

Lessons learned from one of New Zealand's most challenging civil engineering projects: rebuilding the earthquake damaged pipes, roads, bridges and retaining walls in the city of Christchurch 2011 - 2016.

Lest we forget – SCIRT restores Memorial Arch

Story: Bridge of Remembrance and Memorial Arch

Theme: Construction

A document which describes the process that SCIRT took to restore the Bridge of Remembrance and Memorial Arch.

This document has been provided as an example of a tool that might be useful for other organisations undertaking complex disaster recovery or infrastructure rebuild programmes.

For more information about this document, visit www.scirtlearninglegacy.org.nz



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Lest we forget – SCIRT restores Memorial Arch

Christchurch's iconic Bridge of Remembrance and Memorial Arch was a symbol of the rebuild.



An Anzac Day parade on the Bridge of Remembrance.

The restoration project recognised the importance of the city's past amid the focus on the future.

The war memorial was reopened on April 25, 2016 – Anzac Day – more than five years after the February 2011 earthquakes left the bridge and arch broken and battered. Restoring and ensuring the memorial in the central city met post-earthquake standards cost about \$6.6 million in total.

Rebuild work by SCIRT covered two sections: the bridge and, most importantly, the arch. Repairs to the bridge crossing the Avon River cost \$650,000. However, the restoration of the Memorial Arch required high-level intervention, innovation and imagination, costing \$5.8 million.

The Bridge of Remembrance and Memorial Arch was initially funded by the people of Christchurch as a symbol of gratitude and in honour of the memory of those Cantabrians who served in the Great War (1914-1918).

A bridge which linked Oxford Terrace and Cambridge Terrace was modified to accommodate the war memorial.

First mooted in 1919, donations poured in for the new monument to service and sacrifice. By 1921, the Christchurch City Council had agreed to provide funds for a suitable supporting structure for the bridge.

Noted North Island architects William Prouse and William Gummer were tasked with the design of the Memorial Arch. Gummer's work combined traditional elements within a framework of formal geometry and the design was built up on the angles in a hexagon. As the design evolved, the arch's spiritual and symbolic elements complemented the utilitarian purpose of the bridge. The Memorial Arch with the cross supreme illustrated eternal hope and the spirit of sacrifice, while the British coat of arms and the Canterbury coat of arms were acknowledged on the minor arches. Where the buttresses terminated, the lions highlighted conquests while laurel wreaths on the bridge parapets honoured victors.

In the central panel of the arch, a Latin inscription read: *Quid non pro patria* – What will a man not do for his country.

With a tender of £16,078, Christchurch-based Scott and Sons secured the construction contract. The foundation stone was laid on April 25, 1923 by the Governor-General, Viscount Jellicoe of Scapa.

The Bridge of Remembrance and Memorial Arch was officially opened on Armistice Day, November 11, 1924.

Over the years, thousands of soldiers marched across that bridge en route from King Edward Barracks – home to hundreds of army drills – to the railway station and overseas service. In time, the memorial would also pay tribute to those Cantabrians who served in World War II and conflicts in Korea, Malaysia, Borneo and Vietnam.

Nearly 90 years later, the badly damaged war memorial was again the focus of the people of Christchurch. The Memorial Arch – a site of reflection – was one of the city's most treasured remaining historic structures left standing after a series of earthquakes rumbled through the region.



An 8.2-tonne beam with a central sliding plate is hoisted into place on the Memorial Arch.

Restoring a heritage structure would require finesse and a flair for problem solving.

For SCIRT's Downer team, the two-and-a-half-year project would prove technically challenging. It would involve precision modelling, high-tech laser scanning and skilled staff squeezing into tight work spaces within the arch.

It proved to be one of the most difficult and rewarding projects of the rebuild. Each step was meticulously planned as heritage approval was required for every aspect of the repair and restoration work. Perhaps the biggest challenge was to strengthen the arch with minimal impact on the heritage fabric and facade. Strengthening took two years of complex work to complete.

Repairs to the 360-tonne, 14-metre high and 20-metre wide Memorial Arch – an imposing structure of sharp

lines and ornate decoration – included the insertion of steel inside the masonry columns to strengthen the structure and concrete that increased the weight of the arch to 470 tonnes.

The addition of a "rocking collar" at the base would help the reinforced arch withstand a one in 2500 year earthquake. Significant modifications to the articulation of the structure allowed the rocking action to occur in any direction.

Underpinning that resilience was the strengthened bridge supporting the arch.

In all, 32 micro-piles were driven up to 30 metres deep to a layer of gravel to support the arch on the bridge. The original foundations were only three metres deep.

The octagonal rocking collar was laced with reinforcing bars that connected each end of the arch to the micro-piles. The rocking collars allowed the arch to rock backwards and forwards in response to ground movement. Sliding joints were installed in the top of the three arches to allow the arch to move from side to side. Combined, these features would allow the structure to move in a controlled manner if there was an earthquake and reduce the likelihood of damage.

The strengthening efforts involved work inside the confined space of the arch. SCIRT's specially trained contractors and the crew worked carefully to ensure they did not damage the iconic structure.

SCIRT's innovative work on the Memorial Arch was recognised with the Canterbury Heritage Awards 2016 Public Realm – Saved and Restored Award.



The restored Memorial Arch on the Bridge of Remembrance in Christchurch.