Within tolerance

Construction can't be perfect all the time, so allowable tolerances have been defined to maintain quality. Here are some of the key tolerances you should work to in order to ensure quality buildings.

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THE DEFINITION of construction tolerance is an allowable variation in something that can be measured. These may be:

- the permitted variation from a given dimension or quantity
- the range of variation permitted in maintaining a specified dimension
- a permitted variation from location or alignment.

A number of documents are readily available that give practical guidance on construction tolerances. While these tolerances are a permitted deviation from perfect, the aim is always to be accurate when constructing and finishing a building. Taking everything to the outer tolerance limit may make achieving quality difficult for following trades.

Interpreting tolerances correctly

Tolerances apply up to and including the length over which each tolerance is stated to apply. Tolerances are not typically interpolated or proportioned to the actual length of building element being measured.

For example, a 4 mm deviation measured over a 2 m length of wall surface means that the same 4 mm deviation is to be applied over a 1 m wall surface or a 500 mm wall surface.

Out of plumb wall and bottom plate that isn't straight.

The tolerance cannot be interpolated to mean a 2 mm deviation over a 1 m wall surface or 1 mm deviation over a 500 mm wall surface.

Similarly, deviations over longer wall surfaces would be unacceptable if the deviation exceeded 4 mm within any 2 m length of that surface.

Horizontal, vertical and diagonal surface tolerances should be interpreted in the same way.

Straight edge to check framing

When checking framing, use as long a straight edge as is practicable. Where space is not limited, the straight edge should be at least 3 m in length.

With timber-framed buildings on a slab or framed foundation, slab and floor and wall framing that is outside accepted tolerances will have a significant impact on the achievable finish quality.

Measuring surface variations

Surface variations or offsets are considered to be a deviation from a plane within a continuous flat or curved surface.

Deviations of a vertical surface from a true vertical plane should be measured from a plumb line through a plan position or reference point. The maximum deviation of a vertical surface from that plumb line should not exceed the deviation stated below.

Deviations from a horizontal surface should be measured from a nominated datum point in the specifications. Where no datum is given and one cannot be inferred, measurements should be taken from the highest or lowest point in the element being measured (see Figure 1). The maximum deviation of a horizontal surface from that datum should not exceed the maximum permitted deviation.

Building set-out tolerances

Buildings must be accurately located on site to ensure that the provisions of the Resource Management Act (RMA), such as side yards, height planes and the like, are not compromised.

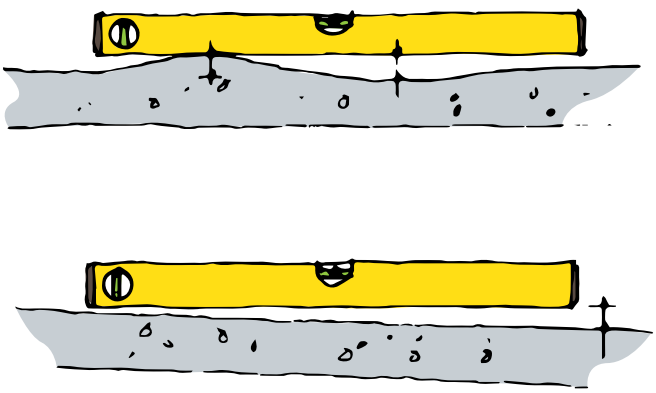

Figure 1: Measuring deviations from a horizontal surface.

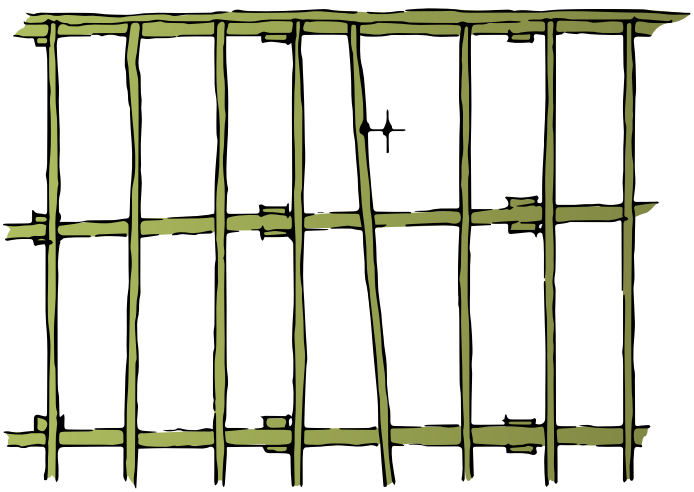

Figure 2: Floor joists should be parallel to within ±5 mm per 3 m.

NZS 3604:2011 *Timber-framed buildings* specifies that the building must be within 15 mm of the specified location on a site plan.

For a building set-out, the footprint must be accurate to 1/200th of the length with ±5 mm variation of the specified dimensions. The same criterion applies for the location of internal walls.

Permitted timber defects

NZS 3631:1988 *New Zealand timber grading rules* sets out the permitted defects for a range of timber grades. This standard has not been updated since NZS 3604 was updated in 2011 so it still refers to 50 mm thick timber and No. 1 framing grade.

Permitted defects for structural framing:

- For bow in timber, see NZS 3631:1988 Table 2. For example, the maximum permitted bow in a 2.4 m length of 50 mm thick framing is 15 mm (35 mm for a 3.6 m long member).
- For crook in timber, see NZS 3631:1988 Table 3. For example, the maximum permitted crook in a 2.4 m length of 100 mm wide framing is 10 mm (15 mm for a 3.6 m long member).
- For twist in timber, see NZS 3631:1988 Table 5. For example, the maximum permitted twist per 100 mm of width in a 2.4 m length of 50 mm thick framing is 5 mm (10 mm for a 3.6 m long member). For a ➤

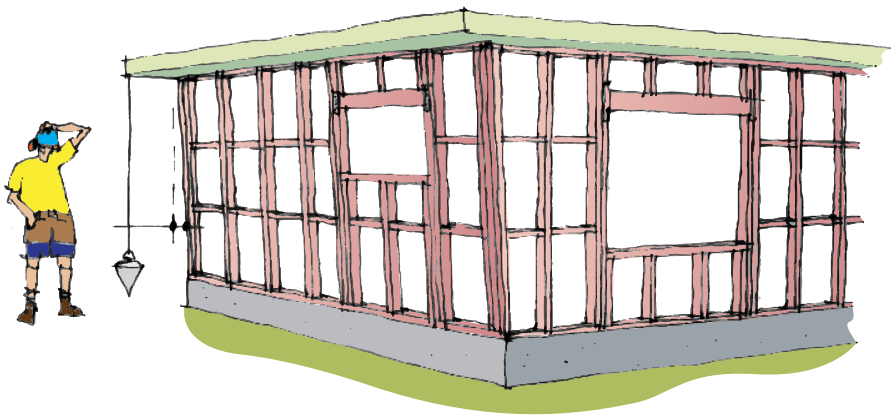

Figure 3: Walls should be vertical to within ±5 mm for every 2.4 m rise in height.

2.4 m length of 90 x 45 mm framing, the maximum permitted twist is 5 mm.

For permitted knots pith and sloping grain in structural timber, see NZS 3631:1988. This gives examples of unacceptable timber quality in Figures 1-21. Figures 22-28 define how twist, crook, bow and sloping grain is to be measured.

Concrete slab surface level

Within 6 months of new, BRANZ suggests concrete slabs be level to within ±10 mm of the specified floor level in any one room or space. The maximum permitted surface deviation is ±3 mm in any 3 m of length.

Suspended floor framing and support tolerances

There are a number of tolerance limits given for suspended floors:

- Concrete piles should be vertical to within 15 mm per metre of height.
- Timber piles should be within 10 mm of vertical in the first metre above ground and within 20 mm of vertical over their total length.
- Bearers and joists should be horizontal to within 5 mm for every 10 m, or a total of 10 mm in any length of 10 m or more, and straight to within ±5 mm per metre.
- Consecutive bearers and joists should be parallel to within ±5 mm per 3 m (see Figure 2).
- The floor plane structure should not slope by more than 1:190 and should not deviate from level by more than 8 mm in any 3 m of length.

Finished suspended timber floor

Suspended floors should:

- be level to within ±10 mm within a single room or space
- have individual sheets or boards that are flat and straight to within ±6 mm for every 3 m of length
- not deflect by more than 1:360 when subjected to reasonable loads under normal conditions.

Wall framing – timber

There are a number of specific limits for timber wall framing given in NZS 3604:2011.

Wall frames should be vertical to within ±5 mm for every 2.4 m rise in height (see Figure 3).

Wall frames should not:

- deviate from in-plan position by more than 15 mm
- deviate from a flat plane by more than ±6 mm for every 3 m in any direction
- be out of line by more than 1.5 mm for every 1.3 m of length in any direction.

The maximum:

- inter-storey relative displacement of load-bearing walls is 5 mm
- deviation from line in plan is 5 mm for lengths up to 10 m and 10 mm in total for lengths over 10 m
- deviation from horizontal is 5 mm for lengths up to 10 m and 10 mm in total for lengths over 10 m
- bow in studs depends on location:
  - For corners, bows must not exceed 2 mm in any 2.4 m length.
  - For all other studs, 6 mm gradual bow is permitted.

Roof framing – timber

For timber roof framing:

- vertical elements in roof frames should be straight to within ±5 mm for every 2.4 m rise in height
- horizontal elements should be straight to within ±5 mm in lengths up to 10 m or no more than 10 mm in total for lengths over 10 m.

An example

To show the effect of work that might meet tolerances for one aspect of construction but cause quality issues for another, let's take a large picture window. Say the trimming studs are within the out of plumb tolerance, but the one on the left slopes to the left and the one on the right slopes to the right.

If the cladding is then trimmed to that rough opening, as is common, the window flange cover at the top of the window will not meet the 10 mm minimum specified in E2/AS1. This is a quality issue even though the individual framing members are within the NZS 3604:2011 limits.