

# Pampoen Nek Cutting

By *Dustin Strever*

**S**ituated in a pristine part of the country near the Hartbeespoort Dam in the Gauteng province of sunny South Africa, the Pampoen Nek Cutting bisects the landscape into what will one day be an extension to the highway road network connecting the northern suburbs of Johannesburg with the mining towns of Brits and Rustenburg and the resort complex at Sun City. The cut needed extensive soil support along the highway. The owner decided that soil nails with shotcrete facing would provide a durable and economical solution to stabilize the soil slopes.

### SELECTING THE WET-MIX PROCESS

Shotcrete Africa SCP, the subcontractor to Aveng Ground Engineering, was awarded the shotcrete portions of the contract. Aveng Ground Engineering was responsible for all of the piling and soil nails for the project.

During the beginning phase of the planning process, Shotcrete Africa SCP proposed to the engineering consultants, Aurecon, and the overall client, South African National Roads Agency (SANRAL), that more consistent quality and better daily production could be achieved with wet-mix shotcrete placement as opposed to the specified dry-mix process (gunite). Test panels were shot and tested at 14 days. The uniformity of the compressive strength

results and the minimal dust created while shooting facilitated approval of the wet-mix alternative. It should be noted that wet-mix shotcrete is in its infancy in above-ground civil works in South Africa. Shotcrete Africa SCP is a pioneer in bringing mainstream education and acceptance of wet-mix shotcrete to the engineers and clients.

While there was a contract pay item for “colored gunite,” the original on-site specification called for a screeded and brushed shotcrete finish.

### ROCKSCAPING

Due to the poor collapsible soil conditions, maintaining the screeded and brushed finish required significant quantities of fill shotcrete (void filling) that also potentially added time to the project. With strict budgets to keep, alternative solutions were needed. Because the project was in such a pristine part of the country, Shotcrete Africa SCP proposed rockscaping. We then sprayed some mockup panels with a simple rockscaping finish that once painted would mimic the surrounding rock strata. SANRAL approved of the approach and Shotcrete Africa SCP went onto the fast track to respray the already completed work while still keeping up with the drill teams that were installing over 18 m (60 ft) long soil nails. Budget constraints limited Shotcrete Africa



Fig. 1: Shotcrete finish—woodfloated and brushed



*Fig. 2: Sample of rockscaping, woodfloat, and brushed finish for the clients to inspect*

SCP to a nominal 50 mm (2 in.) additional shotcrete, requiring our team to get more creative. A minimal application on larger flat areas of the face was applied and thickened up to 200 mm (8 in.) where a nice shadow needed to be placed. More shotcrete than originally planned was used; however, it was necessary to complete the job efficiently.

As the wall placement progressed, the project developed an audience who would pop past every day giving “recommendations and advice.” Shotcrete Africa SCP found it best to smile and nod and then continue to just let the shotcrete carvers to do what they thought was best. The poor ground



*Fig. 3: Completed wall with aesthetically pleasing outcrop and shadowing*



*Fig. 4: Completed works on the eastern side*

conditions, and in some cases very large voids formed by the excavators, now started to add value as shotcrete could follow the large earth shapes to give the wall the depth and naturalness that was desired at the start.

## MIXTURE DESIGN

The specified shotcrete strength was 30 MPa (4350 psi). Shotcrete Africa SCP with the collaboration of the material supply partner, 3Q Concrete, designed a mixture that included for 1 m<sup>3</sup>:

- Water (195 L [51 gal.]);
- OPC cement (360 kg [794 lb]);
- Silica fume (20 kg [44 lb]);
- Fly ash (90 kg [198 lb]);
- Coarse aggregate - crushed (<6.7 mm [0.3 in.]) Dolomite stone (1235 kg [2723 lb]);
- Fine aggregate (530 kg [1168 lb]);
- Superplasticizer (2.925 L [0.772 gal.]); and
- Air-entraining admixture (675 mL [23 fl oz]).

This mixture design provided a water-cementitious materials ratio of 0.43 and consistent compressive results of over 40 MPa (5800 psi) on the 116 cores tested on the project. Only two were less than the required compressive strength of 28.5 MPa (4150 psi)—a fantastic result and testament to 3Q Concrete as this was the first time the ready mixed supplier had supplied concrete for wet-mix shotcrete. Granted, there were some teething problems with getting the slump correct when the concrete truck arrived on site. An 80 mm (3 in.) slump was requested, but our REED C50HP had no issues dealing with the slightly stiffer mixture. In fact, other than bursting into flames (aftermarket light over the hopper spontaneously combusted), the REED pumped beautifully, and the client became used to seeing daily production

rates of over 30 m<sup>3</sup> (40 yd<sup>3</sup>). Our production rate was limited only by the face of the wall available to shoot at any time.

## MAINTAINING THE FREEFORM NATURE OF THE ROCKSCAPING

One aspect of the shoot that was a bit more challenging than the rest of the project was a 20 m (66 ft) high pile wall with a perfectly level capping beam cast across the top for 40 m (131 ft). This very straight line and flat surface had no place in the freeform nature of our rockscaping, so we placed all types of items in the concrete to provide unevenness, including 250 mm (10 in.) diameter cores varying in height from 200 to 400 mm (8 to 16 in.) along with some local boulders that were found. The steel welded wire reinforcing was then extended over this “unevenness” and then shotcreted, resulting in no visible straight lines.

## MATCHING THE EXISTING SURROUNDING ROCK

The last stage of the contract was to apply several layers of non-toxic paint from access boom lifts to match the colors of the surrounding rock. Again, all manner of folks provided their input; however, a good balance was achieved between matching the surrounding colors and adding age and watermarks with the streaks of black running down the face. You can't please everybody when it comes to subjective art, but the client was happy and that's what counts.

## CONCLUSIONS

We sprayed a total of 763 m<sup>3</sup> (1000 yd<sup>3</sup>) of shotcrete over 3500 m<sup>2</sup> (38,000 ft<sup>2</sup>). The design thickness was 200 mm including the rockscaping. Our waste factor was just under 10%. The final result speaks for itself—the client has a



Fig. 5: From an absolutely flat-topped and flat-faced piled wall to this



Fig. 6: Final wall with a view over the Hartbeespoort Dam

safe and durable concrete soil retention solution. And it's expected that "Joe Public" as they drive past at 120 km/h (75 mph) probably won't even notice our shotcrete creation. That's the idea, right? A shotcrete solution that blends in so seamlessly that unless you get up close, you'll miss it!



**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. Dustin 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, Dustin 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 the ASA since its inception 6 years ago.

## 2018 OUTSTANDING INTERNATIONAL PROJECT

*Project Name*  
**Pampoen Nek Cutting**

*Project Location*  
**Hartbeespoort, Gauteng, South Africa**

*Shotcrete Contractor*  
**Shotcrete Africa SCP\***

*Architect/Engineer*  
**Aurecon Consulting Engineers/Aveng**

*Material Supplier/Manufacturer*  
**3Q Concrete**

*Equipment Manufacturer*  
**REED Shotcrete Equipment\***

*General Contractor*  
**Aveng Ground Engineering**

*Project Owner*  
**South African National Roads Agency**

\*Corporate Member of the American Shotcrete Association