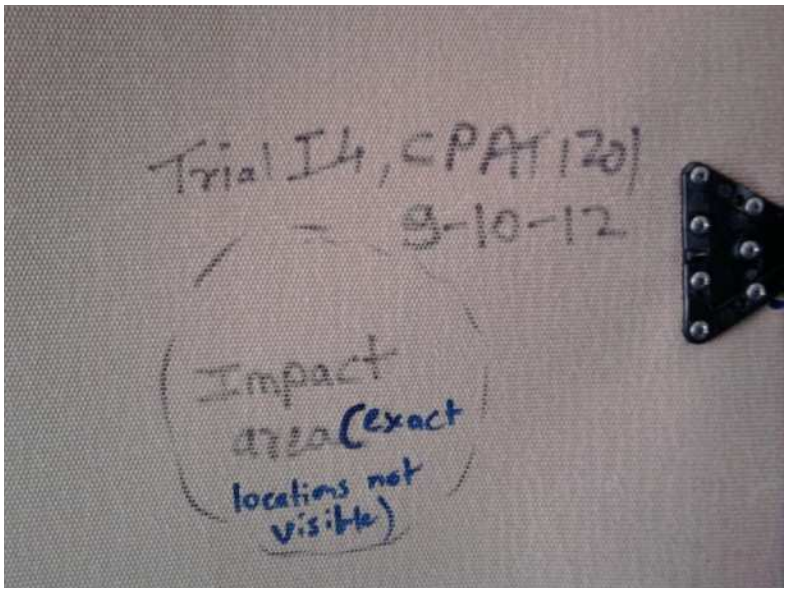


**Figure 11:** Impact location for Test 3 (Note: Test 3 was labelled "Trial I4" during testing)