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TECHNICAL NOTE No.2
Simulated Wind Load Testing of Roof and Wall Cladding Systems

1 INTRODUCTION

The Cyclone Testing Station (CTS) is an independent authority on the effects of high wind and related damage to low-rise building systems in Australia, South East Asia and the Pacific.

CTS provides a service to the building industry for testing the effects of wind forces on buildings and building components.

The CTS has the equipment and technical expertise to test existing and new roof and wall claddings to comply with Australian and International standards.

2 AIRBOX AND TEST SET UP

The CTS normally conducts simulated wind load testing using the airbox testing facility.

2.1 Airbox Testing Facility and Test Setup

The airbox test rig is an open top pressure chamber. The top-testing surface of the air box has an internal clearance width of 2.05 m and an adjustable length of up to 10 m. Centrifugal fans introduce air pressure inside the airbox and simulate the combined effect of suction pressure on external surfaces and positive internal pressure on internal face applied to the sheeting. Cyclic loading is achieved by opening and closing pressure dump valves.

The test cladding panel will be fixed to the supports to become the top horizontal surface. The supporting members will be bolted to the CTS airbox. The test panels are normally mounted *outside facing out,* to model a combination of negative (suction) pressure and positive internal pressure, this being the larger magnitude wind load case.

2.2 Test Specimen

The test panel normally consists of one or two full central sheet(s) and two narrower side sheets, covering a total width of 2044 mm. Plastic sheeting will be loosely fitted around the airbox chamber perimeter, above the supports, but below the test panel, to minimize air leakage when the airbox is pressurised.

For the simulated wind load tests, the test specimen shall incorporate no fewer than three supporting members. The CTS recommends triple spans arrangement for multi-span testing. If the special case of single span cladding is to be investigated, a single span test specimen should be used, but the results of such tests **shall not** be extrapolated to the multispan case.

3 AIRBAG TESTING

The CTS can perform cladding tests in an alternative test rig using airbags. The airbags are placed between the cladding and the bed of the test rig and inflated. The load is measured on the test rig and converted to an equivalent pressure.

4 SIMULATED WIND LOAD TESTING OF CLADDING SYSTEMS

4.1 General

The ability of wall and roof cladding to resist wind pressures in non-cyclonic and cyclonic regions is determined by testing cladding systems.

A test cladding system consists of sheeting, and fastenings and not their supporting members assembled together as it will be in practice. The test is not intended to test the supporting structure, but does test the strength of the cladding fasteners fixed into the type, grade and thickness of cladding supports.

4.2 Serviceability Testing – Non Cyclonic and Cyclonic Regions

The CTS can perform serviceability testing, prior to any strength test. Note that AS4040.2 and AS4040.3 specify identical serviceability testing requirements for non-cyclonic and cyclonic regions respectively.

Applied pressure versus cladding deflections data is required when developing the cladding's serviceability limit state design capacity tables. For serviceability testing the CTS can place a maximum of six deflection measurement devices to nominated points on the test cladding panel. The locations of these points are determined during discussions with client and/or the client's engineer. Note that once serviceability testing is completed, the same test panel can then be tested for strength.

4.3 Static Strength Testing – Non Cyclonic Regions

The CTS performs static strength testing in accordance with *AS4040.2-1992, "Methods of Testing Sheet Roof and Wall Cladding, Method 2: Resistance to Wind Pressures for Non-Cyclone Regions*". This standard sets out a test method for determining the resistance of roof and wall cladding to wind pressure for non-cyclonic regions. Static strength test results can be used to determine strength design wind capacities

The strength test criteria are specified as follows: The test pressure shall be determined by multiplying the strength Limit State design pressure (failure pressure) by the factor to allow for variability of structural units (k_t), as defined in Table 5.1 of *AS1562.1 –1992*, "*Design and Installation of Sheet Roof and Wall Cladding, Part 1: Metal*". If a number of identical tests are carried out, then each sample is required to support this test pressure.

Note that Clause 6.3 of *AS4040.2* requires that the test pressure must be held for 1 minute. However, as the test method is for an ultimate limit state design strength criteria, the test specimen can show signs of distortion and permanent deformation and still be considered a successful outcome.

The reverse case, where a design pressure is to be determined, based on a single static test failure pressure, is not directly covered by *AS4040.2*, but the CTS approach is similar. For this case, the static Limit State strength design pressure is calculated by dividing the failure pressure by 1.5, the value of (k_t), for a single unit tested.

4.4 Cyclic Strength Testing – Cyclonic Regions

Note that for cyclic strength testing, a target test pressure is required before starting the test.

4.4.1 Testing Regime for Metal Roof Cladding

The CTS performs cyclic strength testing in accordance with *Specification B1.2: Design of Buildings in Cyclonic Areas* of the Building Code of Australia (*BCA) 2008 Volume One*. This specification sets out a loading regime for determining the resistance of roof cladding to wind pressures in cyclonic regions.

The Low-High-Low (LHL) test regime is mandatory for metal roof cladding and its immediate supporting members. The LHL test sequence consists of 10360 cycles at various

percentages of the test pressure (P_t) and one cycle to the full test pressure, which must be held for at least 10 seconds. Details of the loading sequence are presented in Table 1.

Table 1: *Low-High-Low Fatigue Loading Sequence*

Sequence	No. of Cycles	Load
A	4500	0 to 0.45 P_t
B	600	0 to 0.60 P_t
C	80	0 to 0.80 P_t
D	1	0 to 1.00 P_t
E	80	0 to 0.80 P_t
F	600	0 to 0.60 P_t
G	4500	0 to 0.45 P_t

The test pressure (P_t) for strength limit state shall be equal to the design pressure for the wind load strength limit state multiplied by the appropriate factor for variability (k_t) as defined in AS/NZS1170.0. Additional strength tests with different span lengths can be counted as replicates provided that they have the same mode of damage and/or deformation.

The results from cyclic testing allow a Strength Limit State design wind load capacity to be determined for metal roofing in cyclonic regions of Australia.

4.4.2 Testing Regime for Wall and Non Metallic Roof Cladding

The CTS performs cyclic strength testing for wall claddings and non-metallic roof cladding in accordance with *AS4040.3-1992, "Methods of Testing Sheet Roof and Wall Cladding, Method 3: Resistance to Wind Pressures for Cyclone Regions*". This standard sets out a test method for determining the resistance of wall cladding to wind pressures in cyclonic regions.

A fatigue loading sequence will be conducted in accordance with AS4040.3. The fatigue loading sequence is presented in Table 2 below where P_t is the Target Limit State test pressure.

Table 2: AS4040.3 *Fatigue Loading Sequence*

No. of Cycles	Cycle Load
8000	0 to 0.40 P_t
2000	0 to 0.50 P_t
200	0 to 0.65 P_t
1	Ultimate Load

For one test sample, *AS4040.3-1992* specifies an Ultimate Load of 1.30 P_t for the Single Load Cycle. If either two or three identical tests are performed, then the Single Load Cycle value to be applied reduces to either 1.20 Pt or 1.00 Pt respectively, but all of the tests must support the smaller load. Note that the single load test cycle must be supported for 1 minute.

The test pressure is then divided by the material capacity reduction factor to obtain the Strength Limit State Design Wind Load capacity.
The results from cyclic testing allow a Strength Limit State design wind load capacity to be determined for non metal roofing and wall cladding in cyclonic regions of Australia.

5 NATA ACCREDITED TEST REPORTS

After completion of testing, the CTS will issue a commercial in confidence test report describing the test methods, results and if requested, recommended design capacities for the configurations tested.

Note that the CTS test procedures are conducted in accordance with its quality management system which is NATA accredited.

CTS will issue Test Summary Sheets in conjunction with test reports. These Test Summary Sheets will be provided for each profile and will reference the corresponding report number. Test Summary Sheets have an expiry date about four (4) years from the date of report (either June 30 or December 31) and are valid until the expiry date noted at which time they must be reappraised.

6 REFERENCES

- AS/NZS1170.0:2002 – Structural Design Actions – General Principles
- AS/NZS1170.1:2002 – Structural Design Actions – Permanent, Imposed and Other Actions
- AS/NZS1170.2:2011 – Structural Design Actions – Wind Actions
- AS1562.1:1992 – Design and Installation of Sheet Roof and Wall Cladding – Metal
- AS/NZS1562.2:1999 – Design and Installation of Sheet Roof and Wall Cladding – Corrugated Fibre-Reinforced Cement
- AS1562.3:2006 – Design and Installation of Sheet Roof and Wall Cladding – Plastic
- AS4040.0:1992 – Methods of Testing Sheet Roof and Wall Cladding – Introduction, List of Methods and General Requirements
- AS4040.2:1992 – Methods of Testing Sheet Roof and Wall Cladding – Resistance to Wind Pressures for Non-Cyclone Regions
- AS4040.3:1992 – Methods of Testing Sheet Roof and Wall Cladding – Resistance to Wind Pressures for Cyclone Regions
- Building Code of Australia