NATIONAL HERBARIUM OF NSW

SUSTAINABILITY AWARD
ACSE AWARDS 2022

scpconsulting

PROJECT OVERVIEW

The National Herbarium of NSW is a state significant project, in the Australian Botanic Garden Mount Annan, commissioned by the Royal Botanic Garden and funded by the NSW Government. Purpose built to safeguard the Australian Institute of Botanical Science's growing collection of over 1.4 million botanical specimens.

An inherently sustainable project by virtue of its ultimate purpose, to ensure the protection and survival of a myriad of plant species, and to share knowledge, we believe the National Herbarium of NSW is a great example of sustainability and has created a precedence for future sustainable projects in NSW.

A major feature of the project was the construction of 6 protective vaults, designed to be able to shield the collection from bushfires and extreme temperatures. A high-performance solution was required to ensure the safety of the prized botanical collection, some of which date back to 1770.

The ever-growing collection is conservatively valued at $100 million currently, however it is truly priceless as some specimens are irreplaceable.

The newly imagined herbarium and associated buildings were designed by Architectus with Richard Leplastrier and Craig Burton and constructed by FDC Construction & Fitout. Structural engineering for the project was a collaboration between SCP Consulting and PMI Engineers.

PROJECT BRIEF

The project brief, produced by the Royal Botanic Gardens and the Domain Trust, was detailed and ambitious.

Their vision was to develop the Centre of Innovation in Plant Sciences, to position the Royal Botanic Gardens and the Domain Trust as Australia's leading scientific institution, synonymous with research in plant sciences. The new National Herbarium of NSW forms a key piece in meeting that goal.

Key Project Objectives:

- **To create an internationally recognised plant sciences innovation centre**
- **To provide safe storage of irreplaceable plant specimens of international significance and capacity for future expansion**
- **To increase and share knowledge of Australian and NSW plant life**
- **To advance science education and innovation in Western Sydney**
- **To improve functionality and provide value for money for the government**

As joint structural engineering consultants for FDC, SCP and PMI were tasked with delivering a design in line with the key objectives set out by the client, as well as working together to ensure a fully coordinated and functional structural design that was sympathetic to the surrounding environment, reflected the key project objectives and supported the architectural intent.

SUSTAINABILITY PROCESS AND CHALLENGES

Given the importance and fragility of the seed bank, a key outcome of the project was to provide a safe and stable climate for the botanical collection. A high performance solution was required that could satisfy the insulation requirements to protect the specimens that was also sympathetic to the environment.

The challenge to the sustainability of the project was providing the required level of homeostasis without creating a huge demand on energy consumption. This led to the consideration of different structural materials with a focus on their thermal mass qualities. The chosen design solution was load bearing rammed earth walls, a concept SCP had never encountered,

HOWEVER LIKE ALL ENGINEERING CHALLENGES, SCP ACCEPTED IT GLADLY.

The load bearing rammed earth walls supporting the concrete roof slab above the vaults were required to be designed for a Fire Resistance Level (FRL) of 120/120/120 mins.

The current Australian standards don't cover the fire rating capabilities of this construction methodology and to comply with the BCA requirements we needed to assess the fire resistance level of a 4m high, 400mm thick rammed earth wall in accordance with the AS 1530.4:2014.

The assessment was carried by Warrington Fire, who ran several tests on rammed earth wall specimens 3000mm long x 3000mm high x 400mm thick. Testing assessed the performance of the wall subjected to a vertical load, and the installation of fire rated (compliant) doors. The specimens were found to perform in accordance with AS 1530.4:2014. A desktop study was conducted to correlate the result obtained on the test specimens to a 4000mm high wall. The test result showed that the integrity and insulation performance was maintained for the whole duration of the test. On the basis of this testing a fire test certificate was able to be issued by Warrington Fire stating that the rammed earth, constructed in accordance with the test specimen would achieve the 120/120/120 FRL

SUSTAINABILITY OUTCOMES

An imaginative and ambitious project spearheaded by environmental scientists, the new Herbarium was concepted, designed and built with ecologically sensitive and energy saving features at its core.

Ensuring a sustainable outcome, the first priority in meeting the performance requirements were passive solutions, including; building materials and building design. In addition to extreme heat events such as bushfires, consideration was also required to minimise the amount of direct sunlight heating the vaults thus improving the longevity and performance of the structure.

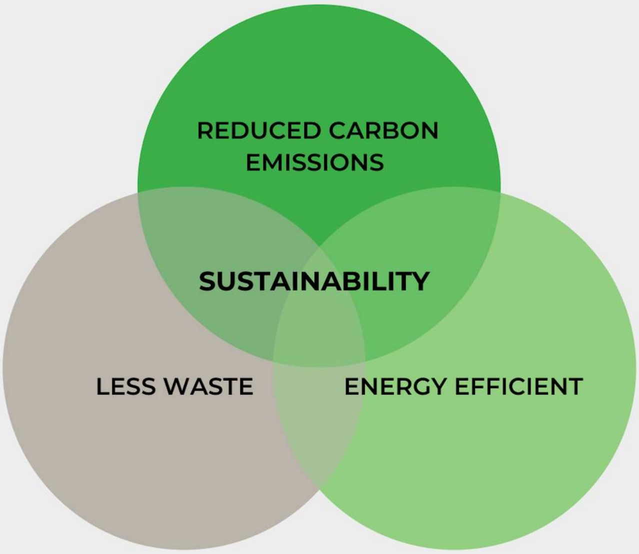
Designed by PMI Engineers, an innovative hovering winged 'fly-roof' protects and cools the vaults, whilst providing greater shade on external terraces for visitors.
The distance from the top of the vaults to the fly roof of several metres created a cavity through which warm air that accumulated under the roof from sunlight, could be evacuated out the sides of the building to prevent heat build up and maintain a more stable temperature at the roof level of the vaults.

These passive design features minimised demand on mechanical cooling and therefore energy usage.

Rammed earth, is a technique for constructing foundations, floors, and walls by using natural raw materials. Remnants of its earliest use date back 10 000 years in the Middle East. In the Herbarium project, rammed earth was used to construct the walls of the seed va. The sustainability benefits in selecting rammed earth were undeniable.

An assessment of the R-value of rammed earth compared to concrete indicated rammed earth had vastly superior insulation performance. Rammed earth has an R-value of 2.48, which is more than 10 times higher than concrete (R-value = 0.23).

SUSTAINABILITY OUTCOMES CONTINUED



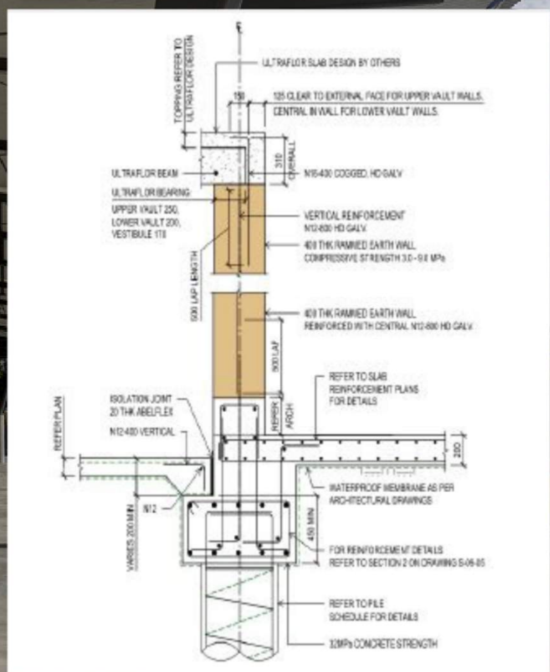
The kilometres travelled of building materials is an important consideration in evaluating the lifecycle carbon emissions for a project, the rammed earth solution was locally sourced and mixed on site thereby reducing the lifecycle carbon emissions for the project.

Further enhancing the 'green credentials' of a rammed earth solution, the construction of rammed earth walls also used a form, rather than traditional formwork, and very minimal vertical reinforcement.

This reduces wastage and material usage such as chairs, spacers and ties.
Sustainability considerations extended to energy and water usage throughout the facility.

Minimising reliance on mains power, a large format photovoltaic array, situated on the fly-roof, generates solar energy for the facility. In addition to the seed bank, the site also hosts a substantial nursery.

To improve sustainability the project was designed to harvest and reuse rainwater, allowing it be used in the irrigation of living plant specimens.



INNOVATION & CREATIVITY

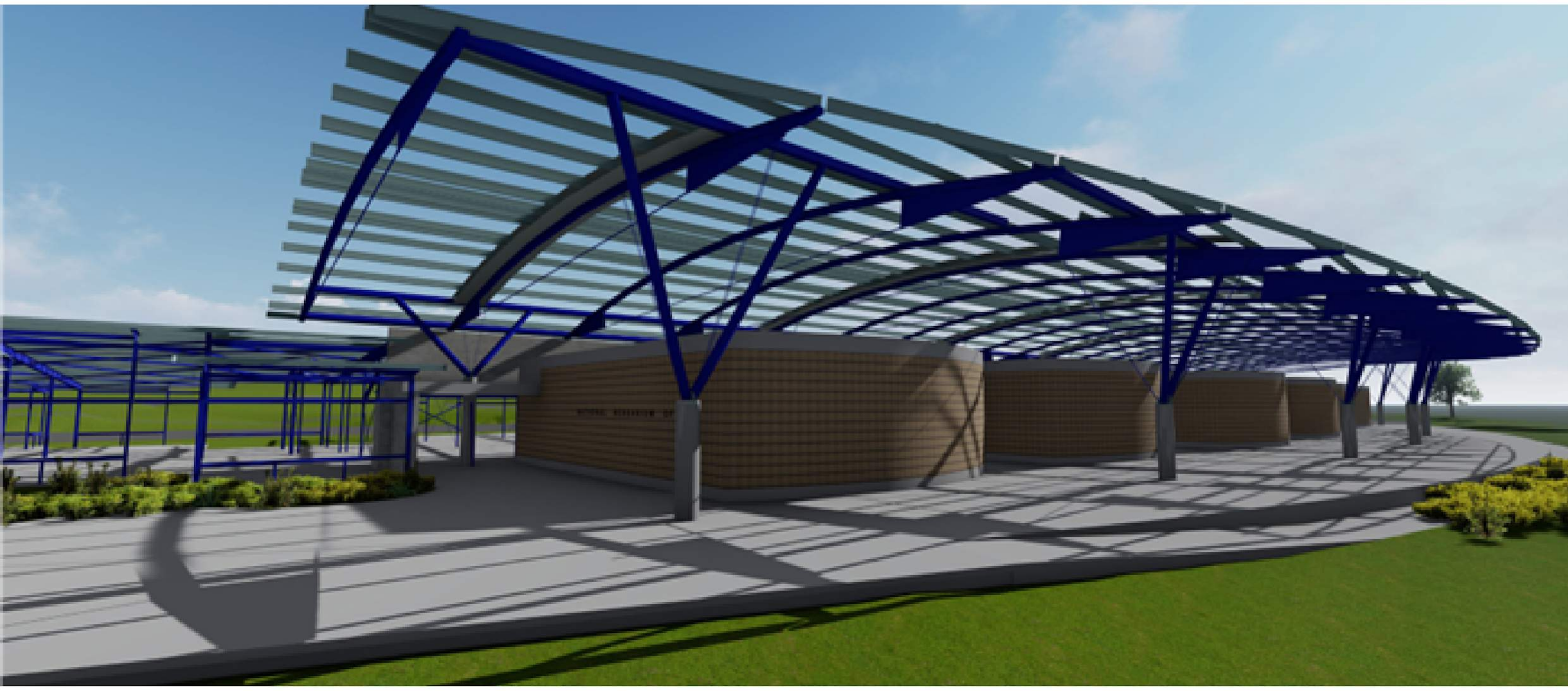
The collaborative design team demonstrated true innovation through the proposal of a large ‘fly-roof’. The roof will assist with protecting the specimen vaults from water and excessive heat while simultaneously providing a deeply shaded external setting for public access and use. The roof is both simple in its shape and intricate.

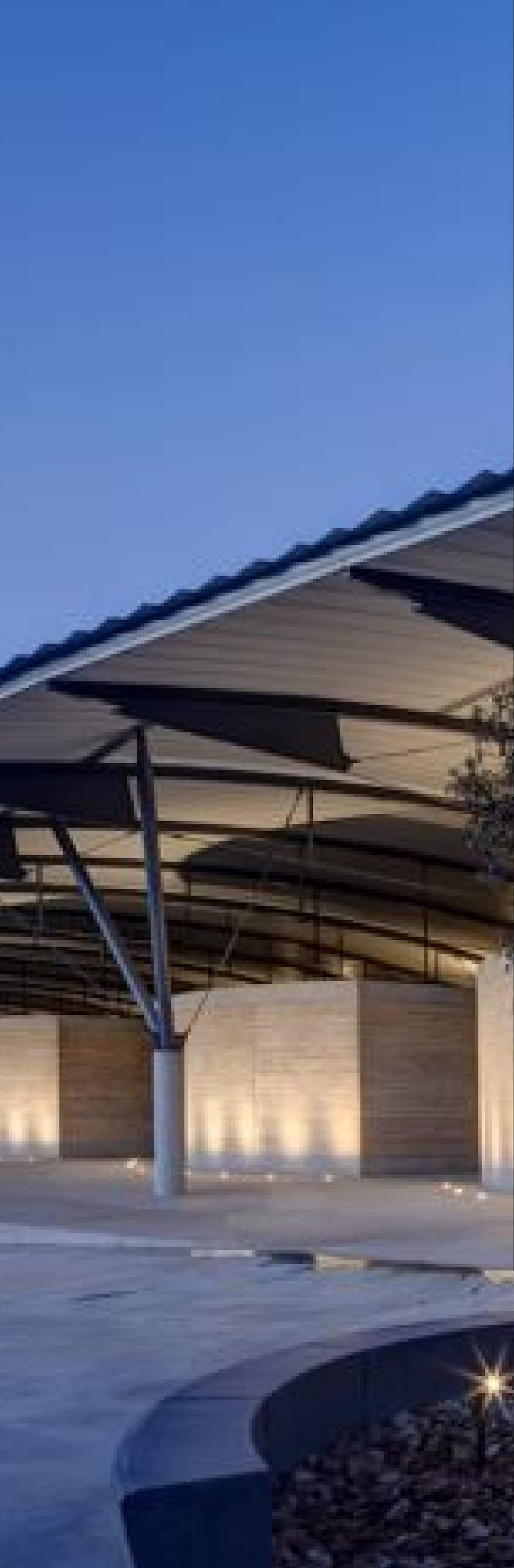
Exposed structural connections provide a point of interest for visitors to the site, highlighting and celebrating the beauty of the structural components, of which are often hidden away.

The long span structure of this roof will support a large format photovoltaic array that will generate electrical energy for the facility, and the roof’s surface will be used to harvest rainwater for irrigation.

Truly unique in its proposal and in its simplicity, the rammed earth walls used for the thermal mass of the vaults leveraged the innate qualities of earth as a building material, as well as blending harmoniously with the surrounding environment, as was the architectural intent.

This seamless connection between natural environment and built structure creates the backdrop to a landmark building that celebrates the importance of connectivity.





INITIATIVE EXPANDED OR CONTINUED IN THE FUTURE

The design guidelines that are used in Australia to design rammed earth structures are contained within HB195 The Australian Earth Building Handbook.

This was written in 2002 jointly by Dr Peter Walker (University of Bath) and Standards Australia and references the work of committee BD-083 Earth Building.

The scope of this Handbook clearly states that it is limited to lightly loaded one and two storey structures.

It is therefore ideally suited to domestic housing construction anywhere in Australia but most particularly, given it's thermal properties, in Arid areas of the country where temperatures can be extreme.

As these areas tend to be remote, one of the key advantages is availability of materials.

In the right location, local soils can be used rather than having to procure and transport more conventional housing materials such as timber and brick over long distances.

The limitations of one to two storey structures is related to its loadbearing design. If used as a non loadbearing cladding material then these limitations are not so relevant.

An obvious opportunity would be to replace traditional brick or precast concrete cladding on buildings such as sport centres and aquatic centres, where large open internal spaces need to be air conditioned.

An additional sustainability benefit in these cases is the reduced energy needed to create rammed earth compared to clay bricks. HB195

The Australian Earth Building Handbook states that rammed earth construction uses typically 50% less energy to produce it compared to fired clay bricks.