

Mata Kuliah
“Komputer dan Simulasi”

**SLOPE/W Software: Geometry, Material
Properties, Loadings Method of Analyses,
Execution,
and Post Processing**

GeoStudio 2012



SLOPE/W™

- SLOPE/W – A software for computing the factor of safety of earth and rock slopes based on **limit equilibrium method**.



SEEP/W™

- SEEP/W – A **finite element** software for analyzing groundwater seepage and excess pore-water pressure dissipation problems within porous materials such as soil and rock.



SIGMA/W™

- SIGMA/W – A **finite element** software that can be used to perform stress and deformation analyses of earth structures.

PROBLEM 1

In the textbook, *Soil Mechanics* by Lambe and Whitman (1969), the authors present a hand-calculated factor of safety for a simple slope with an underdrain. The purpose of this example is to verify SLOPE/W by comparing its solution with the hand calculations. Features of this simulation include:

Analysis method: Bishop

Use of a piezometric line

Use of a single point Grid and Radius slip surface

Use of points on regions to control slice discretization

FoS = ?

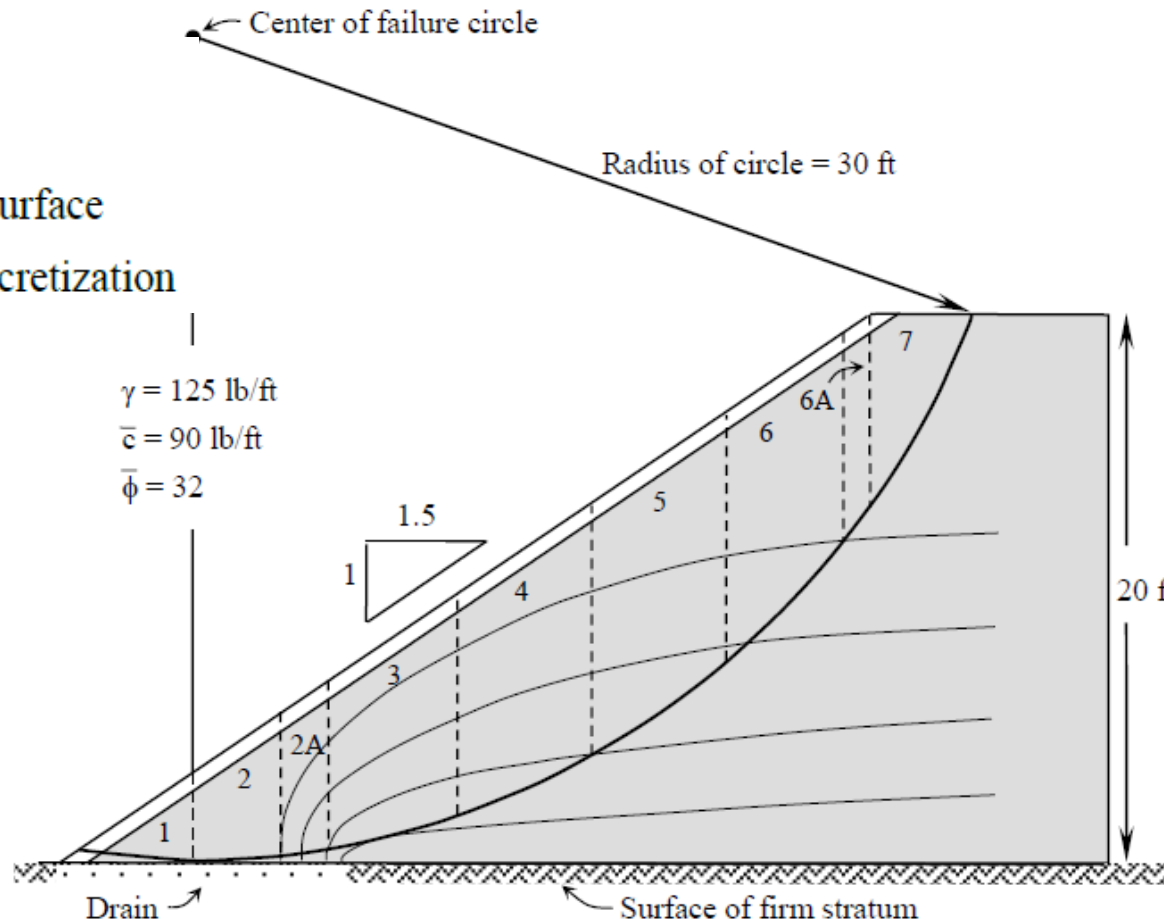


Figure 1 Stability of slope with an underdrain (after Lambe and Whitman)

PROBLEM 1

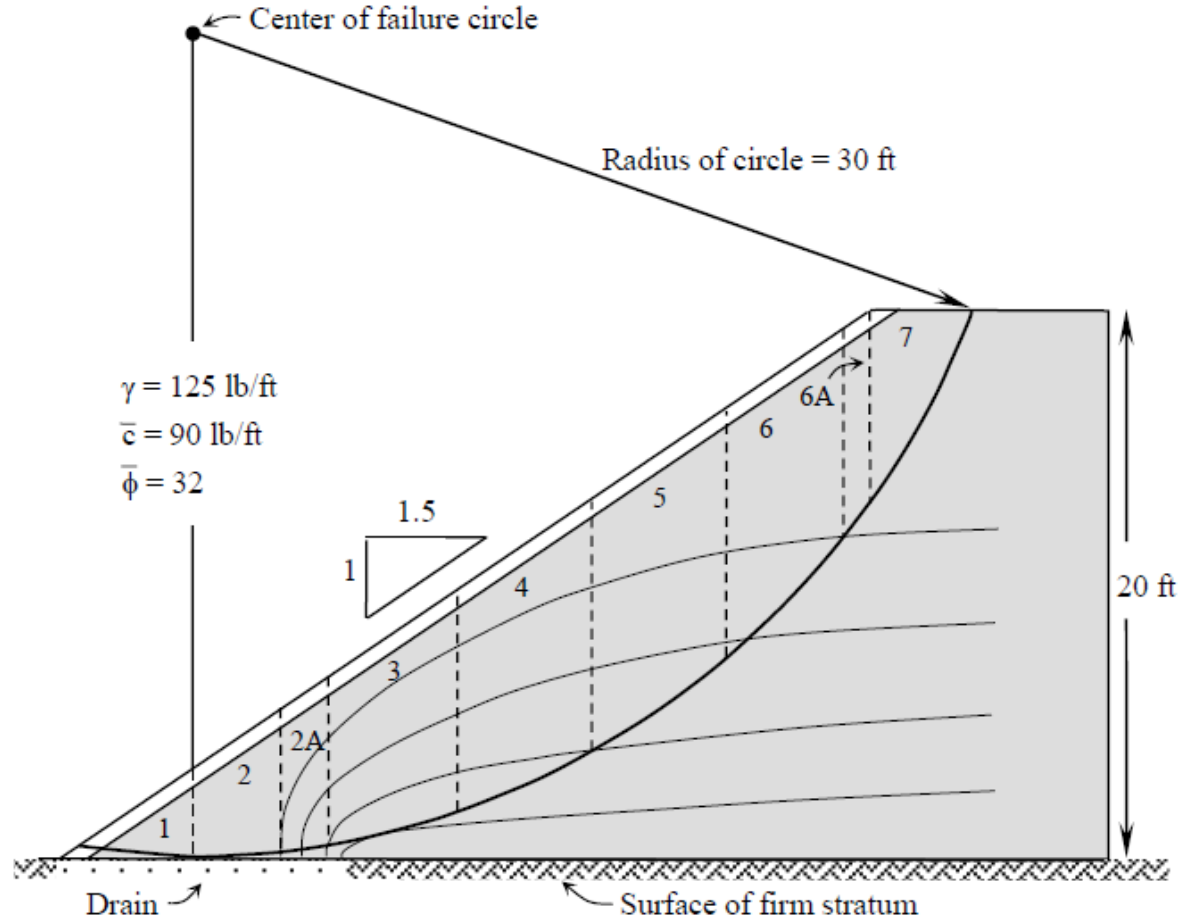


Figure 1 Stability of slope with an underdrain (after Lambe and Whitman)

Require:

- FoS (Bishop method) hand calculated
- FoS (Bishop method) computed using SLOPE/W



Two components of the Software:

- DEFINE → Input the geometry, material properties, loading, methods of analyses, and **execution**
- RESULTS → post processing (output)

STARTING PAGE

GeoStudio 2012

File Edit View Window Help

GeoStudio® 2012 Full license

June 2013 Release

New Project...
Create a new empty project

Create a project with this analysis:

- SLOPE/W
- SEEP/W
- SIGMA/W
- QUAKE/W
- TEMP/W
- CTRAN/W
- AIR/W
- VADOSE/W

Open...
Browse for projects

Open a recent project:

- Dam with concrete cutoff.gsz
- Seepage thru an earth embankment....
- Grid and Radius.gsz
- Verification - the sandbox problem.gsz
- SLOPE Tutorial.gsz
- SLOPE Tutorial-edit.gsz
- Comparison with hand calculations.gsz
- Grid and Radius.gsz
- Case2(fi'=34)-2012coba.gsz
- Case2(fi'=34).gsz
- SLOPE Tutorial.gsz
- SLOPE Tutorial.gsz
- SLOPE Tutorial.gsz

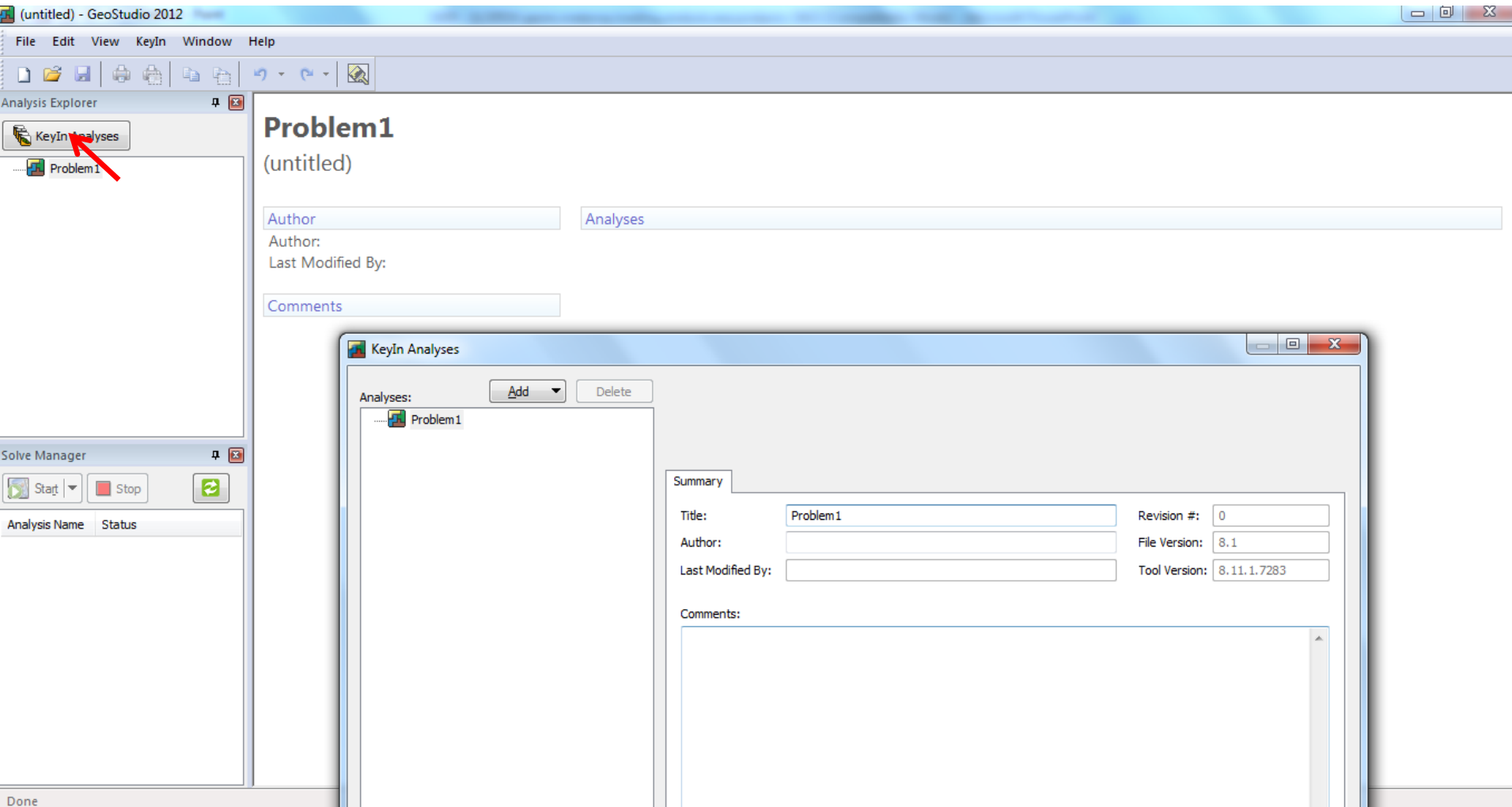
Examples
Find sample projects online

Movies
Watch tutorials and workshops

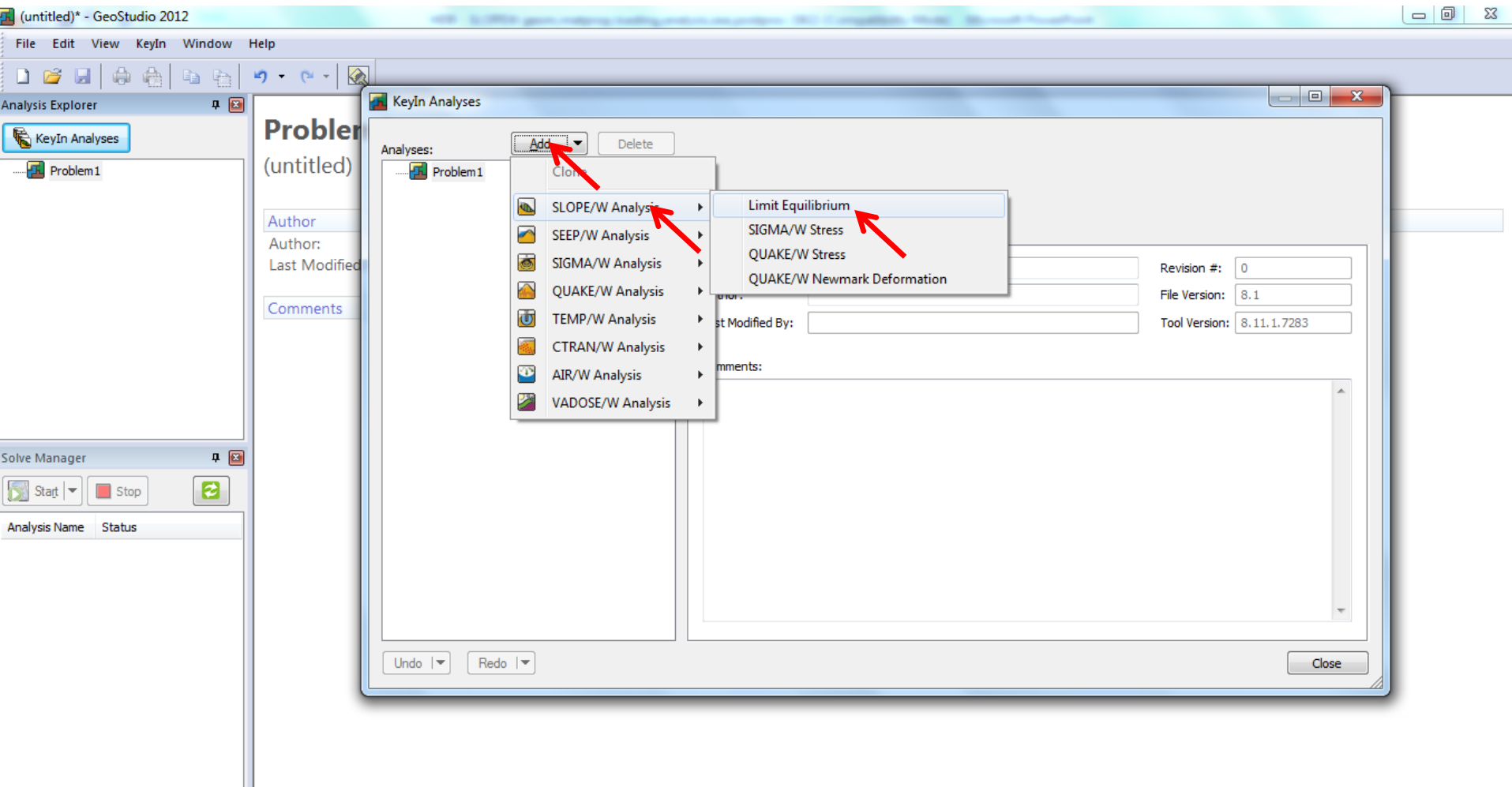
Engineering Books

- Stability Modeling with SLOPE/W
- Seepage Modeling with SEEP/W
- Stress-Deformation Modeling with SIGMA/W
- Dynamic Modeling with QUAKE/W
- Thermal Modeling with TEMP/W
- Contaminant Modeling with CTRAN/W
- Air Flow Modeling with AIR/W
- Vadose Zone Modeling with VADOSE/W

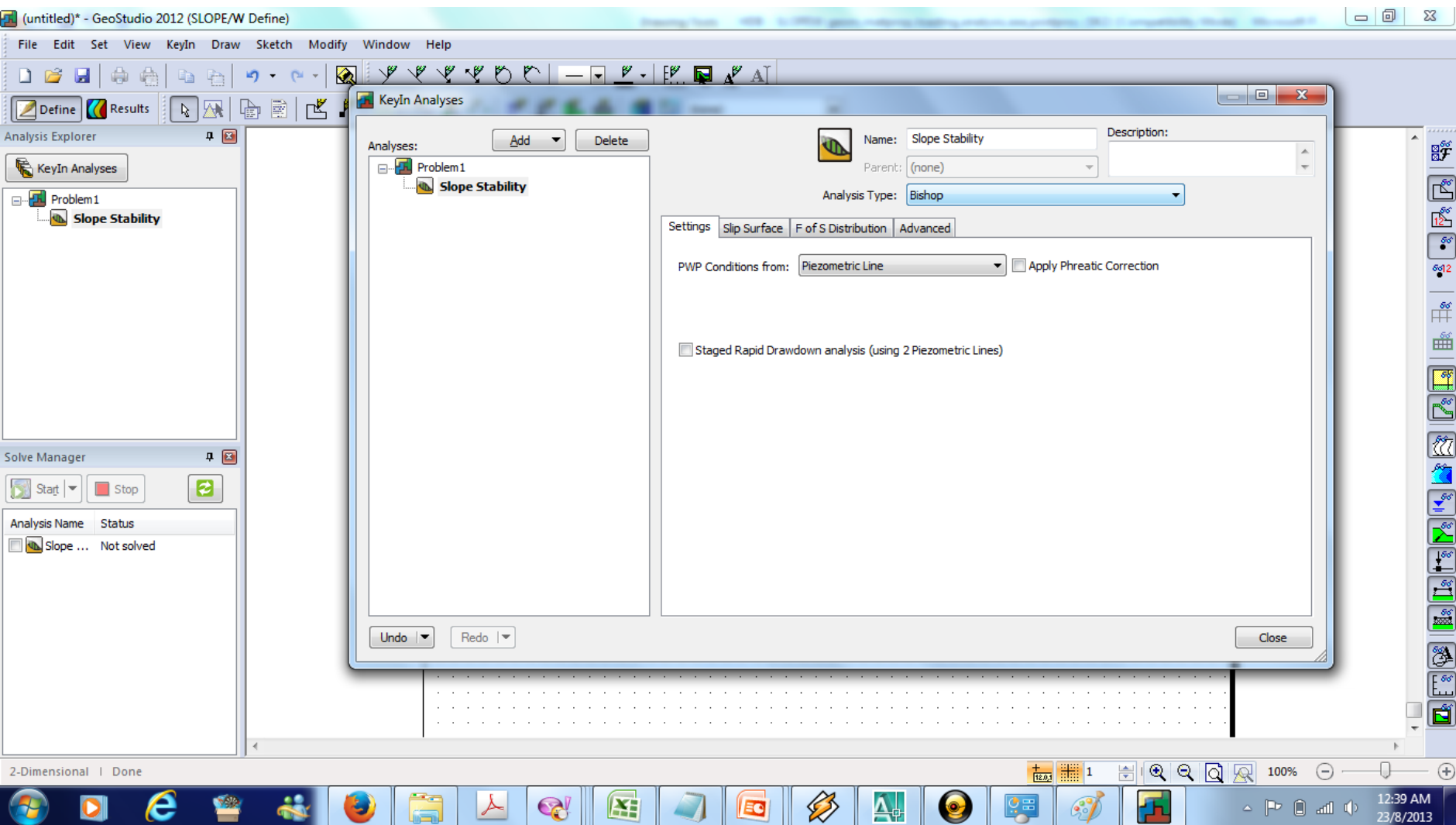
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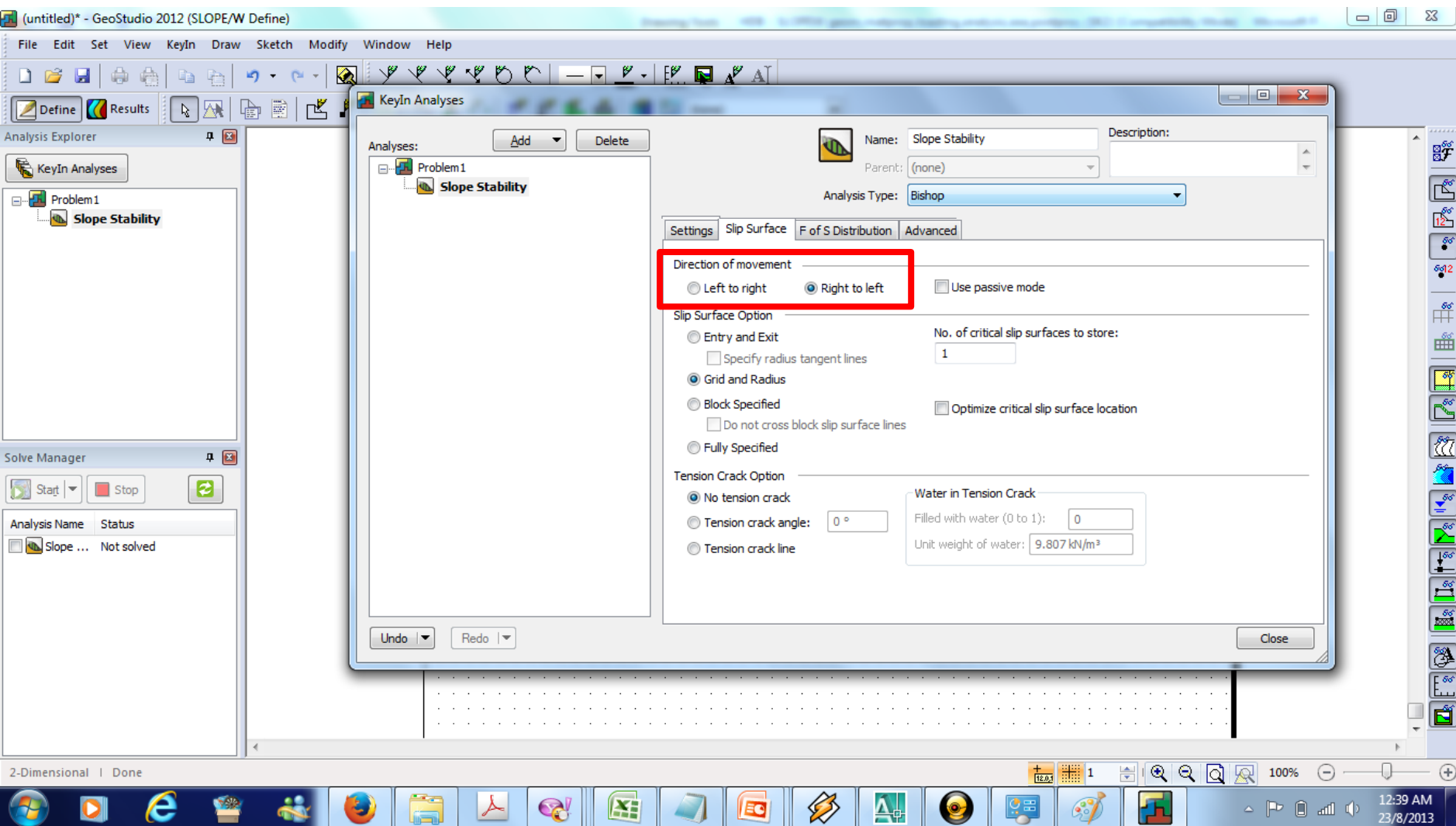
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STARTING PAGE



PROBLEM 1

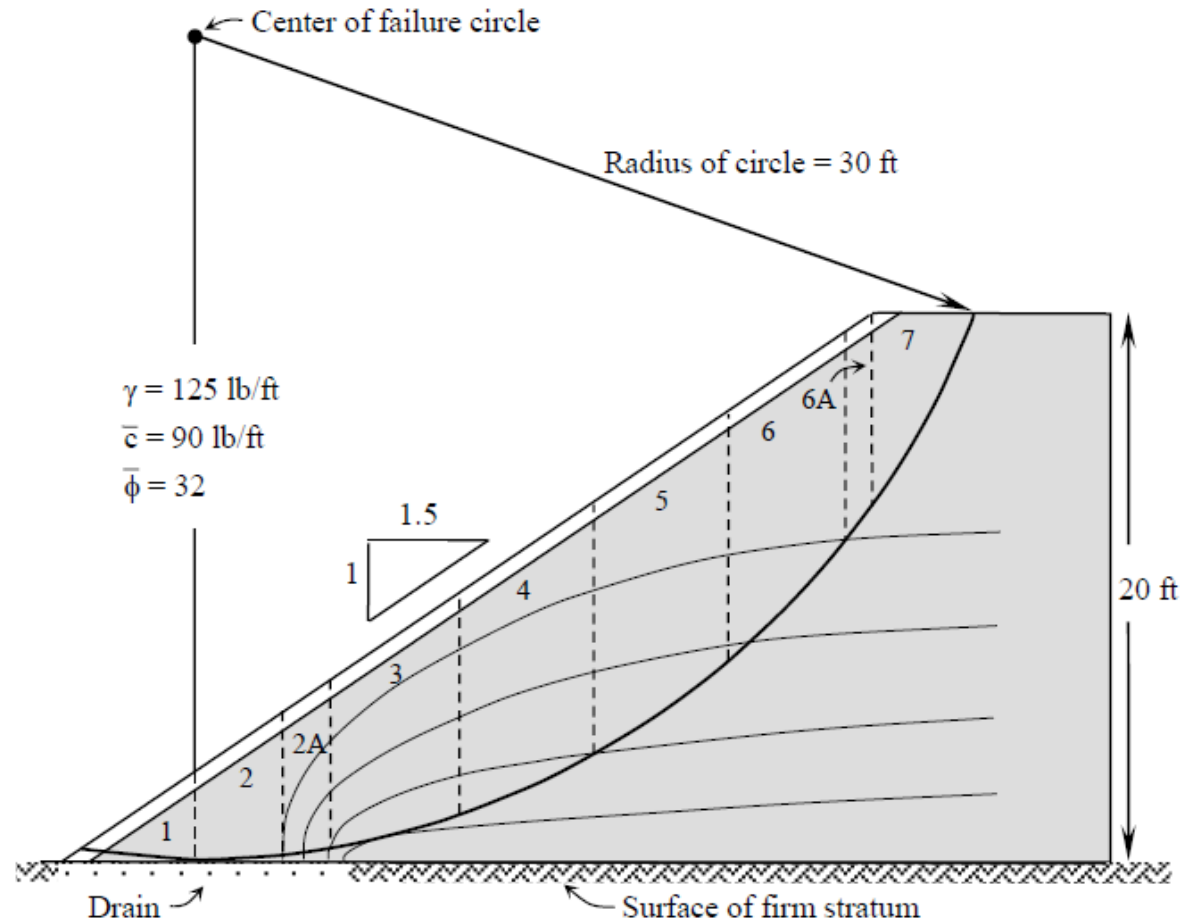
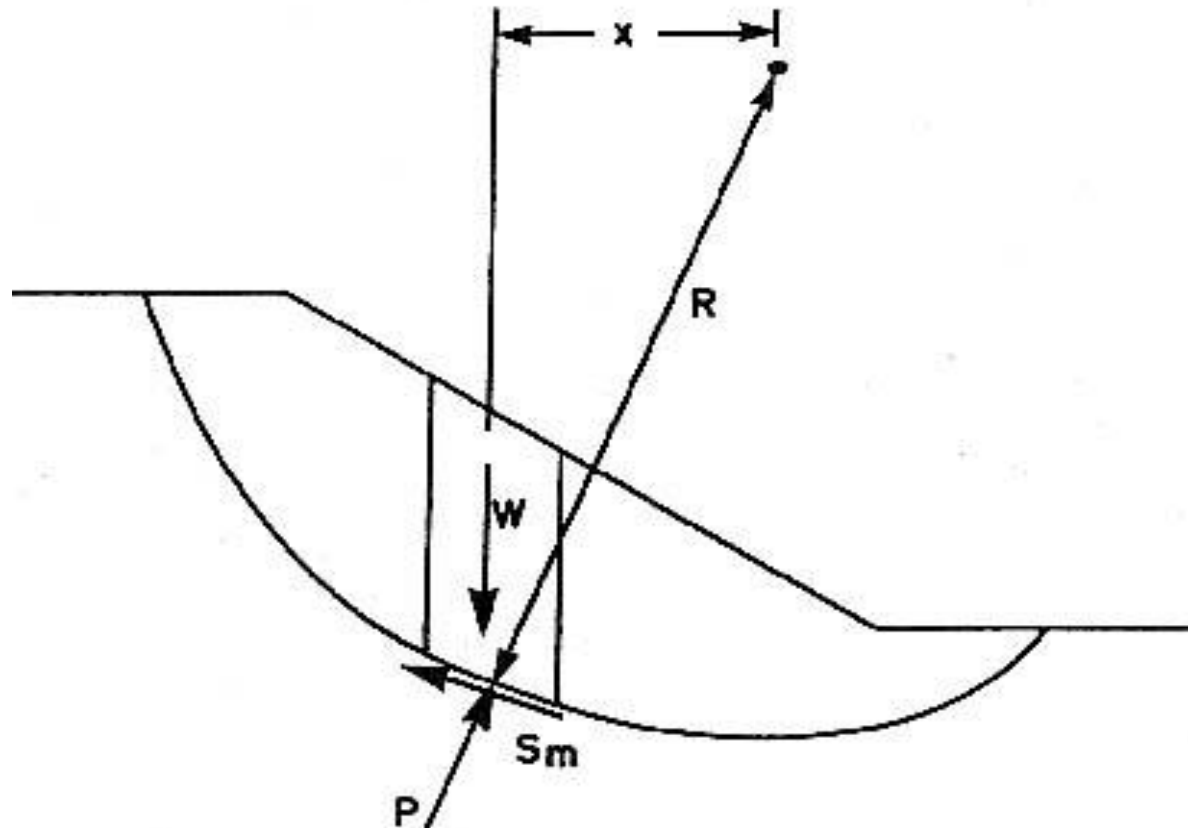


Figure 1 Stability of slope with an underdrain (after Lambe and Whitman)

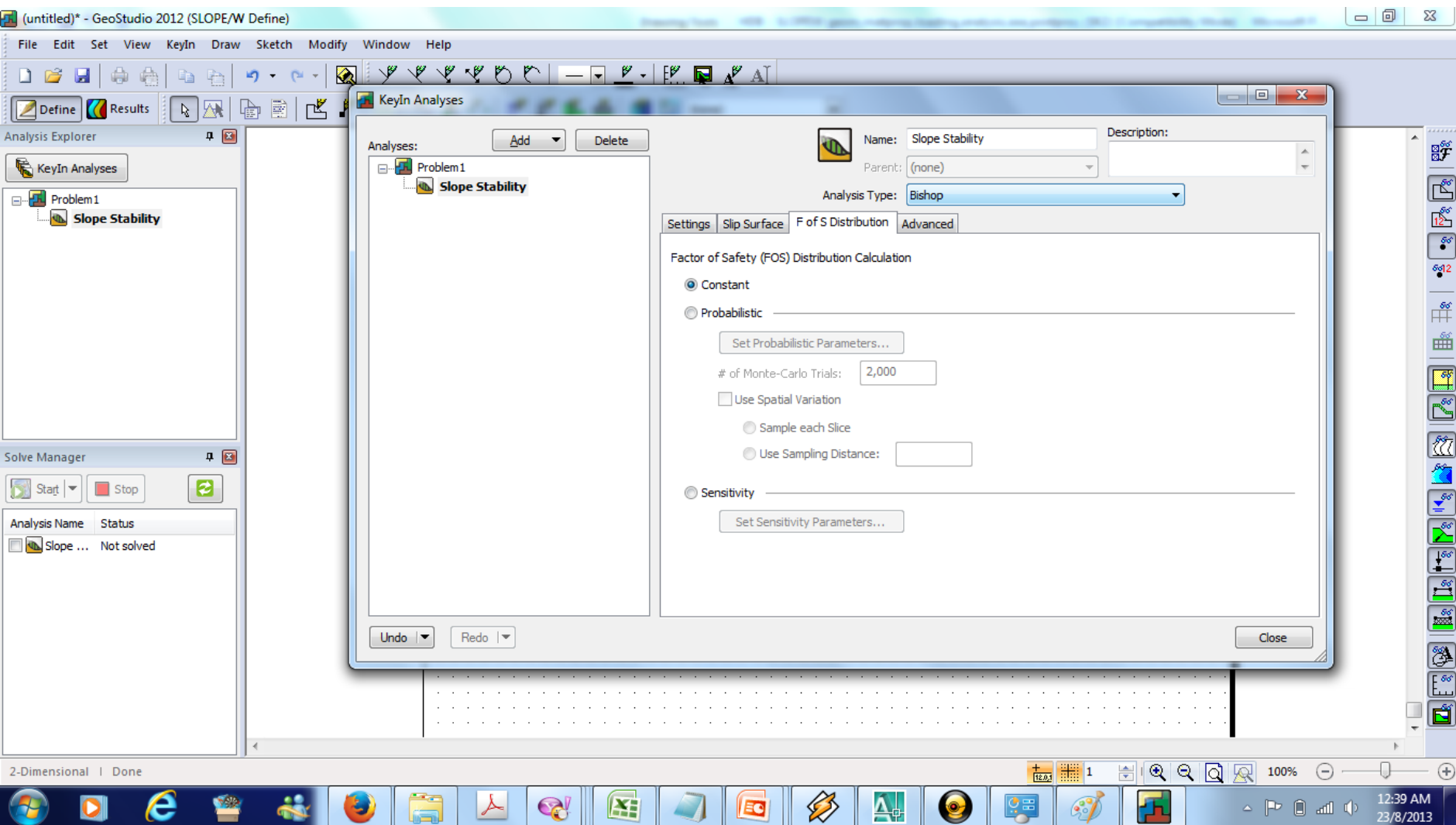
Direction of movement: right to left

PROBLEM 1

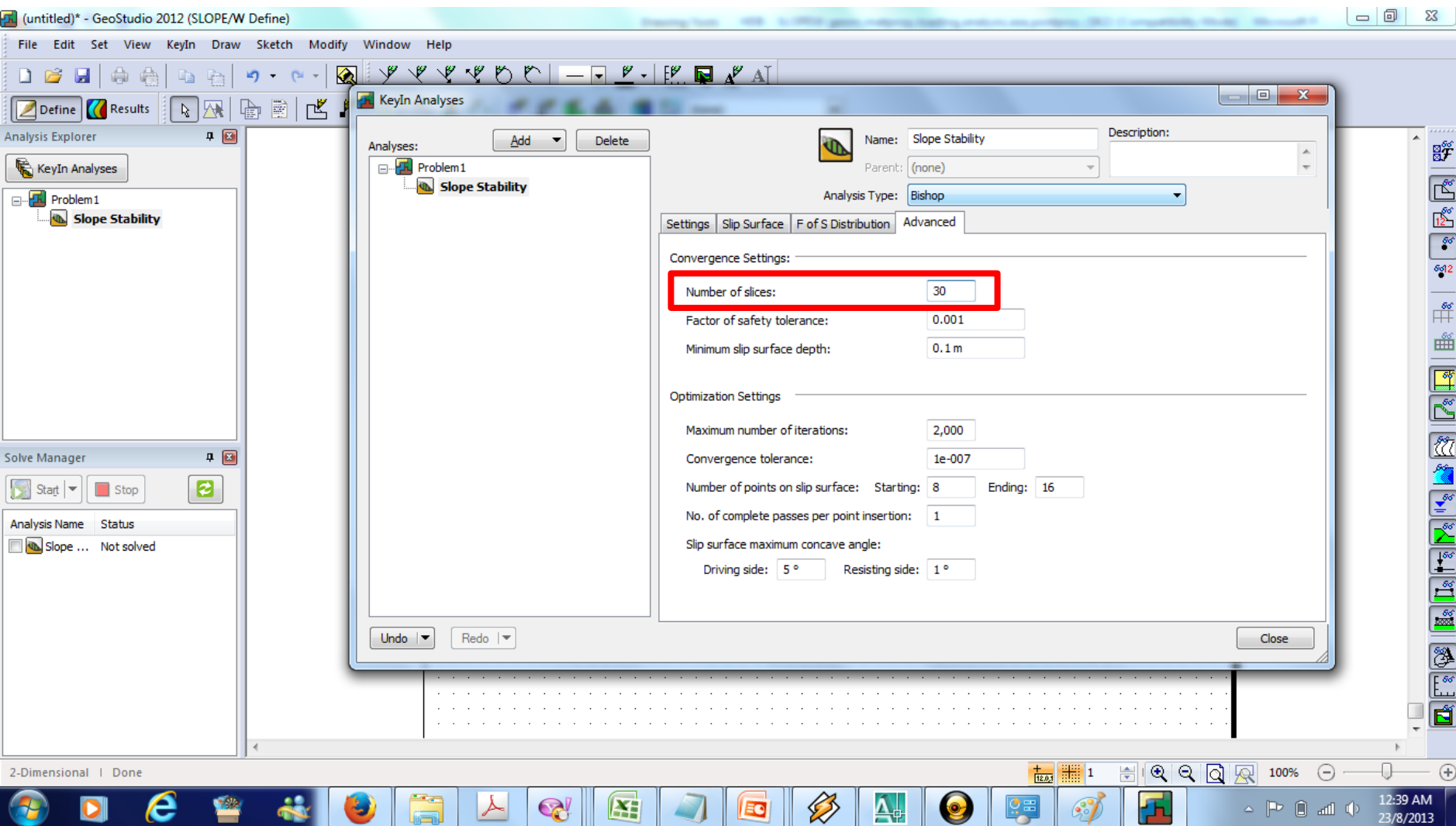


Direction of movement: left to right

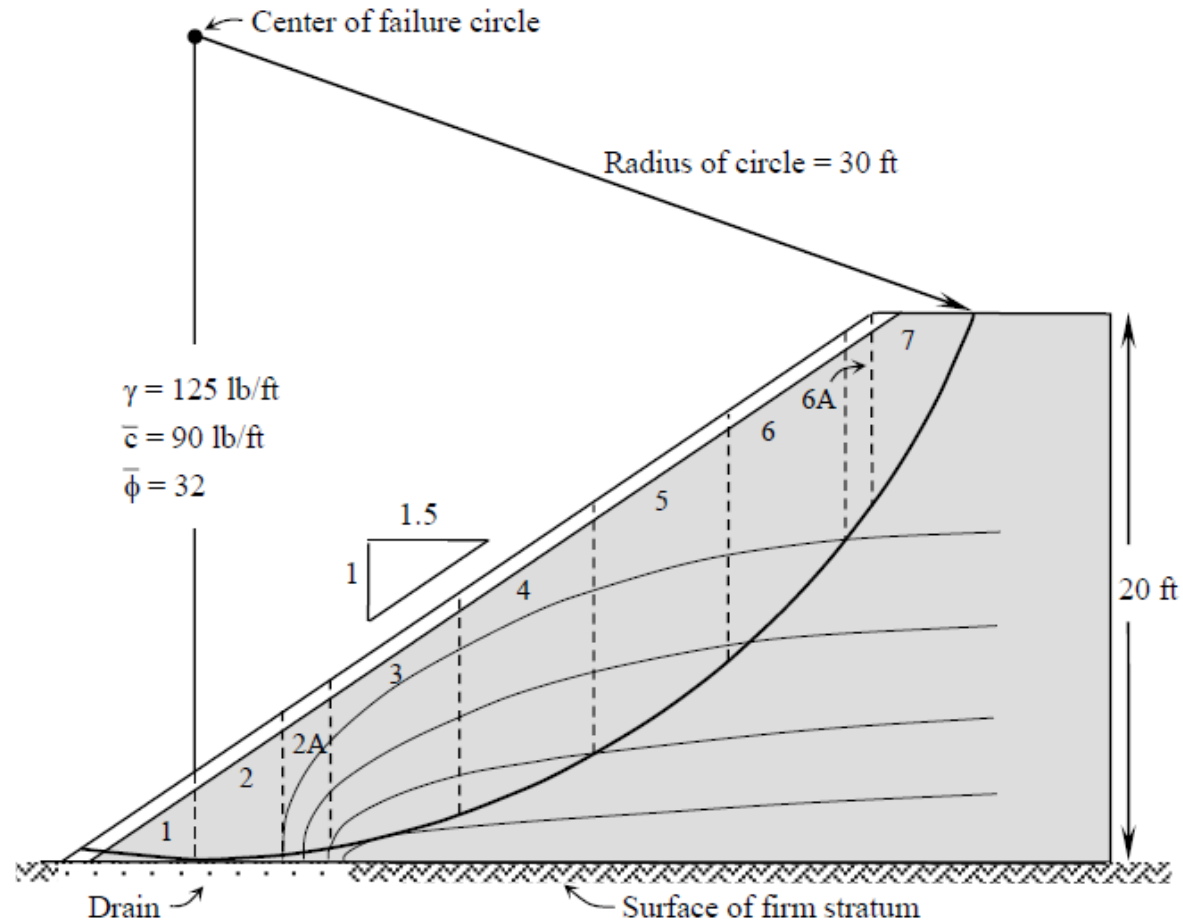
STARTING PAGE



STARTING PAGE



PROBLEM 1



Specifying the number of slices to be greater than the default number of 30 seldom alters the factor of safety significantly. Specifying the number of slices lower than the default value of 30 is not recommended unless you want to investigate a specific issue like, for example, comparing the SLOPE/W results with hand calculations. Making the number of slices too high simply creates an excessive amount of unnecessary data without a significant improvement in safety factor accuracy.

Suggested sequence of analysis using SLOPE/W:

- Geometry: sketch the geometry
- Set page size, unit and scale
- Geometry:
 - Draw points
 - Draw regions
- Material properties:
 - Input material properties data
 - Assign material properties
- Choose the method of analyses
- Draw piezometric lines
- Draw and assign loadings
- Choose the method to draw slip surfaces
- Execute the analysis
- Post processing (output)

PROBLEM 1

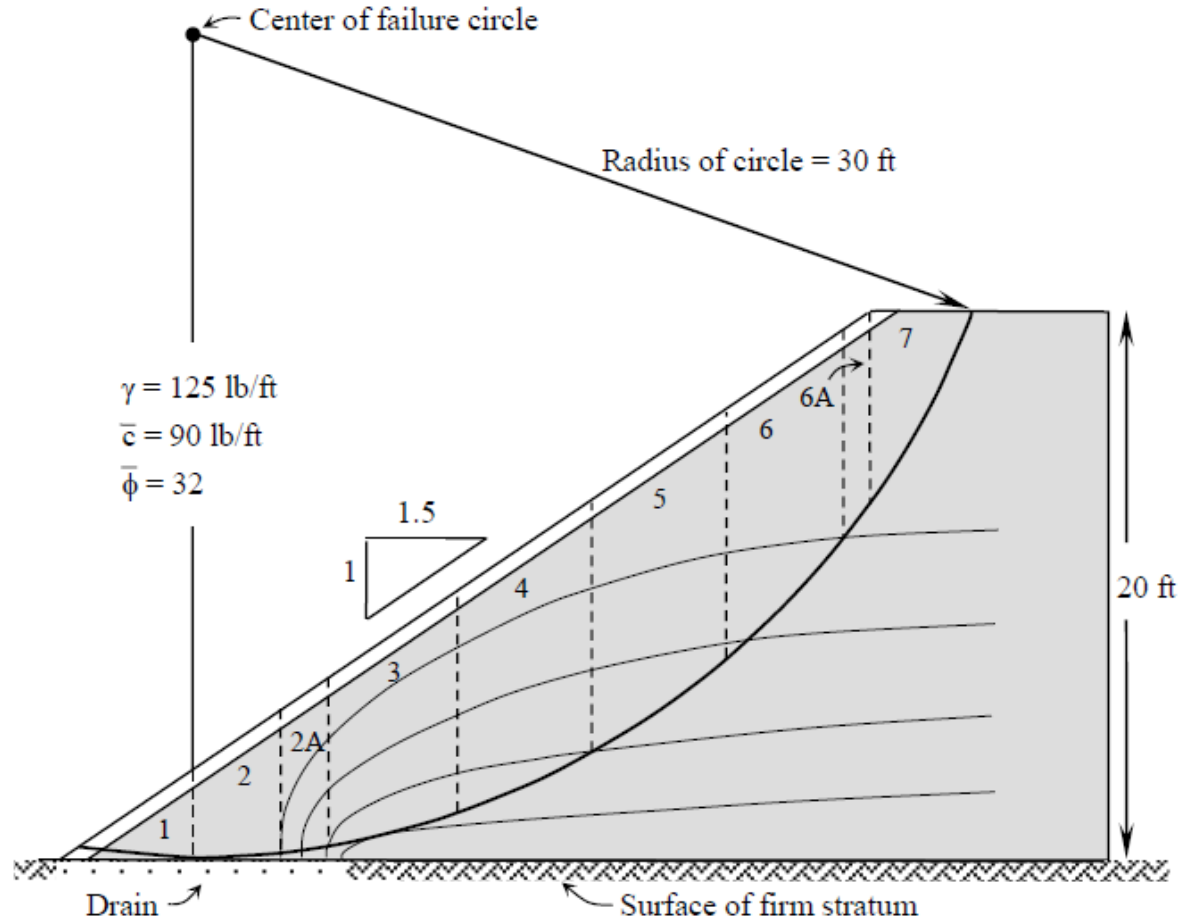


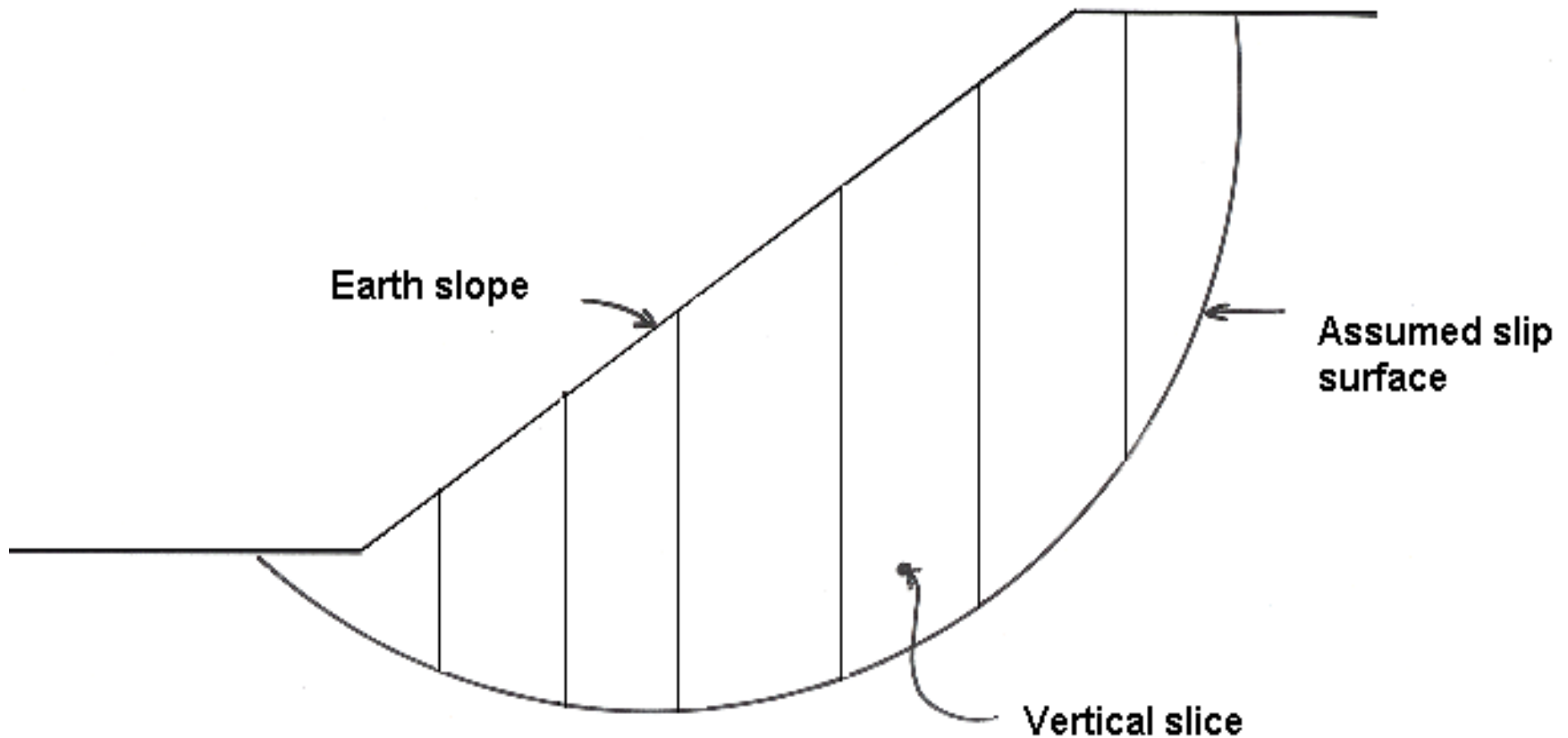
Figure 1 Stability of slope with an underdrain (after Lambe and Whitman)

Require:

- FoS (Bishop method) hand calculated
- FoS (Bishop method) computed using SLOPE/W

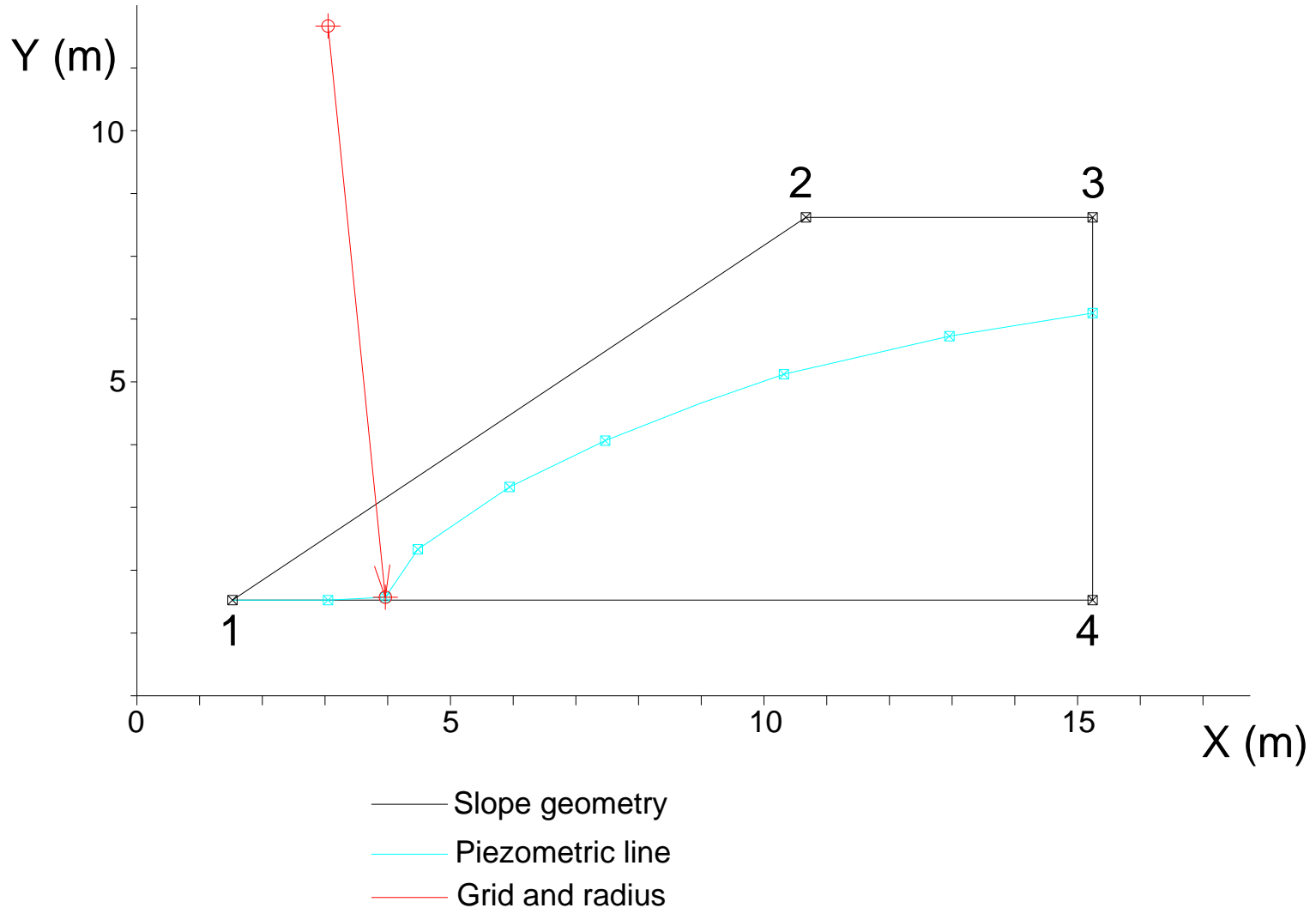
PROBLEM 1

× Center of rotation



PROBLEM 1

Model for Numerical Analysis



PROBLEM 1

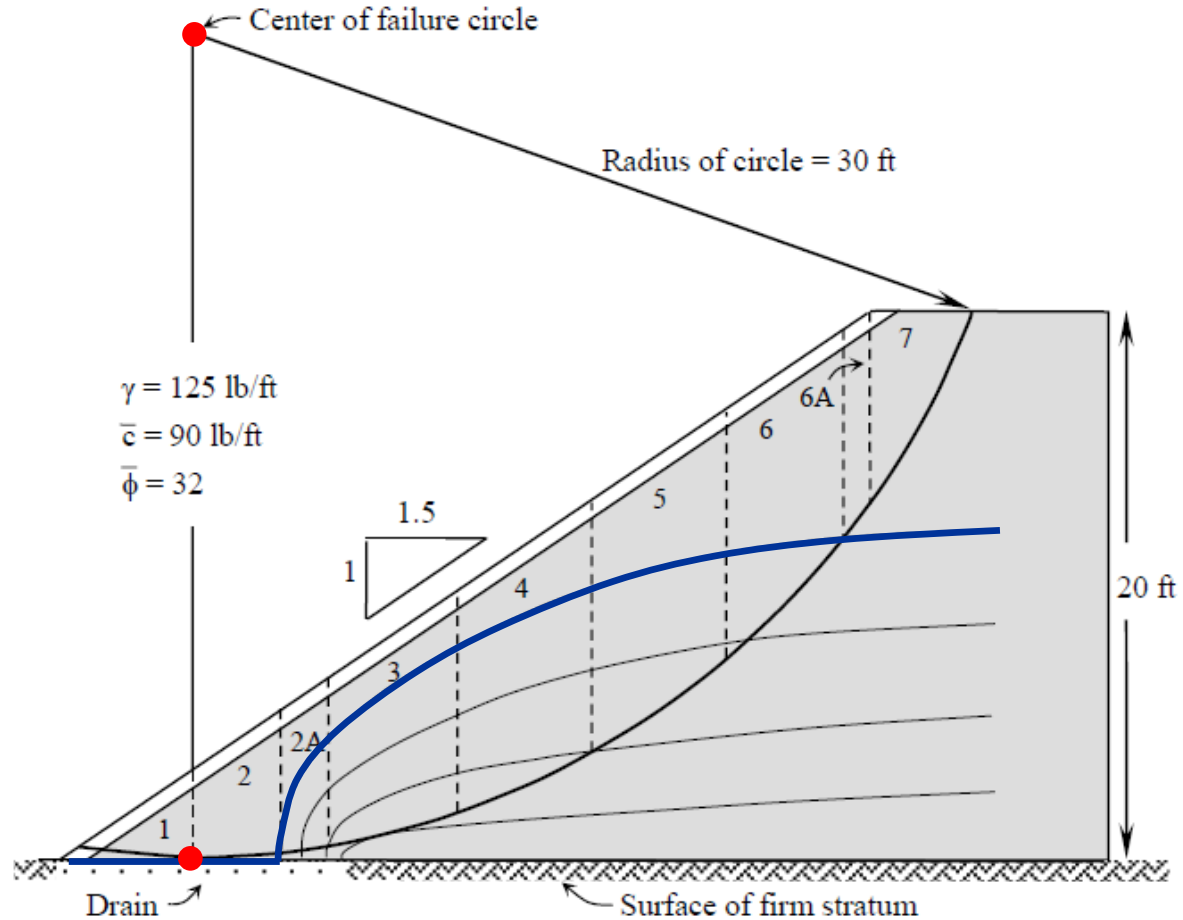


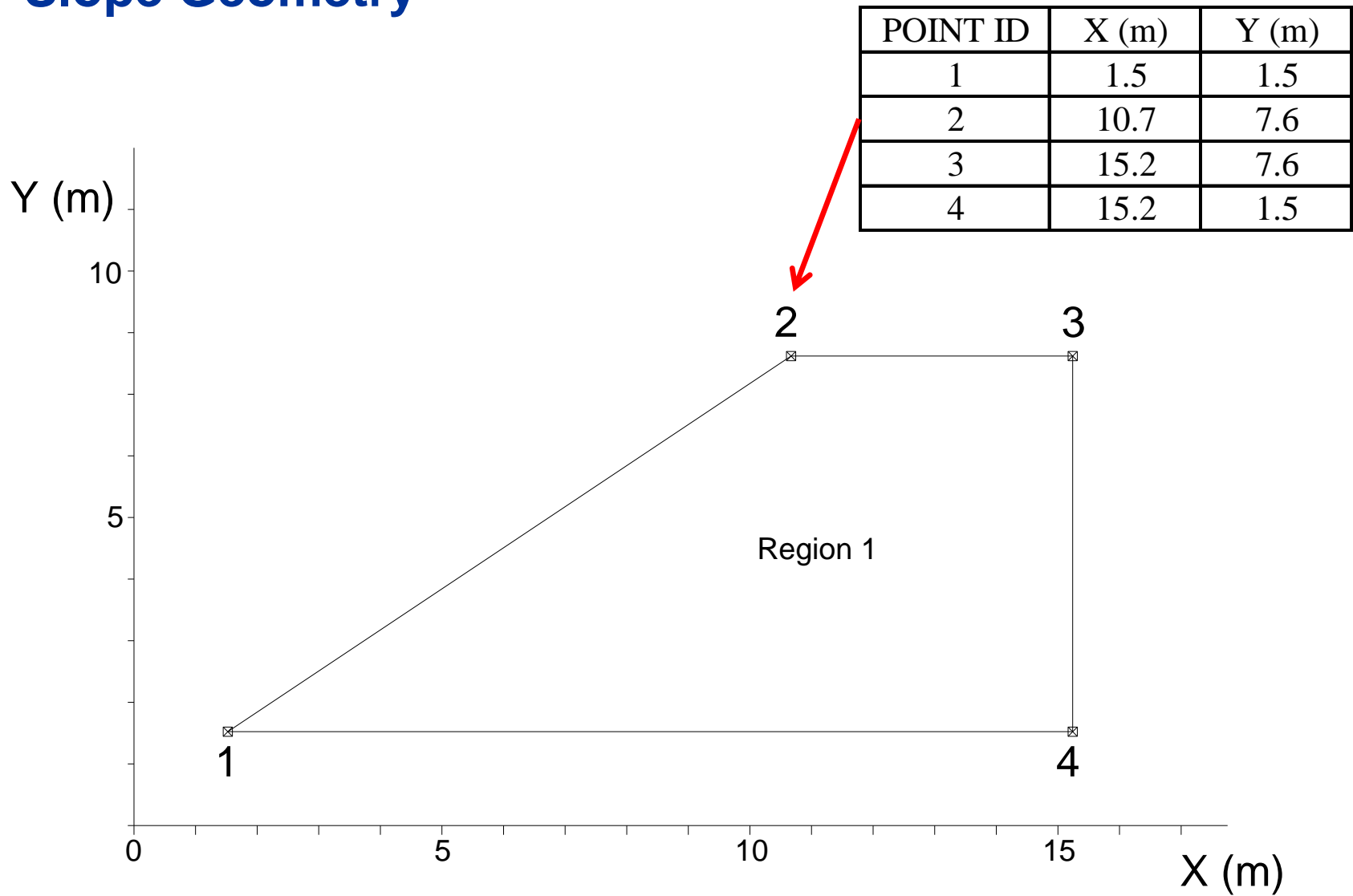
Figure 1 Stability of slope with an underdrain (after Lambe and Whitman)

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- FoS (Bishop method) computed using SLOPE/W

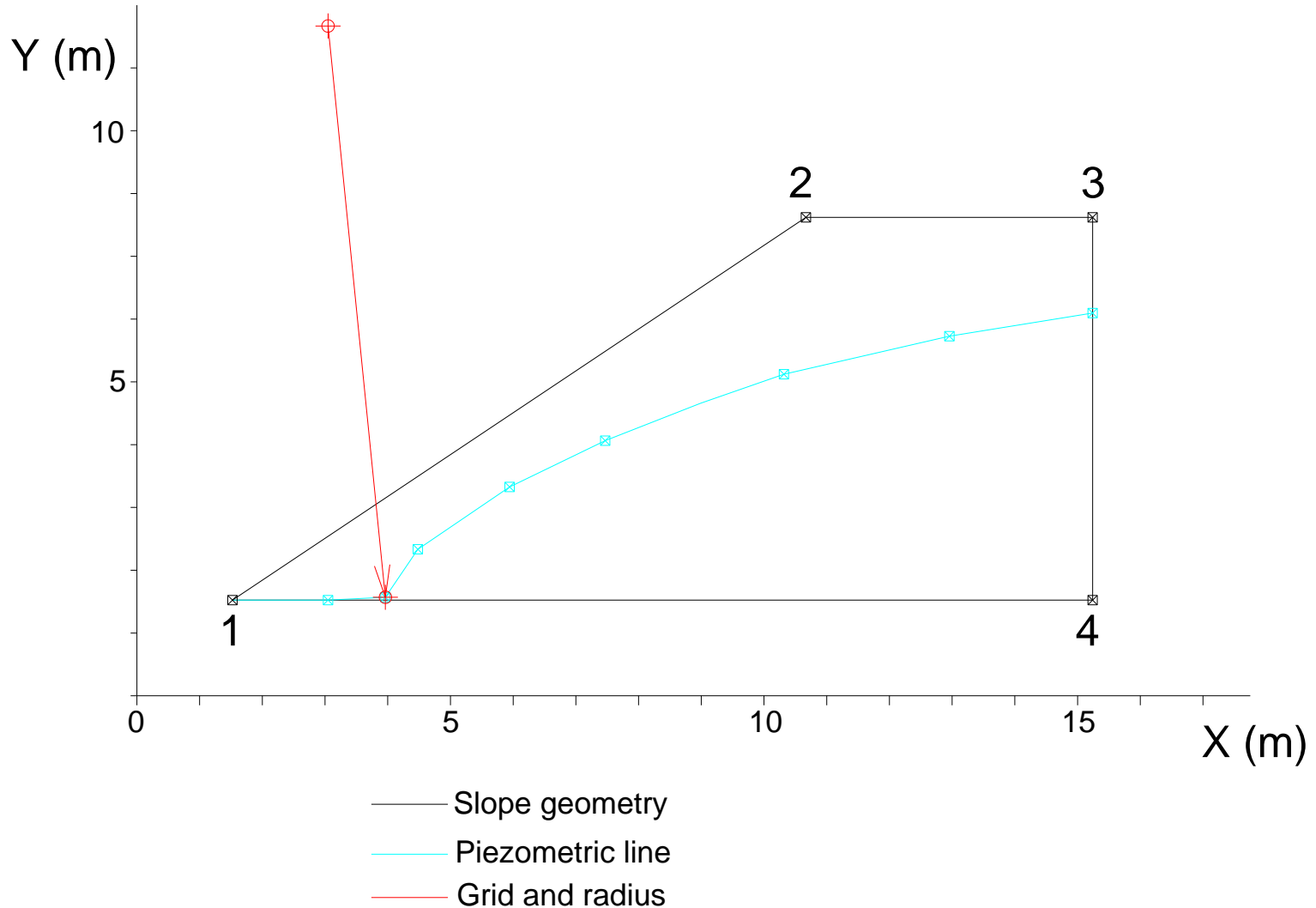
PROBLEM 1

Slope Geometry



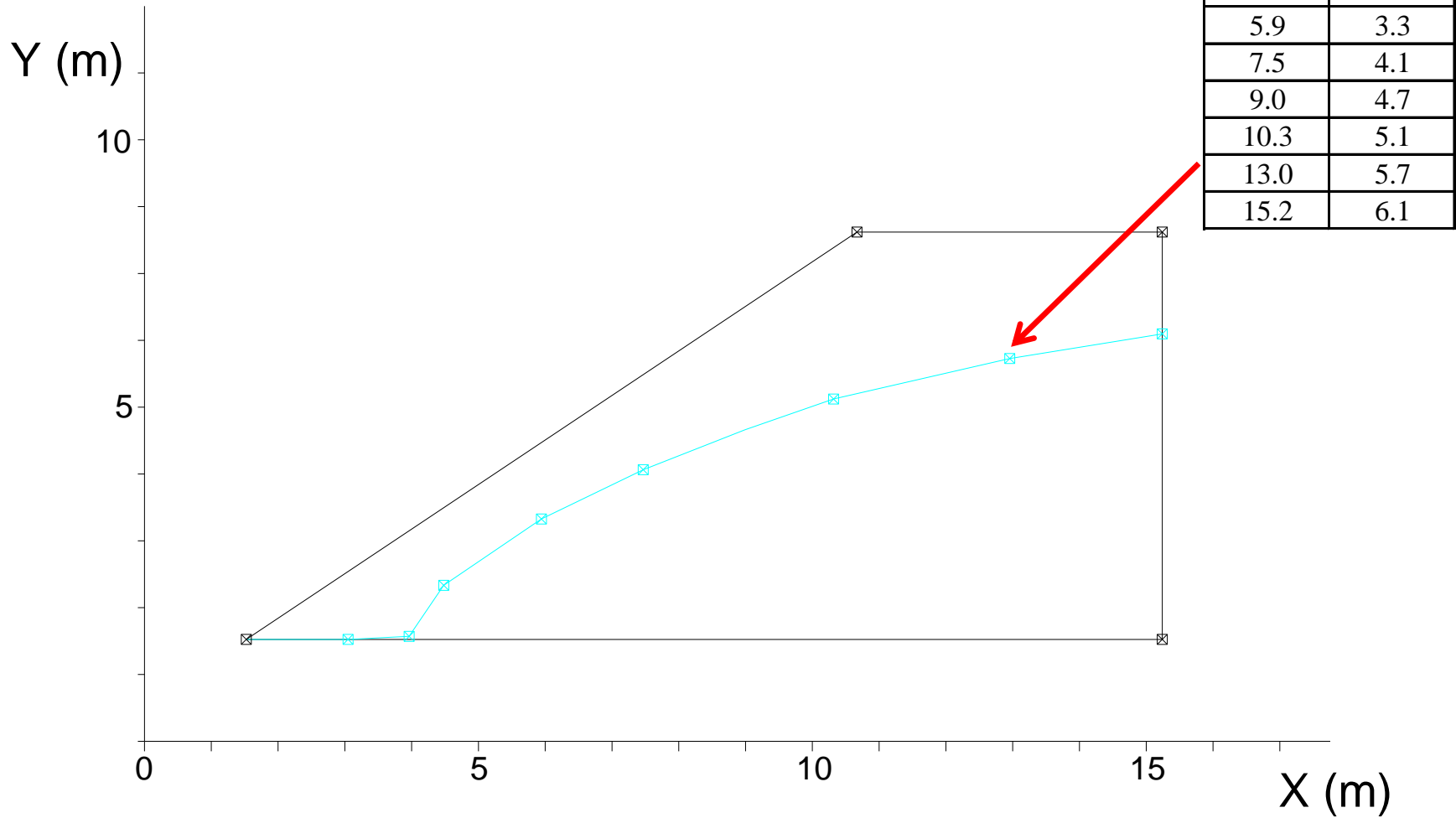
PROBLEM 1

Model for Numerical Analysis



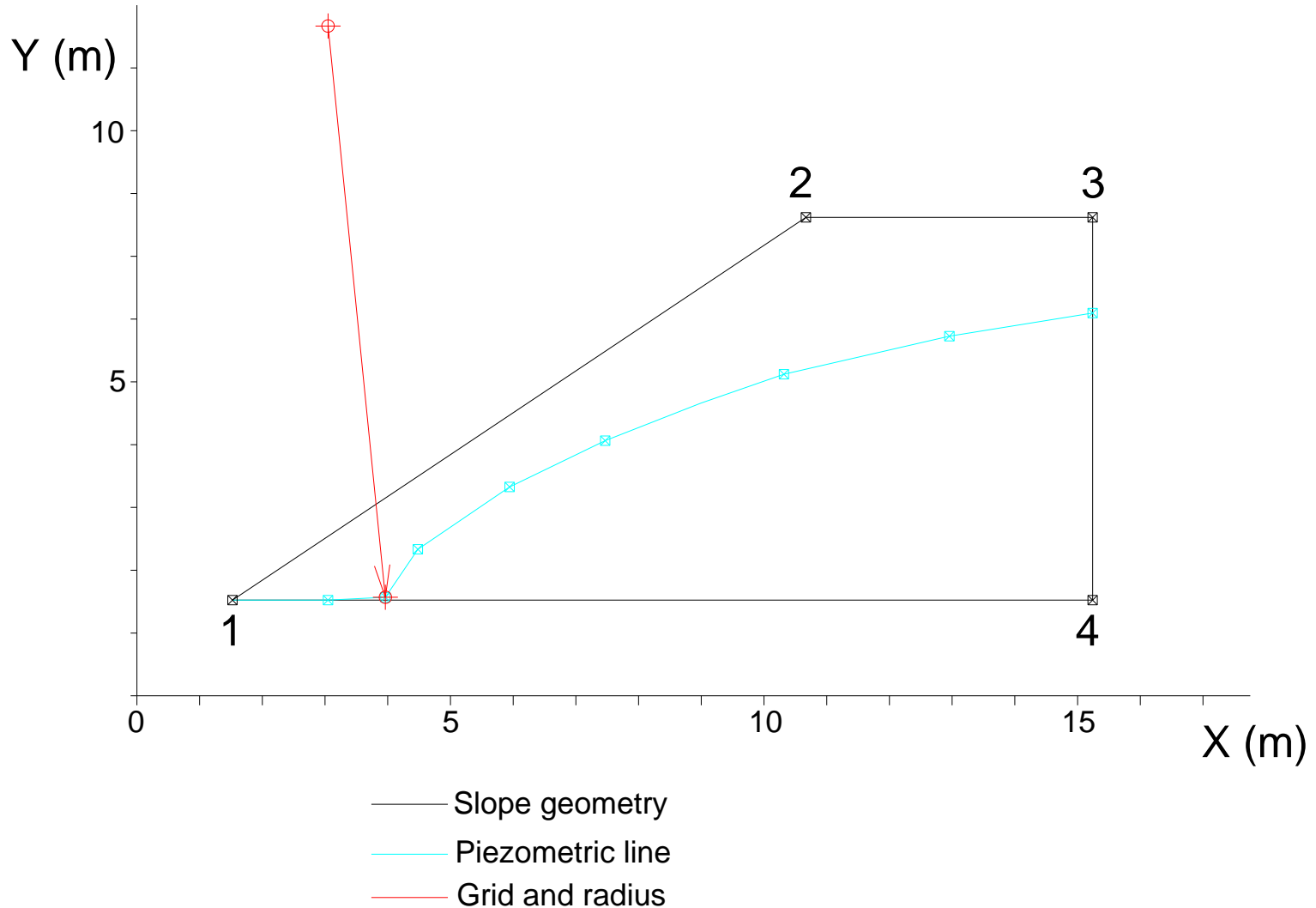
PROBLEM 1

Piezometric Line



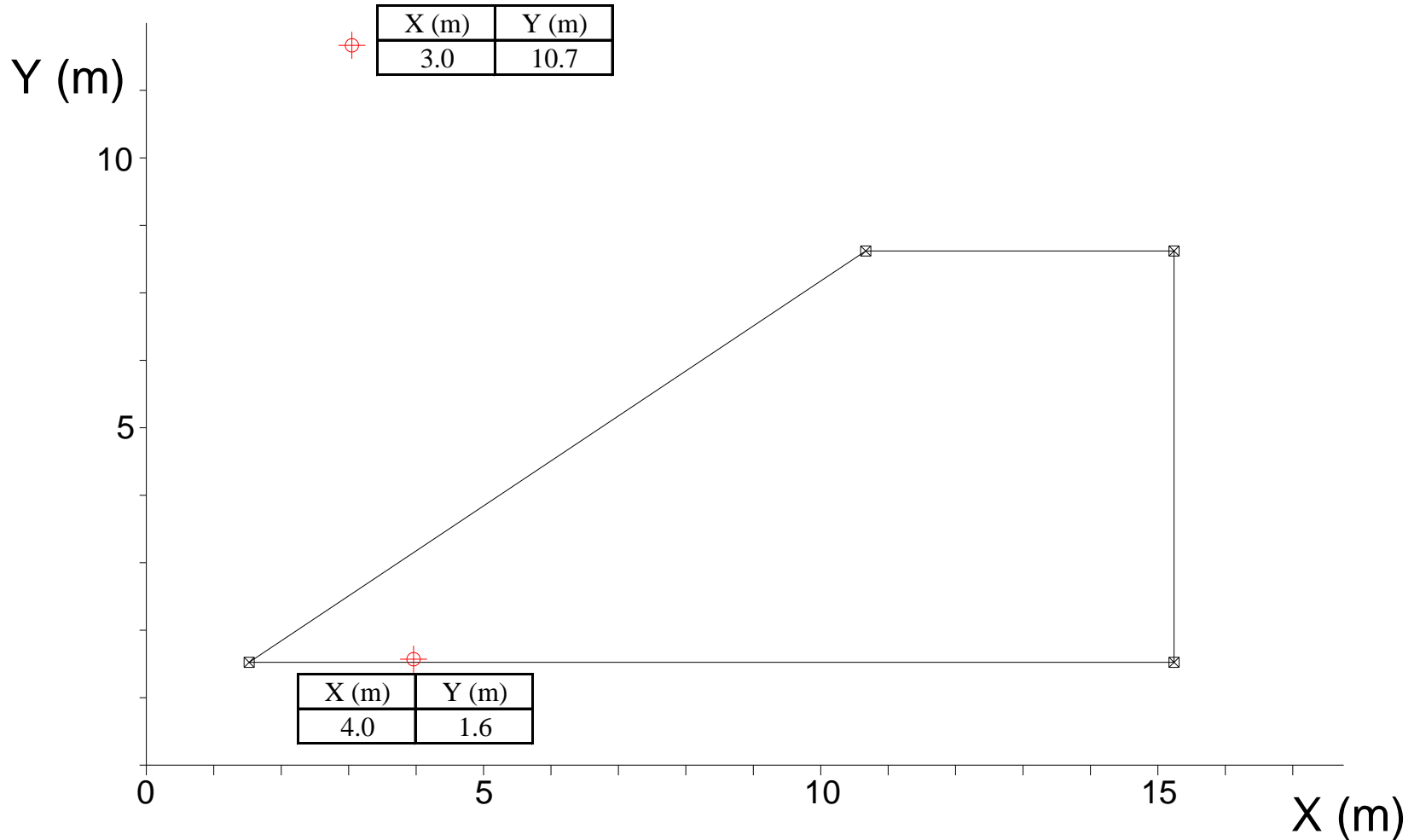
PROBLEM 1

Model for Numerical Analysis



PROBLEM 1

Grid and Radius

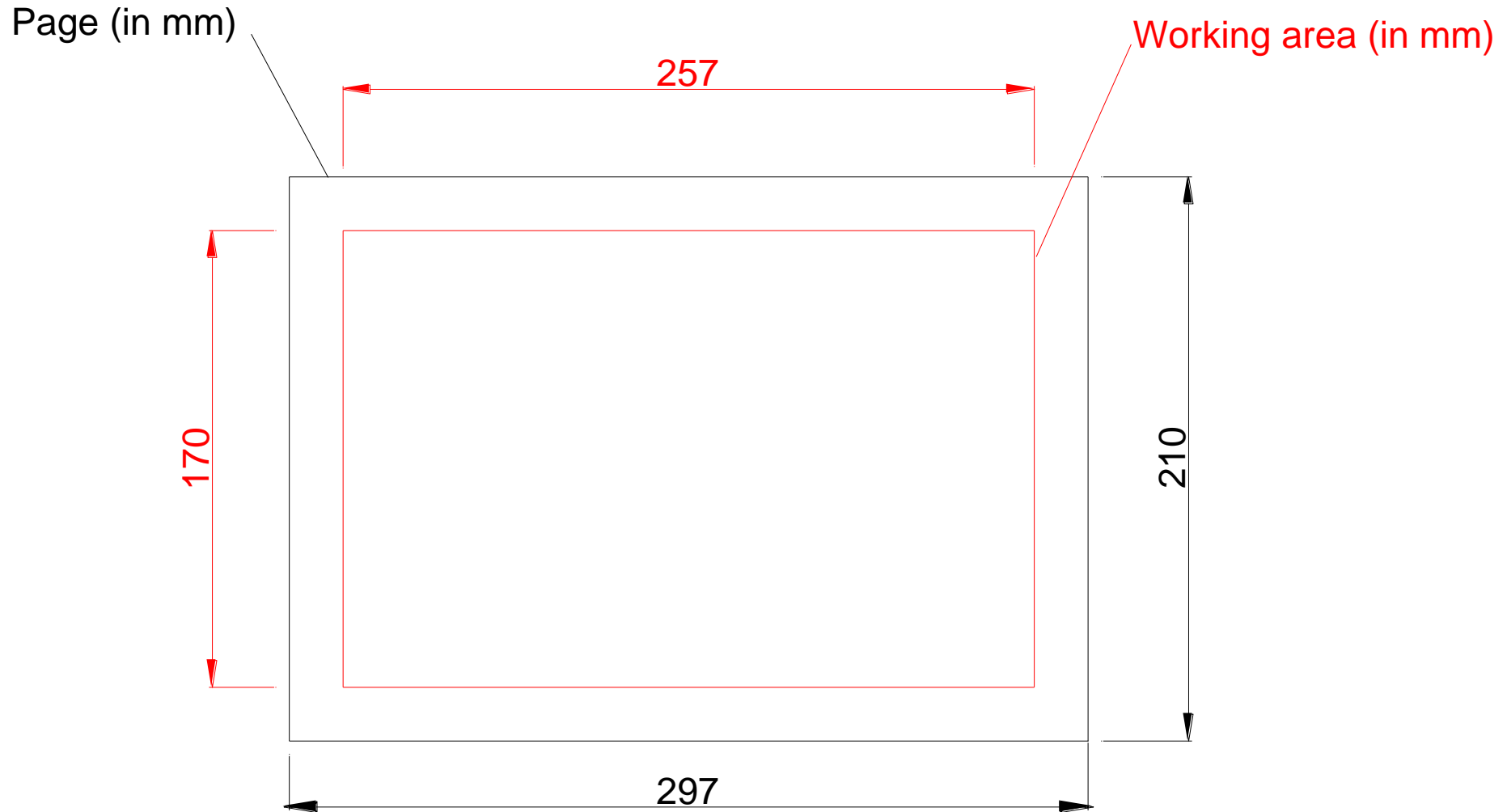


Suggested sequence of analysis using SLOPE/W:

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- Draw and assign loadings
- Choose the method to draw slip surfaces
- Execute the analysis
- Post processing (output)

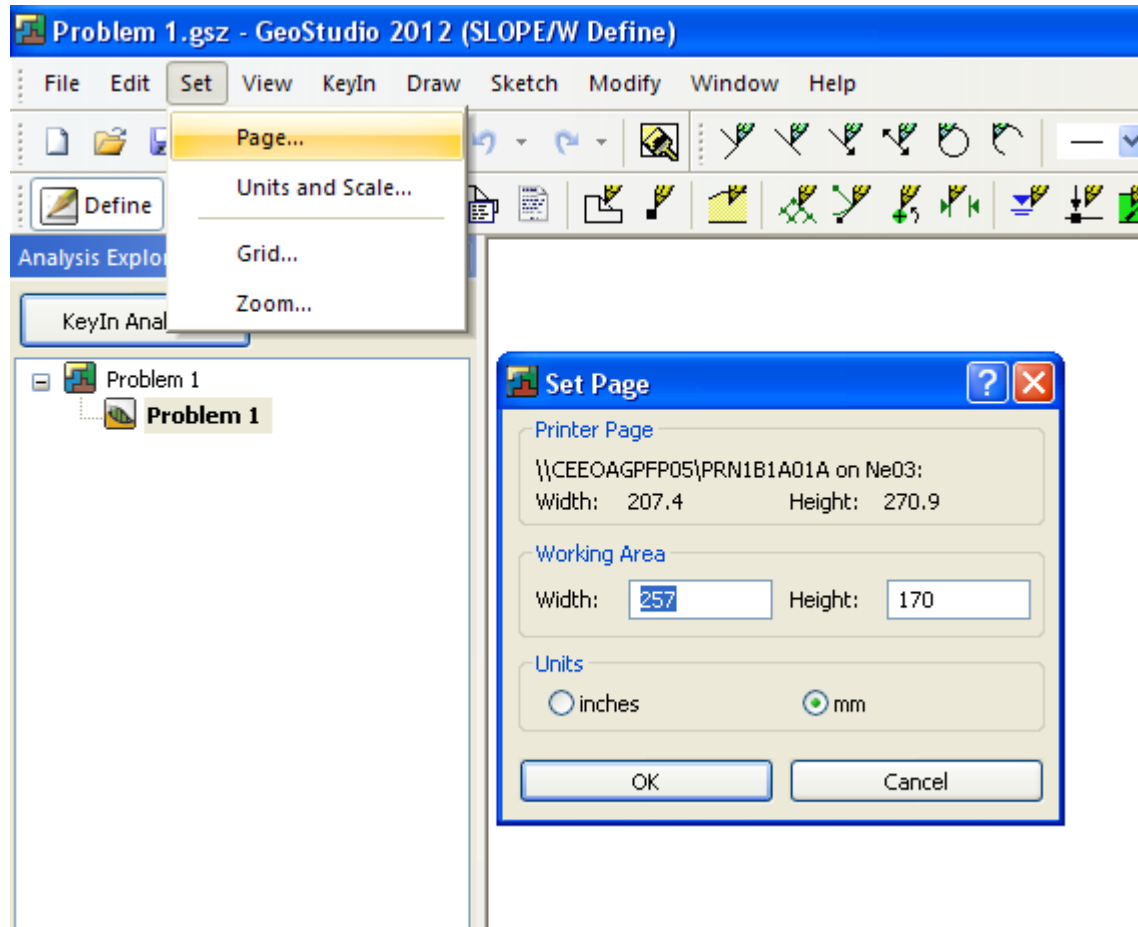
PROBLEM 1

Set Page and Working Area



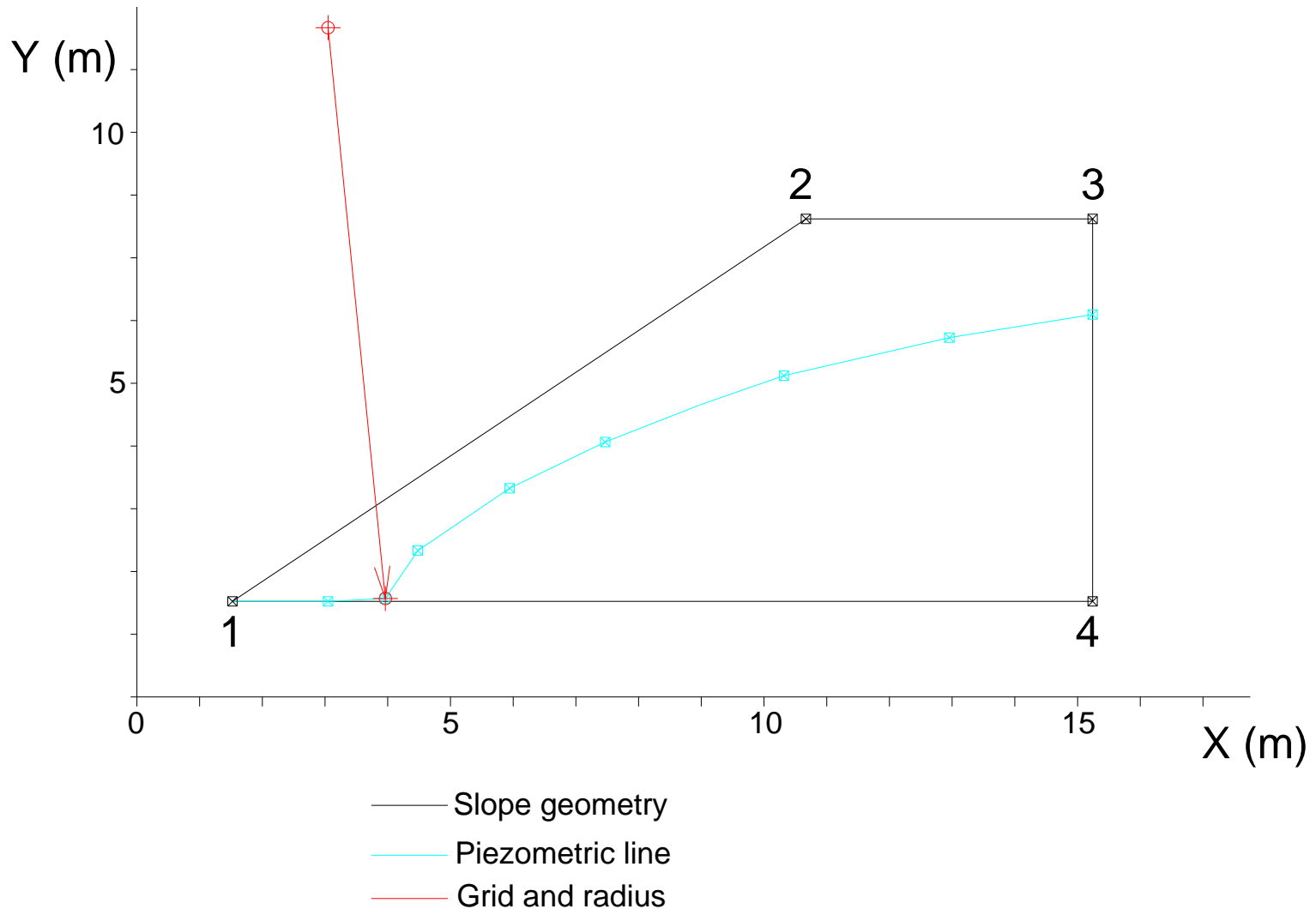
PROBLEM 1

Set Page and Working Area



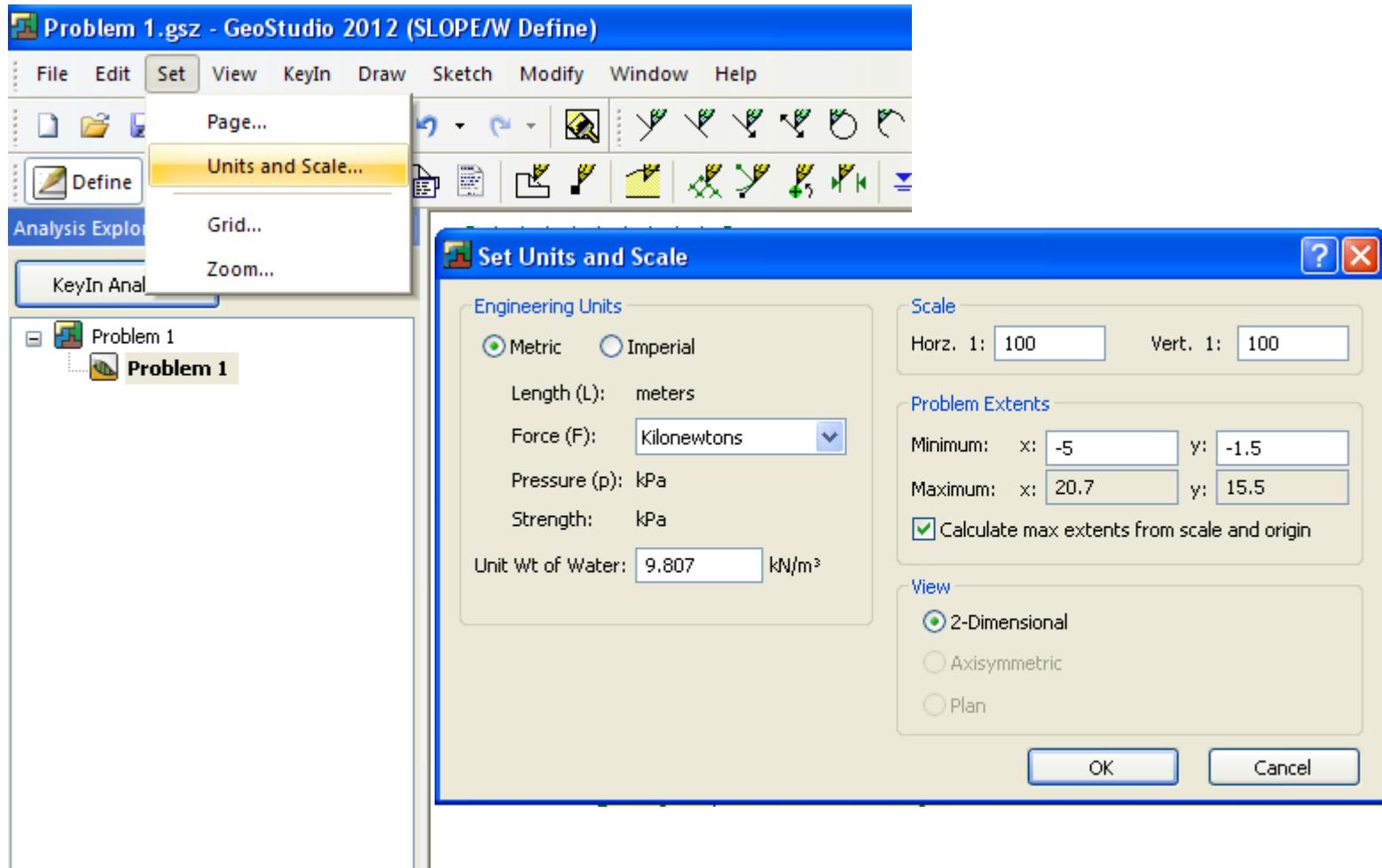
PROBLEM 1

Set Unit and Scale



PROBLEM 1

Set Unit and Scale



Suggested sequence of analysis using SLOPE/W:

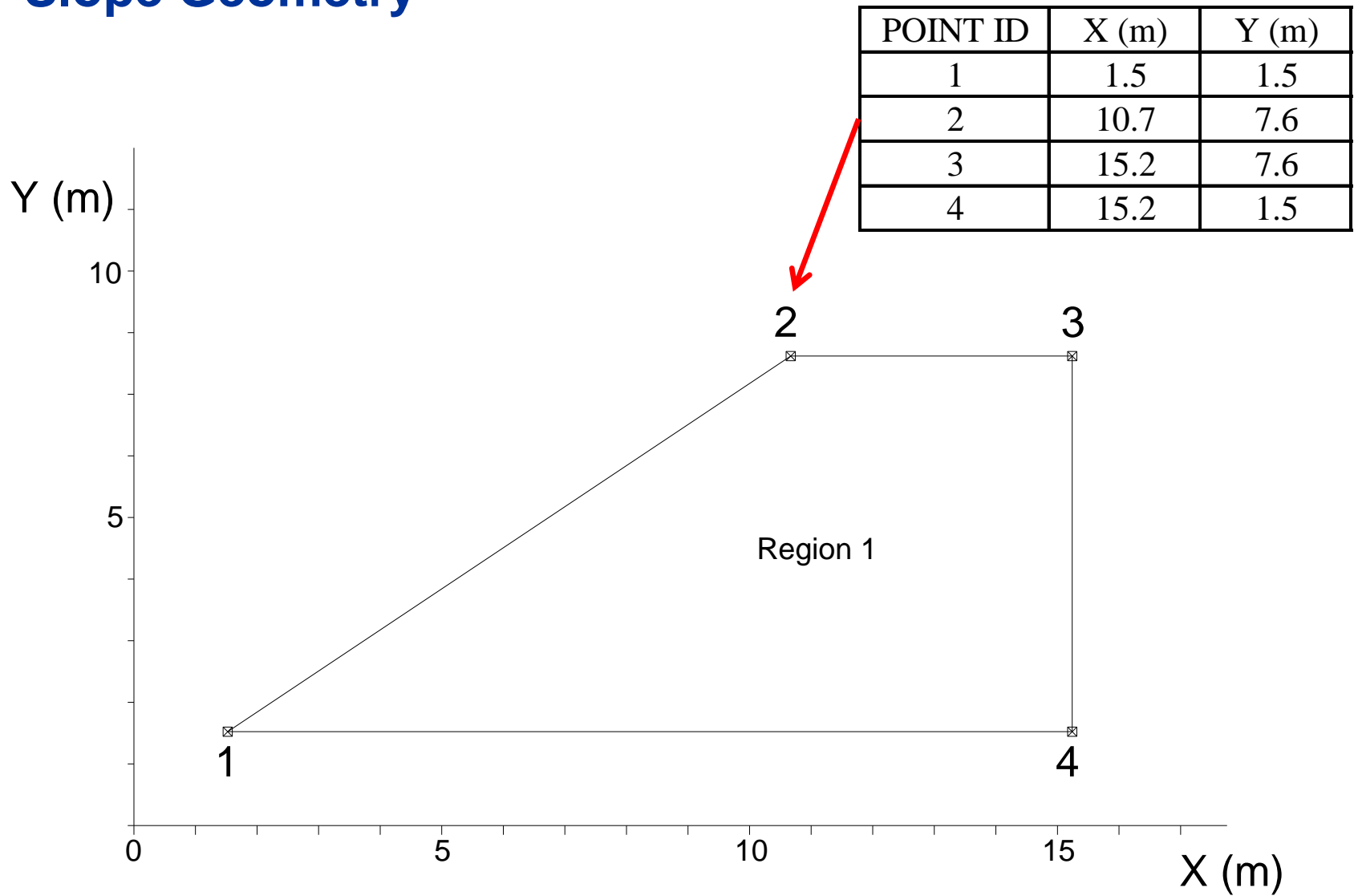
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- Set page size, unit and scale
- Geometry:
 - Draw points
 - Draw regions
- Material properties:
 - Input material properties data
 - Assign material properties
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PROBLEM 1

Slope Geometry



Draw Points (KeyIn – Points)

- Input the point coordinate one-by one or
- Paste the coordinate data

Draw Points (Draw – Points)

- To draw a point: left click in the model area.
- To edit a point: left click in the existing point.

PROBLEM 1

Draw Points

The screenshot displays a software application window with a menu bar (File, Edit, Set, View, KeyIn, Draw, Sketch, Modify, Window, Help) and a toolbar. The 'KeyIn' menu is open, showing options like Analyses..., Regions..., Points... (highlighted), Materials..., Strength Functions..., Probability Functions..., Hydraulic Functions..., Spatial Functions..., Slip Surface..., Pore Water Pressure..., Pore Air Pressure..., Point Loads..., Surcharge Loads..., Reinforcement Loads..., and Seismic Load....

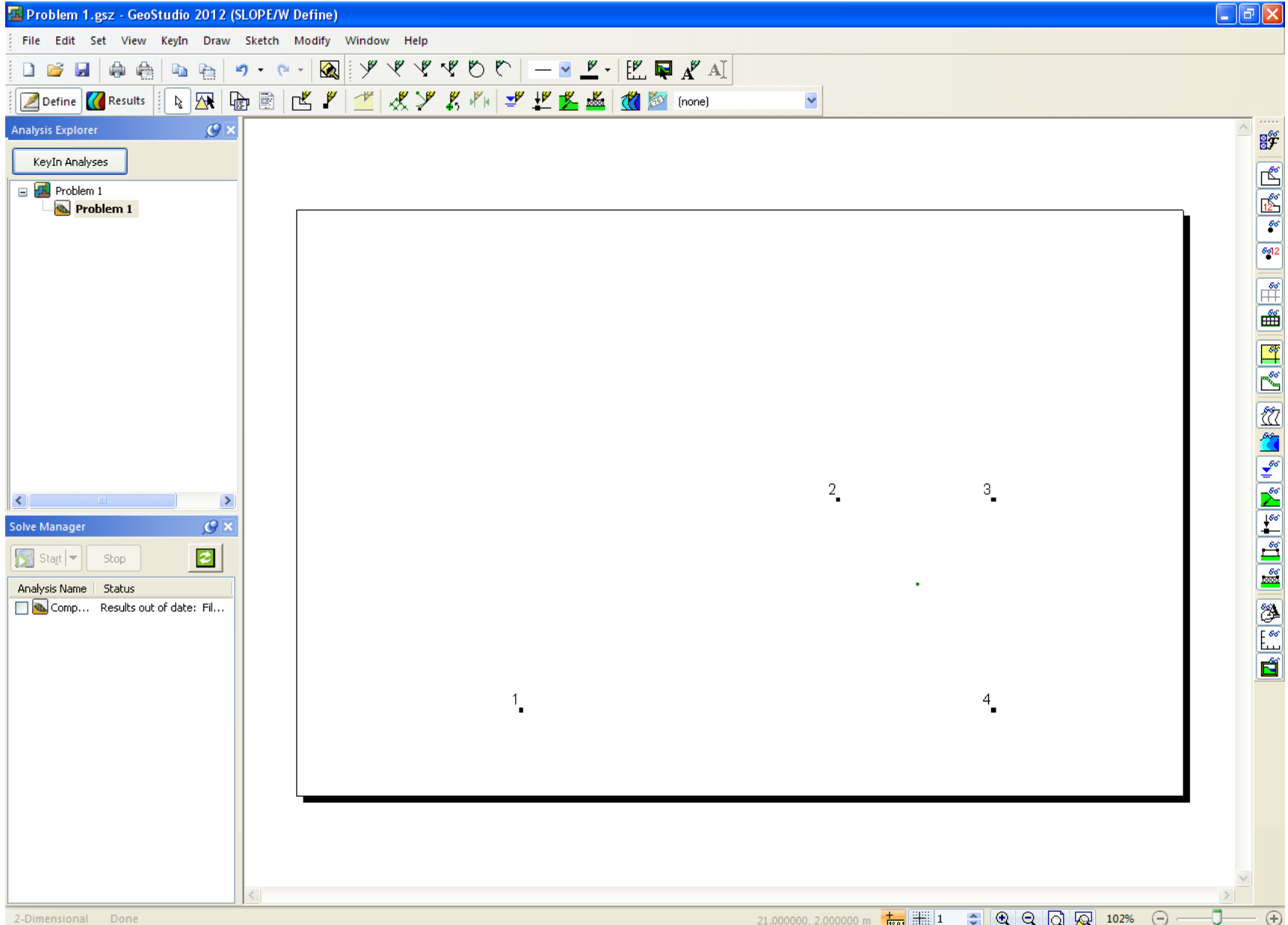
The 'KeyIn Points' dialog box is open, showing a table of points. The table has columns for ID, X (m), Y (m), Label, and Pinned. The data is as follows:

| ID | X (m) | Y (m) | Label | Pinned |
|----|-------|-------|--------------|--------|
| 1 | 1.5 | 1.5 | Point+Number | Yes |
| 2 | 10.7 | 7.6 | Point+Number | Yes |
| 3 | 15.2 | 7.6 | Point+Number | Yes |
| 4 | 15.2 | 1.5 | Point+Number | Yes |
| 5 | --- | --- | Point+Number | Yes |

The dialog box also includes 'Add' and 'Delete' buttons on the right, and 'Undo' and 'Redo' buttons at the bottom left. A 'Close' button is at the bottom right.

PROBLEM 1

Draw Points



Suggested sequence of analysis using SLOPE/W:

- Geometry: sketch the geometry
- Set page size, unit and scale
- Geometry:
 - Draw points
 - Draw regions
- Material properties:
 - Input material properties data
 - Assign material properties
- Choose the method of analyses
- Draw piezometric lines
- Draw and assign loadings
- Choose the method to draw slip surfaces
- Execute the analysis
- Post processing (output)

Draw Regions (KeyIn – Regions)

- Input the point numbers of each coordinate separated by commas.
- Point numbers should be in sequence of clockwise or counter-clockwise direction of each region.
- Draw each region one-by one.

Draw Regions (Draw – Regions)

- To draw a region: click in the model area.
- To edit a region: click on one region.

PROBLEM 1

Draw Regions

Problem 1.gsz - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Analyses... Define Results

Analysis Explorer

KeyIn Analyses

Problem 1

Problem 1

Regions... Points... Materials... Strength Functions... Probability Functions... Hydraulic Functions... Spatial Functions... Slip Surface... Pore Water Pressure... Pore Air Pressure... Point Loads... Surcharge Loads... Reinforcement Loads... Seismic Load...

KeyIn Regions

| Region | Points |
|--------|---------|
| 1 | 1,2,3,4 |
| 2 | |

Region Type: Background Polygon

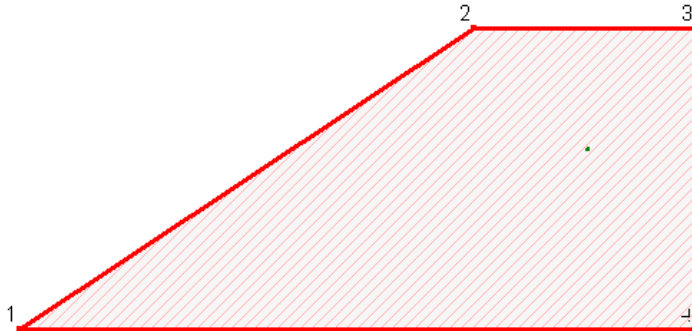
Region Points: 1,2,3,4

Undo Redo Close

Start Stop

Analysis Name Status

Comp... Results out of date: Fil...



PROBLEM 1

Draw Regions

Problem 1.gsz - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Analyses...
Define Results
Analysis Explorer
KeyIn Analyses
Problem 1
Problem 1

Regions...
Points...
Materials...
Strength Functions
Probability Functions...
Hydraulic Functions
Spatial Functions
Slip Surface
Pore Water Pressure...
Pore Air Pressure...
Point Loads...
Surcharge Loads...
Reinforcement Loads...
Seismic Load...

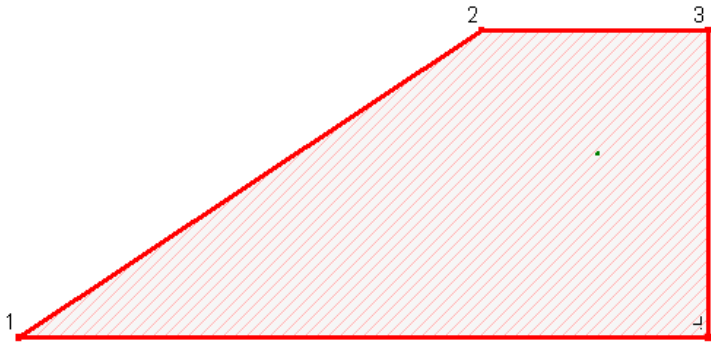
KeyIn Regions

| Region | Points |
|--------|---------|
| 1 | 1,4,3,2 |
| 2 | |

Region Type: Background Polygon
Region Points: 1,4,3,2

Undo Redo Close

Solve Manager
Start Stop
Analysis Name Status
Comp... Results out of date: Fil...



Suggested sequence of analysis using SLOPE/W:

- Geometry: sketch the geometry
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- Geometry:
 - Draw points
 - Draw regions
- Material properties:
 - Input material properties data
 - Assign material properties
- Choose the method of analyses
- Draw piezometric lines
- Draw and assign loadings
- Choose the method to draw slip surfaces
- Execute the analysis
- Post processing (output)

PROBLEM 1

Input Material Properties Data

The screenshot displays the GeoStudio 2012 (SLOPE/W Define) interface. The main window is titled "Problem 1.gsz - GeoStudio 2012 (SLOPE/W Define)". The "KeyIn" menu is open, showing options like "Analyses...", "Regions...", "Points...", "Materials...", "Strength Functions...", "Probability Functions...", "Hydraulic Functions...", "Spatial Functions...", "Slip Surface...", "Pore Water Pressure...", "Pore Air Pressure...", "Point Loads...", "Surcharge Loads...", "Reinforcement Loads...", and "Seismic Load...". The "Materials..." option is selected. The "KeyIn Materials" dialog box is open, showing a list of materials with "Homogeneous Embankment" selected. The "Name" field is set to "Homogeneous Embankment" and the "Color" is yellow. The "Material Model" is set to "Mohr-Coulomb". The "Basic" tab is active, showing "Unit Weight" as 19.6 kN/m³, "Cohesion" as 4.3 kPa, and "Phi" as 32°. The "Solve Manager" window is also visible at the bottom left, showing "Start" and "Stop" buttons and a table with "Analysis Name" and "Status" columns.

Problem 1.gsz - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View **KeyIn** Draw Sketch Modify Window Help

Analyses...
Regions...
Points...
Materials...
Strength Functions...
Probability Functions...
Hydraulic Functions...
Spatial Functions...
Slip Surface...
Pore Water Pressure...
Pore Air Pressure...
Point Loads...
Surcharge Loads...
Reinforcement Loads...
Seismic Load...

Analysis Explorer

KeyIn Analyses

Problem 1
Problem 1

KeyIn Materials

Materials

| Name | Color |
|------------------------|--------|
| Homogeneous Embankment | Yellow |

Add
Delete
Assigned...

Name: Homogeneous Embankment Color: Yellow Set...

Material Model: Mohr-Coulomb

Basic Suction Drawdown Liquefaction Advanced

Unit Weight: 19.6 kN/m³ Cohesion: 4.3 kPa
Phi: 32°

Undo Redo Close

Solve Manager

Start Stop

| Analysis Name | Status |
|---------------|-----------------------------|
| Comp... | Results out of date: Fil... |

Suggested sequence of analysis using SLOPE/W:

- Geometry: sketch the geometry
- Set page size, unit and scale
- Geometry:
 - Draw points
 - Draw regions
- Material properties:
 - Input material properties data
 - Assign material properties
- Choose the method of analyses
- Draw piezometric lines
- Draw and assign loadings
- Choose the method to draw slip surfaces
- Execute the analysis
- Post processing (output)

PROBLEM 1

Assign Material Properties

Problem 1.gsz - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Regions...
Points
Materials...
Surface Layer Materials...
Slip Surface
Pore-Water Pressure...
Point Loads...
Surcharge Loads...
Reinforcement Loads...
Contours...
Contour Labels

Analysis Explorer

KeyIn Analyses

Problem 1
Problem 1

Draw Materials

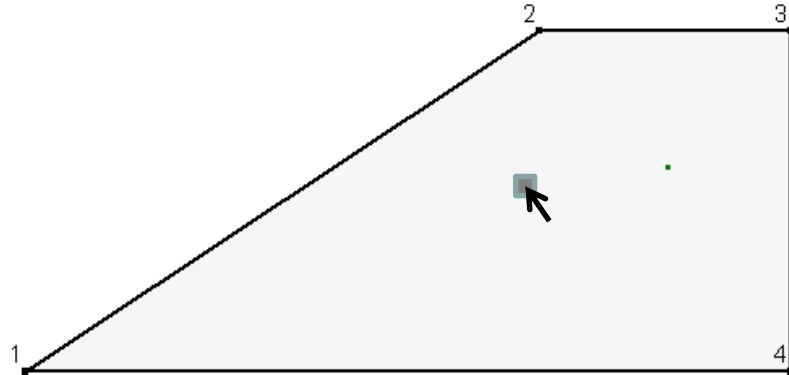
Select: ☒ Regions

☐ Remove ☒ Assign: 1 - Homogeneous E...

Solve Manager

Start Stop

| Analysis Name | Status |
|---------------|-----------------------------|
| Comp... | Results out of date: Fil... |



PROBLEM 1

Assign Material Properties

Problem 1.gsz* - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Define Results

Analysis Explorer

KeyIn Analyses

Problem 1

Compare with hand calculation

Solve Manager

Start Stop

Analysis Name Status

Comp... Results out of date: Fil...

Draw Materials

Select: ☒ Regions

☐ Remove ☐ Assign: 1 - Homogeneous E...

Homogeneous Embankment

The screenshot displays the GeoStudio 2012 interface. The main window shows a yellow trapezoidal region defined by vertices 1, 2, 3, and 4, labeled 'Homogeneous Embankment'. The 'Draw Materials' dialog box is open, showing the 'Regions' selection method. The 'Assign' radio button is selected, and the material '1 - Homogeneous E...' is chosen from the dropdown menu. The 'KeyIn...' and 'View Assigned...' buttons are visible. The 'Analysis Explorer' on the left shows 'Problem 1' and 'Compare with hand calculation'. The 'Solve Manager' at the bottom shows the 'Start' and 'Stop' buttons and a table with columns 'Analysis Name' and 'Status'.

Suggested sequence of analysis using SLOPE/W:

- Geometry: sketch the geometry
- Set page size, unit and scale
- Geometry:
 - Draw points
 - Draw regions
- Material properties:
 - Input material properties data
 - Assign material properties
- Choose the method of analyses
- Draw piezometric lines
- Draw and assign loadings
- Choose the method to draw slip surfaces
- Execute the analysis
- Post processing (output)

PROBLEM 1

Choose the Method of Analyses

Problem 1.gsz - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Analyses...

- Regions...
- Points...
- Materials...
- Strength Functions >
- Probability Functions...
- Hydraulic Functions >
- Spatial Functions >
- Slip Surface >
- Pore Water Pressure...
- Pore Air Pressure...
- Point Loads...
- Surcharge Loads...
- Reinforcement Loads...
- Seismic Load...

Define Results

Analysis Explorer

KeyIn Analyses

Problem 1

Problem 1

Solve Manager

Start Stop

Analysis Name Status

Comp... Results out of date: Fil...

Homogeneous Embankment

1 2 3 4

The screenshot displays the GeoStudio 2012 (SLOPE/W Define) software interface. The main window shows a diagram of a homogeneous embankment, which is a yellow-filled trapezoidal shape with vertices labeled 1, 2, 3, and 4. The text 'Homogeneous Embankment' is centered within the shape. The 'Analyses...' menu is open, listing various analysis options such as Regions, Points, Materials, Strength Functions, Probability Functions, Hydraulic Functions, Spatial Functions, Slip Surface, Pore Water Pressure, Pore Air Pressure, Point Loads, Surcharge Loads, Reinforcement Loads, and Seismic Load. The 'Solve Manager' window is also visible, showing a table with columns for Analysis Name and Status, and a row for 'Comp...' with a status of 'Results out of date: Fil...'. The top menu bar includes File, Edit, Set, View, KeyIn, Draw, Sketch, Modify, Window, and Help. The toolbar contains various icons for drawing and analysis, and a dropdown menu is set to '(none)'.

PROBLEM 1

Choose the Method of Analyses

The screenshot displays the GeoStudio 2012 (SLOPE/W Define) software interface. The main window is titled "Problem 1.gsz* - GeoStudio 2012 (SLOPE/W Define)". The menu bar includes File, Edit, Set, View, KeyIn, Draw, Sketch, Modify, Window, and Help. The toolbar contains various icons for file operations, analysis, and drawing. The Analysis Explorer on the left shows a tree structure with "Problem 1" and "Problem 1" under it. The KeyIn Analyses dialog box is open, showing the "Analyses:" list with "Problem 1" and "Problem 1" under it. The "Name:" field is set to "Problem 1", and the "Description:" field is empty. The "Analysis Type:" is set to "Bishop". The "Settings" tab is selected, showing "PWP Conditions from:" set to "Piezometric Line" and "Apply Phreatic Correction" checked. The "Staged Rapid Drawdown analysis (using 2 Piezometric Lines)" checkbox is unchecked. The "Solve Manager" at the bottom left shows a table with "Analysis Name" and "Status" columns, with "Problem..." listed as "Not solved". The "Close" button is visible in the bottom right corner of the dialog box.

Problem 1.gsz* - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Define Results

Analysis Explorer

KeyIn Analyses

Analyses:

Add Delete

Problem 1

Problem 1

Name: Problem 1

Description:

Parent: (none)

Analysis Type: Bishop

Settings Slip Surface F of S Distribution Advanced

PWP Conditions from: Piezometric Line

Apply Phreatic Correction

Staged Rapid Drawdown analysis (using 2 Piezometric Lines)

Undo Redo

Close

Solve Manager

Start Stop

Analysis Name Status

Problem... Not solved

PROBLEM 1

Choose the Method of Analyses

Problem 1.gsz* - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Define Results

Analysis Explorer

KeyIn Analyses

Analyses: Add Delete

Problem 1
Problem 1

Name: Problem 1 Description:

Parent: (none)

Analysis Type: Bishop

Settings Slip Surface F of S Distribution Advanced

Direction of movement

☐ Left to right ☒ Right to left ☐ Use passive mode

Slip Surface Option

☐ Entry and Exit
☐ Specify radius tangent lines

☒ Grid and Radius

☐ Block Specified
☐ Do not cross block slip surface lines

☐ Fully Specified

No. of critical slip surfaces to store: 1

☐ Optimize critical slip surface location

Tension Crack Option

☒ No tension crack

☐ Tension crack angle: 0°

☐ Tension crack line

Water in Tension Crack

Filled with water (0 to 1): 0

Unit weight of water: 9.807 kN/m³

Undo Redo Close

Solve Manager

Start Stop

Analysis Name Status

Problem... Not solved



PROBLEM 1

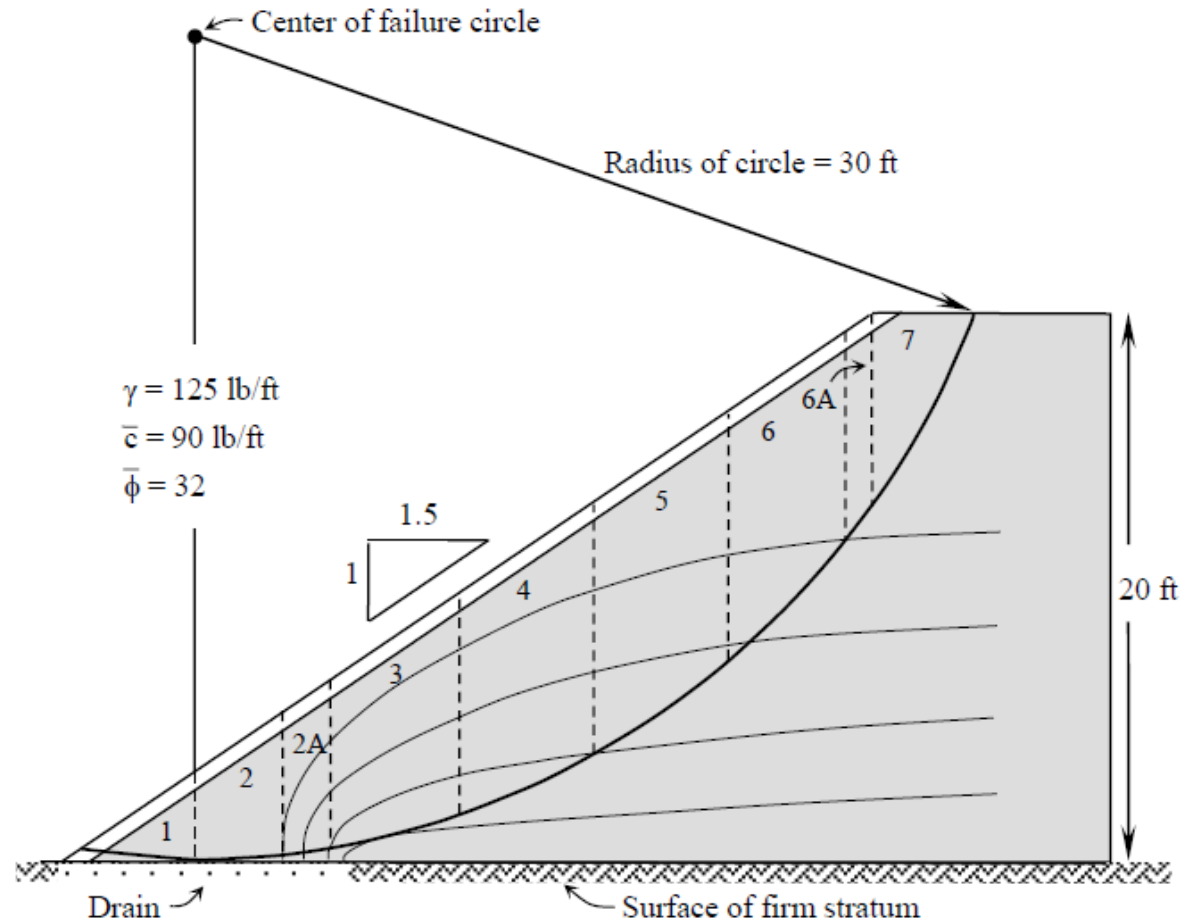
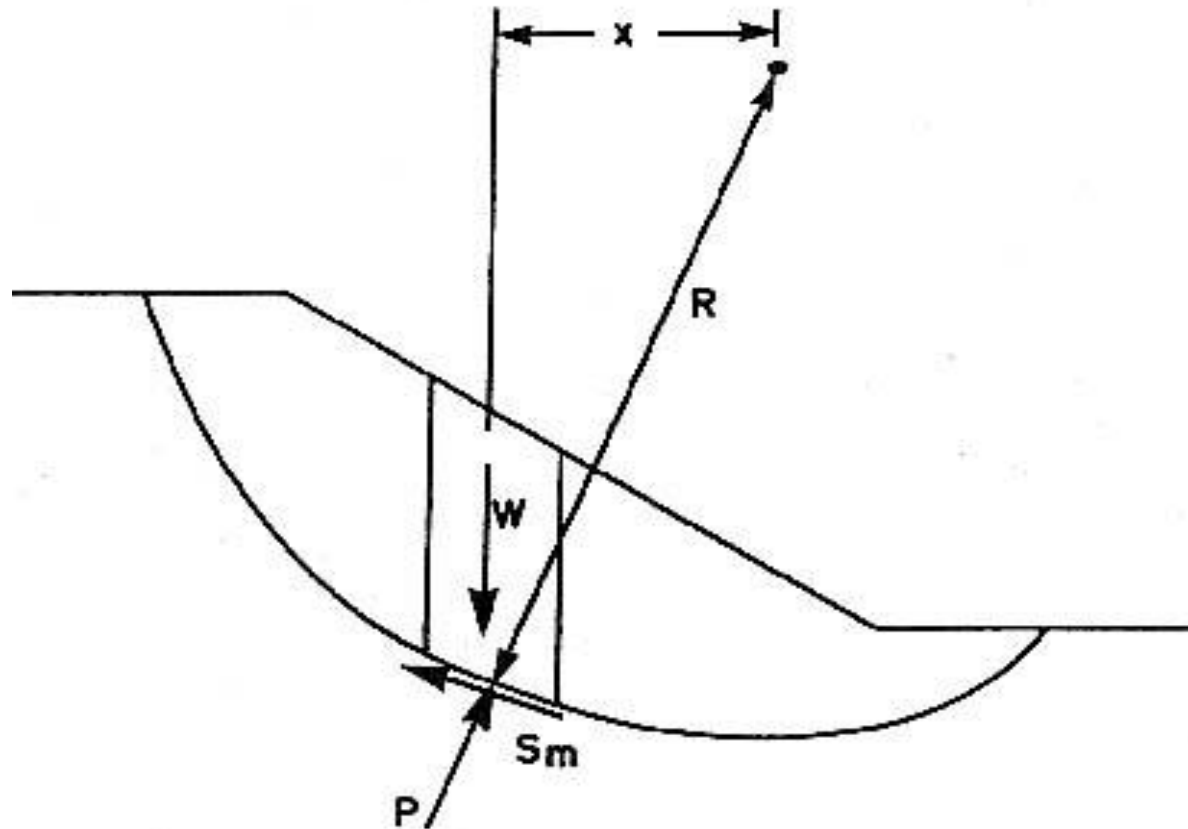


Figure 1 Stability of slope with an underdrain (after Lambe and Whitman)

Direction of movement: right to left

PROBLEM 1



Direction of movement: left to right

PROBLEM 1

Choose the Method of Analyses

Problem 1.gsz* - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Define Results

Analysis Explorer

KeyIn Analyses

Analyses: Add Delete

Problem 1
Problem 1

Name: Problem 1 Description:

Parent: (none)

Analysis Type: Bishop

Settings Slip Surface F of S Distribution Advanced

Factor of Safety (FOS) Distribution Calculation

☒ Constant

☐ Probabilistic

Set Probabilistic Parameters...

of Monte-Carlo Trials: 2,000

☐ Use Spatial Variation

☐ Sample each Slice

☐ Use Sampling Distance:

☐ Sensitivity

Set Sensitivity Parameters...

Undo Redo Close

1 4

PROBLEM 1

Choose the Method of Analyses

Problem 1.gsz* - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Define Results

Analysis Explorer

KeyIn Analyses

Analyses: Add Delete

Problem 1

Problem 1

Name: Problem 1 Description:

Parent: (none)

Analysis Type: Bishop

Settings Slip Surface F of S Distribution Advanced

Convergence Settings:

Number of slices: 30

Factor of safety tolerance: 0.001

Minimum slip surface depth: 0.1 m

Optimization Settings

Maximum number of iterations: 2,000

Convergence tolerance: 1e-007

Number of points on slip surface: Starting: 8 Ending: 16

No. of complete passes per point insertion: 1

Slip surface maximum concave angle:

Driving side: 5° Resisting side: 1°

Undo Redo Close

Solve Manager

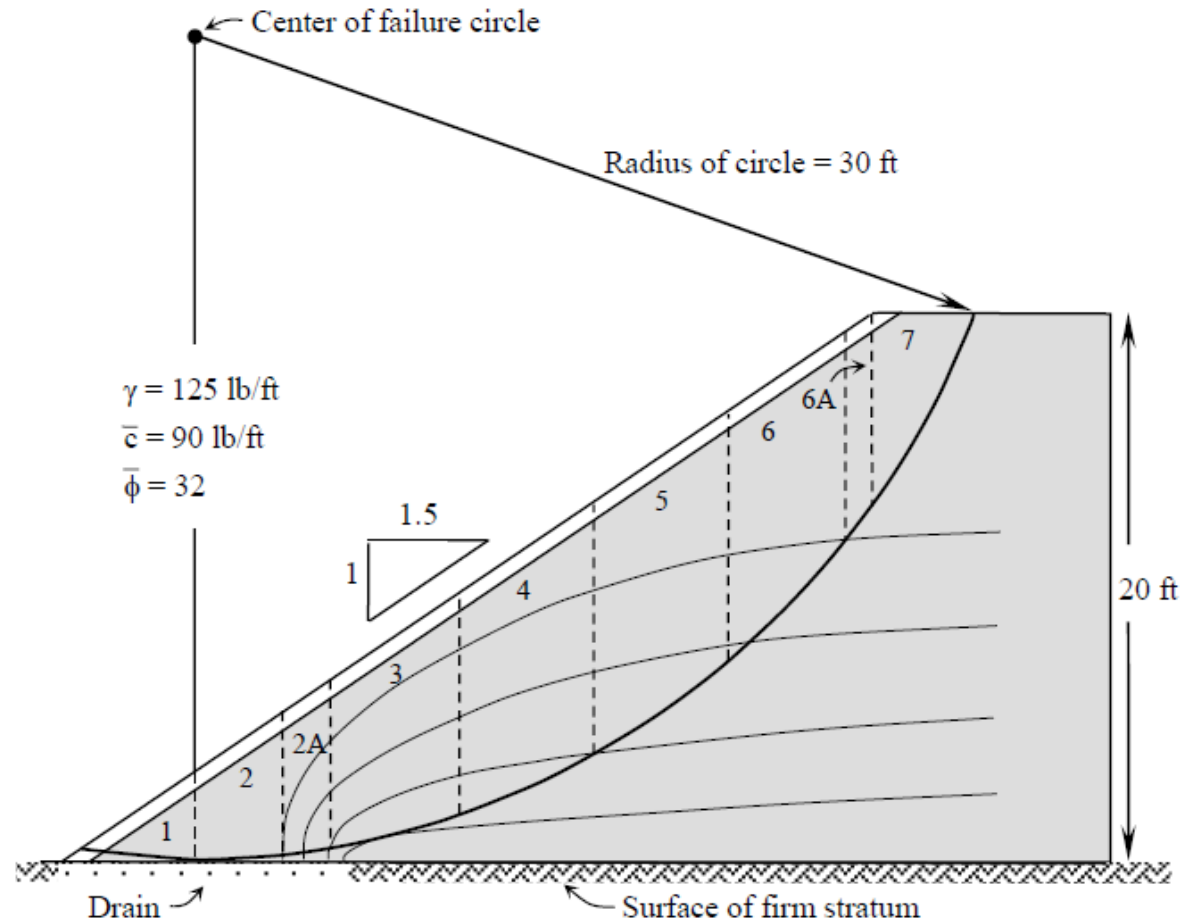
Start Stop

Analysis Name Status

Proble... Not solved

1 4

PROBLEM 1



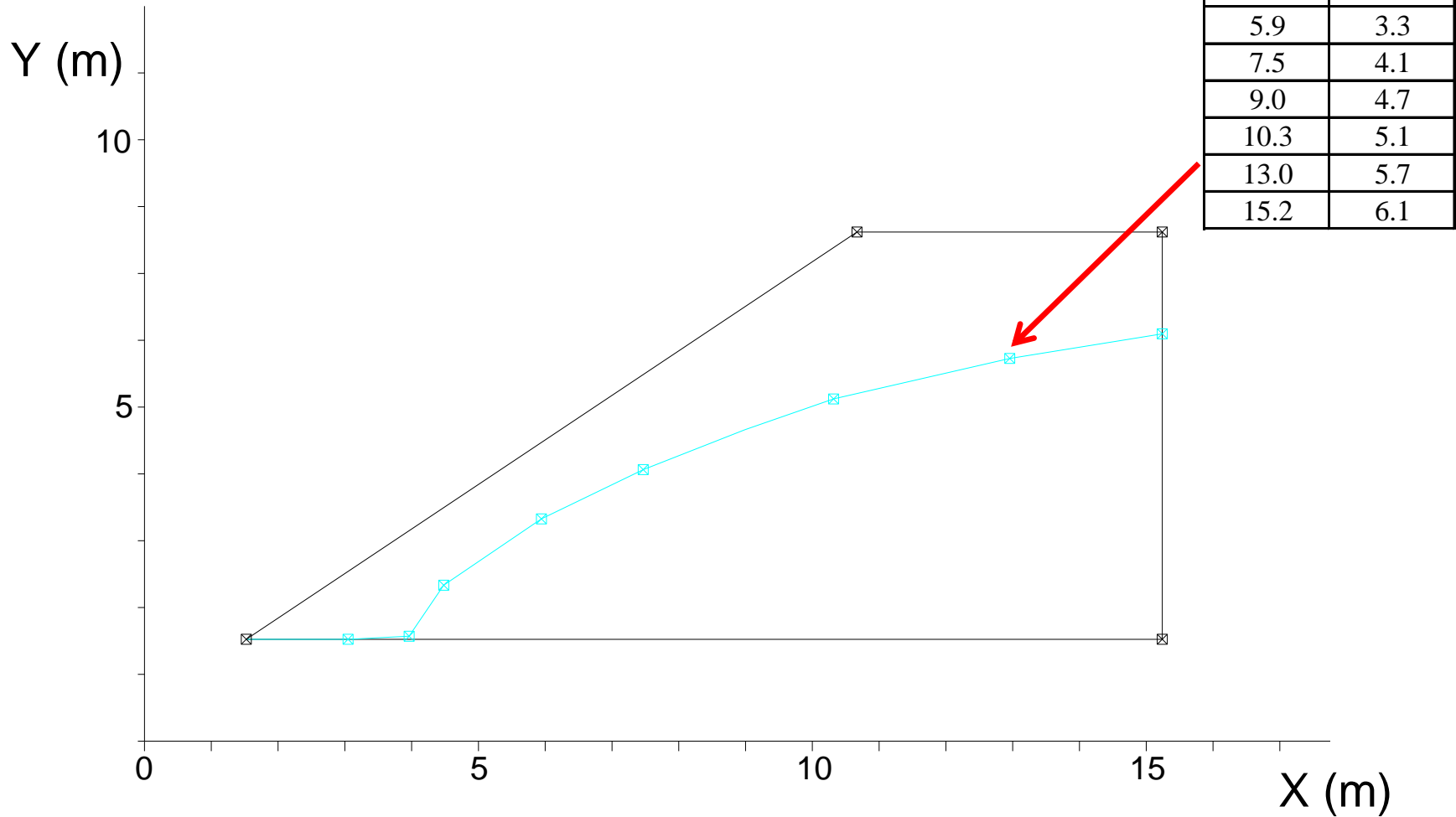
Specifying the number of slices to be greater than the default number of 30 seldom alters the factor of safety significantly. Specifying the number of slices lower than the default value of 30 is not recommended unless you want to investigate a specific issue like, for example, comparing the SLOPE/W results with hand calculations. Making the number of slices too high simply creates an excessive amount of unnecessary data without a significant improvement in safety factor accuracy.

Suggested sequence of analysis using SLOPE/W:

- Geometry: sketch the geometry
- Set page size, unit and scale
- Geometry:
 - Draw points
 - Draw regions
- Material properties:
 - Input material properties data
 - Assign material properties
- Choose the method of analyses
- Draw piezometric lines
- Draw and assign loadings
- Choose the method to draw slip surfaces
- Execute the analysis
- Post processing (output)

PROBLEM 1

Piezometric Line



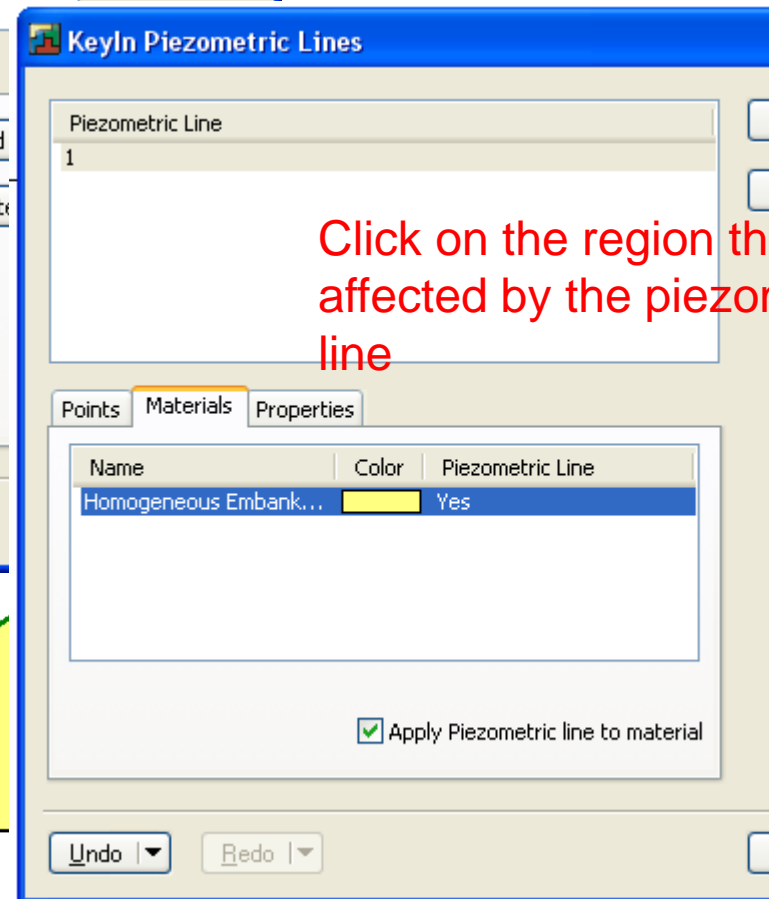
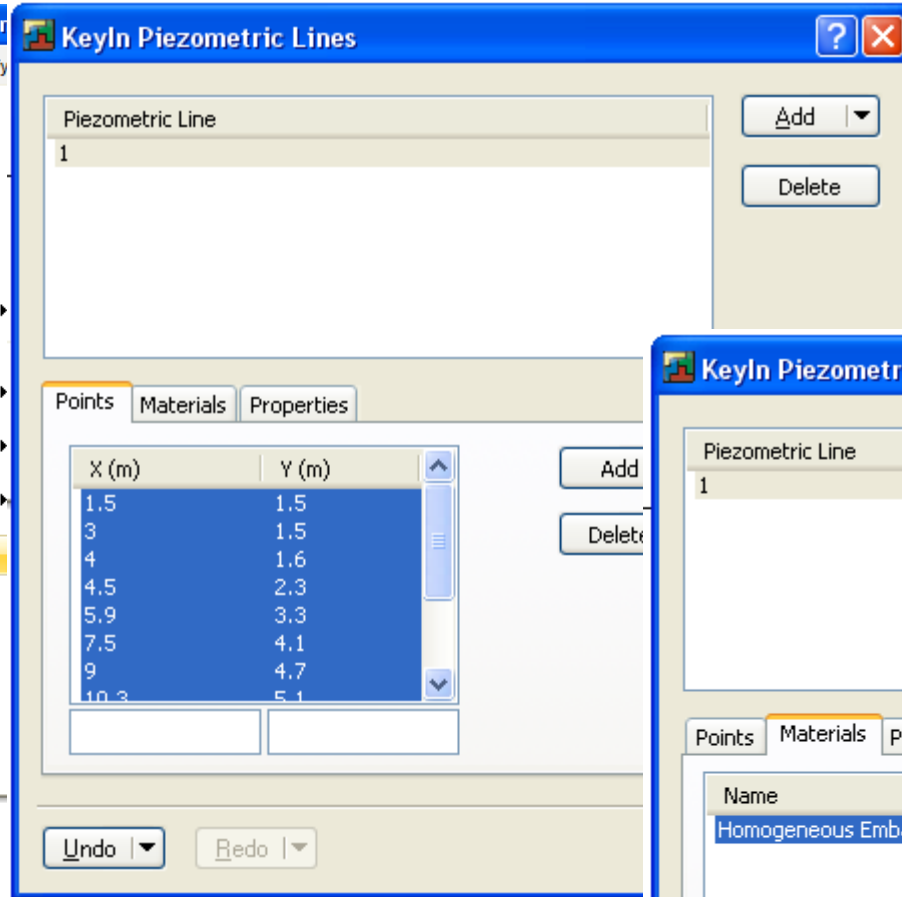
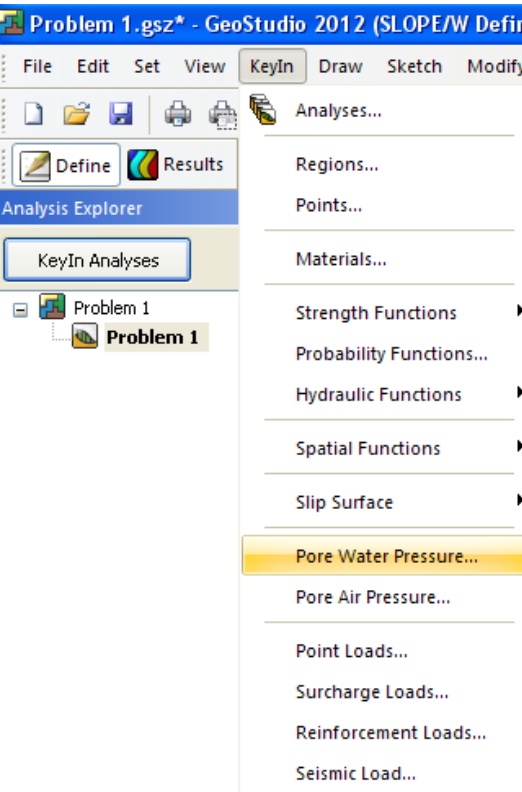
Draw Piezometric lines

(KeyIn – Piezometric Lines)

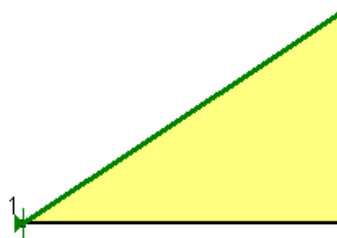
- Input the point coordinate one-by one or
- Paste the coordinate data

PROBLEM 1

Draw Piezometric Line

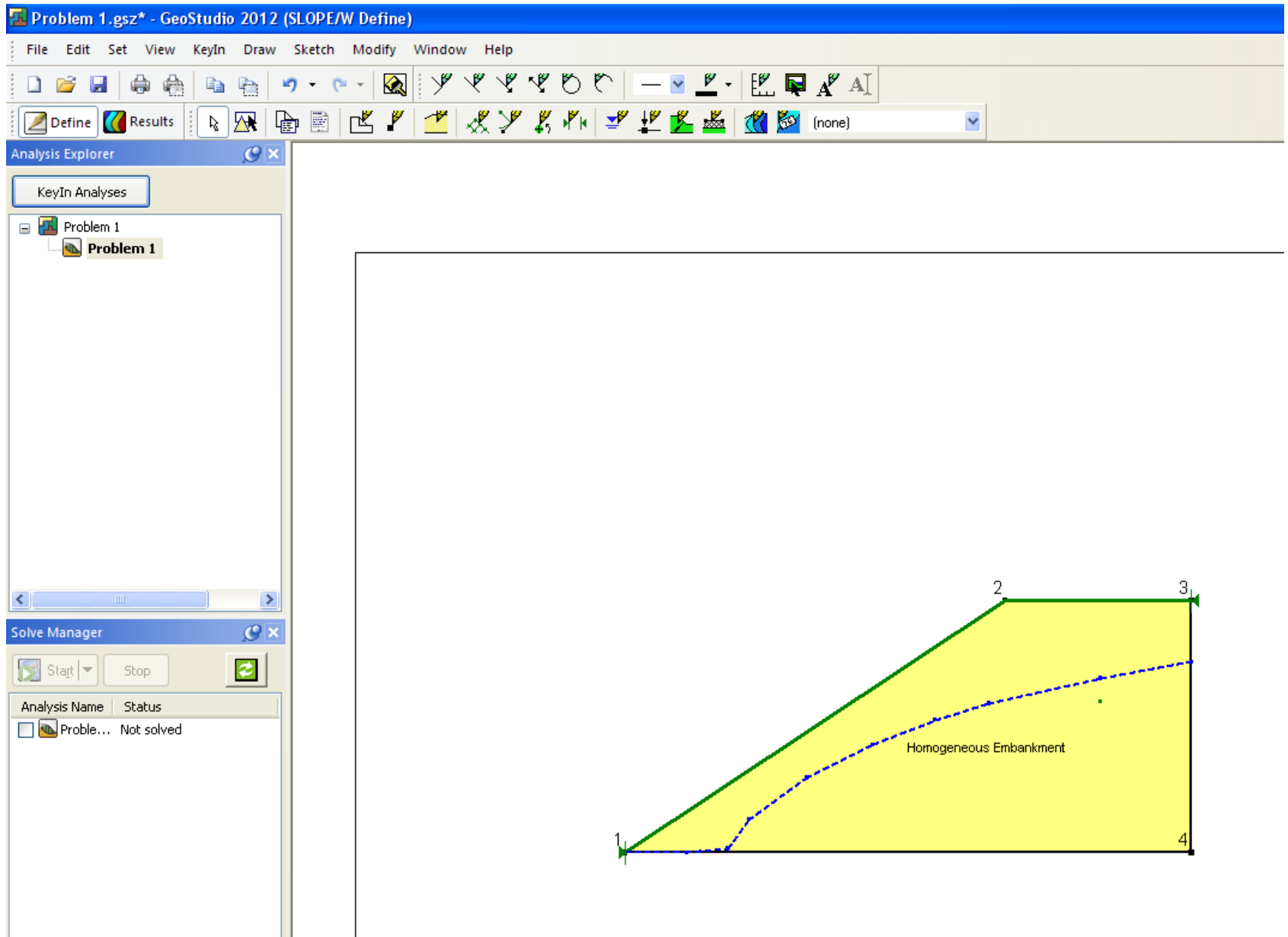


Click on the region that is affected by the piezometric line



PROBLEM 1

Draw Piezometric Line

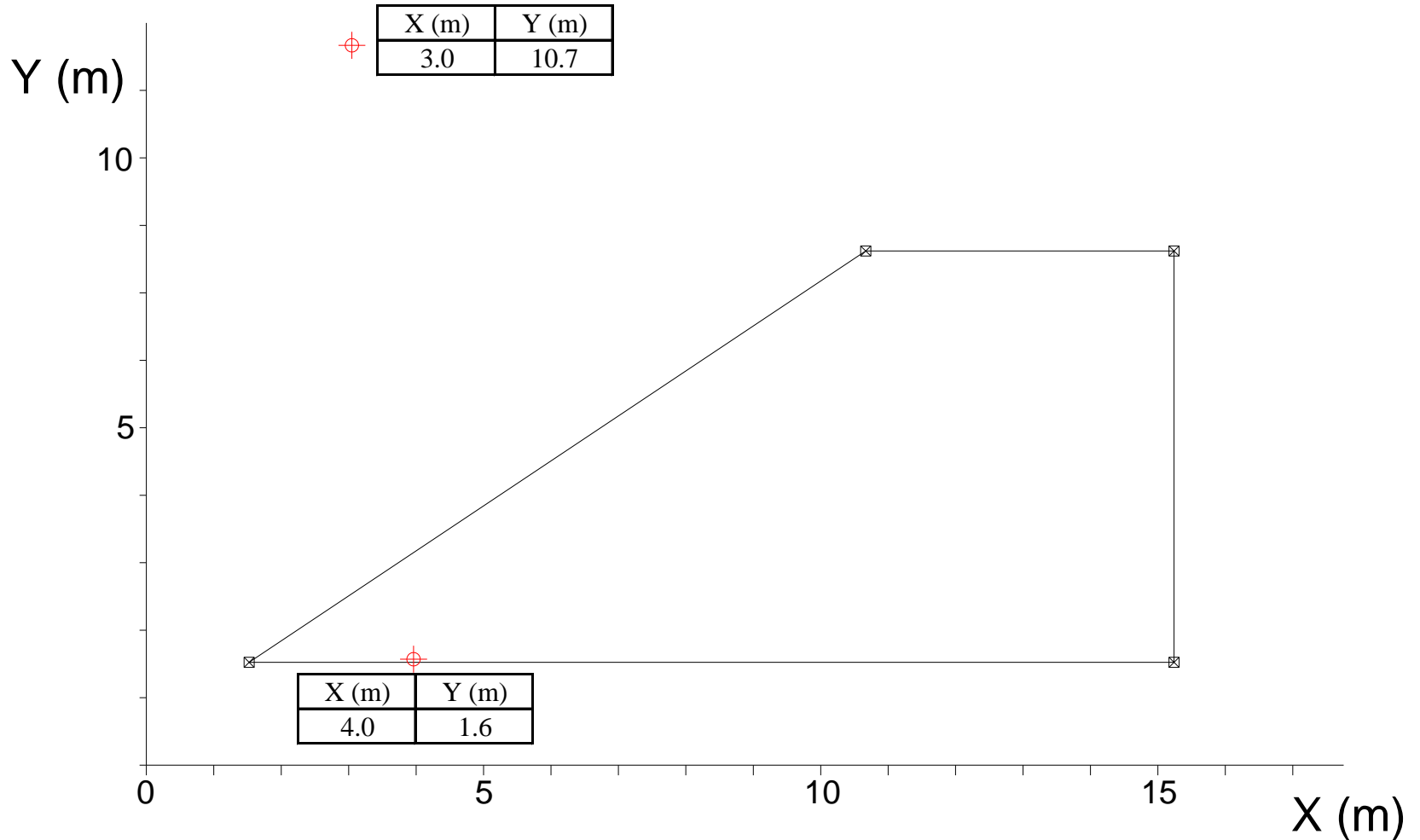


Suggested sequence of analysis using SLOPE/W:

- Geometry: sketch the geometry
- Set page size, unit and scale
- Geometry:
 - Draw points
 - Draw regions
- Material properties:
 - Input material properties data
 - Assign material properties
- Choose the method of analyses
- Draw piezometric lines
- Draw and assign loadings
- Choose the method to draw slip surfaces
- Execute the analysis
- Post processing (output)

PROBLEM 1

Grid and Radius



PROBLEM 1

Choose the method to draw slip surfaces: Grid and Radius

Problem 1.gsz* - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Analyses...

Regions...

Points...

Materials...

Strength Functions

Probability Functions...

Hydraulic Functions

Spatial Functions

Slip Surface

Grid and Radius...

Axis Point...

Limits...

Pore Water Pressure...

Pore Air Pressure...

Analysis Explorer

KeyIn Analyses

Problem 1

Problem 1

Problem 1a

Solve Manager

Start Stop

Analysis Name Status

Problem... Solved 8:17

Problem... Not solved

KeyIn Slip Surface

Grid Corner Points

| | X | Y |
|--------------|---|------|
| Upper Left: | 3 | 10.7 |
| Lower Left: | 3 | 10.7 |
| Lower Right: | 3 | 10.7 |

of Grid Increments

X: 0 Y: 0

Radius Corner Points:

| | X | Y |
|--------------|---|-----|
| Upper Left: | 4 | 1.6 |
| Lower Left: | 4 | 1.6 |
| Upper Right: | 4 | 1.6 |
| Lower Right: | 4 | 1.6 |

of Radius Increments: 0

Projection Angles

☐ Use Left (Passive) Angle of: 135.00

☐ Use Right (Active) Angle of: 45.00

OK Cancel

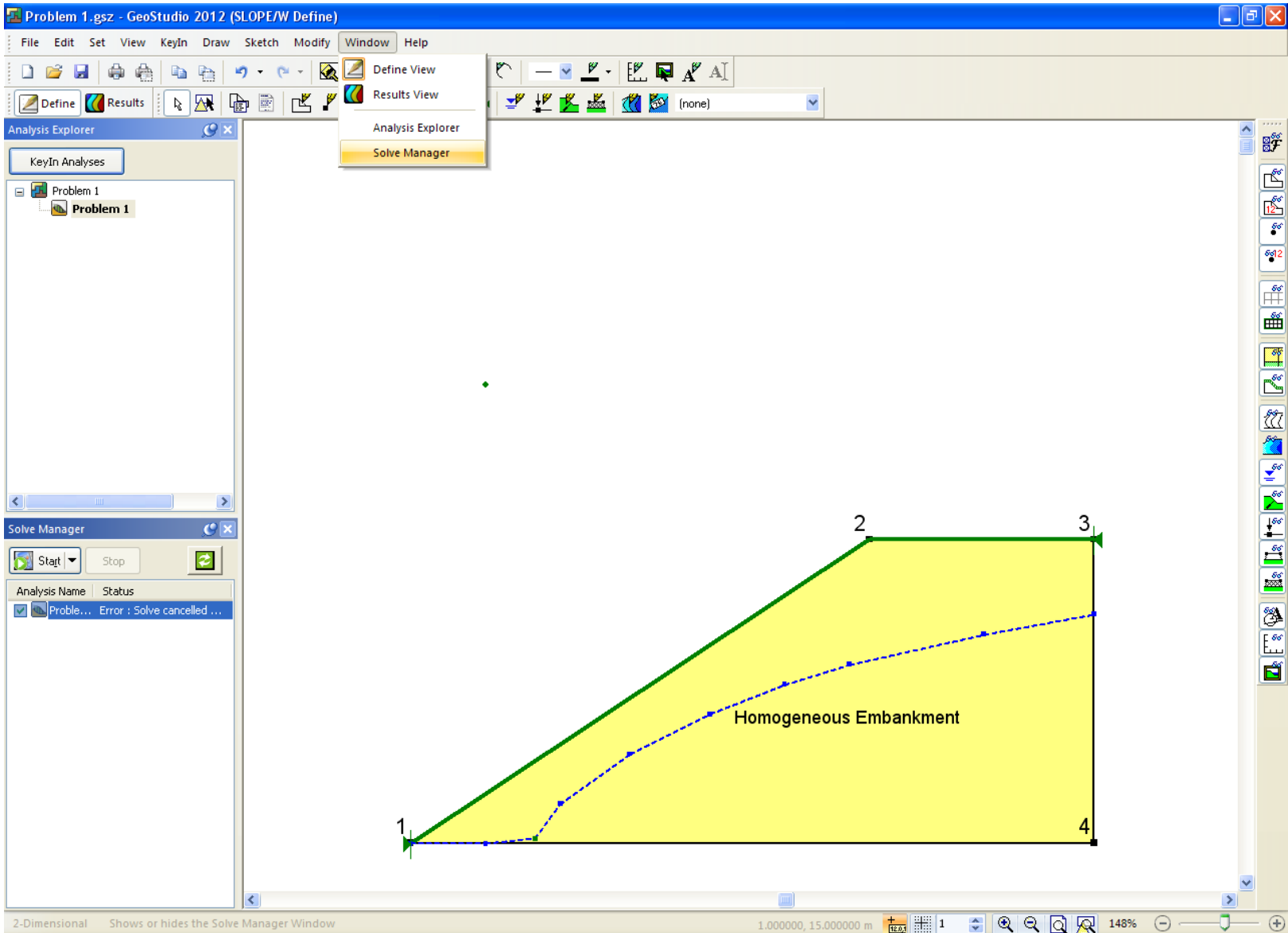
Homogeneous Embankment

Suggested sequence of analysis using SLOPE/W:

- Geometry: sketch the geometry
- Set page size, unit and scale
- Geometry:
 - Draw points
 - Draw regions
- Material properties:
 - Input material properties data
 - Assign material properties
- Choose the method of analyses
- Draw piezometric lines
- Draw and assign loadings
- Choose the method to draw slip surfaces
- Execute the analysis
- Post processing (output)

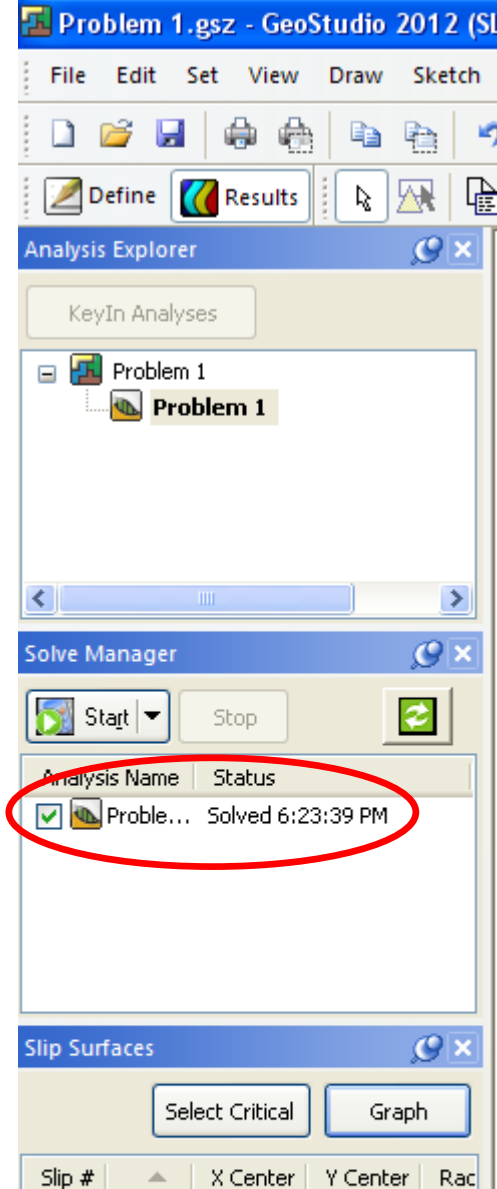
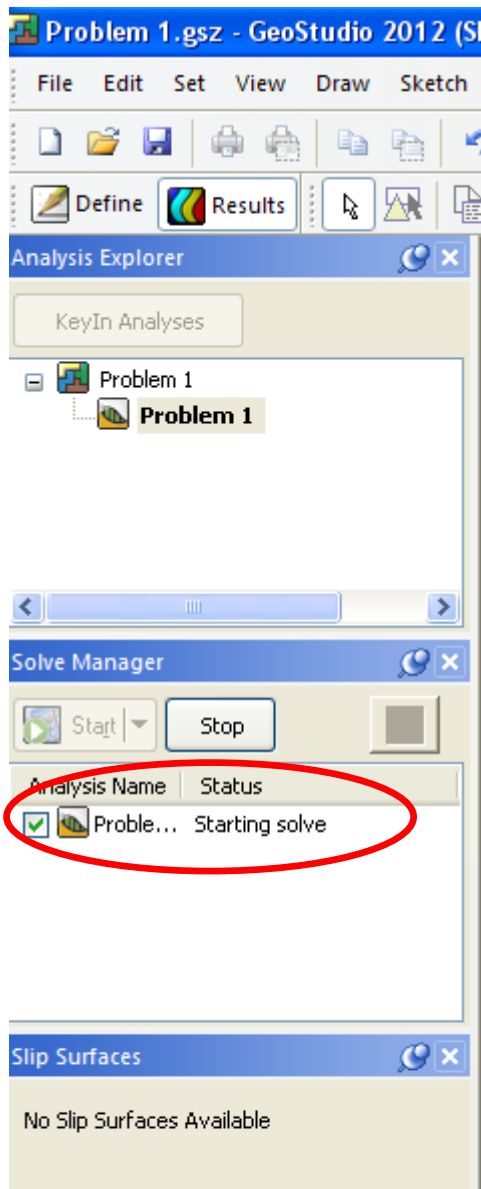
PROBLEM 1

Execute the Analysis



PROBLEM 1

Execute the Analysis

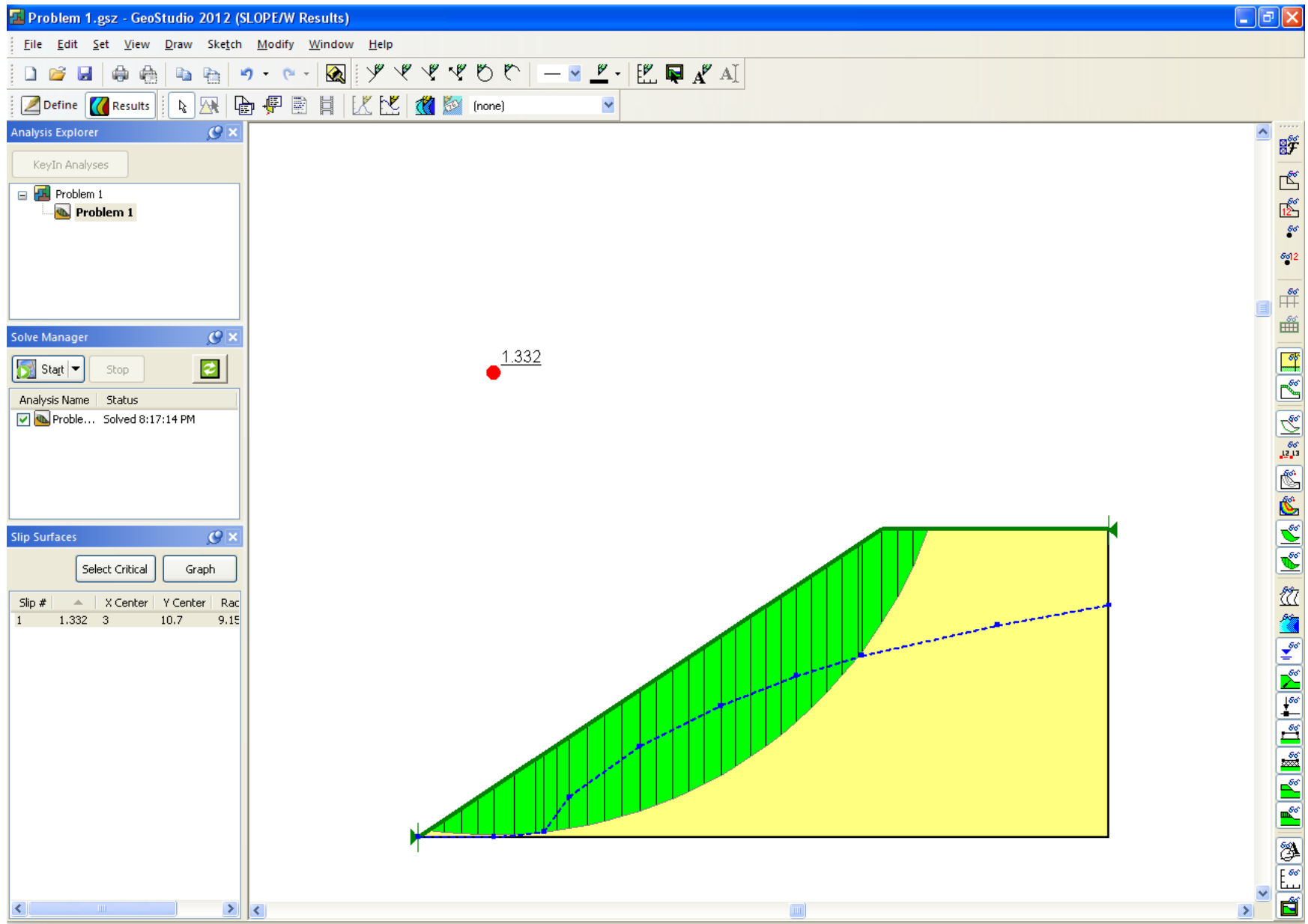


Suggested sequence of analysis using SLOPE/W:

- Geometry: sketch the geometry
- Set page size, unit and scale
- Geometry:
 - Draw points
 - Draw regions
- Material properties:
 - Input material properties data
 - Assign material properties
- Choose the method of analyses
- Draw piezometric lines
- Draw and assign loadings
- Choose the method to draw slip surfaces
- Execute the analysis
- Post processing (output)

PROBLEM 1

Output of FoS



Problem 1 – Comparison with Hand Calculation

Table 3 Lambe and Whitman calculation of the Bishop Simplified factor of safety

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | | (9) | |
|-------|--------------------|-------------------------|---------------------------|---------------------------------|--------------------------|---------------------|-------------|-------------|-------------|-------------|
| Slice | Δx (ft) | $c\Delta x_i$ (kips) | $u_i\Delta x_i$ (kips) | $W_i - u_i\Delta x_i$ (kips) | $(5)\tan \phi$ (kips) | $(3)+(6)$ (kips) | Mi | | (7) + (8) | |
| | | | | | | | F = 1.25 | F = 1.35 | F = 1.25 | F = 1.35 |
| 1 | 4.5 | 0.40 | 0 | 0.9 | 0.55 | 0.95 | 0.97 | 0.97 | 1.0 | 1.0 |
| 2 | 3.2 | 0.29 | 0 | 1.7 | 1.05 | 1.35 | 1.02 | 1.02 | 1.3 | 1.3 |
| 2A | 1.8 | 0.16 | 0.05 | 1.25 | 1.80 | 1.95 | 1.06 | 1.05 | 0.9 | 0.9 |
| 3 | 5.0 | 0.45 | 1.05 | 3.55 | 2.25 | 2.70 | 1.09 | 1.08 | 2.5 | 2.5 |
| 4 | 5.0 | 0.45 | 1.45 | 4.15 | 2.55 | 3.00 | 1.12 | 1.10 | 2.7 | 2.75 |
| 5 | 5.0 | 0.45 | 1.25 | 4.55 | 2.7 | 3.15 | 1.10 | 1.08 | 3.85 | 2.9 |
| 6 | 4.4 | 0.40 | 0.50 | 4.1 | 2.63 | 3.05 | 1.05 | 1.02 | 2.9 | 2.95 |
| 6a | 0.6 | 0.05 | 0 | 0.5 | 2.30 | 0.35 | 0.98 | 0.95 | 0.35 | 0.4 |
| 7 | 3.2 | 0.29 | 0 | 1.5 | 2.95 | 1.25 | 0.93 | 0.92 | 1.3 | 1.35 |
| | | | | | | | | | 15.8 | 16.05 |

For assumed $F = 1.25$

$$F = \frac{15.8}{12.3} = 1.29$$

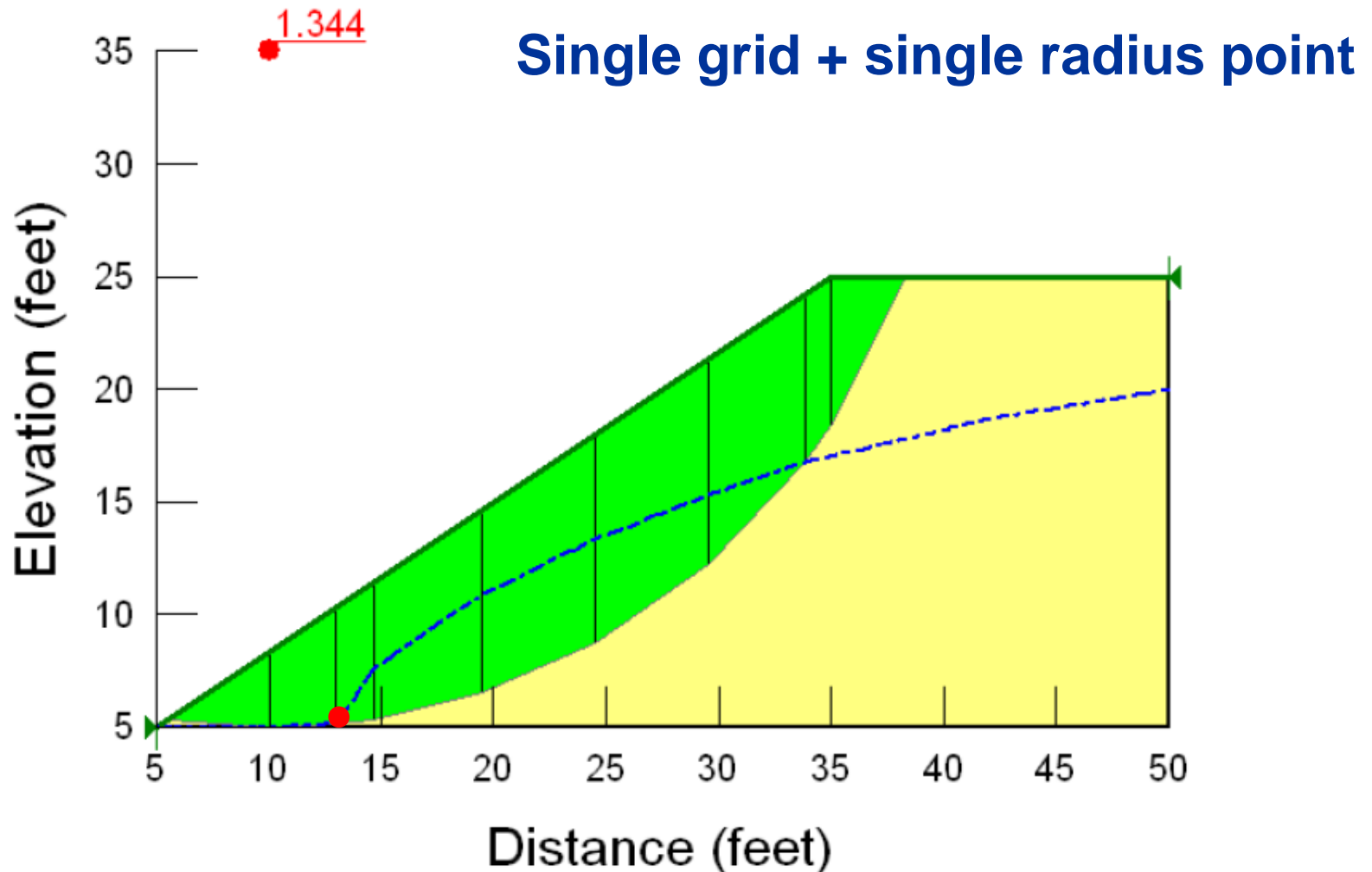
$F = 1.35$

$$F = \frac{16.05}{12.3} = 1.31$$

FoS = 1.25 – 1.35

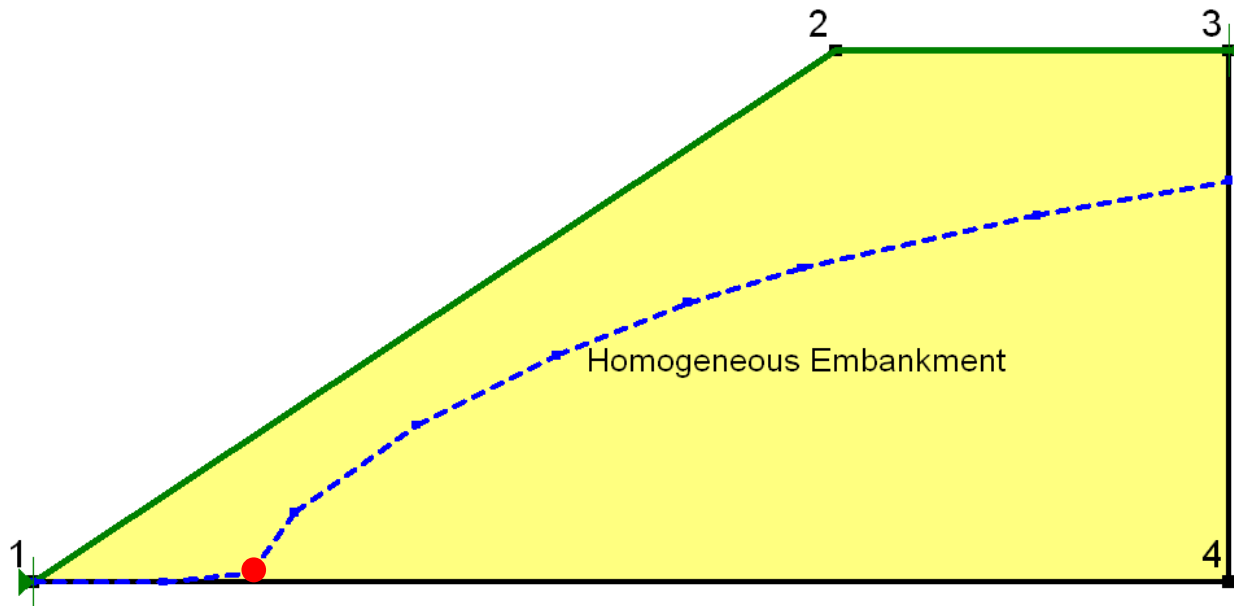
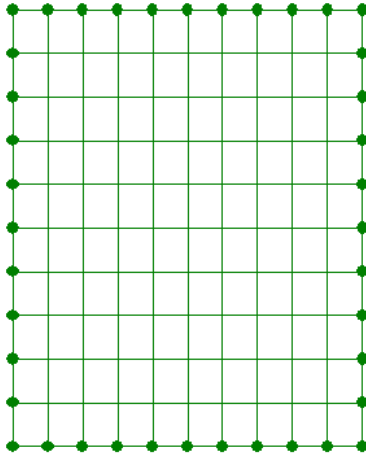
As shown in the above calculations, a trial factor of safety of 1.25 results in a computed factor of safety of 1.29, and a trial factor of safety of 1.35 results in a computed value of 1.31. Since the trial value of 1.25 is too low and the trial value of 1.35 is too high, the correct value using the Bishop Simplified method is between 1.25 and 1.35.

PROBLEM 1



of slices. Specifying the number of slices to be greater than the default number of 30 seldom alters the factor of safety significantly. Specifying the number of slices lower than the default value of 30 is not recommended unless you want to investigate a specific issue like, for example, comparing the SLOPE/W results with hand calculations. Making the number of slices too high simply creates an excessive amount of unnecessary data without a significant improvement in safety factor accuracy. Figure 5-9 shows the

PROBLEM 1a (Grid + Single Point Radius)



PROBLEM 1a Grid + Single Point Radius)

Problem 1.gsz - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Define Results

Analysis Explorer

KeyIn Analyses

Analyses:

- Problem 1
 - Problem
 - Problem 1

Clone

- SLOPE/W Analysis
- SEEP/W Analysis
- SIGMA/W Analysis
- QUAKE/W Analysis
- TEMP/W Analysis
- CTAN/W Analysis
- AIR/W Analysis
- VADOSE/W Analysis

Name: Problem 1 Description:

Parent: (none)

Analysis Type: Bishop

Settings Slip Surface F of S Distribution Advanced

PWP Conditions from: Piezometric Line ☐ Apply Phreatic Correction

☐ Staged Rapid Drawdown analysis (using 2 Piezometric Lines)

Undo Redo Close

Solve Manager

Start Stop

Analysis Name Status

Problem... Solved 8:17:14 PM

Homogeneous Embankment

1 4

PROBLEM 1a (Grid + Single Point Radius)

Problem 1.gsz - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Define Results

Analysis Explorer

KeyIn Analyses

Analyses: Add Delete

Problem 1
Problem 1
Problem 1a

Name: Problem 1a Description:

Parent: (none)

Analysis Type: Bishop

Settings Slip Surface F of S Distribution Advanced

PWP Conditions from: Piezometric Line ☐ Apply Phreatic Correction

☐ Staged Rapid Drawdown analysis (using 2 Piezometric Lines)

Undo Redo Close

Solve Manager

Start Stop

Analysis Name Status

Problem... Solved 8:17:14 PM

Problem... Not solved

Homogeneous Embankment

1 4

PROBLEM 1a (Grid + Single Point Radius)

Problem 1.gsz - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Define Results

Analysis Explorer

KeyIn Analyses

Problem 1

Problem 1

Problem 1a

Problem 1b

Problem 1c

KeyIn Slip Surface

Grid Corner Points

| | X | Y |
|--------------|---|----|
| Upper Left: | 1 | 15 |
| Lower Left: | 1 | 10 |
| Lower Right: | 5 | 10 |

of Grid Increments

X: 10 Y: 10

Radius Corner Points:

| | X | Y |
|--------------|---|-----|
| Upper Left: | 4 | 1.6 |
| Lower Left: | 4 | 1.6 |
| Upper Right: | 4 | 1.6 |
| Lower Right: | 4 | 1.6 |

of Radius Increments: 0

Projection Angles

☐ Use Left (Passive) Angle of: 135.00

☐ Use Right (Active) Angle of: 45.00

OK Cancel

A

B

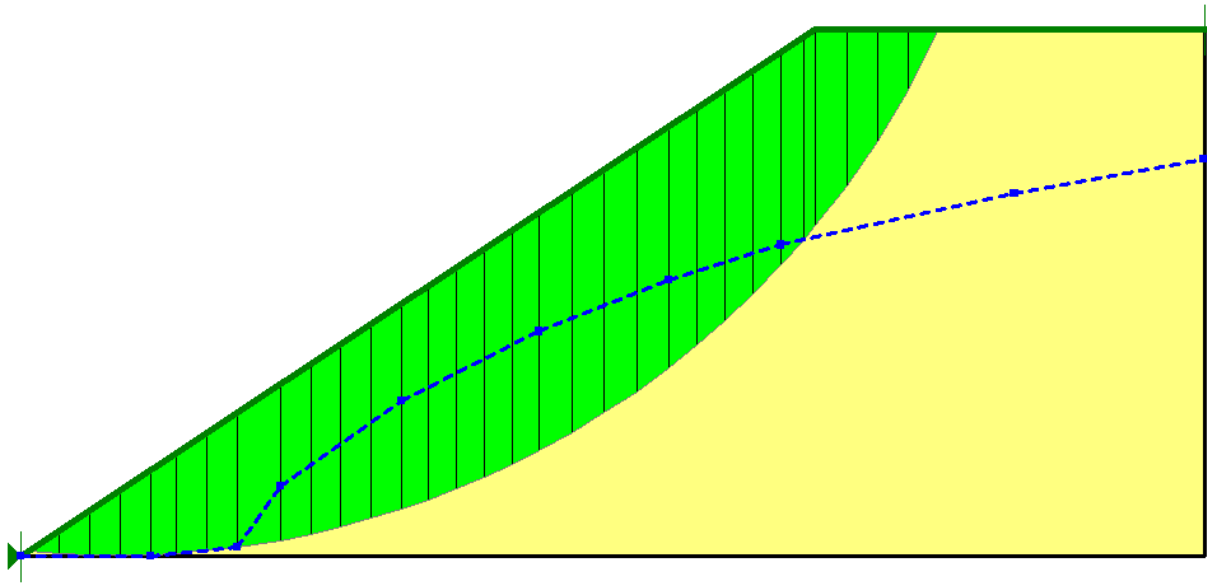
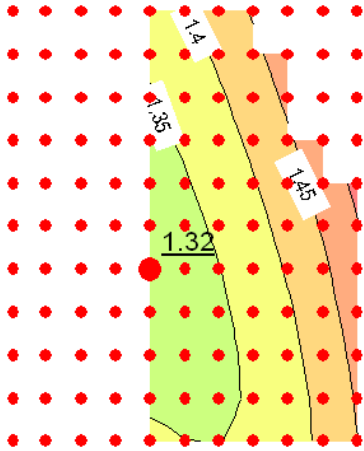
C

- Draw-Slip Surface-Grid (A-B-C)
- Draw-Slip Surface-Radius
- KeyIn Slip Surface

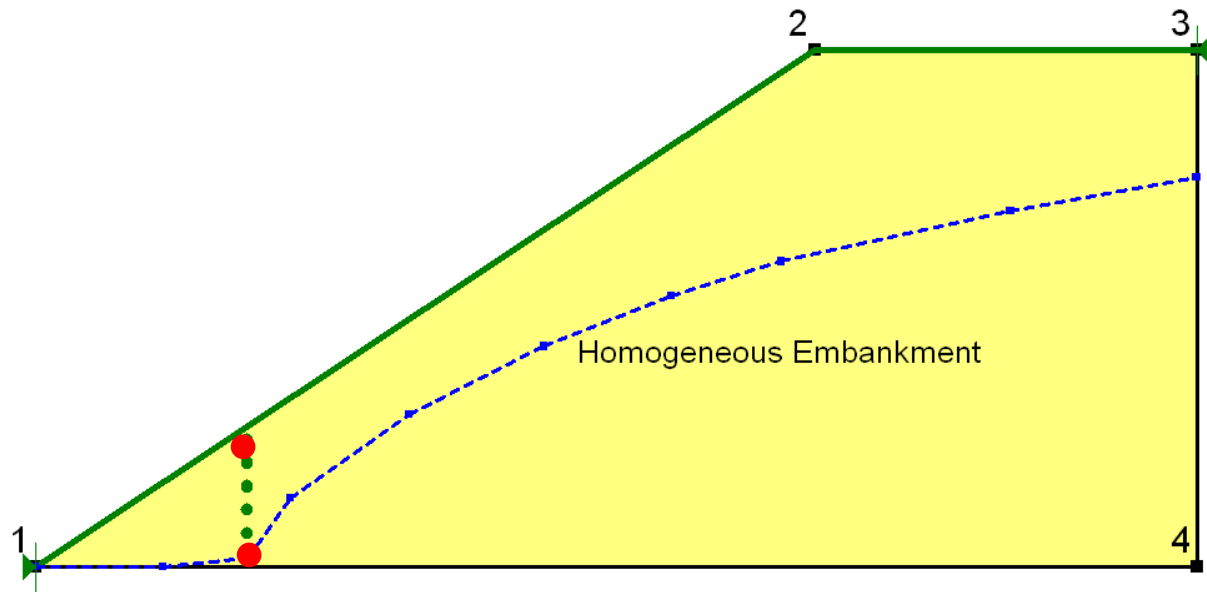
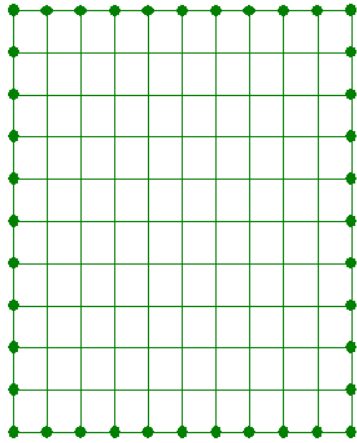
Homogeneous Embankment

1 2 3 4

PROBLEM 1a (Grid + Single Point Radius)



PROBLEM 1b (Grid + Two Points Radius)



PROBLEM 1b (Grid + Two Points Radius)

Problem 1.gsz - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Define Results

Analysis Explorer

KeyIn Analyses

Problem 1

- Problem 1
- Problem 1a
- Problem 1b**
- Problem 1c

Solve Manager

Start Stop

| Analysis Name | Status |
|---------------|------------------------|
| Proble... | Solved 8/26/2013 8:17: |
| Proble... | Solved 5:21:43 PM |
| Proble... | Solved 5:22:07 PM |
| Proble... | Solved 5:04:26 PM |

KeyIn Slip Surface

Grid Corner Points

| | X | Y |
|--------------|---|----|
| Upper Left: | 1 | 15 |
| Lower Left: | 1 | 10 |
| Lower Right: | 5 | 10 |

of Grid Increments

X: 10 Y: 10

Radius Corner Points:

| | X | Y |
|--------------|---|-----|
| Upper Left: | 4 | 3 |
| Lower Left: | 4 | 1.6 |
| Upper Right: | 4 | 3 |
| Lower Right: | 4 | 1.6 |

of Radius Increments: 5

Projection Angles

☐ Use Left (Passive) Angle of: 135.00

☐ Use Right (Active) Angle of: 45.00

OK Cancel

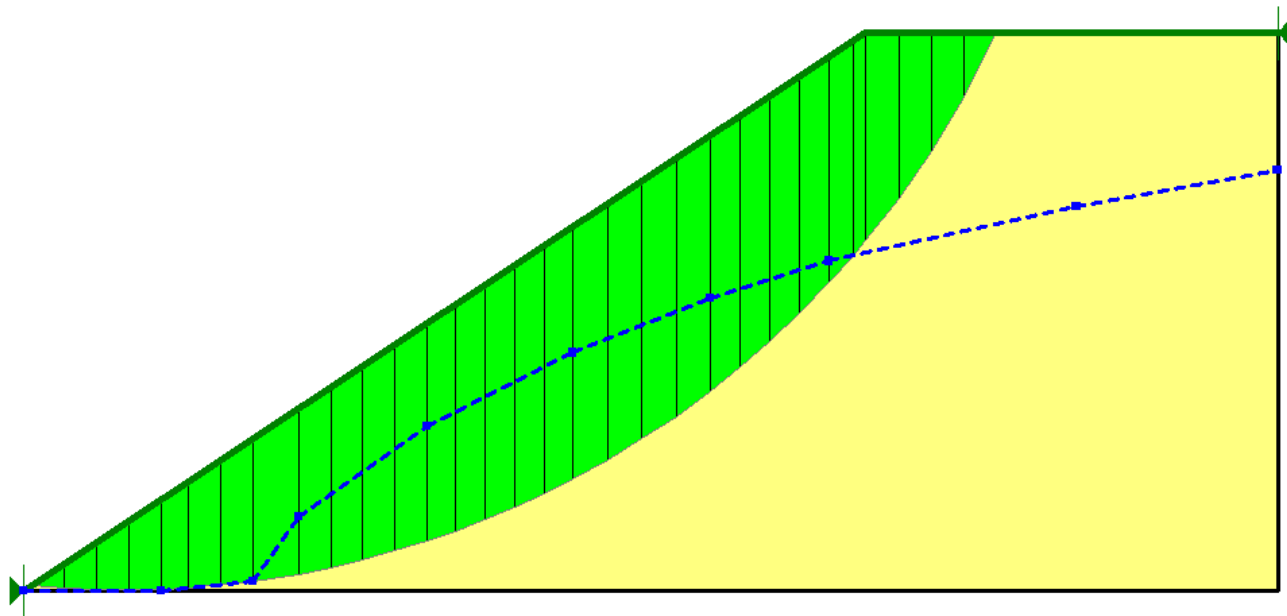
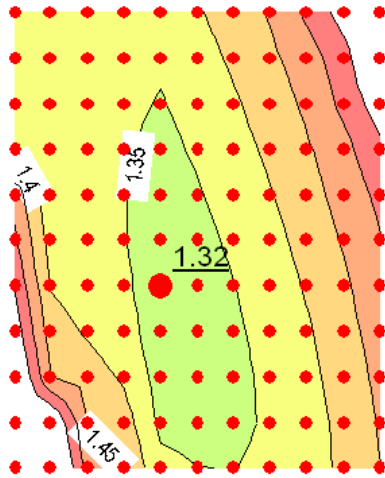
Homogeneous Embankment

2 3 1 4

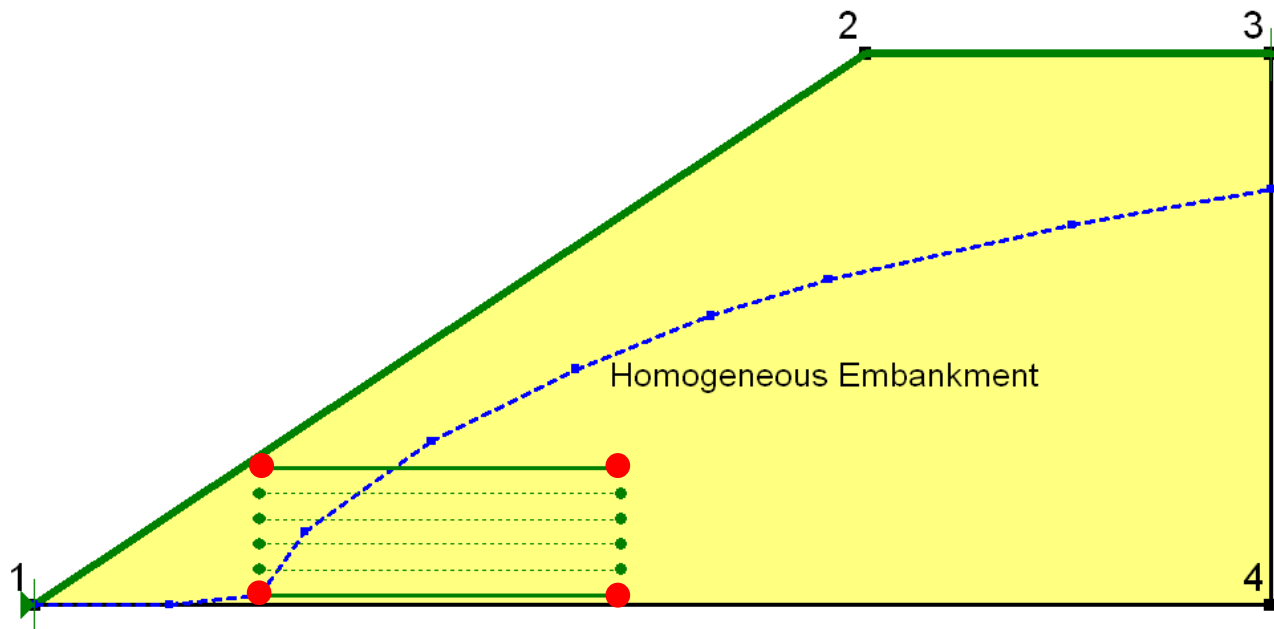
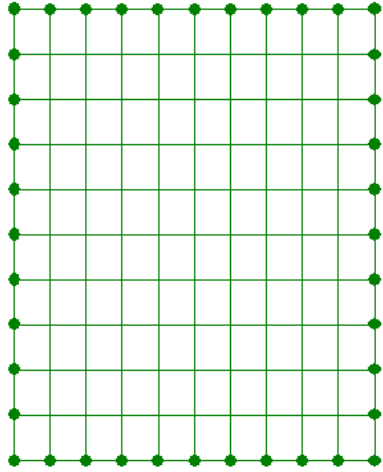
- Draw-Slip Surface-Grid
- Draw-Slip Surface-Radius
- KeyIn Slip Surface

2-Dimensional For Help, press F1 -4.000000, 15.000000 m 1 130%

PROBLEM 1b (Grid + Two Points Radius)



PROBLEM 1c (Grid + Four Point Radius)



PROBLEM 1c (Grid + Four Point Radius)

Problem 1.gsz* - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Define Results

Analysis Explorer

KeyIn Analyses

Problem 1
Problem 1a
Problem 1b
Problem 1c

KeyIn Slip Surface

Grid Corner Points

| | X | Y |
|--------------|---|----|
| Upper Left: | 1 | 15 |
| Lower Left: | 1 | 10 |
| Lower Right: | 5 | 10 |

of Grid Increments

X: 10 Y: 10

Radius Corner Points:

| | X | Y |
|--------------|---|-----|
| Upper Left: | 4 | 3 |
| Lower Left: | 4 | 1.6 |
| Upper Right: | 8 | 3 |
| Lower Right: | 8 | 1.6 |

of Radius Increments: 5

Projection Angles

☐ Use Left (Passive) Angle of: 135.00

☐ Use Right (Active) Angle of: 45.00

OK Cancel

• Draw-Slip Surface-Grid

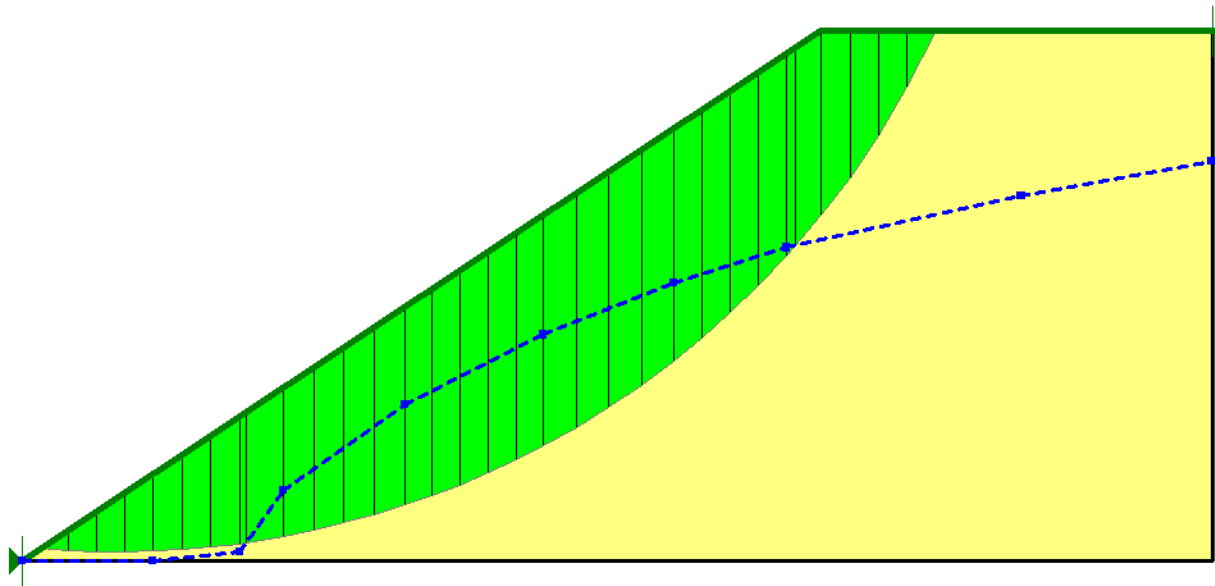
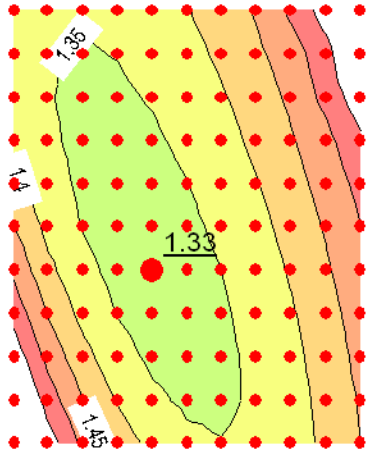
• Draw-Slip Surface-Radius (A-B-C-D)

• KeyIn Slip Surface

Homogeneous Embankment

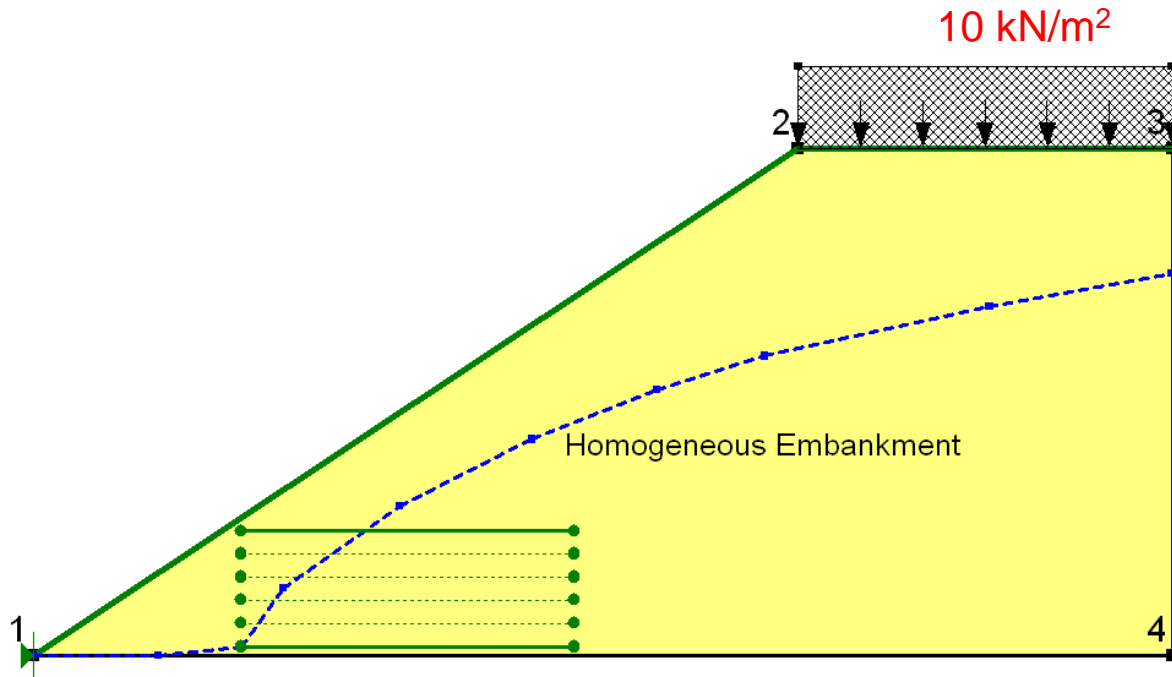
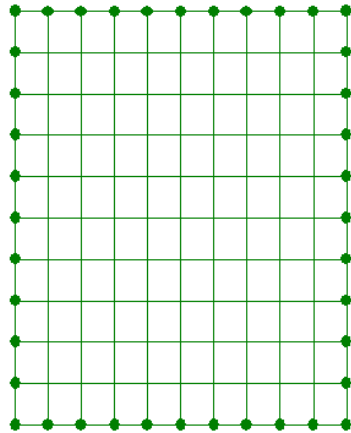
The diagram shows a yellow homogeneous embankment with a green slip surface grid. The grid is defined by corner points (1, 15), (1, 10), and (5, 10). The radius is defined by corner points (4, 3), (4, 1.6), (8, 3), and (8, 1.6). The slip surface is a dashed blue line. The radius is a solid blue line. The embankment is labeled 'Homogeneous Embankment'. The points A, B, C, and D are marked on the slip surface grid. A is at (4, 3), B is at (8, 3), C is at (8, 1.6), and D is at (4, 1.6). The diagram also shows a green grid of 10x10 increments.

PROBLEM 1c (Grid + Four Point Radius)



PROBLEM 1d

(Grid + Four Points Radius + Surcharge Load)



Draw and Assign a Distributed Load

Assign Surcharge Unit Weight

(KeyIn – Surcharge Loads – Points)

- Input only the top points of the surcharge region
- The point coordinate one-by one or paste the coordinate data

Draw and Assign a Distributed Load

Assign Surcharge Unit Weight

(KeyIn – Surcharge Loads – Properties)

- Surcharge unit weight can be vertical or normal to a surface.
- Positif vertical means downward loading.
- Positif normal unit weight mean load towards the surface.

Draw and Assign a Distributed Load

- The actual amount of the distributed load is equal to the height of the surcharge load regions times surcharge unit weight.

Example: $q = 1 \text{ m} \times 10 \text{ kN/m}^3 = 10 \text{ kN/m}^2$

PROBLEM 1d

(Grid + Four Points Radius + Surcharge Load)

Problem 1.gsz - GeoStudio 2012 (SLOPE/W Define)

File Edit Set View KeyIn Draw Sketch Modify Window Help

Analyses...

Define Results

Analysis Explorer

KeyIn Analyses

- Problem 1
 - Problem 1
 - Problem 1a
 - Problem 1b
 - Problem 1c
 - Problem 1d**

Regions...

Points...

Materials...

Strength Functions

Probability Functions...

Hydraulic Functions

Spatial Functions

Slip Surface

Pore Water Pressure...

Pore Air Pressure...

Point Loads...

Surcharge Loads...

Reinforcement Loads...

Seismic Load...

Solve Manager

Start Stop

| Analysis Name | Status |
|-------------------|---------------------------|
| Problem... | Solved 8/26/2013 8:17:... |
| Problem... | Solved 5:21:43 PM |
| Problem... | Solved 5:22:07 PM |
| Problem... | Solved 5:04:26 PM |
| Problem... | Solved 5:59:28 PM |

KeyIn Surcharge Loads

Surcharge Load

| Surcharge Load | Surcharge (Unit Weight) (kN/... |
|----------------|---------------------------------|
| 1 | 10 |

Points

| X (m) | Y (m) |
|-------|-------|
| 10.7 | 8.6 |
| 15.2 | 8.6 |
| --- | --- |

KeyIn Surcharge Loads

Surcharge Load

| Surcharge Load | Surcharge (Unit Weight) (kN/... |
|----------------|---------------------------------|
| 1 | 10 |

Points

Unit Weight: 10 kN/m³

Direction: Vertical

Homogeneous Embankment

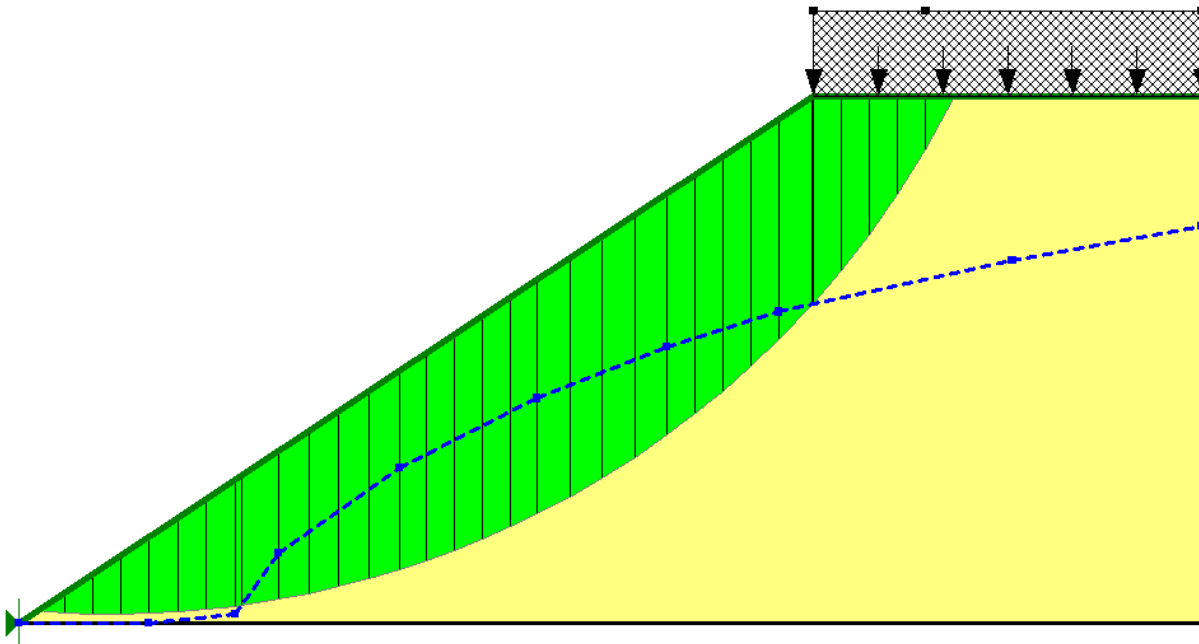
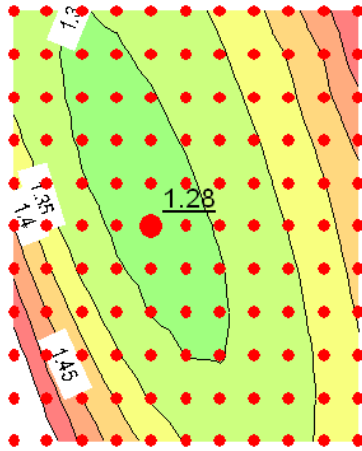
2

4

1 m

PROBLEM 1d

(Grid + Four Points Radius + Surcharge Load)



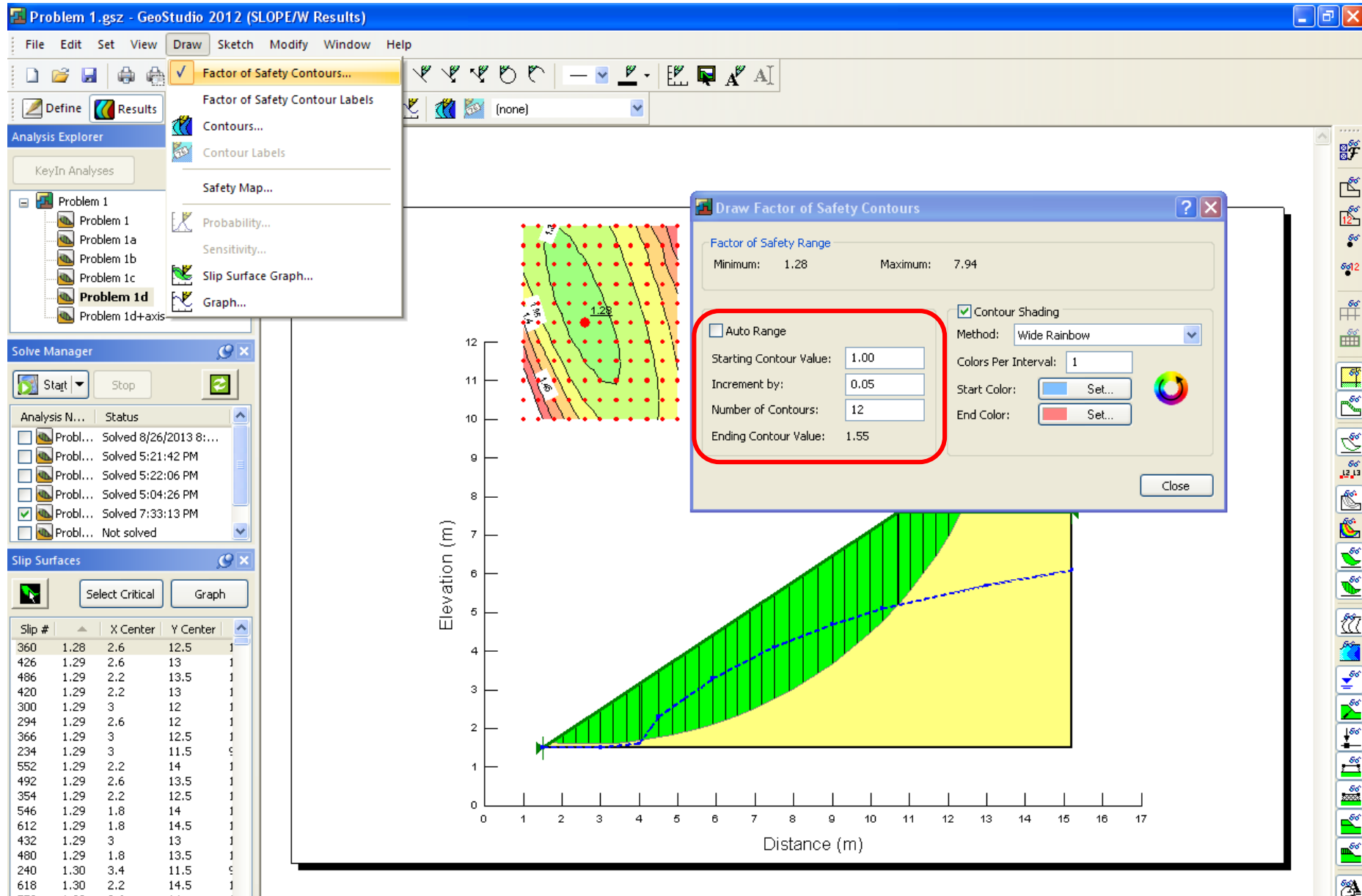


Two components of the Software:

- DEFINE → Input the geometry, material properties, loading, methods of analyses, and **execution**
- RESULTS → post processing (output)

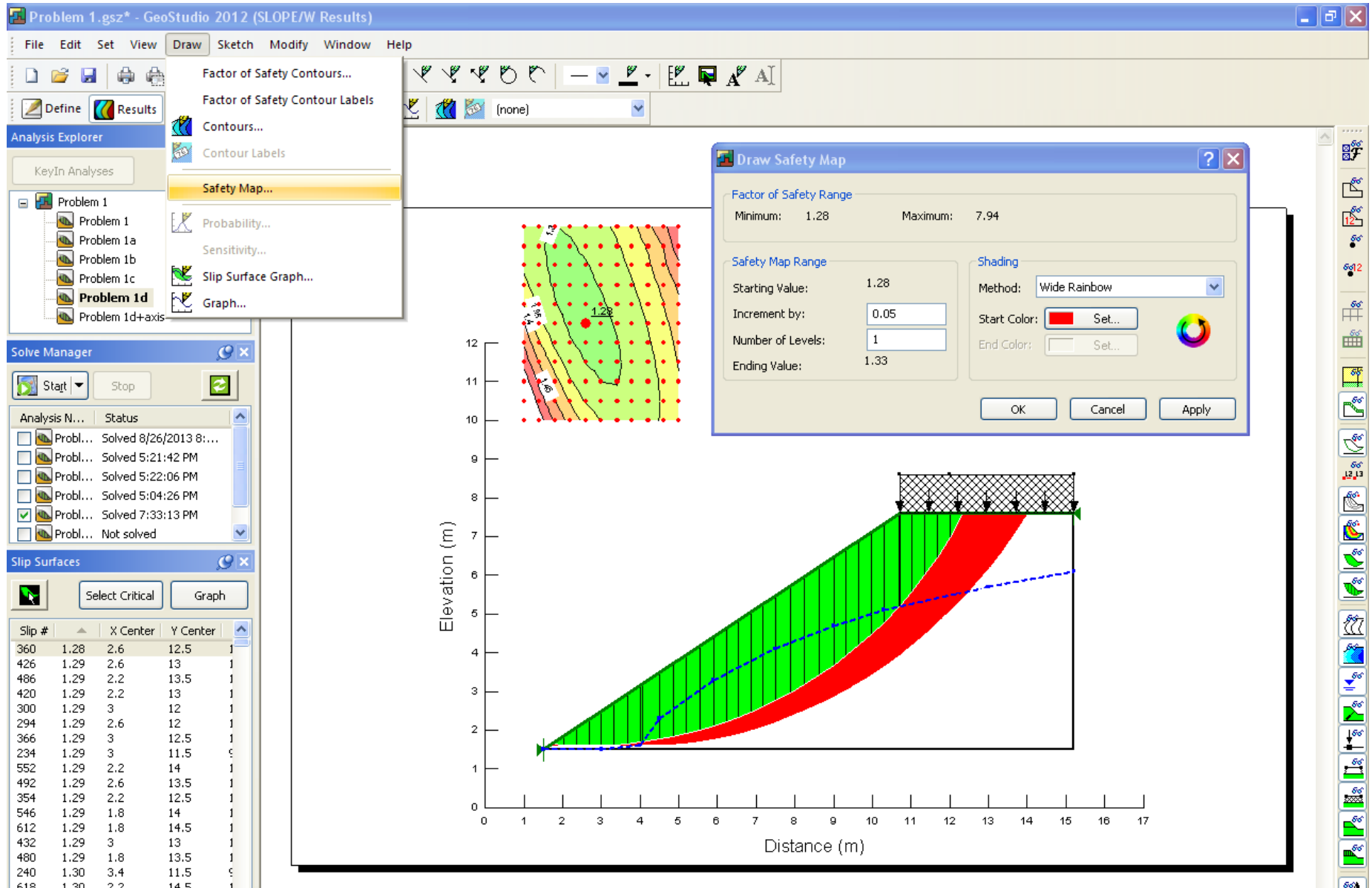
Post Processing (Output)

Draw Contour of FoS



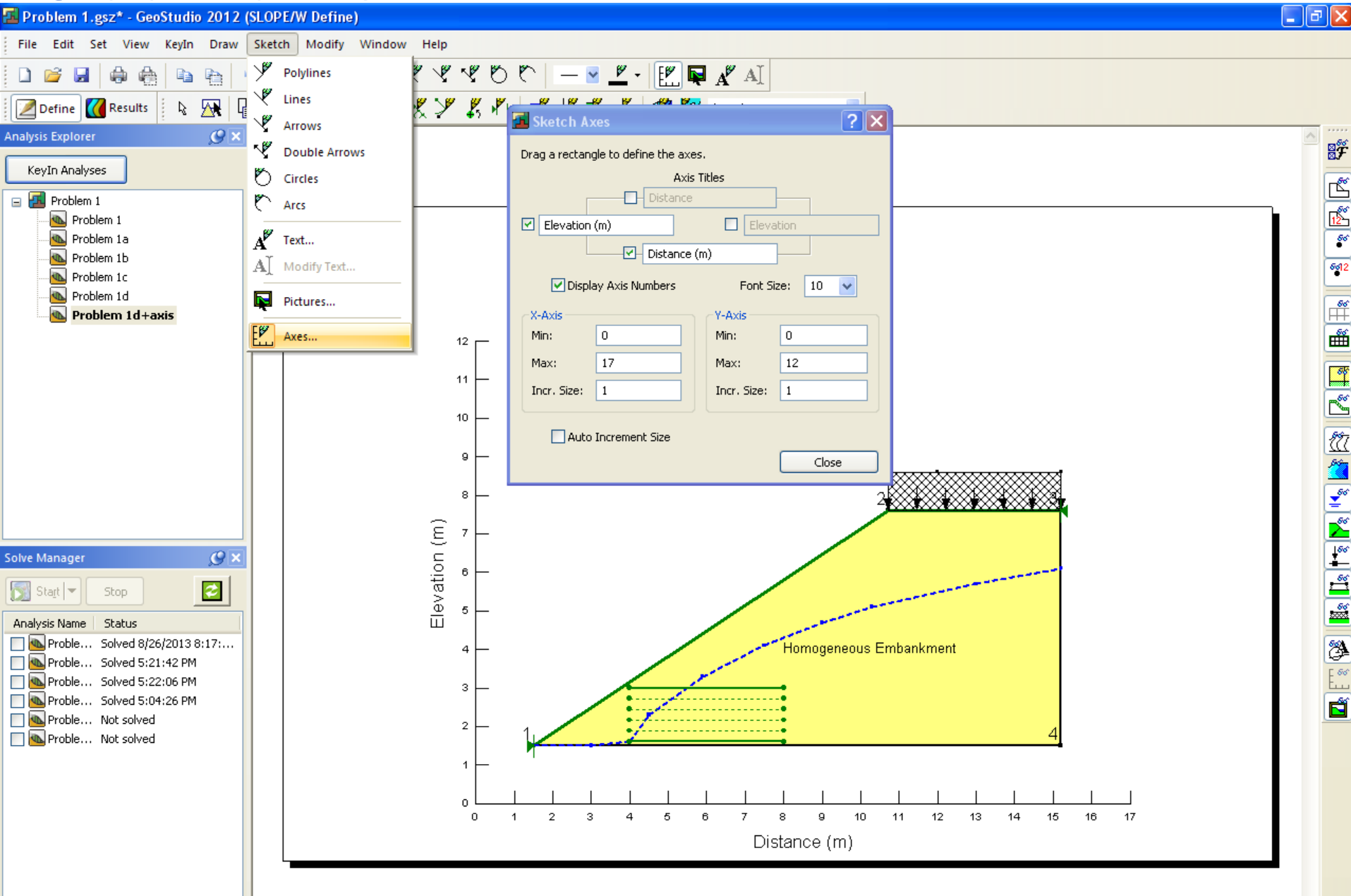
Post Processing (Output)

Draw Safety Map



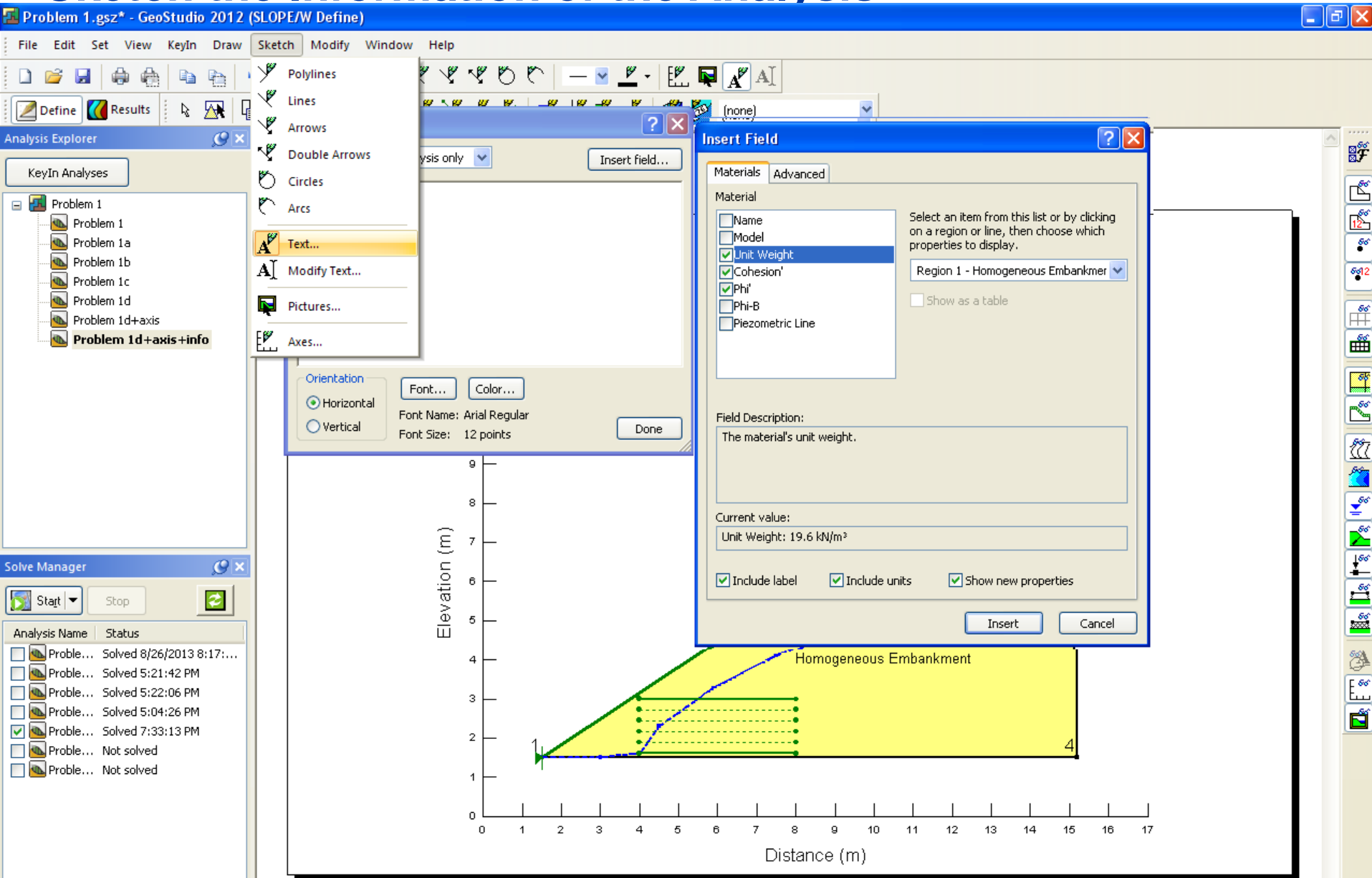
Post Processing (Output)

Sketch the Axis



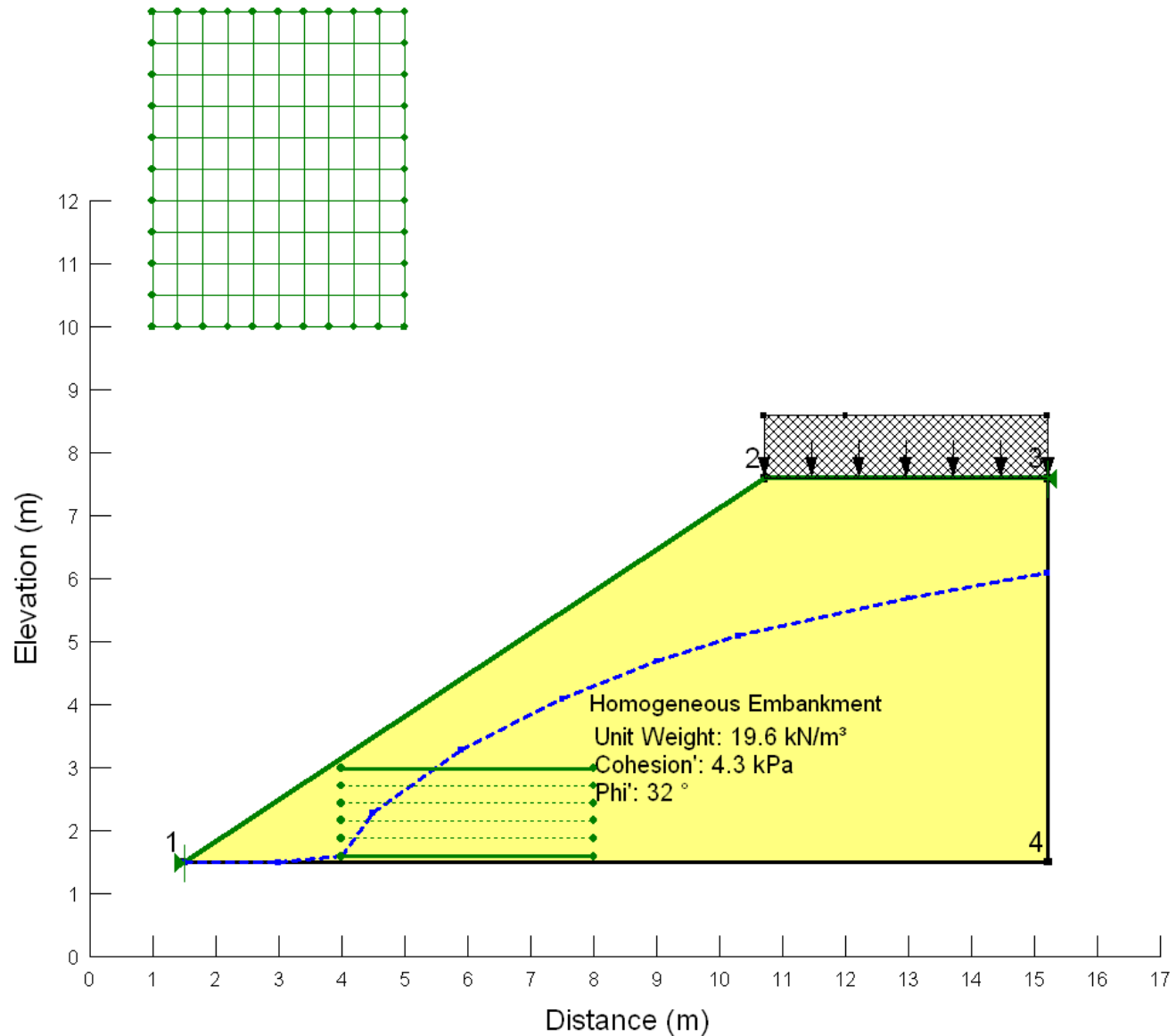
Post Processing (Output)

Sketch the Information of the Analysis

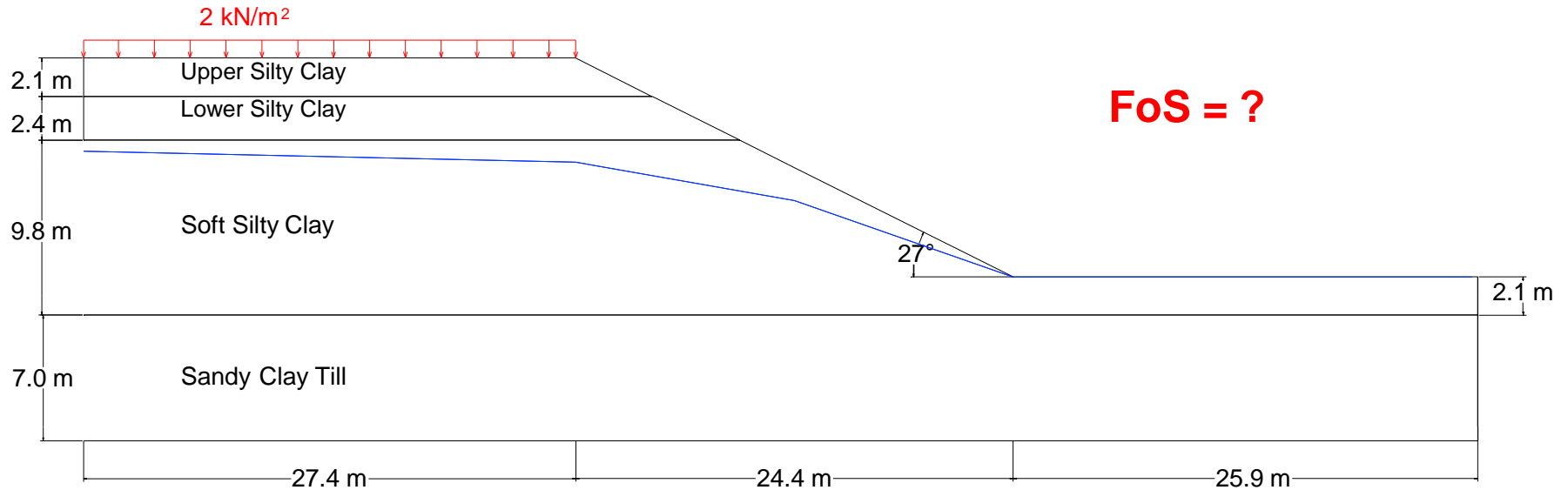


Post Processing (Output)

Sketch the Information of the Analysis



PROBLEM 2



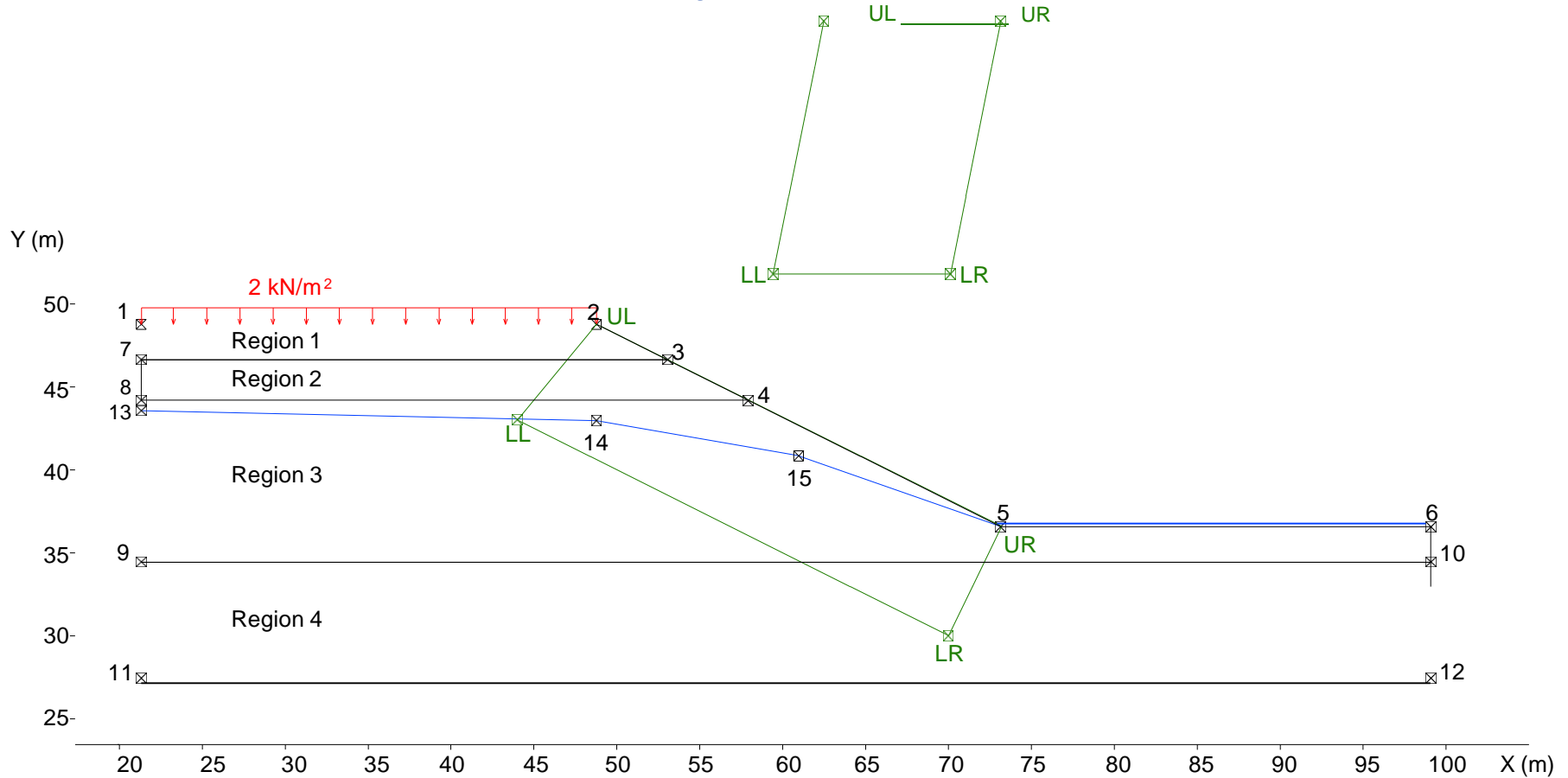
FoS = ?

Soil properties:

| Upper Silty Clay | Lower Silty Clay | Soft Silty Clay | Sandy Clay Till |
|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| $\gamma = 18.1 \text{ kN/m}^3$ | $\gamma = 17.6 \text{ kN/m}^3$ | $\gamma = 17.3 \text{ kN/m}^3$ | $\gamma = 19.3 \text{ kN/m}^3$ |
| $c = 0$ | $c = 28.7 \text{ kPa}$ | $c = 14.4 \text{ kPa}$ | $c = 28.7 \text{ kPa}$ |
| $\phi = 30^\circ$ | $\phi = 21^\circ$ | $\phi = 20^\circ$ | $\phi = 27^\circ$ |

PROBLEM 2

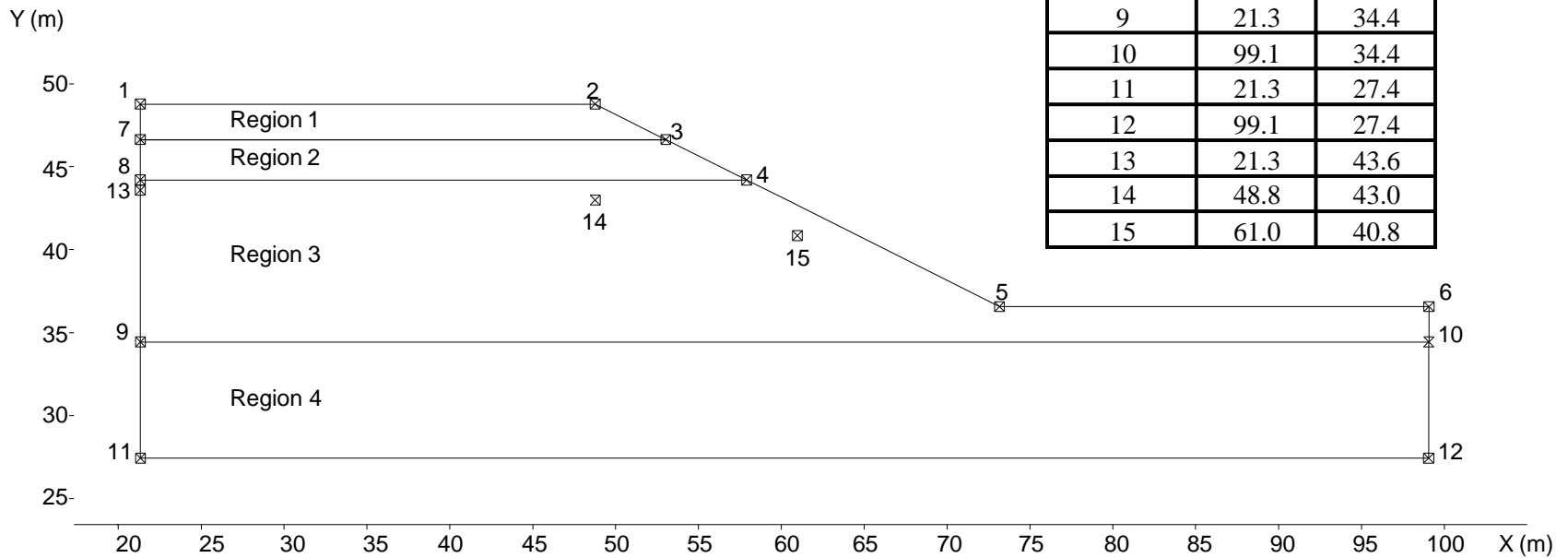
Model for Numerical Analysis



UL = Upper Left LL
= Lower Left
LR = Lower Left
UR = Upper Right

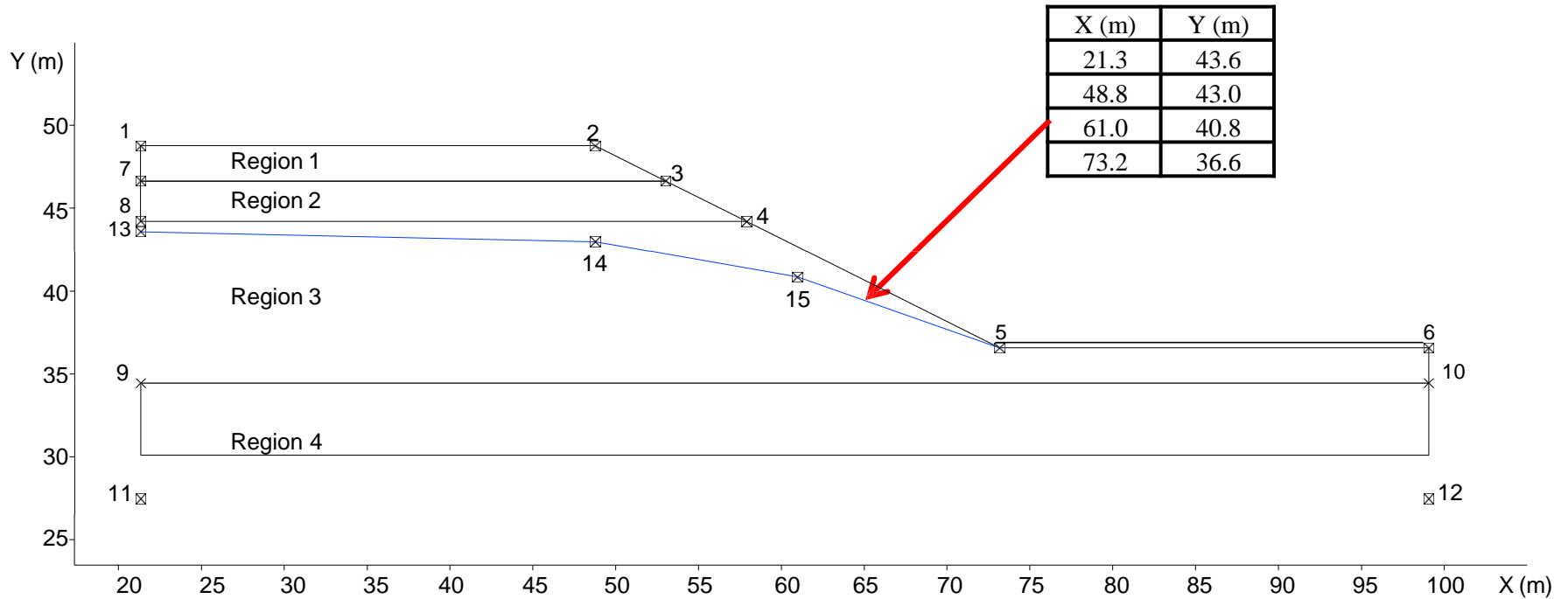
Slope Geometry

| POINT ID | X (m) | Y (m) |
|----------|-------|-------|
| 1 | 21.3 | 48.8 |
| 2 | 48.8 | 48.8 |
| 3 | 53.0 | 46.6 |
| 4 | 57.9 | 44.2 |
| 5 | 73.2 | 36.6 |
| 6 | 99.1 | 36.6 |
| 7 | 21.3 | 46.6 |
| 8 | 21.3 | 44.2 |
| 9 | 21.3 | 34.4 |
| 10 | 99.1 | 34.4 |
| 11 | 21.3 | 27.4 |
| 12 | 99.1 | 27.4 |
| 13 | 21.3 | 43.6 |
| 14 | 48.8 | 43.0 |
| 15 | 61.0 | 40.8 |



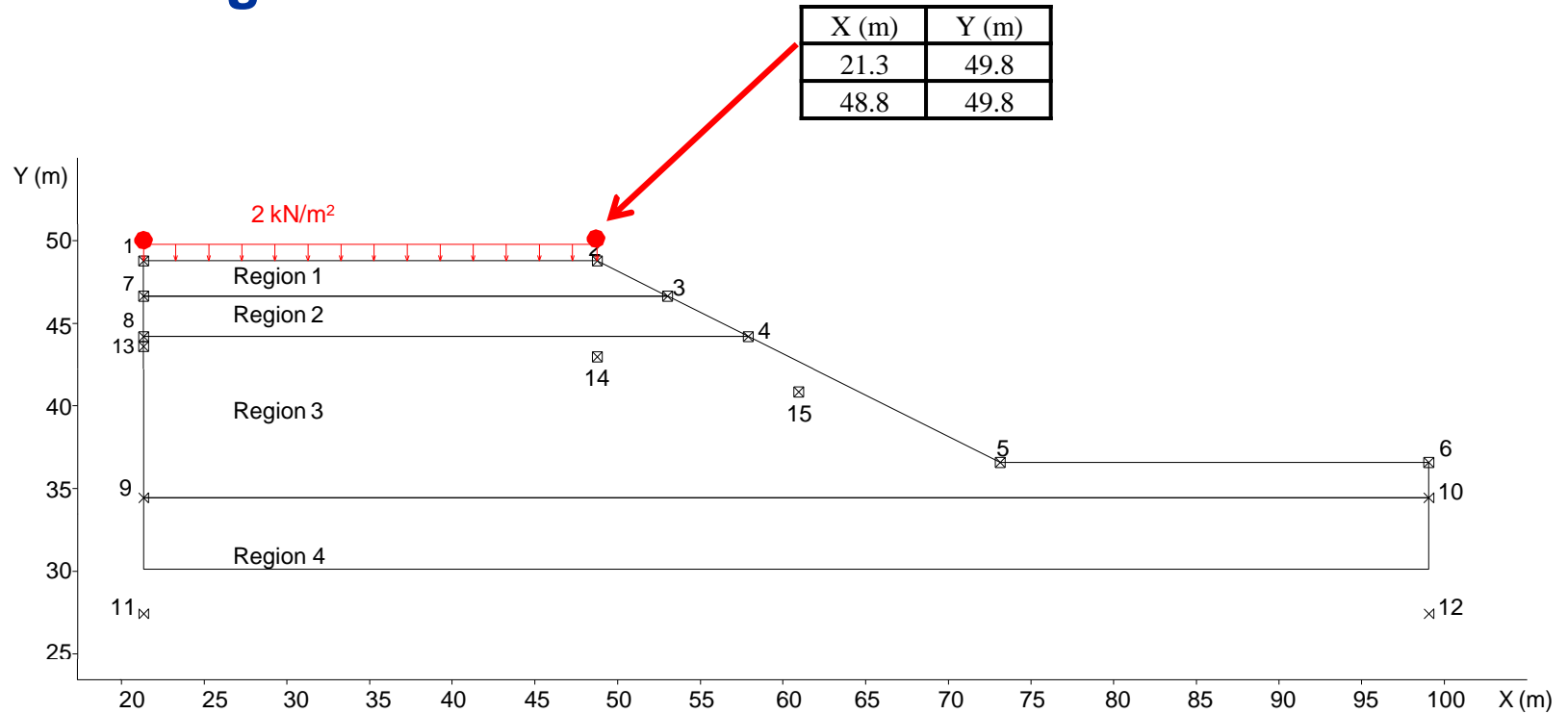
PROBLEM 2

Piezometric Line



PROBLEM 2

Surcharge Load

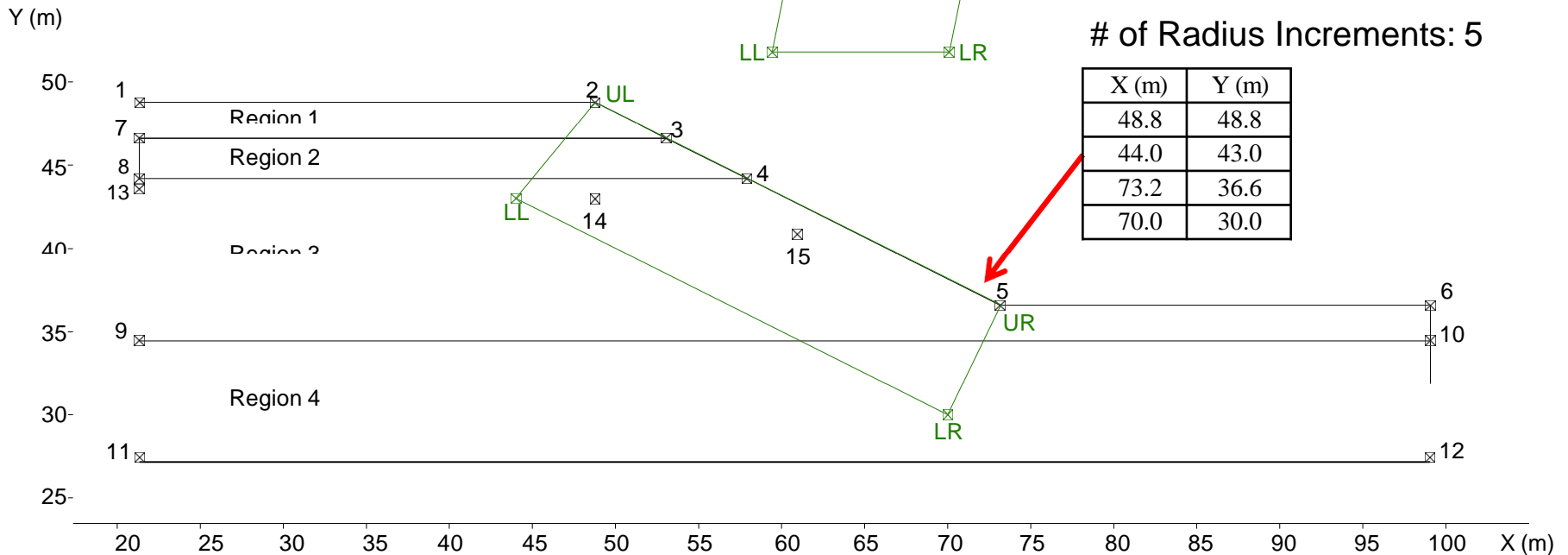


PROBLEM 2

Grid and Radius

of Grid Increments:
10 increments in X and Y directions

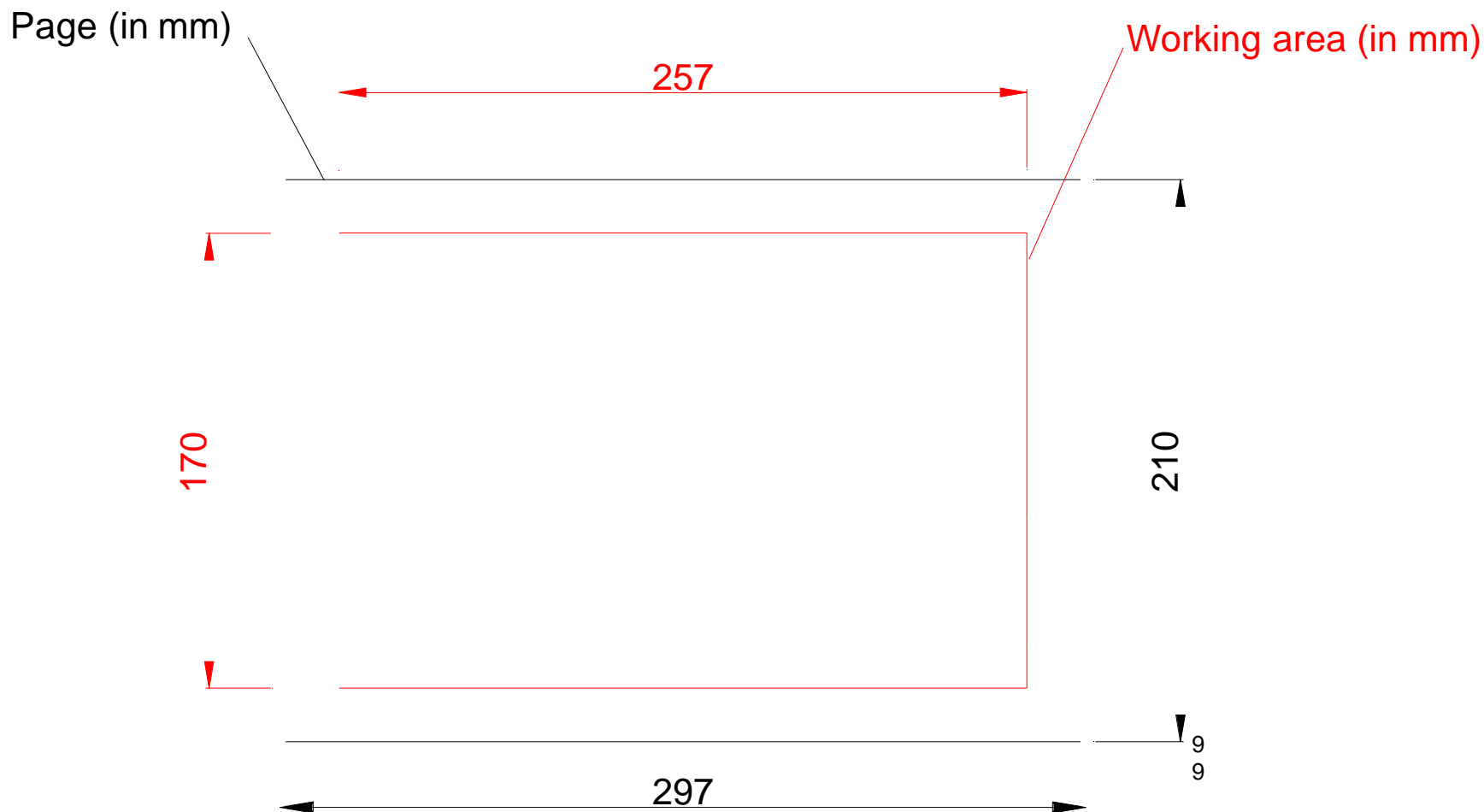
| X (m) | Y (m) |
|-------|-------|
| 62.5 | 67.1 |
| 59.4 | 51.8 |
| 70.1 | 51.8 |



UL = Upper Left
LL = Lower Left LR
= Lower Left UR =
Upper Right

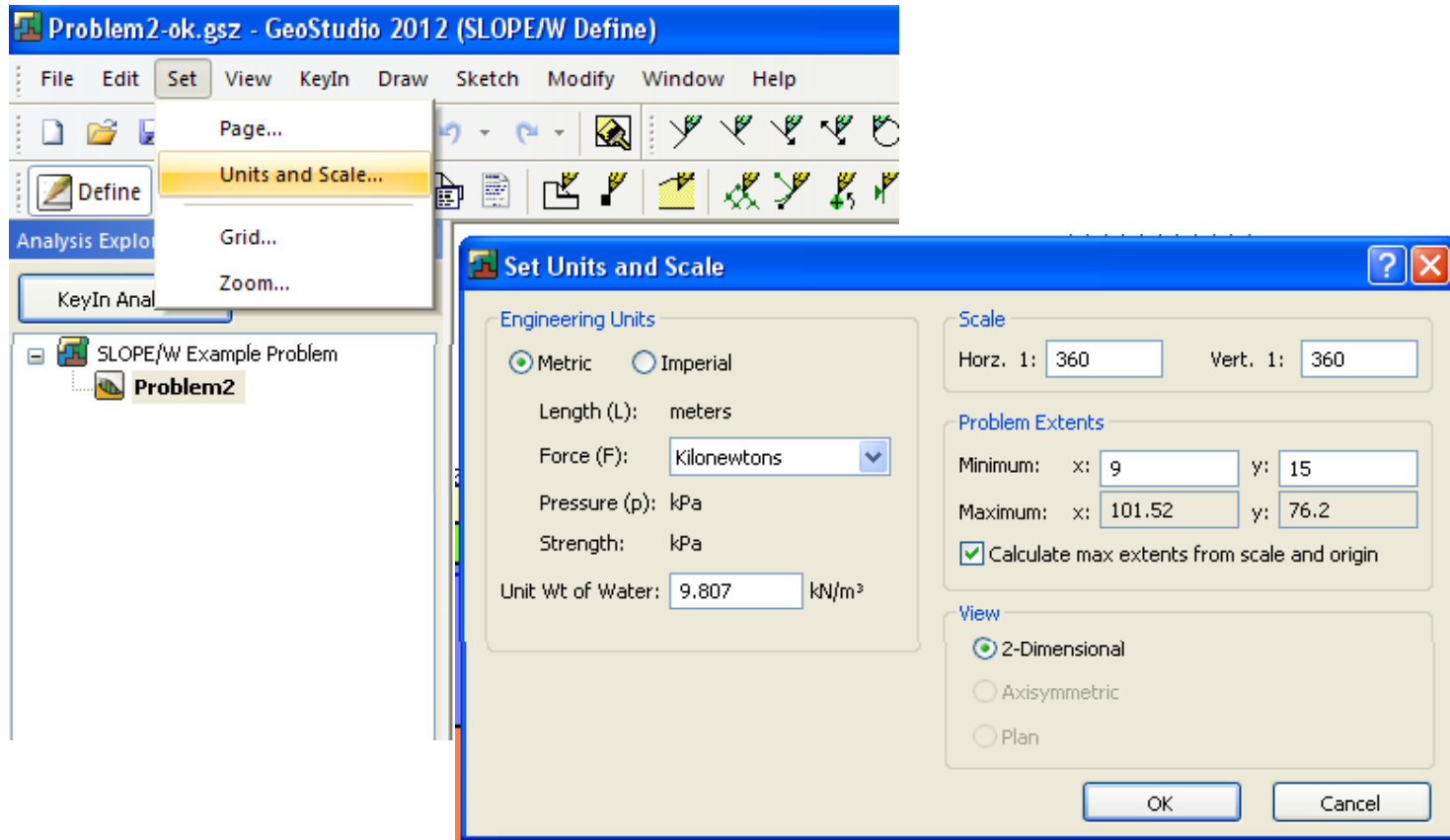
PROBLEM 2

Set Page and Working Area



PROBLEM 2

Set Unit and Scale



1
0
0

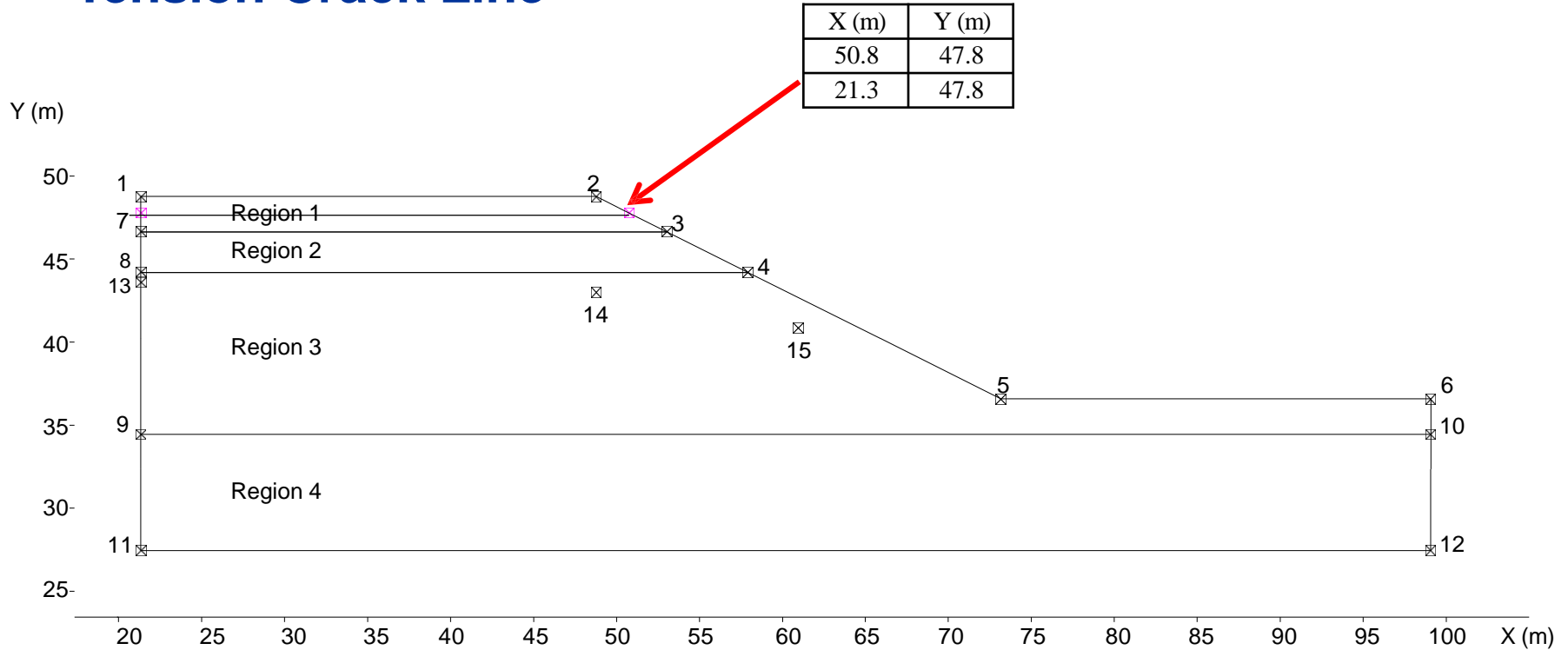
PROBLEM 2

- **Case 2: Calculate FoS by applying phreatic line correction.**
- **Case 3: Calculate FoS incorporating tension cracks: Crack depth: 1 m**

Crack is filled with water

PROBLEM 2

Tension Crack Line



THE END