PRODUCT DATA SHEET

SVSLOPE®

Support for Multi-Plane Analysis (MPA™)

SVSLOPE is the most advanced 3D slope stability analysis software available, with advanced searching methods that are implemented to correctly determine the location of the critical slip surface. The software provides you with powerful 2D or 3D analysis for increased accuracy when calculating the factor of safety. Advanced probabilistic analysis or accommodation of spatial variation is possible with the software. SVSLOPE can be combined with SVFLUX™ to import pore-water pressures or SVSOLID™GT to import soil stress conditions.

Design and Analyze Different Locations Simultaneously

Slope stability analysis is often targeted at topographically complex sites with features that vary greatly in three dimensions, or seemingly simple surface topology with strong and weak internal layers that vary across the site. For these types of sites, it can be difficult to determine where the location of the failure is most likely to be. Typically, an engineer would be required to perform tedious and time-consuming analysis at different locations in sequence to find the location of the failure. SVSLOPE now supports a new feature called Multi-Plane Analysis (MPA) that enables rapid, thorough, and simple-to-perform analysis of a 3D site at different locations simultaneously.

MPA requires a 3D model of the site, which can be created through SVDESIGNER™ or SVSLOPE. When executing the solver, each location and direction (for example, plane) undergoes full-limit equilibrium analysis through SVSLOPE®3D, with either 2D or 3D analysis. This approach allows users to quickly and easily create different 2D slices or rotated 3D models of the site in an automated manner, while still using the same underlying analysis method with which they are familiar and comfortable. Once the location of the failure surface is located through MPA, standard search methods can be performed as follow-up to refine the solution, if desired.

Real-world Example of Software in Action

Users have used the SVSLOPE MPA feature on a number of geotechnical projects, including the process of analyzing a tailings dam site with curved banks on both sides of the crest and varying underground material layers. On this particular project, there was a weak layer that varies in thickness and depth across both banks.

MPA is defined by creating a number of planes across the model. Each plane defines a 2D slice of the model and contains configuration parameters, such as the slope limits and slip surface search methods. The entire plane configuration process is designed so that it is quick to perform on one or many planes at once. For example, the slope limits may be defined for all planes at once by simply drawing a polygon that encloses the area of interest on the 3D model. The slip surface search method is then automated, with some options available to the user.

Although there are multiple ways to create planes, the most common one, which was used in this case, is to simply select a point on each of the two banks. Planes are then created along the slope automatically, at configurable distance intervals. The direction for each plane is automatically set based on the surface geometry. Each plane can be set to use multiple similar directions so that the critical direction is more likely to be found.

Results Collected and Aggregated into the Original 3D Model for Visualization

The MPA solver makes full use of all CPU power available on the system, which allows for rapid iteration. The solver collects the results of each individual analysis and aggregates them into the original 3D model for visualization.

An example of 2D analysis is shown in Figure 1 where the results are projected onto the 3D model. The factor of safety for each plane is shown and contoured, which gives an overview of slope stability throughout the model. Each line represents the extent of the 2D critical slip surface transformed onto the coordinates of the 3D model. In this example, the top left area of the model has the lowest factor of safety due to the weak layer being dominant in that region. For similar reasons, the right bank has some areas with a lower factor of safety than their surroundings. The shape and size of each slip surface can also be visualized for one or more planes at once.

In Figure 2, the results of the same tailings dam model after being analyzed in 3D are shown. Critical slip surfaces are now shown on the model as outlines indicating their extent on the top surface. You can select each trial with its full 3D ellipsoid visualized. Moreover, a Factor of Safety Map is draped onto the top surface. The color at each location on this map indicates the lowest factor of safety of any trial surface that has passed through that location.

You can perform an analysis of each model in 3D by simply setting the MPA mode to 3D and using the same model setup procedure. Switching from a 2D MPA analysis to 3D, or vice versa, takes seconds. The MPA feature works by allowing you to specify and analyze many sections of a 3D model at once.

System Requirements

Operating System
Windows 7 (SP1 or later), Windows 8, Windows 10

Processor
Intel Pentium-based or AMD Athlon-based PC or workstation

Memory
1 GB minimum, 2 GB recommended, (more memory typically results in better performance)

Display Resolution
1024px x 768px or better

Hard Disk
500 MB minimum free disk space, 2 GB or more recommended (includes space for all example models)

Video
256 MB VRAM minimum with full support for OpenGL 3.3

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SVSLOPE At-A-Glance

Modeling

- 2D/3D limit equilibrium slope stability modeling of soil and rock slopes
- 14 analysis methods including classic method of slices such as Bishop, Janbu, Spencer, Morgenstern-Price, GLE, Sarma Non-Vertical, and stress-based methods
- Perform hybrid Kulhawy analysis by importing stress fields from SVSOLID in 2D and 3D
- Couple unsaturated, steady-state or transient, seepage analysis with SVFLUX
- Support for entry of the vertical side shear resistance

Soil Strength and Slope Analysis

- Support for more than 28 soil strength models including Mohr-Coulomb, Hoek-Brown, Undrained, Anisotropic, Bilinear, Frictional-Undrained, ALM1/ALM2/ALM3/ALM4 and four unsaturated shear strength models
- Support for rock and soil constitutive models
- Extensive support for reinforced slopes including grouted anchors, micropiles, and geomembranes
- External loading conditions can be represented in 2D or 3D models
- Multi-Plane Slope Stability Analysis enables spatial slope stability analysis in 2D and 3D
- Advanced 2D and 3D probabilistic analysis such as Monte Carlo, Latin Hypercube, and the Alternative Point Estimation Method (APEM) in 2D and 3D
- Spatial variability of material properties (2D only) aids in improving the calculation of factors of safety
- Advanced Seismic analysis including Newmark and Spectral Pseudo-Static methods

Searching Methods

- Comprehensive critical slip surface searching methods including Greco, Cuckoo, Wedges, Hybrid Ellipsoid, Composite, and optimization of critical slip surfaces in 2D and 3D
- Automatic determination of slip direction in 3D
- Improved block searching in 2D

Geometry

- Create geometrically complex digital twin 3D models with SVDESIGNER conceptual model builder
- Create 3D models from triangulated surfaces (TINS)
- Multiple 3D model-building methodologies (extrusions, 2D cross-section stitching, 3D layer cake, Block model, or material volume method)
- Slice 3D models into 2D cross-sections

Computations

- Parallel processing and improved solution algorithm for greatly reduced solution times
- Parallel processing and CPU core sensing and management controller implemented for MPA computations
- One- or two-way sensitivity analysis allows the generation of a contoured surface of the factor of safety based on the relationship between two input variables
- Import SLOPE/W, Slide and CLARA-W models for further analysis
- Extensive QAQC release process

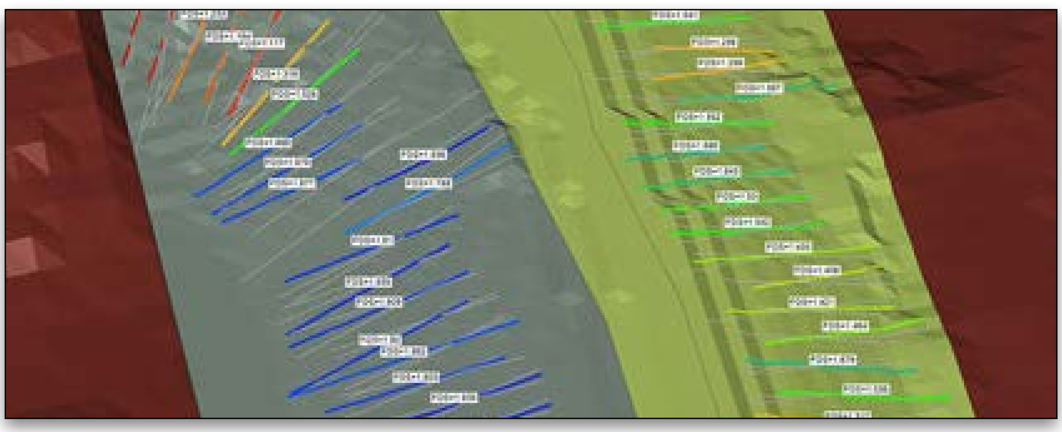

Figure 1: 3D projection of results.

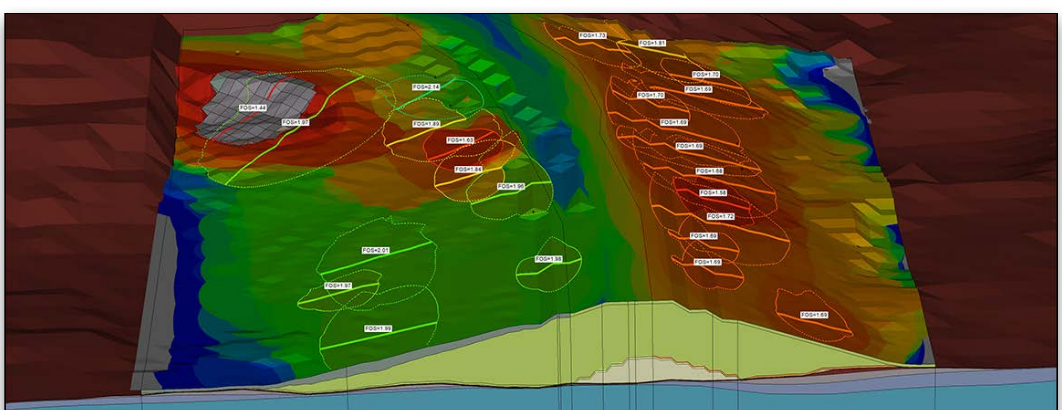

Figure 2: Visualization of shape and FOS of 3D slip surfaces.

Advancing Infrastructure