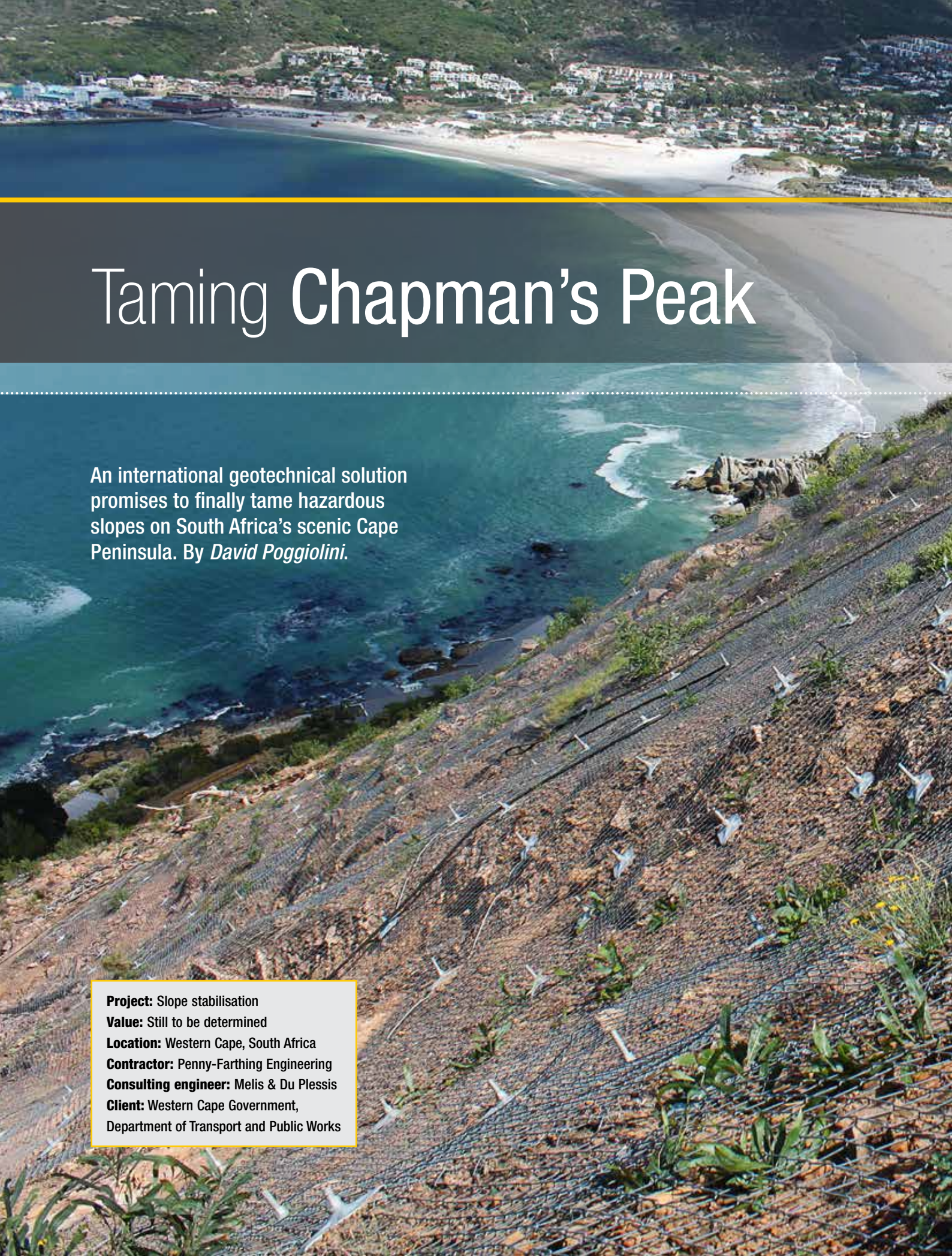
Taming **Chapman's Peak**

An international geotechnical solution promises to finally tame hazardous slopes on South Africa's scenic Cape Peninsula. By *David Poggiolini*.



Project: Slope stabilisation
Value: Still to be determined
Location: Western Cape, South Africa
Contractor: Penny-Farthing Engineering
Consulting engineer: Melis & Du Plessis
Client: Western Cape Government, Department of Transport and Public Works


David Poggiolini

Swiss geotechnical expertise promises to finally bring an end to the hazardous problems that plague a scenic stretch of road on the Western Cape.

Chapman's Peak Drive runs along the Atlantic Coast between Noordhoek and Hout Bay on the Cape Peninsula, and has been subjected to a host of dangerous incidences, ranging from large rock falls to mudslides.

The more recent episode was at the end of November 2013 when exceptionally heavy and intense rainfall destabilised a 600m section of mountain slope, resulting in severe rock debris and mudslides, and wreaked havoc on the Hout Bay side of the drive. The severity of the event resulted in an immediate shutdown of the road to all vehicles for two weeks to allow emergency repairs and clearing.

Two Western Cape firms, geotechnical contractors Penny-Farthing and consulting engineers Melis & Du Plessis, have been appointed to rehabilitate and stabilise the cuttings since then.

The latter was responsible for introducing the Western Cape Government, Department of Transport and Public Works to Geobrugg's range of geotechnical solutions for the task at hand. The department is responsible for the rehabilitation work on the road, which falls outside of concessionaire Entilini Operations' contractual obligation on the toll road.

Melis & Du Plessis had used one of Geobrugg's geotechnical solutions on another section of Chapman's Peak drive back in 2004 with significant success. The company's rock fall barriers, which were installed by Haw & Inglis on behalf of Entilini Operations, have proved their worth to date, holding back large rocks and other debris.

Bart Schoevaerts, managing director of Geobrugg Southern Africa, says that one of the company's solutions includes a debris-flow barrier. Five of these will be installed on the unstable slope to stop further debris flows from reaching the road. This is the first time that such a system is being used on the continent. In addition, Melis & Du Plessis designed measures to stabilise a number of gulley heads using the company's Tecco system.

Melis & Du Plessis

Damage done
A more advanced method of stabilising this section of the mountain is needed to avoid a repeat of the incident in November 2013.

He adds that the company's shallow landslide barriers will be installed in three other areas of the compromised cutting to intercept further landslides.

Swiss tested

Melis & Du Plessis undertook the assessment of the geo-hazards of the site.

Schoevaerts says that the success of the system is dependent upon a thorough assessment of the site. "Once we have the specifications of the geo-hazard, our engineers are able to design a system that is able to perform with 100% accuracy," he says.

Schoevaerts says that the complete solution focuses on stopping or reducing further destabilisation of the scree slopes, while intercepting any debris flows from the remaining unstable material.

Developed and tested in Switzerland, Geobrugg's Tecco stabilisation system comprises high-tensile steel wire mesh used in combination with soil and/or rock nails to stabilise steep slopes in unconsolidated material and any rock liable to slip and break out. The wire mesh has a tensile strength of 1 770 Newton per square millimetre (N/mm2).

Schoevaerts explains that the surface is first cleaned, levelled and shaped, and then covered with the mesh. The mesh is fastened by ground or rock nails and pre-stressed with a defined force against the nails with special spike plates.

Reacting to this, the mesh presses against the slope surface preventing deformations, slips and break-outs. He says this external pre-stress increases the safety and efficiency of the system.

The nails to which the system are fastened are arranged in a pattern. They can also be used to stabilise deeper-reaching slips or slides. He says that the drill-hole matrix was designed by Melis & Du Plessis, considering that the success of the system is dependent upon a thorough understanding of the unique ground conditions, including slipping or creeping surfaces or zones.

Debris barrier

Meanwhile, the debris flow barrier system comprises a number of components. Schoevaerts explains that the Rocco ring net is the main element of the system and comprises the high-tensile 1 770N/mm^2 wire with a diameter of 3mm.

Ring nets with 12 windings are built into the lower intensity systems, and with 16 windings for the higher intensity standard systems – as is the case with the technology that is being installed at Chapman's Peak.

The net itself absorbs energy by plastic

At heights
There is a 260m elevation from the road to the top of the slope and larger packs were needed to power the three drills on site. Another challenge is the loose debris, with the contractor having to install its own temporary barriers to safeguard against landslides.

The mesh presses against the slope surface, preventing deformations, slips and breaking out.

deformation. Meanwhile, support ropes transmit the forces in the net over posts to anchors.

The abrasion protection defends the upper support ropes when the barrier is completely filled and is overtopped. It consists of steel angles with welded shackles to fix it on the upper ropes.

The support and retaining ropes are anchored in the soil or rock with spiral rope anchors. These are equipped with a flexible head, which ensures that forces not working directly in the pulling direction can also be transmitted. Two galvanised tubes over the anchor head, plus the galvanized spiral rope, provide double corrosion protection.

The brake rings dissipate energy via plastic deformation and friction, and protect the support ropes from overload, while steel tubes also protect the rope from corrosion and mechanical damage.

Base plates for the posts are set on a concrete foundation, which is fixed with tension and pressure anchors in the ground of the torrent.

Schoevaerts says the posts are hinged on the plates. All elements that come in contact with the ropes are finished without sharp edges to avoid rope damage.

Shackles connect the ring net and the ropes. They guarantee that the net can slide on the rope without damaging it. The nets are also connected vertically with shackles, which he says are a stronger connection than the net itself.

The ropes have pressed loops on one side and the free-end is fixed with wire rope clips.

Extended scope

At the time of visiting the site, Alexis van der Merwe, of Melis & Du Plessis, believed that the gully head stabilisation was about 60% complete. The next stage of the works will be the construction of the debris-flow and landslide fences, with the entire works scheduled to be completed in the first half of 2016.

He says that there is an array of challenges facing the professional team. One of these is the extremely sensitive working environment. "Environmental approval of the works has been a key issue on the project. Plant species have been assessed and where necessary marked for protection," says Van der Merwe. "Plant species are marked weekly, and every effort is made by the professional team to avoid damaging them."

Leon Oosthuysen, site agent for Penny-Farthing Engineering, says that a major challenge on this project has

Photographs: David Poggiolini

SITE HIGHLIGHTS

- Swiss geotechnical solutions specifically designed for unique site conditions
- Sensitive environment impacts production scheduling
- Steep terrain and difficult access complicate drilling operations

been accessing the site with drills and power packs. An old South African National Parks road at the top of the slope was used to transport most of the machinery to the top of the slope and was then carried down to the work face.

There is a 260m elevation from the road to the top of the slope, and larger packs were needed to power the three drills on site. He says that coolants are used every morning to prepare the machines for pumping hydraulic fluids at these heights. This preparatory work can take up to 45 minutes, calling for careful sequencing and planning before drilling can start.

Oosthuysen says the company is drilling 135m to 150m vertically and about 180m to 220m in a horizontal direction. The holes are drilled at about 125° upslope and the anchors must be in 2m of solid rock.

Actual drilling is a significant challenge as the terrain is overlain with boulders. He says that only 2,3m of drilling is undertaken in soft sandy material before the drilling crew encounters rocky terrain.

The drill grid takes into consideration the instability of the slope and, in line with Geobrugg's philosophy, the drilling of holes has been limited significantly to avoid compromising it further.

The instability of the slope also means that there are a number of safety

Taming a mountain
The more recent episode occurred at the end of November 2013 when exceptionally heavy and intense rainfall destabilised a 600m section of mountain slope, resulting in severe rock debris and mudslides and wreaking havoc on the Hout Bay side of the drive from Chapman's Peak.

concerns. When we visited the site, the contractor had installed its own temporary barrier to halt cascading debris, which included massive boulders – in some instances, the size of a car. As many as 42 people work on the site which is monitored by safety officers 24 hours a day to manage the sheer risks involved.

No cranes needed

Schoevaerts says that one of the advantages of the system is that it is light enough to be carried to the top. The system is made in modular, manageable sections which are carried to the work face where they are assembled *in situ*.

Without this option, the project would have called for the use of a large crane and closure of the toll road. This would result in major on-site logistical problems and significant negative impacts on daily business for the toll-road operator. The use of mobile cranes and truck-mounted boom cranes would have significantly pushed up construction costs.

What is more, Geobrugg's system accommodates the least amount of holes. This, again, reduces the construction costs by keeping drilling to a minimum – normally a major expense in geotechnical operations

Once the entire mesh has been placed, it will eventually be hidden by plants and vegetation, while the barriers are discreet enough to blend into the surroundings. ■■

OPINION

It is encouraging to see new ways of tackling problems being introduced into the country. Clearly, South Africa is opening up to more sophisticated technologies. Just as interesting are Schoevaerts' views that the company has seen a rise in global demand for its technologies due to more extreme weather conditions and the impacts of global warming. One can, therefore, assume that we will continue seeing more of Geobrugg's systems being used in Africa.

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