How to run a Limit Equilibrium Method analysis from PLAXIS 2D

Finite Element Analysis - Limit Equilibrium in One Click

Application	PLAXIS 2D GeoStudio (SLOPE/W) PLAXIS 2D LE
Version	PLAXIS 2D 2023.1 GeoStudio 2023.1 PLAXIS LE CONNECT Edition V21 PLAXIS 2D CONNECT Edition V22.01 PLAXIS LE CONNECT Edition V21 GeoStudio SLOPE/W 2022
Status	Technology Preview

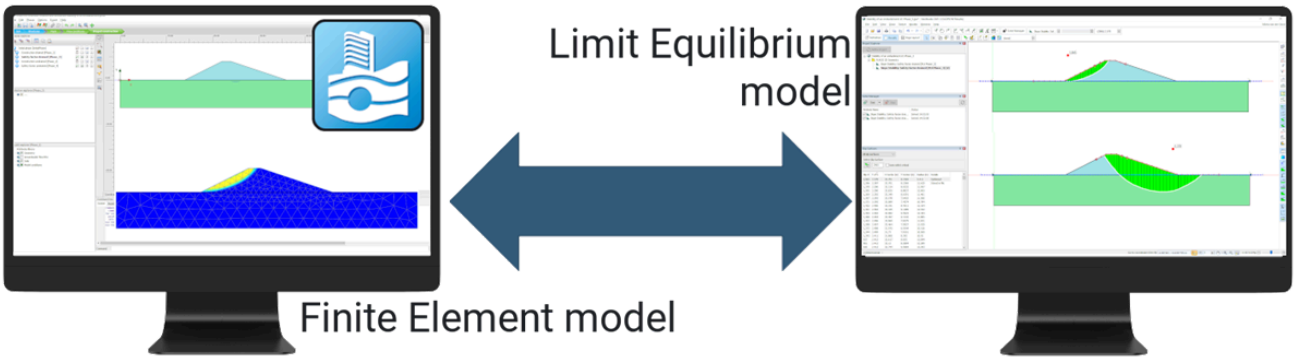


Figure 1. Easy conversion from PLAXIS 2D to GeoStudio SLOPE/W

Introduction

For the determination of a Factor of Safety, the strength reduction method is a very powerful tool to obtain the most critical slip surface, a slip surface that may be circular but can also have any other form. However, there may be circumstances in which more information is required than just the most critical slip surface or when the critical slip surface is of minor importance from an engineering point of view. For instance:

- For a large dam, both the global stability as well as the stability of the sloped sections in between berms must be determined.
- For a road project in the mountains, both the stability of the hillside above and below the road must be determined, as failure below the road would lead to a loss of the road whereas a failure above the road would only lead to rockfall and temporary loss of service.
- The critical slip surface is very small, for instance, just the corner of the crown of an embankment. This is not important from an engineering point of view, and the global stability would be of greater interest.

In these cases, determining a Factor of Safety using the Limit Equilibrium Method would be the solution. With Limit Equilibrium, it is possible to specify exactly what part of the model the Factor of Safety must be determined while the method would still have the benefit of determining the most critical, possible non-circular, slip surface in that area. It would also allow within one model to determine different factors of safety for different parts of the model.

With the *PLAXIS 2D - Limit Equilibrium converter* tool, you will be able to quickly open the same model with the same geometry, the same staged construction configuration, the same loading conditions and the same material assignments in GeoStudio SLOPE/W or PLAXIS LE to run your Limit Equilibrium Method analysis.

1 Usage instructions

1. Download the package from **Downloads** below
2. Extract the zipped package and copy the content (*lem_converter.pyw* file and the entire *plaxis_fele* folder to:
   [PLAXIS 2D install folder]\pytools\input
   When using PLAXIS 2D, the default installation folder will be:
   For PLAXIS 2D 2023:
   C:\Program Files\Seequent\PLAXIS 2D 2023.1\pytools\input
   For PLAXIS 2D CONNECT Edition V22:
   C:\Program Files\Bentley\Geotechnical\PLAXIS 2D CONNECT Edition V22\pytools\input
3. Start PLAXIS 2D Input
4. Make sure Geotechnical SELECT Entitlements (GSE) are enabled
5. Now you can
   - Convert a PLAXIS model to GeoStudio or PLAXIS LE;
   - or read a GeoStudio (SLOPE/W) model and convert to PLAXIS 2D.

If you do not have write access to add files to the PLAXIS 2D installation folder, you can use this alternative approach:

- Save and extract the zipped package in a local folder
- Then, in PLAXIS 2D Input, go to Expert > Run Python script > Open ... and browse to *lem_converter.pyw* and select that one to launch the PLAXIS 2D to Limit Equilibrium converter

2a. Conversion PLAXIS to Limit Equilibrium

Follow these instructions for conversion from PLAXIS 2D to a Limit Equilibrium file: GeoStudio SLOPE/W or PLAXIS LE

6. Select the tab ***PLAXIS to LEM***.
7. Launch a PLAXIS file you want to convert to a Limit Equilibrium Method model
8. Go to Staged Construction and select the **phase**
9. Either
   - From the *Expert* menu, choose *Run Python tool* > **lem_converter**
   - Or from the *Expert* menu:
     - Choose *Run Python Script* > *Open*
     - Go to the location where you stored the script files
     - Select **lem_converter.pyw**
10. PLAXIS 2D will prompt for the port configuration:
    - activate it (click OK)
    - the tool will automatically pick up the port number and password
11. The tool will present a dialogue for a selection of what to convert
12. Select to use GeoStudio (SLOPE/W) or PLAXIS LE as the target Limit Equilibrium software

13. Select the conversion settings, e.g. which slip direction you want to consider
14. Click to *Convert*.
15. The conversion process will start, resulting in a message with

    - Conversion warnings and info
    - Options to view the full log file
    - And open the newly generated LEM model file

16. Using the button, you can select to directly open the newly generated LEM model file
17. After a few seconds, PLAXIS LE or GeoStudio will be loaded with the model.

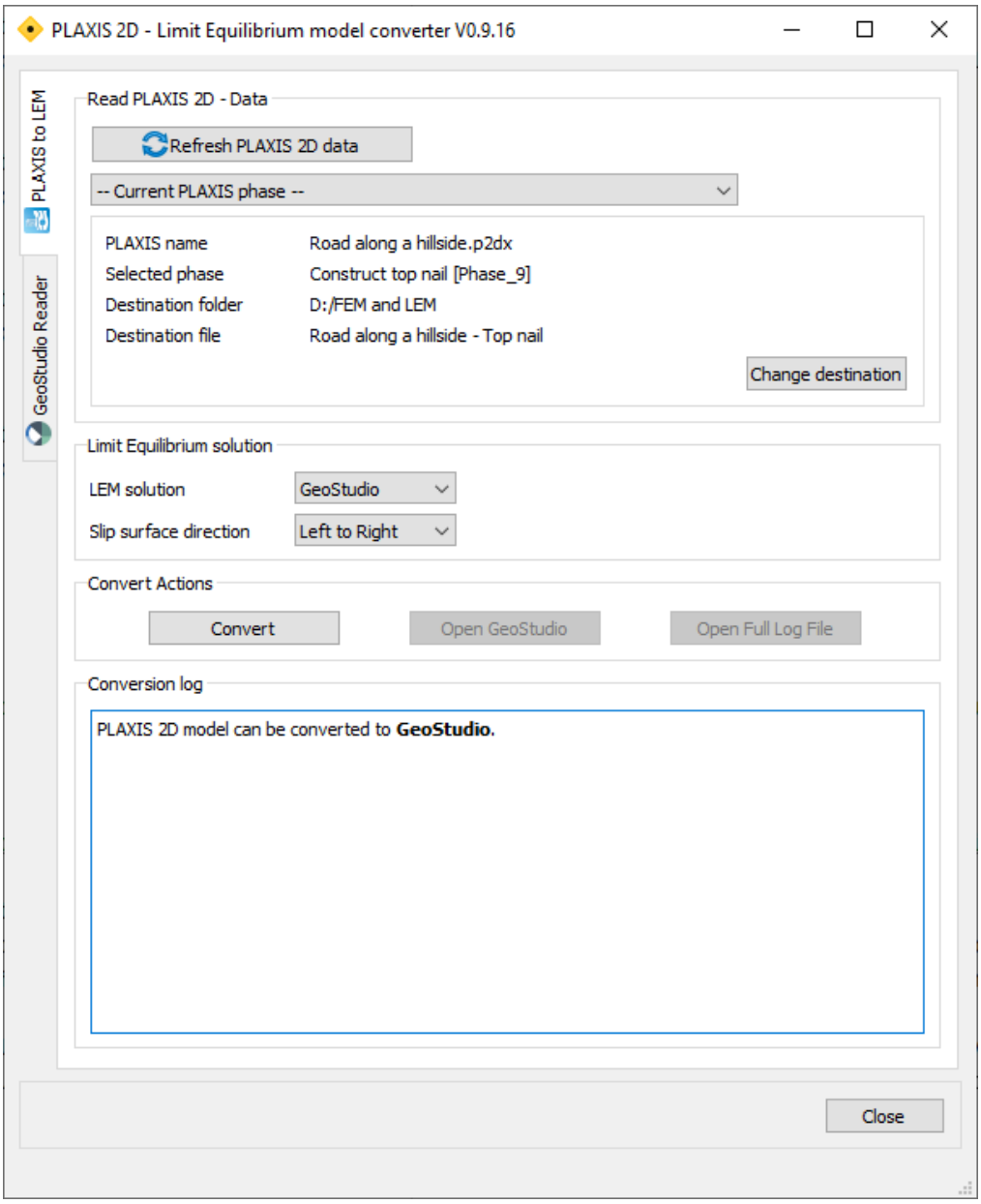


Figure 2. PLAXIS 2D to Limit Equilibrium converter tool user interface directly after launching

2b. Conversion GeoStudio SLOPE/W to PLAXIS 2D

Follow these instructions for conversion from a 2D GeoStudio geometry to a PLAXIS model

6. Select the tab **GeoStudio Reader**.
7. Select a source GeoStudio file (*.gsz)
8. Select the appropriate geometry
9. Click to *Convert*

    - The tool will warn when a model is still open in PLAXIS 2D to prevent data loss.

10. The conversion will start a new PLAXIS model and builds up the model according to the data in the GeoStudio model

Note: Only geometry and soil material assignments are converted from GeoStudio files to PLAXIS.

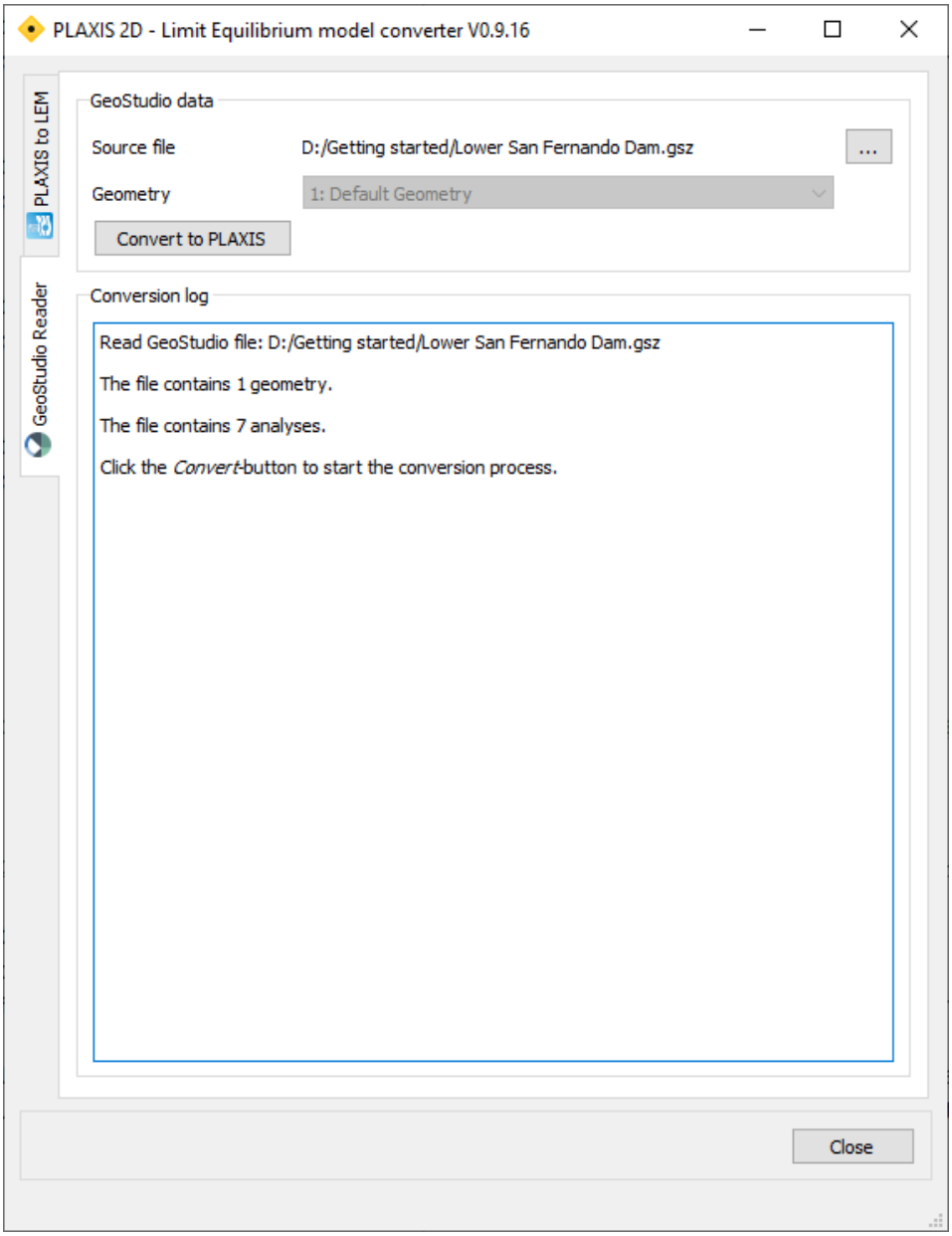
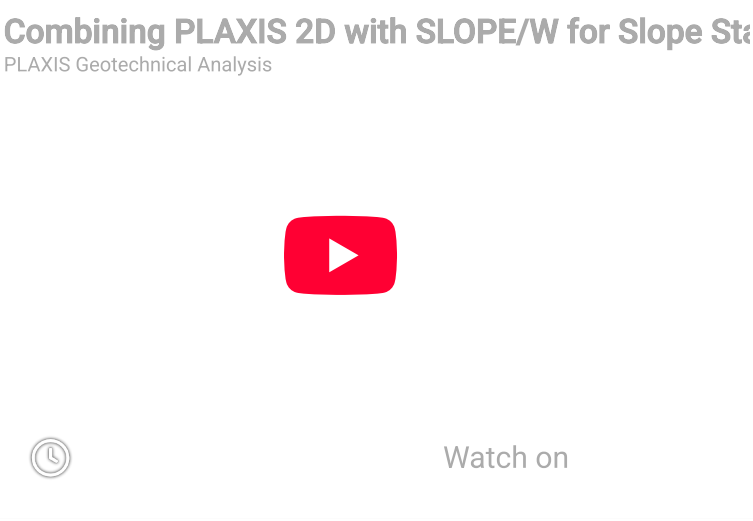


Figure 3. GeoStudio reader tab - user interface

Example

In the video below, a slope has been modelled in PLAXIS 2D, and the safety analysis predicts one global factor of safety. With the PLAXIS 2D to Limit Equilibrium converter, we can investigate multiple parts of the analysis to run an analysis for.



For an older demonstration using PLAXIS LE, see here.

Limitations

Limitations converting PLAXIS 2D to a LEM model

The phase configuration of a PLAXIS 2D model can be converted into a Limit Equilibrium model (GeoStudio or PLAXIS LE). By default, the geometry, material assignments and available parameters, distributed loads and the water table will be converted.
GeoStudio's SLOPE/W model starts by default with a Morgenstern-Price method and a Circular Entry and Exit method.
The PLAXIS LE model starts, by default, with a Circular Slope Search using the GLE (Fredlund) calculation method for a first, fast, robust approximation of the slope stability.

In the current version, the following limitations/restrictions apply:

- Only PLAXIS 2D Plane strain models are supported.
- Not all soil models in PLAXIS 2D have an equivalent soil model in GeoStudio or PLAXIS LE. Supported soil models include Mohr-Coulomb, Hardening Soil, HS small, Soft Soil, Soft Soil Creep, and Hoek-Brown.
- Groundwater flow definitions and specific pore pressure definitions are not converted, including settings for the hydraulic conductivity.
- Unsaturated soil behaviour (suctions) is not converted.
- Structural elements can be converted to GeoStudio Reinforcements or PLAXIS LE supports. However, plate elements, vertical embedded beams, fixed-end anchors, and node-to-node anchors (when not part of a tie-back/ground anchor) are not converted.
- PLAXIS 2D stress results cannot yet be included in the Limit Equilibrium analysis for or a stress-based stability analysis (sometimes also referred to as *Kulhawy*).
- Soil polygons inside a bigger soil polygon that are not connected to the edge of the bigger cluster are not supported. It is suggested to connect the smaller "floating" soil polygon with at least two lines to the edge of the bigger contour.
- Circular/arc shapes are not supported in this converter. The conversion tool will discretize any arc into multiple segments with straight lines.
- Design approaches and design standards are not converted.
- GeoStudio specific:
    - Water levels are partly supported when converting from PLAXIS 2D to GeoStudio
    - Only strength model parameters for SLOPE/W are converted, no SEEP/W and SIGMA/W data conversion.

Note that the PLAXIS 2D to Limit Equilibrium model converter will indicate this in the conversion log. Make sure to read it before continuing in GeoStudio or PLAXIS LE.

Limitations specific to reading GeoStudio files to convert to PLAXIS 2D

- Only geometry and soil material assignments are converted from GeoStudio files to PLAXIS.
- Only strength model parameters for SLOPE/W are converted, no SEEP/W and SIGMA/W data conversion.
- Only reading GeoStudio 2D regions/geometries is supported.

Requirements

The latest PLAXIS 2D - Limit Equilibrium converter requires:

- PLAXIS 2D 2023.1
- Either PLAXIS LE 2D CONNECT Edition V21 or newer, or GeoStudio 2023.1
- PLAXIS 2D started with activated Geotechnical SELECT Entitlements [GSE]. See here how to do this.

This tool requires access to the PLAXIS Python Remote scripting library using Python 3.8.x.

Updates and release version info

This tool is released as a Technology Preview and available as a separate download version only. Any updates will be added to this page, so check this page regularly.

Version **0.9.16** [2023-04-06]	link	• Support for PLAXIS 2D 2023.1 and its Python environment
		• Conversion PLAXIS to Limit Equilibrium
		  ○ we can change the file name for the resulting LEM file
		  ○ changing the destination folder will be remembered after refreshing or changing the selected phase
		  ○ PLAXIS LE and GeoStudio can deal with cable bolts
		  ○ Launch the latest GeoStudio installation that can be found in the Windows registry
		• GeoStudio Reader
		  ○ Enabled GeoStudio reader
		  ○ Support for GeoStudio 2023.1
		  ○ Conversion from GeoStudio to PLAXIS will warn about an open PLAXIS 2D model
		  ○ Disregard GeoStudio 3D Geometry items (SLOPE3D, SEEP3D)

Downloads

- PLAXIS 2D - Limit Equilibrium converter – Version 0.9.16 [zipped package]
  supporting PLAXIS 2D 2023.1, PLAXIS LE 21.01, GeoStudio 2023.1

- PLAXIS 2D to Limit Equilibrium converter – Version 0.9.9 [zipped package]
  supporting PLAXIS 2D V22.01, PLAXIS LE 21.01, GeoStudio 2021.1

- PLAXIS 2D to PLAXIS LE phase converter – Version 0.9.3 [zipped package]
  supporting PLAXIS 2D V21.01, PLAXIS LE 21.01

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