HVAC&R Nation
AN AIRAH PUBLICATION

Skills WORKSHOP
Managing condensate for condensing boilers

FEATURE
Duct troubles

Rebuilding Christchurch
An earthquake-proof HVAC retrofit

BROUGHT TO YOU BY AIRAH GIVING BACK TO THE INDUSTRY SINCE 1920

PRINT POST APPROVAL NUMBER PP 727272/60606

July 2017 / ISSUE 103 / FREE

The complex rebuild of Christchurch Arts Centre included the creation of three new plant rooms.

REBUILDING CHRISTCHURCH

In 2011, the New Zealand city of Christchurch was shaken to its foundations by a magnitude 6.3 earthquake. As well as taking the lives of 185 people, it destroyed or damaged many of the city's buildings, including the heritage-listed Arts Centre. ***Sean McGowan*** *reports on the painstaking rebuild that is returning the site to its former glory.*

Located in the heart of the city, the Arts Centre of Christchurch is made up of 23 neo-gothic stone buildings that were home to the Canterbury College (now the University of Canterbury) until the late 1970s.

The site was then transferred to the Arts Centre of Christchurch Trust Board to be used for a variety of arts-related activities. The buildings – all of which are heritage listed – made up a thriving arts precinct offering art and artisan studio spaces, galleries, theatres and cinemas as well as speciality shops, bars, cafes and restaurants.

Such was the Arts Centre's success that it became a major tourist attraction for the city in the decades that followed.

But in September 2010, a major earthquake struck the region and caused significant damage to some of the buildings, resulting in the chimneys of the Great Hall, Observatory and Clock Tower collapsing.

Five months later, a larger and more devastating earthquake struck the city. Buildings that had already been damaged or weakened by the previous earthquake were unable to withstand the shocks.

Of the 3,000 buildings inspected within the four avenues of central Christchurch, 45 per cent were given red or yellow stickers to restrict access because of safety problems.

One of the sites most affected was the Arts Centre of Christchurch. Although no one died on the site during either earthquake, all historic buildings were made inaccessible to the public, and the entire complex was closed.

Initial estimates of NZ$100 million (AU$96 million) to rebuild the Centre were soon revised to more than NZ$200 million (AU$192 million), with an estimated rebuild time of 15 years originally floated.

Ultimately, as the scope became better known and understood, the cost to rebuild was revised upwards to NZ$290 million (AU$277 million), making it one of the largest heritage restorations projects to be undertaken anywhere in the world.

BRICK BY BRICK

Given the size and heritage nature of the site and its buildings, the rebuilding of the Arts Centre of Christchurch has been conducted in stages.

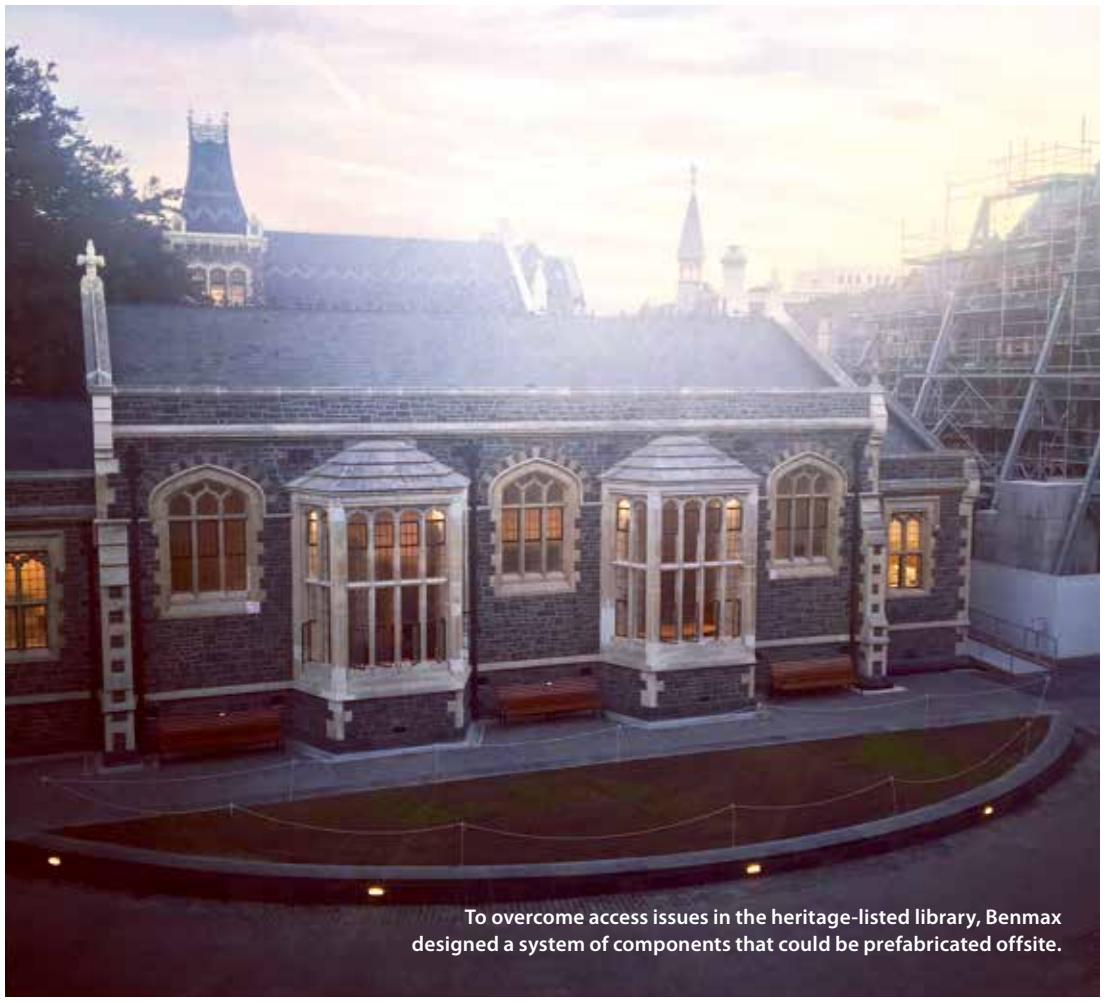
Following the appointment of multiple builders on the project, significant structural works commenced in 2013 with the aim of stabilising and strengthening the buildings prior to their refurbishment.

Some of the buildings were literally pieced together brick by brick in a painstaking rebuild that not only returned them to their former glory, but also reinforced the building structures to meet strict earthquake-proofing codes.

Following much of these works, ACT-based Benmax Group was directly engaged by the Arts Centre in 2015 to complete the design and installation of mechanical services for a number of buildings across the site.

"It was a really complex site when we first got there," says Benmax NZ director Geoff Absolom, M.AIRAH.

"At times, work was very challenging, with the conservation of the existing building structures given priority. The original schematics could not change, yet the services within the building, including HVAC, required a modern, earthquake-resistant retrofit."



To overcome access issues in the heritage-listed library, Benmax designed a system of components that could be prefabricated offsite.

> The HVAC solution at the Arts Centre of Christchurch takes advantage of the constant temperature of the subterranean water supply below the site.

Benmax Group created three new plant rooms – one in the basement area of the heritage-listed Library building, another below the Workshop building, and a third in the existing Chemistry building.

The Library plant room was designed to serve the site's C Block, which includes the Great Hall and Chemistry buildings, while the new Workshop plantroom serves a number of other buildings as well as providing redundancy to the main Library plantroom.

NEW TECH IN OLD DIGS

One of the major challenges for the Benmax team was in making the mechanical services plant fit within the confines of the existing Library basement.

Working with documents prepared by consulting engineer Powell Fenwick, a great deal of work was completed by Benmax site supervisor Dave Morley and his team to not only ensure the plant would fit within the space, but would also meet the stringent requirements required by Heritage New Zealand.

"We were given some pretty clear instructions around what we were allowed to fix to, what we weren't allowed to fix to, how they wanted it to look and what items such as radiators were to look like," says Morley.

With components of the Library plantroom required to be constructed of steel, space as well as access became a significant problem.

Accessed only by a small narrow staircase, the Benmax team was confronted with the challenge of not only getting materials down into the Library basement, but also major pieces of HVAC equipment, including heat pumps, heat exchangers, and ancillary pumps.

"The Library plantroom was definitely the most challenging build on the site so far," says Morley.

"With a maximum ceiling height of 3m in the basement, and only one narrow stairwell to access the room, we had very little flexibility to get the system components into the space. The basement was originally designed to hold books – we had to get large, heavy industrial components like pumps into the space.

"It meant we had to get creative."

To overcome these issues, Benmax designed a system of components that could be prefabricated offsite. It commissioned the Victaulic construction piping services (CPS) department to assist with the design, and provide detailed spool drawings, which were used in the prefabrication of the pipework.

As well as providing an overall design of the heating and cooling systems in the plantroom, Victaulic also broke down the schematics into smaller, segmented spools that were small enough to meet the space restrictions of the site.

"The spool drawings were exceptionally good," says Morley. "They were labelled, numbers and were essentially foolproof. Our team was able to quickly fabricate the spool pieces based on the information provided, and we knew exactly where each assembly belonged on the site.

A size limit of 3m was placed on each length to ensure it could be taken down the staircase, before fitting together like a Meccano set.

"Even at 3m, we were pulling the pipe right down to the bottom (of the staircase) then lifting it up at the far end to twist around the right angle at the bottom of the stairs that entered the basement," adds Morley.

To allow large pieces of equipment into the basement, the floor of the library above was temporarily removed before being reinstated.

Both approaches also avoided welding works being conducted within the confined space of the basement.

"We only had the plantroom space to work in," says Morley.

"It's not like we had a lot of space available to use to build anything outside, and we really didn't want to be creating too much heat in an old, historic building with timber floors directly above us."

ARTESIAN HEATING

The HVAC solution at the Arts Centre of Christchurch takes advantage of the constant temperature of the subterranean water supply below the site.

EARTHQUAKE PROOFING

In order to meet new regulations in place around the earthquake proofing of plantroom components, the Benmax team were required to meet strict codes.

This included having seismic engineers review the design of components and how they are fixed and secured into place.

"It became a coordination nightmare, really," says Benmax site supervisor Dave Morley.

"In Australia, 63mm fusiotherm pipe would require just a straight hanger, enabling you to deal with everything in the same plane as the pipe and parallel with the pipe. But what you need to do here [in Christchurch] is install brackets at 45 degrees for anything 200mm or more off the ceiling.

"So it means that if you are 600mm off the ceiling, for example, you are also 600mm out on each side of the pipework, creating a large V-shape. This impacts on access, future access and maintenance and has implications for other services because they also require the same fixing."

> The basement was originally designed to hold books – we had to get large, heavy industrial components like pumps into the space. It meant we had to get creative

Four bore wells have been drilled in two locations – two that extract water from deep in the artesian water basin, and another two at a more shallow depth that re-inject that water back.

"The water is extracted from the well, goes through a heat exchanger and into an artesian ring main made of 250mm HDPE pipe, before going into the other plant room on the ring main and being re-injected into the artesian basin on the other side of the site," says Morley.

"So, part of the ring main is going clockwise and the other part is going anti-clockwise. That way we keep the water pure, because there's no stagnant water in there – it's constantly moving."

This design also provides redundancy in the event that one of the ring mains is inoperable.

"The Arts Centre could actually operate the whole site from the Library bore wells just by opening valves in the plantrooms," Morley says. "So, we've got four different modes it can go into, just by closing the valves in the various plantrooms. It's a very clever system."

The water extracted from the artesian basin is a constant 12°C, and supplies five heat pumps in the Library plantroom that are used to provide heating throughout the buildings.

In the main Workshop plantroom, two heat pumps provide heating water to fan-coil units (FCUs), radiators and under-floor heating serving the AA Block, Gymnasium and future additional buildings as they are repaired.

In the Chemistry building, a single heat pump working in reverse provides chilled water for the climate control of the University of Canterbury's James Logie Memorial Collection of Classical Antiquities – a permanent public display.

"The system is required to control humidity closely in the Chemistry building," says Morley. "It's probably the most complicated system on the whole site."

FURTHER WORKS

The plantrooms installed below the Library and Workshop buildings have recently been connected via a linked line to provide a further level of redundancy. Pipe connections to other buildings yet to be restored have also been installed for future connection, in anticipation of their completion in the coming years.

While more than half of the Arts Centre of Christchurch has now been reopened to the public, including the Great Hall, the Library and the Chemistry building, there is much still to be completed.

The Classics building is scheduled to reopen later in 2017, while the West Lecture and School of Art will reopen to the public in 2018.

Other buildings, including the 126-year-old Engineering building, are not scheduled to be completed until after 2019. ■

THE ARTS CENTRE OF CHRISTCHURCH AT A GLANCE

THE EQUIPMENT

Dehumidifiers: Calonex
FCUs: Aermec and EPI
Heat pumps: York
Heat exchangers: Sondex
Pumps: Grundfos
Radiators: EPI

THE PERSONNEL

Builders: Simon Construction Ltd and Fletcher Construction
Client: The Arts Centre of Christchurch
Consulting engineer: Powell Fenwick
Prefabrication design: Victaulic
Mechanical services: Benmax Group