Evaluation Method

BRANZ EM7 [December 2018]

Performance of mid-rise cladding systems

1222 Moonshine Rd
RD1, Porirua 5381
Private Bag 50 908
Porirua 5240
New Zealand
branz.nz

Funded from the Building Research Levy

The work reported here was funded by BRANZ from the Building Research Levy.

ISSN: 2624-1579

Performance of mid-rise cladding systems

BRANZ Evaluation Method EM7

Reference

BRANZ. (2018). *Performance of mid-rise cladding systems.* BRANZ Evaluation Method EM7. Judgeford, New Zealand: BRANZ Ltd.

Abstract

This evaluation method (EM7) represents a series of tests from AS/NZS 4284:2008 *Testing of building facades*, with specific nominated values for the performance levels. EM7 provides a means of assessing the weathertightness-oriented performance of generic domestic-oriented external wall cladding systems for use on buildings between 10 m and 25 m in height and expects that a drained and ventilated cavity is used as part of the cladding design. The aim is to provide a test with a consistent set of parameters for use in the design of claddings for mid-rise building.

Keywords

Facade testing, weathertightness, air infiltration, seismic racking.

Parameters

- SLS pressure of ±2.25 kPa (with larger negative values possible)
- Seismic SLS displacement of ±15 mm
- Static water at 675 Pa air pressure
- Cyclic water penetration at air pressures of 338–675 Pa, 450–900 Pa and 675−1350 Pa

Contents

1. General

This evaluation method (EM7) represents a series of tests from AS/NZS 4284:2008 *Testing of building facades*, with specific nominated values for the performance levels. EM7 provides a means of assessing the weathertightness-oriented performance of generic domestic-oriented external wall cladding systems for use on buildings between 10 m and 25 m in height and expects that a drained and ventilated cavity is used as part of the cladding design. The aim is to provide a test with a consistent set of parameters for use in the weathertight design of claddings for mid-rise buildings. The parameters have been developed from research funded by the Building Research Levy and engagement with a variety of industry stakeholders. For buildings less than 10 m in height, New Zealand Building Code (NZBC) clause E2 *External moisture* Verification Method E2/VM1 provides a simpler method of determining whether a cladding system complies with NZBC clause E2.3.2, although EM7 could also be used. Compared with E2/VM1, the procedure herein has the following differences:

- Greater emphasis on the air barrier (rigid underlay) and exterior cladding working together as a cladding system.
- A requirement for the cladding system to provide a degree of airtightness.
- Increased test pressures to reflect the change in height of the buildings and the greater significance of local and internal pressure factors on larger buildings.
- The use of seismic racking to verify performance following an earthquake.
- Specimen details that are more representative of mid-rise construction.

1.1 Use

Further to demonstrating compliance with NZBC clause E2.3.2, other aspects of NZBC compliance may be revealed during use of EM7 – for example, this can contribute to NZBC clause B1 *Structure* clause B1.3.2.

EM7 includes the mandatory parts of AS/NZS 4284:2008 except for:

- structural test at serviceability limit state (SLS)
- structural test at ultimate limit state (ULS)

These tests (or other tests from AS/NZS 4284) can be added in to the EM7 test sequence if desired, in which case, the test becomes an AS/NZS 4284:2008 test using the parameters of EM7. If there are *any* modifications to the EM7 test process (tests added or removed), the test loses its EM7 status and reverts to an AS/NZS 4284:2008 test.[1]

The tests in this evaluation method shall be undertaken in a test facility with IANZ or equivalent accreditation for testing to the procedures of AS/NZS 4284:2008. This test is not applicable to a cladding that is completely sealed and expects the incorporation of a drained and ventilated cavity. It is intended for this standard method to provide higher levels of security for all stakeholders regarding the weathertightness performance of cladding systems used on mid-rise buildings.

This test (EM7) is not intended to be used to verify the weathertightness of window systems or other elements within a cladding. Window suppliers may choose to use AS/NZS 4284:2008 tests at air pressures beyond the scope of NZS 4211:2008

[1] This is so that any EM7 test can be directly compared to another EM7 test.

Specification for performance of windows to support the use of their products installed in certain claddings beyond a ULS of 2.5 kPa and where seismic racking must be considered.

Alternatively, the scope of NZS 4211:2008 may in future be extended to allow operable windows to be tested to pressures beyond 2.5 kPa and to demonstrate performance following seismic racking. (This was under consideration by the Window & Glass Association New Zealand in October 2018.)

2. Scope

The scope of EM7 is restricted to buildings that:

- have a height measured from the lowest ground level adjacent to the building to the highest point of the roof (except for chimneys, aerials and the like) of 25 m or less
- have cladding systems exposed to a specific peak positive SLS air pressure of up to 2.25 kPa (ULS 3.2 kPa)
- have claddings that include a drained and ventilated cavity of 20 mm minimum depth with an inter-storey horizontal drainage joint every 2 floors, or 7.0m, and minimum ventilation openings of 1000 mm^2/m
- include window and door units that are manufactured to comply with the relevant pressures and inter-storey deflections
- have inter-storey deflections designed for up to ±15 mm of horizontal in-plane movement during seismic SLS events assuming a 3 m inter-storey height (height/200)
- have cladding supported on lightweight framing (expected to be timber or light steel framing) with studs at centres no greater than 600 mm that is structurally connected to the floor at each level of the building – this evaluation method is not intended to be used with infill framing that is isolated from structural movement of the building
- have a rigid building underlay affixed to the framing.

Comment

AS/NZS 1170.2:2011 *Structural design actions – Part 2: Wind actions* could be used to calculate the increase in SLS pressure above and beyond the 1515 Pa associated with E2/VM1. Table 4.1 in that standard can be used to calculate a worst-case increase in wind speed of 17%. This corresponds to an increase in pressure of 37%, which would give an SLS of 2.075 kPa and a ULS of 2.9 kPa. This does not represent much increase over the 2.5 kPa ULS limit stated in E2/VM1. Instead, the approach taken has been to approximately increase the pressures associated with E2/VM1 by 50%. This scope will allow the inclusion of buildings on which the effects of local pressure factors and internal pressures are more significant than expected by E2/VM1.

3. Specimen details

The minimum size of the wall cladding specimen to be tested shall be 3000 mm high by 3000 mm wide including a fixed window of 1800 mm high x 800 mm wide. The underlay (air barrier) shall include removable inspection ports but otherwise will be installed as per the manufacturer's details. The removable ports allow inspection of the wall cavity and permit the wetwall test to be performed more easily. BRANZ research shows that circular inspection ports will not significantly alter the general behaviour of the underlay in the air, water or seismic test if sized and located as specified.

3.1 Included details

The wall cladding details that shall be included, as a minimum, for any test specimen using EM7 are:

- typical vertical joint(s)
- typical (vertical) external corner
- typical (vertical) internal corner
- cladding detail at the bottom of the cladding (footer)
- cladding detail at soffit
- cladding detail at saddle junction with a balustrade or parapet
- typical horizontal control joint (if such joints are needed in addition to inter-storey joints)
- typical vertical control joint
- typical window head detail
- typical window sill detail
- typical window jamb detail
- typical inter-storey/tenancy horizontal drainage joint
- 12 mm pipe penetration detail
- square flange, 200 mm round duct penetration
- vertical cladding termination.

Test specimens must include all cladding details or junctions for which compliance with this evaluation method is intended to be demonstrated and claimed. Air seals around the windows shall be appropriate for the performance expectations.[2] If several cladding types or orientations or different underlays or the like are to be tested in one sample panel, each option shall be at least 3000 mm high x 3000 mm wide. If other elements are included, the sample may need to be larger. This helps to ensure that sufficient length of each type of joint and detail is exposed to the test conditions.

If any changes are made to the test order or sample details or tests are removed or added, the test is no longer recognised as an EM7 test. It becomes an AS/NZS 4284:2008 test using parameters selected from EM7. This evaluation method is a particular implementation of AS/NZS 4284:2008 intended for assessing the generic weathertightness performance of drained cladding systems on mid-rise buildings. It is not intended to replace the use of AS/NZS 4284:2008 when required by a specifier.

[2] It is unlikely that gunned foam on a backing rod will maintain its required airtightness under seismic racking. It is likely that a wet-applied seal and backing rod will be necessary.

3.2 Inspection ports

To enable inspection of the drainage cavity during testing and to facilitate the wetwall test, inspection ports shall be installed.

The ports are to be 150 mm diameter (6-inch) screw-in marine access hatches. These are to be installed into the specimen using screws, with silicone sealant used to provide an air seal. The cut-out hole will be 165 mm, and the distance from the edge of this hole to the edge of the sheet will be no less than 115 mm.

The ports are to be installed no more frequently that at 400 mm centres horizontally and 800 mm centres vertically, where possible. Sufficient ports shall be installed to ensure that, when open, the majority of the air pressure is held across the wetwall. (This may require up to 20 ports in a 3000 x 3000 mm sample). There is no minimum number of ports. However, it is expected (where timber framing is used) that at least one port will be installed between dwangs in each normal-width stud cavity.

3.3 Pressure measurement

As well as measuring the booth pressure, a pressure tap shall be available in each cavity compartment to enable the pressure difference across the wetwall to be measured.

4. Test procedure

EM7 comprises the following tests methodologies of AS/NZS 4284:2008:

- Preliminary test at SLS pressure of +2.25 kPa and then -2.25 kPa.
- Air infiltration test 1 at -75 Pa and then +75 Pa.
- Seismic test at SLS displacement of ±15 mm.
- Air infiltration test 2 at ±75 Pa followed by air leak standardisation.
- Water penetration test – static pressure test at 675 Pa and three-stage cyclic test at 338–675 Pa, 450–900 Pa and 675–1350 Pa.
- Water management tests with simulated gaps in the wetwall (static and cyclic).
- Wetwall test – seal degradation at static pressure of 75 Pa across the wetwall.

It is possible that some modifications will be required to reach the acceptance criteria. These modifications must be documented in the test report, noting the restrictions in AS/NZS 4284:2008 clause 8.1.2 where the air and water tests must be repeated if changes are made that affect these factors. If there are water-sensitive materials or elements used in the system that are wetted by the water tests, these must be dried adequately before retesting.

These modifications should then be incorporated into the product literature or cladding design so that construction on site matches the specimen as modified.

If changes to the sample are still necessary after four sets of modifications, the test cannot claim a pass to EM7 but may be used as a development test to AS/NZS 4284:2008. It can be retested (or a new specimen tested) after appropriate design changes have been made.

4.1 Preliminary test at SLS pressure

Apply a preconditioning loading to the external face of the test sample for a period of 1 minute of positive pressure followed by a period of 1 minute of negative pressure (suction). The loading shall be +2.25 kPa[3] and -2.25 kPa, but a higher negative pressure test may be applied if desired.

4.2 Air infiltration test 1

Unlike AS/NZS 4284:2008, it is necessary in this method to determine the air leakage through the specimen itself, not just the total leakage through the test sample and test enclosure. Measurements are performed at ±75 Pa to align the air infiltration/ exfiltration with the ASTM E1677-11 value for an undamaged air barrier and the AAMA 508-14 interpretation of a damaged air barrier (after the seismic racking test).

4.2.1 Method

Seal the face of the specimen in the manner described in AS/NZS 4284:2008 clause 8.4.2 paragraph 2. Record the volumetric air flow rate at -75 Pa and +75. The results provide a measure of the airtightness of the test enclosure.

[3] The scope of EM7 is not limited by negative pressures, hence greater negative pressures can optionally be applied to help verify the structural adequacy of the system at negative pressures beyond -2.25 kPa. Safety measures must be taken to prevent any damage to the sample at high pressures from impacting people or plant.

Unseal the specimen and then repeat the above pressure sequence. The results provide a measurement of the combined airtightness of the total specimen and enclosure leakage.

Subtract the enclosure leakage results from the total leakage to provide an estimate of the specimen leakage.

If the booth leakage is more than 20% different from the typical booth leakage found from testing previous samples in previous tests, the reason for the difference must be identified and the test repeated if necessary.

4.2.2 Criteria

The specimen air leakage at ±75 Pa must not exceed 0.3 L/s.m^2.

4.2.3 Testing leakage at other pressures

If desired for comparison purposes, airtightness tests at other pressures (for example, ±150 Pa) may also be performed in addition to the tests at ±75 Pa.

4.3 Seismic test at SLS displacement

The purpose of the seismic test is to verify the test specimen can accommodate a reasonable amount of inter-storey drift while remaining serviceable. In AS/NZS 4284:2008, a water penetration test is subsequently used to assess the severity of any damage. In EM7, we also use an air infiltration test as a metric of damage and perform this prior to the water penetration test so that the specimen airtightness is not altered due to the presence of water in any materials.

4.3.1 Method

Using the procedure in AS/NZS 4284:2008 clause 8.9, perform 15 cycles of ±15 mm inter-storey movement with a period of approximately 15 seconds.

Inspect and report the condition of the specimen after the completion of all the cycles.

The deflection should be measured on a significant piece of structure such as a floor slab or ribbon plate/joist in the plane of the air barrier and not the cladding, ram or reaction frame. The measurement point must be as close as practicable to the attachment of the ram to the structure. This is to ensure that the structure is racked by the correct amount, with any movement in the cladding being dependent upon the transfer of movement through the structure. Hence, the connections used in the structure must mirror the construction connections used in practice.

Comment

In an AS/NZS 4284:2008 test, the seismic deflection is to be specified, i.e. there is no default value. The value is based on what is typically used in a AS/NZS 4284:2008 test. This test is a serviceability test, so there is little value in going to more extreme values of deflection. There has not been any research into the effect of different loading periods, so these are not specified but it is assumed that the deflection will be effected by some kind of hydraulic actuator.

4.4 Air infiltration test 2

4.4.1 Method

See 4.2.1.

4.4.2 Criteria

The specimen air leakage at ±75 Pa must not exceed 0.6 L/s.m^2 (including the measurement uncertainty), being double the air leakage measured in the air infiltration test 1. It is required that errors in the air leakage measurement be minimised and the air leakage be quoted with its expanded uncertainty.

If the air leakage exceeds 0.6 L/s.m^2, the sample has suffered damage and design changes should be considered before continuing the test.

4.4.3 Airtightness standardisation

Following the completion of air infiltration test 2, bring the specimen air leakage up to 0.6 L/s.m^2 at +75 Pa[4] by drilling 3 mm diameter holes 150 mm above horizontal seams in the air barrier and 150 mm above the base of the specimen such that they are evenly distributed across the test specimen. (Note: The airtightness at -75 Pa may be different.) This is to ensure EM7 specimens have a standardised airtightness prior to water penetration testing and that this airtightness corresponds to a non-perfect air barrier.

Comment

It will probably be necessary to drill the holes while the test is in progress to achieve the correct airtightness level.

4.5 Water penetration tests – static and cyclic

Water penetration tests are performed in accordance with AS/NZS 4284:2008.

4.5.1 Static pressure water penetration test

The water penetration test by static pressure shall be conducted in accordance with AS/NZS 4284:2008 clause 8.5 at a test pressure of 675 Pa.

4.5.2 Cyclic pressure water penetration test

The water penetration test by cyclic pressure shall be conducted in accordance with AS/NZS 4284:2008 clause 8.6 using the positive serviceability pressure of 2.25 kPa. The three stages of the test involve pressures varying from 338–675 Pa, 450–900 Pa and 675–1350 Pa.

This test shall commence within 30 minutes of the completion of the static pressure test, otherwise the sample shall be pre-wet for a further 5 minutes.

4.5.3 Criteria

Water that is able to penetrate to the back of the wetwall through introduced defects and joints shall be controlled. It may contact battens and other cavity surfaces, but no

[4] Where positive pressure refers to the pressure in the booth being higher than atmospheric pressure outside the booth, with the exterior face of the cladding inside the booth.

water shall be transferred to the plane of the rigid wall underlay, cavity air sealing or structural framing due to a design or systemic failure. Water that may arrive on the rigid underlay due to an isolated blemish may be disregarded. No water may drip through an air space within the cavity where it is possible for water to impact on a surface in the cavity and splash onto the wall underlay. However, any spattering of water into the cavity through the introduced defects shall be ignored.

The inspection ports in the underlay/air barrier shall be used to assess the majority of the construction. In addition, within 30 minutes of the completion of the water penetration tests, the air seal from around the windows shall be removed and also inspected for non-compliance.

4.6 Water management tests– static and cyclic

The procedures in section 4.5 shall be repeated following the introduction of 6 mm diameter holes through the wetwall as permitted by AS/NZS 4284:2008 clause 9.9.

The intent is to simulate potential leaks where sealant could get missed, cover could be low or overlapping joints may have openings. These water leakage holes shall be formed in the following places:

- Through the window/wall joint at three-quarter height of both jambs of the window(s).
- Immediately above the window head flashing(s).
- Through the external sealing of the horizontal and vertical joints – for example, at their ends.
- Through the external and internal corners.
- Through the pipe and duct penetration external seals.
- Above any other wetwall penetration details.

The introduction of defects must only penetrate to the plane of the back of the wetwall so the water management of the cavity can be assessed.

4.6.1 Criteria

See 4.5.3 .

4.7 Wetwall test – seal degradation

4.7.1 Method

With the inspection ports in the air barrier/underlay open and the air seal from around the window(s) removed, perform a static pressure water penetration test (see 4.5.1) with an air pressure of 75 Pa applied across the wetwall for 15 minutes. The air pressure across the air barrier shall be less than 75 Pa.[5]

4.7.2 Criteria

See 4.5.3.

[5] If the air pressure across the air barrier is not less than 75 Pa, this may be achieved by opening more ports in the rigid air barrier.

5. Reporting

The test report shall contain the following:

- Test date and report number.
- Confirmation that this is an EM7 test without modification.
- Testing agency, contact details and IANZ accreditation number (for the AS/NZS 4284:2008 test procedures).
- Identification of IANZ-accredited test officer and other persons attending the test.
- Name of client and specifier.
- Name of sample designer/manufacturer and installer.
- Any deviations from the official test method.
- Detailed specimen description, including drawings. All materials must be uniquely identified and not described generically.
- The results of each test and relevant observations on the behaviour or performance of the test samples with a summary of each test result as acceptable or unacceptable. This shall include the pressure drop across the air barrier during the wetwall test.
- Photographs of the system under test.
- A summary statement of overall conformance or non-conformance.
- Any other relevant requirements from the AS/NZS 4284:2008 test method.

6. Referenced documents

AAMA 508-14 *Voluntary test method and specification for pressure equalized rain screen wall cladding systems.*

AS/NZS 1170.2:2011 *Structural design actions – Part 2: Wind actions.*

AS/NZS 4284:2008 *Testing of building facades.*

ASTM E1677-11 *Standard specification for air barrier (AB) material or system for low-rise framed building walls.*

New Zealand Building Code Verification Method E2/VM1 *External moisture*, 3rd edition, Amendment 7 (2017).