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Testing deck details

BRANZ engineers have been looking at timber deck details in a project to define verified solutions for attaching decks and building safe handrails and barriers.

Figure 1: Test specimen weathering outside. The deck joists are attached to a ribbon board coach screwed to the wall framing.

NEW ZEALANDERS like decks around their houses to add outdoor living spaces. Consequently, much is published about how to build them including proprietary how-to guides, numerous *Build* articles and the Ministry of Business, Innovation and Employment *Guidance on barrier design* published in March 2012.

Two areas of concern

BRANZ identified two areas of timber deck design where current information is lacking or confusing:

- Cantilevered handrails or barriers.
- The attachment of decks to the building.

A BRANZ Building Research Levy-funded project set out to provide industry with verified solutions for these areas.

Some NZS 3604:2011 details confusing

Generally, timber deck construction is covered by clause 7.4 of NZS 3604:2011 *Timber-framed buildings*. Where the deck is greater than 1 m above ground, the New Zealand Building Code requires a barrier or handrail to safeguard people from falling.

The barrier is required to resist horizontal and vertical loads from people, so this is a critical consideration in its design. A 140 × 50 mm top rail on its flat can span horizontally between lateral supports up to 1.8 m, for example, between a house wall or return railings.

If there are no suitable supports within that distance, the barrier must be designed to cantilever up from its attachment to the deck structure. NZS 3604:2011 provides details for this cantilevered connection to the deck, but these are confusing and conflicting.

Where the height of the deck is greater than 3 m above ground, its support structure is outside the scope of NZS 3604:2011 and specific engineering design is required.

Proposed BRANZ deck details

No strings attached on pages 36–37 of this *Build* shows the proposed BRANZ deck details. These construction details have been verified by calculation against New Zealand Building Code requirements or have been tested.

Complete barrier construction details tested

Generally, cantilevered deck barriers are supported against lateral crowd loading by posts connected at their base to the edge of the deck structure. This is a demanding

Figure 2: Testing connections under vertical loading.

Figure 3: Testing post connections under lateral loading using a hydraulic ram.

detail for a timber structure, so NZS 3604:2011 requires the deck's joists and dwangs to be at least 190 mm deep to provide sufficient meat for the connection.

Neither NZS 3604:2011 nor the MBIE guidelines provide complete timber barrier construction details, so the BRANZ details required independent verification and testing.

Connections to the building

Figures 1 and 2 on page 36 show deck joists attached to a ribbon board (or stringer) coach screwed to the wall framing. If this attachment is through timber weatherboards and a drained cavity with waterproofing washers and shaped packers, the screws must project quite a distance from their point of attachment in the studs. This has raised questions about the load capacity of this arrangement.

Because the effects of repeated wetting and drying can cause slack in the connections, the test specimens were left outside to weather for 3 months after construction (see Figure 1). They were artificially wetted to reach over 25% moisture content before being dried for testing.

The details were then tested under gravity (downwards) loading (see Figure 2) and earthquake (outwards) loading.

Weakest link limits projection

It was interesting to see that, under outwards earthquake loading, the weak link was the connection of the floor joists to the top plate and the plate to studs inside. In most cases, this is only two skew nails.

As it is not generally practical to access this wall framing for reinforcing when constructing a deck, this detail limits the maximum size of the deck before supplementary bracing is required. This is the reason for the projection limit of 2 m in NZS 3604:2011 clause 7.4.2.

Barrier details and deck connections

For buildings where crowd loading is not anticipated, AS/NZS 1170 *Structural design actions* provides barrier loads for two situations:

- Interior of single unit residential – stair landings of private houses.
- Exterior balconies and decks in residential and light commercial buildings.

There are loads specified for horizontal and vertical loads on the top rail and for distributed loads on the infill.

Timber infills were tested under face loading between supports to simulate the infill barrier loads specified in AS/NZS 1170.1:2002. Test results were analysed to produce maximum spacing for the infill members between supports such as post to post or rail to rail.

Figure 6 on page 37 shows a 125 × 125 mm H5 post extended up from the ground to double as handrail supports. These were checked by calculation using NZS 3603:1993 *Timber structures standard* and examples tested in the lab. The details provide maximum heights and spacings for several post sizes.

Figures 4 and 5 on pages 36–37 show cantilevered post connections, which may be used as alternatives to the details in NZS 3604:2011.

Moving to the lab

Test specimens were set up in the BRANZ Structures laboratory and tested under lateral loading at the top using a hydraulic ram (see Figure 3). Deflections at the top of the post were measured to assess the system stiffness against the 30 mm lateral deflection to the top which is suggested in the MBIE guidelines.

Some of the details tested are shown on pages 36–37. None of the details failed by breaking, but all were sensitive to the deflection limit of 30 mm. This effectively determined the maximum post spacing for a given top rail size.

Figure 3 on page 37 shows base connections for cantilevered wall framing with inside and outside cladding. The presence of the bottom plate makes a robust connection between studs and deck quite tricky.

This detail proved to be very sensitive to deflection and required sizeable stud to plate connections to achieve satisfactory stiffness.

An alternative would be a steel L bracket directly connecting each stud to a joist, but this would require specific engineering design to ensure the bolting detail is satisfactory.

For more The BRANZ construction sequences for each of the verified BRANZ deck details will be available later this year at www.branz.co.nz.