REINFORCING CONCRETE FLOOR SLABS

Lessons from the Canterbury earthquakes mean that all concrete floor slabs must now be reinforced with steel bars or welded mesh with a reasonable degree of ductility.

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Traditionally, NZS 3604:1999 *Timber framed buildings* allowed unreinforced concrete floor slabs. However, the series of Canterbury earthquakes since September 2010 has highlighted deficiencies with this construction.

Issues with unreinforced floor slabs

When ground liquefies, if close to waterways, it can spread laterally towards them. Unreinforced concrete has little resistance to these forces, and the slab fails in tension with cracks forming.

The ground spreading in Canterbury also caused failure of some steel mesh reinforcing because the mesh lacked ductility – it only stretched by a small amount before it broke. It needs to be able to stretch more.

Requirements change over time

When slabs between 12 m and 24 m long are reinforced with mesh, a minimum of 2.27 kg/m² of steel is required (the previously used 665 mesh has a mass of 2.33 kg/m²).

However, an amendment to NZS 3604:1999 in May 2006 required reinforcing bars and steel mesh to comply with AS/NZS 4671:2001 *Steel reinforcing materials*. The reinforcing bars had to be grade 300E and the mesh had to be grade 500N or 500E ('N' stands for normal grade and 'E' stands for earthquake grade). NZS 3604:2011 *Timber-framed buildings* continued this requirement.

Latest changes remove 500N mesh

In August 2011, the Department of Building and Housing issued Amendment 11 to New Zealand Building Code compliance document clause B1 *Structure*. This included modifications to NZS 3604:2011 for it to remain as an Acceptable Solution, including:

- removing the options for unreinforced and fibre-reinforced slabs
- replacing NZS 3604:2011 clause 7.5.8.1(a) and (b) with 'All slab-on-ground floors shall be reinforced concrete in accordance with clauses 7.5.8.3, 7.5.8.4 and 7.5.8.6.4. All reinforcing steel, including welded mesh, shall be ductility class E in accordance with NZS 4671.'

This modification overrides clause 2.5 of NZS 3604, so grade 500N mesh is no longer acceptable.

Ductility class E steel now required

The key issue is that reinforcing steel and welded mesh must have a reasonable degree of ductility. Ductility class E steel is required by AS/NZS 4671:2001 to exhibit a minimum uniform elongation of 15% for grade 300E and 10% for grade 500E, compared to only 1.5% for grade 500L (low ductility) and 5% for grade 500N.

The currently available 66X meshes exhibit very low ductility and do not meet the new requirements. The first paragraph of NZS 3604:2011 commentary clause 7.5.8.3 is no longer applicable.

500E mesh and alternatives

Grade 500E mesh satisfies the requirements of AS/NZS 4671 and is now available in limited quantities.

In the meantime, meshes with sufficient available uniform elongation but with a strength grade (verified lower characteristic yield strength) less than 500 MPa may be used with an increase in the required weight of steel.

Grade 300E reinforcing bars may be used as an alternative to mesh. D10 bars at 300 mm centres in each direction or D12 bars at 450 mm centres in each direction may be used.

To calculate the required weight of steel, use 500 divided by minimum yield stress of the steel in the mesh (in MPa) multiplied by the weight of mesh specified in NZS 3604:2011 (2.27 kg/m² total or 1.15 kg/m² in each direction). For example, if the minimum yield stress of the steel mesh is 410 MPa, then the weight will need to be 500/410 × 2.27 = 2.77 kg/m².

For more information, see the Department of Building and Housing Guidance on reinforcement for concrete slabs-on-ground *at www.dbh.govt.nz/earthquake-concrete-slabs-guidance or BRANZ Bulletin 541* Concrete floor slabs.

FREE JOINTS

Amendment 11 to B1 *Structure* includes detailing of 'free joints' in slabs. These joints are required when the slab length is greater than 24 m. R12 dowels (not deformed steel), 600 long at 300 centres are required to be lapped 300 mm with the slab reinforcement on both sides of the joint and with a bond breaker to all bars on one side of the joint (see clause 7.5.8.8).