Stable foundations

Stable foundations are important for all buildings to keep them from sinking, or tilting like the leaning tower of Pisa!

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Foundations are defined as 'walls, blocks or piles that transmit the weight of a structure to the underlying ground'. These days, the foundation on flat ground is likely to be a concrete slab with edge thickenings and thickening beneath load-bearing internal walls. In the past, however, some interesting materials were used.

Foundations are the first and most important step in building – if they are incorrectly designed, poorly placed or unstable, the results will be problematic. One famous foundation failure is the leaning tower of Pisa. Soon after construction began in 1173, it began to lean, and had tilted 4.5° to the south by the time it was completed. The deformation of the soft clay beneath continued until the 1990s when engineering analysis suggested the tower was nearly toppling. The solution, completed in 2008, involved removing soil from beneath the foundations on the north side and gradually straightening the 14,500 tonne tower.

Figure 1: A shaped stone pile at Ranzau (built 1844).

Foundations similar to Roman times

Building foundations have not changed much since Roman times. There are two basic types:

- A footing made of timber, stone or concrete that distributed the load over a sufficiently large area.
- A series of piles driven so deeply that they either rested on rock or were held in place by friction.

The type of soil and building size helps define which type is the most appropriate.

Early New Zealand houses

In early timber-based houses, corner posts were placed directly into the soil that also formed the floor. An alternative was a ground plate of puriri that provided a base for the framed wall. When the walls were earth construction, these needed to be kept dry, so a stone or brick base was used. For suspended floors, something was needed to lift it above the damp earth – the pile.

New Zealand timber houses made use of a huge variety of pile materials to support the floor and superstructure. Locally sourced, shaped riverstones still support Ranzau – a house at Hope, near Nelson, built around 1844 (see Figure 1). Near Kaikoura, Fyffe House, thought to date from the mid-1840s, stands on piles made from discarded whalebone vertebrae. Timber piles only became common in later years.

Timber and concrete piles

Early timber piles were originally rough tree logs standing on end, often puriri or totara. After 1900, square sawn totara blocks were common, but brick piers or even octagonal glazed earthenware blocks were used.

Cheap precast concrete piles became available in the 1920s, although it was not until the late 1920s that they replaced timber piles. Rather than precast, piles could be formed in situ by filling empty 4-gallon kerosene tins with concrete.

Rotting timber piles

Anyone who has bought an old timber-piled house knows the delights of undulating and sloping floors coupled with sticking windows and doors. As the timber piles slowly rotted at and just beneath ground level, parts of the house would sink. This differential movement of parts of the house caused the once-square window surrounds to be forced out of true. From the 1960s onwards, a screwdriver or strong metal rod became a standard inspection kit item to stab the subsoil piles to see if they were still sound. If not, repiling would be top of the renovation list.

As an example, floors in parts of a 1908 house on a relatively dry site sank over 90 years until the bottom of the laundry floor joists touched the ground. When the house was lifted using hydraulic jacks, the bottom of the piles appeared as decayed, spongy wooden teeth (see Figure 2). They were replaced with modern treated timber

piles. The house was lowered back down, leaving a 400 mm air gap above the ground and with the floors levelled as far as possible – unevenness being part of the character!

Alberton renovation

Built in Auckland in 1863, Alberton originally stood on timber piles with perimeter support from local scoria, stacked into walls. The New Zealand Historic Places Trust renovated Alberton in the early 1970s, and timber piles were replaced with precast concrete ones and treated timber jack studs. Just one original timber pile remains (see Figure 3).

Perimeter walls

Perimeter walls could be built in stone, brick or (after 1900) in concrete. The open pattern of freestanding 'isolated' piles coupled with timber lattice, spaced boards or even a series of drilled holes allows ground moisture to be removed. Continuous walls require the inclusion of vermin-proof subfloor ventilators. Modern ventilators are made of precast concrete or pressed metal, but in earlier years, cast iron with intricate hole patterns could be used.

The maze foundation, which provides support for the heavy external and internal walls in brick, concrete and stone buildings, is less common in New Zealand due to the predominance of timber housing.

Bracing for earthquakes

Until the 1930s, there was little consideration given to the need for bracing in house foundations. The 1929 Murchison earthquake changed that, and requirements for bracing foundations were soon introduced. The 1936 State House Specification called for continuous reinforced concrete foundation walls. Clear lateral bracing requirements are contained in modern timber-framed house construction standards.

Mostly unseen, foundations are designed to keep houses off the ground and as stable as possible, no matter what nature may throw at them.

Figure 2: 90-year-old totara piles after house lifted (hydraulic pipes connecting the central pump to distributed lifting jacks are visible).

Figure 3: Today's restored Alberton (originally built 1863) with a modern timber jack stud in the foreground on top of a pre-cast concrete pile and the original timber pile with scoria wall behind.