Ohakea's HANGARS

No 3 hangar at Ohakea aerodrome, under construction. Taken by an unidentified photographer circa 18 April 1939. Alexander Turnbull Library, Wellington, New Zealand.

A pair of concrete hangars at the Royal New Zealand Airforce base at Ohakea represents one of New Zealand's most significant engineering achievements. They were among the world's first large stressed concrete arch buildings.

The hangars were part of a scheme proposed by Wing Commander the Hon. Ralph Cochran, who had been seconded from the Royal Air Force in 1936 to advise the New Zealand Government on air force development. The scheme was put into action on 1 April 1937 when the Royal New Zealand Air Force was separated from the army and became a separate organisation.

A top priority was to establish two squadrons of medium bombers capable of locating and attacking enemy ships before they reached New Zealand. Thirty Wellington bombers were ordered from the United Kingdom. They would operate from new airfields at Ohakea and Whenuapai. The Public Works Department was asked to design suitable hangars, each capable of accommodating nine Wellingtons.

Chief Designing Engineer Charles Turner led the design team. The team used cardboard models to work out the interior dimensions, then made preliminary designs in structural steel, reinforced concrete, and combinations of both materials. The most economic and quickest to build had reinforced concrete walls and a steel roof. But structural steel could not be ordered until the design was almost complete, and it would take a long time to reach New Zealand. Reinforced concrete would cost about six per cent more than steel, but 95 per cent of the materials would be locally-sourced, and 80 per cent of the reinforcing steel could be ordered within "a week or so" of starting the design. Construction could start immediately the design was ready.

The final design features a two-hinge concrete arch roof consisting of a stressed slab stiffened by arch ribs. Large buttresses outside the side walls support the roof. Concrete annexes surround the back and sides of each hangar.

Practical construction considerations strongly influenced the final choice. Mr Turner paid special attention to the "centring", a steel frame that supported the timber form-work. The buttresses reduce the arch span, minimising the need for hard-to-get structural steel for the centring.

Mr Turner divided the roof into three separate arches. This reduced the length of the centring, which only needed to support one arch at a time. The shrinkage joints pass vertically through two of the intermediate ribs: what looks like one rib is two "half-ribs" with a joint covered by copper flashing. Each section was poured separately. When the arch was self-supporting, the centring was winched along greased rails to the next section. After finishing the first roof, contractors winched the centring to the second construction site. When Ohakea's hangars were completed,

Hangers under construction. Alexander Turnbull Library, Wellington, New Zealand.

the centring was dismantled and moved to Whenuapai where two identical hangars were built.

Mr Turner notes that the arch ribs were "first designed to follow the pressure line resulting from their own weight, the weight of the intermediate slab, and a wind loading of 20 pounds [9.09 kilograms] per square foot [304.8 millimetres] of roof ... The reinforced concrete slab... was also designed to follow its own pressure line." The slabs were thickened at the ribs, and stiffening flanges along their lower edges double as rainwater channels.

The buttresses splay outside the arch pressure line to eliminate any chance they might overturn, with a "small but definite load" transmitted through the vertical columns.

Shortly before the design was complete, Mr Turner was fortunate to read an article about a recently-completed reinforced concrete arch building, the Sports Arena at Hershey, Pennsylvania. This provided useful input into the design of the Mesnager hinges, which provide flexible joints between arch and buttresses.

To protect against bomb splinters, the sliding doors were made of heavily reinforced concrete panels, 4.57 metres high and 254 millimetres thick, with windows above.

Construction began with the buttresses, walls, and annexes. The ground at Ohakea was strong enough to resist the arch thrust, but to resist earthquake stresses the buttresses were connected with pre-stressed rolled steel joists laid in underfloor trenches. Each tie was made in two halves and installed with a 42 millimetre gap. The halves were heated with flame-throwers to expand the steel until the connector pin could be dropped in. This process took about eight to ten minutes per tie.

Each section of the arched roof required a continuous pour of 316 cubic meters of concrete. This took between 24 and 30 hours, with work usually starting at five in the evening. Close communication with the meteorological office reduced weather problems. While pouring the first section, workers were instructed to periodically adjust jacks between the form-work and centring to compensate for deformation. Subsequently the form-work was set up to allow for sag, based on measurements taken while pouring the first section.

Ohakea officially opened on 18 September 1939, and its first concrete hangar was completed later that year.

FACTBOX

Internal dimensions 67.06 metre clear width by 51.8 metre depth ▪ **Mass of centring** 141 tonnes ▪ **Concrete slab thickness** 102 millimetres, thickened to 152 millimetres at ribs ▪ **Rib spacing** 6.1 metres ▪ **Rib depth** 610 millimetres at crown, 762 millimetres at ends ▪ **Doors** 7.62 metres high by 7.16 metres wide by 254 millimetres thick ▪ **Total cost (including design)** £76,750 ▪ **Construction contractor** McMillan Brothers Limited

But the Wellington bombers never reached New Zealand. After Germany invaded Poland on 1 September 1939 the bombers were given to the Royal Air Force. By late November 1939 Ohakea's Air-Gunner and Observer (navigator) Training School was training air crew for the RAF under the Empire Air Training Scheme.

The threat of a Japanese invasion in prompted the replacement of Ohakea's grass runways 1942 with longer concrete runways suitable for heavy bombers. But training remained Ohakea's main function during World War II.

Ohakea's hangars represent the cutting-edge of mid-twentieth century structural technology. Their basic shape remains clearly visible, though lightweight steel doors were installed in 1961, and their roofs were sheathed with long-run steel roofing in 1989. The Institution of Professional Engineers New Zealand recognised them as part of New Zealand's engineering heritage in 1990. This year these outstanding examples of engineering were proposed for Category I Historic Place registration.

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