GREGORY GEOTECHNICAL SOFTWARE
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GSTABL7© with STEDwin©

Slope Stability Analysis System
Version 2.005.2

About GSTABL7© with STEDwin©:

GSTABL7 with STEDwin is a powerful, comprehensive slope stability analysis system. The system consists of a computer program package containing the combination of GSTABL7 and STEDwin. GSTABL7 and STEDwin each maintain unique version numbers to track updates and improvements in the individual programs, but the package GSTABL7© with STEDwin© has a combined version number to identify the integrated package. The current release of GSTABL7© with STEDwin© is Version 2.005.2. GSTABL7 with STEDwin is a 32-bit Windows program. The current version is Windows XP® and Windows 7®, including the 64-bit Windows 7 operating system.

GSTABL7 performs all the slope stability analyses calculations, and STEDwin provides an extremely user-friendly graphical user interface. The features of GSTABL7© with STEDwin© are described below.

GSTABL7 was written and compiled in Visual Fortran, and runs under the Microsoft® Windows operating systems. GSTABL7 with STEDwin is a 32-bit Windows program. GSTABL7 was originally a spin-off of one of the older public domain versions of STABL by Purdue University and is based on some of the original philosophy. However, it is NOT a version of the Purdue programs. GSTABL7 was written in Visual Fortran to be compatible with the Windows® operating system. The "7" in the GSTABL7 name does not indicate a version number, but is part of the name that does not change from version to version. When GSTABL7 was originally written, it performed 7 main functions and that is the source of the "7" in the name. However, the program now performs many more functions.

Analysis Options

- Analysis by **GLE (General Limit Equilibrium) Method of Slices**
    - Provides complete force and moment equilibrium or can be used to calculate the factor of safety (FS) for force and moment separately, satisfying equilibrium for each separately.
    - Robust search of multiple trial failure surfaces or individual user-specified failure surface. Any shape failure surface, including circular arc, block, wedge, and random, is supported. Up to 20 search boxes may be used to generate block surfaces.
    - Includes both **Spencer and Morgenstern-Price** type analyses
    - Seven "ki" functions for variation of side-force angles along the failure surface
        - Constant
        - Bi-Linear
        - Half-Sine
        - Clipped-Sine
        - Semi-Parabolic with LN function
        - Semi-Parabolic with Log function
        - User Specified
    - User-input Lambda Coefficient scaling function that adjusts side-force angle function magnitude)
    - Option of adjusting trial Lambda during iterations of factor of safety (FS) calculations

- Analysis by **Modified Bishop and Simplified Janbu Method of Slices**. Circular, random, and sliding block search routines are available for analysis. Use of the Janbu empirical coefficients with the Simplified Janbu method for multiple-surface searches or for a specified single surface.

- A "**Single Circular Surface Generator**" option is included that allows generation of a single circular surface by input of the circle center coordinates and radius length, or by the circle center coordinates and the beginning point on the ground surface.

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Soil Options

- Up to 20 isotropic soil options may be included in the analysis

- Up to 20 soil types may be assigned **Nonlinear Undrained Shear Strength** (NONLIN). This option allows variation of undrained shear strength with depth and/or horizontal position, using depth/horizontal continuous functions with user-input coefficients. The user can select the coefficients to allow the functions to match actual test results (SPT, CPT, UU, CU, etc.) indicating strength variation with depth or horizontal position. No need to place lines in the profile to define locations for shear-strength variation. The variation is calculated continuously along the failure surface based upon an X and/or Y reference point input by the user. Undrained shear strength can be either increasing or decreasing with depth and/or horizontal position. An X and/or Y "cap" coordinate value can also be used to establish the point below or beyond which the function will remain constant. The NONLIN option can be used in conjunction with the Anisotropic function (described later) to analyze the slope using SHANSEP or similar soil models.

- Up to 20 soil types may be assigned **Curved Phi Envelope** (strength envelope line curves through zero at zero normal stress). This option (CURVED) allows the use of a curved phi envelope instead of a "straight-line" Mohr-Coulomb envelope for shear strength. The curved-phi envelope is calculated from the phi and c input in the isotropic soil input menu and a "critical effective confining stress" input by the user. Both phi-c soils and phi only soils are applicable.

- Up to 20 soil types may be analyzed using the **Fiber-Reinforced Soil** (FIBER) option. This option allows input of fiber properties and mixture rates, then calculates an increased phi and/or c due to fiber reinforcement, and applies the fiber-reinforced phi and c in the analysis. The method is based upon the model developed by the Author in 1999 and refined in 2006 (Gregory, 1999, 2006). To the best of our knowledge, this is the only known slope stability analysis program that includes a specific option for fiber-reinforced soil.

- Analysis of the slope with **Anisotropic soil strength properties**. Up to 20 soil types and 20 direction ranges for each soil type may be used. This function may be used to model tension cracks or bedding planes, as well as different soil strengths in different directions. The **tension cracks may be modeled with no water, or with water in the cracks**. Tension cracks and bedding planes can be modeled anywhere in the soil profile without having to add additional lines. The user can specify any range in the anisotropic soil option to ignore the Anisotropic soil properties and use the current phi and/or c being calculated in other options such as NONLIN and CURVED. The Aniso function can also be used in conjunction with the Nonlinear undrained shear strength option to accurately model soils using models such as the SHANSEP method.

- Any soil unit weight may be used. This allows analysis with lightweight fill materials such as Geofoam.

Stabilizing Elements Options

Options for analysis of stabilizing elements in the slope include piers/piles, tiebacks, soil nails, planar reinforcement (geotextiles/geogrids), and applied forces, as described below. ALL ANALYSIS METHODS, INCLUDING GLE, BISHOP, AND JANBU ARE AVAILABLE FOR ALL STABILIZING ELEMENT OPTIONS.

- Analysis of up to **50 rows of Piers/Piles** in the slope. Piers/piles can be located on surface as well as subsurface boundaries. Piers/piles can be located on surface or subsurface boundaries allowing analysis of staged construction.

- Analysis of up to **50 rows of Tiebacks** or surface point loads on the slope. Four load options are available. The user can specify: (1) both normal and tangential forces are considered (applicable for preloaded tiebacks), (2) only tangential forces are considered (applicable to passive tiebacks with nominal preload), (3) only normal forces are considered, or (4) both normal and tangential forces are considered within a limited range.

- Analysis of up to **50 rows of Soil Nails** in the slope. Load distribution along the soil nail is automatically calculated within the program using the FHWA method. No need for the user to input load points along the nail. Soil nails can be located on surface, as well as subsurface boundaries allowing analysis of staged construction.

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- Analysis of up to **50 layers of Planar Reinforcement** (geotextiles/geogrids) in the slope, with up to 10 points defining each layer. Reinforcement can be located on surface, as well as subsurface boundaries.

- Option of including up to **50 Applied Forces** in the slope. Applied Forces may consist of both stabilizing and destabilizing forces. Examples of stabilizing forces include items not specifically programmed into GSTABL7, such as sheetpile walls, stone columns, micro-piles, etc. Examples of destabilizing forces include items such as seepage forces, deadman anchors in the slope for adjacent structures, power poles in the slope, etc. The user can input a description of the Applied Forces that will be printed in the output. Applied Forces can be located on surface, as well as subsurface boundaries.

Surcharge Load Option

- Analysis of the slope with up to 10 boundary (surcharge) loads, anywhere on the ground surface.

Seismic Analysis Options

- Pseudo-Static earthquake or similar seismic-loading analysis using horizontal and vertical coefficients, and seismic pore-pressure factor. The seismic pore-pressure factor option can be turned "on" or "off" when using the horizontal and vertical coefficients.

- Maximum probable displacement during an earth-quake event may be calculated for a single surface using **Newmark's Method for upper bound displacement**. The yield coefficient needed for the Newmark analysis is automatically calculated within the program.

Water Options

- Up to 10 phreatic water surfaces, with up to 40 points defining each surface may be included in the analysis. The user may select the "vertical" or "perpendicular" method (or anywhere in between) of calculating the pressure head on the slice bases from the phreatic surface, by inputting a "pore-pressure inclination factor."

- Both a pore pressure ratio (r_u) and a pore pressure constant may be included for any soil.

Unit System and Profile Coordinates

- Either **English or SI units** are explicitly supported. The appropriate unit labels are automatically printed in the output.

- The **X and Y coordinates of the profile origin may be any positive value specified by the user**. There is no need to start with zero for the x and y coordinates.

- An **"X-Plus – Y-Plus**" option is available for easily shifting the profile further from or closer to the origins without having to re-input the profile values.

Output

- Comprehensive text output of all input items, as well as output of the analysis results.

- The text output includes tables of base stresses for a Bishop or Janbu analysis, and tables of side forces, force angles, thrust-line ratio, and base stresses for a GLE analysis.

- Both screen plots and graphical output plots of the geometry, analysis results, and graphs of base and side forces are generated automatically by the program. Graphical outputs are report quality and can be printed on any available Windows printer.

GRAPHICAL USER INTERFACE

STEDwin© by Harald W. Van Aller, P.E., is a highly-customized graphical user interface (smart editor) that was developed to work specifically with **GSTABL7©** by Garry H. Gregory, Ph.D., P.E., to provide a powerful, user-friendly

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Slope Stability Analysis System. **STEDwin** itself performs no stability analysis but creates data files in the format expected by GSTABL7 and prepares high-quality graphics from the output. This allows you to concentrate on the engineering aspects of slope stability analysis.

- Easy to learn Windows interface gets you up and running quickly and ***increases your productivity.***
- ***User-friendly*** input with built-in help and error checking.
- Prints full-page, report quality black and white or ***color graphics*** to any Windows printer. A small graphic logo (16- or 256-color .BMP file) can be included on the plots.

GRAPHICS

STEDwin produces high quality screen graphics from the GSTABL7 output and plot files.

- Full-page, report quality graphics can be printed on any Windows printer or exported as "BMP" and CAD format "DXF" files.
- Text is automatically printed on the plots to show which method was used to calculate the reported factors of safety--i.e. "Factors of Safety are Calculated by GLE (Morgenstern-Price) Method."
- Any of the individual surfaces on the plot of the "10 most critical surfaces" graph may be selected for printing.
- The initiation and termination limits for search-type analyses are shown on the plots to help interpret analysis technique.
- Text labels (up to eight characters for each soil type) can be entered in the soil properties table included on graphs.

DATA ENTRY

- Simple, spreadsheet-like data entry and modification makes STEDwin extremely easy to learn and use.
- Includes input menus and screens for all functions and options of GSTABL7.
- Considerable error checking and documentation of GSTABL7 error codes is provided.
- Soil boundary lines, piezometric surfaces, and surface boundary loads can be inserted and deleted.
- Anisotropic soil parameters are entered using a unique system, which allows ANISO data to be entered in any order. To help visualize complex data, a plot of the angular ranges can be viewed at any time.
- A ***geometry preview*** feature allows you to view the input data before running GSTABL7. This reduces the chance that GSTABL7 will abort due to input errors.

GEOGRID DESIGN

- A GeoGrid Design screen simplifies entry of planar reinforcement layers for GSTABL7. This allows you to easily define up to 50 horizontal reinforcing layers by specifying the geogrid length, vertical spacing and strength properties for one or two types of reinforcing grids or geotextiles. STEDwin uses the design information to generate data in the format expected by GSTABL7. If desired, the data can then be manually edited.

The program "*GSTABL7 with STEDwin*" is distributed exclusively by GREGORY GEOTECHNICAL SOFTWARE (A Division of Gregory Geotechnical), from our Stillwater, Oklahoma offices.