

Making the road safe for travellers

Bentley products help create barriers against lethal rockfalls

Scenic, winding Chapman's Peak Drive was a popular route for South African tourists and commuters – until boulders began dropping from the mountainsides above.

Wildfires stripped away the ground cover that held topsoil and screes, or loose rocks, in place. The exposed mountains eroded, rockfalls intensified – some of them fatal – and the road was closed to traffic.

A team of firms tackled the challenge of making the roadway safe again. Thanks to a combination of innovative thinking and Bentley software, Chapman's Peak Drive is once again open to traffic.

Creating a digital terrain model

In May 2002, Entilini Concession Ltd, was named to rehabilitate the road. Designing new safety measures required a digital terrain model (DTM) of the mountain; PhotoSurveys of Cape Town produced detailed models of all the

terrain above and along the nine-kilometer road.

PhotoSurveys created the models to a 150-millimeter resolution, through a combination of aerial photography and land surveys. The DTM triangles were delivered to Entilini as a 3D MicroStation design file with one-meter contours.

Engineers used the **model to predict rockfall frequency distributions, bounce heights, and rockfall energies** at specific locations.

South Africa-based subconsultant Vela VKE Consulting Engineers used MicroStation and GEOPAK Site DTM tools to mosaic the DTM triangles into a triangulated irregular network (TIN) model. The TIN was then used as a base over which to drape the aerial photography, using Bentley Descartes.

Four sets of aerial images showed the mountainside at various stages of vegetation cover, helping the engineers identify individual boulders and rockfall starting areas in 3D. This was an essential element in identifying input data for a 3D rockfall model, devel-

oped from the DTM and geological analyses by Geotest Ltd. The Swiss firm used proprietary software and a commercial GIS to generate the model, delivering the data to Vela VKE as GIS coverages and grids.

Rolling 40,000 virtual rocks

The model proved invaluable for design and verification of rockfall protection measures, according to Gene Lohrentz of Vela VKE. First, the engineers used the model to predict rockfall frequency distributions, bounce heights, and expected rockfall energies at specific locations.

From this data, engineers selected trajectories and areas for detailed 2D analyses, to help design the rockfall protection measures. The most extensive of these measures was a range of catch fences placed along corridors of frequent rockfalls.

To determine where the fences should be erected, the team modelled the trajectories of some 40,000 virtual rocks. The trajectories were then draped as vectors over the TIN, using MicroStation and GEOPAK.

Once designed, catch-fence lines were placed on the TIN model in MicroStation. With the use of GEOPAK, fast and accurate cross sections were extracted for each fence, helping verify the positions of anchors and anchor cables.

Construction began in October 2002, and Chapman's Peak Drive opened to traffic in December 2003 –

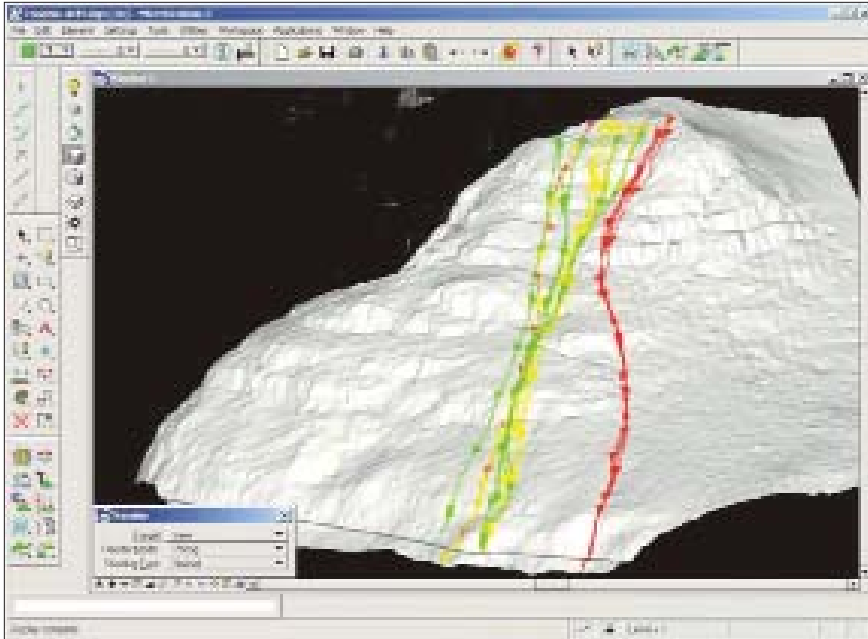


▲ Vela VKE's Gene Lohrentz (center) shows off the BE Award for the firm's work to reopen Chapman's Peak Drive. At left: awards master of ceremonies Alan Farkas. At right: Gabe Norona, Bentley Civil senior vice president.



Civil

◀ **Rockfall trajectories** modeled in 3D helped determine where catch fences should be built.



Project

Rock Fall Protection for Chapman's Peak

Organization

Vela VKE Consulting Engineers (PTY) Ltd.

BE Awards category

Civil Road Design

Project objectives

Design measures such as catch fences to protect road traffic from dangerous rockfalls

Fast facts

The project team used a 3D model of the mountainous terrain to identify dangerous areas – simulating the trajectories of 40,000 virtual rocks to determine where fences should be located.

Bentley products used

MicroStation
GEOPAK Site

a feat only made possible through the efforts of a team of skilled and innovative designers and contractors.

The rockfall design has won multiple awards for the firms involved.

In addition to a 2004 BE Award of Excellence, the project earned the South African Association of Consulting Engineers' 2004 National Engineering Excellence Award. ■