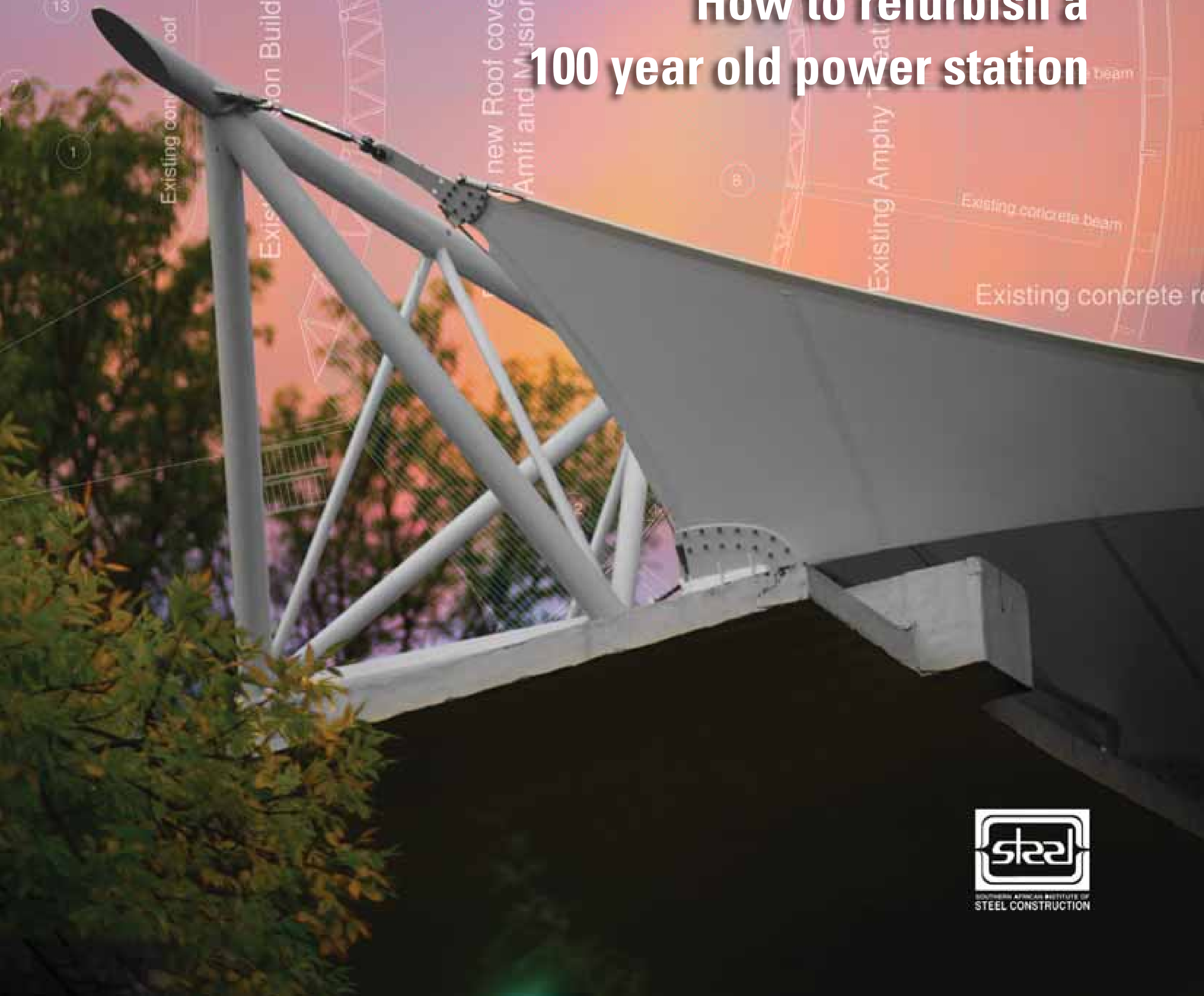
steel CONSTRUCTION

OFFICIAL JOURNAL OF THE SOUTHERN AFRICAN INSTITUTE OF STEEL CONSTRUCTION
Volume 39 No. 3 2015

TUBULAR STEEL STRUCTURES

FABRICATED STRUCTURAL STEEL
A DESIGNATED PRODUCT

How to refurbish a 100 year old power station



SOUTHERN AFRICAN INSTITUTE OF STEEL CONSTRUCTION

University of Pretoria: Musaion Amphitheatre Roof

A radial tensioned tensile fabric model (using Ferrari Fabrics) was chosen and since only a quadrant was available to work with, hidden compression members needed to be introduced to retain a horizontal semi-circular tubular truss, (fixed to the roof on the Musaion stage side) and a three-dimensional semi-circular tubular truss (fixed to the radially converging and cantilevering beams on the amphitheatre side).

The Musaion Theatre with its adjacent amphitheatre is a well-known building within the heritage sensitive precinct of the University of Pretoria campus. The client's brief called for an all-weather enclosure that did not compromise the existing line of the two opposing edges of the stage and amphitheatre that cantilever towards each other. The design solution was chosen on a competition basis.

PROJECT TEAM

Client:	University of Pretoria
Architect:	ARC Architectural Consultants (Pretoria) (Pty) Ltd
Structural Engineer:	WSP Group Africa (Pty) Ltd
Quantity Surveyor:	Bham Tayob Khan Pretoria Inc.
Project Manager:	ARC Architectural Consultants (Pretoria) (Pty) Ltd
Steelwork Contractor:	CICon PM
Tensile Contractor:	Texwise Architectural Structures (Pty) Ltd
Electrical Engineers:	TPS Consulting Engineers

The amphitheatre accommodates a 3 000 seated audience in a two-tiered semi-circular roofed concrete structure, which is placed 14m detached from the external stage area on a radial pattern.

The design honoured the importance of preserving the heritage of the two structures and proposed a floating roof. An exacerbating factor was that no structural information of the existing structure was available!

As no additional support structure could be introduced to the existing structure and loading capability needed to be assessed, based on codes of practice relevant to the 1950s, a very lightweight solution was needed: A radial tensioned tensile fabric model (using Ferrari Fabrics) was chosen and since only a quadrant was available to work with, hidden compression members needed to be introduced to retain a horizontal semi-circular tubular truss, (fixed to the roof on the Musaion Theatre side) and a three-dimensional semi-circular tubular truss (fixed to the radially converging and cantilevering beams on the amphitheatre side). The tensile fabric and supporting cables, then served as the tension elements.

The construction programme was dictated by the event programme of the Musaion and Amphitheatre and could only be scheduled in the allowed six-week break. The solution was to

fabricate the elements off-site to a precision surveyed matrix. The timeframe did not allow for a re-survey of the erected steel support structure, before cutting and fabricating the tensile fabric. The coinciding national strike in the steel and related industries also did not help the already tight deadlines.

The external tube rolling sub-contractor had no workforce to roll the circular hollow sections. The solution was to cut the main members to shorter lengths, weld the end plates onto the segments, bolt them together and then 'persuade' the three main members into the required radius using Tirfors, chain blocks and the additional help of a forklift against a specially prebuild profile to achieve the necessary radius for the 127 and 150mm diameter tubes. The infill support tubular sections were profiled and positioned and the structure then tack welded together.

The four main tubular rafters could not be rolled into the required radius, since there was not a large enough machine available in South Africa to do the job. As a solution the tubes were segmented into lengths, cut at an angle and welded together, resulting into a curved compression member.

The structure was then disassembled, welded all round and moved to the yard, where it was assembled again to the original surveyed matrix as was required on site. The four main tubular trusses were also installed and the whole structure surveyed to check and mark the positions of the cleats for the cables required by the textile contractor.

The structure was disassembled again, brought back into the workshop and all cleats were welded on. Thereafter the structure was moved to the sandblasting bay and painted to specification.

During the erection phase, access for a crane to lift the large units into position was limited to a distance of 80m to the nearest concrete surface strong enough to support the crane and its load. This challenge was already solved in the workshop by fabricating smaller sections and then using a spider crane on rubber tracts to get right up to the building to lift the sections the 11m to the roof. The sections were then manually positions and bolted together to form the final curve. The contractor should be commended for initiating creative solutions of transporting completed sections to the site to continue the workflow.

The floor area between the Amphi and the Musaion is heritage sensitive brick paving and therefore large spreader planks were used to protect the paving to build a double tower after which the tubular rafters were hoisted into position with a chain block to the 14m above NGL (Natural Ground Level). This process was repeated four times to achieve the total installation.