

GEOSTASE[®] - Slope Stability Analysis Software

General Description

GEOSTASE[®] is a 2-D limit equilibrium slope stability analysis software program developed by Dr. Garry H. Gregory, Ph.D., P. E., D.GE, Principal Consultant with GREGORY GEOTECHNICAL (GREGEO). The name **GEOSTASE[®]** is an acronym for **G**eneral **E**quilibrium **O**ptions for **S**tability **A**nalysis of **S**lopes and **E**mbankments. The name is a United States Registered Trademark (Registration No. 4,000,187) owned by Dr. Gregory. The program was written in Visual Fortran (double precision) using the Fortran 95 and later language versions. The program was developed for the Microsoft Windows[®] operating system and explicitly accommodates either English or SI units. **GEOSTASE[®]** version 4.30.10 is being released to the general user public on or about January 8, 2018. Dr. Gregory has been using the program on all his slope stability analyses for more than 10 years, involving hundreds of complex analyses. The general features of **GEOSTASE** are briefly described below.

Operating System and General Features

GEOSTASE is designed for the Microsoft Windows[®] operating system and functions in Windows 7, 8, and 10. The program is currently 32-bit but runs on 64-bit systems. The software is capable of interaction with the Microsoft Office cut, copy, and paste functions such that data in cells in applications such as Excel can be copied and pasted directly into the software input cells. The software produces report-quality graphics and report text directly from the analyses without having to import into 3rd party software to produce the graphics and text. Full soil colors can be accommodated with standard default colors and user-selected colors are available for each individual analysis for both screen and hardcopy output. The program explicitly accommodates either English or SI units and displays appropriate unit labels in the output. The main calculation functions of the program are coded for double precision. Convergence during analyses are controlled by force/moment imbalance tolerances as well as factor of safety tolerance criteria. Export of graphics to image files or PDF formats can be performed. Graphics of the slice stresses/forces are available interactively within the program. Help files, the user manual, and the verification manual will be available interactively within the program. The verification manual includes comparative analyses from the program with other popular software

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results or results of benchmark analyses from the literature. An option is available to accommodate a user-specified (imported) logo to be applied on the profile plots. Graphics options include plots of the critical failure surface (with slices) and of all surfaces analyzed in a search. Example plots are provided at the end of this document. The program allows user-specified project name/description, plot scale and user-specified figure or plate numbers for the plots. A “profile preview” of the analysis section is available for interactive viewing as the user develops the analysis profile.

Licensing and Support Features

GEOSTASE is offered as a perpetual license with hardware-key activation which allows the software to be utilized on multiple computers by installing a key on the active computer during use. The hardware keys are driverless. The license allows the software to be installed and used at any location on any compatible computer by inserting a hardware key during use. The software will be available from the *GREGORY GEOTECHNICAL* website for download by licensed users. A standard level of support via email (preferred) and/or telephone will be provided at no additional charge if the user maintains the latest version of the software.

Technical Features

General - The program contains options for analysis of slope stability using a variety of popular limit equilibrium methods including the *Spencer Method*, *Morgenstern-Price Method*, *Simplified Bishop Method*, *Simplified Janbu Method*, *Simplified Janbu Corrected Method*, *United States Army Corps of Engineers (USACE) Modified Swedish Method*, and the *Lowe and Karafiath Method*. The Spencer method contains options for parallel and bi-linear side force functions and the Morgenstern-Price method contains options for a variety of side-force functions including half-sine, clipped-sine, parabolic functions, and user-specified functions. Standard search options include circular, random, wedge, block, and composite surface options. The software also includes a non-circular refined search option, referred to as the ZRSAUTO search option. ZRS is an acronym “Zone Reduction and Shifting,” which is a highly sophisticated pseudo-random searching technique. There is an option for generating circular surfaces tangent to a user-specified subsurface boundary or to a specified offset from the boundary. Trial slip

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surfaces that begin or terminate on vertical boundaries are accommodated. Generating trial slip surfaces on vertical subsurface boundaries are allowed. The program includes an option to “turn off” or “suppress” input of features such as reinforcement, water surfaces, seismic forces, and similar items so that these items are not included in the analyses, but are still available in the input and can be turned back on by the user whenever desired.

An option for orienting the slope in either the right or left direction is included. The software can accommodate negative coordinates and true vertical boundaries. The program output provides nominal statistical data for any search including output of standard deviation, coefficient of variation, and minimum, maximum, and average factor of safety (F) values for all valid surfaces from each search.

Soil Options – Soil options include user-specified unit weight including moist unit weight (above piezometric surface) and saturated unit weight (below piezometric surface) automatically applied in the program. The software includes soil strength options including Mohr-Coulomb ($\phi - c$), curved strength envelope using power-curve (2-parameter) or modified power curve (3-parameter) functions, undrained shear strength (S_u) ratio, variation of undrained strength with depth and/or horizontal position using linear and non-linear functions, anisotropic strength, multi-stage strength (for use with 3-stage rapid drawdown and multi-stage seismic analyses), and fiber-reinforced soil (FRS) strength, including in combination with curved strength envelope.

Water Surfaces and Pore-Pressures – *GEOSTASE* includes options for piezometric surfaces, phreatic surfaces (with and without correction factor), ru (pore-pressure ratio) option, constant pore pressure option, and artesian pressure option. The program allows these options to be selected separately for each soil layer. Unit weight of water can be user selected or using standard default values. The surcharge load of ponded water on the ground surface is automatically included and an option is provided to include or not include pore pressures from surface water. The program is able to automatically generate a water surface coincident with the ground surface or at a specified offset below the ground surface.

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Rapid Drawdown Analyses – Rapid drawdown analyses options are provided including 3-stage rapid drawdown analyses with options for the Duncan, Wright, and Wong (1990) procedure and the VandenBerge and Wright (2016) procedure. Full text output is provided for all three stages of the analyses.

Reinforcement and Loads - The software includes explicit options for reinforcing elements and loads including piers/piles, tiebacks (anchors), soil nails, planar reinforcement (geogrids), applied forces, line loads, a generic reinforcement option (to model virtually any type load and non-linear distribution), distributed loads including uniform, triangular, and trapezoidal loads applied at any orientation and anywhere within the profile including on surface and subsurface boundaries or anywhere within the soil mass not on a boundary. Application of reinforcement forces includes options for both “Method A” (non-factor of safety dependent) and “Method B” (factor of safety dependent) methods. There is an option to distribute reinforcement forces to adjacent slices rather than on just the intersecting slice and the distribution distance can be user selected with a distribution factor.

Tension Cracks and “XCLUDE” Lines – An option is included to explicitly include tension cracks in the profile with user-specified percentage of water fill, including dry. A feature for allowing user-specified zones or areas to exclude from the search is provided in the form of XCLUDE lines.

Seismic Analyses – The software includes options for application of pseudo-static horizontal and vertical coefficients (k_h , k_v) and includes options for calculating the seismic yield coefficient (k_y). A seismic displacement option is included for calculating the probable maximum displacement of the slope from a seismic event using Newmark’s simplified screening analyses.

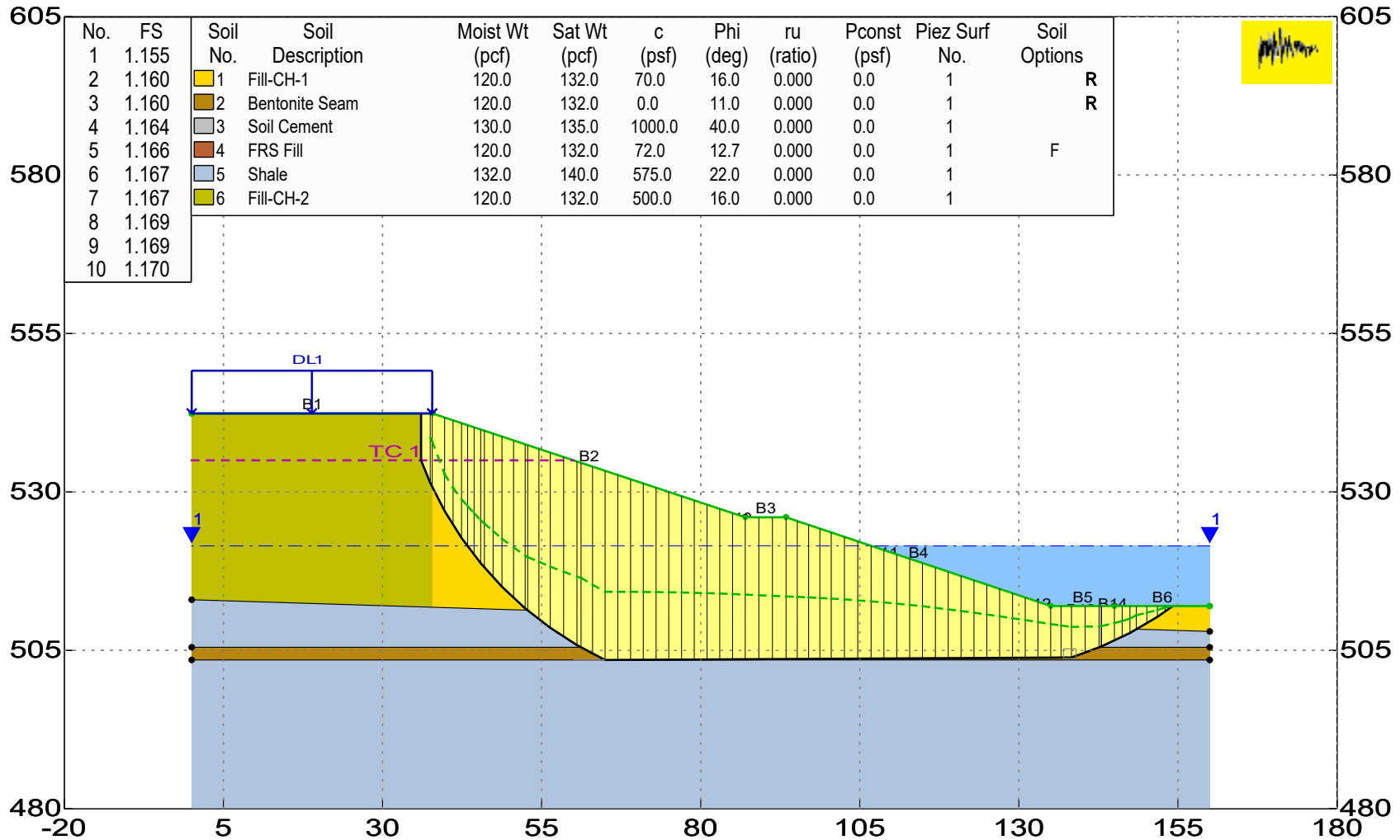
Multi-stage seismic analyses options are included using the Duncan, Wright, and Wong (1990) and the VandenBerge and Wright (2016) interpolation for both 2-stage and 3-stage analyses with full text output of each stage. An alternate 3-stage method is also included. A multi-stage post-seismic analysis option is also available.

DEEP SLOPE FAILURE PROBLEM

Creep Failure Condition with Bentonite Seam

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\\Deep-Slope-Failure-P-Right.gsd



WALTER BOULDIN DAM

3-Stage Rapid Drawdown Analysis - Duncan, Wright, and Wong Method

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Walter-Bouldin-Dam-3RD.gsd

