

REPORT NO. TS785

Simulated Wind Driven Debris Impact Testing of Crimsafe Debris Screen

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1 Introduction

In this testing program, simulated wind driven debris impact loading of a Crimsafe debris screen to be installed on public cyclone shelters in Queensland was performed. The screen was loaded in accordance with the *Design Guidelines for Queensland Public Cyclone Shelters, Sep 2006 including amendment 1*. The testing was performed with the use of new test materials, supplied by *G.James Glass & Aluminium*. All tests were conducted in the air cannon testing facility located at James Cook University.

2 Design Guidelines for Debris Loads

The structural design guidelines for debris loads state that the external fabric of public cyclone shelters is to be at least capable of resisting wind debris defined as:

- a) Five spherical steel balls of 2 grams mass and 8 mm diameter impacting at $0.4 \times V_{10,000}$ for horizontal trajectories and $0.3 \times V_{10,000}$ for vertical trajectories.
- b) A 100 mm x 50 mm piece of timber of 4 kg mass impacting end-on at $0.4 \times V_{10,000}$ for horizontal trajectories and $0.1 \times V_{10,000}$ for vertical trajectories.

In Queensland's tropical cyclone region (Region C) $V_{10,000} = 85$ m/s. Thus, the required impact speeds are:

$$0.1 \times V_{10,000} = 8.5 \text{ m/s}$$

$$0.3 \times V_{10,000} = 25.5 \text{ m/s}$$

$$0.4 \times V_{10,000} = 34.0 \text{ m/s}$$

3 Test Criteria and Procedures

3.1 Test Loads

For Cyclonic Regions C the debris test loads for the external fabric of public cyclone shelters are specified as follows:

- Test Load A: End-on impact of timber 4 kg in mass, with cross-section dimensions of 100 mm x 50 mm, impacting at the speed specified for the trajectory.
- Test Load B: Series of five steel balls of 2 grams mass and 8 mm diameter, successively impacting at the speed specified for the trajectory.

3.2 Test Sequence

A test specimen shall be subject to successive test loads applied in the following order:

- 1) Debris Test Load A
- 2) Debris Test Load B

Test load A shall impact the most critical location(s). The testing authority shall determine the most critical location(s) by test. Test load B shall successively impact at various random locations on the test specimen.

3.3 Acceptance Criteria

A test specimen shall:

- a) Prevent a debris missile from penetrating through
- b) If perforated, have a maximum perforation width of less than 8 mm.

4 Test Apparatus and Procedure

The debris screen test specimen was tested in the Cyclone Testing Station's air cannon testing facility; the air cannons were used to fire the series of steel spheres. The air cannons consist of 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 specimen was mounted on a target support frame located about 2200 mm away from the exit opening of the barrel. A digital velocity meter is installed at the exit of the barrel to measure the velocity of the missiles, at its tail end, before it impacted the targets.

5 Test Specimens

The screen size of the test specimen was 1357 x 1343 mm to fit into an opening of 1487 x 1463 mm. The test specimen was supplied in aluminium extrusion frames, which were mounted in a 200 x 100 x 4 mm RHS frame using M8 bolts at 400 mm centres around the perimeter.

5.1 Screen Assembly

The debris screen included a single layer of screen material (subsequently labelled S1.1). The *Crimsafe* woven wire mesh infill was made from stainless steel 304 strands of 0.9 mm diameter. The individual strands are woven to produce a continuous mesh with aperture sizes of about 2.0 x 2.0 mm. A detail drawing of the aluminium extrusion frame assembly is provided in Appendix A.

6 Results

A summary of the test results is presented in Table 1. Photographs of damage are provided in Appendix B

Table 1: Impact Testing Results

Trial No.	Date Tested	Impact Location & Test Load	Impact Velocity (m/s)	Results and Observations
S1.1	25 May 2010	Various, Test Load B	>34.0	Pass. Small indentations.

7 Conclusions

A test program of simulated wind driven debris impact loading was successfully performed on a *Crimsafe* debris screen.

The method and criteria of testing (in accordance with the *Design Guidelines for Queensland Public Cyclone Shelters, Sep 2006 including amendment 1*) has been presented. The results demonstrate the performance of the screen when subjected to Debris Test Loads B.

The *Crimsafe* screen tested is deemed to satisfy the Debris Test Load B impact load performance requirements detailed in the *Design Guidelines for Queensland Public Cyclone Shelters, Sep 2006 including amendment 1*.

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Appendix A – Drawings of Screen Frame Assemblies

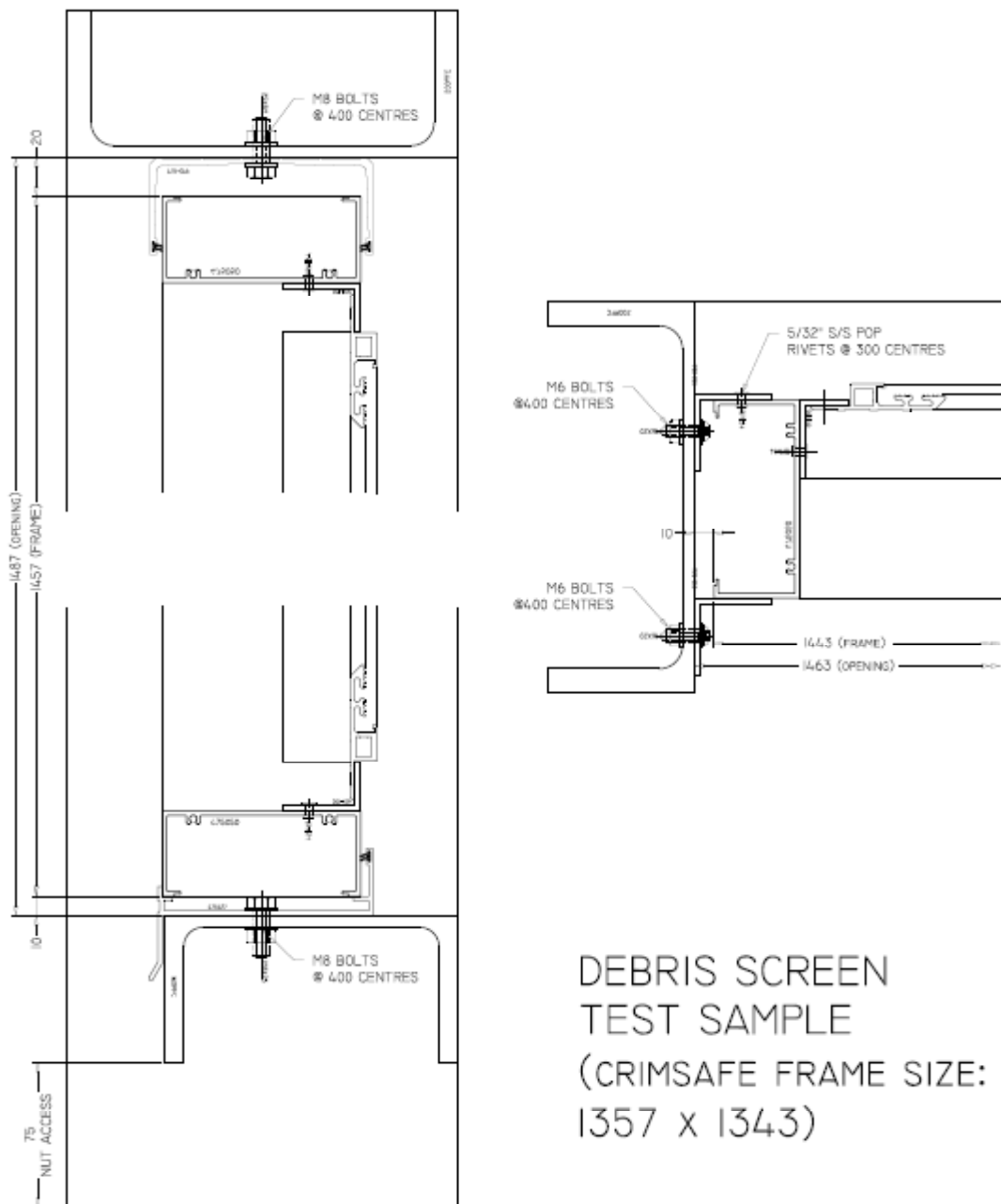


Figure 1: Detail drawing of single layer screen aluminium extrusion frame assembly

Appendix B – Photographs of Damage



Figure 3: Inside view of typical damage after Trial S1.1