Steel framing in New Zealand

Although New Zealand has always had plenty of iron ore, it's only since the 1970s that we have enjoyed a viable steel industry and an increase in the use of steel framing.

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New Zealand has ample supplies of iron ore in the form of ironsands on the west coast of both islands and limonite in Northland and at Onekaka near Nelson. But initial attempts to produce iron, starting in 1849 with a blast furnace in New Plymouth, failed because the ironsand blocked the draught. In 1866, John Chambers sent 100 tons (102 tonnes) of Taranaki ironsand to Staffordshire, England where it was manufactured into iron.

Early iron-making unsuccessful

In 1882, a puddling furnace was built in Onehunga, using local ironsand and coal from Westport and Newcastle. Trials in February 1883 exceeded all expectations. Samples sent to Christchurch were made into horseshoe nails and were reportedly 'equal to the best Swedish [iron] when properly rolled or manufactured'. But a succession of short-lived ironmasters, coupled with the problems of the ironsand, meant the plant never produced suitable quality iron again.

In 1886, Sir Henry Bessemer – who, in 1854, invented the Bessemer Converter for making steel by blowing air through the molten iron – experimented with ironsand. He concluded that, while best-quality iron and steel could be produced, to do so would require considerable research and 'he was too old to go on with it'.

Iron was produced for a short time (1920–35) in Onekaka, Golden Bay, using local limonite ore, coal and limestone. The plant's rebuilt hydroelectric scheme now produces electricity for the local community.

It wasn't until 1969 that New Zealand Steel's Glenbrook plant, using the direct reduction process for reducing ironsand into metallic iron, started a technically and economically viable steel industry.

In 1978, the New Zealand Heavy Engineering Research Association (HERA) was established and continues to support the development of the steel industry through research, publications, education and training.

Heavy steel framing

Steel rails were first rolled in 1860, and by 1862, the continuous mill was producing steel forms, but with no indigenous steel industry, hot rolled heavy steel framing was imported.

Two Wellington buildings mark the start and end of hot steel riveted buildings in New Zealand, although there were many others in between.

The first was the Public Trust building on Lambton Quay. The initial structural design by Government Architect John Campbell was prepared in 1902 by San Francisco architects Reid Brothers. It was considered too expensive, and in 1905, Campbell designed a lighter steel-frame building that was put out to tender in April 1906. Following the San Francisco earthquake that same month, the plans were reportedly revised and reissued on 21 September 1906. Not all local architects were happy, with James O'Dea pointing out to the editor of the *Evening Post* that reinforced concrete buildings had been proven to have better earthquake performance than riveted steel.

The 5-storey plus basement building was to be built in Tonga Bay granite and pressed bricks. The contract was won by J & A Wilson Ltd, who had purchased the Tonga Bay granite quarry in today's Abel Tasman National Park. Workshops were set up on site for both stone and the engineering activities, and all the steel framing was prepared there. The building cost £40,780 (equivalent to $5.9 million in 2009).

J & A Wilson also built the Wellington General Post Office. It was opened in November 1912 and demolished in 1974. Other riveted-steel buildings include Wellington's 1925 telephone exchange, Napier's 1931 Market Reserve building, and Dunedin's 1934 Post Office.

The steel frame of the State Insurance Tower, Wellington (known as the Bank of New Zealand Tower up until 1998) in 1979. (Photo from Alexander Turnbull Library, Dominion Post Collection (PAColl-7327). Reference: EP/1979/2632/10. Photograph by Ron Fox.)

The Tower building was the last hot-riveted steel-framed building and replaced an earlier 3-storey brick gothic-style edifice at 60 Customhouse Quay due to concerns after the 1931 Napier earthquake. Built on reclaimed land, the tide can still be detected around the 90 caisson foundations. Recent testing revealed that the hot steel-riveted beams and columns, encased in concrete, satisfy even today's stringent earthquake resistance requirements.

Death knell for riveted steel

In the 1920s, both gas and electric arc welding were used to join steel framing. In 1926, a 5-storey building for the Westinghouse Electric and Manufacturing Company in Pennsylvania was the first fully welded steel-frame structure.

It required 12% less steel than a riveted frame, providing the death knell internationally for riveted steel.

Welded steel also allowed the creation of large-span roofs. The art deco former New Zealand Road Services building in Dunedin, built in 1939, is amongst our earliest large-scale buildings to use part-welded steel-frame construction, with roof trusses up to 35 m long.

The 30-storey Bank of New Zealand (now State Insurance) building on Willis Street, Wellington was the scene of conflict over welded steel. Construction began in 1973 but was disrupted for 6 years by a labour demarcation dispute with the boilermakers trade union claiming exclusive rights to weld the steel. On its completion in 1984, it was the tallest building in the country, but the dispute effectively stopped the large-scale use of structural steel for many years.

Nowadays, the benefits of steel framing are readily achieved by using off-site prefabrication and on-site bolted assembly.

Light steel framing

After World War I, structural sections started to be made by cold rolling or bending steel strip or sheet. These sections could be combined by mechanised spot welding. In 1935, a complex of 1,200 apartments was built in France using this light steel-framing system, which is now used for a wide range of building types.

It took until the late 1960s for steel-framed housing to be used in New Zealand, and according to the National Association of Steel-framed Housing (NASH), the first plant started operation in Wellington in 1970 (see *Build* 110, pages 54–55).

A very early light steel frame building built in the mid 1990s.

Fast on-site assembly

Nowadays, galvanised sheet is taken from coils up to 1,250 m long and weighing up to 1,500 kg and formed into 89 mm deep studs by a computer-controlled former. The entire building's framing is then packed and delivered to the site. Cold (blind or pop) rivets were originally used, but the improved design and availability of self-drilling screws meant that cladding and trim could be fixed in the same time it took to nail. Now, power-driven self-drilling screws commonly hold the frames together.

The design of individual rolled-steel components has evolved, with pre-punched and dimpled holes coupled with individual component labels supporting fast on-site assembly and the easy fitting of smooth lining and cladding materials. Light steel-frame plants have even been designed to fit into a standard shipping container and are sent to isolated regions for disaster relief or to create new subdivisions.

Four New Zealand manufacturers export their locally designed and made roll-formed steel-framing machinery around the world.

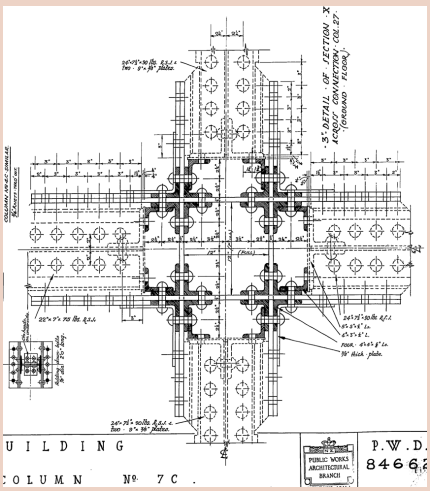
Thermal breaks allow for energy efficiency

The structural development of the steel-frame industry started under American and later Australian standards. The most recent standard, AS/NZS 4600:2005 *Cold-formed steel structures*, is the second edition developed for New Zealand conditions.

Steel is a good thermal conductor, but with increasing concern for energy efficiency, the overall light steel-frame construction must also provide suitable thermal performance. This can only be achieved by providing a suitable thermal break – a small piece of poorly conducting material breaking the flow of heat from the warm inside to the cold outside. The use of thermal breaks permit a 89 mm steel frame to achieve up to R2.2 $m^2 \cdot °C \cdot W^{-1}$, in compliance with the requirements of NZS 4218:2009 for all climate zones.

Steel framing offers many benefits for all scales of construction, particularly off-site prefabrication, so its use will continue to develop.

Tower Insurance building, Wellington (previously known as Government Life), built in 1931.



Detail from the riveted steel framing drawing of the Government Life building.