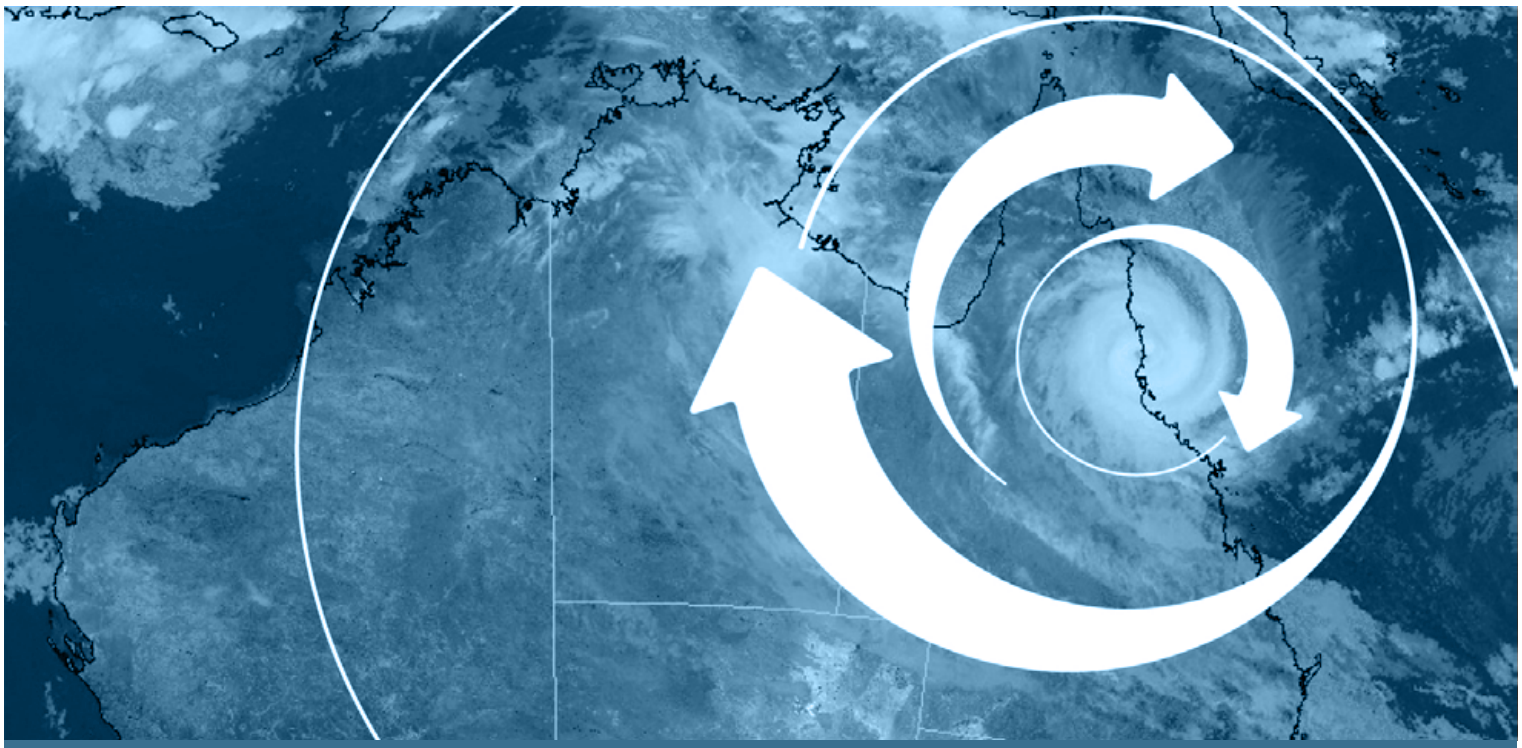

REPORT NO. TS772

Simulated Wind Driven Debris Impact Testing of Locker High Tensile Steel Woven Wire Mesh Debris Screen

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1 Introduction

In this testing program, simulated wind driven debris impact loading of a 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*. The testing was performed with the use of new test materials, purchased from the manufacturer. 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:

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

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

$0.4 \times V_{10,000} = 34.0$ 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) In the case of a debris screen,

   1) If perforated, have a maximum perforation area of less than 2000 mm^2

   2) Not deflect more than 0.8 times the clear distance between the screen and the glazing, at any stage of the test.

4 Test Apparatus and Procedure

The screen test specimen was tested in the Cyclone Testing Station's air cannon testing facility; the air cannon was used to fire the timber missile. The air cannon consists 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 specimens were 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 missile, at its tail end, before they impacted the target.

5 Test Specimens

The debris screen system tested in this program consisted of a support frame and the mesh material covering the clear opening.

5.1 Frame

The debris screen frame was made from 50 x 50 x 3 mm SHS steel. The frame had overall dimensions of 1600 mm width and 2000 mm height; at mid height was a cross SHS section, effectively splitting the open mesh area into two equal sections of 1500 mm width and 925 mm height. Six fixing brackets were welded to the rear of the SHS frame at locations shown in Figure 1 (FB); the brackets were made from 100 x 75 x 6 mm steel angle, cut to 100 mm length, with 16 mm holes for wall mounting. Figure 1 shows a drawing of the frame layout including impact locations. Note that only one half of the frame was fitted with mesh.

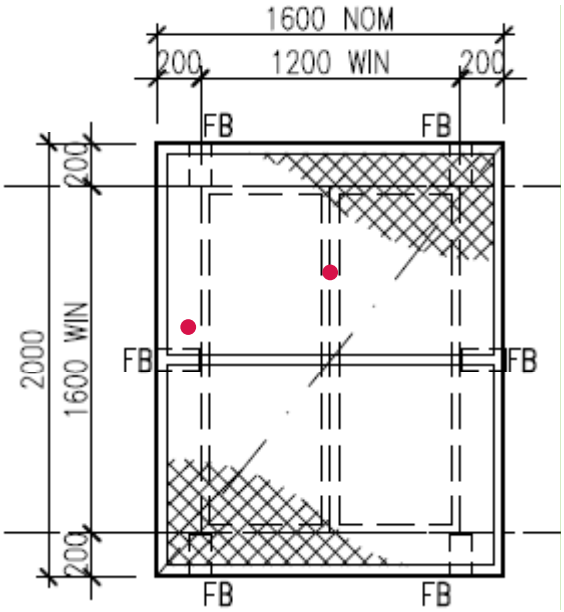

Figure 1: Drawing of debris screen frame showing dimensions, fixing bracket and impact locations

5.2 Locker High Tensile Steel Woven Wire Mesh

The Locker high tensile steel woven wire mesh infill is made from high tensile steel strands of 3.15 mm diameter. The individual strands are woven to produce a continuous mesh with aperture sizes of 6.3 x 6.3 mm.

5.3 Screen Assembly

The mesh was mounted onto the support frame with all edges folded a distance of 50 mm at 90° angle. Around the perimeter and the cross member a 50 x 50 x 20 angle section was used to clamp the mesh to the frame; the angle was screw fixed to the frame (through the mesh) with 14-20 x 45 mm self-drilling metal screws at 100 mm centres at both the front and side faces. The fixing screws on front and side faces were offset by 50 mm.

6 Results

A summary of the test results is presented in Table 1. Further details on the modes of failure and deformation are provided in Appendix A.

Table 1: Impact Testing Results

Trial No.	Date Tested	Impact Location	Test Load	Impact Velocity (m/s)	Screen Deflection (mm)	Results and Observations
1	20 Nov 2008	Corner of mesh	A	35.6	Not measured	**Pass.** Mesh indented, wire strands undamaged.
2	25 Nov 2008	Centre of mesh	A	34.7	120	**Pass.** No damage visible.
3	25 Nov 2008	Various (5 impacts)	B	~34.0	Not measured	**Pass.** Small indentations.

Note: All impacts were performed on the same specimen

7 Conclusions

A test program of simulated wind driven debris impact loading was performed on a Locker high tensile steel woven wire mesh debris screen system.

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

The debris screen system tested is deemed to satisfy the impact load performance requirements detailed in the *Design Guidelines for Queensland Public Cyclone Shelters, Sep 2006*.

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Appendix A – Photographs of Tested Screen

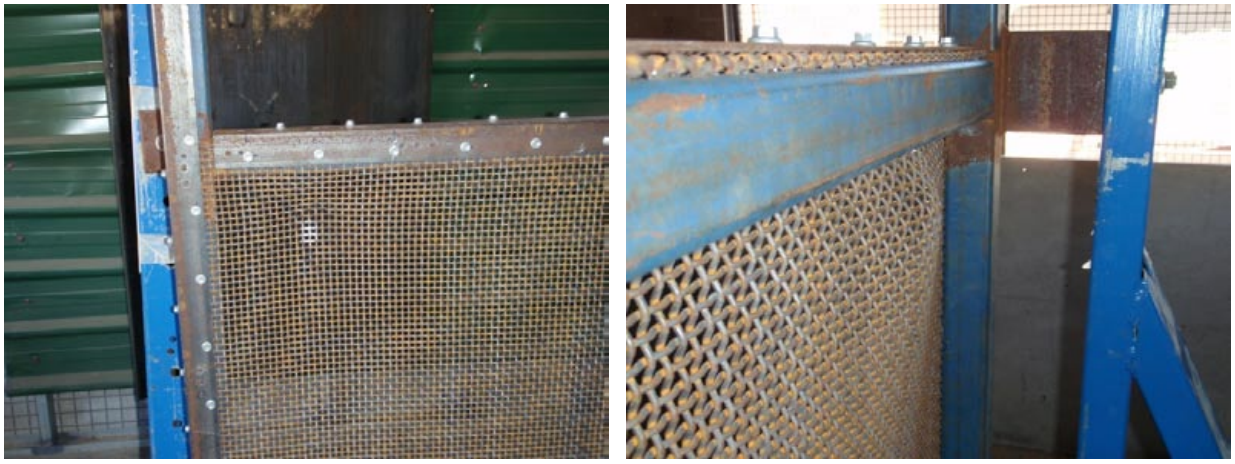

Figure 2: Front (left) and rear views of screen after Trial 1