



REPORT NO. TS775

Simulated Wind Driven Debris Impact Testing of External Personal Access Doors

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By Ulrich Frye

Cyclone Testing Station
School of Engineering and Physical Sciences
James Cook University

for Queensland Government
Department of Public Works
GPO Box 2457, Brisbane, QLD 4001



Disaster Preparedness
Department of Public Works



1 Introduction

In this testing program, simulated wind driven debris impact loading of external doors to be installed on public cyclone shelters in Queensland was performed. The doors were 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:

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

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

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

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 door test specimens were 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

Two different external personal access doors were tested successfully in this program. Both door leaves were 2040 mm high, 1020 mm wide and were tested in the same matching steel frame supported by three hinges; no locks were fitted to the doors. The following sub-sections provide descriptions of the door leaves and frame.

5.1 Steelfinne 38 mm Steel Reinforced Ply Door Leave

This door leave was manufactured from a 25 mm thick plywood core overlaid on each side with a 1.15 mm BMT steel sheet and 4.5 mm external plywood faces. The tests for this door leave are labelled SS in the following Table 1 and Appendix A.

5.2 Sealeck Ultraguard 37 mm Door Leave

This door leave was manufactured from an internal SHS galvanised steel frame filled with high moisture resistant particle board and overlaid on each side with a 0.8 mm BMT steel sheet. The tests for this door leave are labelled SU in the following Table 1 and Appendix A.

5.3 Door Frame

The door frame used for all tests was a 3 mm steel door frame to suit the 1020 x 2040 mm door leaves. Provisions were made for installation of three hinges.

6 Results

A summary of the test results is presented in Table 1. Note that only Test Load A impacts were performed. 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	Impact Velocity (m/s)	Results and Observations
SS1	25 Nov 2009	Top corner, hinged edge	33.8	Pass. Indentation in door. Interior ply face fractured slightly.
SS2	25 Nov 2009	Mid height, hinged edge	34.7	Pass. Indentation in door. Interior ply face fractured slightly.
SS3	26 Nov 2009	Centre, next to bottom edge	35.7	Pass. Indentation in door. Interior ply face fractured slightly.
SU1	19 Jan 2010	Top corner, hinged edge	36.2	Pass. Door deformed along internal SHS frame.
SU2	19 Jan 2010	Centre, next to bottom edge	33.3	Pass. Door deformed along internal SHS frame.
SU3	19 Jan 2010	Mid height, hinged edge	36.8	Pass. Door deformed along internal SHS frame.

Note: All impacts were performed on the same specimen

7 Conclusions

A test program of simulated wind driven debris impact loading was successfully performed on two different external personal access doors.

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 Load A.

The Steelfinne 38 mm steel reinforced ply door and the Sealeck Ultraguard 37 mm door are deemed to satisfy the impact load performance requirements detailed in the *Design Guidelines for Queensland Public Cyclone Shelters, Sep 2006*.

Prepared by

Mr. U. Frye
Research Engineer
Cyclone Testing Station
James Cook University

Checked

Mr. C. J. Leitch
Manager
Cyclone Testing Station
James Cook University

Prof Y. He
Head of School
School of Engineering and Physical Sciences
James Cook University

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Appendix A – Photographs of Tested Doors



Figure 1: Door damage after Trial SS1



Figure 2: Door damage after Trial SS2



Figure 3: Door damage after Trial SS3



Figure 4: Door damage after Trial SU1



Figure 5: Door damage after Trial SU2



Figure 6: Door damage after Trial SU3