THE BRISBANE CRICKET GROUND REDEVELOPMENT NEW NORTHERN GRANDSTAND

Bruce Clarkson

Permafab Pty Ltd

1. ABSTRACT

In April of 1995 Permafab Pty Ltd were awarded the contract for the design, manufacture and installation of the fabric roof membranes to the roof of the new Northern Grandstand at the Brisbane Cricket Ground (The Gabba).

This paper discusses the design , fabrication and installation aspects of this project.

2. BRIEF DESCRIPTION

The roof of the Grandstand is covered by 3500 square metres of SHEERFILL PTFE coated fibreglass Architectural fabric and consists of fifteen separate modules with an average plan area of 233 square metres each. The fifteen bays which are located between each of the sixteen radial roof trusses are generally dimensioned 25.6 metres long and 10.9 m tapering to 8.6 m or 8.1 m wide. There are twelve bays of similar geometry three similar bays of a second geometry. The two geometric setouts are due to the radial gridline system adopted.

3. DESIGN

Each fabric module is a variation of a standard barrel vault. The 460 UB top chord of the trusses form the side perimeters of each of the fabric modules with the fabric clamping system being bolted to a 230mm x 10mm steel plate welded at a constant angle to the flanges of the 460 UB. The inside and outside perimeters are stainless steel catenary cables which are fixed to the 460 UB. There are three arches of 168CHS giving the structure its shape.

The structure was initially proposed with an arch apex height of 2.5 metres above the 460 UB side perimeter beam. An advantage of using the Teflon coated fibreglass material as opposed to the alternate polyester based PVC fabric with Tedlar laminate was that the arch height could be reduced to 1.5 metres which was attractive to the architect and client. This reduction in height of arch was possible due to the higher fabric prestress used for the teflon fabric (approx 4.5 kN/m) compared to 1.5 to 2.0 kN/m for PVC and the different load / elongation characteristics of the two fabric types.

Three dimensional computer models of the structure were generated and load analysis carried out using the wind code loadings (Region B, Category 3 , Vp=49m/s). The results from this analysis indicated that the desired lower arches were allowable. There is only minimal fabric lift off from the arches under maximum design wind load. The maximum fabric stresses resulting from the analysis of this geometry indicated that the Sheerfill 2 fabric was the most suitable for the project. The loads imparted onto the steel structure due to the fabric were used by the structural consultant to check designed steel.

As the design and construction program for the project was quite short it was necessary for there to be close communications between the parties involved. Permafab worked in closely with the architect, Daryl Jackson, the builder, Watpac and the steel fabricator to ensure that the works were completed on schedule.

4. FABRIC

The material used for the roof covering is SHEERFILL 2 HT PTFE coated woven fibreglass architectural fabric manufactured by Chemfab Corporation of Merrimack, New Hampshire, USA.

Sheerfill is the trade name for a fabric woven from fibreglass yarn and then coated with PTFE (polytetrafluoroethylene – commonly referred to as teflon). The material was developed by Chemfab Corporation of the USA in association with the Du Pont Company and Owens Corning Fibreglass Corporation. It has been in continuous service since the first installation at La Verne College , near Los Angeles in 1972 and has been used as the material of construction in the majority of permanent fabric structures worldwide. These include the 105 acre Haj Airport Terminal in Jeddah, Saudi Arabia; the 35000 square metre Airport Terminal Roof at the Denver International Airport; the 37000 square metre cable dome roof of the Georgia Dome in Atlanta which was recently used in the Olympic Games; and the 15000 square metre Hong Kong Stadium Roof which is the venue of the Hong Kong Sevens Rugby Tournament.

The grade of Sheerfill used (Sheerfill 2) is the second strongest of the four grades of structural membranes available from Chemfab. There are also acoustic liner materials of similar construction available.

Apart from the pleasing aesthetics of the installed membrane, the outstanding characteristics of the PTFE coated fabrics are their excellent fire properties , high tensile strength, self cleansing properties and great durability. Of particular interest to the client on this project were the heat and light transmission properties of the fabric and in particular the UV penetration of the membrane which is effectively zero.

5. PATTERNING

Three dimensional patterning models of each structure type are developed once the structural geometry has been finalised. With the tight schedule on this project this was often as the steel was being fabricated. Patterning of the modules was carried out in house by Permafab using purpose written finite element software.

Each of the fifteen modules was made up of twelve separate panels. There were eighteen basic different patterns required, however, as each of the seven rolls used had varying biax data a total of 70 patterns were required.

6. FABRICATION

The fabrication of the fifteen modules was carried out by Structureflex Australia Pty Ltd at their Brisbane factory under a licence agreement with Permafab.

The pattern data which was provided in hard copy and on disk is modified into CAD format for their use in creating the template models which are then plotted directly onto the fabric after checking and approval by Permafab. The plotted template is checked dimensionally on the plotting table prior to the fabric being cut.

The separate panels are joined using a 70mm wide lap seam where the fabric is sealed together under pressure at 364 degrees Celsius. The Teflon surfaces fuse producing a joint with tensile capacity in excess of the single layer membrane.

The completed fabric membranes are cleaned, folded, packaged and were despatched to the site in six separate deliveries. The cleaning of the membranes in the factory was critical on this project as access to fabric underside once installed is very difficult.

7. INSTALLATION

The installation of the membranes was carried out over nine weeks from September 1995 by a team consisting of Permafab's Project Manager and two Installation Supervisors and up to 8 locally sourced riggers.

The most critical aspect of the installation of a fabric structure is the fabric deployment as it is during this process while the fabric is pulled out but before it can be secured to the perimeter that there is a real risk of damage to the membrane. Therefore considerable planning and preparation

by Permafab's Project Manager and Installation Supervisors goes into every fabric deployment. In this case it was considered best to set the folded membranes on deployment platforms which were spanned between the outside ends of the main radial trusses.

These platforms were approximately 12m by 2.4m in size and made up of standard scaffold components. They were supported on specially designed frames which were fitted to the 460 UB top chord of truss. The fabric package was loaded onto the platform on the ground and the platform then lifted into position by crane. Initially six platforms were erected however, it proved easier to use only three due to cranage and site space constraints.

The platforms provided the means for the membranes to be deployed in the least time and safest manner possible. The actual deployments were taking less than an hour after a day and a half had been spent in preparation.

The leading edge of the fabric (where the stainless catenary cable had already been fed into the cable cuff) was pulled to the inner side of the bay using hand operated winches which had been mounted on the catwalk. The sides of the fabric were at all times controlled from the 460 UB side perimeters.

The membrane is temporarily secured and the front and rear catenary cables are set to their design positions. The permanent perimeter hardware (aluminium clamping) is then attached to the fabric rope edge in which holes have been punched during fabrication to suit and secured to the perimeter with a threaded rod. The threaded rod is used to tension the membrane to its design position. The tensioning period for each module was about five days. The perimeter clamping was then bolted up to the M12 holes that had been pre–drilled in the steel perimeter section.

An interesting aspect of the installation process was that five of the fifteen modules extended over Vulture Street. This required the scaffold platforms to be installed over the roadway and for Permafab's deployment and parts of the installation process to be carried out over Vulture Street. The final three fabric deployments required the closure of three of Vulture Streets four lanes for the period of the work.