A 26 m (85 ft) long, highly unusual concrete portico over the entrance of a government building (The Pretoria Canopy), located in Silverton, Pretoria, South Africa, transforms a fairly ordinary looking building into an architectural milestone (Fig. 1).

Due to the organic nature of the structure, the architect proposed to use shotcrete early in the design process. Consultations with Shotcrete Africa SCP were held about 9 months prior to the start of construction.

The flowing, curved shape of the structure would probably have been nearly impossible with use of form-and-pour techniques. The one-sided formwork was a custom fabrication with over 300 individually laser-cut pieces creating a complex, undulating surface. To have to double the amount of formwork, precisely align the two sides, and brace for the incredible pressures that form-and-pour would have generated would most likely have necessitated a re-design of the structure to more easily accommodate the limitations and costs of standard formwork. Using shotcrete mitigated a lot of these problems and reduced the cost. Shotcrete thus enabled the architect to realize their one-off design in the shape and form as originally visualized (Fig. 2).

Sustainability advantages are typically recognized in varying degrees on all shotcrete projects when compared to form-and-pour concrete construction. Although this was a difficult and challenging shape to construct formwork for, the use of the shotcrete process achieved at least a 40% reduction in formwork, labor, and crane costs. This substantial reduction highlights shotcrete’s natural sustainability benefits. The formwork took approximately 3 months

Fig. 1: View walking into the canopy

Fig. 2: View from inside the canopy
to erect from date of award to final use. Any extension in this
time and the ensuing cost would probably have rendered the
project unfeasible without a major redesign.

THE PROJECT
The R3-million Pretoria Canopy project entailed R1.6-million
of formwork, just 70 m³ (90 yd³) of shotcrete, and a substan-
tial 18 tonnes (20 tons) of reinforcing steel. The project was
a tremendous learning curve for all and already interest has
been generated in duplicating these skills and methods on
other interesting projects.

Architect Pieter Breytenbach, Deter Architects & Design-
ers, was given free imaginative reign on the concrete portico
cover over the entrance. It was a fairly old building, so it
was a challenge to design a structure which would comple-
ment the existing building while contributing something to
its aesthetics. To achieve that, he employed one of the oldest
and most robust structures ever designed—the arch.

Making it especially challenging was that the surrounding
ground ramped up towards the entrance, so the design had
to accommodate the gradient slope up to the building plinth.
The only guidance from the client was that they wanted
something “impressive.”

The structure rises up towards the building entrance and
narrows down to a diminishing point, indicating the way to
the door almost like a target. That was the biggest challenge
from a design point of view. Once the design was selected,
the architect had to look at what could be taken away. One
usually has heavy buttresses on an arch, but these were
able to be done away with due to the capabilities of the
concrete and the expertise of the engineers involved.

The idea was to open up the western side of the structure
to provide sufficient natural light. It was fortunate that protec-
tion from the elements was afforded by the existing building.
Polycarbonate (used as a roofing material because it doesn’t
transfer a lot of heat) was clad over ribs tucking into the struc-
ture on the sides which turned three-dimensionally.

As a result, when one approaches the building, the portico
opens up in a well-lit manner, then closing in while tilting up
slightly as the entrance is neared. Two large pillars and the
gutters act as the keystone to the structure. There are long
spans of unsupported, cantilevered concrete between the
pillars, and that’s a homage to the material worked with and
what it is capable of.

SCOPE OF WORK
It is believed this is one of the only structures where every
element of reinforcing bar has its own bar-mark—every
single piece is individual, because everything is either
diminishing or increasing in size and the whole structure is
moving in three directions. It’s definitely not like a normal
column. The reinforcing steel design was done by the
engineer, SCIP.

The concrete mixture design included admixtures such as
Penetron, silica fume, and high-range water-reducing
agents to achieve a slump of just 80 mm (3.2 in.). The
columns are 800 mm (32 in.) deep and 2.4 m (8 ft) wide.

Peri was responsible for the design of the formwork and
shoring. All formwork elements for the soffits were prefab-
ricated by Peri off site to be delivered for assembly on site.
The structure is asymmetric in section and formwork design
had to be done in three-dimension (3-D), taking existing
structures into account. From a formwork point of view, this
project was highly unusual, and many contractors made the
decision to not get involved.

Construction started with the installation of a designed
network of props and scaffolding to support the ribs of the
canopy. Each individual rib was laser-cut and no two were
the same. The forming ply was then placed and fastened to
the support structure. At all times, strict health and safety
was maintained. An initial layer of shotcrete was then placed
to avoid using “spacers” that would have negatively impacted
the smooth finish required by the architect. This, however,
did not go 100% to plan.

The design and installation of the reinforcing bars was
also a challenge. A hands-on approach was the only way
to get the job done (Fig. 3). This project was a question of
complete commitment from all involved and required clear
vision in terms of what had to be achieved. The progress
meetings required detailed technical discussions and the
various trades worked much closer together than normal.
The reinforcing steel bending schedule was complex
and required many clarification meetings to ensure it was
designed and installed correctly.

Fig. 3: Complex reinforcing steel for the canopy
Shooting this intricate web of steel was easy enough (Fig. 4); however, work had to stop occasionally to “catch up” with rebound removal. At all times, an airlance was used to prevent encasement of rebound in the finished sections. We did struggle with “finishing” the placed shotcrete in time before it hardened, but any unfinished work was cut down to 30 to 50 mm (1.2 to 2 in.) below the final surface whilst still wet. This allowed slower placement and careful attention to finishing the following day. A saturated surface-dry (SSD) condition was achieved before applying the final finish coat and hessian burlap and a mist system was used overnight to ensure good curing.

The mixture design was critical to achieve an ideal slump that enabled the company to shoot the 800 mm thick columns through two layers of heavy reinforcing bars with a minimum of rebound and excellent encapsulation of the bars (Fig. 5). The addition of Penetron to the mixture reduced the concrete permeability and helped ensure a long-lasting, durable concrete structure.

On completion, the structure was allowed 14 days to achieve 80% of design strength and then the formwork was removed in stages. It was a tense moment when the final formwork was lowered. The structure sagged less than 10 mm (0.4 in.) at the furthest point and a collective sigh of relief was no doubt shared by all involved. The top of the structure was then inspected for any movement cracks and as a precaution some micro cracking (found to be less than 1 mm thick and 15 mm deep) was repaired using dry-mix shotcrete. A week after completion the repaired section exhibited no further visible cracking.

**CONCLUSIONS**

Shotcretes uses and benefits continue to allow far sighted architects, engineers, and contractors to push the boundaries of what is sometimes thought of as impossible to achieve. This project exemplifies shotcrete’s creative ability to transform the architect’s vision into a solid and durable concrete structure (Fig. 6).
**Eamonn Ryan** is a Journalist and Editor with more than 20 years of experience contributing to almost all South Africa’s financial newspapers and magazines, as well as several overseas publications. He previously served as the Business Editor of Finweek and as Editor of various technical magazines, including Civil Engineering Contractors (a 50-year-old magazine) and Quarry SA. He currently serves as Editor of Plumbing Africa and SA Affordable Housing.

**Dustin Strever** is the Founder and Managing Director of Shotcrete Africa SCP—Africa’s largest specialist shotcrete contractor. Based in Johannesburg, South Africa, Shotcrete Africa SCP offers a variety of shotcrete application services, ranging from small concrete repair using the dry-mix process to bulk structural using the wet-mix shotcrete application. Together with his wife Lynne, Business Manager, they employ over 75 staff. Strever has been involved in the shotcrete industry for over 15 years and was first exposed to dry-mix shotcrete when a client asked him to spray a 7 km (4 mile) precast concrete wall to add robustness. Since then, Strever has made it his mission to improve the perception and quality of shotcrete in South Africa, educating himself and staff with the assistance of the American Shotcrete Association and other leaders in the field. Shotcrete Africa SCP has been a corporate member of ASA since its inception.

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**2019 OUTSTANDING INTERNATIONAL PROJECT**

**Project Name**
Pretoria Entrance Canopy

**Location**
Pretoria, Gauteng, South Africa

**Shotcrete Contractor**
Shotcrete Africa SCP*

**Architect/Engineer**
Pieter Breytenbach - DETER Architects

**Materials Supplier**
Metier Mixed Concrete

**Equipment Manufacturer**
REED Shotcrete Equipment*

**General Contractor**
Bhekinani Civils & Projects

**Engineers**
SCIP

**Formwork Design and Shuttering**
Peri

**Steel Supplier**
Piovesan

*Corporate Member of the American Shotcrete Association

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Fig. 6: A side view of the finished structure before painting