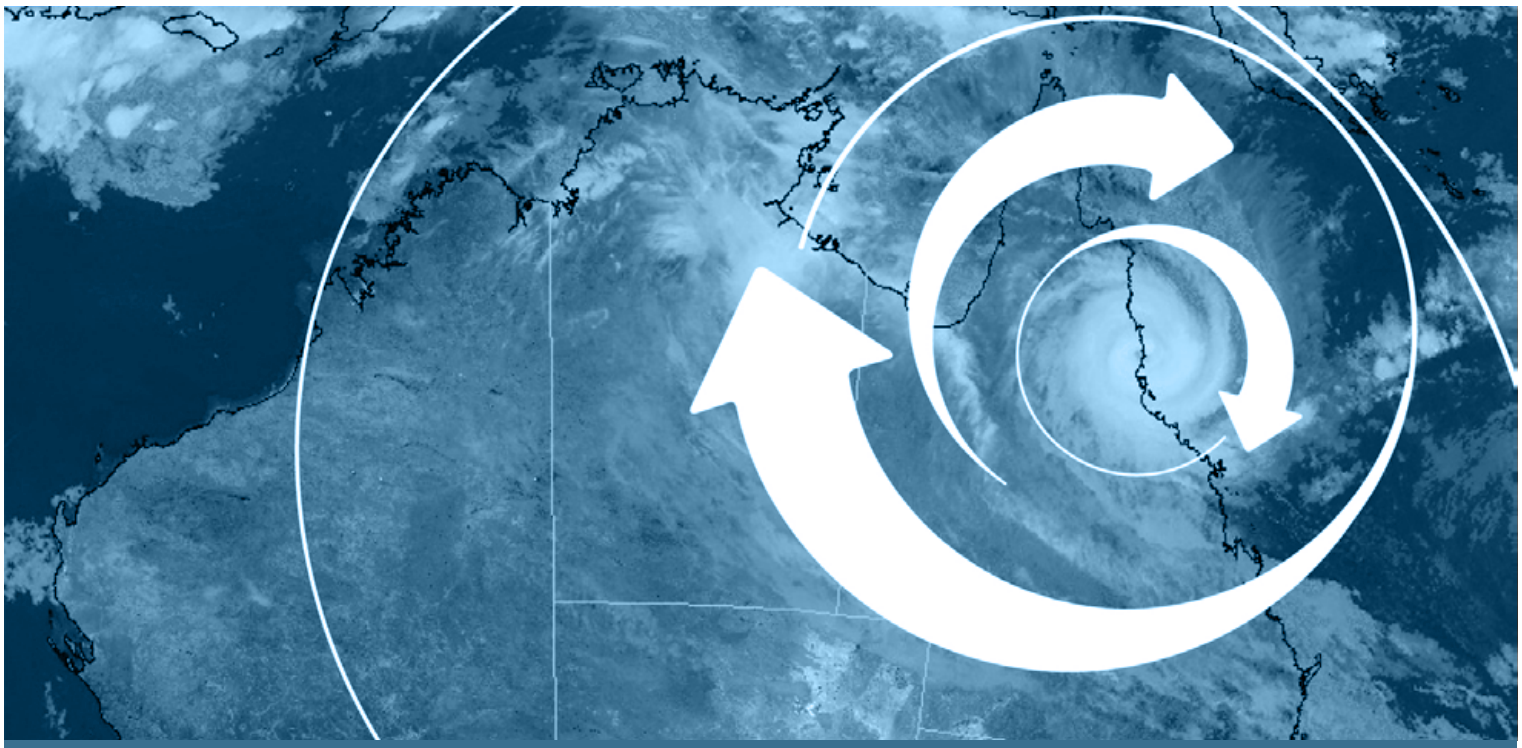

REPORT NO. TS769 Revision A

Simulated Wind Driven Debris Impact Testing of Longspan Roof Cladding

8 June 2010

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

CYCLONE TESTING STATION

JAMES COOK UNIVERSITY AUSTRALIA

Disaster Preparedness
Department of Public Works

Queensland Government

1. Introduction

This Report No. TS769 Revision A is to replace the original document Report No. TS769.

In this testing program, simulated wind driven debris impact loading of *Stramit Longspan* roof cladding to be installed on public cyclone shelters in Queensland was performed. The cladding 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 a local supplier. 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 x $V_{10,000}$ for horizontal trajectories and 0.3 x $V_{10,000}$ for vertical trajectories.

b) A 100 mm x 50 mm piece of timber of 4 kg mass impacting end-on at 0.4 x $V_{10,000}$ for horizontal trajectories and 0.1 x $V_{10,000}$ 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 x $V_{10,000}$ = 8.5 m/s

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

0.4 x $V_{10,000}$ = 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) If perforated, have a maximum perforation width of less than 8 mm.

4. Test Apparatus and Procedure

The roof test specimens were tested in the Cyclone Testing Station's air cannon testing facility. Two differently sized air cannons were used to fire the timber missile and the steel spheres. Both 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 missiles are fired through the barrels and accelerate to the required velocity.

The test specimens were mounted on a target support frame located about 1300 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 missiles, at their tail ends, before they impacted the target.

5. Test Specimens

The test roof specimens were set up in a 900 mm triple span arrangement, supported by 1.5 mm BMT steel z-purlins (Z151015). The cladding was screw fixed to the support as per manufacturer's installation manual using 14-10 x 50 mm self-drilling metal screws fitted with *Square-Lok* cyclone washers.

5.1 Longspan Cladding

The Longspan steel cladding used in this test program was rolled from G550 steel sheeting with a stated Base Metal Thickness (BMT) of 0.48 mm. The total sheet width is approximately 750 mm with eight ribs per sheet which are spaced at 100 mm centres. The cover width of the cladding is 700 mm and the ribs are approximately 27 mm high, 25 mm wide at the top and 60 mm wide at the bottom; the width of the pans between the ribs is 40 mm. Figure 1 presents an end view that shows the sheeting profile. The cladding has an anti-capillary side-lap, visible as an extension on the far right rib in Figure 1.

Figure 1: End view of Longspan cladding showing fixing pattern

6. Results

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

Table 1: Impact Testing Results

Trial No.	Date tested	Impact Location	Impact Velocity (m/s)	Results and Observations
L1	8 Dec 2009	Various (5 impacts)	~30.0	Pass. Small indentations.
L2	11 Dec 2009	Side lap, midspan of end span	9.3	Pass. Deformation across 2 ribs.
L3	14 Dec 2009	Centre of sheet, next to end support	9.6	Pass. Deformation across 2 ribs.
L4	14 Dec 2009	Centre of sheet, midspan of internal span	10.7	Pass. Deformation across 2 ribs.
L5	14 Dec 2009	Side lap, midspan of internal span	9.4	Pass. Deformation across 2 ribs.
L6	14 Dec 2009	Centre of sheet, midspan of end span	9.6	Pass. Deformation across 2 ribs.
L7	14 Dec 2009	Centre of sheet, next to internal support in end span	8.1	Pass. Deformation across 1 rib.
L8	14 Dec 2009	Centre of sheet, next to internal support in internal span	9.8	Pass. Deformation across 2 ribs.

7. Conclusions

A test program of simulated wind driven debris impact loading was performed on *Longspan* roof cladding manufactured by *Stramit Building Products*.

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 roof cladding when subjected to Debris Test Loads A and B.

The roof cladding tested is deemed to satisfy the vertical trajectory 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

Appendix A – Photographs of Tested Cladding

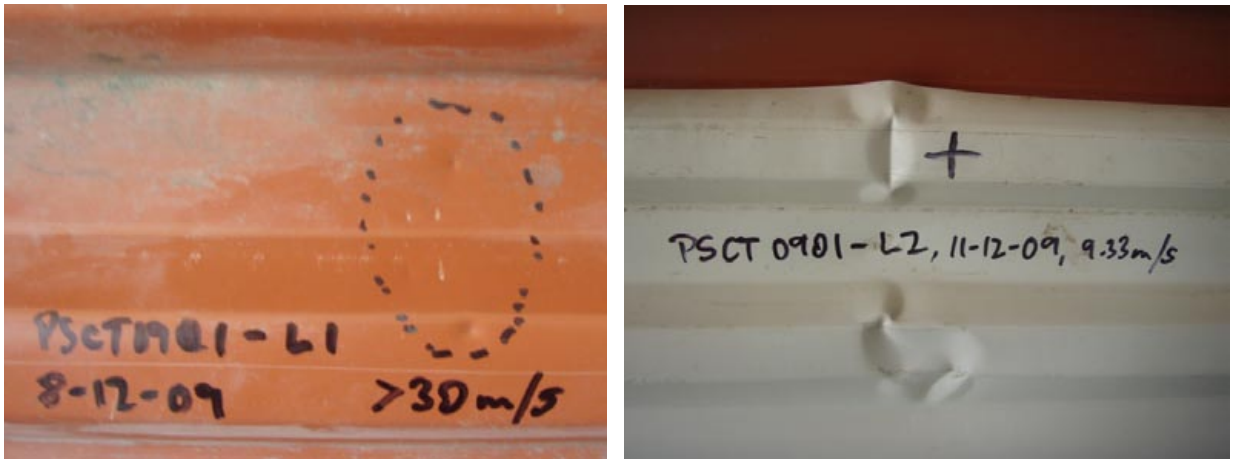

Figure 2: Cladding damage after Trials L1 (left) and L2 (right)

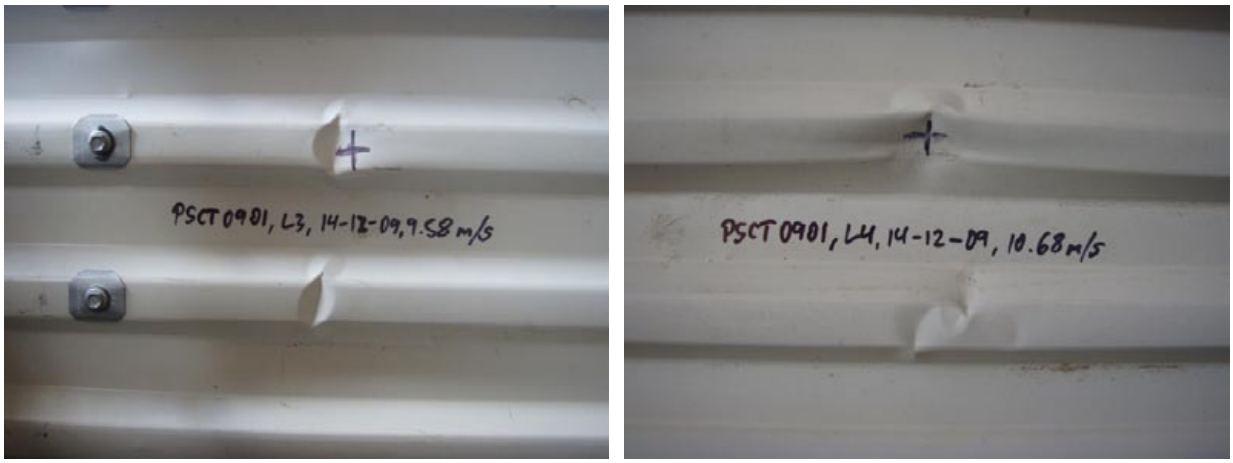

Figure 3: Cladding damage after Trials L3 (left) and L4 (right)

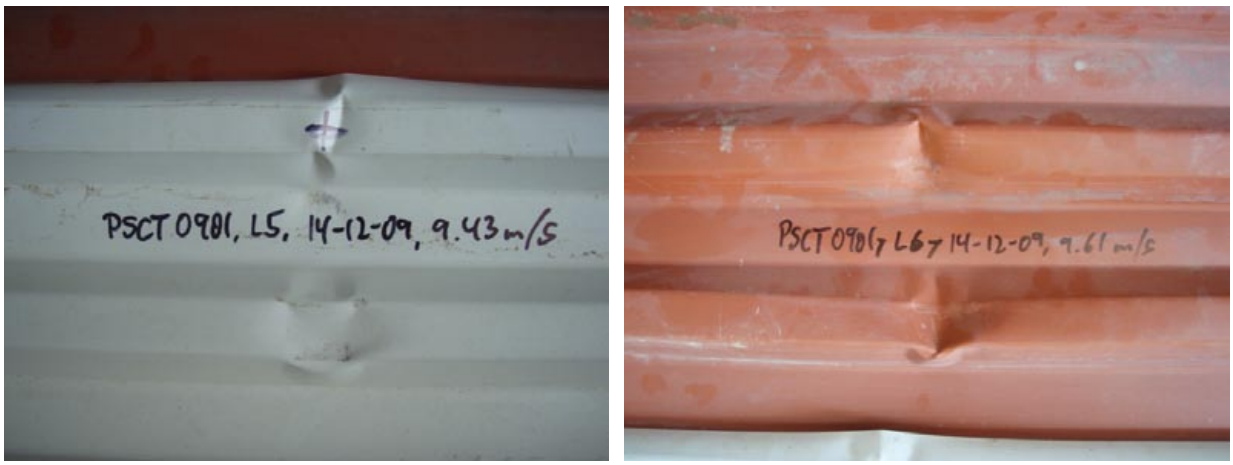

Figure 4: Cladding damage after Trials L5 (left) and L6 (right)

Figure 5: Cladding damage after Trials L7 (left) and L8 (right)