ST0758/3

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Indicative face load testing of the Ezpanel cavity wall system

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Indicative face load testing of the Ezpanel cavity wall system

1. CLIENT

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2. OBJECTIVE

To determine the strength of the Ezpanel Cavity System under face loading so that it may be related to the wall criteria of New Zealand's non-specific design standard NZS 3604[1].

This report is to be read in conjunction with BRANZ test reports ST0758/1 Rev. 1 and ST0758/2 Rev. 1 and pertains to the sample provided only.

3. DESCRIPTION OF SPECIMENS

3.1 Product Description

The nominally 2.4 m x 2.4 m test specimen was made by the client. The exterior wall cladding system includes a vented cavity through the use of battens fixed to the framing as described in BRANZ test report ST0758/1 Rev. 1.

Studs were at 600 mm centres and nogs at 1200 mm centres. All framing timber was 90 x 45 grade MSG 8 Radiata Pine assembled using normal trade practice.

Polystyrene cavity battens, of cross section 55 x 20 mm, were fixed to the front face of the studs and the top plate. 150 mm lengths of these battens were placed as spacers at approximately 45° to the vertical at 300 mm centres along each nog and the bottom plate as described in BRANZ test report ST0758/1 Rev. 1.

The wall was clad with autoclaved aerated concrete (AAC) panels of nominal dimensions 1200 mm horizontal x 600 mm vertical x 50 mm thick, except that the top row of panels was only 170 mm high and the row of panels below this was only 450 mm high. The panels had a measured density of 690 kg/m^3 and were placed in a staggered pattern as shown in Figure 1. The joints were glued with Gorilla Grip Adhesive. Half the vertical joints and all the horizontal joints were off-frame as shown in Figure 1. A 3 mm plaster incorporating a fibre-glass mesh was used on the outside face.

A steel mesh with bars at nominal spacing of 150 mm in both directions and having a 3.2 mm diameter was embedded in the lightweight concrete.

The AAC panels were screwed through the polystyrene and into the timber framing using stainless steel screws at locations shown in Figure 1. The screws were 100 mm long with a 14 mm diameter head and were placed so that the screw head was flush with the outside face of the AAC. They had a shank of 5.1 mm diameter, with the bottom 50 mm threaded with an outside thread diameter of 6.4 mm. The screws were designed to be self drilling in timber.

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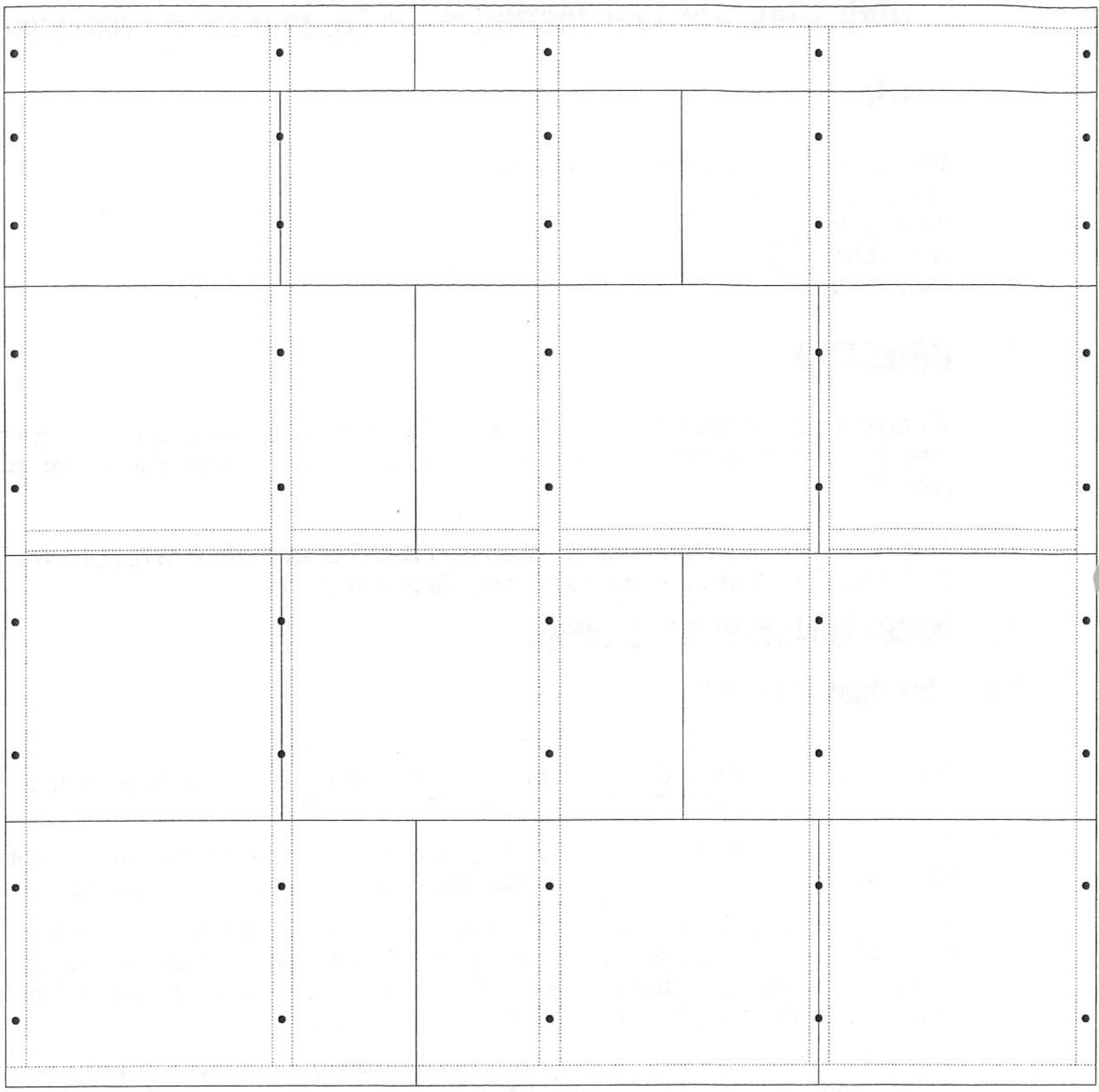

Figure 1. Panel Layout

In this figure:

- The panels are shown in solid lines and the wall framing behind is shown dotted.
- Screws fixing the AAC panels are shown thus as a black dot.

3.2 Construction of the Specimens

The specimen was provided by the client with a sheet of black polythene placed between battens and panels to act as a seal for the face load test.

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4. DESCRIPTION OF TESTS

4.1 Date and Location of Tests

The tests were carried out in July 2008 in the Fire Laboratory of BRANZ Ltd, Judgeford, New Zealand.

4.2 Test Equipment

The specimen was secured in an upright position within the front opening of an airtight pressure chamber. The top and bottom plates were securely fixed directly to the perimeter of the chamber with Tek screws. A layer of black polythene film had been placed between the polystyrene battens and the Ezpanels at the time of the specimen construction to achieve air tightness. The sides of each specimen were not fixed, but were sealed all around using the polythene sheet and adhesive tape so that the studs of the test wall could deflect without restraint from the side of the chamber.

Negative pressure (suction) was applied to the chamber using a centrifugal air pump. The fan speed was computer controlled to the target cyclic loading regime.

The pressure was measured with a Schaevitz differential pressure transducer connected to the inside of the chamber by a length of thick walled plastic tube and verified by a water manometer attached to the pressure box.

The test pressure was recorded using a PC running a software program to record the data.

4.3 Test Procedure

Each specimen was tested under negative pressure applied to the chamber. The pressure was applied in increasing steps of 0.1 kPa. Each pressure step was held for one minute. The pressure was then released back to zero for 15 seconds before the next level of pressure was applied to the specimen. This test procedure is based on AS 4040.2:1992[2].

5. OBSERVATIONS

The first observed damage was horizontal cracks in the plaster surface mirroring the panel horizontal joints. However, at test completion no glued joint had failed. Prior to failure the top of the studs had moved horizontally to be approximately 20 mm closer to the pressure box relative to the top plate).

The failure occurred suddenly and the exact sequence of events is not known. From the subsequent observations, as recorded in the photographs of Figure 2 to Figure 5, it is surmised that the following sequence occurred.

1. Sideways shear at the (top stud)-to-plate joint resulted in withdrawal of the nails in the end grain of the studs and consequently separation of the studs from the top plate as shown in Figure 5.
2. Panel screw fixings at the top right hand side (RHS) pulled through the panels or pulled out of the studs, as shown in Figure 3.
3. Stud rupture occurred on one stud about mid-height of the specimen as shown in Figure 3.

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4. Panel cracking occurred at the top LHS as shown in Figure 4.

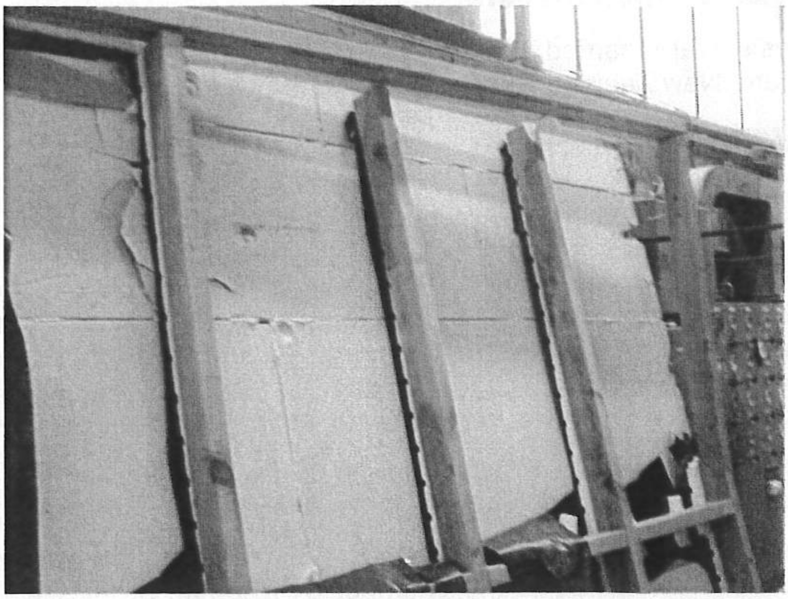

Figure 2. General photograph of specimen construction and failure modes taken after the test. (The black polythene sheet used as a seal between battens and framing has been partially removed.)

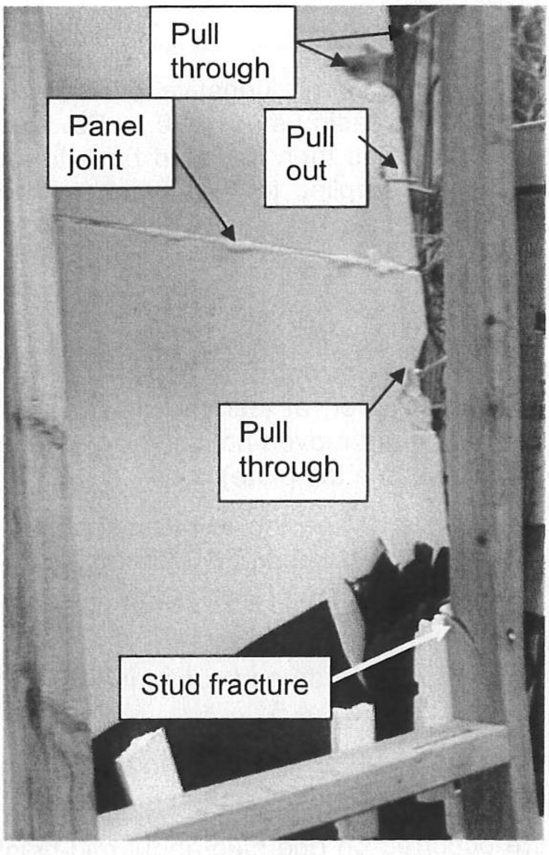

Figure 3. View of Stud fracture, panel joints, batten packers, screw pull-through and pull-out.

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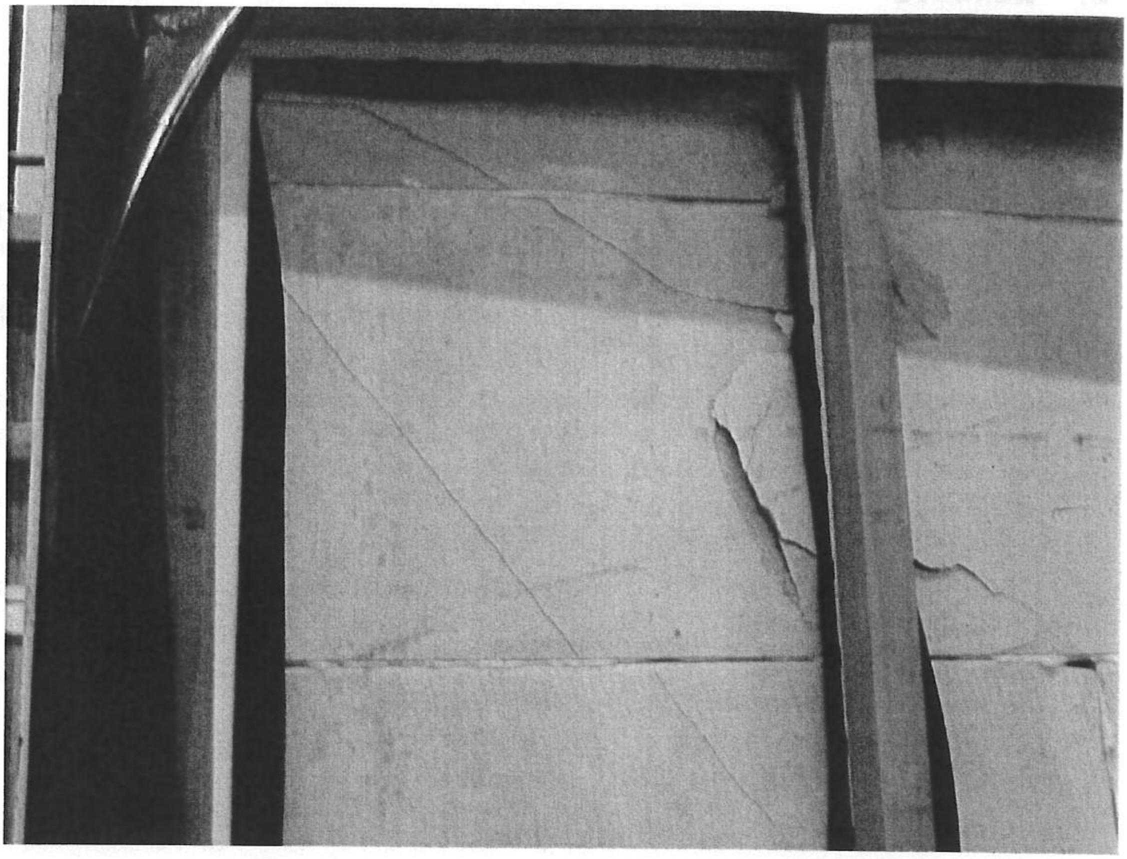

Figure 4. Cracks in panels and screw pull-through

Figure 5. Separation of studs from the top plate

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6. RESULTS

The maximum pressure resisted for one minute was 5.099 kPa.

7. DESIGN WIND SPEEDS

The analysis given below is only applicable to the exterior walls of buildings which fall within the scope of NZS 3604[1]. It assumes that the interior of these walls is fully lined which allows building internal pressures to be ignored in this analysis. It also assumes that the framing is separately designed for the design wind speeds calculated below.

AS 4040.2-1992[2] states that the test pressures are to be equal to the design pressures multiplied by the appropriate factor for variability. The factor for variability has been cited from Table 5.1 of AS 1562.1:1992[3] and for a single test specimen it is 1.5 for Strength Limit State. (Note, by comparing with values in Table 5.1 of AS 3623:1993[4] it can be shown that for these variability factors the coefficient of variability is assumed by AS 1562.1:1992 to be 10%.)

The Ultimate Limit State (ULS) design differential pressure (called p_z) is the specimen strength given in Section 6 divided by 1.5. Thus, $p_z = 5.099/1.5 = 3.399$ kPa

NZS 3604 wind loadings are based on NZS 4203:1992. The design ultimate wind pressure, q_z, is given by Eq 5.5.1 of NZS 4203[5] as:

$q_z = 0.6V_u^2$ (pascals)

The ultimate design external wind pressure on the building, p_e, from Eq 5.6.3 of NZS 4203 is:

$p_e = C_{pe}K_aK_LK_pq_z$

For cladding of buildings within the scope of NZS 3604, $C_{pe} = 0.65$ suction, $K_a = 1.0$, $K_L = 2.0$ (for buildings less than 25 m high) within 0.5a of a corner and 1.5 within 1.0a of a corner, (where 'a' = 0.2 times the length of the wall) and generally $K_p = 1.0$.

Substituting these values gives: $p_e = 1.3q_z$ within 0.5a of a corner.

The internal pressure, p_i, has been taken to be zero for lined walls as in this instance the internal pressure does not act on the cladding in this type of construction. Thus,

$p_z = p_e + p_i = p_e + 0 = p_e$

The ultimate design wind speed is calculated from:

V_u^2 (pascals) = $q_z/0.6 = p_e/1.3/0.6 = 3399/(1.3 \times 0.6)$, giving $V_u = 66.0$ m/sec

The design ultimate wind speed for Very High wind zones, as stipulated in NZS 3604, is 50 m/sec. Thus, the cladding system tested is suitable for all NZS 3604 wind zones (including Very High).

BRANZ test report ST0758/2 Rev. 1 provided design wind speeds and pressures subjected to satisfactory performance of a complete wall specimen under face load

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pressures. As this report has resulted in slightly lower design wind pressures, the design pressures and wind speeds given in this report govern.

8. CONCLUSION

The conclusions on maximum wind speeds and basic wind pressures summarised below require the wall framing to also be designed for the stipulated wind speeds and pressures. The building must be internally lined. The screw anchors are at a maximum centres of 600 mm in the horizontal direction and 300 mm in the vertical direction and must be at least 22 mm from panel edges and 100 mm from corners. At least two screws are required on each panel side except that a single screw at side mid-length may be used at panel sides which do not exceed 200 mm.

The Ezpanel Cavity System, when fixed as described herein, may be used as exterior wall cladding in NZS 3604 type construction for all wind zones up to and including "Very High". It can resist an ultimate limit state differential wind pressure across the cladding up to 3.4 kPa for all buildings fixing the cladding as described herein.

9. REFERENCES

1. Standards New Zealand. NZS 3604:1999. *Timber Framed Buildings*. SNZ, Wellington, New Zealand
2. Standards Australia. AS 4040.2 – 1992. *Method of testing roof and wall cladding. Method 2: Resistance to wind pressures for non-cyclone regions*. SA, Sydney, Australia.
3. Standards Australia. AS 1562.1 – 1992. *Design and installation of sheet roof and wall cladding*. SA, Sydney, Australia.
4. Standards Australia. AS 3623 – 1993. *Domestic metal framing*. SA, Sydney, Australia.
5. Standards New Zealand. NZS 4203:1992. *Loadings standard*. SNZ, Wellington, New Zealand.

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