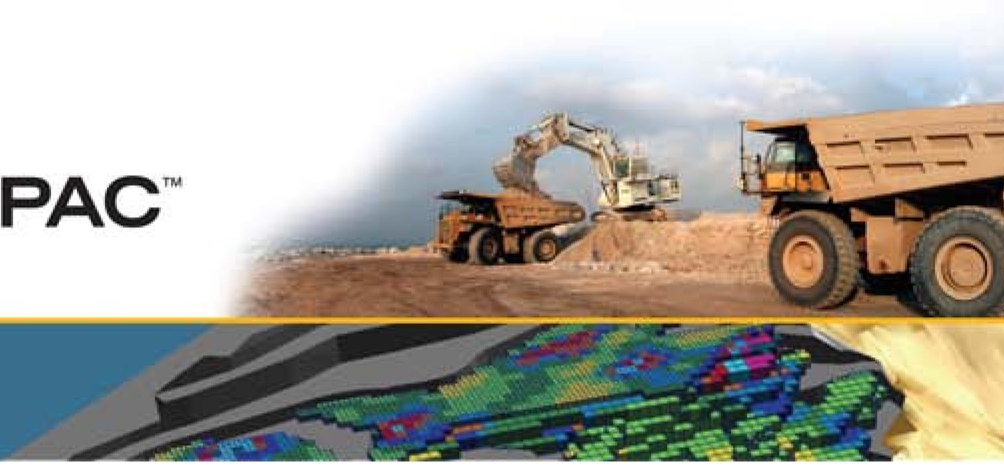
GEMCOM SURPAC™

Geology and Mine Planning



Solids Modelling in Surpac v6.1

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GEMCOM

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Product
Gemcom Surpac 6.1

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Introduction

Overview

Solids Modelling allows us to use triangulation to create three-dimensional models based on Digital Terrain Models (DTMs) and String files. This tutorial introduces the theory behind the solids modelling process and provides detailed examples using the solids modelling functions in Surpac. By working through this tutorial, you will gain skills in the construction, use of and modification of solids models.

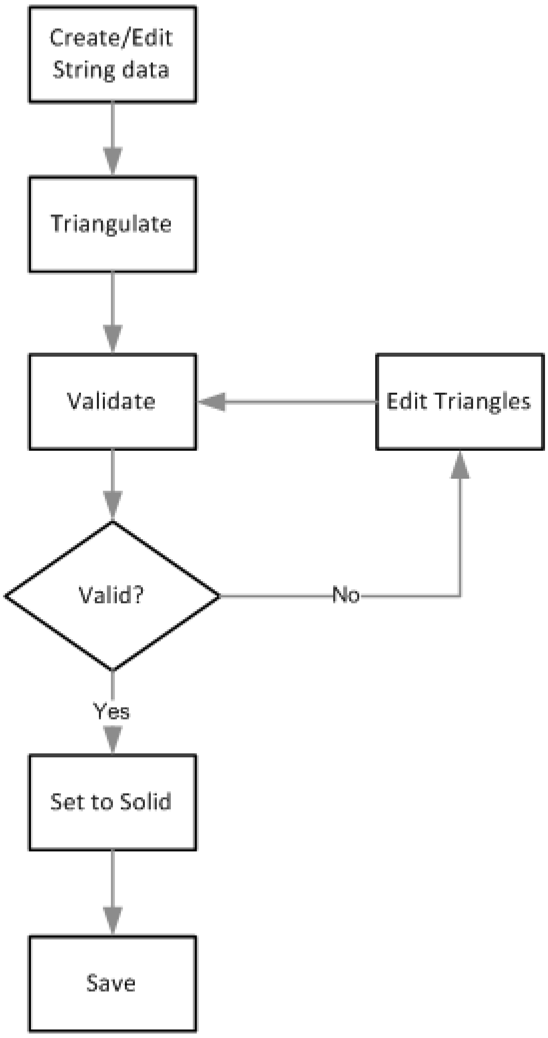
Requirements

This tutorial assumes that you have a basic knowledge of Surpac. We recommend that you understand the procedures and concepts in the Introduction to Surpac manual. The DTM Surfaces tutorial may also be helpful in understanding some of the concepts in this tutorial.

You will also need to have:

- Surpac installed on your computer, and
- The data set accompanying this tutorial.

Workflow



Note: This workflow demonstrates the steps in this tutorial. There are other ways to achieve a result.

Solids Concepts

What is a Solid model?

A Solid model is a three-dimensional triangulation of data. For example, a solid object may be formed by wrapping a DTM around strings representing sections through the solids.

Solid models are based on the same principles as Digital Terrain Models (DTMs). Solid models use triangles to link polygonal shapes together to define a solid object or a void.

The resulting shapes may be used for:

- visualisation.
- volume calculations.
- extraction of slices in any orientation.
- intersection with data from the geological database module.

A DTM is used to define a surface. Creating a DTM is automatic. Triangles are formed by connecting groups of three data points together by taking their spatial location in the X - Y plane into account.

The drawback of this type of model is that it cannot model a structure that may have foldbacks or overhangs, for example:

- geological structure.
- stopes.
- underground mine workings, for example: declines, development drives and draw points.

A Solid model is created by forming a set of triangles from the points contained in the string. These triangles may overlap when viewed in plan, but do not overlap or intersect when the third dimension is considered. The triangles in a solid model may completely enclose a structure.

Creation of Solid models can be more interactive than the creation of DTMs, although there are many tools in Surpac that can automate the process.

The following diagram shows an example of a Solid model (design decline and ore body).

Terminology

A Solid model is made up of a set of non-overlapping triangles. These triangles form objects that may have a numeric identifier between 1 and 32000. Objects represent discrete features in a solid model. For example, in the above diagram, the decline and the ore bodies have different object numbers since they represent different features.

However, features such as ore bodies can consist of discrete pods, and you may want to give these pods the same object number to indicate that they are from the same structure. In this case, each discrete pod must have a different trisolation number. A trisolation is a discrete part of an object and may be any positive integer.

Object and Trisolation numbers give reference to all the objects contained in a Solid model.

An object trisolation may be open or closed. A trisolation is open if there is a gap in the set of triangles that make up the trisolation. An object may contain both open and closed trisolations.

The reason for treating objects as open or closed are:

- a closed object can have its volume determined directly by summing the volumes of each of the triangles to an arbitrary datum plane.
- a closed object always produces closed strings when sliced by a plane.
- a closed object could be used as a constraint in the Block Modelling module.
- an open object cannot provide the same capabilities; when sliced by a plane the strings it produces may be open or closed or both.

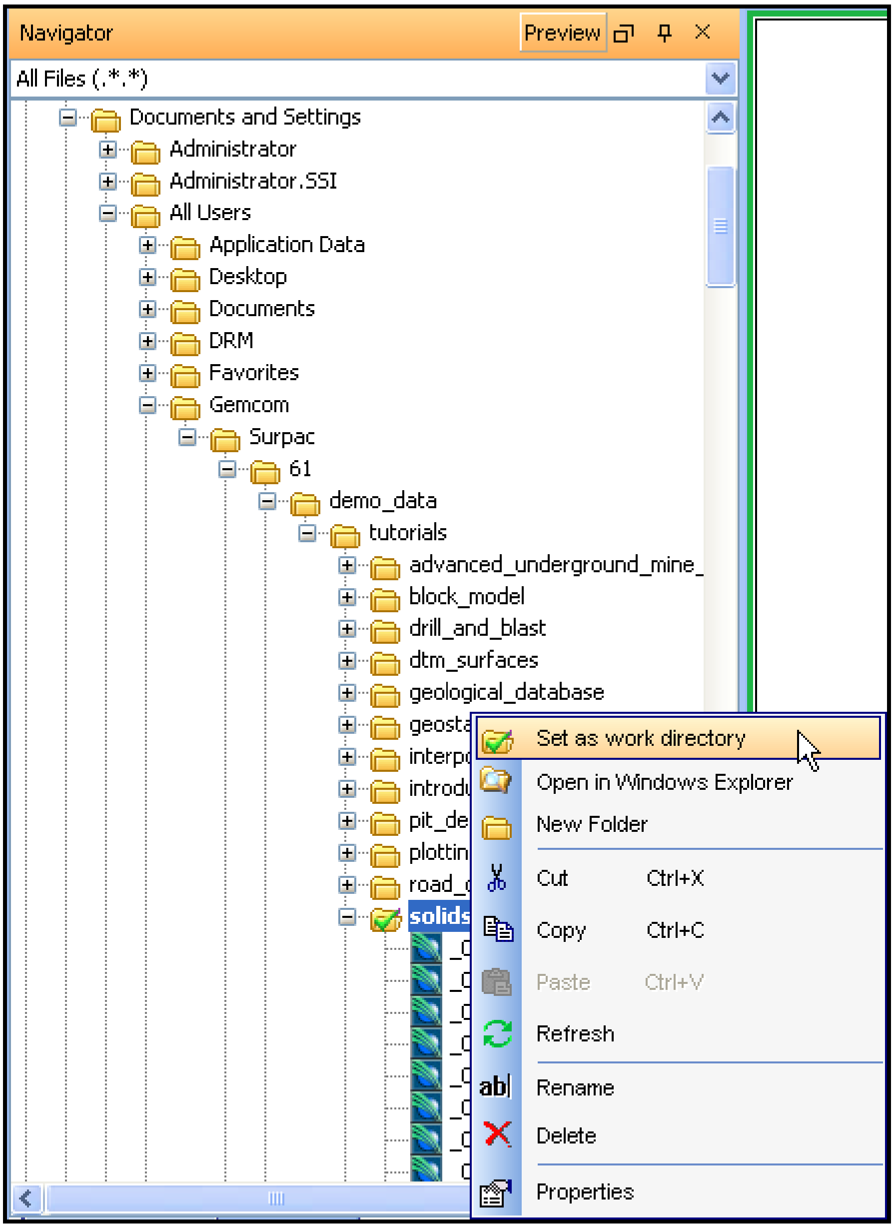
Solids Files

Solid models are stored in the same way that DTMs are stored, in two ASCII text files, with .str and .dtm extensions.

Set Up For This Tutorial

Task: Set the Work Directory (Windows XP)

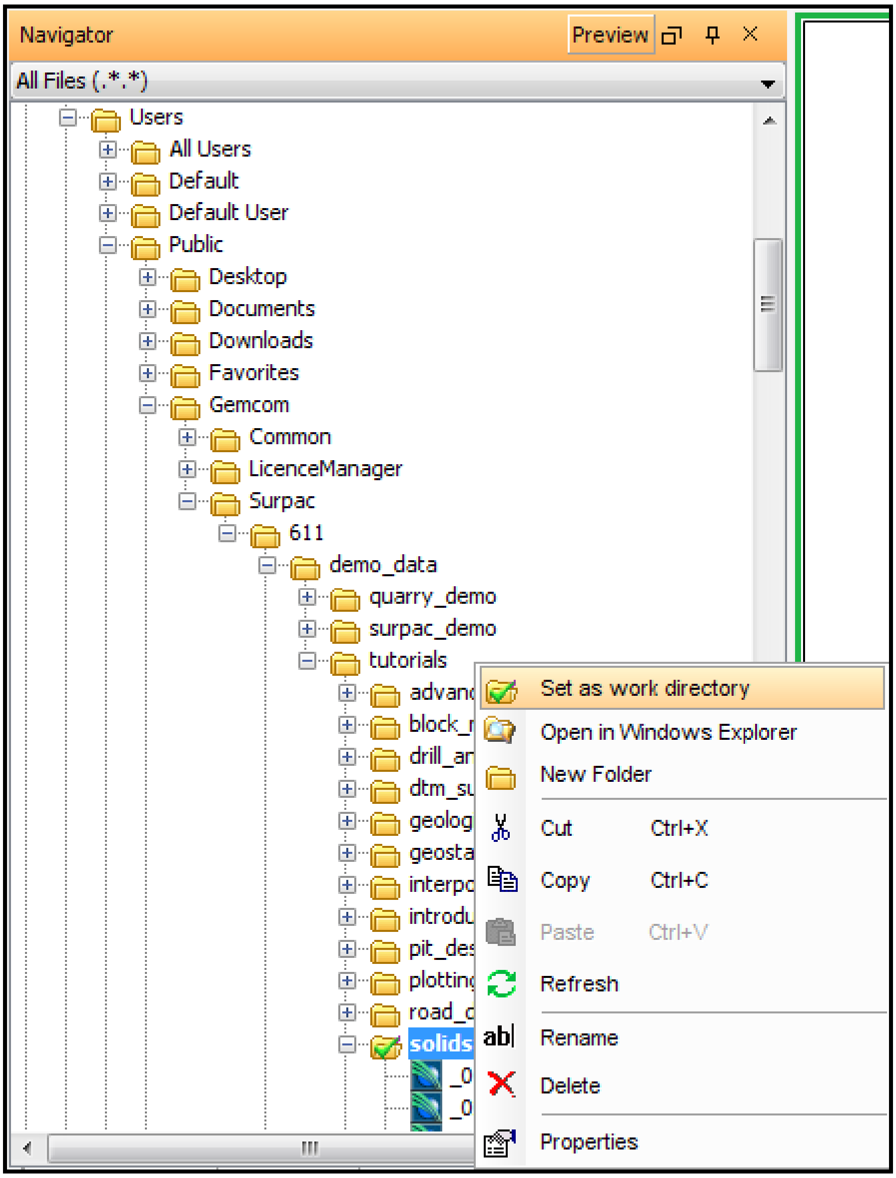
1. In the **Navigator**, right-click the **solids** folder.
2. From the popup menu, select **Set as work directory**.



The name of the work directory is displayed in the title bar of the Surpac window.

Task: Set the Work Directory (Windows Vista)

1. In the **Navigator**, right-click the **solids** folder.
2. From the popup menu, select **Set as work directory**.

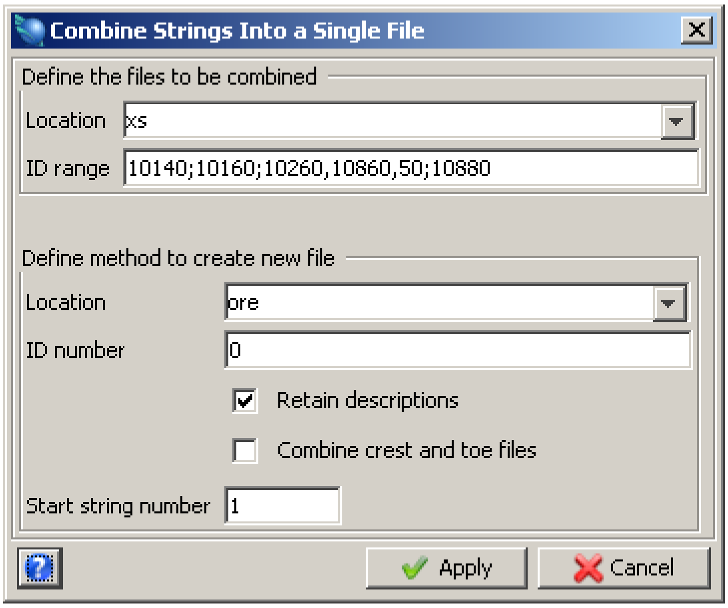


The name of the work directory is displayed in the title bar of the Surpac window.

Preparing Data

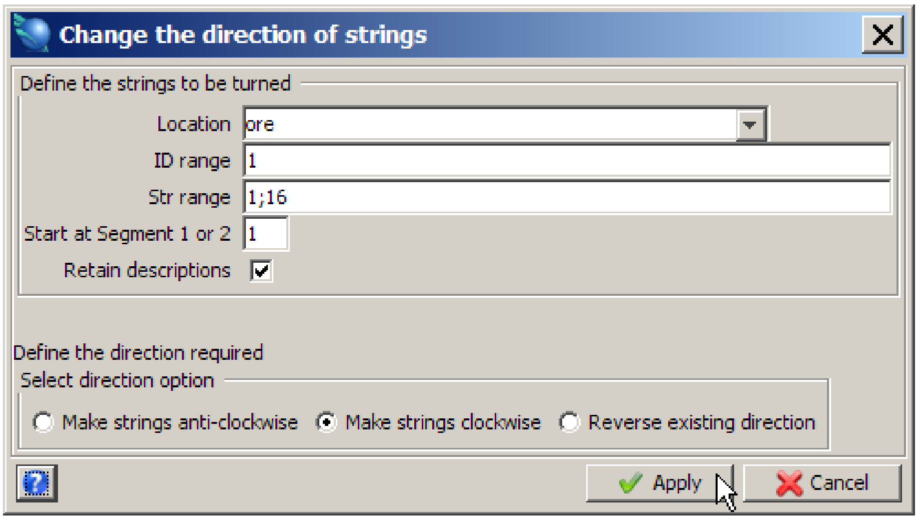
Task: Combine String Files into one File

1. Choose **File tools > Combine/Split file options > Combine string files**.
2. Enter the information as shown, and then click **Apply**.



This will combine all sixteen files into one string file called **ore1.str**.

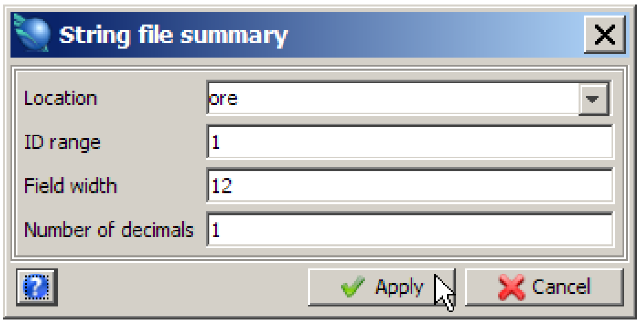
3. Choose **File tools > Change string directions**.
4. Enter the information as shown, and then click **Apply**.



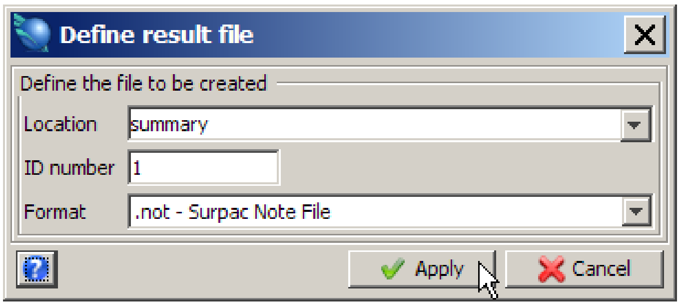
This will ensure that all digitised segments are set to clockwise. This string file is a series of sectional interpretations, representing a copper ore body.

Task: Check String File Directions Using String File Summary

1. Choose **File tools > String summary**.
2. Enter the information as shown, and then click **Apply**.



3. Enter the information as shown, and then click **Apply**.

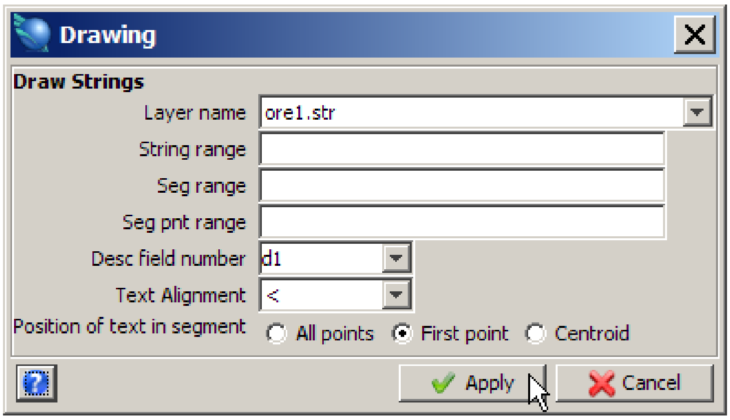


File **summary1.not** is displayed.

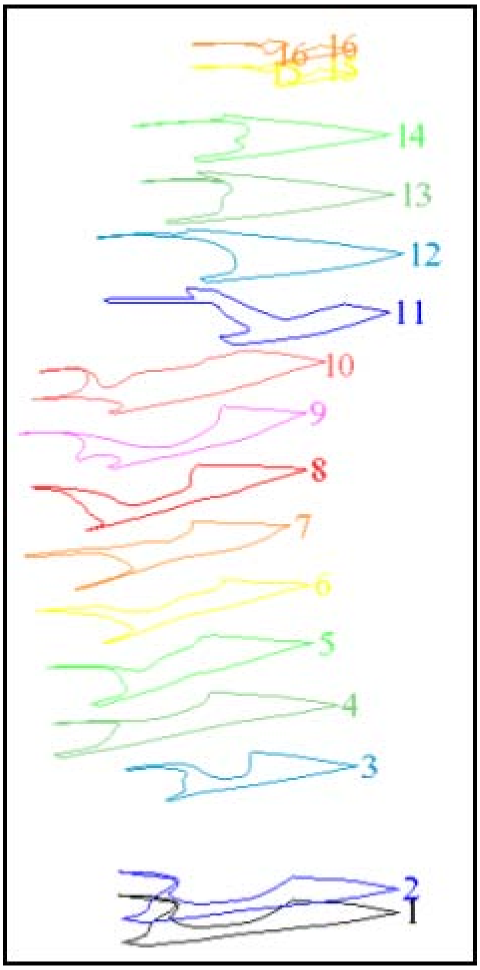
```
                 String Summary Report          Jul 07, 2008
File: ore1.str
Date: 07-Jul-08      Purpose: Reversed strings
String  Segment  Direction  # Points  2d Len  3d Len  Area      X Min   X Max   Y Min
-----------------------------------------------------------------------------------------
1       1        Clockwise  98        782.3   782.3   10521.4   5234.6  5468.5  900.2
2       1        Clockwise  80        781.8   781.8   10510.2   5234.6  5468.5  900.2
3       1        Clockwise  66        619.9   619.9   7753.7    5253.3  5428.9  921.4
4       1        Clockwise  26        178.8   178.8   417.3     5301.7  5372.3  1016.3
4       2        Clockwise  18        174.8   174.8   928.1     5385.3  5434.1  990.0
4                           44        353.5   353.5   1345.4    5301.7  5434.1  990.0
5       1        Clockwise  29        209.9   209.9   646.0     5301.7  5377.4  1015.9
5       2        Clockwise  20        176.3   176.3   995.8     5385.3  5434.1  990.0
5                           49        386.2   386.2   1641.8    5301.7  5434.1  990.0

                            337       2923.7  2923.7  31772.5   5234.6  5468.5  900.2
File Summary :-
Location = ore
ID range = 1
2d Len  3d Len  Area     X Min   X Max   Y Min   Y Max   Z Min    Z Max
------------------------------------------------------------------------
2923.7  2923.7  31772.5  5234.6  5468.5  900.2   1078.8  10140.0  10880.0
String Summary Report                                                   1/1
```

4. Close **summary1.not**.
5. Click the **Reset graphics** icon.
6. Open **ore1.str**.
7. Choose **Display > Strings > With string numbers**.

8. Enter the information as shown, and then click **Apply**.



Ore 1 string is displayed.

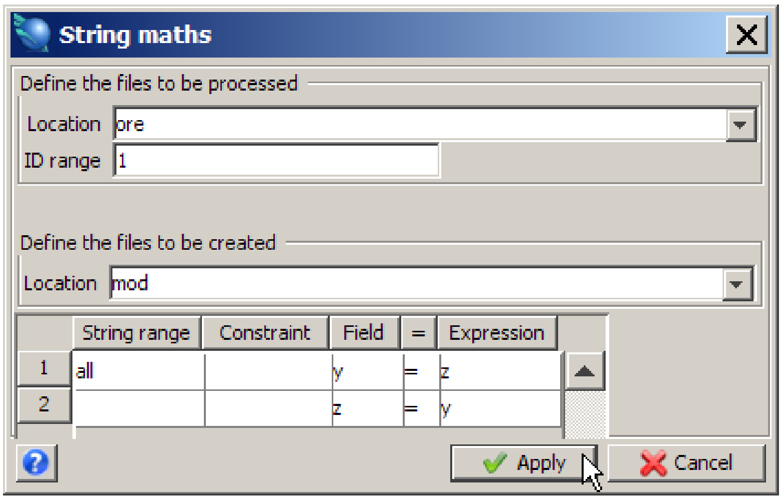


Note: The same results could be achieved by opening all the files into one layer and then saving the layer as **ore1.str**.

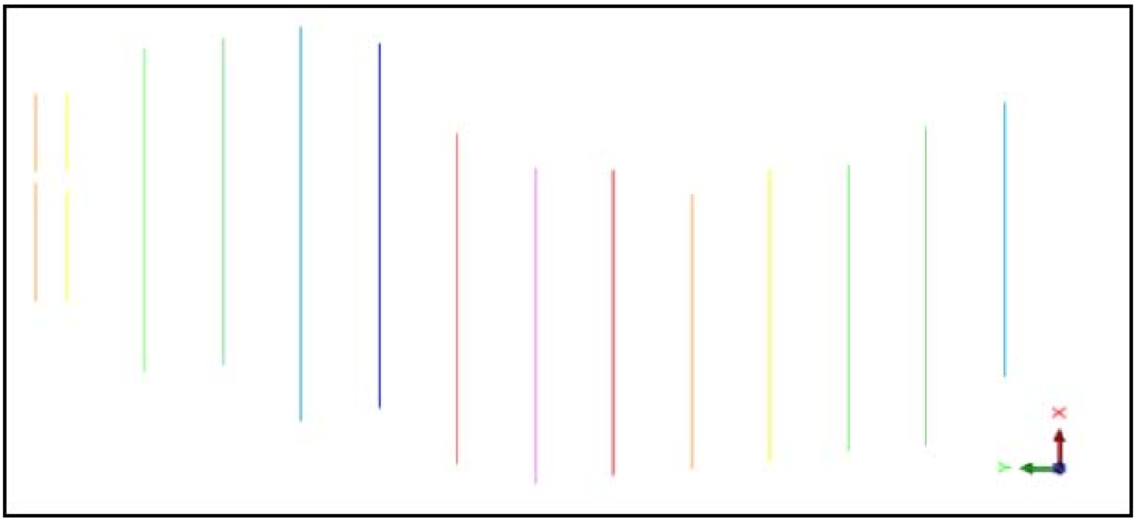
Use this file to do a final check that all strings are closed and clockwise in direction.

Task: Transform Data from Section View to Plan View

1. Click the **Reset graphics** icon .
2. Choose **File tools > String maths**.
3. Enter the information as shown, and then click **Apply**.



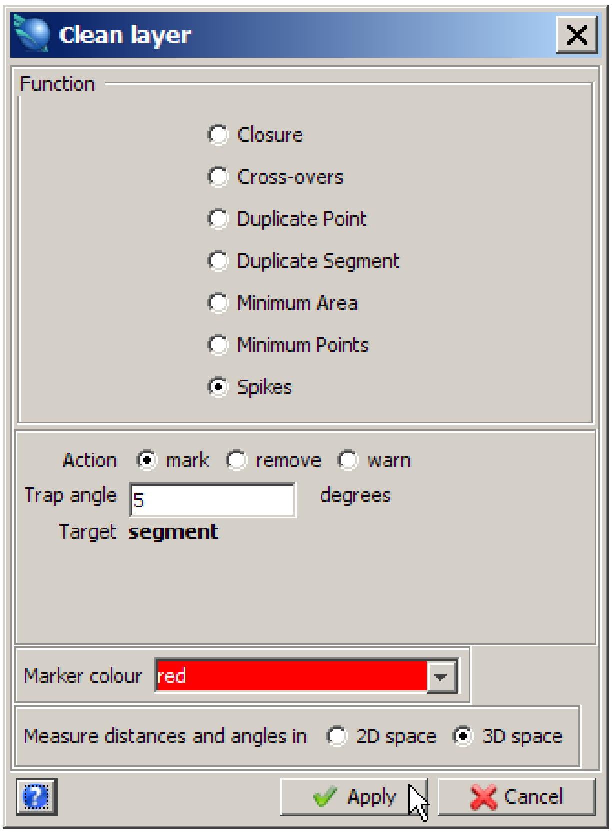
4. Open **mod1.str**.
   The plan view of the segments is displayed.



Task: Check and Remove Foldbacks

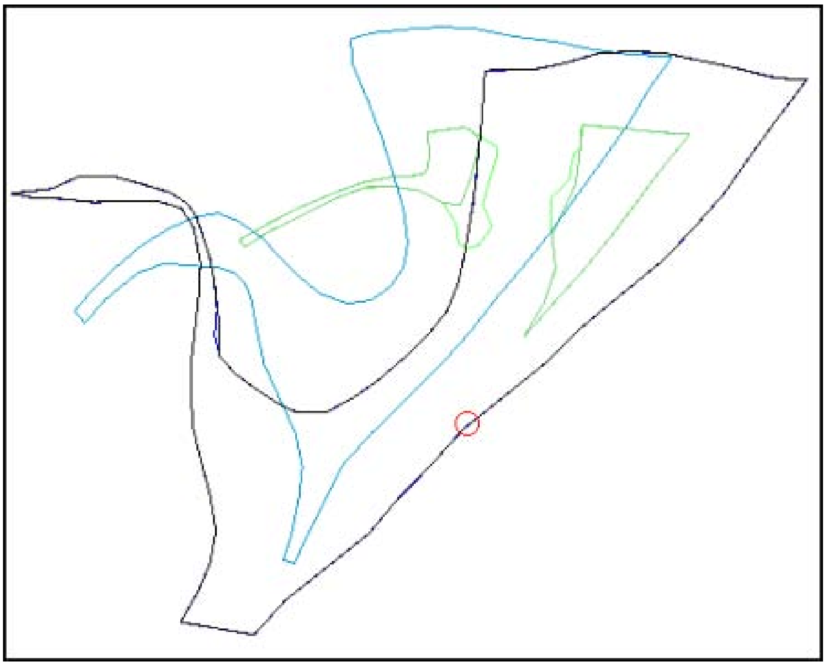
1. Click the **Reset graphics** icon .
2. Open **mod1.str**.
3. Choose **Edit > Layer > Clean**.
   Note: By using the Layer option, all strings are checked.

4. Enter the information as shown, and then click **Apply**.



A temporary marker (a red circle) appears on one of the segments.

5. Zoom in on the highlighted area to view the foldback.

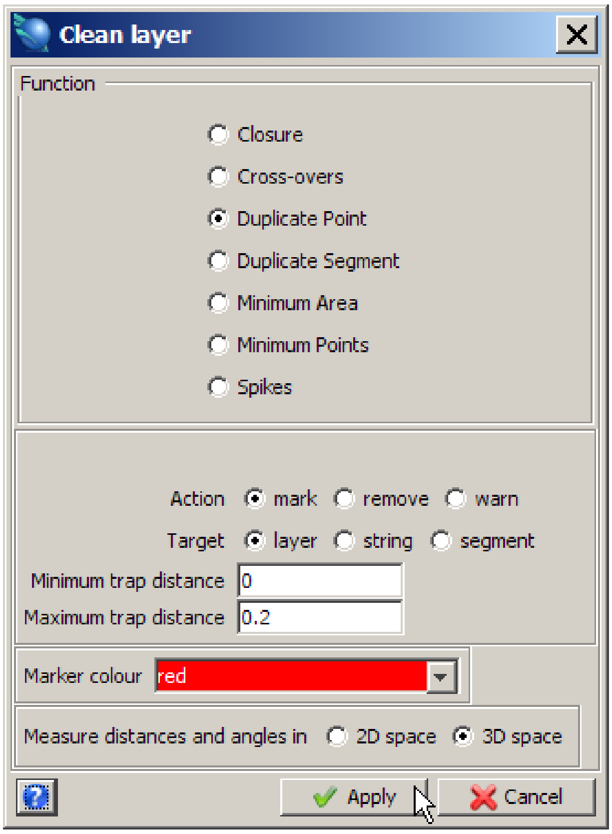


6. Re-run the **Clean** function with **Action** set to **remove**.
This will automatically remove the foldback.

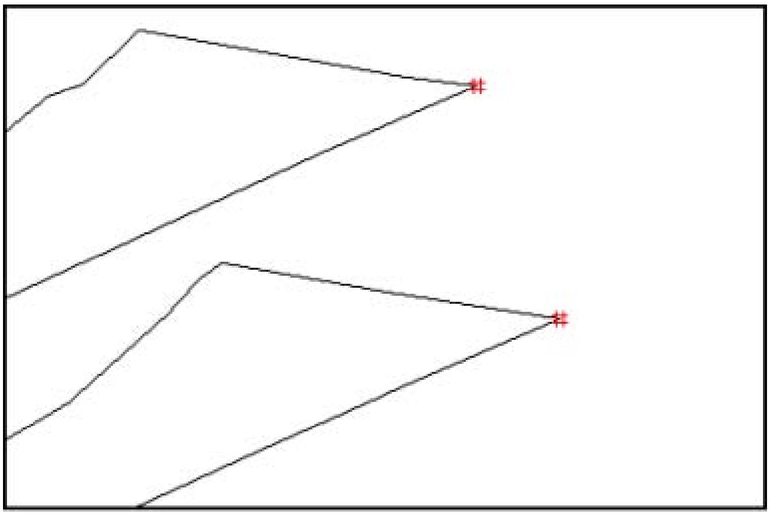
Note: Any errors highlighted by the **Clean Layer** function can also be manually edited if preferred.

Task: Highlight and Remove Duplicate Points

1. Click the **Reset graphics** icon .
2. Open **mod1.str**.
3. Choose **Edit > Layer > Clean**.
4. Enter the information as shown, and then click **Apply**.



Note: Duplicate points are highlighted by a temporary marker (red hash symbol) as shown. Surpac will not triangulate points less than 0.05 units apart.



5. Re-run the **Clean** function with **Action** set to **remove** to delete any duplicate points.

Note:To see all of the steps performed in this section, run **_01_data_preparation.tcl.** You will need to click **Apply** on any forms presented.

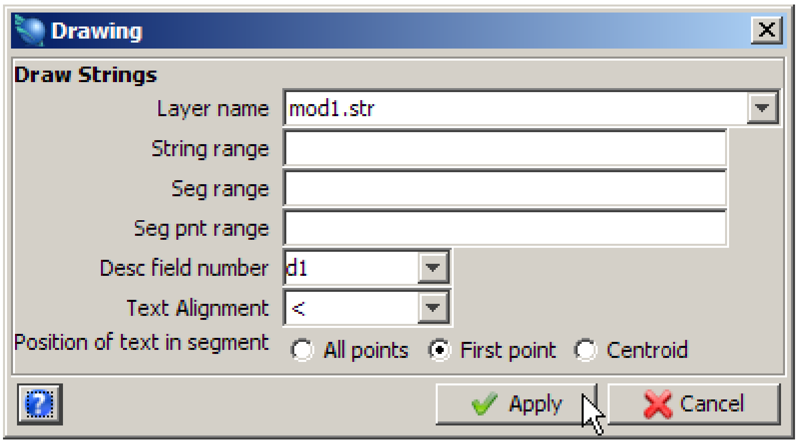
Creating a Solid

The following sections describe the various triangulation methods that can be used to create a Solid model.

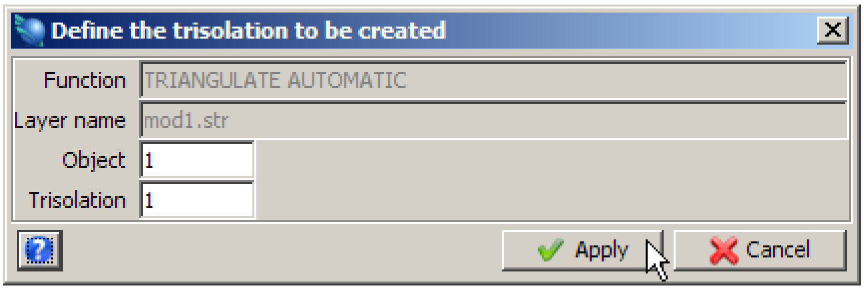
Triangulating Using Between Segments

Task: Create a Solid Model

1. Click the **Reset graphics** icon .
2. Open **mod1.str**.
3. Choose **Display > Strings > With string numbers**.
4. Enter the information as shown, and then click **Apply**.



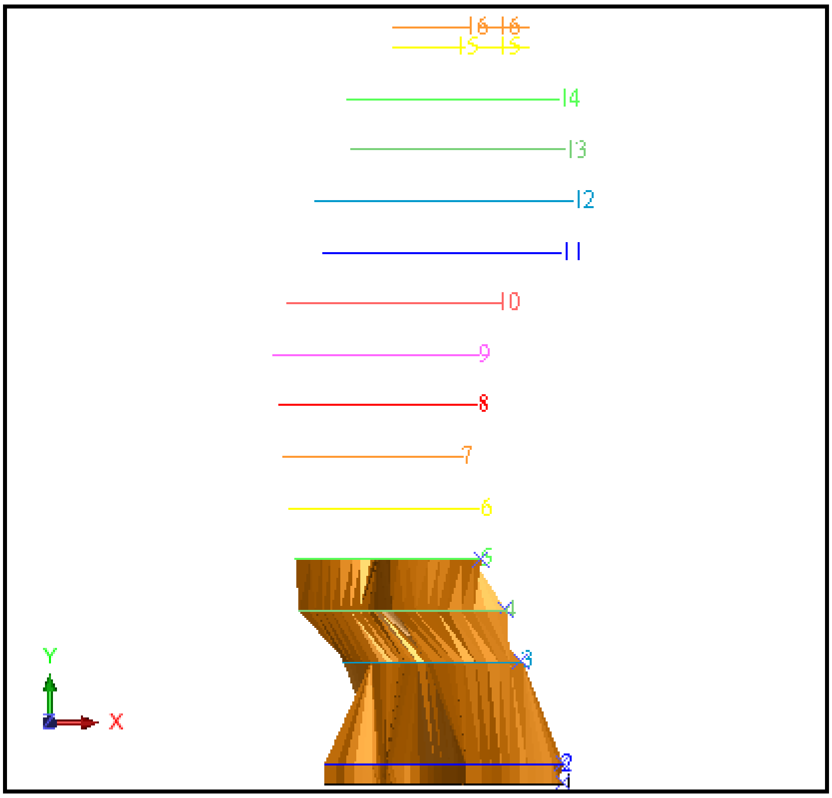
5. Choose **Solids > Triangulate > Between segments**.
6. Enter the information as shown, and then click **Apply**.



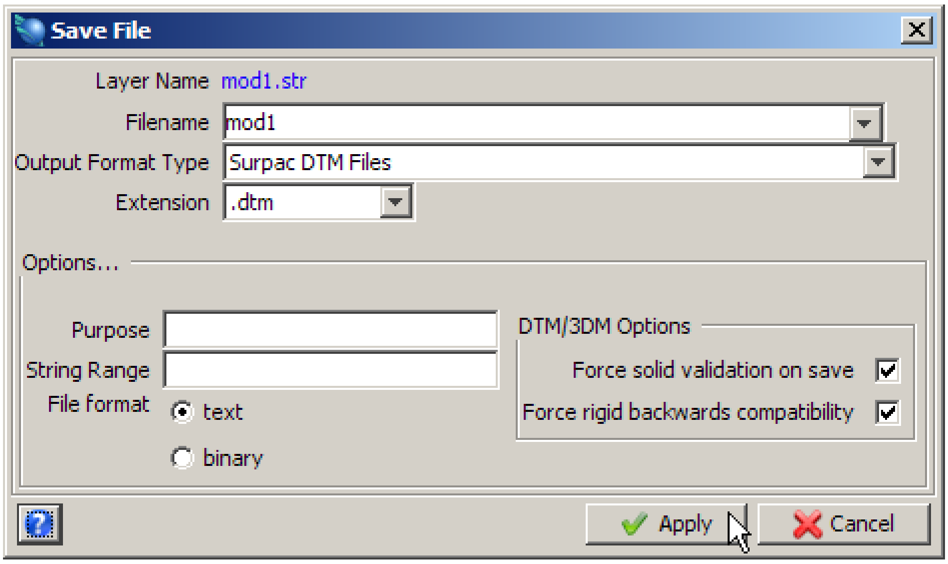
   You are prompted to **Select a point on the first segment to be triangulated**.

7. Click string 1.
   You are prompted to **Select a point on the next segment to be triangulated**.
8. Click string 2.
   Continue using the **Between segments** function up to and including string 5.
9. Press **ESC.**

The part of the solid created using triangulate between segments is displayed.



10. Save **mod1.dtm**.



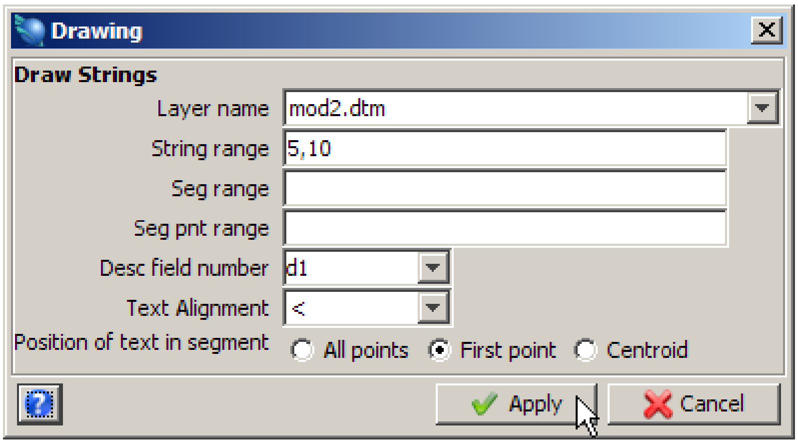
Note: You can use the **Between segments** function indefinitely as long as the selected strings are still in the same active layer as the first string selected.

Note: To see all of the steps performed in this section, run **_02a_create_solid_automatic_tri-angulation.tcl.** You will need to click **Apply** on any forms presented.

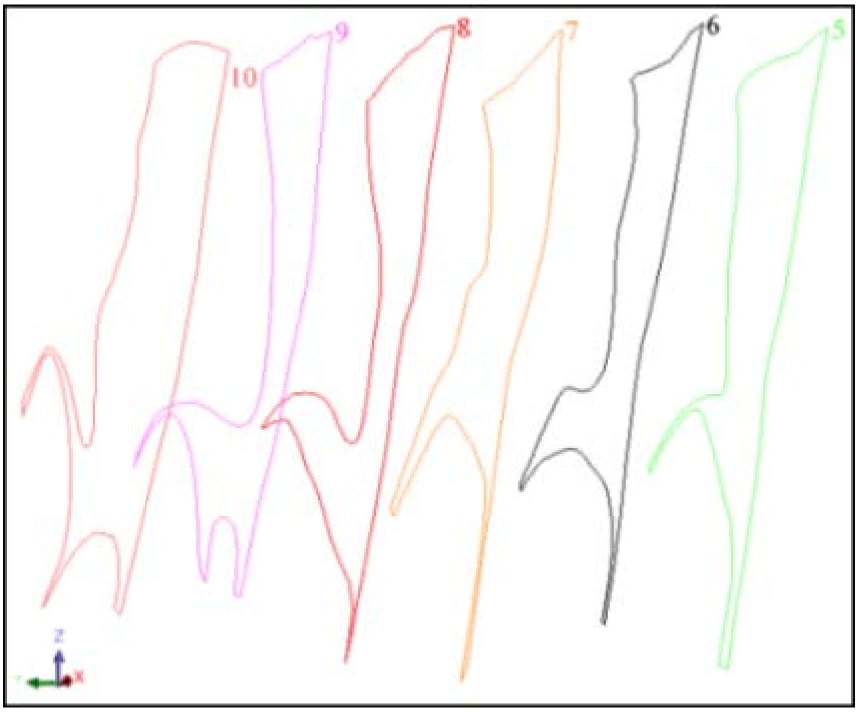
Triangulating Using Control Strings

Task: Create Control Strings Using the Digitiser

1. Click the **Reset graphics** icon .
2. Open **mod2.dtm**.
3. Choose **Display > Hide everything** to erase all strings and objects.
4. Choose **Display > Strings > With string numbers**.
5. Enter the information as shown, and then click **Apply**.

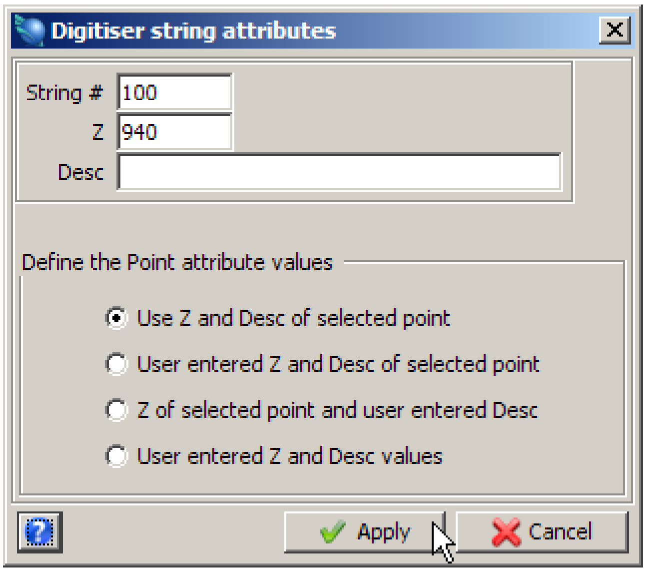


Strings 5 to 10 are displayed.

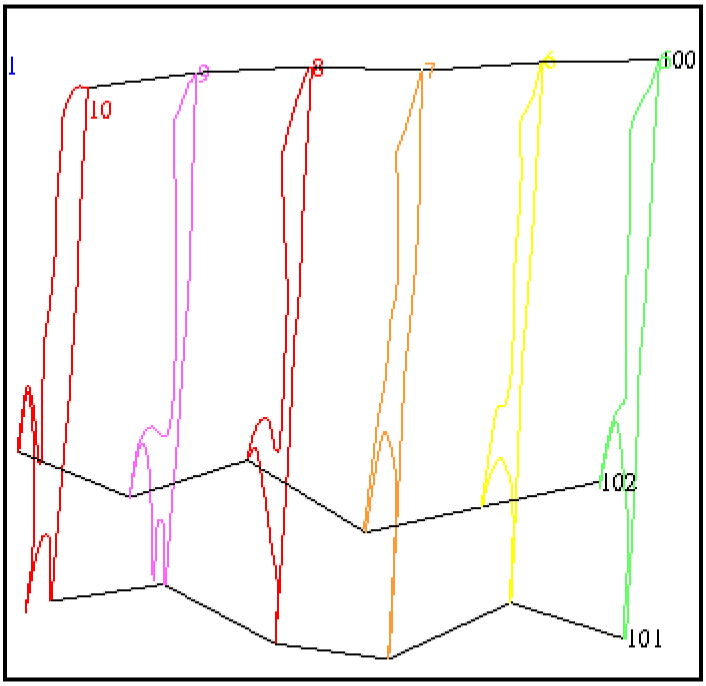


6. Choose **Create > Digitise > Start new string**.

7. Enter the information as shown, and then click **Apply**.

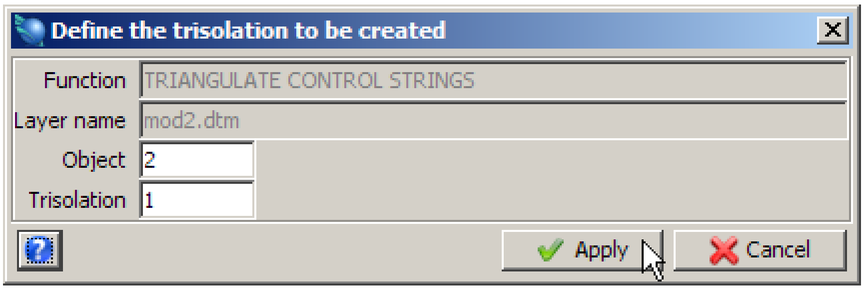


8. Choose **Create > Digitise > New point by selection**.
   Each point digitised will snap to an existing point in each polygon.
9. Digitise string 100 as shown between strings 5 and 10.

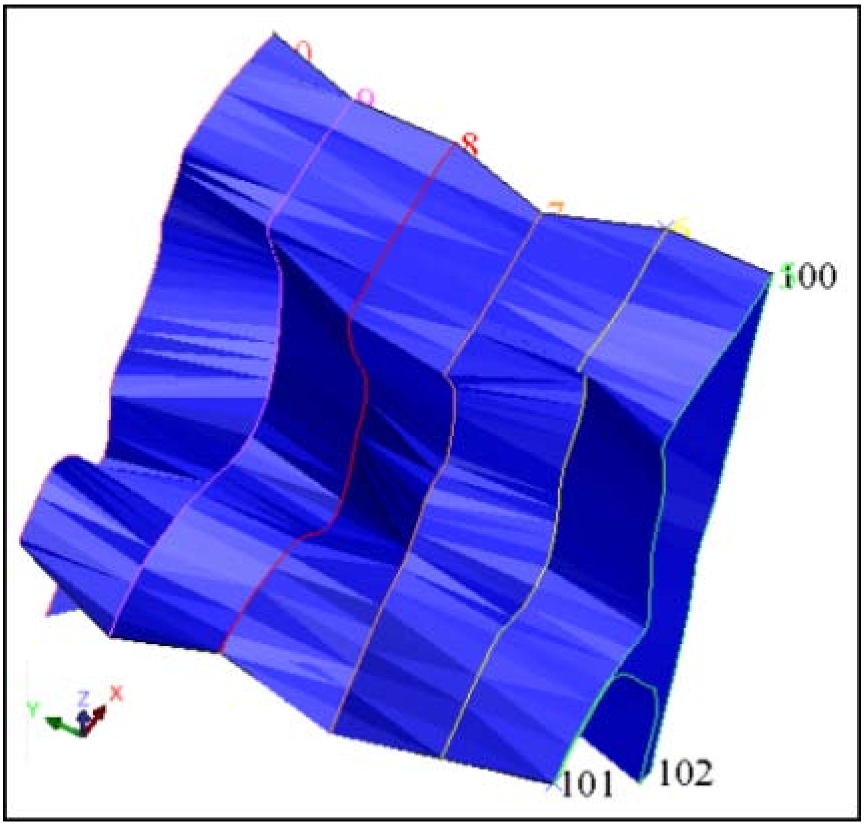


10. Choose **Create > Digitise > Start next string**.
11. Choose **Create > Digitise > New point by selection** and digitise string101.
12. Choose **Create > Digitise > Start next string**.
13. Choose **Create > Digitise > New point by selection** and digitise string102.
14. Press **ESC.**
15. Choose **Solids > Triangulate > Using control strings**.
16. Click on String 100.
    Tip: When selecting each control string graphically, click on the string midway between the polygons. This will ensure that the control string is correctly selected.
17. Next, click String 101 and then click String 102.

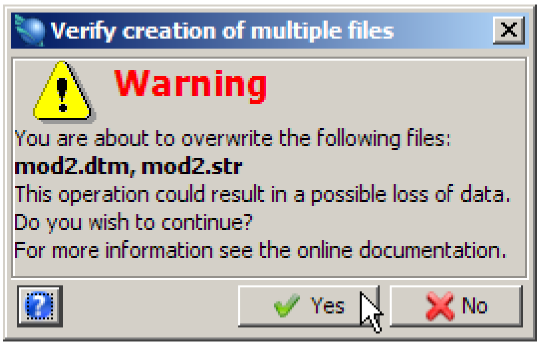
18. Press **ESC**.
19. Enter the information as shown, and then click **Apply**.



The part of the solid which uses control strings is displayed.



20. Choose **File > Save as > string/DTM** to save this part of the model as **mod2.dtm**.



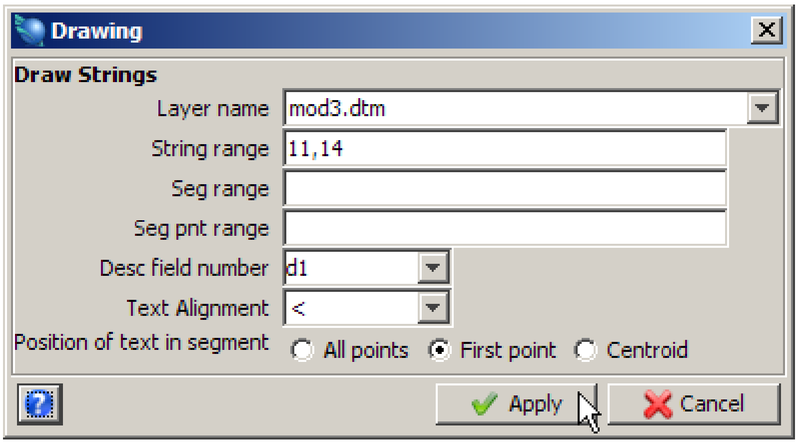
21. Click **Yes**.

Note: To see all of the steps performed in this section, run **_02b_create_solid_control_ strings.tcl.** You will need to click **Apply** on any forms presented.

Triangulating Using Many Segments

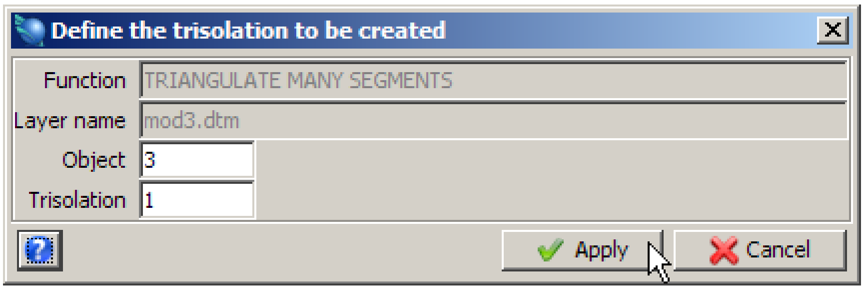
Task: Create a Solid by Specifying a Range of Strings

1. Click the **Reset graphics** icon .
2. Open **mod3.dtm**.
3. Choose **Display > Hide everything** to erase all strings and objects.
4. Choose **Display > Strings > With string numbers**.
5. Enter the information as shown, and then click **Apply**.

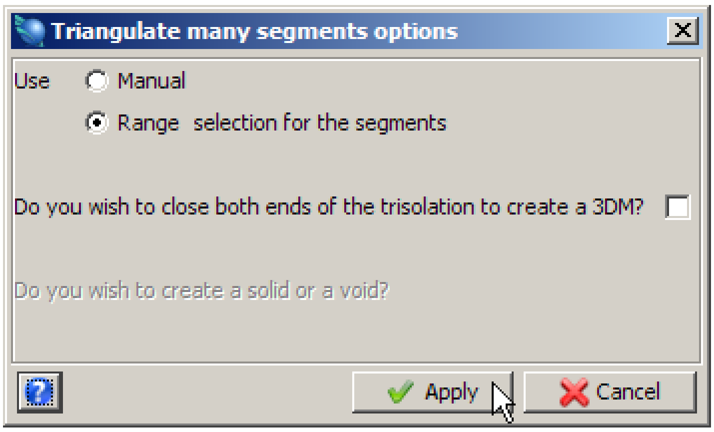


Note: The range definition form could be applied with a blank string range to triangulate all strings in the current graphic layer.

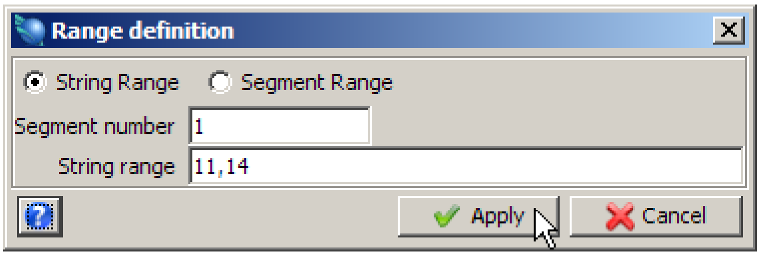
6. Choose **Solids >Triangulate > Many segments**.
7. Enter the information as shown, and then click **Apply**.



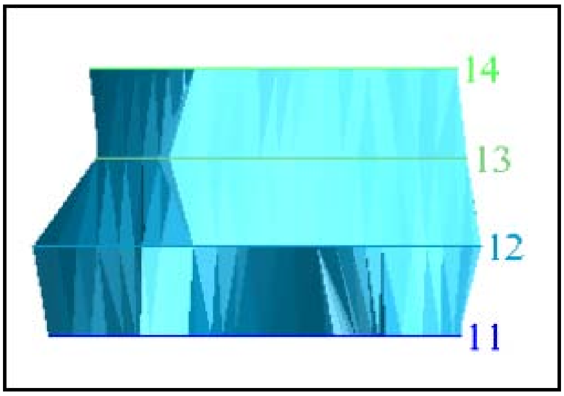
8. Enter the information as shown, and then click **Apply**.



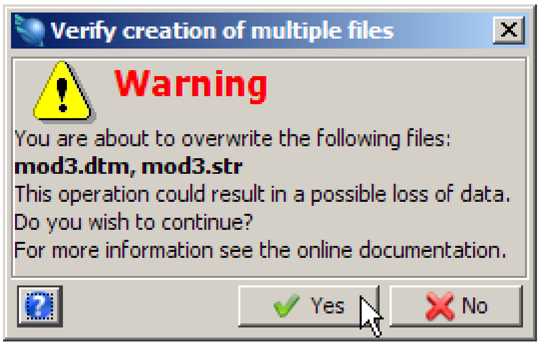
9. Enter the information as shown, and then click **Apply**.



Selected segment image is displayed.



10. Save as **mod3.dtm**.



11. Click **Yes**.

If you want to run manually through the material again, you will need to copy **original_mod3.dtm** to **mod3.dtm**.

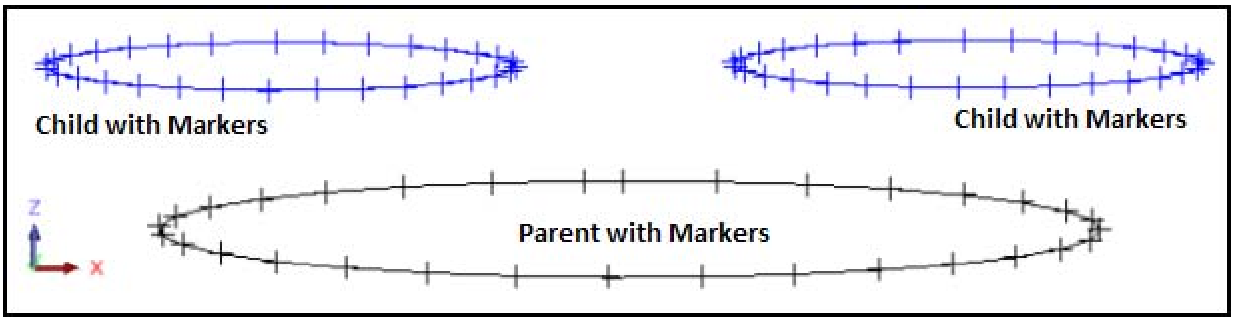
Note: To see all of the steps performed in this section, run **_02c_create_solid_triangulate_many_segments.tcl.** You will need to click **Apply** on any forms presented.

Triangulating Using Bifurcation Techniques

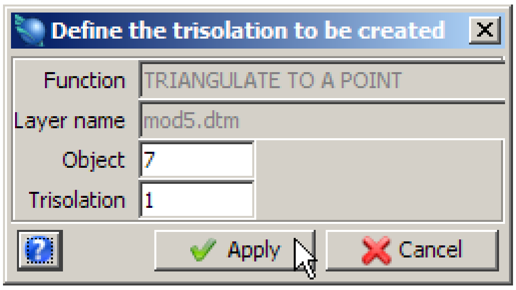
Task: Perform Bifurcation - One Segment to Many Segments

1. Click the **Reset graphics** icon .
2. Open **bifurc1.str**.
   Put it in a suitable view so that you can see all three shapes.
3. Choose **Display > Point > Markers** to display all points as markers.

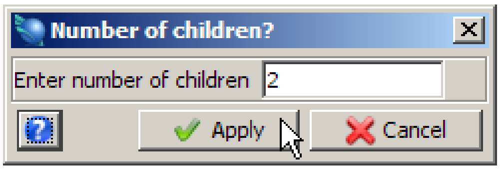
The Parent and Child segments with Markers are displayed:



4. Choose **Solids > Triangulate > One segment to many segments**.
5. Enter the information as shown, and then click **Apply**



6. Enter the information as shown, and then click **Apply**.

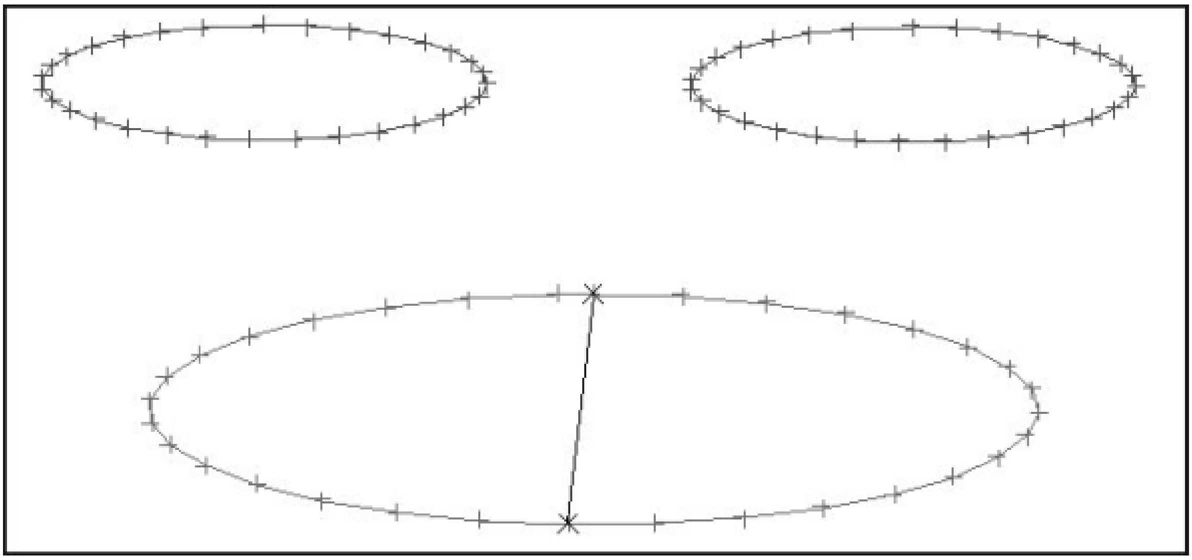


You are prompted to select the first break point on the parent segment for the first child.

7. Click the parent segment.
Here you are being asked to select where you are going to perform the bifurcation,

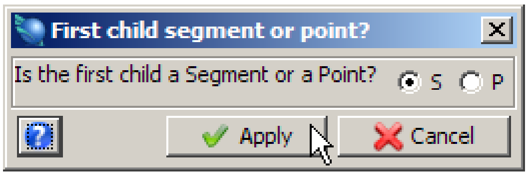
You are prompted to select the second break point on the parent segment for the first child.

8. Click the opposite side of the parent segment.
The bifurcation example is displayed.

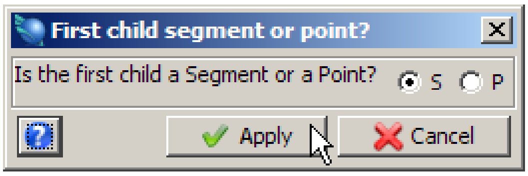


You are asked to select the portion of the parent segment to join to the first child. This means which side of the parent will you join up with which child.

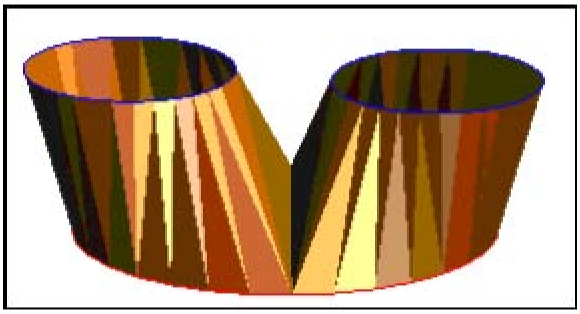
9. Click the left side of the parent segment.
10. Enter the information as shown, and then click **Apply**.



11. Click the left child.
    You are asked whether the next child is a segment or a point



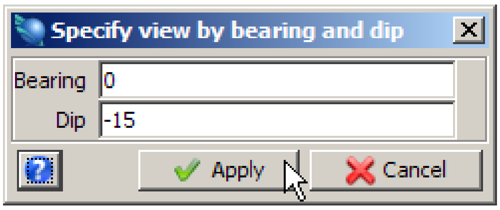
12. Click **Apply** on this form and then click the right child.
    The bifurcation example is displayed.



Note: This is just one way of performing a bifurcation. The benefits are the relative simplicity and the ability to split the parent string to more than two components.

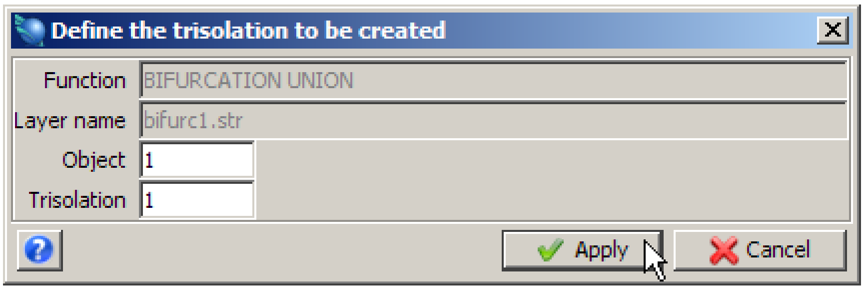
Task: Perform One Segment to Two Segments (Bifurcation Union)

1. Click the **Reset graphics** icon.
2. Open **bifurc1.str**.
3. Choose **View > Data view options > View by bearing & dip**.
4. Enter the information as shown, and then click **Apply**.

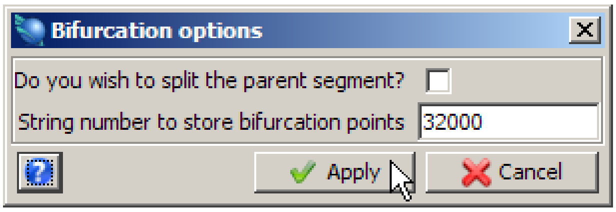


5. Choose **Solids > Triangulate > One segment to two segments**.

6. Enter the information as shown, and then click **Apply**.



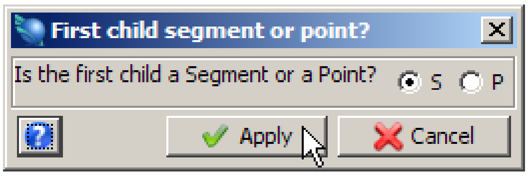
7. Enter the information as shown, and then click **Apply**.



You are prompted to select the parent segment.

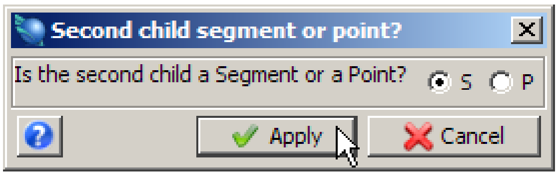
8. Click the parent segment.
You are then prompted to choose whether the first child is a **(S)egment** or a **(P)oint**.

9. Click **Apply,** and then click the left child.

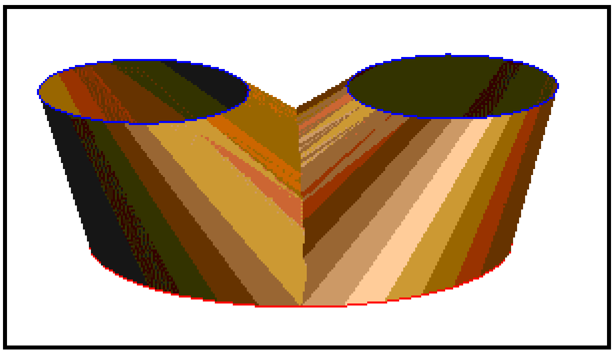


You are then prompted to choose whether the second child is a **(S)egment** or **(P)oint**.

10. Click **Apply,** and then click the right child.



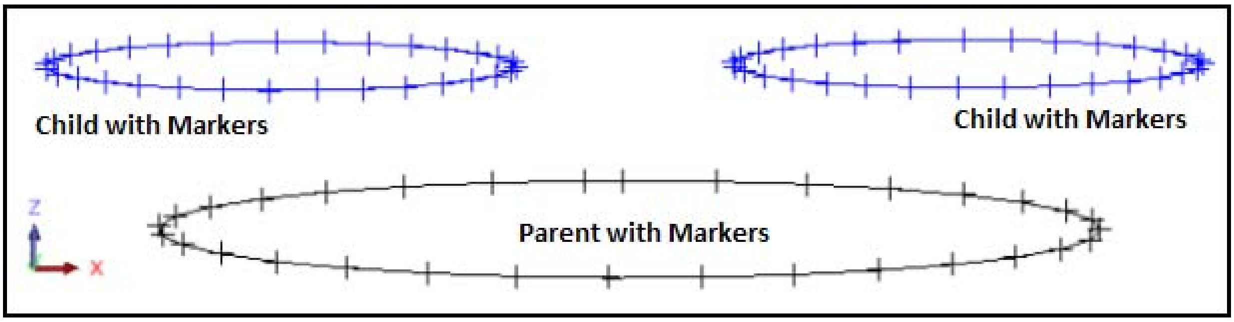
The bifurcation example is displayed.



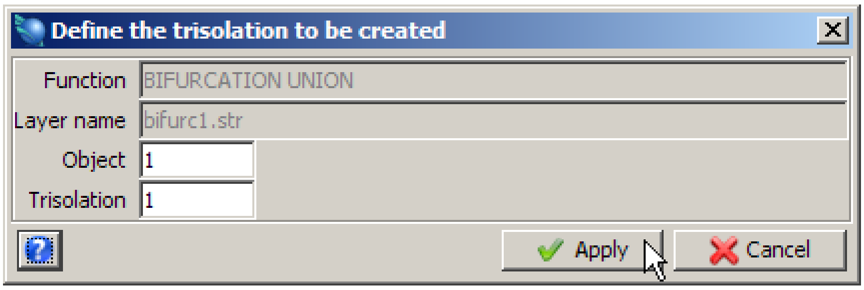
Task: Perform Bifurcation Union – Split Parent

1. Click the **Reset graphics** icon .
2. Open **bifurc1.str**.
3. Put it in a suitable view so that you can see all three shapes.

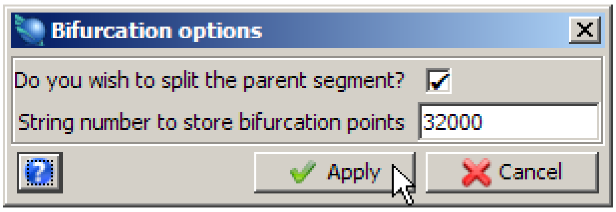
4. Choose **Display > Point > Markers** to display all points as markers.
   The bifurcation example is displayed.



5. Choose **Solids > Triangulate > One segment to two segments**.
6. Enter the information as shown, and then click **Apply**.

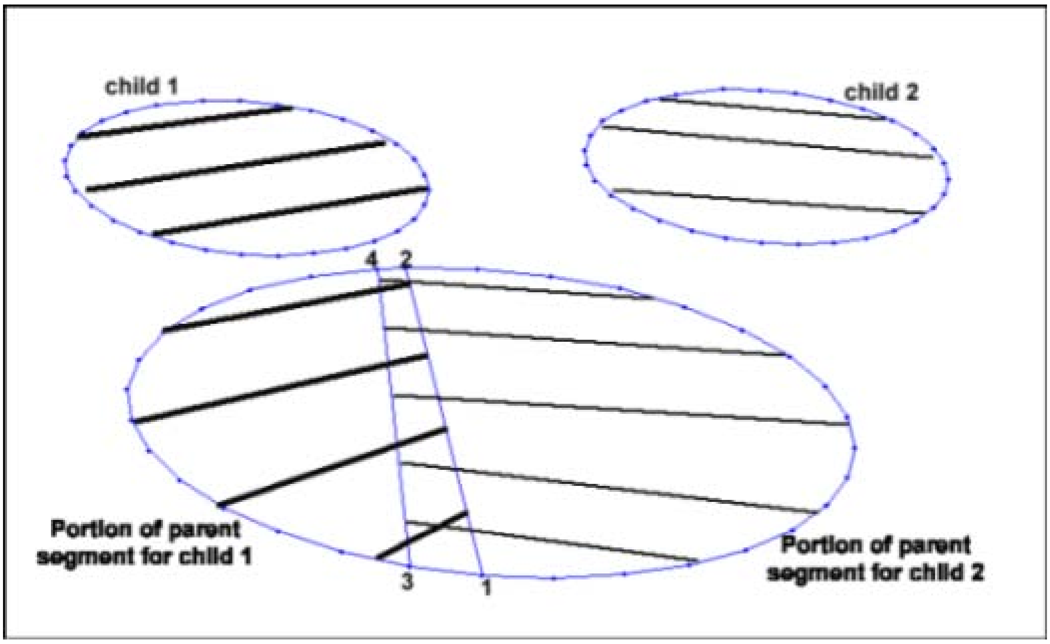


7. Enter the information as shown, and then click **Apply**.



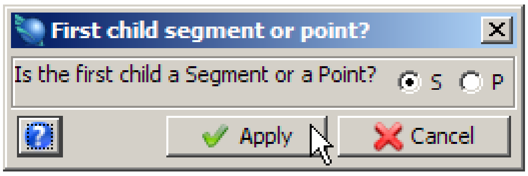
The position of the line of bifurcation is controlled by splitting the parent segment in different ways.

Note: The two breaklines defined must always overlay as shown.



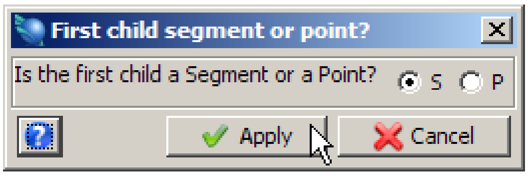
Note: The first series of prompts will define a portion of the parent segment to be assigned to the first child.

8. Click the first break point on the parent segment for the first child (ie. point 1 as shown)
9. Click the second break point on the parent segment for the first child (ie. point 2 as shown)
10. Click the parent segment on the left side of the defined breakline.
11. Click **Apply** and then click child 1.

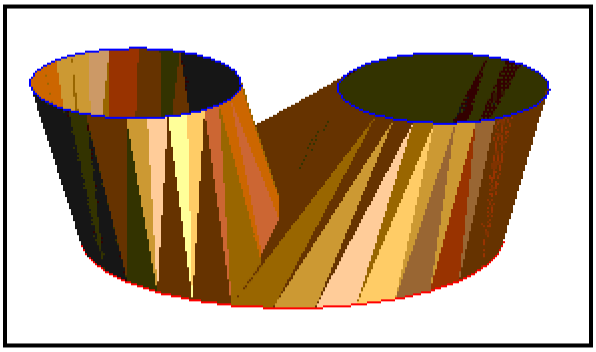


Note: The next series of prompts will define a portion of the parent segment to be assigned to the second child.

12. Click the first break point on the parent segment for the second child(point 3 as shown).
13. Click the second break point on the parent segment for the second child(point 4 as shown).
14. Click the parent segment on the right side of the defined breakline.
15. Click **Apply** and then click child 2.



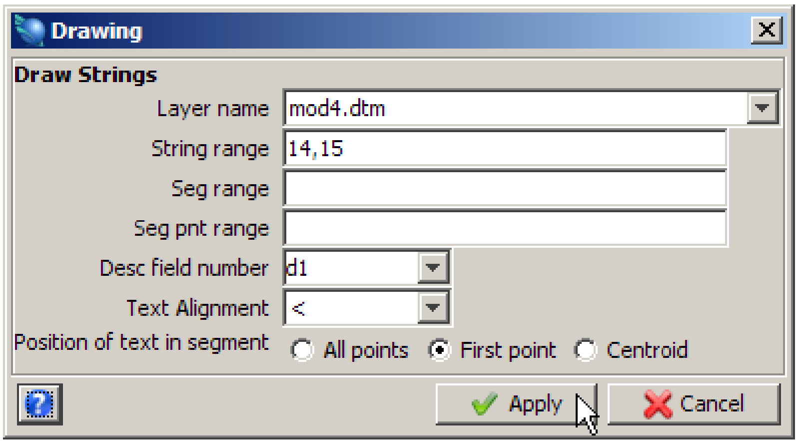
The bifurcation example is displayed.



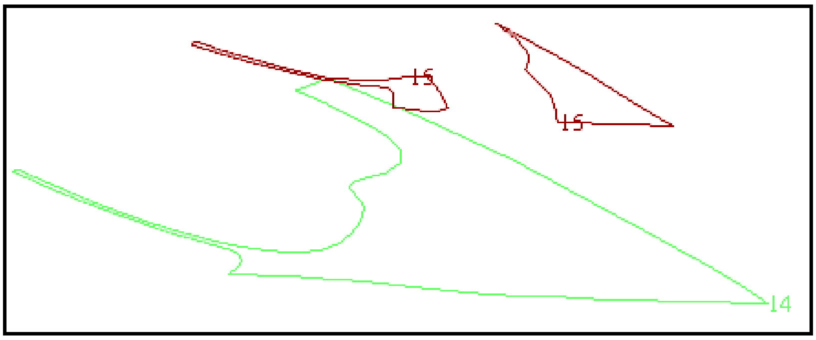
Note: To see all of the steps performed in this section, run **_03a_bifurcation.tcl.** You will need to click **Apply** on any forms presented.

Task: Use One Segment to Two Segments to Model a Bifurcation.

1. Click the **Reset graphics** icon .
2. Open **mod4.dtm**.
3. Choose **Display > Hide everything**.
4. Choose **Display > Strings > With string numbers**.
5. Enter the information as shown, and then click **Apply**.

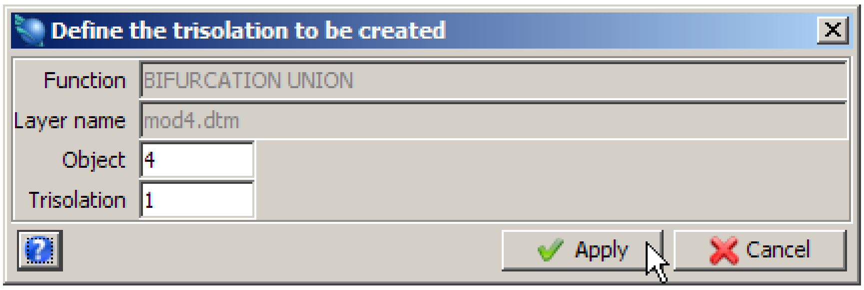


Note: String 14 will be the parent segment and the two segments of string 15 will be the child segments.

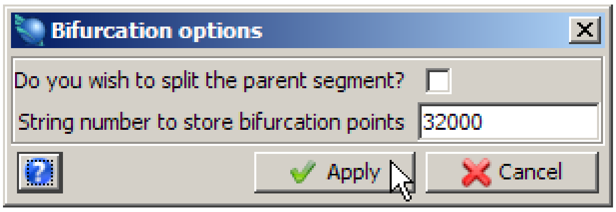


6. Choose **Solids > Triangulate > One segment to two segments**.

7. Enter the information as shown, and then click **Apply**.



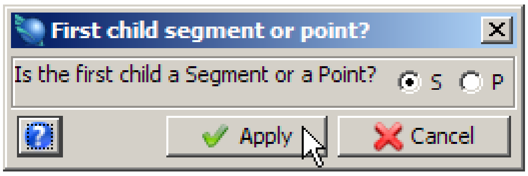
8. Enter the information as shown, and then click **Apply**.



You are prompted to select the parent segment.

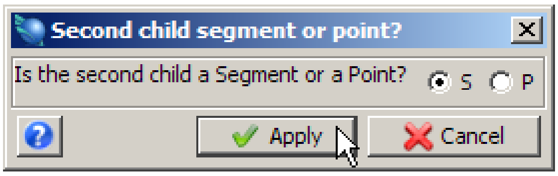
9. Click string 14.
You are then prompted to state whether the first child is a **(S)egment** or a **(P)oint**.

10. Enter the information as shown, and then click **Apply**.



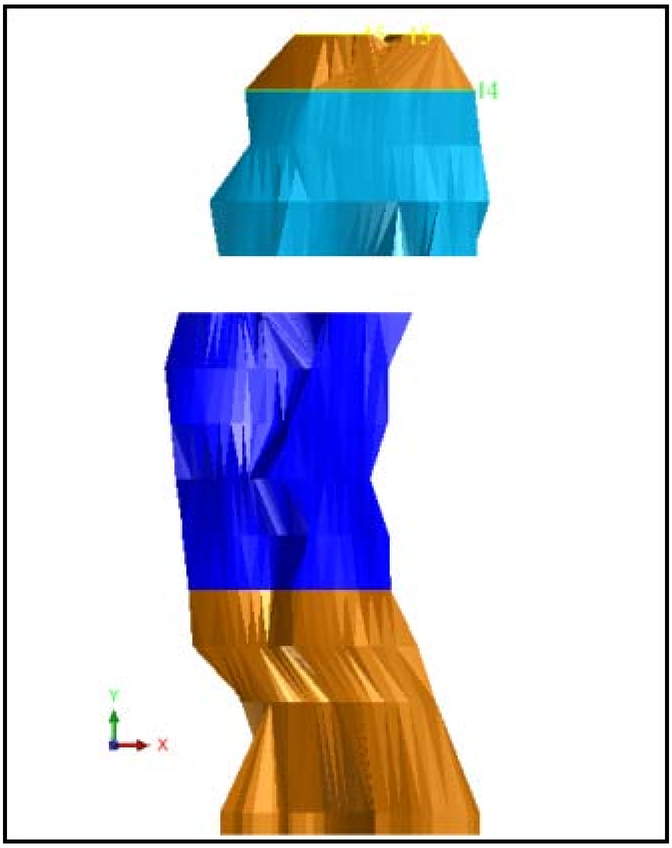
11. Click the left child segment of string 15.
A prompt will appear asking whether the second child is a **(S)egment** or **(P)oint**.

12. Enter the information as shown, and then click **Apply**.



13. Click the right child segment of string 15.
14. Choose **Display > All layers**.
15. Click the **Zoom all** icon .

The following image is displayed.

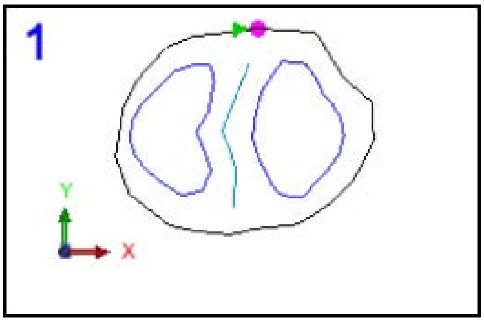


16. Save as **mod4.dtm**.

Note: To see all of the steps performed in this section, run **_03b_bifurcation_on_model.tcl.** You will need to click **Apply** on any forms presented.

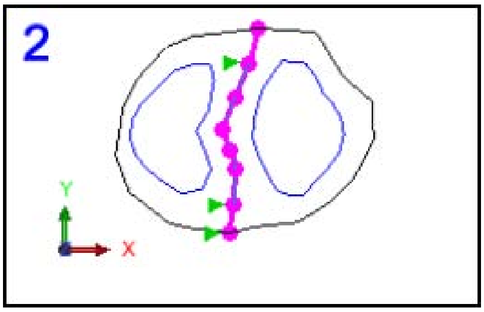
Task: Perform Bifurcation Using the Triangulate Shape Tool

1. Start the triangulation.
2. Open **bifurc4.str**.
3. Zoom out.
4. Choose the Triangulate Shape tool by clicking the icon.
5. Click the start point as shown.



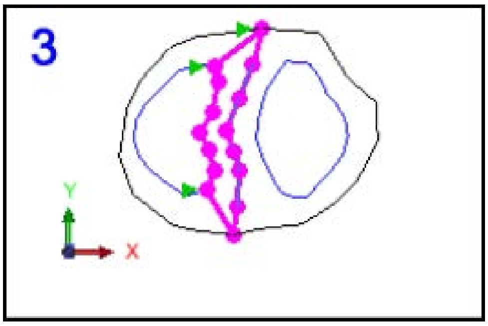
Notice that the point is highlighted as you hover over it, or if you click the point.

6. Select the line of bifurcation as shown, clicking the points indicated with green arrows.

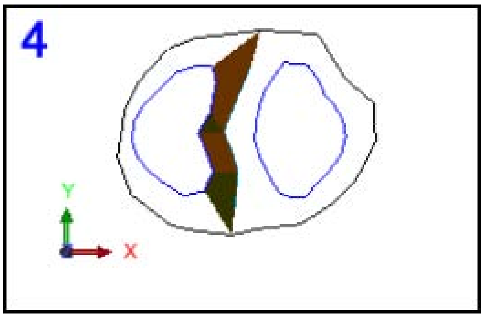


Hint: When selecting the points in a segment, Surpac chooses the shortest path between two points. This sometimes gives unwanted results by either skipping intermediate points or flipping to the opposite side of the segment. This is easily fixed by clicking on the intermediate points, which anchors the point by forcing Surpac to select it.

7. Continue selecting the shape by following the left child node as shown and returning to the start point.

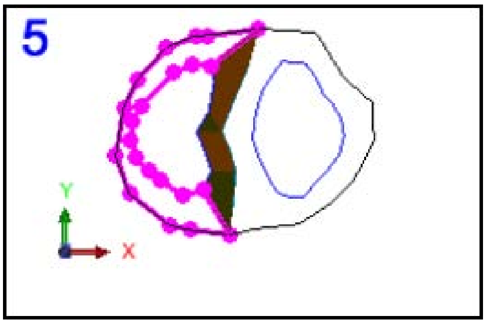


8. Notice that once the shape is joined up by clicking at the start point, that part of the model is triangulated as shown.



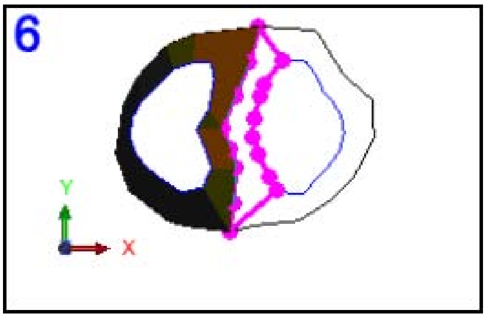
You have now triangulated the right side of the left child and next you will triangulate the left side of the left child.

9. Select the points as shown, finishing at the point where you started.



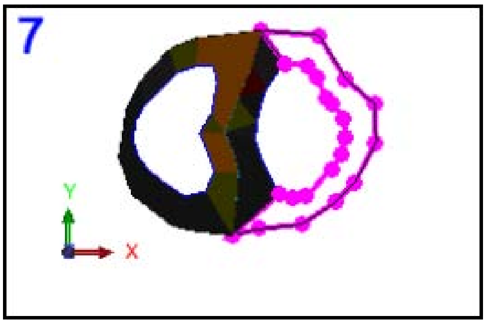
You have now finished the triangulation for the left child

10. Select the points as shown, finishing at the point where you started.

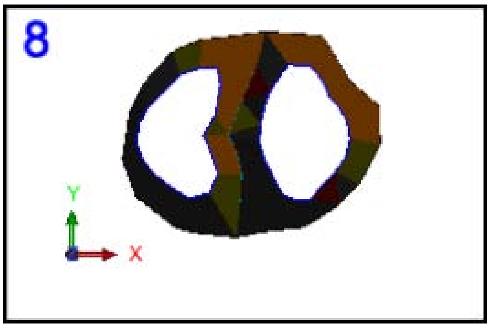


You have now triangulated the left side of the right child.

11. Select the points as shown, finishing at the point where you started.

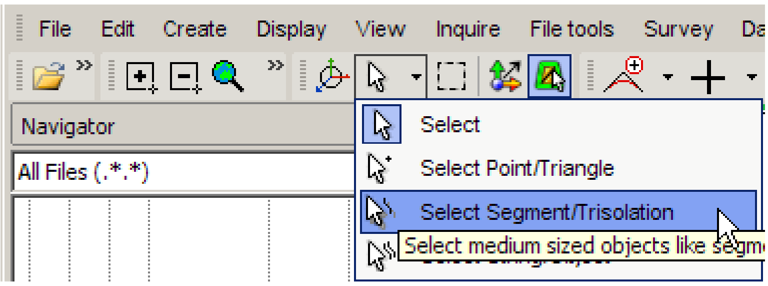


12. You have now finished triangulating the bifurcation using the Triangulate Shape tool. The bifurcation example is displayed.



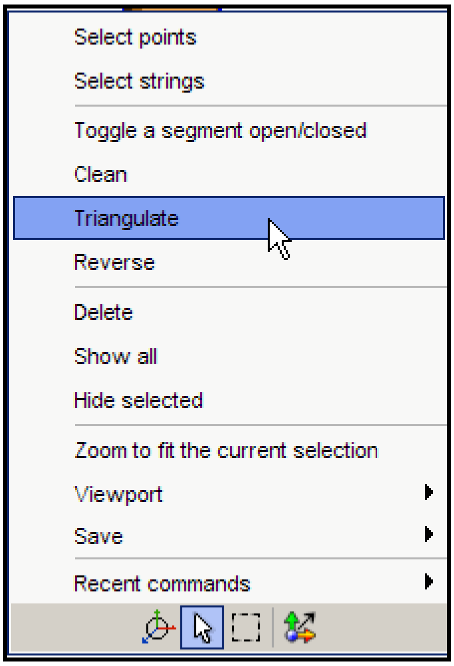
Next you will use data-centric mode to triangulate inside the parent and child segments to close the solid.

13. Click the Select Mode tool and select Segment/Trisolation mode as shown.



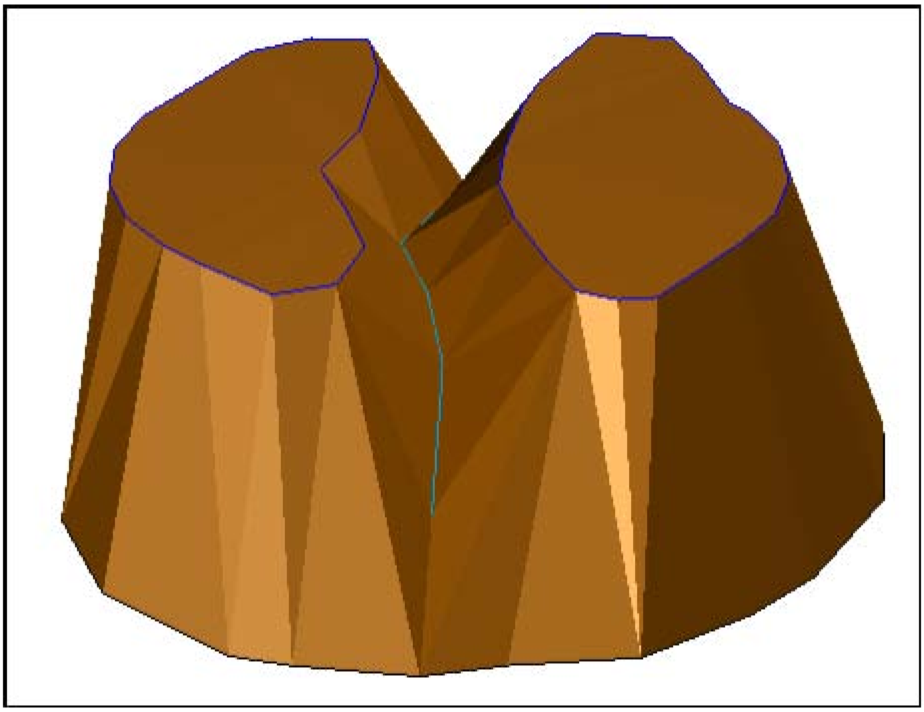
14. Click the parent segment to select it, and then right click to display a popup menu.

15. Choose **Triangulate**.



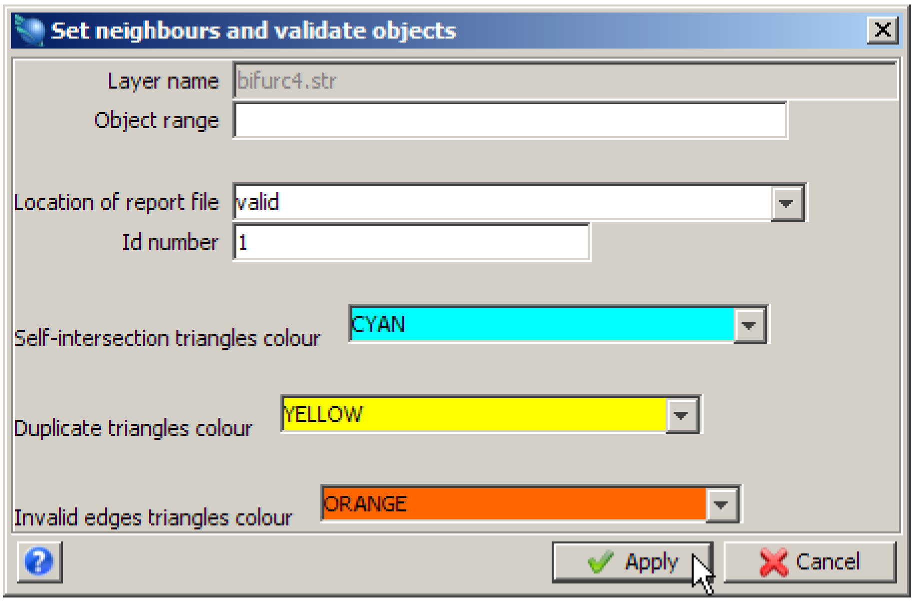
Notice that the parent segment has become closed.

16. Click the left child segment to select it, and then right click to display a popup menu.
17. Choose **Triangulate**.
18. Click the right child segment to select it, and then right click to display a popup menu.
19. Choose **Triangulate**.
    The closed solid is displayed.

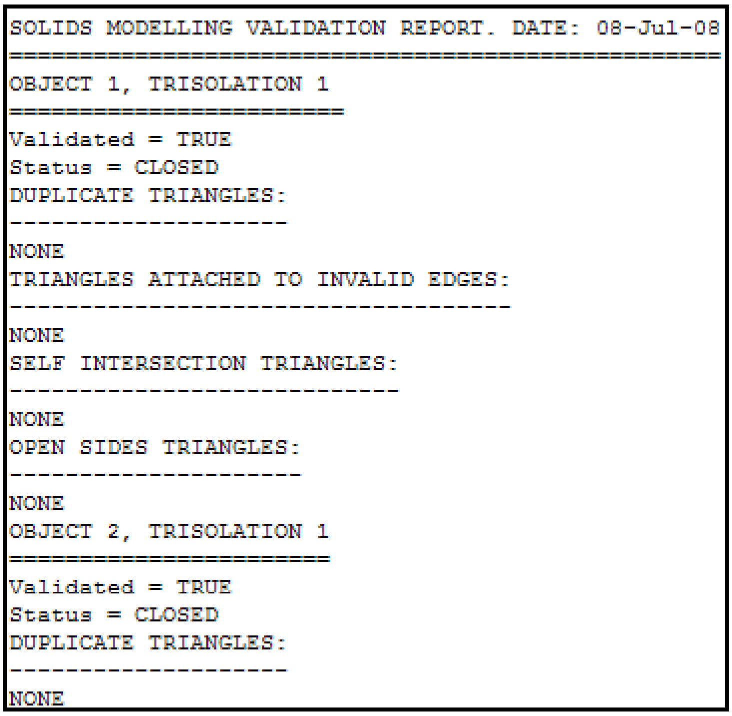


20. Save the solid model as **bifurc4finished.dtm**.
21. Choose **Solids > Validation > Validate object**.

22. Enter the information as shown, and then click **Apply**.



23. Open the file **valid1.not** in a text editor.
The Solids Modelling Validation report is displayed.



```
SOLIDS MODELLING VALIDATION REPORT. DATE: 08-Jul-08
===================================================
OBJECT 1, TRISOLATION 1
========================
Validated = TRUE
Status = CLOSED
DUPLICATE TRIANGLES:
--------------------
NONE
TRIANGLES ATTACHED TO INVALID EDGES:
------------------------------------
NONE
SELF INTERSECTION TRIANGLES:
----------------------------
NONE
OPEN SIDES TRIANGLES:
---------------------
NONE
OBJECT 2, TRISOLATION 1
=======================
Validated = TRUE
Status = CLOSED
DUPLICATE TRIANGLES:
--------------------
NONE
```

You can see that from the report that the solid is closed and validated.

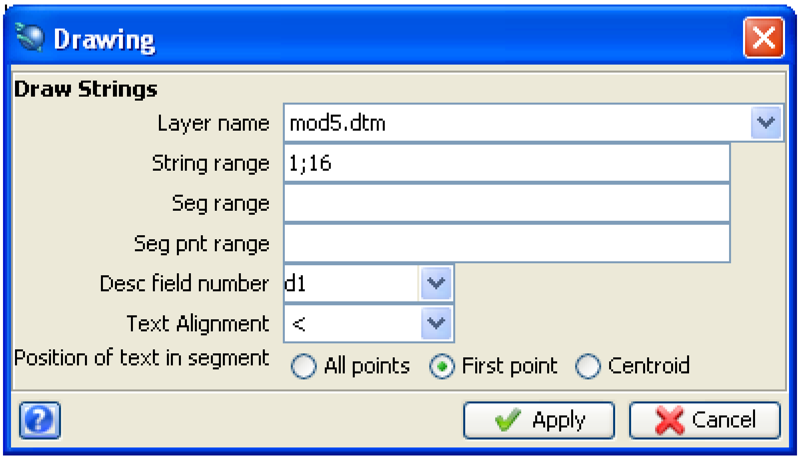
Triangulating Using Segment to a Point

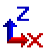
Segment to a point is a useful function for creating the ends of your ore body. In the following tasks you will learn about:

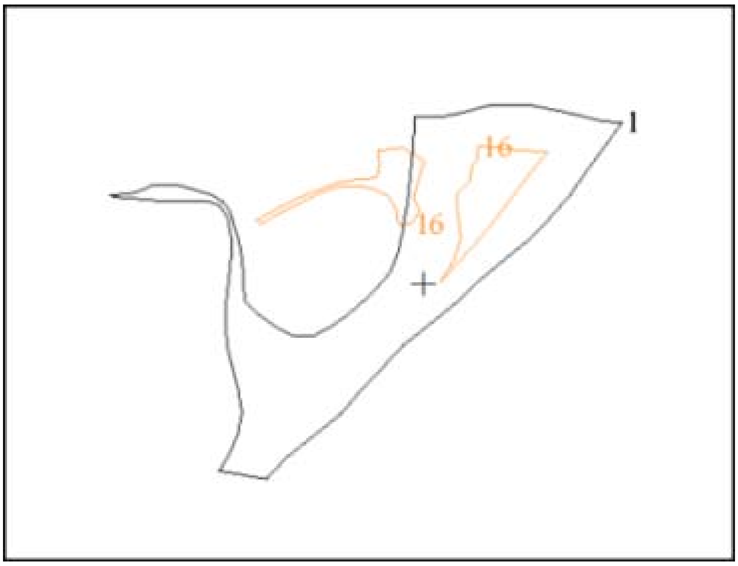
- Creating points to triangulate using the digitiser.
- Creating a solid using **Segment to a point**.

Task: Create Points to Triangulate Using the Digitiser

1. Click the **Reset graphics** icon .
2. Open **mod5.dtm**.
3. Choose **Display > Hide everything** to erase all strings and objects.
4. Choose **Display > Strings > With string numbers**.
5. Enter the information as shown, and then click **Apply**.

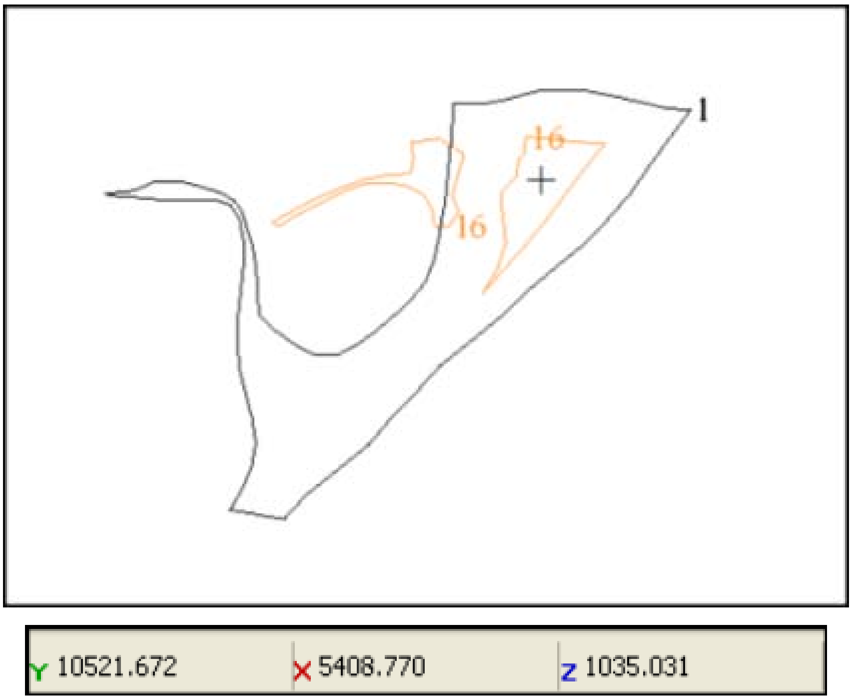


6. Click the  icon to put the data in section view.
   The strings are displayed.
7. Move the cursor to the centre of string 1 as shown.



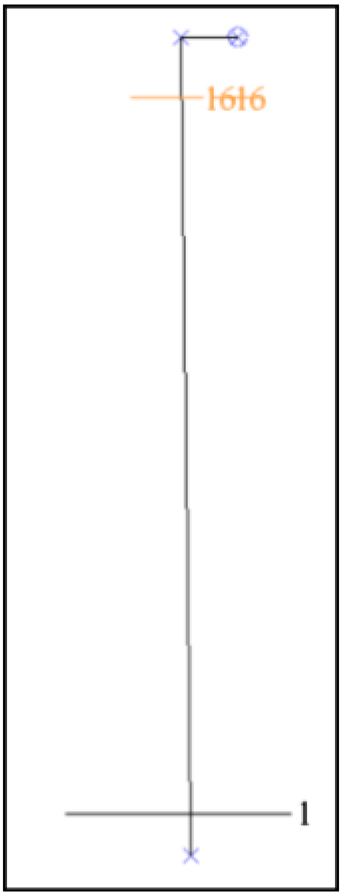
Notice that the elevation (z) of the centre point of string 1 is at approximately 990m.

8. Move the cursor to the centre of string 16 as shown.



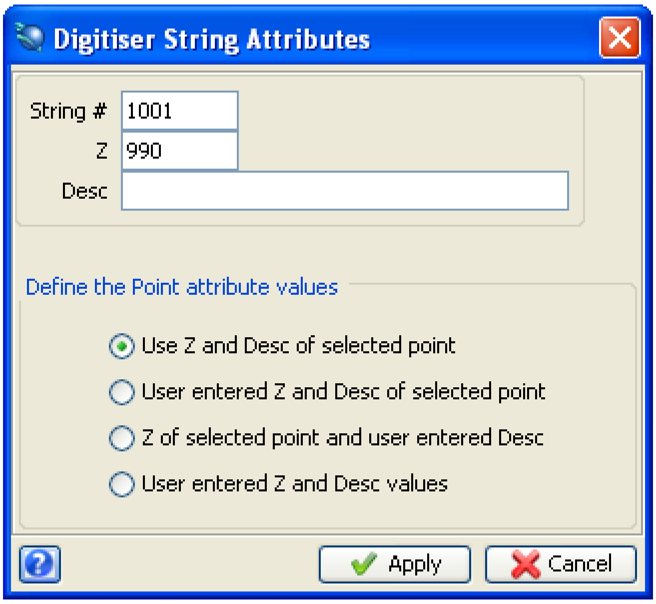
Notice that the elevation (z) of the centre point for string 16 is at approximately 1035m.

You will now digitise string 1001 as shown to use as end points for the model.



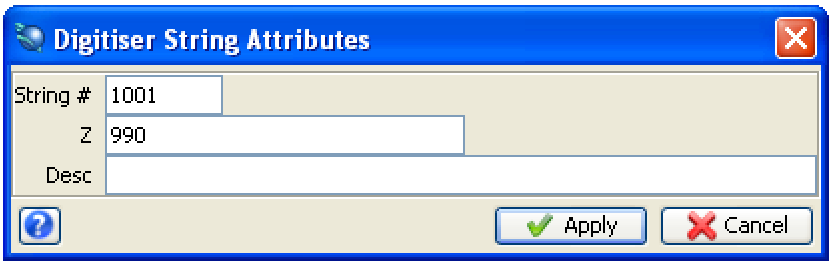
9. Click the  icon to zoom to the extents of the data and return the data to plan view.
10. Zoom out to create space for the end points.

11. Choose **Create> Digitise > Properties**.
12. Enter the information as shown, and then click **Apply**.

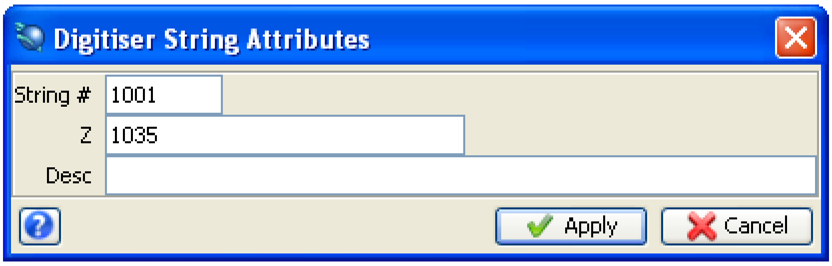


You will now use the digitiser to create the end points for triangulation.

13. Choose **Create > Digitise options > Enter attributes for each point**.
14. Choose **Create > Digitise > New point at mouse location**.
15. Click the southern most point.
16. Enter the information as shown, and then click **Apply**.

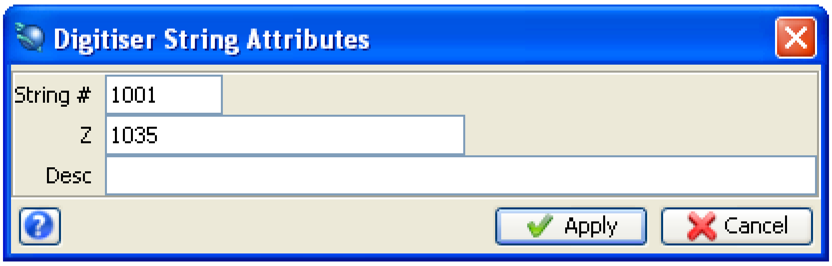


17. Click the northern most point.
18. Enter the information as shown, and then click **Apply**.

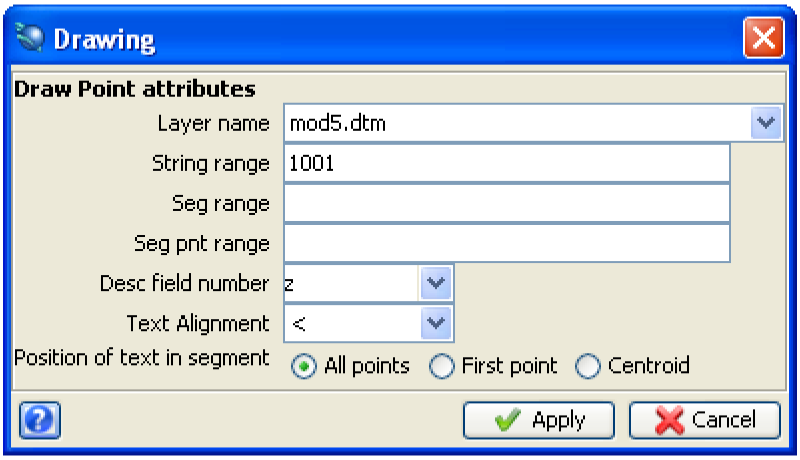


19. Click the final point on string 1001.

20. Enter the information as shown, and then click Apply.

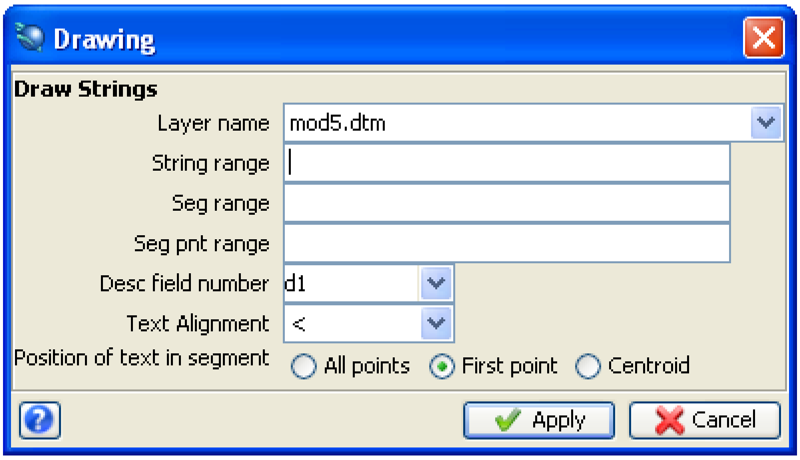


21. Press **ESC** to finish digitising.
22. Click the icon to view the data in long section view.
23. Choose **Display > Point > Attributes**.
24. Enter the information as shown, and then click **Apply**.

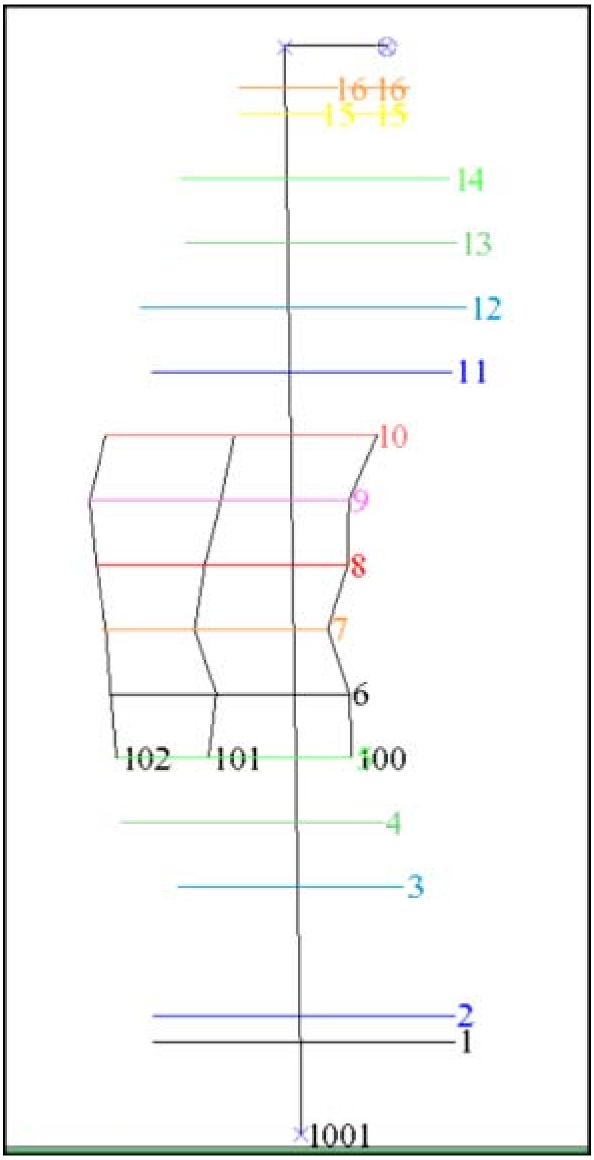


The data is displayed as shown.

25. Choose **Display > Strings > With string numbers**.
Enter the information as shown, and then click **Apply**.



26. Click the  icon from the toolbar to zoom to the extents of the data and return the data to plan view.
The strings are displayed as shown.

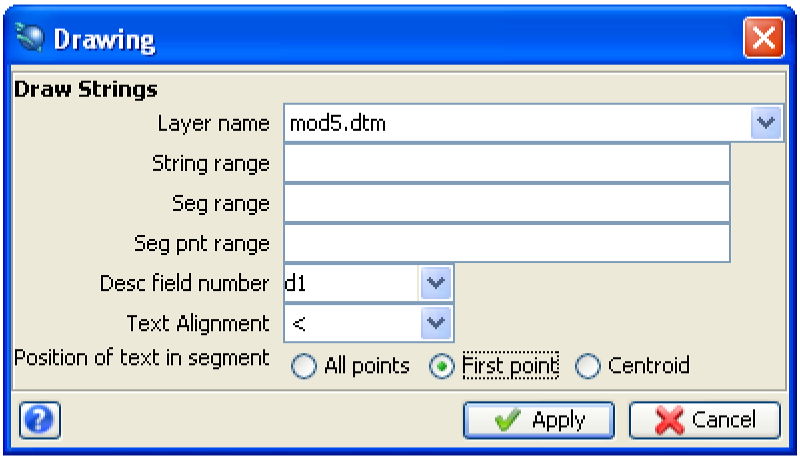


27. Save **mod5.dtm**.

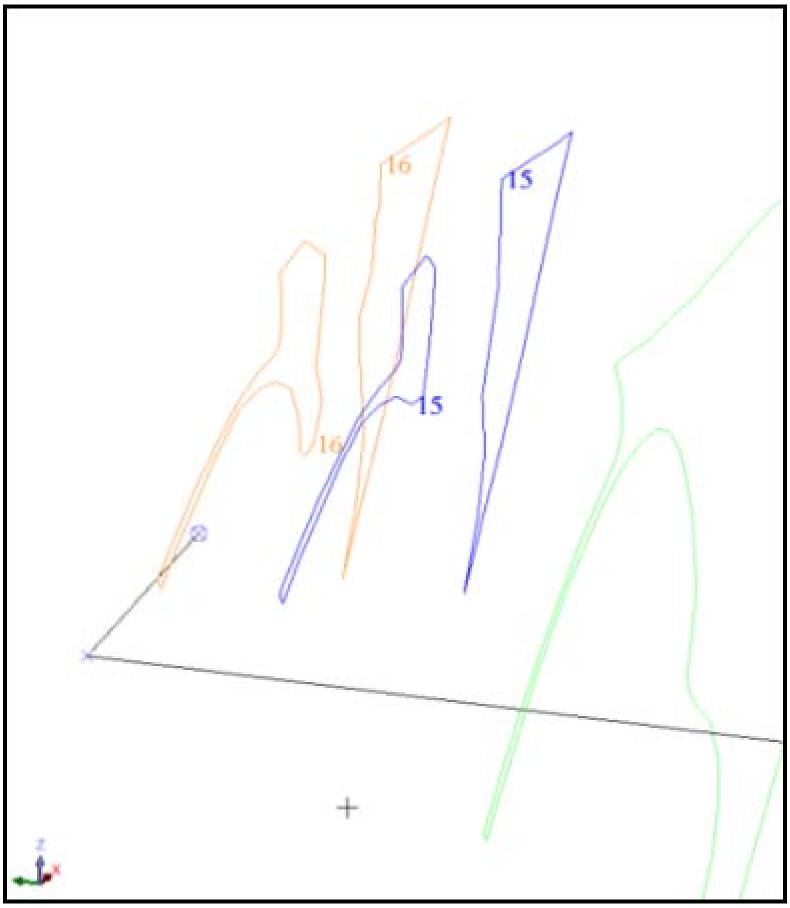
Task: Create a Solid Using Segment to a Point

1. Click the **Reset graphics** icon .
2. Open **mod5.dtm**.
3. Choose **Display > Hide everything** to erase all strings and objects.
4. Choose **Display > Strings > With string numbers**.

5. Enter the information as shown, and then click **Apply**.



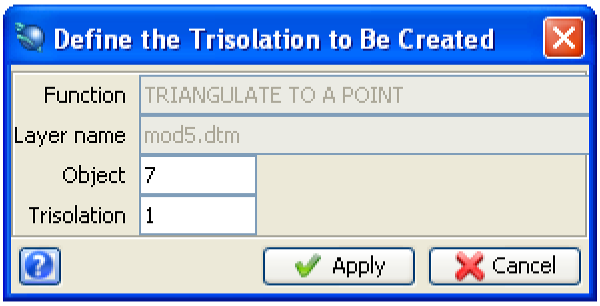
6. Display the northern end of the model as shown.
   Note:You need to see the points on string 1001 and also both segments of string 16.



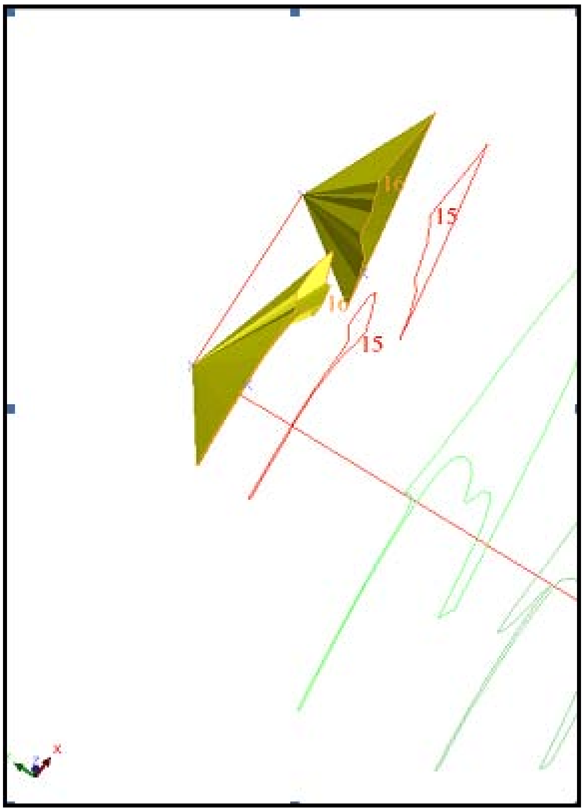
7. Choose **Solids > Triangulate > Segment to a point**.

8. Enter the information as shown, and then click **Apply**.

9. Click a point of string 1001 (ie. the one you just digitised).
10. Click the matching segment of string 16.
11. Press ESC. You have now finished the first triangulation.
12. Choose **Solids > Triangulate > Segment to a point**.
13. Enter the information as shown, and then click **Apply**.

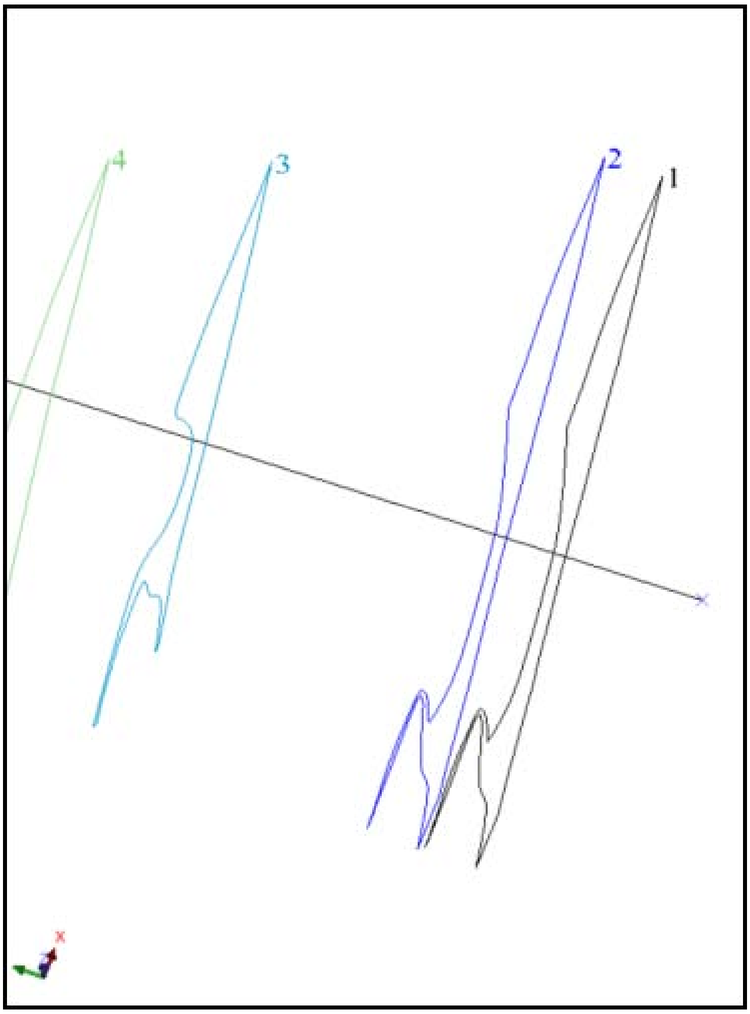


14. Click the second Northern point of string 1001.
15. Click the second matching segment of string 16.
16. Press **ESC**.
    The northern end will look like the image shown.

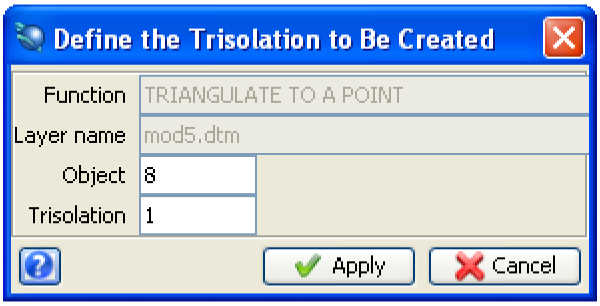


You will now repeat this process on the other end of the data.

17. Change to the view as shown.



18. Choose **Solids > Triangulate > Segment to a point**.
19. Enter the information as shown, and then click **Apply**.

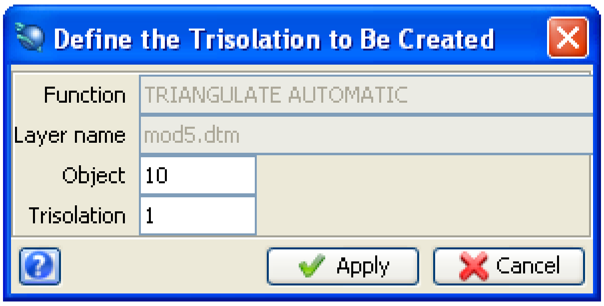


20. Click the southern point of string 1001, and then click string 1.
21. Press ESC to finish the triangulation.
22. ick the  icon to zoom to the data extents.
23. Choose **Display > All layers**.

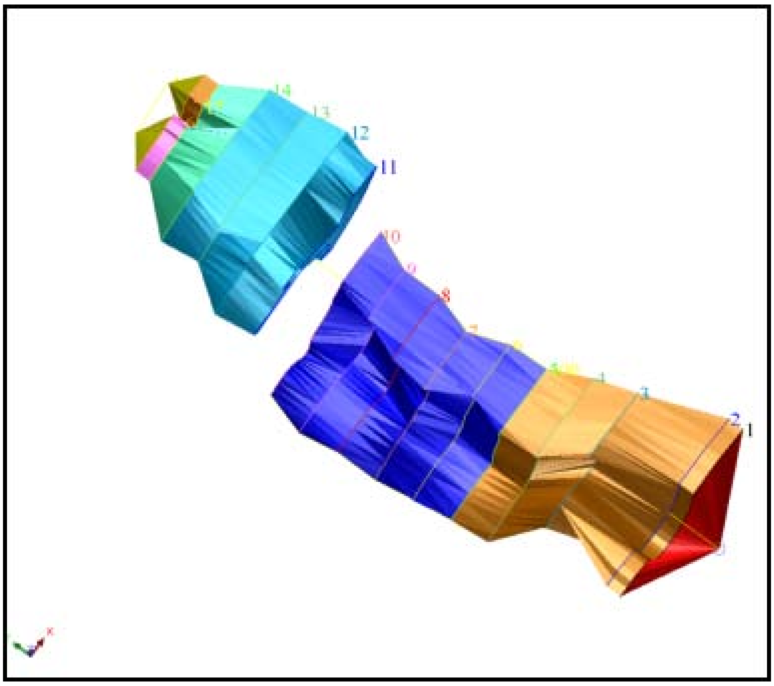
    Notice that there is still a gap between strings 15 and 16. You will now create objects 9 and 10 to fill these gaps.
24. Choose **Solids > Triangulate > Between segments**.

25. Enter the information as shown, and then click **Apply**.

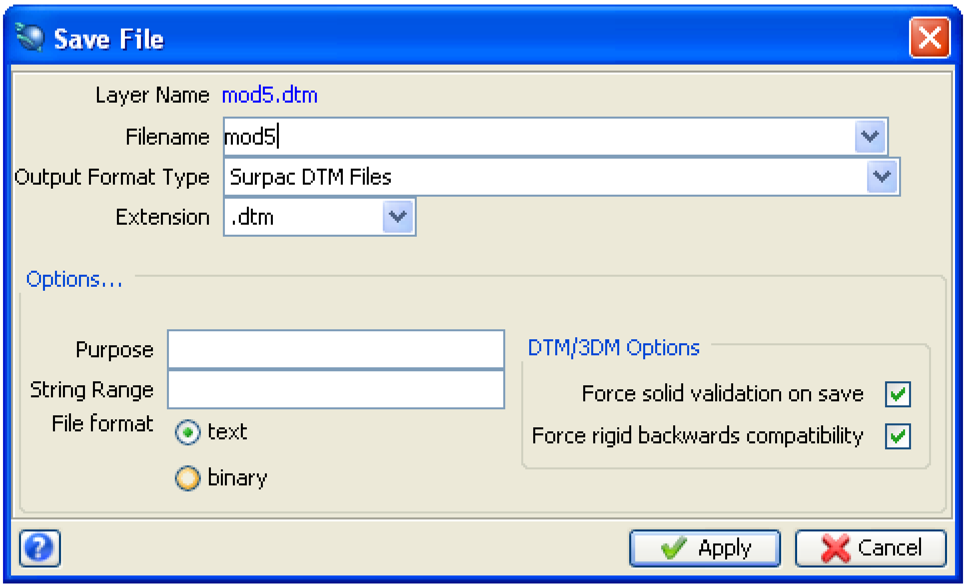
26. Click a segment on string 15.
27. Click the corresponding segment on string 16.
28. Press **ESC**.
29. Choose **Solids > Triangulate > Between segments**.
30. Enter the information as shown, and then click **Apply**.

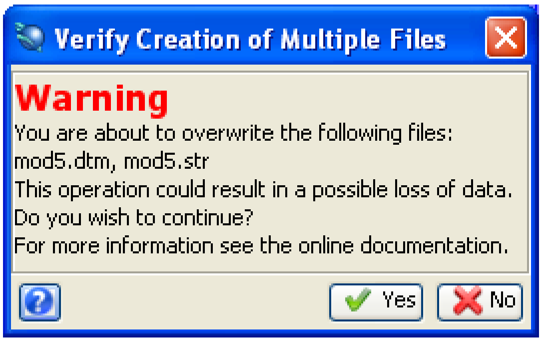


31. Click the other segment on string 15.
32. Click the corresponding segment on string 16.
33. Press **ESC**.



34. Save **mod5.dtm**.





35. Click **Yes**.

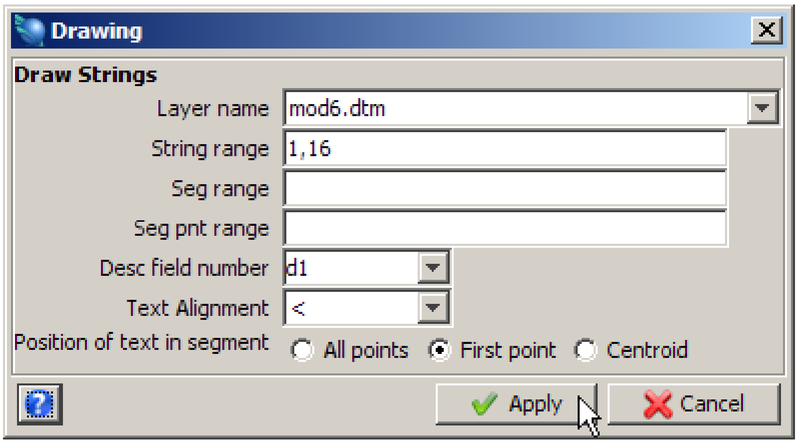
Note: If you want to see all of the steps performed in this chapter, run **_04a_segment_to_a_point.tcl**. You will need to click **Apply** on any forms presented.

If you want to run manually through the material again, you will need to copy **original_mod5.dtm** to **mod5.dtm**.

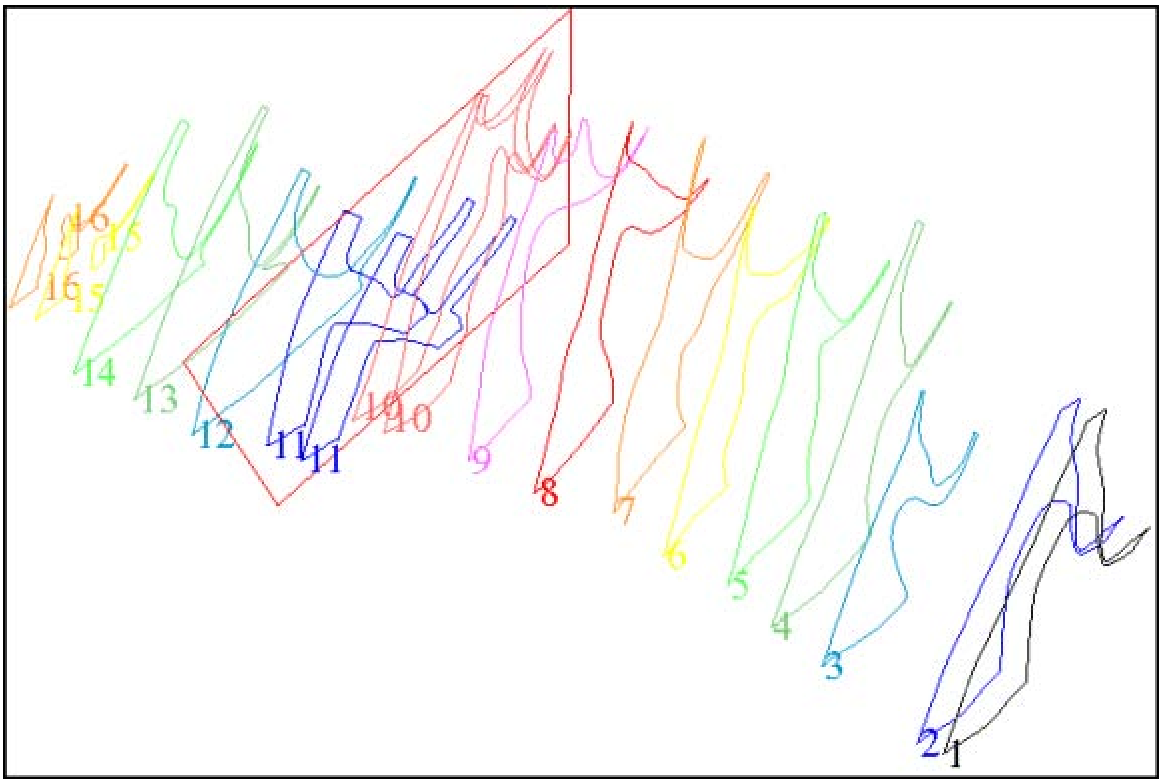
Triangulating a Fault

Task: Triangulate a Fault – Data Preparation

1. Click the **Reset graphics** icon .
2. Open **fault1.str**.
3. Open **mod6.dtm**.
4. Choose **Display > Hide surface/solid**.
5. Choose **Display > Strings > With string numbers**.
6. Enter the information as shown, and then click **Apply**.



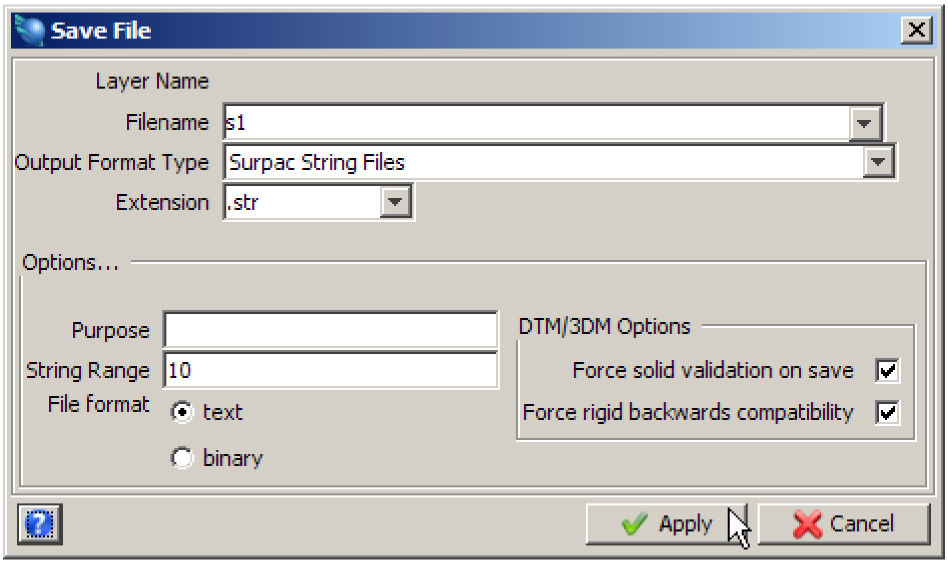
7. Rotate the data as shown to view the fault plane.
   Section Strings plus fault are displayed.



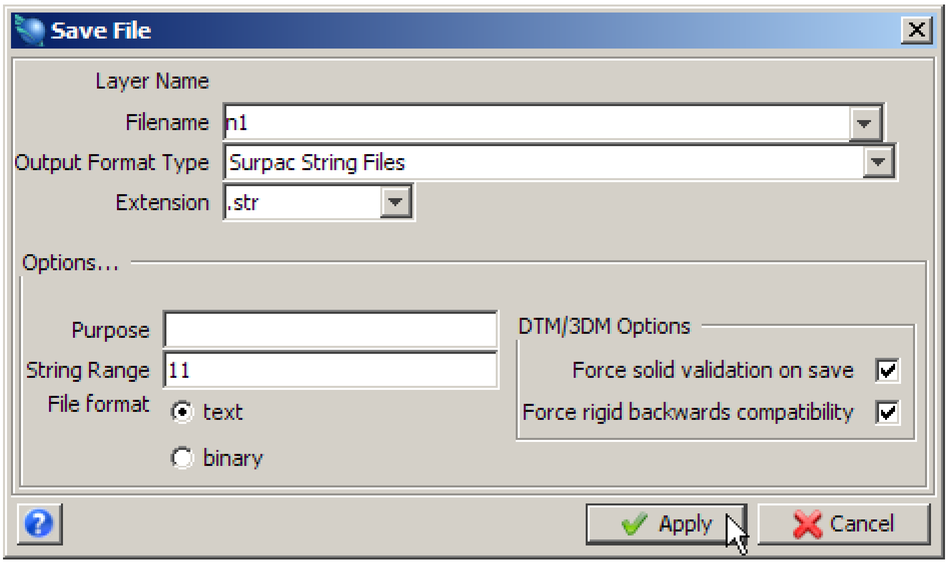
The string **fault1.str** represents the fault through this area. Ideally, you need two shapes that coincide with the fault on either side of the fault. The following steps illustrate one way of doing this.

8. Choose **File > Save > string/DTM**.

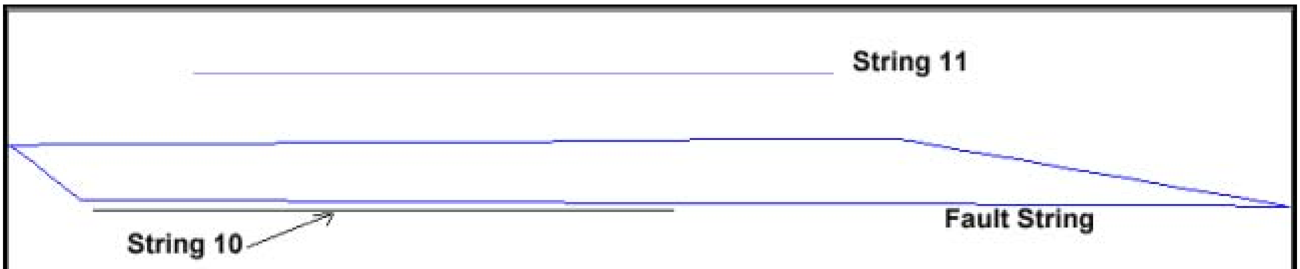
9. Enter the information as shown, and then click **Apply**.



10. Choose **File > Save > string/DTM**.
11. Enter the information as shown, and then click **Apply**.



12. Click the **Reset graphics** icon .
13. Open **south1.str**, **north1.str** and **fault1.str**.
    The plan view of the fault is displayed.

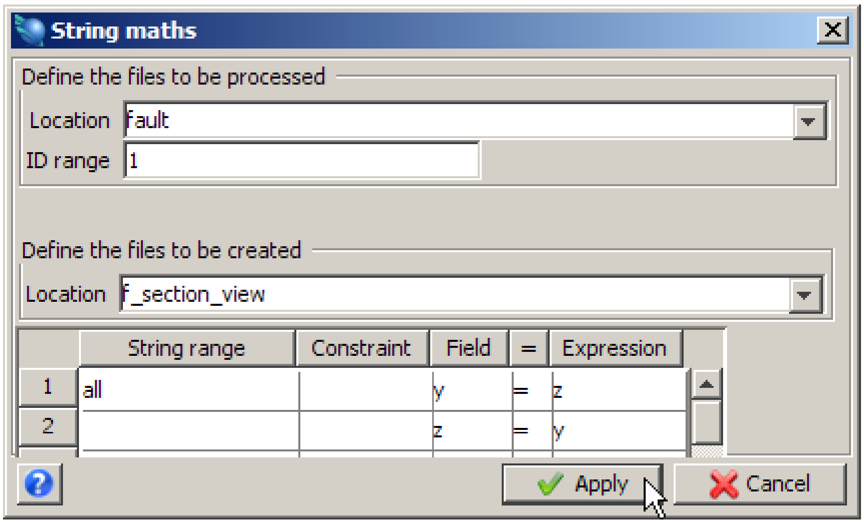


Plan view of Fault and ore polygons immediately north (String 11) and south (String 10) of fault.

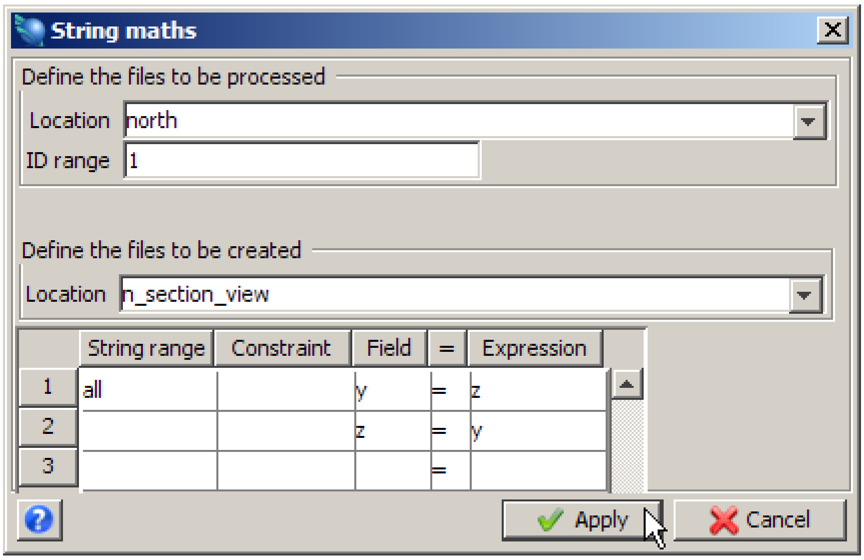
You now need to press these strings onto the surface of the fault.

This function works only on Z or Description fields, therefore you will need to swap your Y and Z coordinates to make this function work correctly (ie. go to section view).

1. Choose **File tools > String maths**.
2. Enter the information as shown, and then click **Apply**.

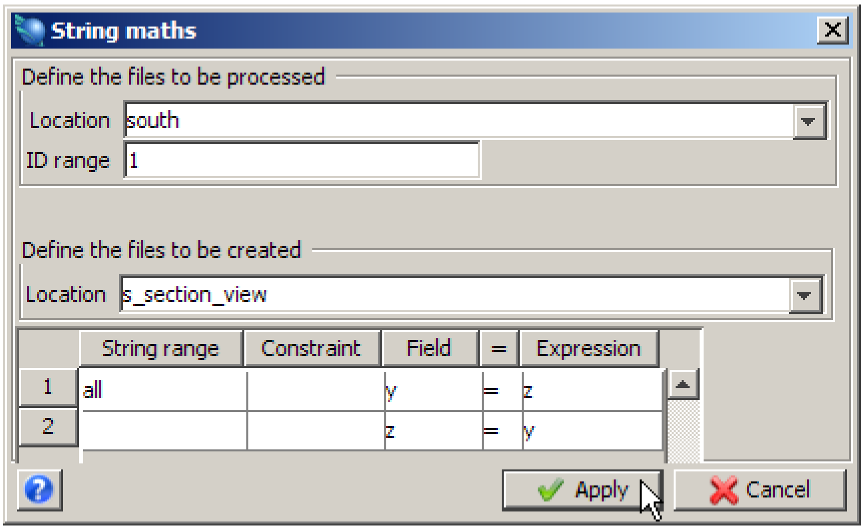


3. Choose **File tools > String maths**.
4. Enter the information as shown, and then click **Apply**.

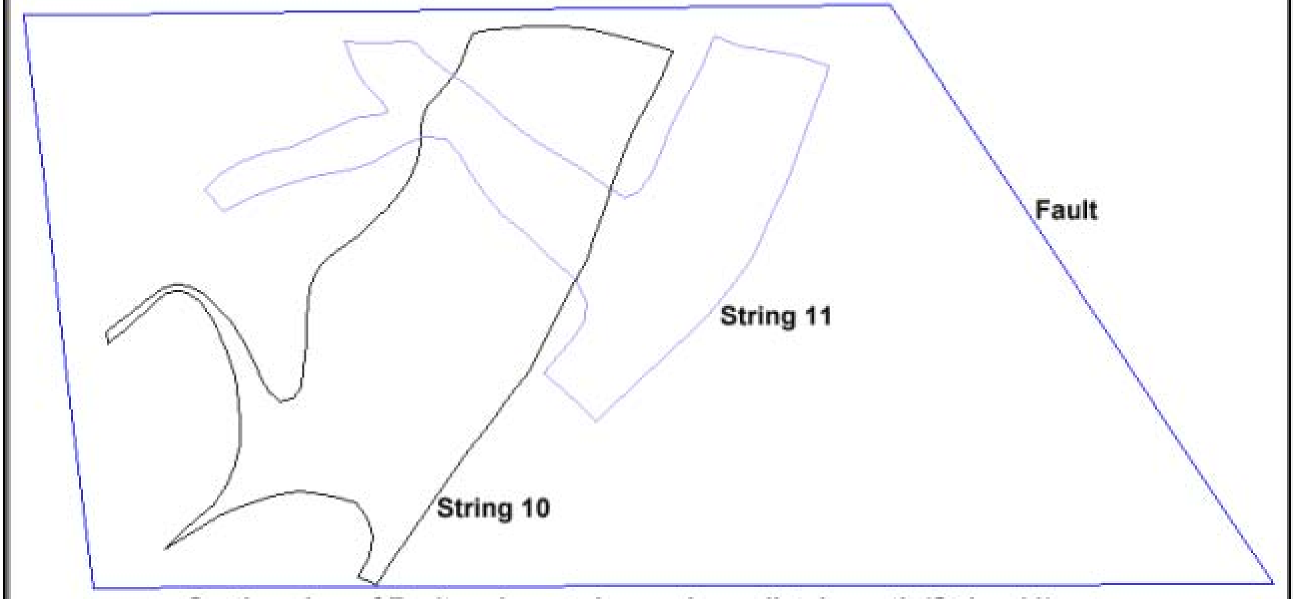


5. Choose **File tools > String maths**.

6. Enter the information as shown, and then click **Apply**.



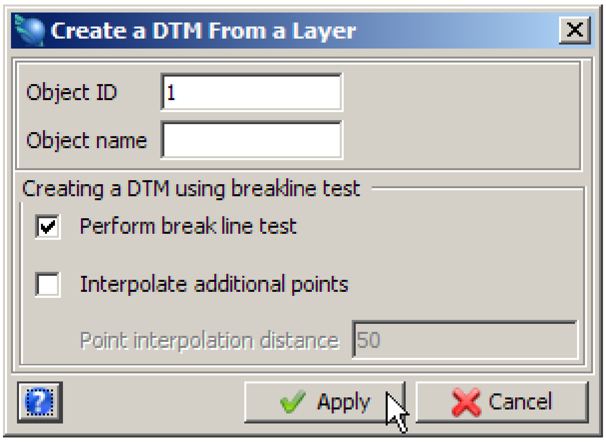
7. Click the **Reset graphics** icon .
8. Open **n_section_view1.str**, **s_section_view1.str** and **f_section_view1.str** in that order. The fault with Ore Polygons is displayed.



Section view of Fault and ore polygons immediately north (String 11) and south (String 10) of fault.

9. Choose **Surfaces > Create DTM from Layer**.

10. Enter the information as shown, and then click **Apply**.

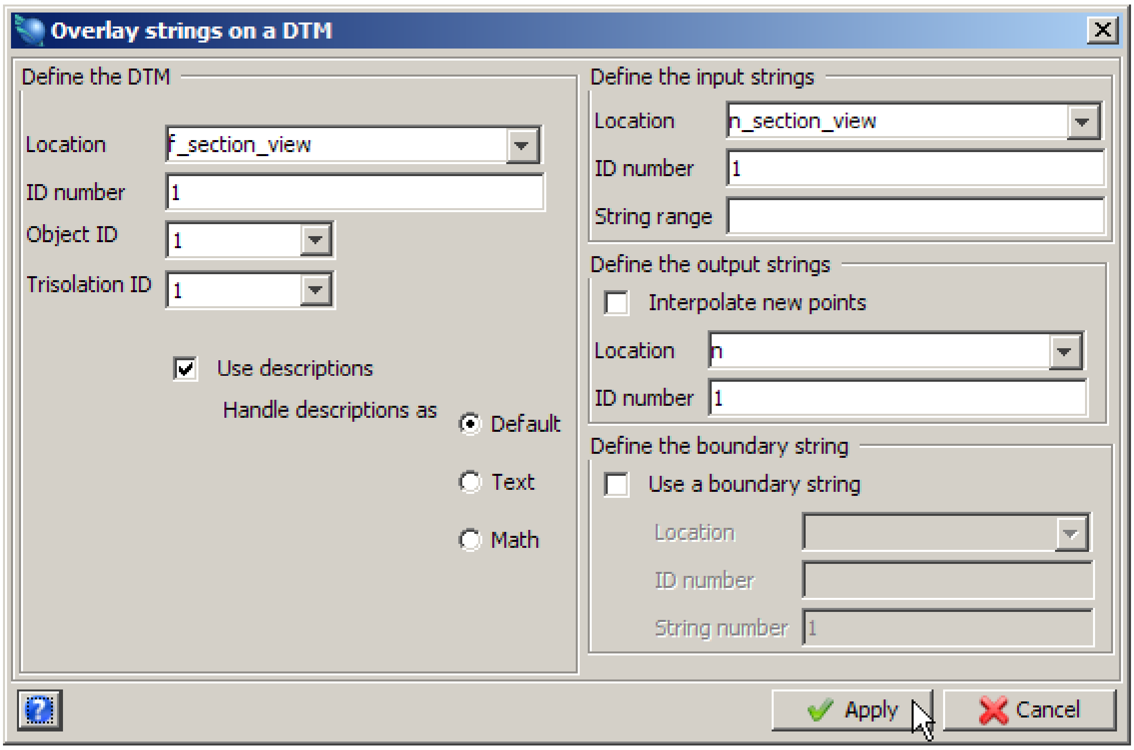


11. Save as **f_section_view.dtm**.

Note: To see all of the steps performed in this section, run **_04b_triangulate_fault_data_preparation.tcl.** You will need to click **Apply** on any forms presented.

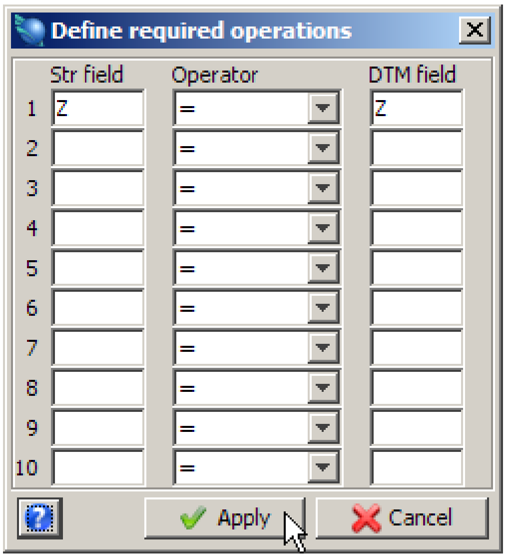
Task: Triangulate a Fault - Draping Strings and Triangulating

1. Choose **Surfaces > DTM file functions > Drape strings over a DTM**.
2. Enter the information as shown, and then click **Apply**.



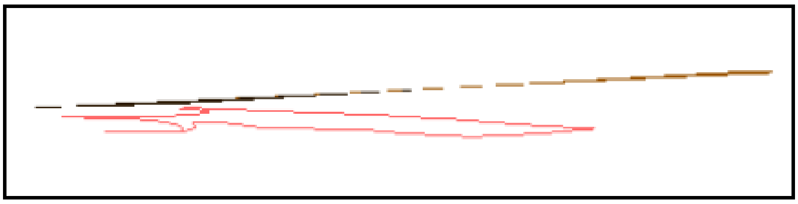
The operation to be performed is Z = Z and this is the default operation displayed.

3. Enter the information as shown, and then click **Apply**.

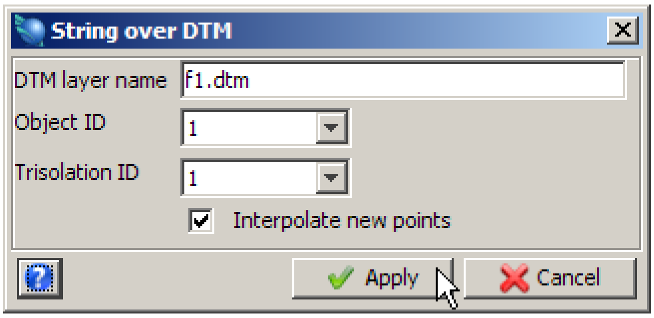


Strings can also be pressed onto a DTM by opening the DTM into one layer and the string file to be pressed into another. You will now press string 10 in file **s1.str** against the fault plane.

4. Click the **Reset graphics** icon .
5. Open **f_section_view1.dtm**.
6. Open **s_section_view1.str**, which contains string 10.
7. Rotate the view so you can clearly see the string.

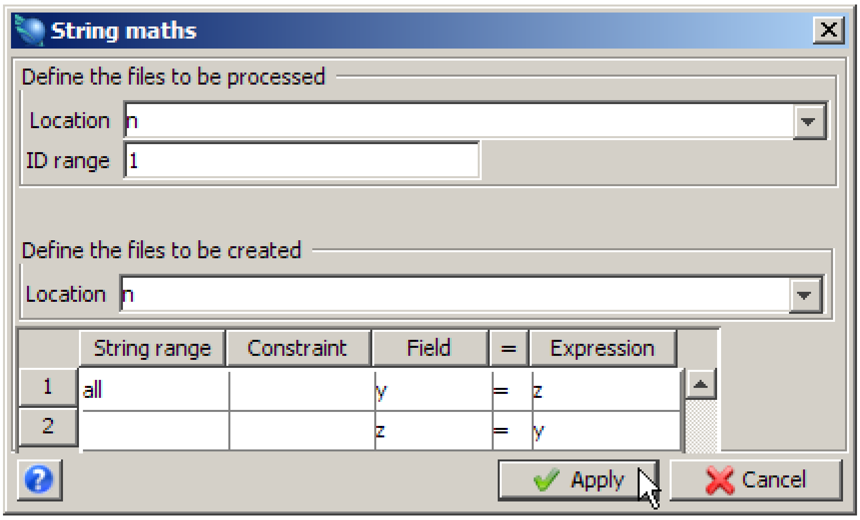


8. Choose **Surfaces > Drape string over DTM**.
   You are prompted to select the string to be draped over the DTM.
9. Click string 10.
   You will be prompted to select the layer that contains the DTM file.
10. Enter the information as shown, and then click **Apply**.

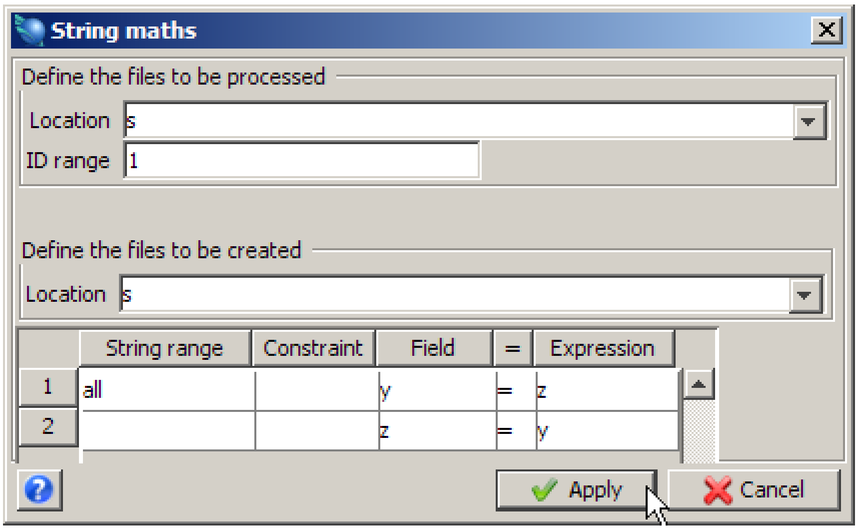


Note: You will see that the string is pressed onto the DTM surface. New points will be interpolated into the pressed string so that the strings are pressed perfectly against the DTM surface.

11. Save as **s1.str**.
12. Choose **File tools > String maths**, and swap **n1.str** (string 11) back to plan view as shown.



13. Choose **File tools > String maths**, and swap **s1.str** (string 10) back to plan view as shown.

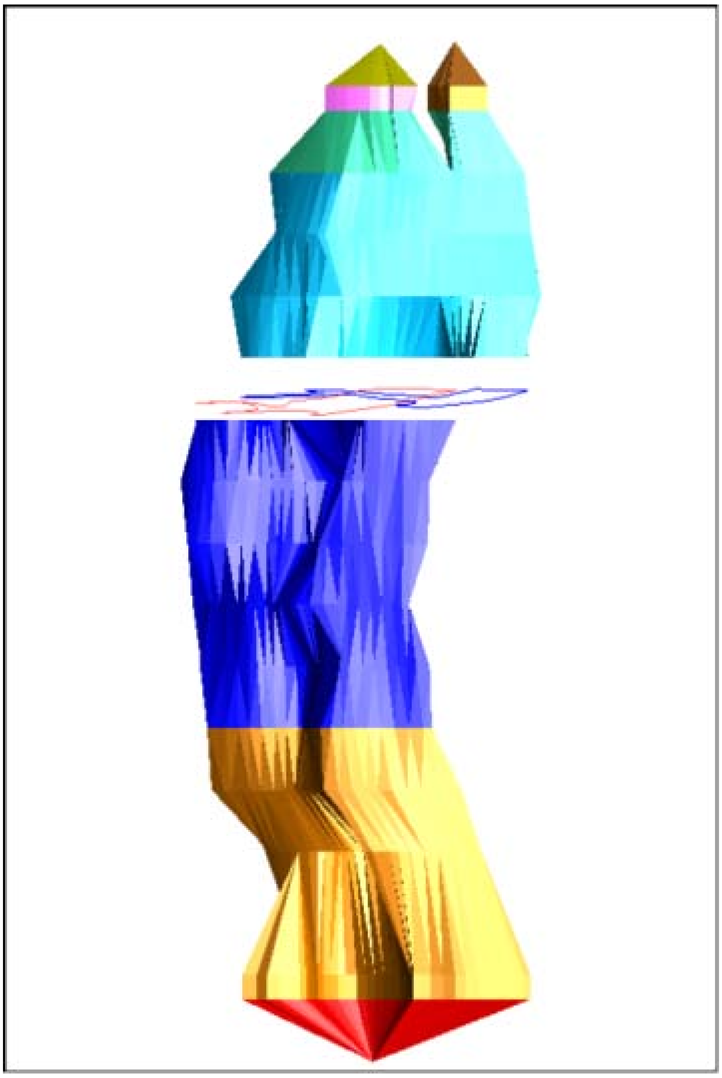


Now you are ready to incorporate the newly created strings into your solid model.

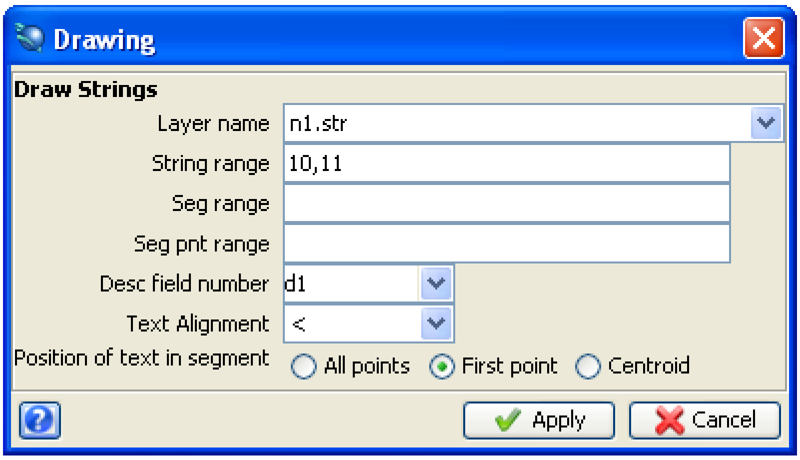
14. Click the **Reset graphics** icon .
15. Open **s1.str**.
16. Open **n1.str**, appending it to the same layer.
    Note: Hold down the **CTRL** key while dragging and dropping **n1.str** into graphics.

    You should see that the two string segments are coincident along the plane of the fault.
17. Open and append **mod6.dtm**.

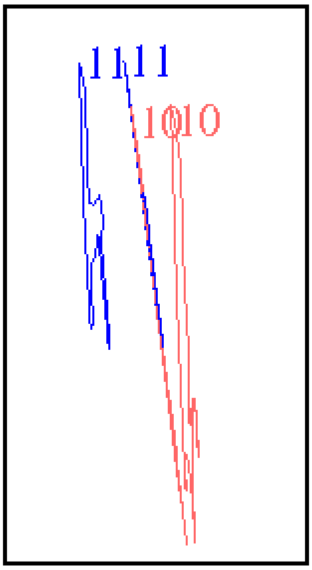
Two string segments are displayed.



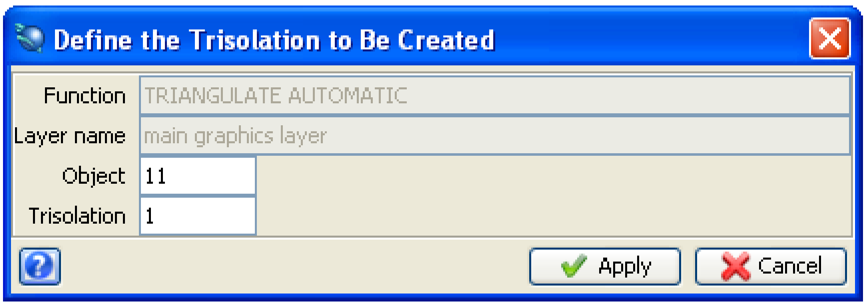
18. Choose **Display > Hide everything**.
19. Choose **Display > Strings > With string numbers**.
20. Enter the information as shown, and then click **Apply**.



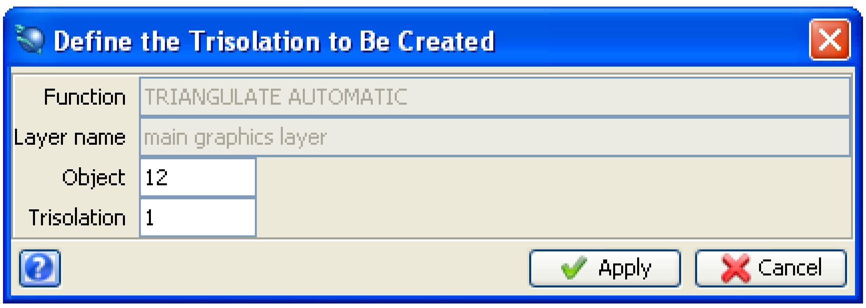
21. Zoom in and adjust the view as necessary to see the data clearly.



22. Choose **Solids > Triangulate > Between segments**.
23. Enter the information as shown, and then click **Apply**.

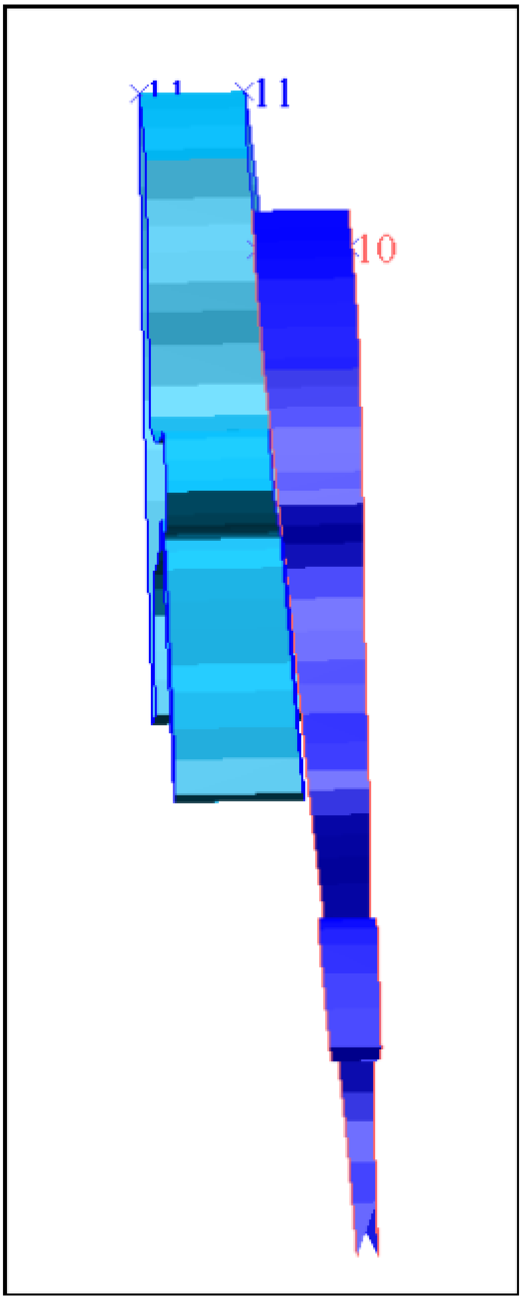


24. Click string 10, segment 1 and then string 10, segment 2.
25. Press **ESC**.
26. Choose **Solids > Triangulate> Between segments**.
27. Enter the information as shown, and then click **Apply**.



28. Click string 11, segment 1 and string 11, segment 2.
29. Press **ESC**.

The following image is displayed.



30. Save as **mod6.dtm**.

If you want to run manually through the material again, you will need to copy **original_mod6.dtm** to **mod6.dtm**.

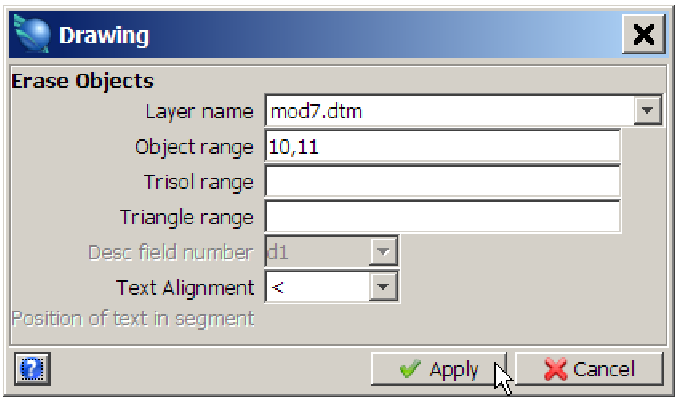
Note: To see all of the steps performed in this section, run **_04c_draping_strings_and_tri-angulating_fault.tcl.** You will need to click **Apply** on any forms presented.

Triangulating Using Inside Segment and One Triangle

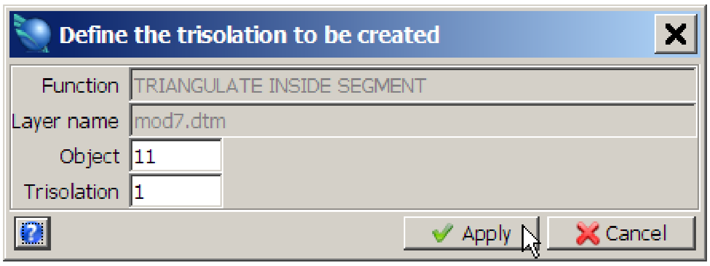
Task: Triangulate Inside a Segment

1. Click the **Reset graphics** icon .
2. Open **mod7.dtm**.
3. Choose **Display > Hide surface/solid**.

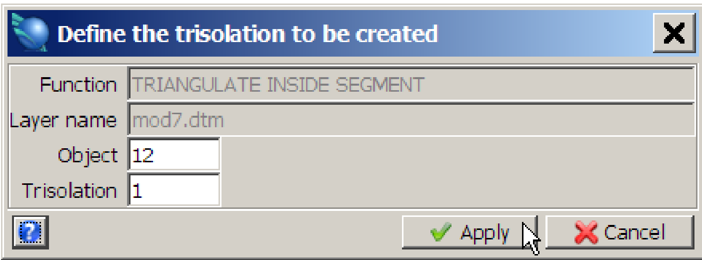
4. Choose **Display > Strings > With string numbers**.
5. Enter the information as shown, and then click **Apply**.



6. Choose **Solids > Triangulate > Inside a segment**.
7. Enter the information as shown, and then click **Apply**.



8. Click String 10, Segment 2. (ie. the segment located on the fault)
9. Choose **Solids > Triangulate > Inside a segment**.
10. Enter the information as shown, and then click **Apply**.



11. Click string 11, segment 2. (ie. the segment located on the fault)
12. Press **ESC**.
13. Save the result as **mod7.dtm**.

If you want to run manually through the material again, you will need to copy **original_mod7.dtm** to **mod7.dtm**.

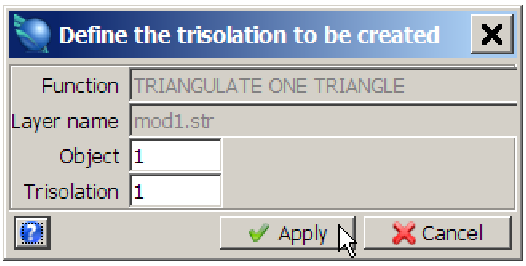
Note: To see all of the steps performed in this section, run **_04d_triangulate_inside_segment.tcl.** You will need to click **Apply** on any forms presented.

Task: Triangulate Using the One Triangle Function

1. Click the **Reset graphics** icon .
2. Open **mod1.str**.
3. Zoom in on any part of the file.
4. Choose **Display > Point > Markers** to display all the points in the segments.
5. Choose **View > Data view options > View by bearing & dip**.

6. Enter the information as shown, and then click **Apply**.

7. Choose **Solids > Triangulate > One Triangle**.
8. Enter the information as shown, and then click **Apply**.



9. As prompted, click a point on a string.
10. As prompted, click a point on a following string.
11. As prompted, click a point on the first string, adjacent to the first point you selected.

Note: A closed triangle is displayed. The software prompts you to select another point. If you select a point on the second string, a second triangle will appear. Using this process you can manually build up the triangulation.

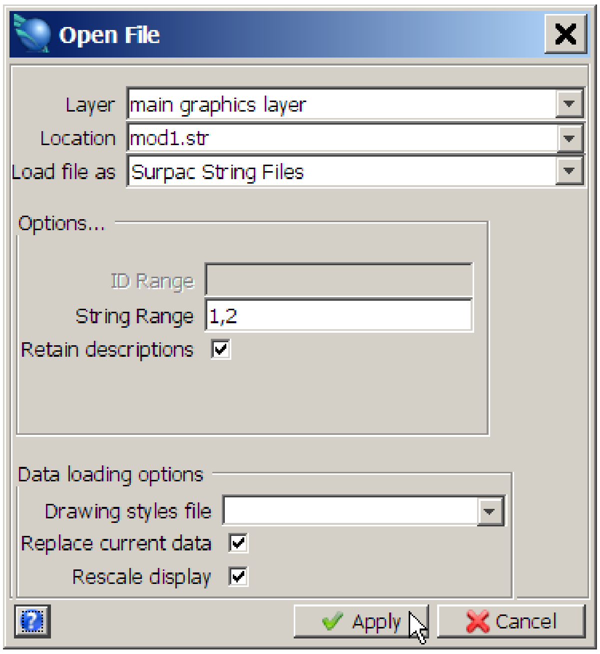
12. Press **ESC**.

Note: To see all of the steps performed in this section, run **_04e_triangulate_one_triangle.tcl.** You will need to click **Apply** on any forms presented.

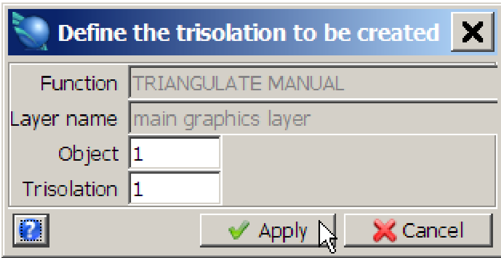
Triangulating Using Manual Triangulation

Task: Triangulate Using Manual Triangulation

1. Choose **File > Open > String/DTM file**.
2. Enter the information as shown, and then click **Apply**



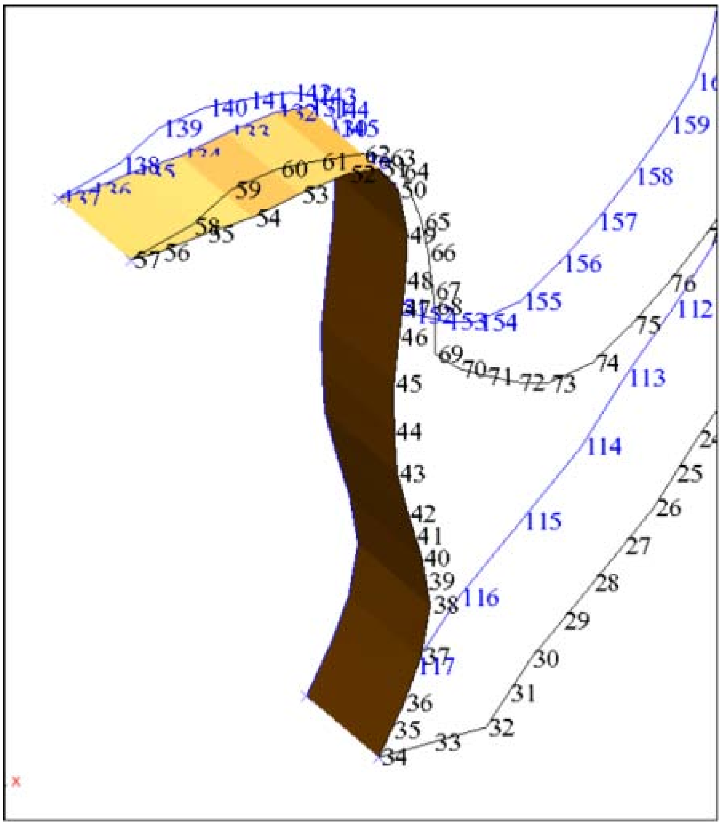
3. Choose **View > Data view options > View by bearing & dip** to change the view to Bearing = 70, Dip = -20.
4. Zoom in on strings 1 and 2.
5. Choose **Display > Point > Numbers** to display the numbering sequence of strings 1 and 2.
6. Choose **Solids > Triangulate > By manually selecting points**.
7. Enter the information as shown, and then click **Apply.**



Note: Follow the prompts at the bottom of the screen with care as the segments must be selected in a strict order.

8. Click point 34 on string 1 and then the corresponding point 118 on string 2.
9. Click point 57 on string 1 and then the corresponding point 137 on string 2.
10. Press **ESC**.

The triangulated image is displayed.

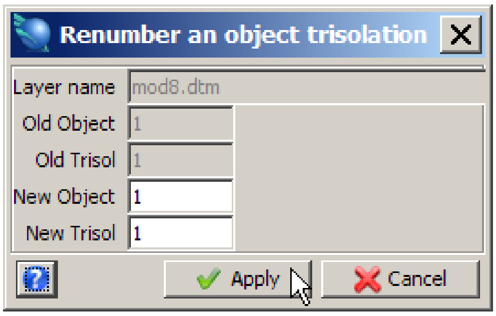


Note: To see all of the steps performed in this section, run **_04f_triangulate_manual.tcl.** You will need to click **Apply** on any forms presented.

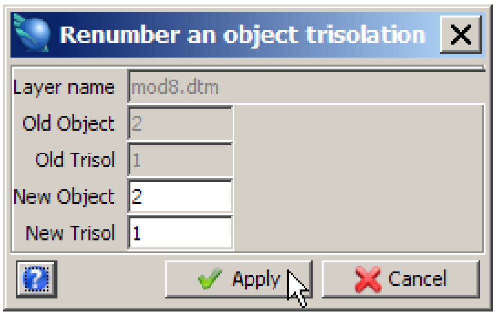
Editing Solids

Task: Edit a Solid

1. Click the **Reset graphics** icon .
2. Open **mod8.dtm**.
3. Choose **Solids > Edit trisolation > Renumber**.
   Note: This function allows you to renumber a trisolation by pointing to and clicking on triangles.
4. Click each trisolation in the lower part of the solid and enter the following information to renumber all the trisolations south of the fault to Object = 1, Trisolation = 1.



5. Click each trisolation in the upper part of the solid and enter the following information to renumber all the trisolations north of the fault to Object = 2, Trisolation = 1.



6. Press **ESC**.
   You will see two objects displayed on the screen.
7. Save the file as **mod8.dtm**

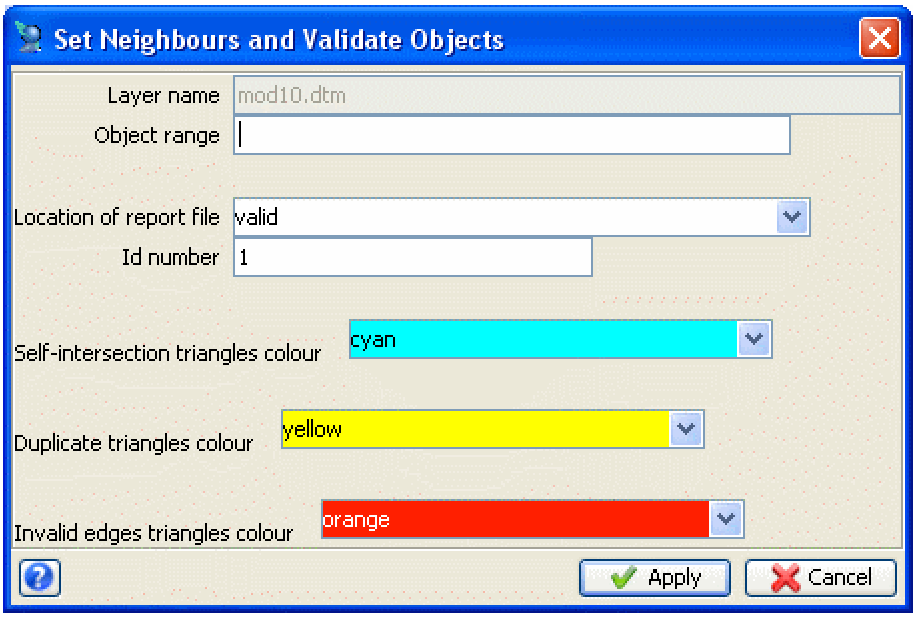
If you want to run manually through the material again, you will need to copy **original_mod8.dtm** to **mod8.dtm**.

Note: To see all of the steps performed in this section, run **_06_edit_solid.tcl.** You will need to click **Apply** on any forms presented.

Validating Solids

Task: Validate Solids

1. Click the **Reset graphics** icon .
2. Open **mod10.dtm**. This is the Solid model with objects 1 and 2.
3. Choose **Solids > Validation > Validate object**.
4. Enter the information as shown, and then click **Apply**.



Note: Leaving the object number blank will allow both object 1 and object 2 to be validated.

5. Open **valid1.not**.
   The Solids Modelling Validation report is displayed.

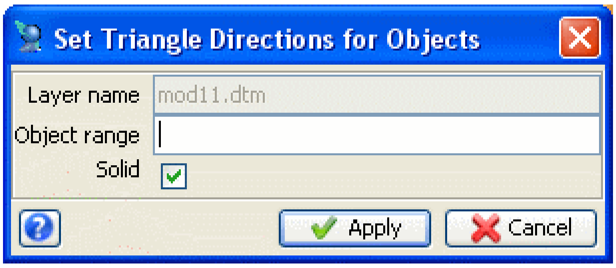
```
SOLIDS MODELLING VALIDATION REPORT. DATE: 08-Jul-08
===================================================
OBJECT 1, TRISOLATION 1
========================
Validated = TRUE
Status = CLOSED
DUPLICATE TRIANGLES:
--------------------
NONE
TRIANGLES ATTACHED TO INVALID EDGES:

NONE
TRIANGLES ATTACHED TO INVALID EDGES:
------------------------------------
NONE
SELF INTERSECTION TRIANGLES:
----------------------------
NONE
OPEN SIDES TRIANGLES:
---------------------
NONE
```

6. Close **valid1.not**.

Setting an Object to Solid or Void

Task: Set an Object (Trisolation) to Solid or Void

1. Click the **Reset graphics** icon .
2. Open **mod11.dtm**.
3. Choose **Solids > Validation > Set object to solid or void**.
4. Enter the information as shown, and then click **Apply**.
   This will make both objects into solids.



5. Choose **File > Save > string/DTM** to save your model as **mod11.dtm**

Note: The solid can now be used to calculate a volume, or as a constraint in block model filling. Later you will use the model you have created to demonstrate viewing solid models, intersecting drill holes and performing volume calculations.

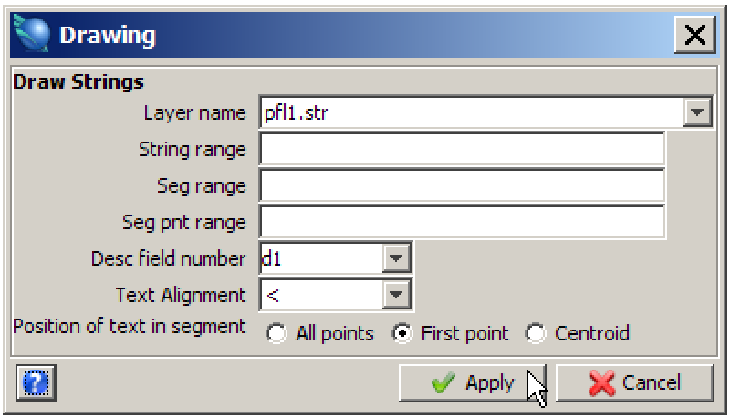
If you want to run manually through the material again, you will need to copy **original_mod11.dtm** to **mod11.dtm**.

Note: To see all of the steps performed in this section, run **_07_solids_validation.tcl.** You will need to click **Apply** on any forms presented.

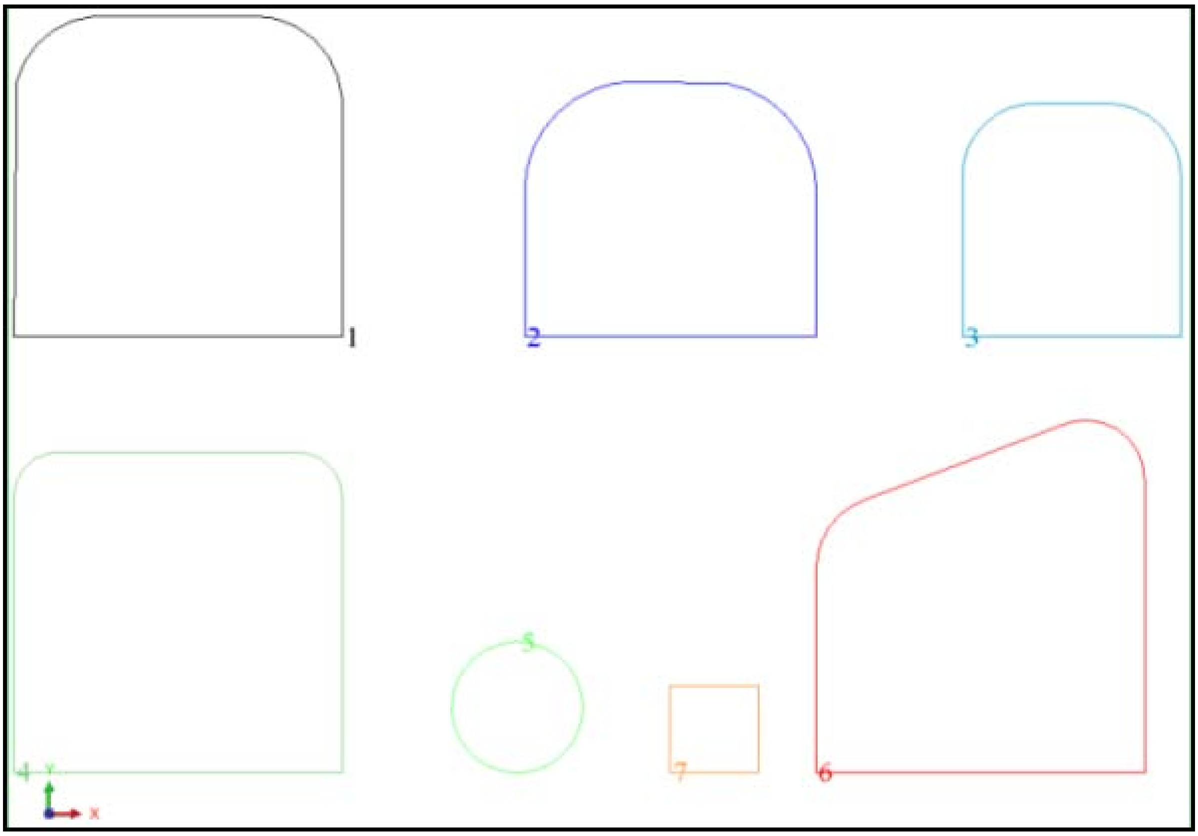
Triangulating Using Centre Line and Profile

Task: Create a Solid Using Centre Line and Profile.

1. Click the **Reset graphics** icon .
2. Open **pfl1.str**.
   These are a series of profile strings representing the outlines of various underground features.
3. Choose **Display > Strings > With string numbers**.
4. Enter the information as shown, and then click **Apply**.

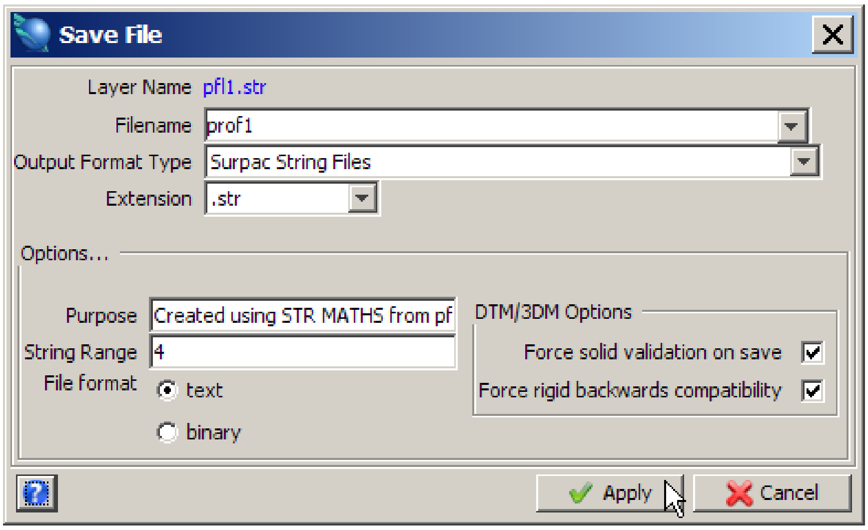


The profiles examples are displayed.

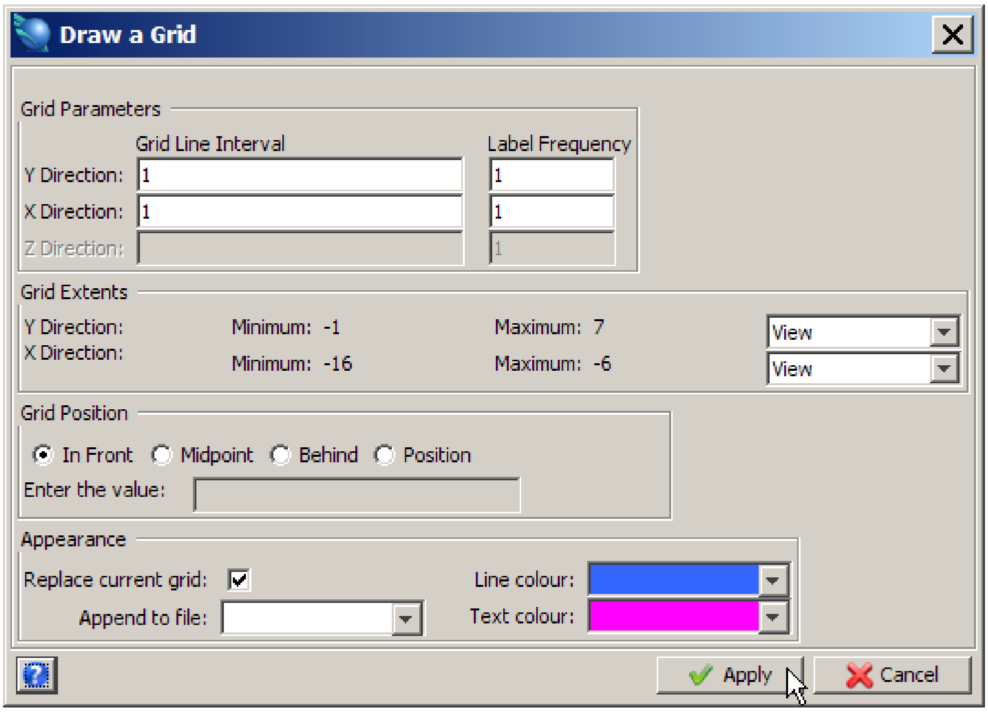


5. Choose **File > Save > string/DTM**.

6. Enter the information as shown, and then click **Apply** to save string 4 only into **prof1.str**.

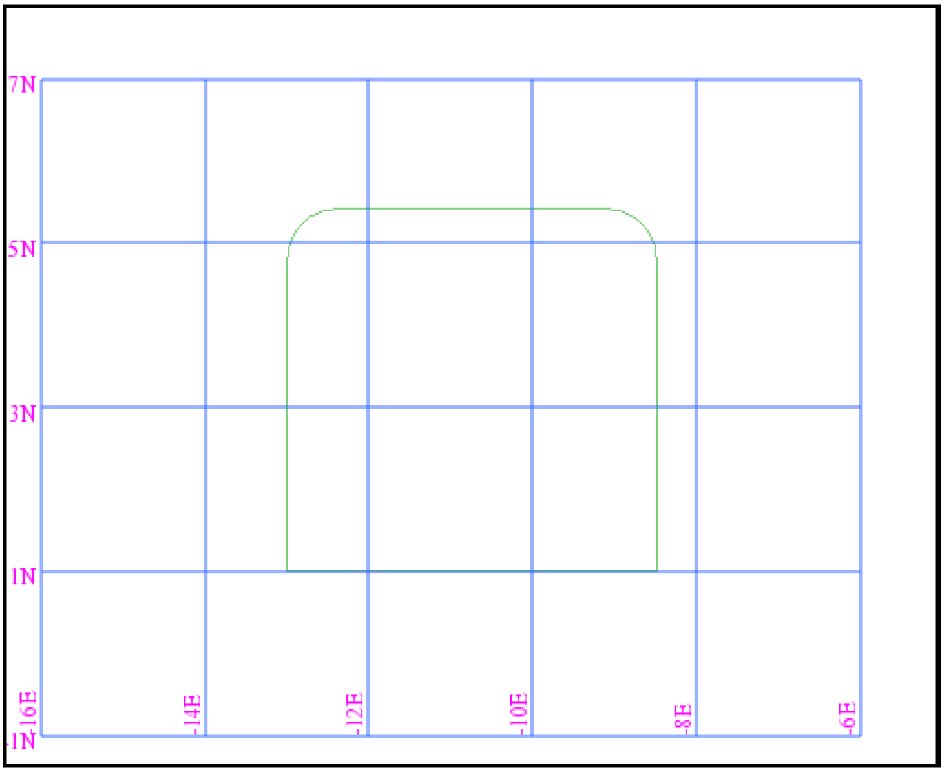


7. Click the **Reset graphics** icon .
8. Open **prof1.str**.
9. Choose **View > Zoom > Out**.
10. Choose **Display > 2D grid**.
11. Enter the information as shown, and then click **Apply**.



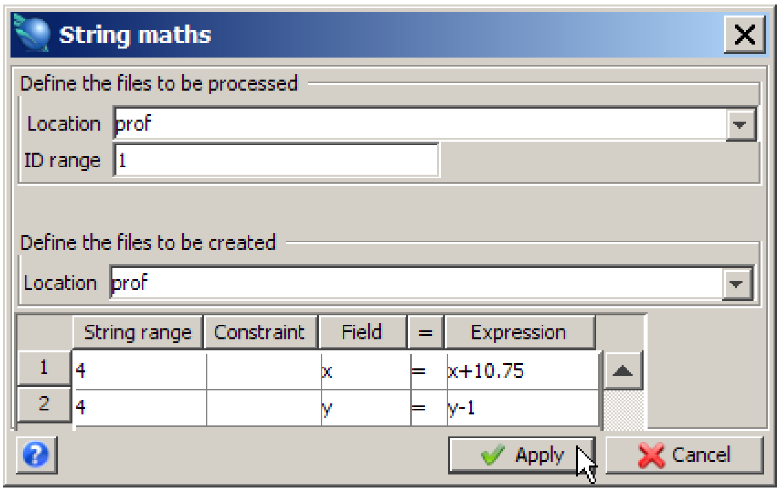
Note: In order for the profile to be correctly applied to a centre line, the centre, bottom point of the profile needs to have coordinates of X = 0, Y = 0.

The profile example is displayed.



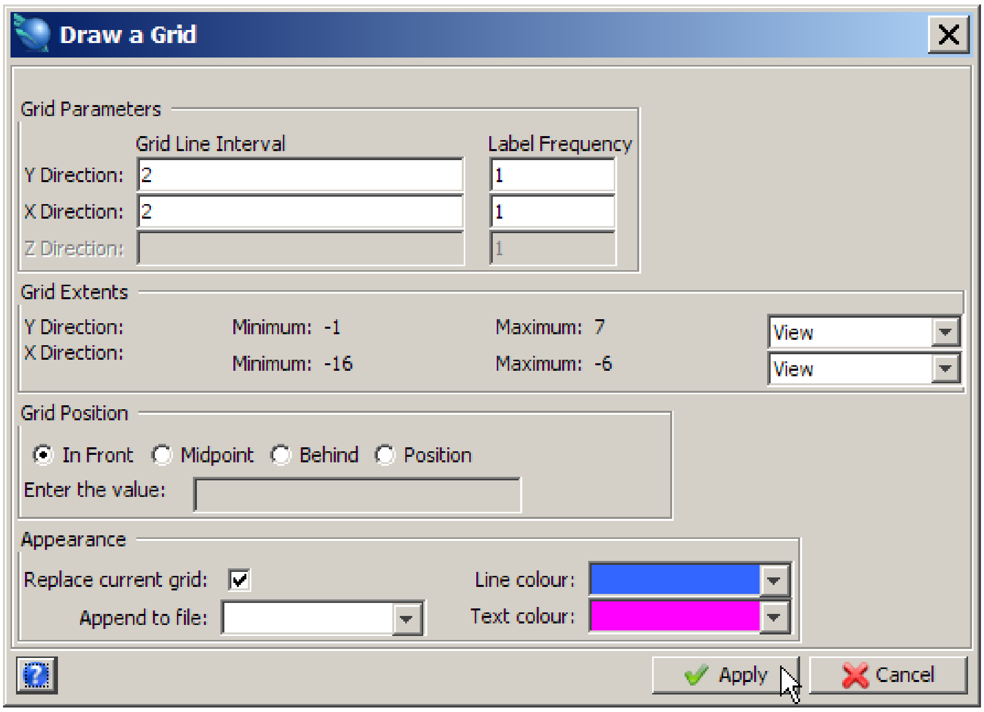
Note: The profile needs to move 10.75 in the x direction and -1 in the y direction to have its bottom centre at (0,0)

12. Choose **File tools > String Maths**.
13. Enter the information as shown, and then click **Apply**.

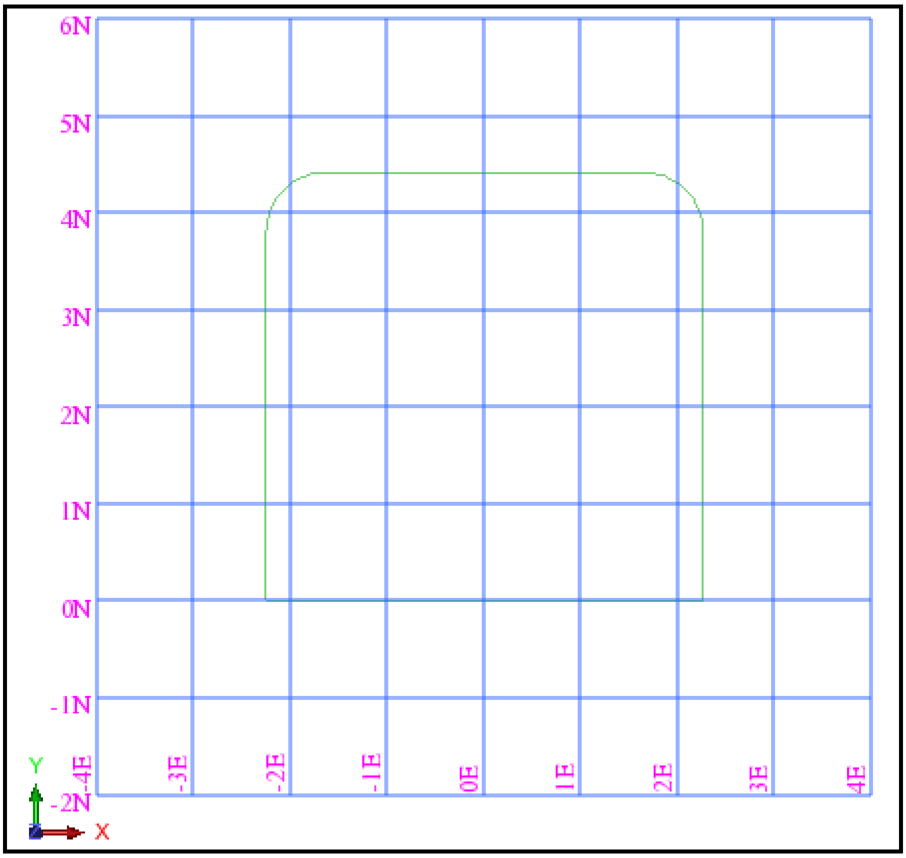


14. Click the **Reset graphics** icon .
15. Open **prof1.str**.
16. Choose **View > Zoom > Out**.
17. Choose **Display > 2D grid**.

18. Enter the information as shown, and then click **Apply**.



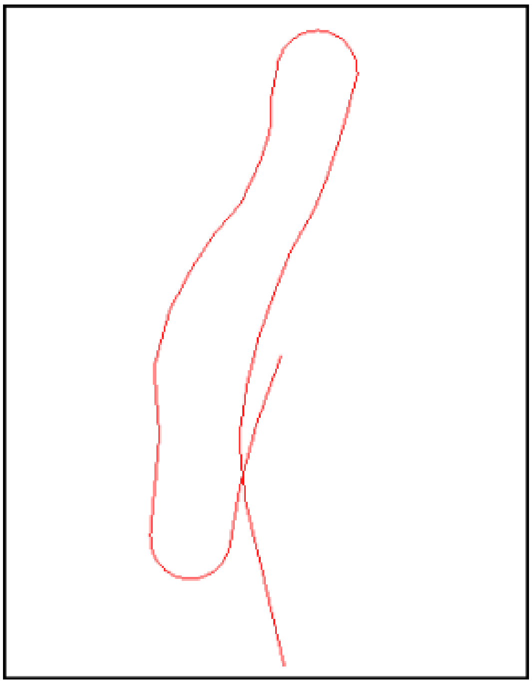
The profile is displayed.



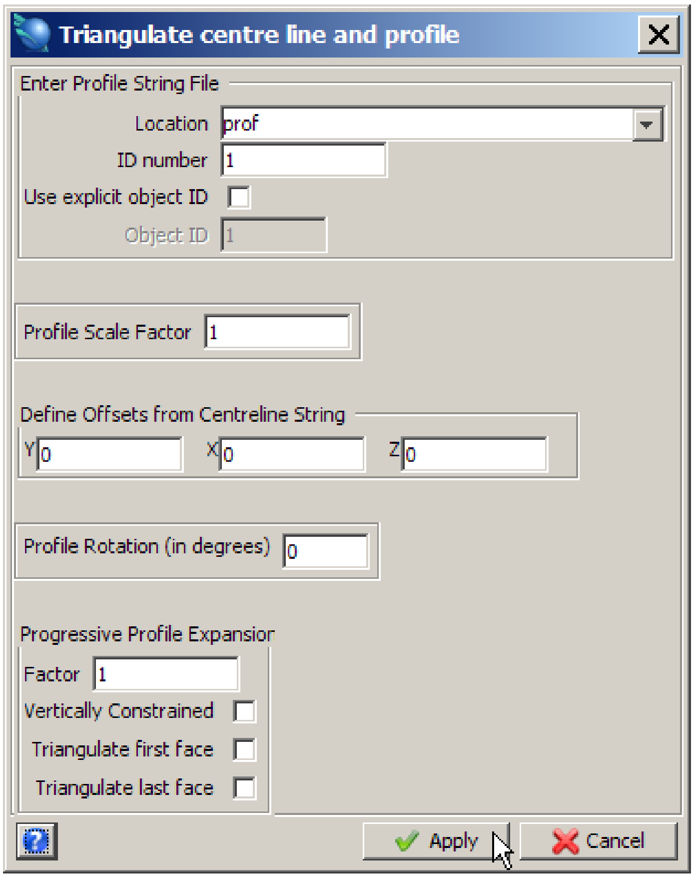
Notice that the centre, bottom point of the profile is now at (0,0)

19. Click the **Reset graphics** icon .

20. Open **dcl100.str**, which represents the centre line of a decline.

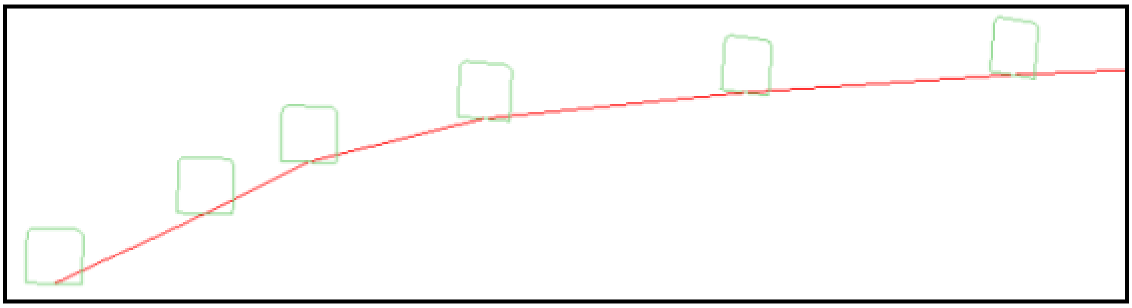


21. Choose **Solids > Triangulate > Using centre line & profile**.
22. Enter the information as shown, and then click **Apply**.



23. Click the centre line.
   Note: The profile string is applied perpendicularly at each point in the centre line and then these profiles are stitched together to form the object.
24. Choose **Display > Hide everything**.

25. Choose **Display > Strings As lines** to see how the solid has been created.
26. Zoom in and use the orbit tool to make the solid easier to visualise.
    The profiles on the centreline are displayed.



Notice that the solid is constructed by applying the profile to each point on the centre line

Note: The centre line and profile function does not save the new file automatically, so if you want the file saved you should specify a new file name.

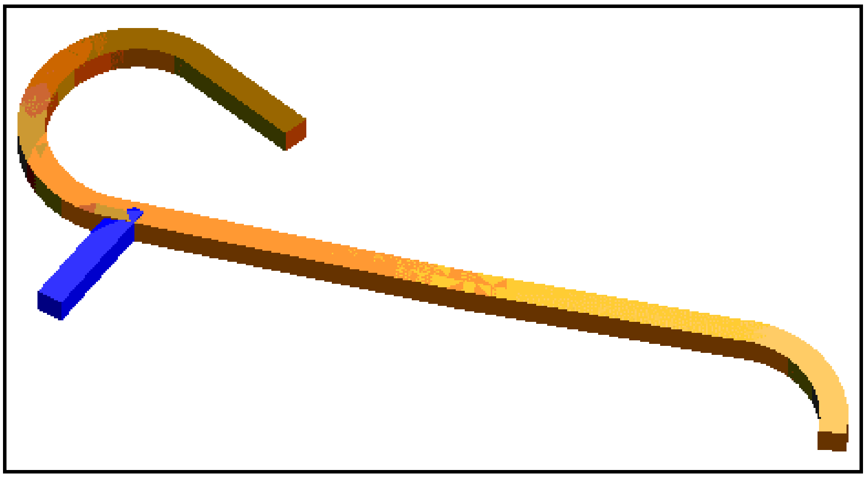
Note: To see all of the steps performed in this section, run **_05_centre_line_and_profile.tcl.** You will need to click **Apply** on any forms presented.

Intersecting Solids and DTM Surfaces

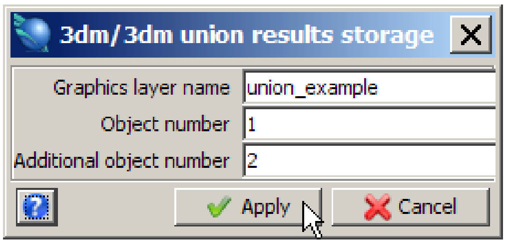
Intersecting Solids

Task: Perform Solids Union

1. Click the **Reset graphics** icon.
2. Open **decline1.dtm**.
3. Open **crosscut1.dtm**.
4. Click the **Zoom all** icon.
   Union of solids is displayed.



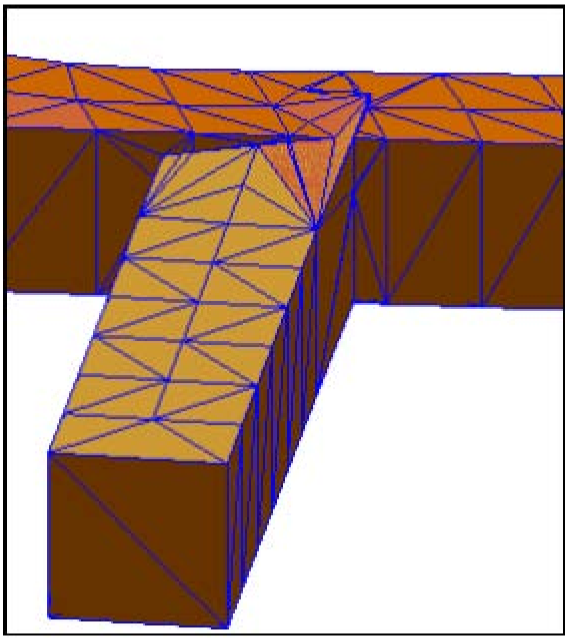
5. Choose **Solids tools > Union solids**.
6. Enter the information as shown, and then click **Apply**.



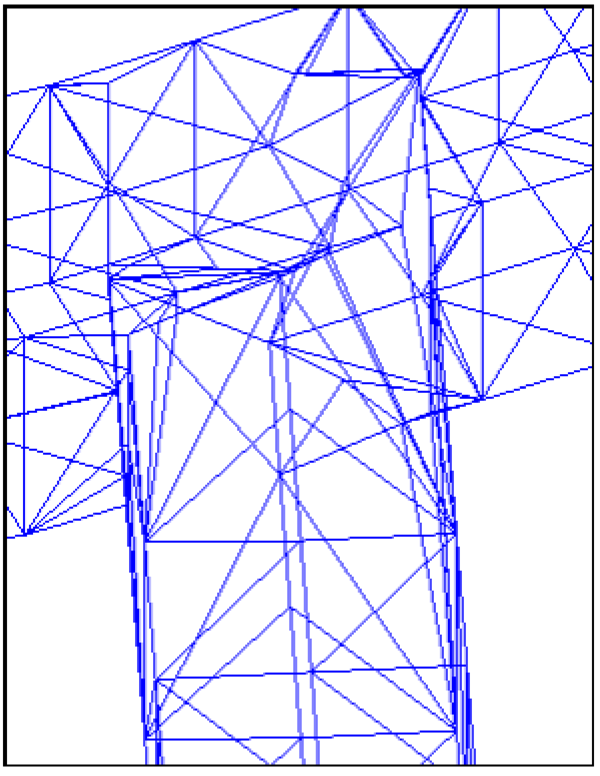
Note: The layer name cannot be the same as any existing layer. The new layer will contain the new solid.

7. Follow the prompts by clicking each of the solids.
   Note: The order of selection is not important. The program will go through the process of uniting the two solids. Notice that the previous objects have been erased from screen and you are now in the layer you specified with the unioned solid displayed. The solid is merely displayed in this layer. You must save it before exiting.
8. Choose **View > Surface view options > Hide triangle edges** and deselect this option for a more effective display.
9. Zoom in to show the area of contact and confirm the result.

The union of the drives is displayed.



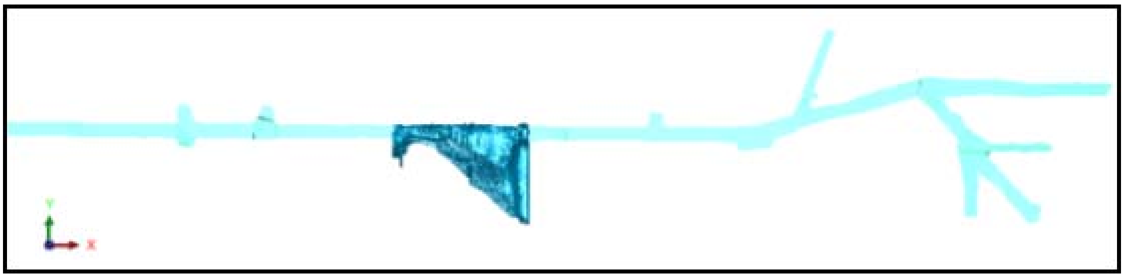
10. Choose **View > Surface view options > Hide triangle faces** to see that the underlying strings have been changed as shown.
    The union triangles are displayed.



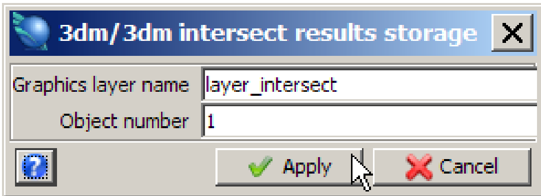
📝 **Note**: To see all of the steps performed in this section, run **_08a_solids_union.tcl.** You will need to click **Apply** on any forms presented.

Task: Perform Intersection of Solids

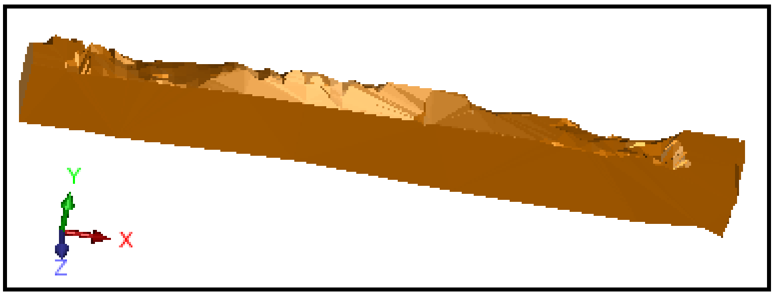
1. Click the **Reset graphics** icon .
2. Open **lev1.dtm**.
3. Open **stope1.dtm**.
4. Click the **Zoom all** icon .
   These solids represent a stope and a development drive as shown.



5. Choose **Solids > Solids tools > Intersect solids**.
6. Enter the information as shown, and then click **Apply**.



7. Follow the prompts by clicking each of the solids in turn.
   Note: The order of selection is not important.
8. You will now be in the layer you specified with the solid displayed. The result is that area of the decline that fell within the stope.

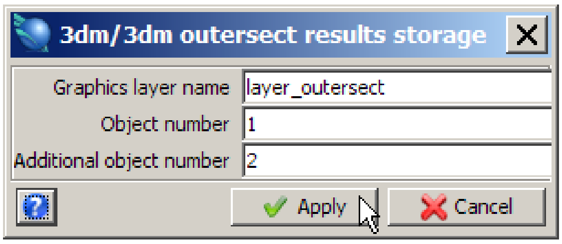


Note: To see all of the steps performed in this section, run **_08b_solids_intersection.tcl.** You will need to click **Apply** on any forms presented.

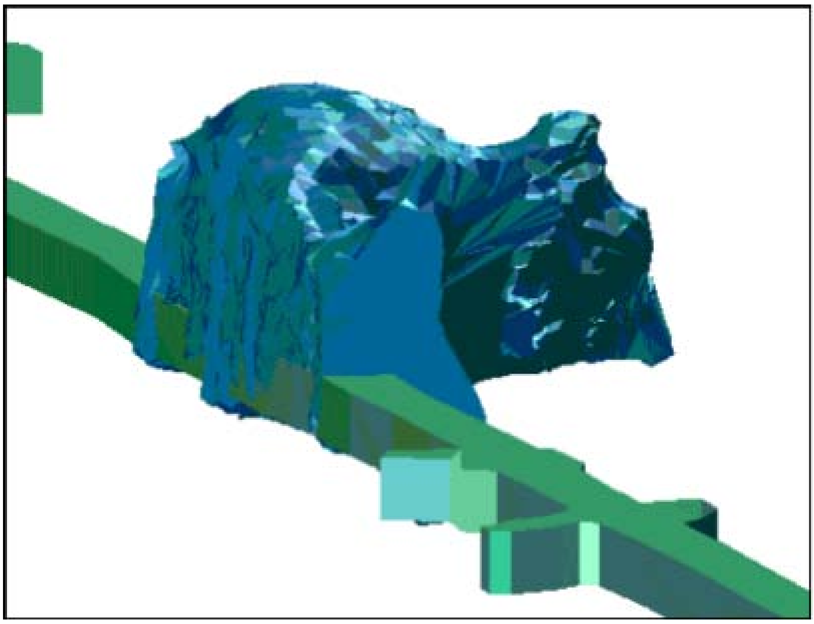
Task: Perform Outersection of Solids

1. Click the **Reset graphics** icon .
2. Open **lev1.dtm**.
3. Open **stope1.dtm**.
4. Click the **Zoom all** icon .
5. Choose **Solids > Solids tools > Outersect solids**.

6. Enter the information as shown, and then click **Apply**.

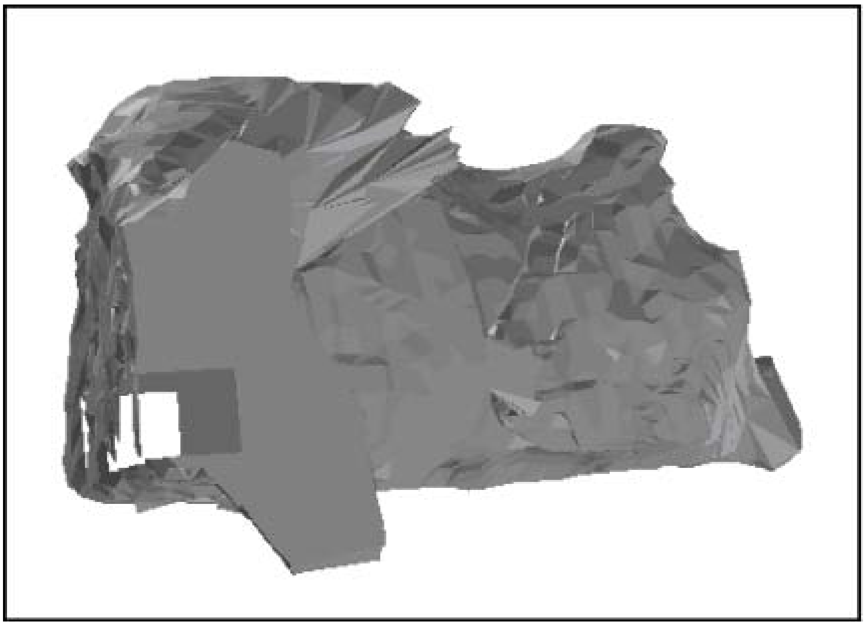


7. Follow the prompts by clicking each of the solids - first the ore body and then the decline.



In this case, the order of selection is important. The outersected solid must be selected first, while the outersecting solid (i.e. that one that will cut into the outersected solid) is selected second.

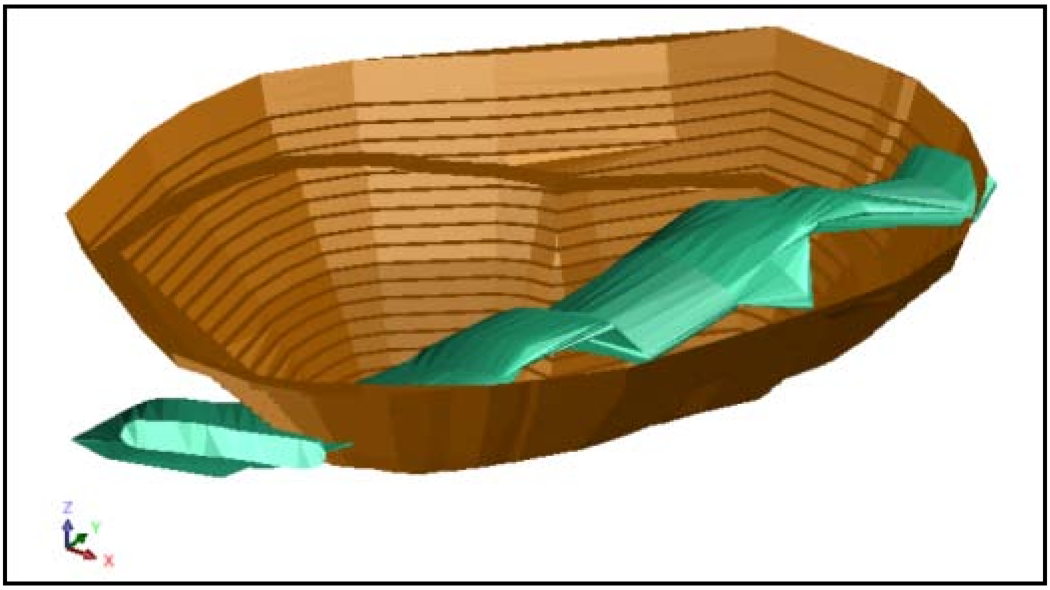
You will be in the layer you specified with the solid displayed. The result is the original solid body with those areas that were common with the decline removed.



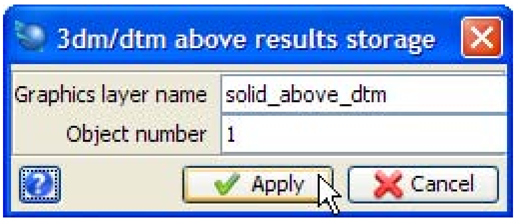
Note: To see all of the steps performed in this section, run **_08c_solids_outersection_solid.tcl**. You will need to click **Apply** on any forms presented.

Task: Clip a Solid Above a DTM

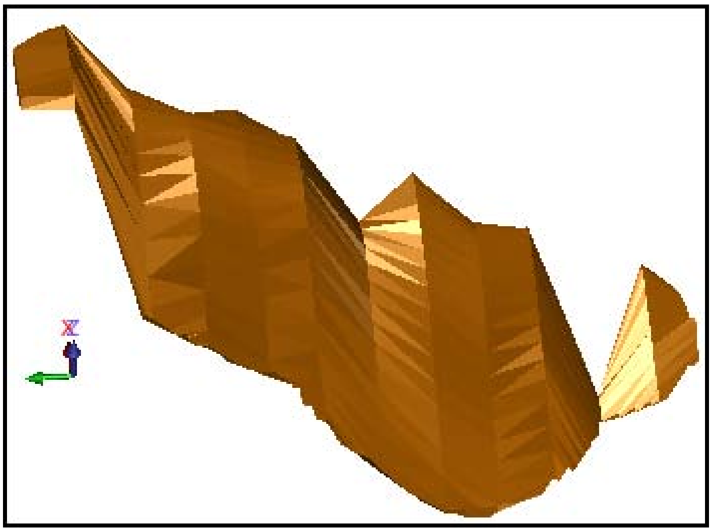
1. Click the **Reset graphics** icon .
2. Open **pit4.dtm**.
3. Open **ore4.dtm**.
   The ore body is displayed.



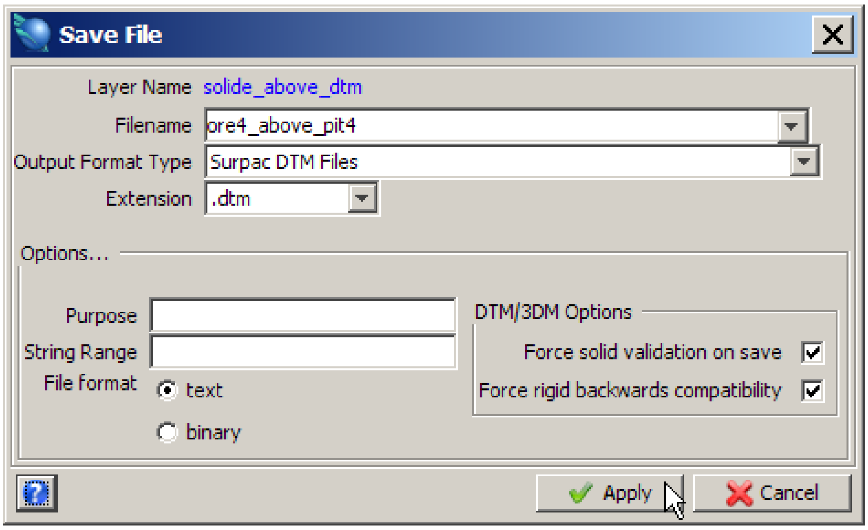
4. Choose **Solids > Solids tools > Clip solid above a DTM**.
5. Enter the information as shown, and then click **Apply**.



6. Click the ore solid and then click the pit DTM.
   The ore body is displayed.



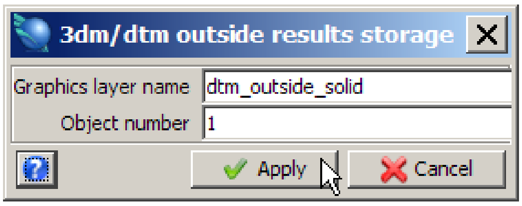
7. Choose **File > Save > string/DTM** if you wish to save the results for further work.



Note: To see all of the steps performed in this section, run **_08d_dtm_above_solid.tcl.** You will need to click **Apply** on any forms presented.

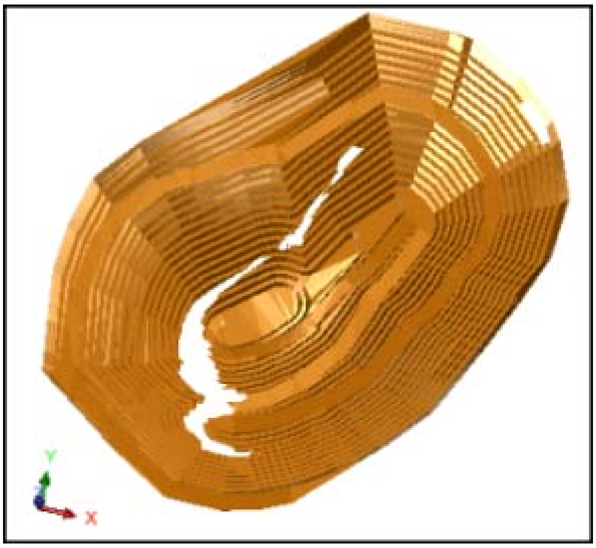
Task: Clip a DTM Outside a Solid

1. Click the **Reset graphics** icon .
2. Open **pit4.dtm**.
3. Open **ore4.dtm**.
4. Choose **Solids > Solids tools > Clip DTM outside a solid**.
5. Enter the information as shown, and then click **Apply**.

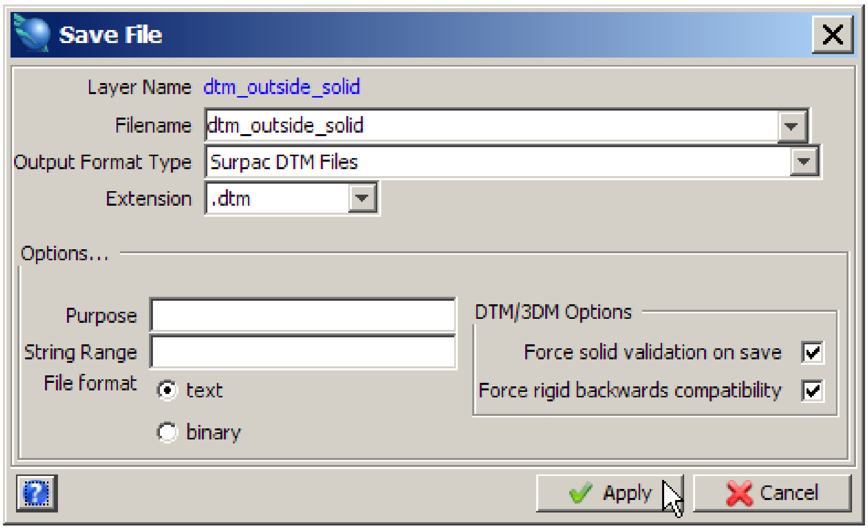


The output solid above the dtm will be stored in the layer **dtm_outside_solid**.

6. Click the solid, and then click the DTM.
   The pit cut by the ore body is displayed.



7. Save **dtm_outside_solid.dtm**.



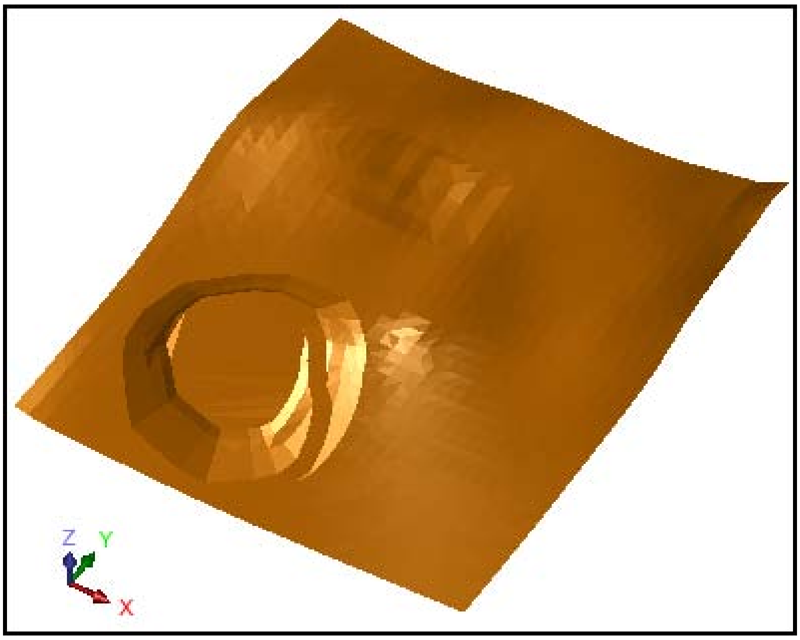
Note: This result is not a solid but is instead a DTM. Only that part of the pit surface that occurred outside the solid ore body is retained.

Note: To see all of the steps performed in this section, run **_08e_dtm_outside_solid.tcl.** You will need to click **Apply** on any forms presented.

Intersecting DTM Surfaces

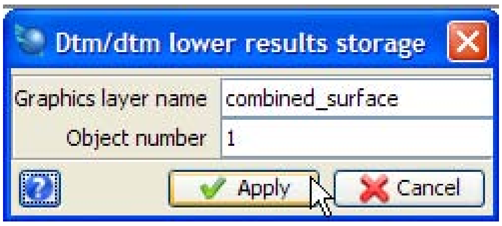
Task: Perform Upper Triangles Intersection of 2 DTMs

1. Click the **Reset graphics** icon .
2. Open **topo2.dtm**.
3. Open **dump1.dtm**.



4. Choose **Surfaces > Clip or intersect DTMs > Upper triangles of 2 DTMs**.

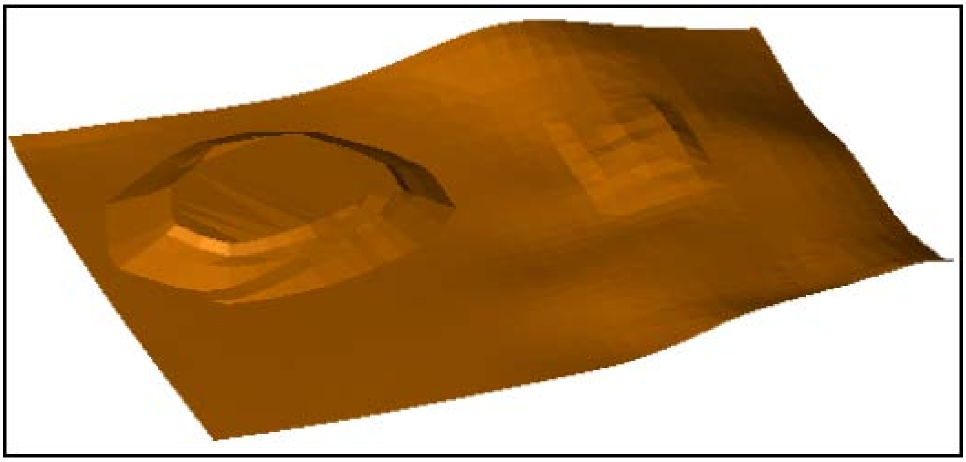
5. Enter the information as shown, and then click **Apply**.



6. Follow the prompts by picking each of the DTMs.

Note: The order of selection is not important.

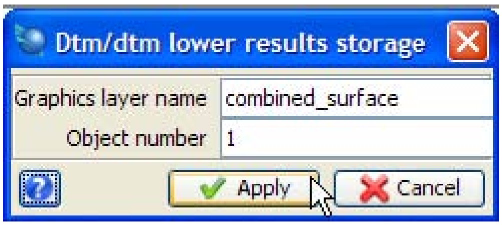
You will be in the layer you specified with the DTM displayed. The result is the waste stockpile surface incorporated into the topographic surface.



Note: To see all of the steps performed in this section, run **_08f_upper_triangles_of_2dtm.tcl.** You will need to click **Apply** on any forms presented.

Task: Perform Lower Triangles Intersection of 2 DTMs

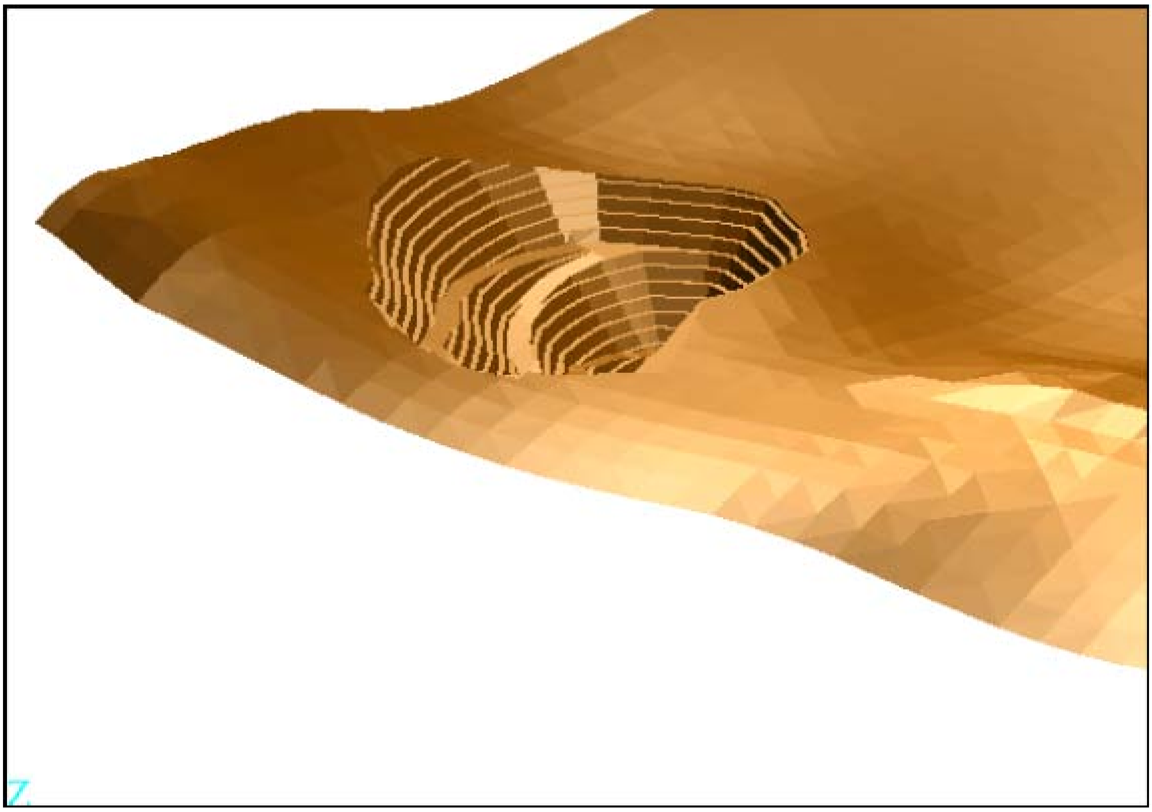
1. Click the **Reset graphics** icon .
2. Open **topo2.dtm**.
3. Open **pit2.dtm**.
4. Choose **Surfaces > Clip or intersect DTMs > Lower triangles of 2 DTMs**.
5. Enter the information as shown, and then click **Apply**.



6. Follow the prompts by picking each of the DTMs.

Note: The order of selection is not important.

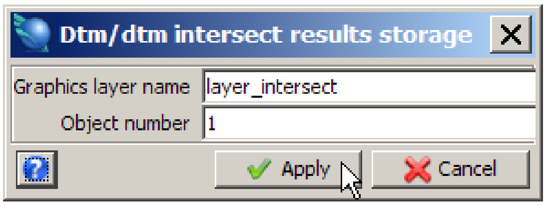
The pit below the topography is displayed.



Note: To see all of the steps performed in this section, run **_08g_lower_triangles_of_2dtm.tcl.** You will need to click **Apply** on any forms presented.

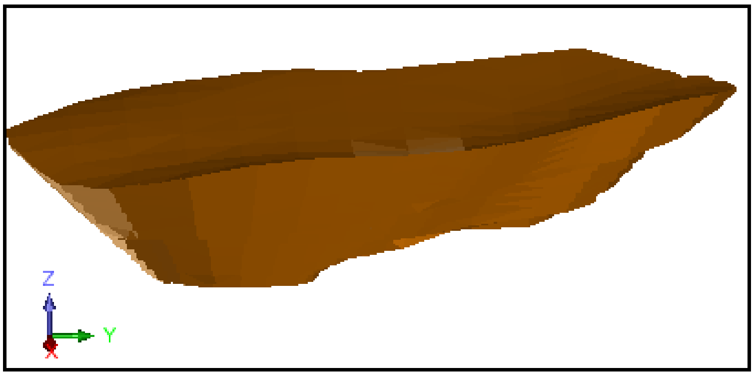
Task: Create a Solid by Intersecting 2 DTMs

1. Click the **Reset graphics** icon .
2. Open **topo2.dtm**.
3. Open **pit2.dtm**.
4. Choose **Surfaces > Clip or intersect DTMs > Create solid by intersecting 2 DTMs**.
5. Enter the information as shown, and then click **Apply**.

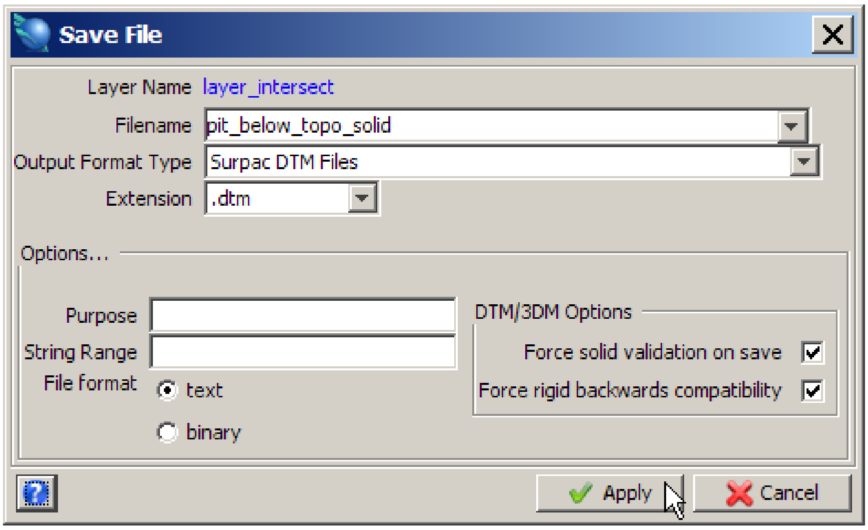


6. Follow the prompts by clicking each of the DTMs.
   Note: The upper DTM (topography) must be selected first, followed by the lower DTM (pit).

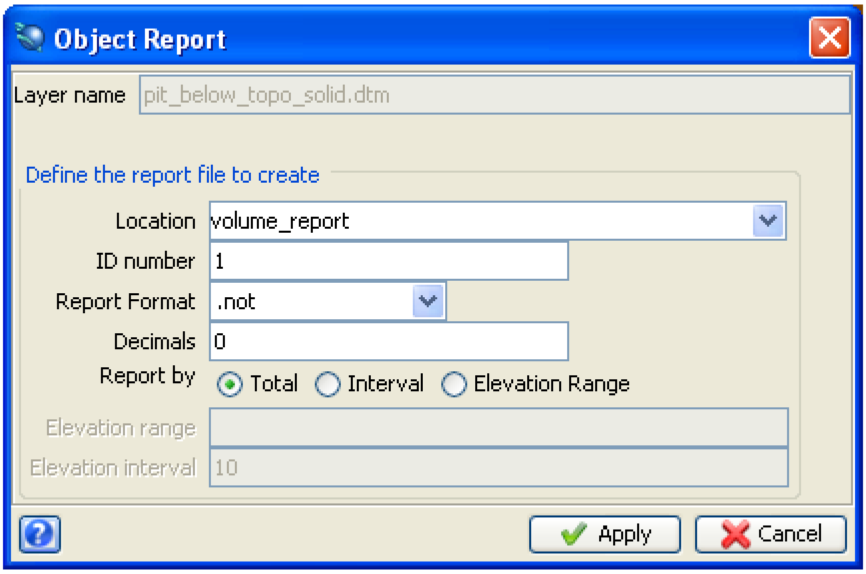
You will be in the layer you specified with the solid displayed. The result is a solid representing the material that will need to be removed from the designed pit.



7. Choose **File > Save > string/DTM**.
8. Enter the information as shown, and then click **Apply**.



9. Choose **Solids > Solids tools > Report volume of solids** to create a note file with the volume of the pit below the topography.
10. Enter the information as shown, and then click **Apply**.



The Solid Modelling object report is displayed.

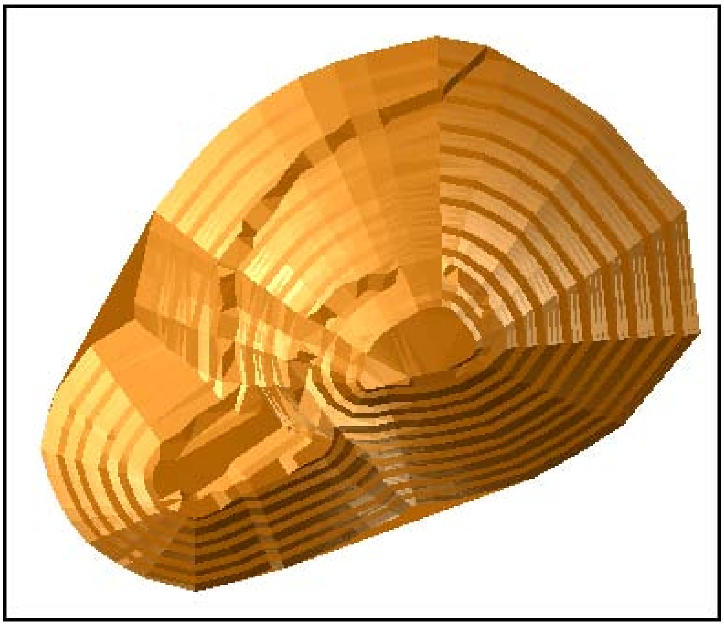
```
SOLID MODELLING OBJECT REPORT
Layer Name: mod12.dtm
Object: 1
Trisolation: 1
Validated = true
Status = solid
Trisolation Extents
X Minimum: 5184.820 X Maximum: 5468.470
Y Minimum: 10055.129 Y Maximum: 10634.653
Z Minimum: 836.580 Z Maximum: 1078.760
Surface area: 421501
Volume : 5337158
Object: 2
Trisolation: 1
Validated = true
Status = solid
Trisolation Extents
X Minimum: 5225.070 X Maximum: 5477.490
Y Minimum: 10619.466 Y Maximum: 10920.397
Z Minimum: 904.633 Z Maximum: 1058.910
Surface area: 191274
Volume : 2293278
Totals
Surface area: 612775
Volume : 7630436
```

Note: To see all of the steps performed in this section, run **_08h_create_solid_intersecting_2dtms.tcl.** You will need to click **Apply** on any forms presented.

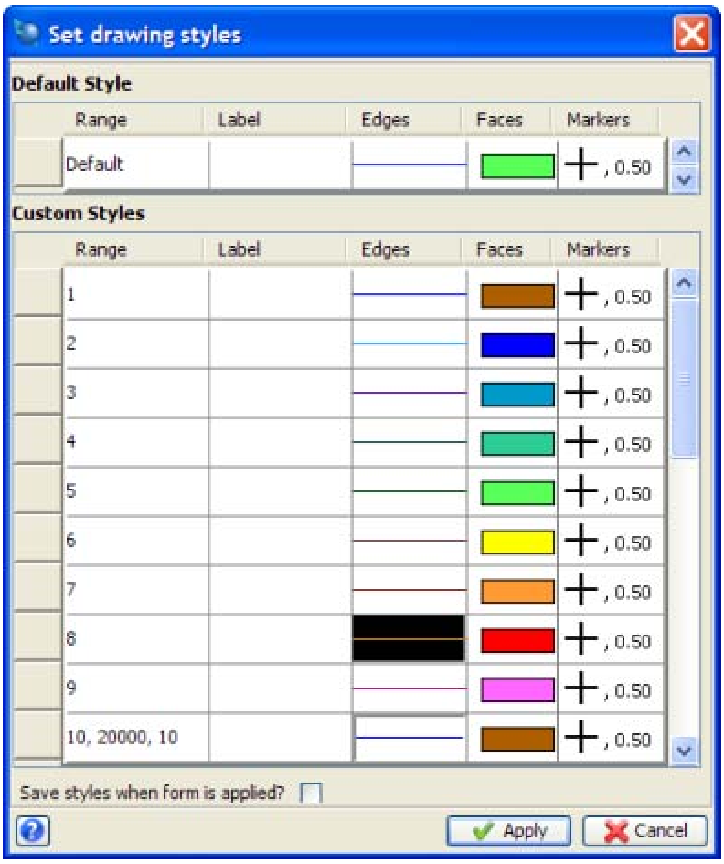
Viewing Solids

Task: View Solids

1. Click the **Reset graphics** icon .
2. Open **pit1.dtm**.
   The pit example is displayed.

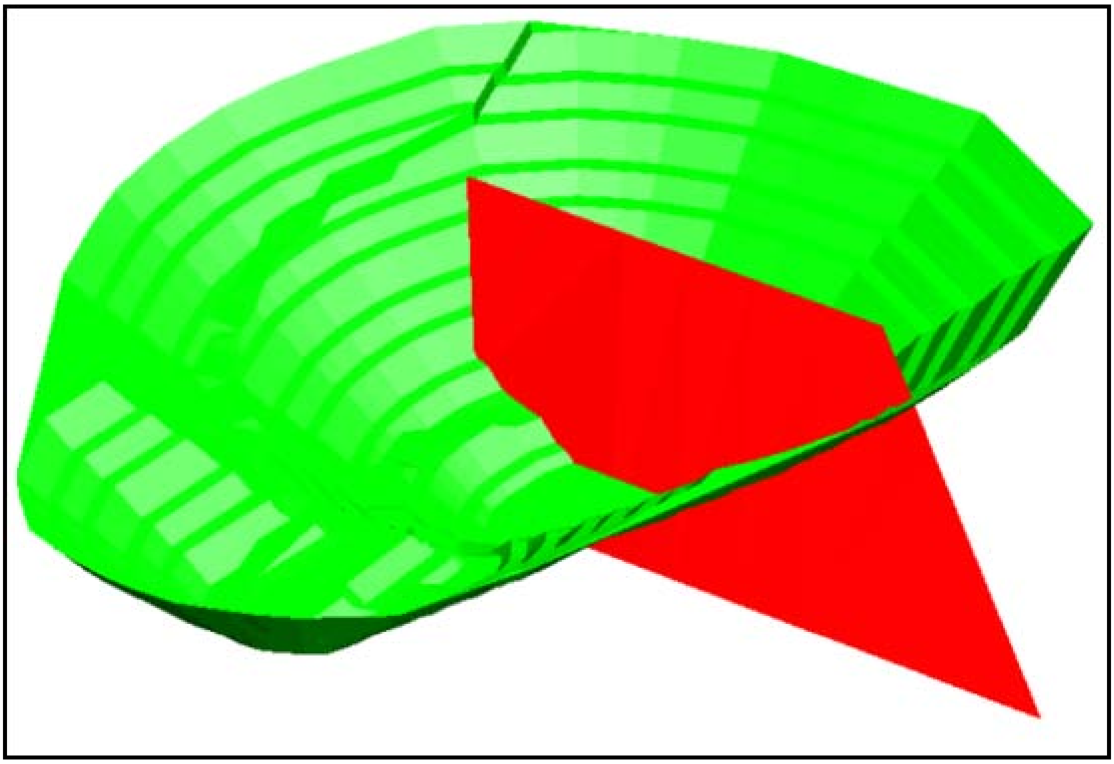


3. Choose **Customise > Display properties > DTM's and 3DM's**.

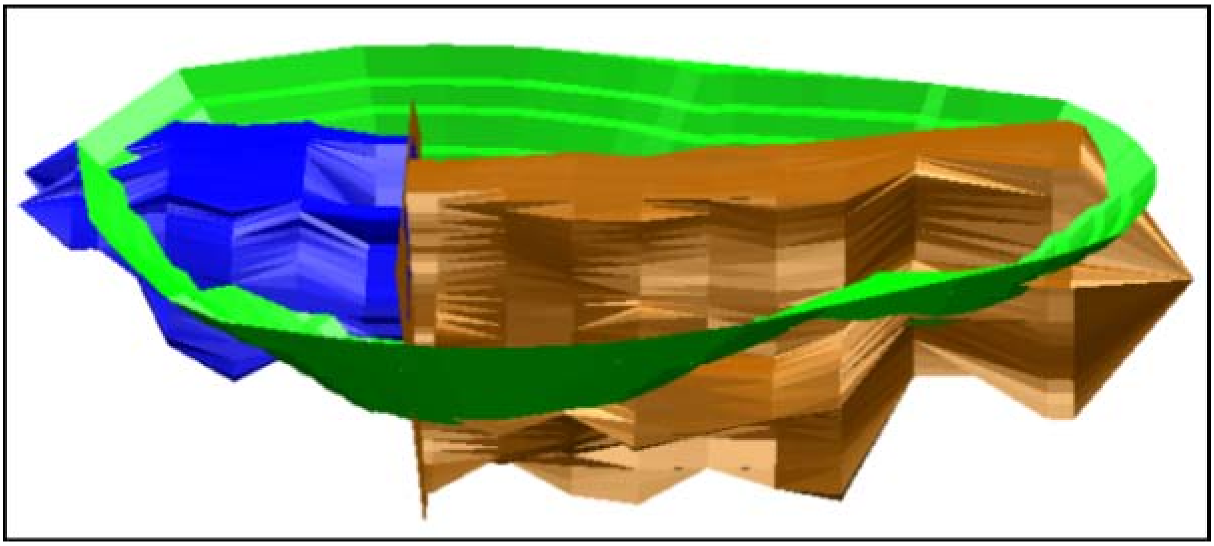


4. Change the colour of the faces for Object 1 and then click **Apply**.

5. Open **fault1.dtm** into its own layer.
6. Choose **Customise > Display properties > DTMs and 3DMs**.
7. Choose another colour for the faces for **fault1.dtm** (object 10).
   The pt and fault line example is displayed.

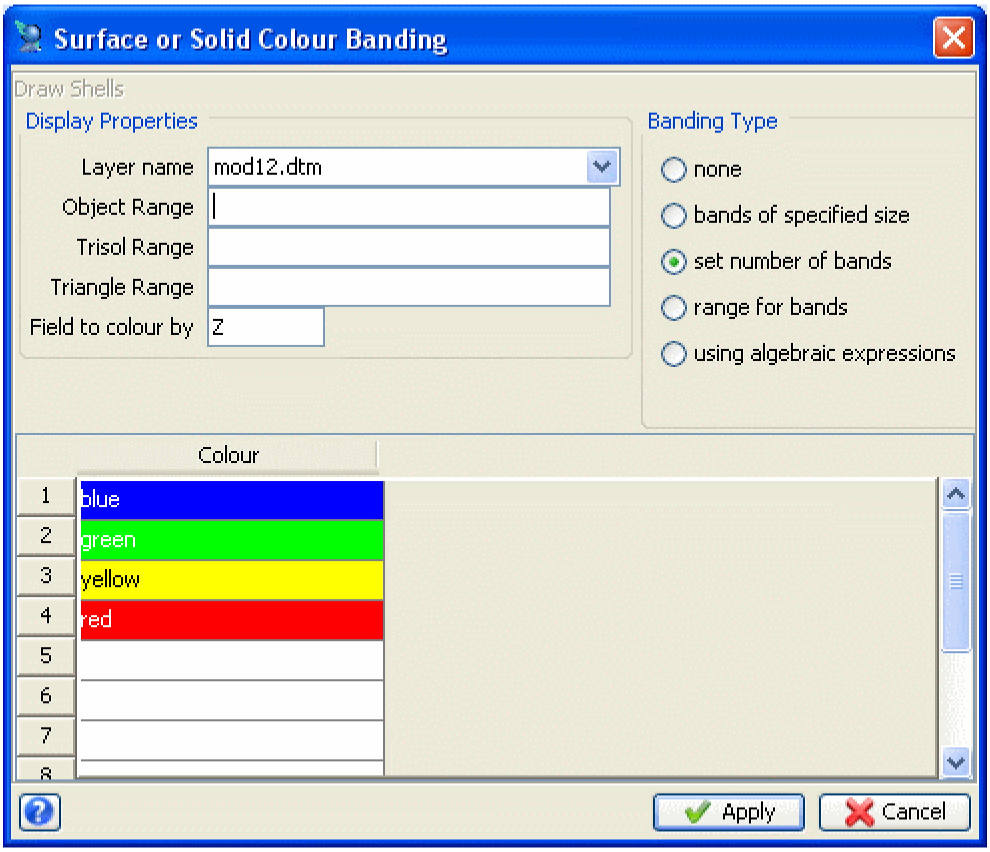


   Notice that the changes are reflected in the active layer only and the pit remains the same colour.
8. Open **mod12.dtm**.
   The solid with the pit and the fault is displayed.

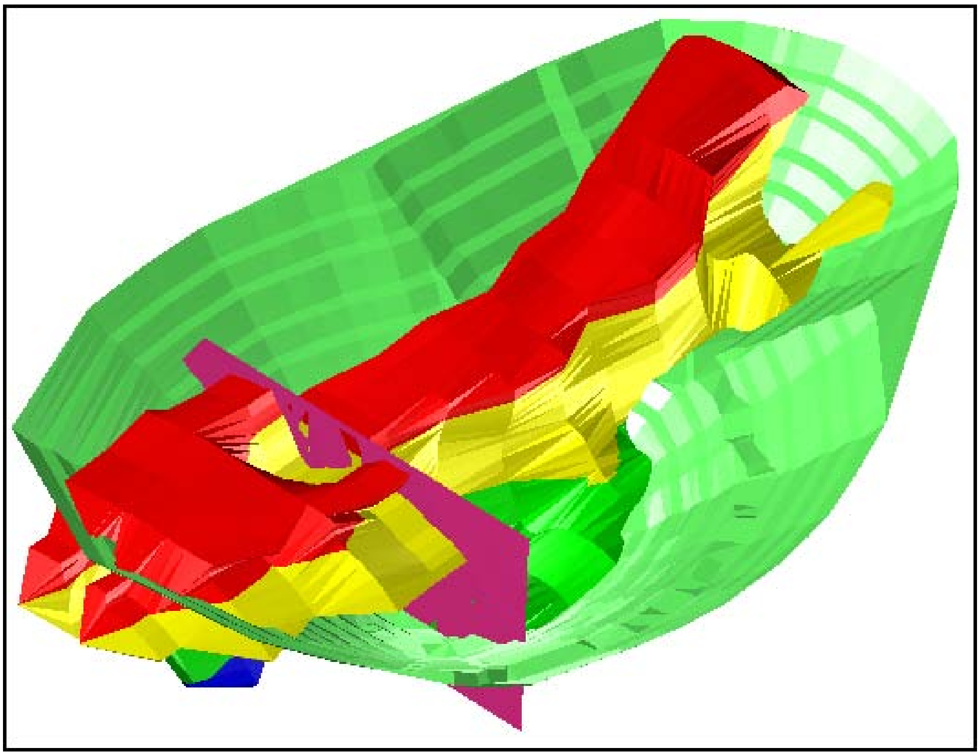


9. Choose **Display > Surface or solid with colour banding**.

10. Enter the information as shown, and then click **Apply**.

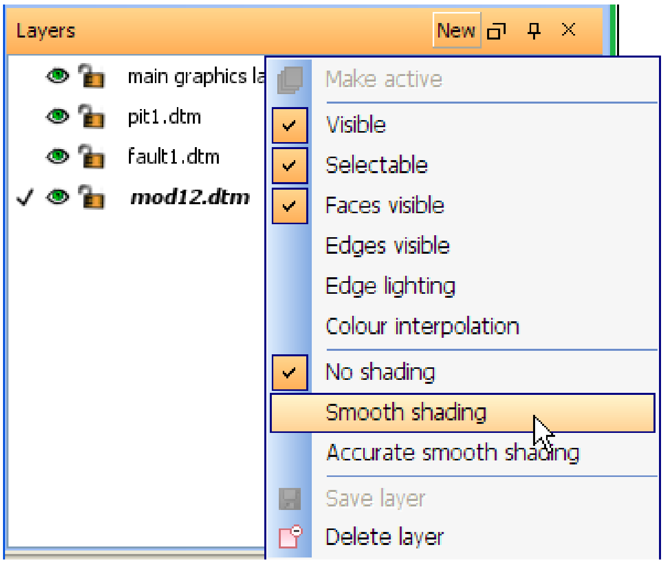


The solid with sharp colour banding is displayed.

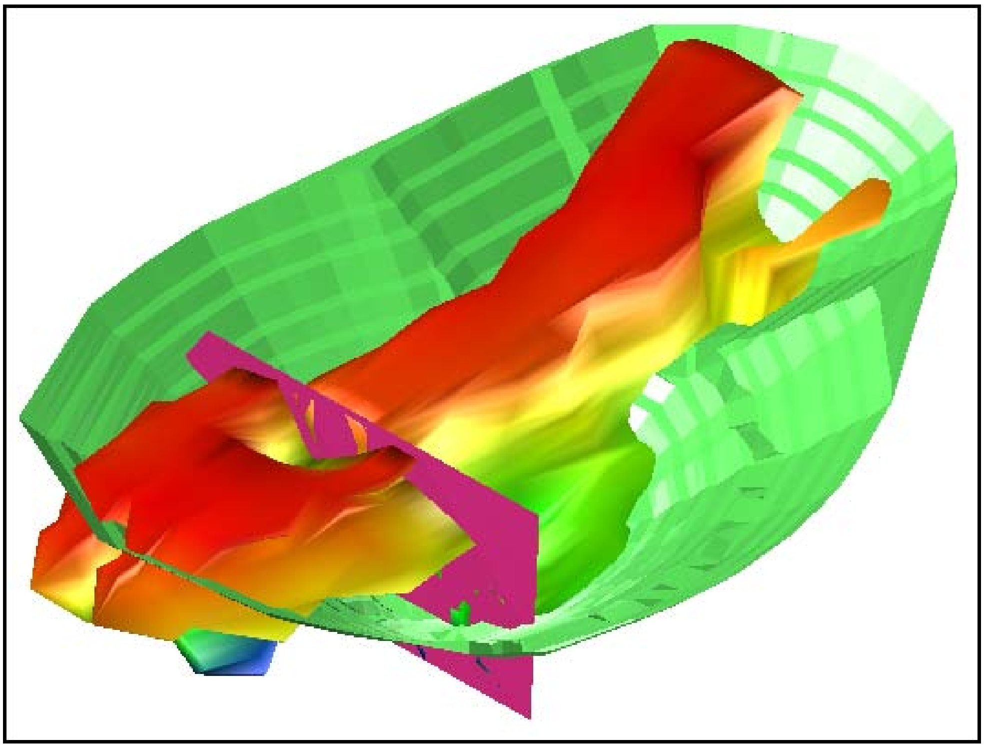


To display the solid with smooth contours.

11. Right-click on the file **mod12.dtm**.



12. Then tick **Smooth shading**.
The solid with smooth colour banding is displayed.

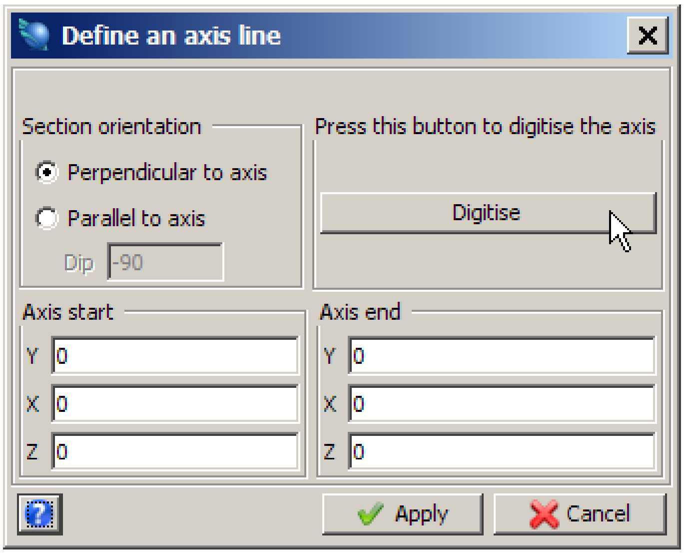


📝 **Note**:To see all of the steps performed in this section, run **_09_view_solid_model.tcl.** You will need to click **Apply** on any forms presented.

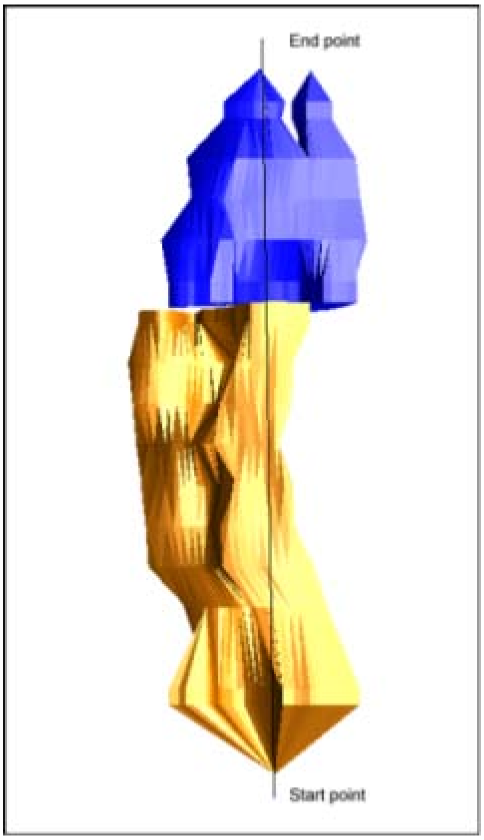
Creating Sections

Task: Create Sections Using the Interactive Method

1. Click the **Reset graphics** icon .
2. Open **mod12.dtm**.
3. Choose **Solids > Solids tools > Create sections**.

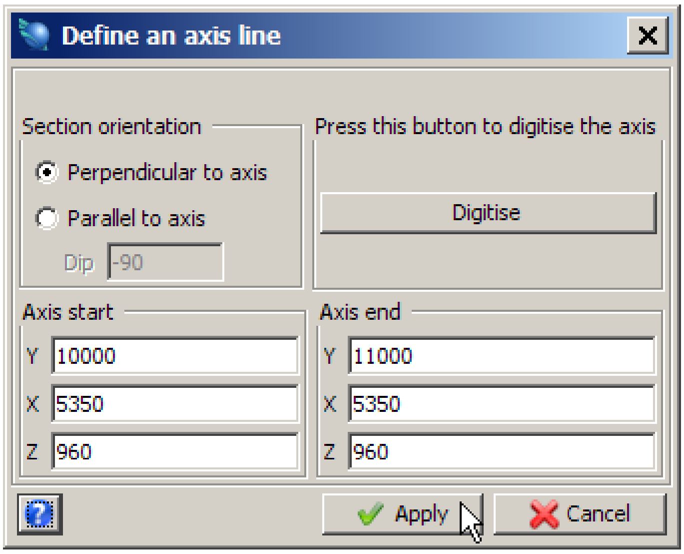


4. Click the **Digitise** button to use your mouse for defining the axis.
5. Click a start point below the bottom centre of the ore body and drag the cursor vertically to the end point of the axis line above the solid.
   The solid with a centreline is displayed.

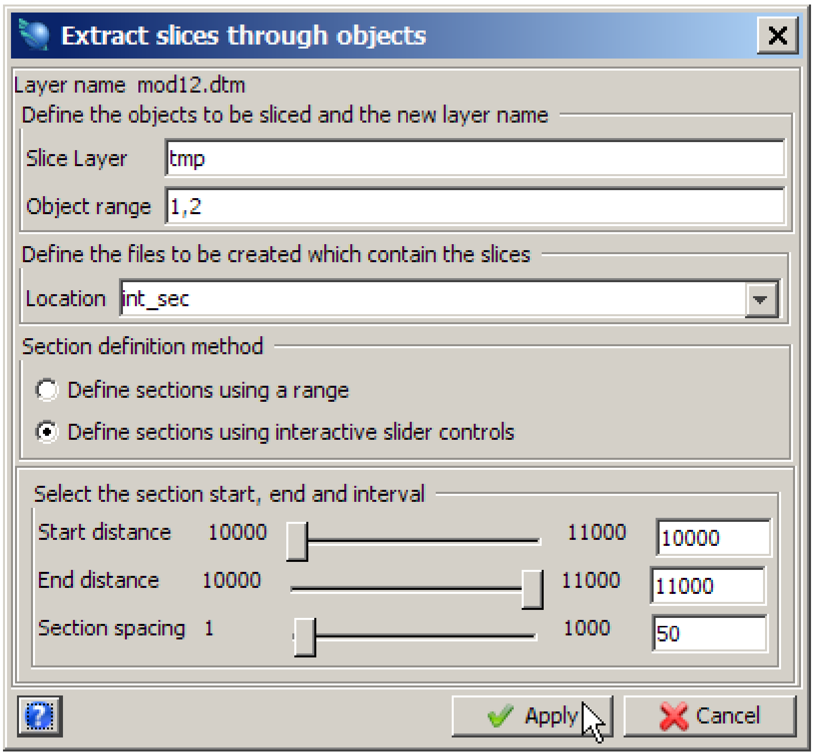


Note: When you have created the axis, the form is redisplayed with the real world coordinates of your axis line. Adjust the coordinates manually using the digitised axis start and axis end points as a guide. In this case, the Eastings and elevations for the axis line must be the same to produce slices that are oriented as Northings.

6. Enter the information as shown, and then click **Apply**.

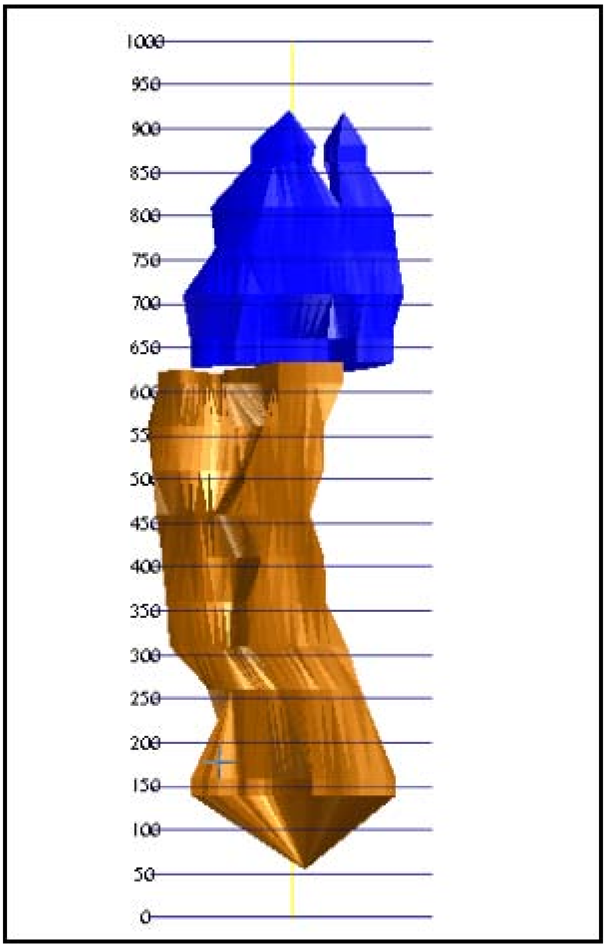


7. Enter the information as shown, and then click **Apply**.

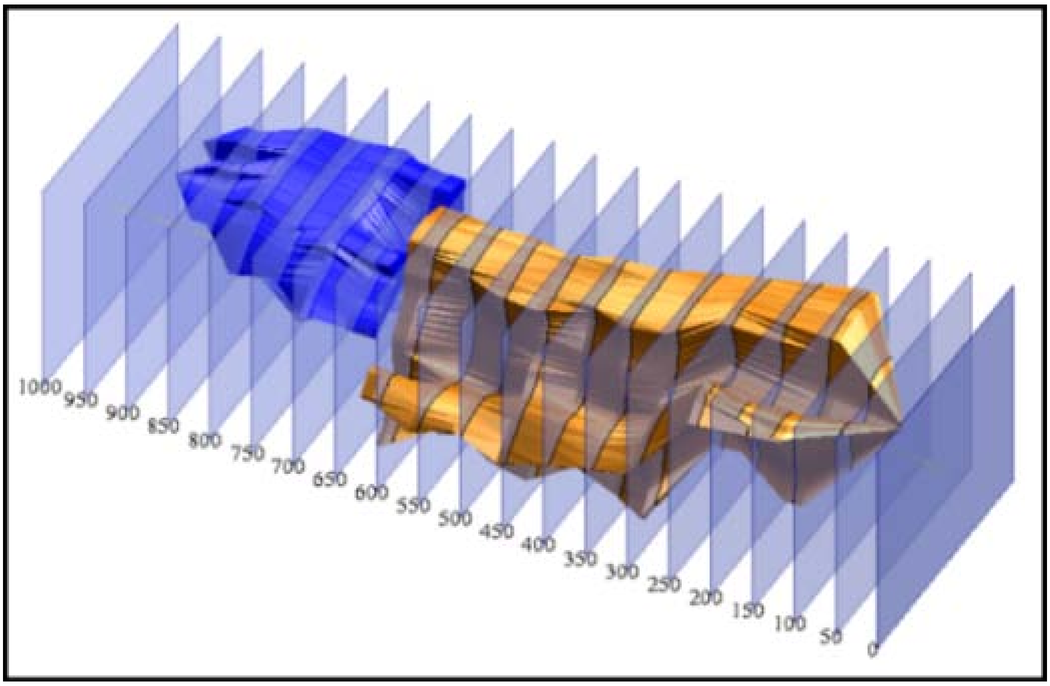


Note: Click the **Interactive slider controls** button to display your slices in real time. The slide controls enable you to adjust the start and end points of your axis and also the distance between slices. Try moving the slide controls up and down to see the effects of your changes. The slices are taken using the values in the boxes on the right side of the slider bars when you click **Apply**. Values may also be manually entered into these boxes.

The solid object with slices is displayed.



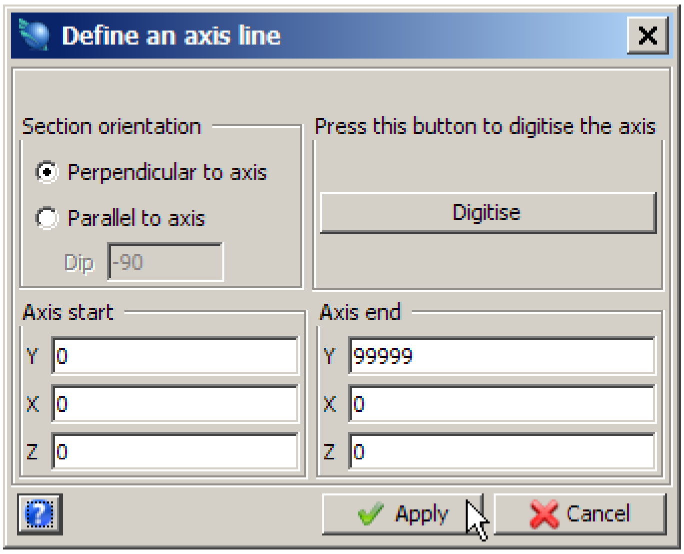
8. Move the object about in 3D space to see how the slices relate to the solid.



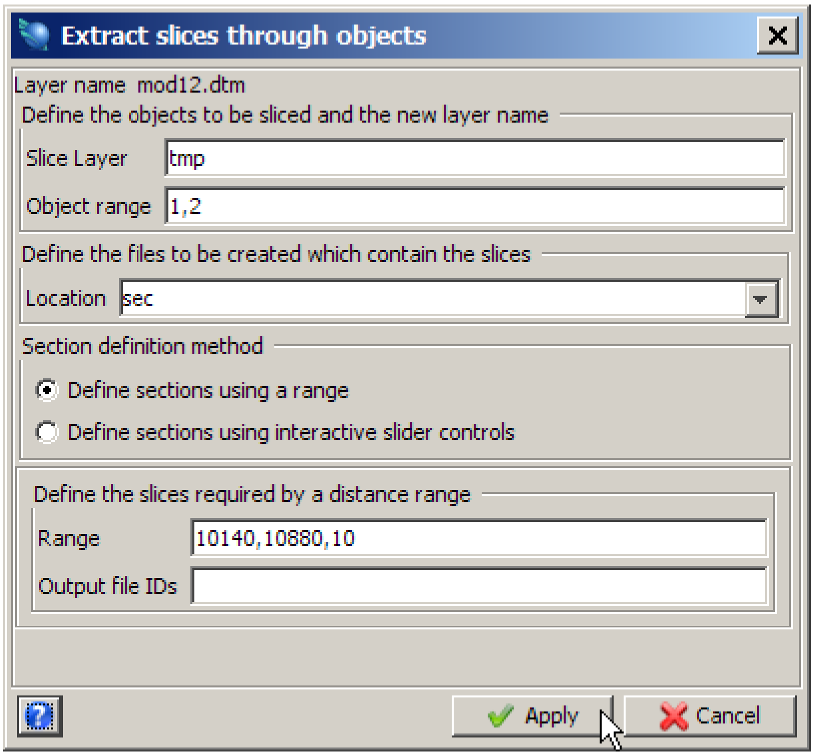
📝 **Note**: To see all of the steps performed in this section, run **_10a_slice_objects_interactive.tcl.** You will need to click **Apply** on any forms presented.

Task: Create Sections by Range

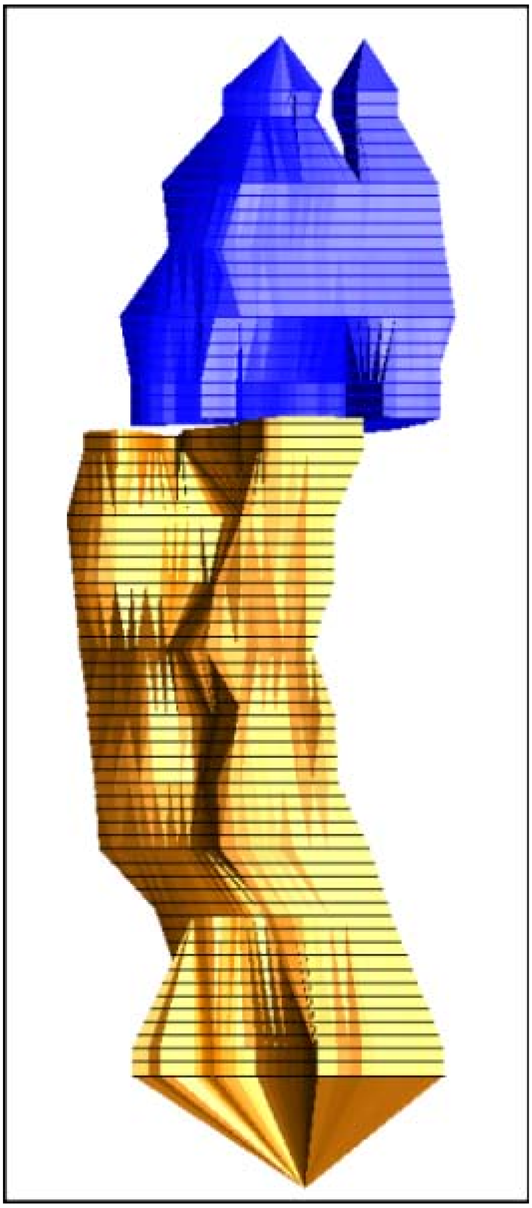
1. Click the **Reset graphics** icon .
2. Open **mod12.dtm**.
3. Choose **Inquire > Report layer extents** to determine the Maximum and Minimum Y, X and Z coordinates.
   Notice that the data shown in the window extends from 10055 north to 10920 north. By defining a north-south axis, the objects can be sliced.
4. Choose **Solids > Solids tools > Create sections**.
   For this exercise you will be slicing this model on Northings (Y). To do this you will need to define a vertical axis.
5. Enter the information as shown, and then click **Apply**.



6. Enter the information as shown, and then click **Apply**.



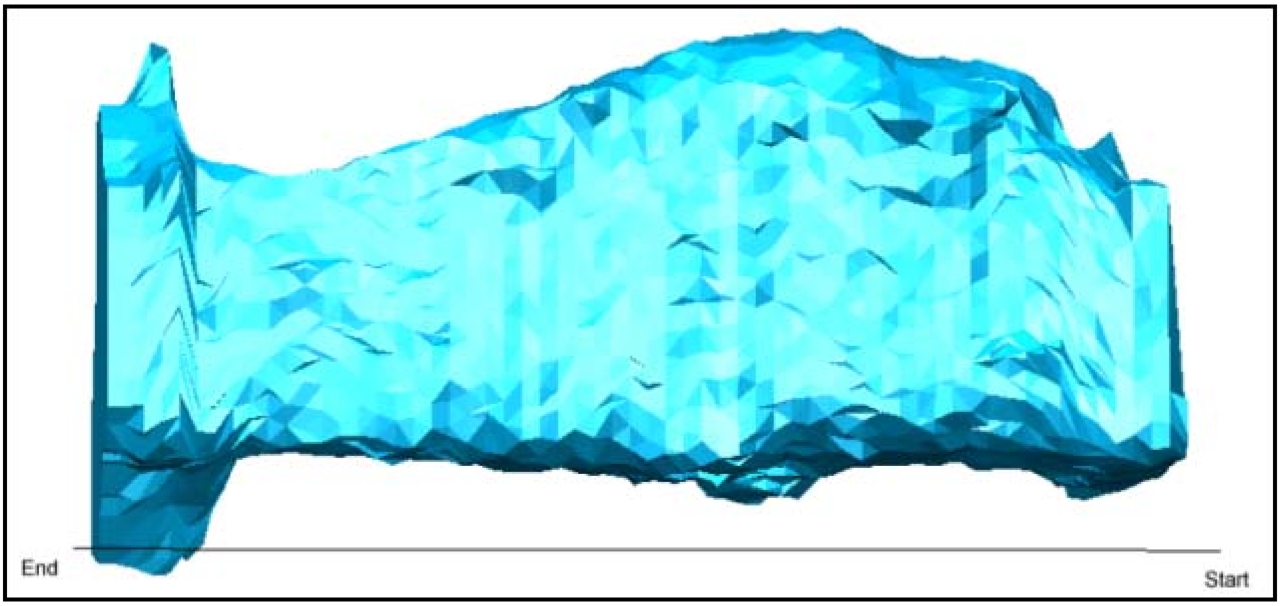
The solid with sections is displayed.



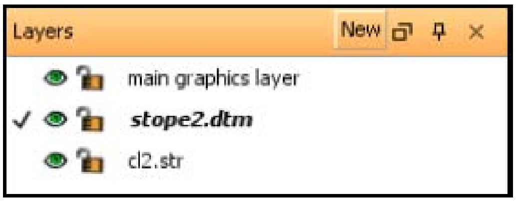
Note: To see all of the steps performed in this section, run **_10b_slice_objects_by_range.tcl.** You will need to click **Apply** on any forms presented.

Task: Create Sections Using a Centre Line

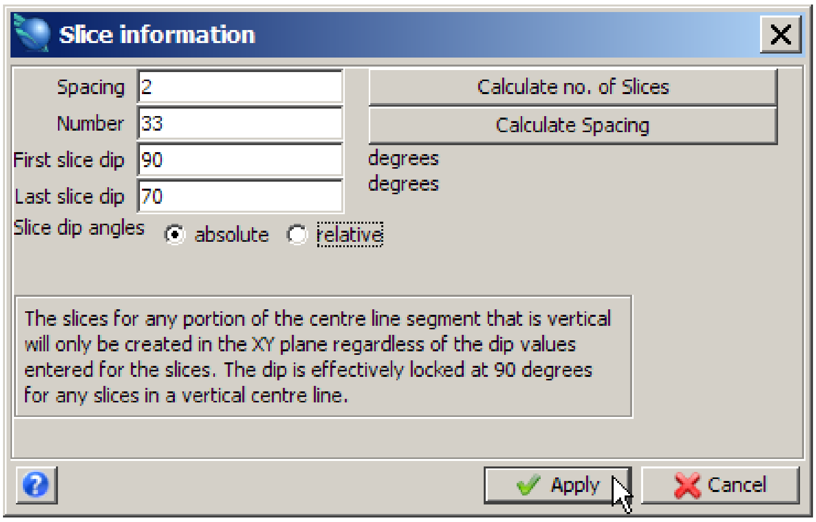
1. Click the **Reset graphics** icon .
2. Open **stope2.dtm**.
3. Open **cl2.str**.
   When slicing a solid, the centreline string and the objects to be sliced may be either in separate layers or in the same layer. For display purposes, it is generally simpler if separate layers are used. Note that if they are in separate layers, the layer containing the solids to be sliced must be set to the active layer.



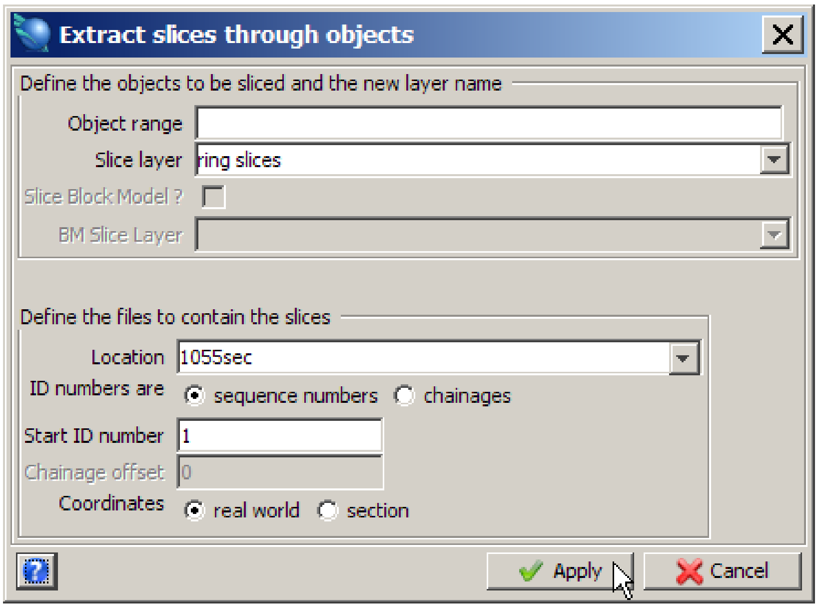
4. Make **stope2.dtm** the active layer.



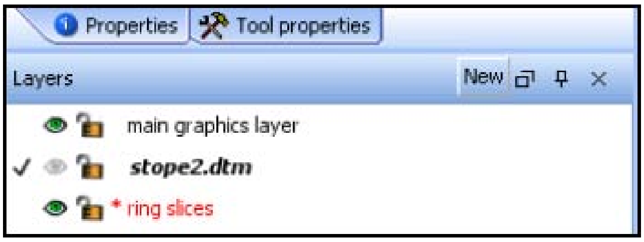
5. Choose **Solids > Solids tools > Section using centre line**.
6. As prompted, click the start and end points of your centre line.
7. Enter the information as shown, and then click **Apply**.



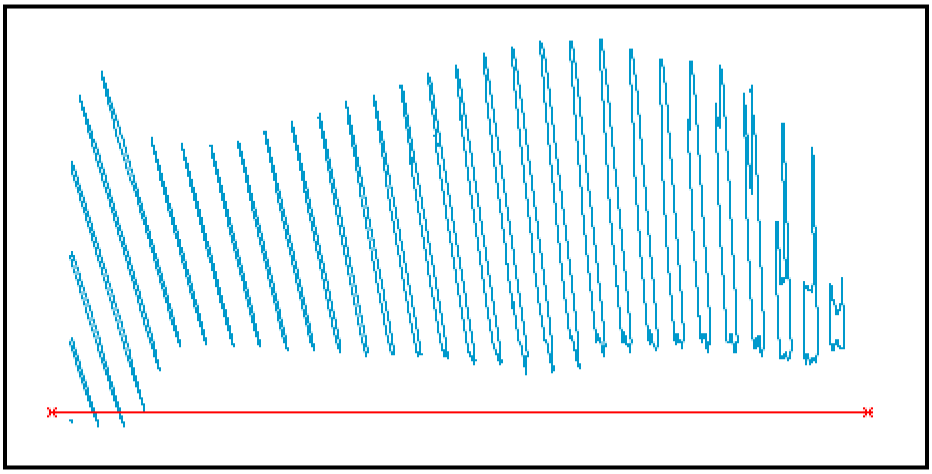
8. Enter the information as shown, and then click **Apply**.



9. Change the **Layers Status** to make the **stope2.dtm** layer invisible.



Ring slice is displayed.



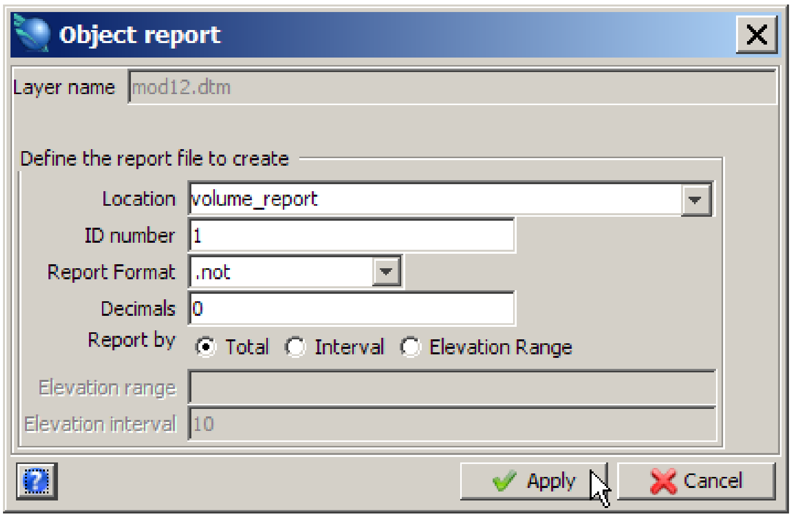
Notice how the slices start at 90 degrees and the last slice is at 70 degrees.

Note: To see all of the steps performed in this section, run **_10c_centre_line_slice.tcl.** You will need to click **Apply** on any forms presented.

Reporting Volumes of Solids

Task: Report Volume of a Solid

1. Click the **Reset graphics** icon .
2. Open **mod12.dtm**.
3. Choose **Solids > Solids tools > Report volume of solids**.
4. Enter the information as shown, and then click **Apply**.



The file **volume_report1.not** is displayed.

```
SOLID MODELLING OBJECT REPORT
Layer Name: mod12.dtm
Object: 1
Trisolation: 1
Validated = true
Status = solid
Trisolation Extents
X Minimum: 5184.820 X Maximum: 5468.470
Y Minimum: 10055.129 Y Maximum: 10634.653
Z Minimum: 836.580 Z Maximum: 1078.760
Surface area: 421501
Volume : 5337158
Object: 2
Trisolation: 1
Validated = true
Status = solid
Trisolation Extents
X Minimum: 5225.070 X Maximum: 5477.490
Y Minimum: 10619.466 Y Maximum: 10920.397
Z Minimum: 904.633 Z Maximum: 1058.910
Surface area: 191274
Volume : 2293278
```

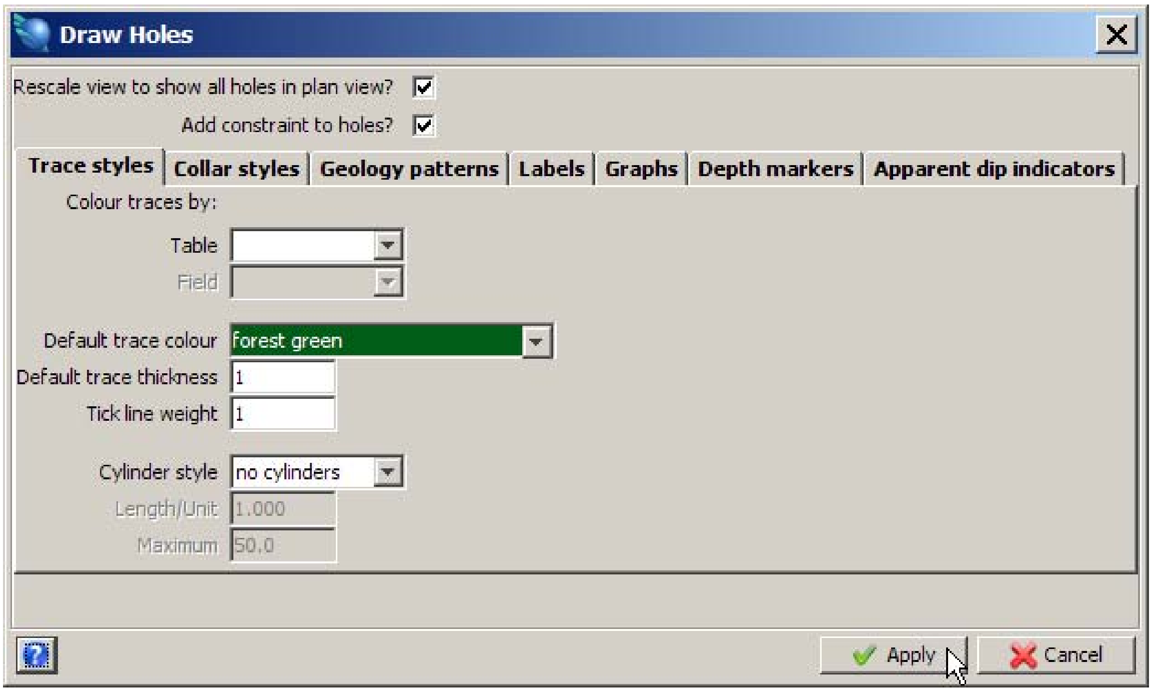
5. Close the report file.

Note: To see all of the steps performed in this section, run **_11_solids_volume_report.tcl.** You will need to click **Apply** on any forms presented.

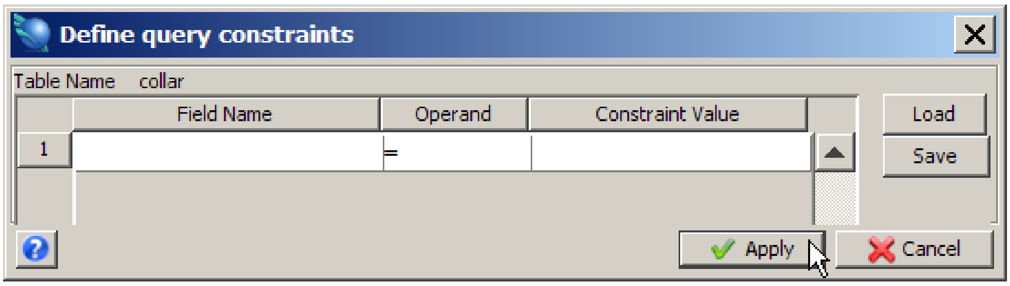
Intersecting Drill Holes with Solid Models

Task: Intersect Drill Holes with Solid Models

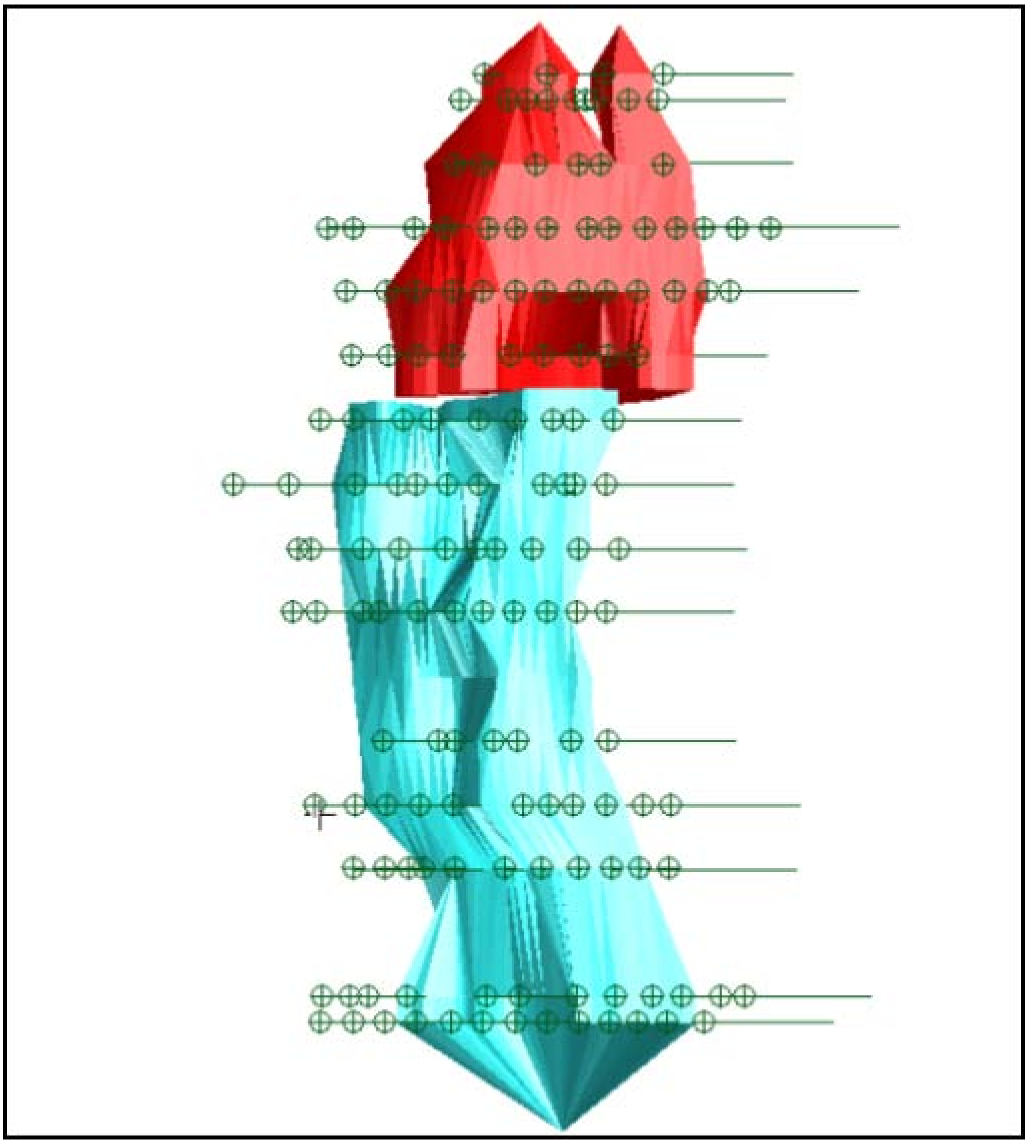
1. Click the **Reset graphics** icon .
2. Open **mod12.dtm**.
3. Open **solids.ddb**.
4. Choose **Database > Display > Drillholes**.
5. Accept the default values, and then click **Apply**.



6. Accept the default values, and then click **Apply**.

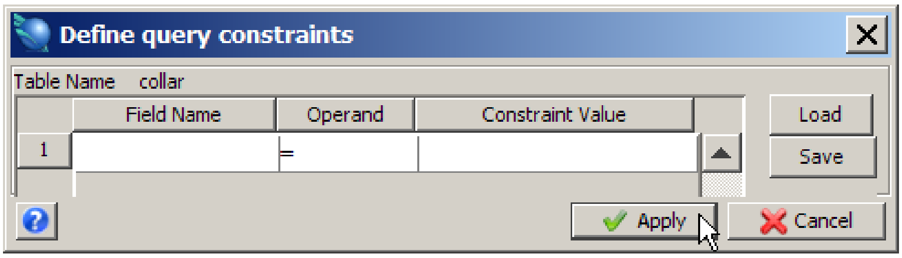


The solid with drillholes is displayed.

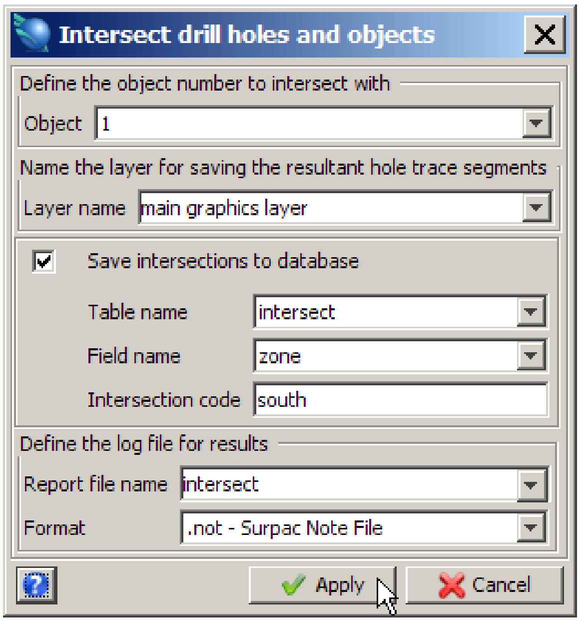


The database has an optional table called **Intersect**, where you will store the results of this processing.

7. Choose **Database > Analysis > Drillhole 3DM intersection**.
8. On the blank constraint form, click **Apply**.



9. Enter the information as shown, and then click **Apply**.

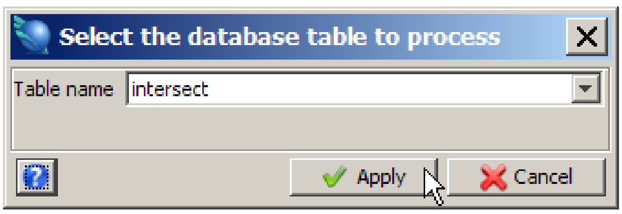


The table called Intersection within the database now contains a field called **zone**, in which a character code **south** has now been stored.

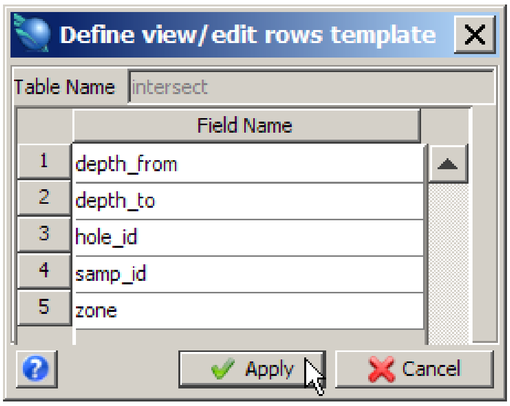
The Drillhole Object Intersection report is displayed.

```
Drillhole Object Intersection Report July 04, 2008
Hole Id  Depth From  Depth To  Intersection Code
-----------------------------------------------
10            11.12     69.15  south
11             7.01     49.37  south
12             9.11     26.88  south
15           173.50    175.67  south
16           159.91    185.20  south
17            29.89     38.64  south
17            90.33    164.64  south
18            90.05    118.37  south
19            70.32    104.86  south
2            180.25    197.10  south
20            14.80     86.73  south
21             3.44     61.14  south
22             5.74     37.47  south
27            71.80     76.80  south
28            59.95     67.40  south
28           149.50    156.98  south
29            49.66     61.99  south
29           127.89    141.79  south
3             49.44     55.00  south
```

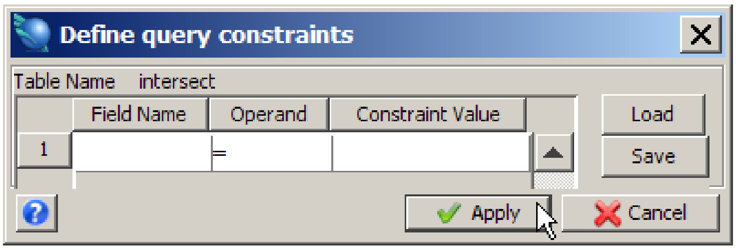
10. Close **intersect.not**.
11. Choose **Database > Edit > View table constrained**.
12. Enter the information as shown, and then click **Apply**.



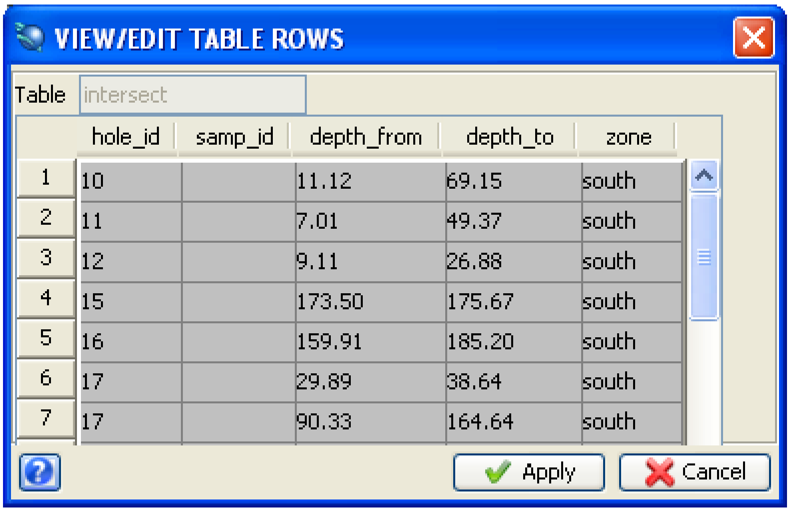
13. Enter the information as shown, and then click **Apply**.



14. Enter the information as shown, and then click **Apply**.



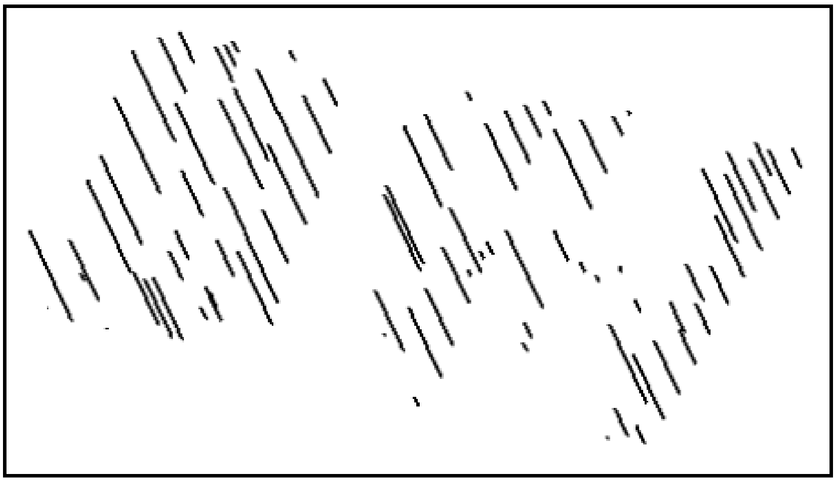
The intersections will be displayed.



	hole_id	samp_id	depth_from	depth_to	zone
1	10		11.12	69.15	south
2	11		7.01	49.37	south
3	12		9.11	26.88	south
4	15		173.50	175.67	south
5	16		159.91	185.20	south
6	17		29.89	38.64	south
7	17		90.33	164.64	south

15. Click **Apply** on the form.
    Note: You can also view the results in the intersection table in the geological database.
16. Choose **Database > Database > Close**.
17. Turn **Faces Off** and rotate the data to see the intersections clearly.

The drillhole trace is displayed.



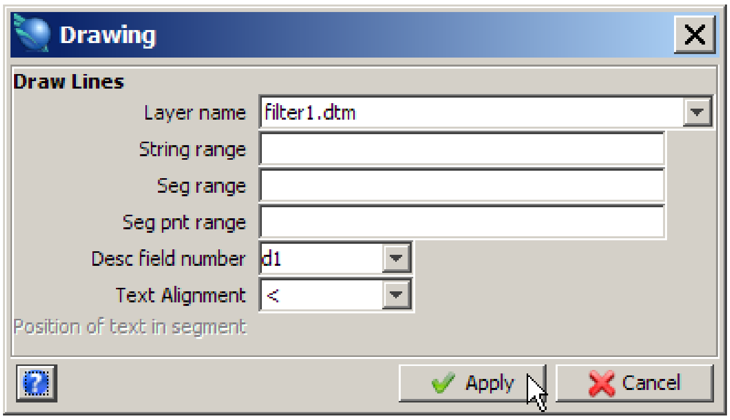
Note: To see all of the steps performed in this section, run **_12_intersect_drillholes_solids.tcl.** You will need to click **Apply** on any forms presented.

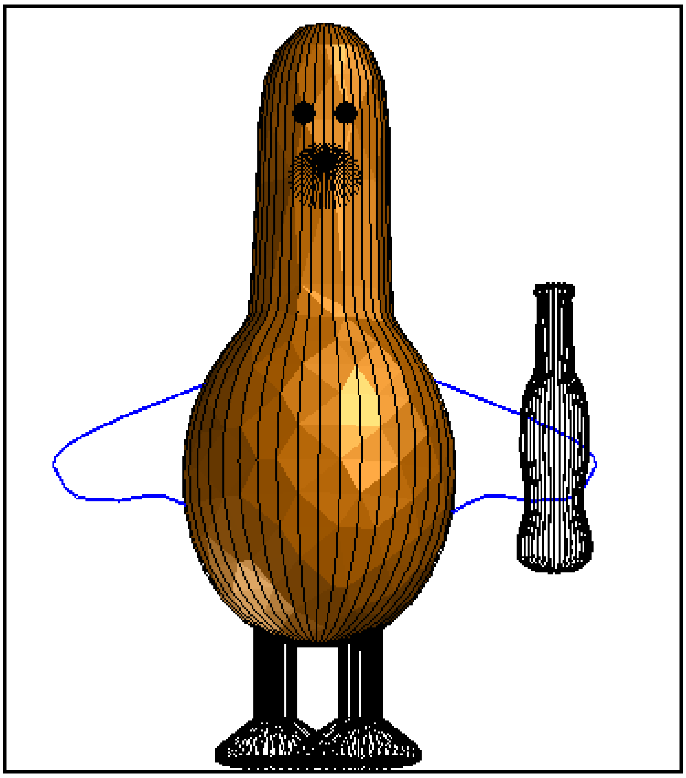
Optimising Trisolations

Task: Optimise Trisolations

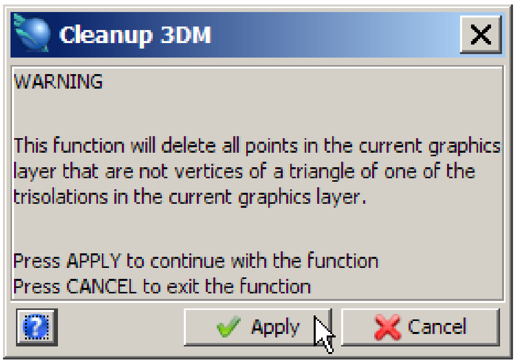
1. Click the **Reset graphics** icon .
2. Open **filter1.dtm**.
3. Choose **Solids > Edit trisolation > Optimise**.
4. Click anywhere on the object.
5. Enter the information as shown, and then click **Apply**.

6. Choose **Display > Strings > As lines**.
7. Enter the information as shown, and then click **Apply**





8. Choose **Solids > Edit trisolation > Delete redundant points**.
9. Click **Apply** on the form presented.



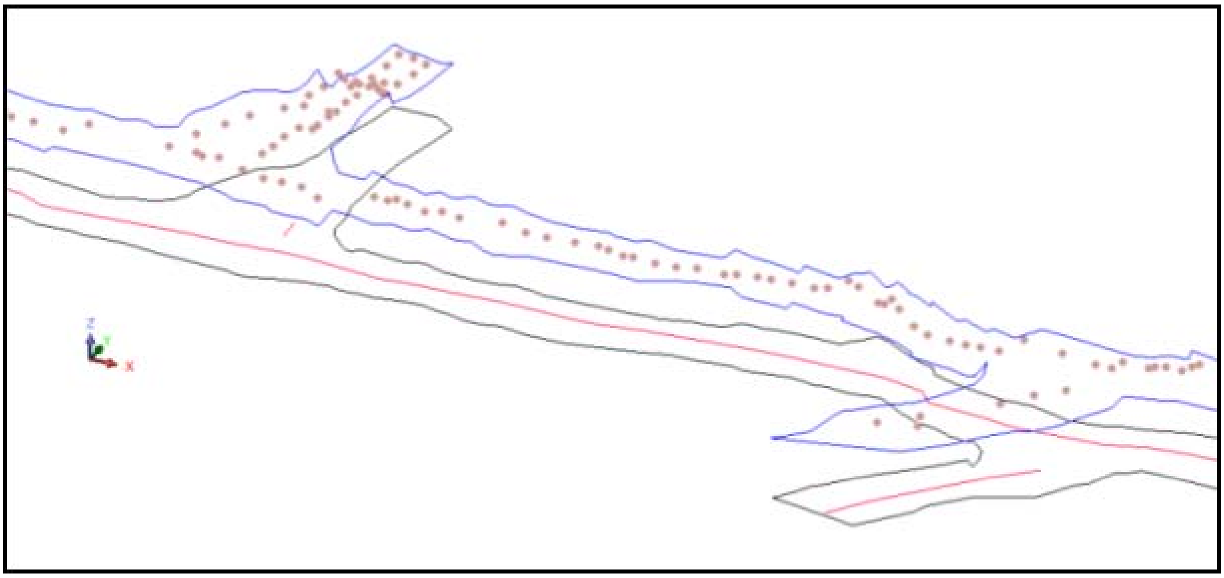
Notice that more than 90% of the points were deleted and any segments not associated with a triangle have been deleted.

Note: To see all of the steps performed in this section, run **_13_optimise_trisolation.tcl.** You will need to click **Apply** on any forms presented.

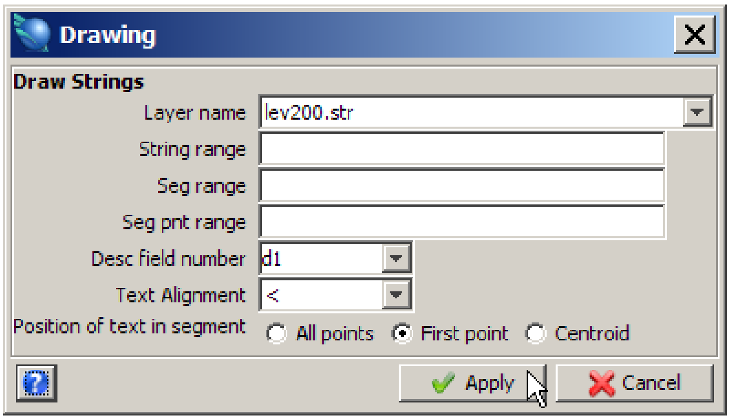
Modelling Underground Data

Task: Model Underground Data

1. Click the **Reset graphics** icon .
2. Open **lev200.str**.
   Floor and back strings are displayed.



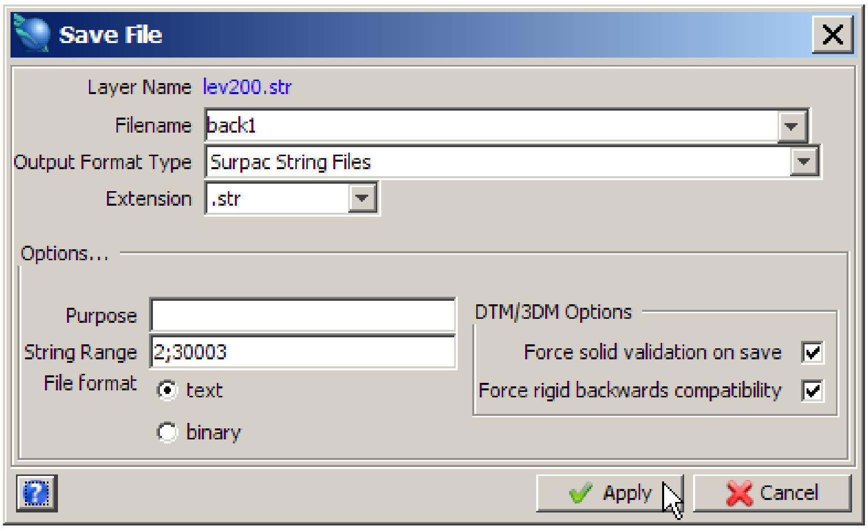
3. Choose **Display > Strings > With string numbers**.
4. Enter the information as shown, and then click **Apply**.



Note: In this case, the string numbers for the backs are 2 and 30003 and for the floor are 1 and 1001. String 30003 is a spot height string. You will need to create separate DTM files for the backs and the floors.

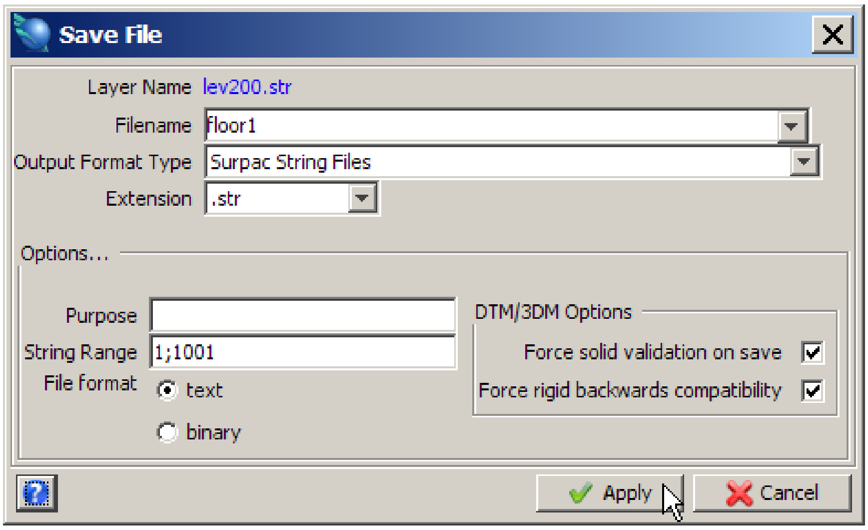
5. Choose **File > Save > string/DTM**.

6. Enter the information as shown, and then click **Apply**.



Note: This creates a string file containing just the back strings. Notice that the separator for the string range is a semi colon.

7. Choose **File > Save > string/DTM**.
8. Enter the information as shown, and then click **Apply**.



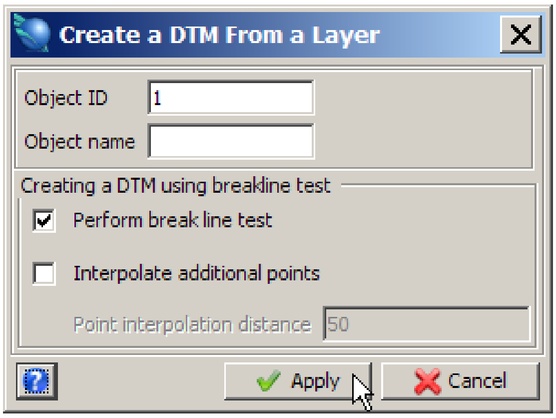
Note: This will create a string file containing just the floor strings. Notice that the separator for the string range is a semi colon.

9. Click the **Reset graphics** icon .
10. Open **back1.str**.

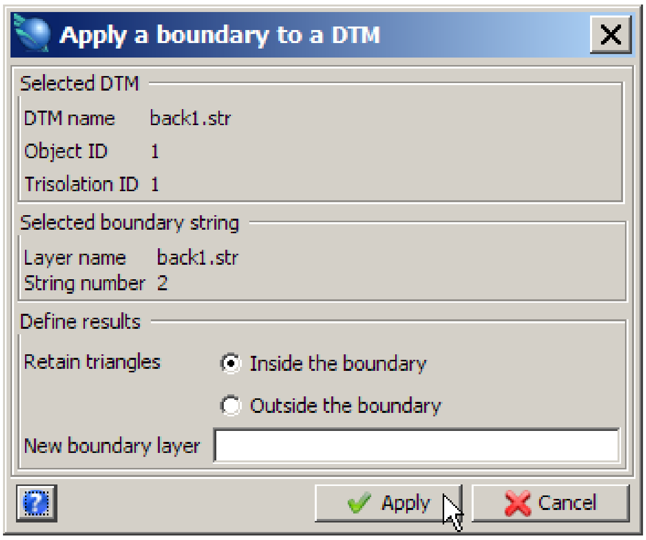
    Strings 2 and 30003 are displayed.

11. Choose **Inquire > Segment Properties** and click on each segment to check its direction. Notice that the pillar segment is anti-clockwise within an enclosing outer boundary segment that is clockwise.
12. Choose **Surfaces > Create a DTM from layer**.

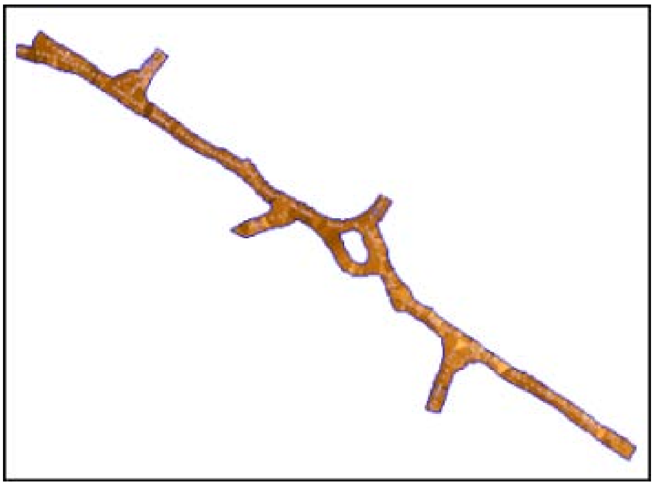
13. Enter the information as shown, and then click **Apply**.



14. Choose **Surfaces > Clip or intersect DTMs > Clip DTM with string**.
    You are prompted to select a string.
15. Click string 2 (ie. pillar and wall pickup string).
16. Enter the information as shown, and then click **Apply**.



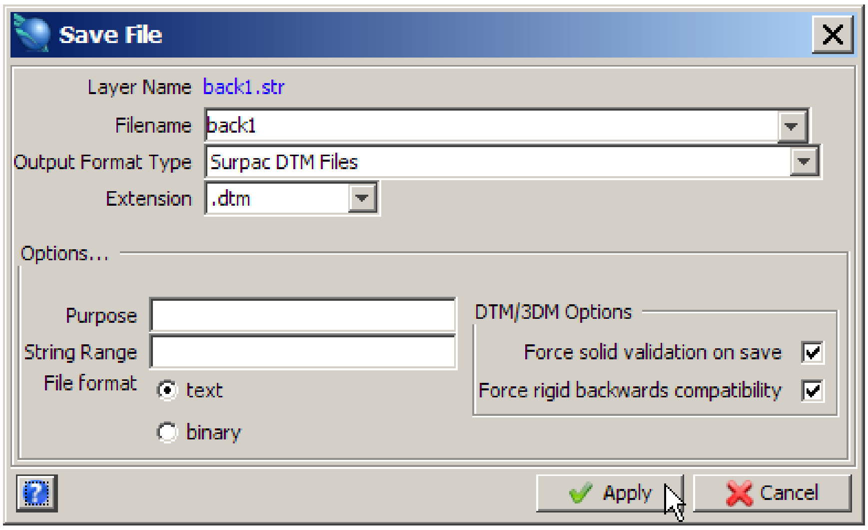
The underground spot height string is displayed.



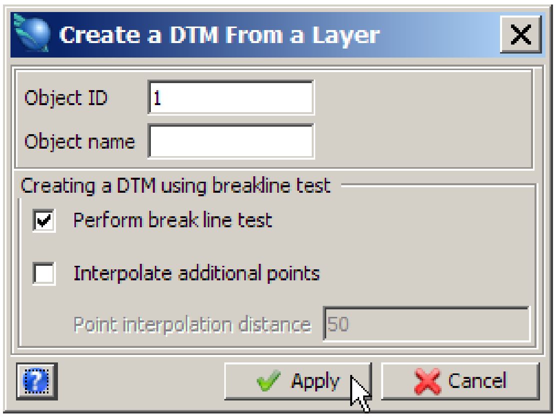
Note: The DTM has been clipped correctly due to the string directions set for the walls and pillars.

17. Choose **File > Save > string/DTM**.

18. Enter the information shown, and then click **Apply**.

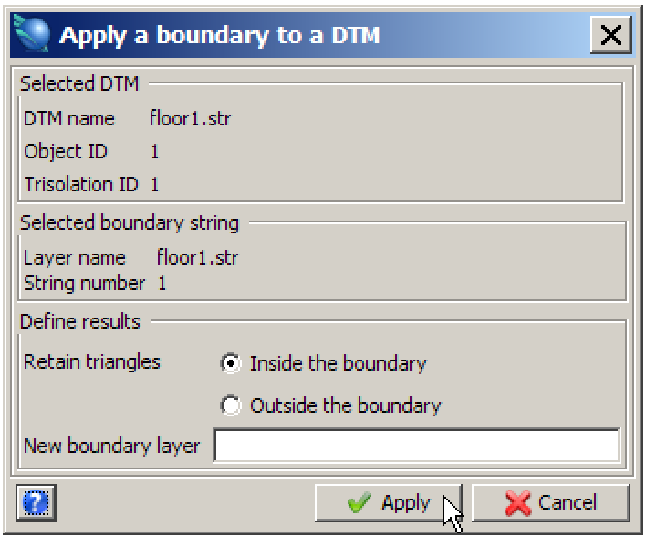


19. Click the **Reset graphics** icon.
20. Open **floor1.str**.
21. Choose **Surfaces > Create DTM from layer**.
22. Enter the information as shown, and then click **Apply**.

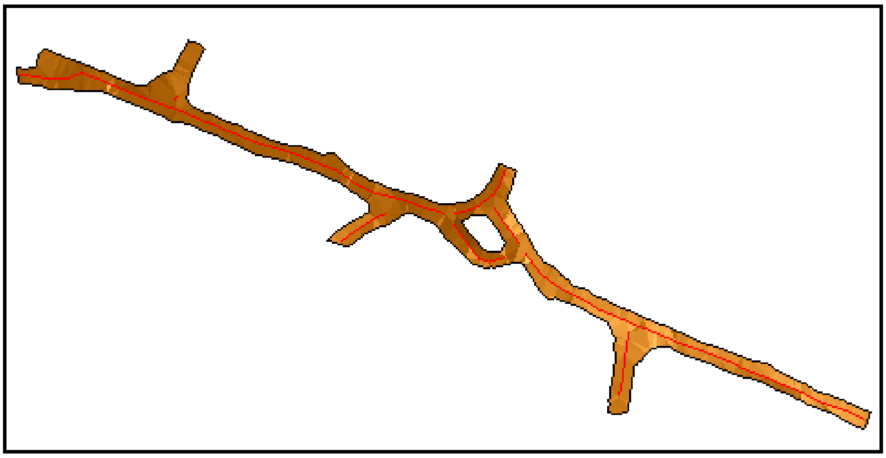


23. Choose **Surfaces > Clip or intersect DTMs > Clip DTM with string**
    You are prompted to select a string.
24. Click string 1.

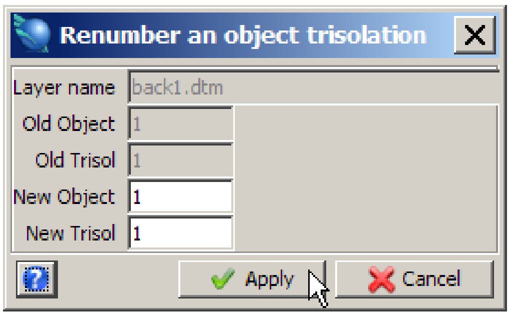
25. Enter the information as shown, and then click **Apply**.



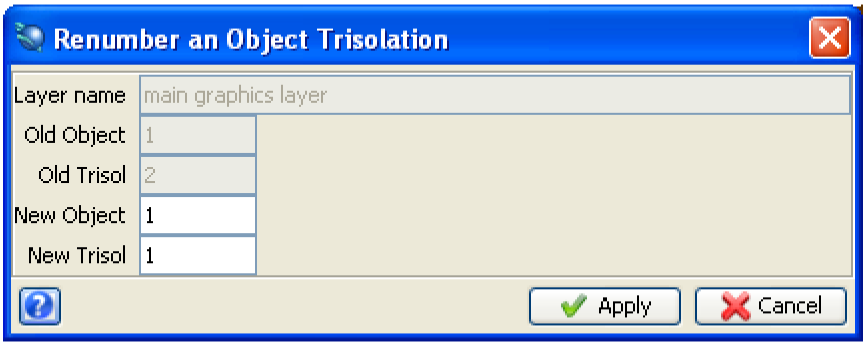
The underground backs are displayed.



26. Save **floor1.dtm**.
27. Click **Reset graphics**.
Now that both clipped DTMs have been created, stitch together the sides to create a closed, validated Solid model.
28. Open and append **back1.dtm** and **floor1.dtm** into the main graphics layer.
Note: To append the DTMs to the same layer, hold down the **CTRL** key and drag and drop the files into graphics.
29. Choose **Solids > Edit trisolation > Renumber**.
30. Click **back1.dtm**.
31. Enter the information as shown, and then click **Apply**.

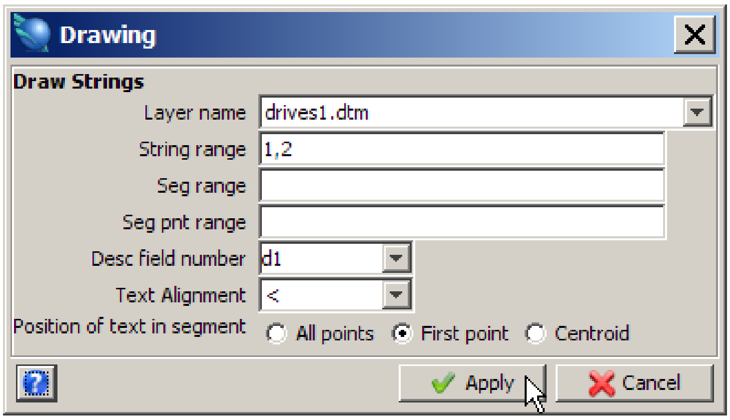


32. Click **floor1.dtm**.
33. Enter the information as shown, and then click **Apply**.

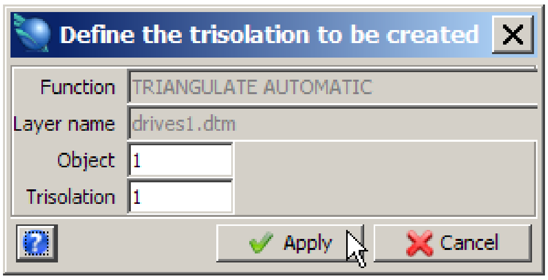


Notice that the old trisolation number is 2 in this case.

34. Press **ESC.**
35. Save the file as **drives1.dtm**.
    Note: When performing Solids modelling, it is good practice to save your work regularly.
36. Click **Reset graphics** .
37. Choose **Display > Strings > With string numbers**.
38. Enter the information as shown, and then click **Apply**.



39. Choose **Solids > Triangulate > Between segments**.
40. Enter the information as shown, and then click **Apply**.

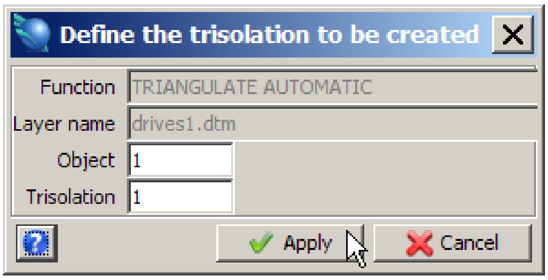


41. Following the prompts from the function line, click first the outer back string, and then the outer floor string
42. Press **ESC.**

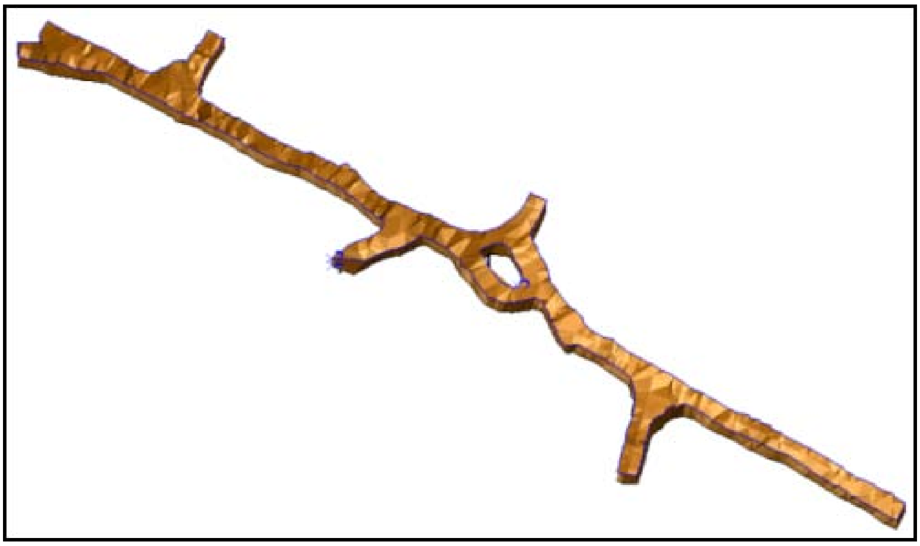
    Repeat the process for the pillar.

43. Choose **Solids > Triangulate > Between segments**.

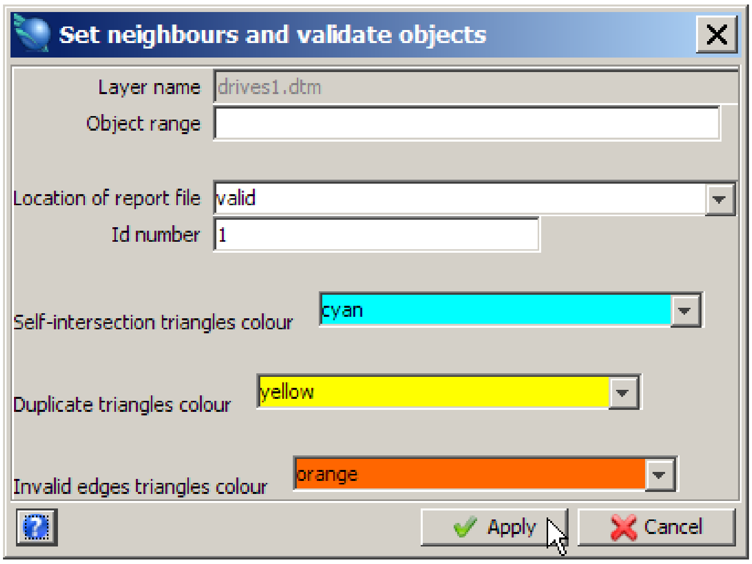
44. Enter the information as shown, and then click **Apply**.



45. Following the prompt from the function line, click first the top string of the pillar, and then the bottom string of the pillar.
46. Press **ESC**.
    The underground result is displayed.



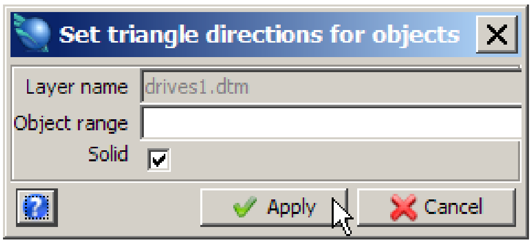
47. Save **drives1.dtm**.
48. Choose **Solids > Validation > Validate object**.
49. Enter the information as shown, and then click **Apply**.



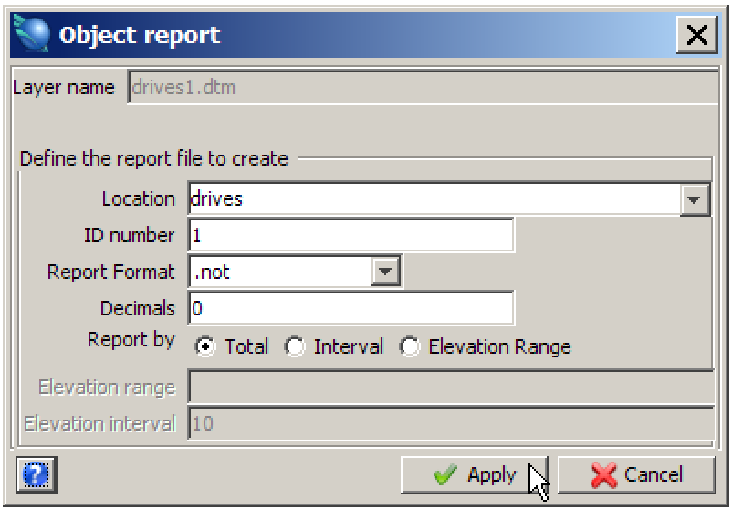
The Solids Modelling validation report is displayed.

```
SOLIDS MODELLING VALIDATION REPORT. DATE: 08-Jul-08
===================================================
OBJECT 1, TRISOLATION 1
========================
Validated = TRUE
Status = CLOSED
DUPLICATE TRIANGLES:
--------------------
NONE
TRIANGLES ATTACHED TO INVALID EDGES:

NONE
TRIANGLES ATTACHED TO INVALID EDGES:
------------------------------------
NONE
SELF INTERSECTION TRIANGLES:
----------------------------
NONE
OPEN SIDES TRIANGLES:
---------------------
NONE
```

50. Choose **Solids > Validation > Set object to solid or void**.
51. Enter the information as shown, and then click **Apply**.



52. Choose **Solids > Solids tools > Report volume of solids**.
53. Enter the information as shown, and then click **Apply**.



The Solid Modelling Object report is displayed.

```
SOLID MODELLING OBJECT REPORT
Layer Name: drives1.dtm

Object: 1
Trisolation: 1
Validated = true
Status = solid

Trisolation Extents
X Minimum: 14147.967 X Maximum: 14401.569
Y Minimum: 11613.344 Y Maximum: 11702.817
Z Minimum: 716.840 Z Maximum: 745.362
Surface area: 8360
Volume : 12296
```

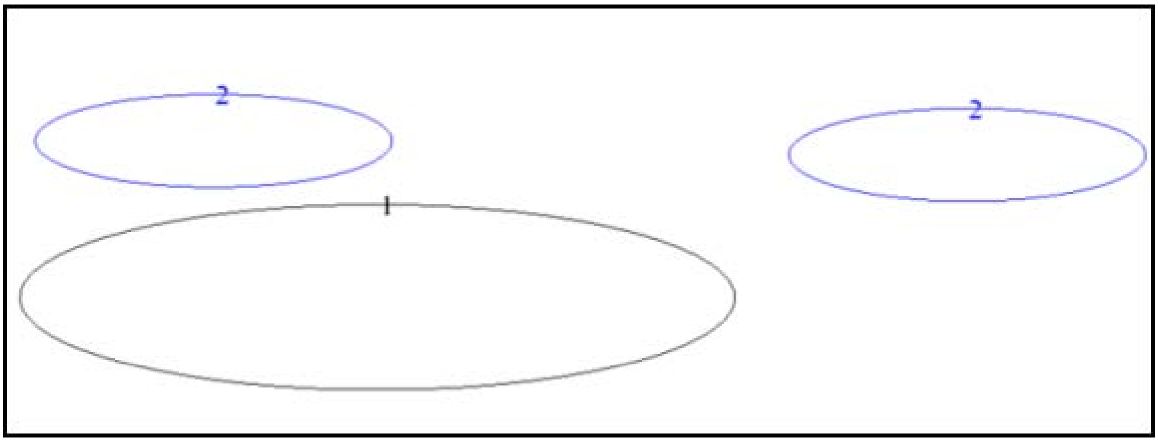
Note: To see all of the steps performed in this section, run **_15_create_underground_model.tcl.** You will need to click **Apply** on any forms presented.

Using The Triangulation Algorithm

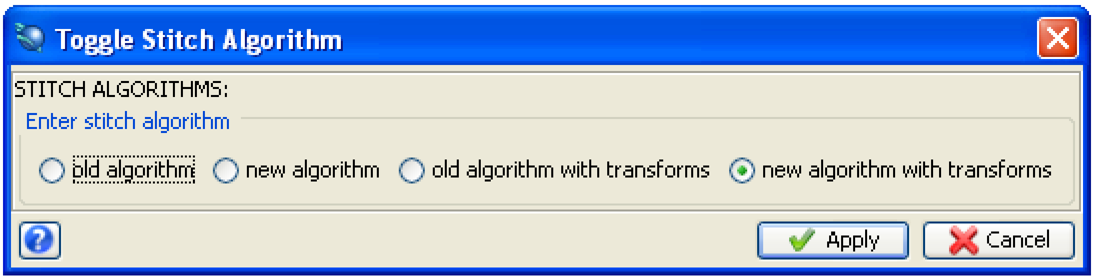
Task: Use the Triangulation Algorithm

1. Click the **Reset graphics** icon .
2. Open **bifurc2.str**.
3. Choose **View > Data view options > View by bearing & dip**.
4. Enter the information as shown, and then click **Apply**.

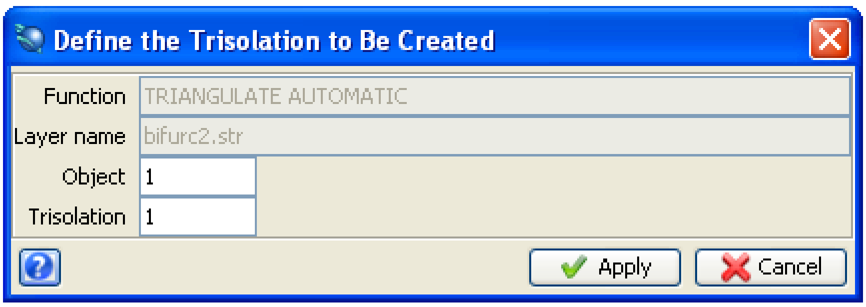
5. Choose **Display > Strings > With string numbers**.
   The bifurcation example is displayed.



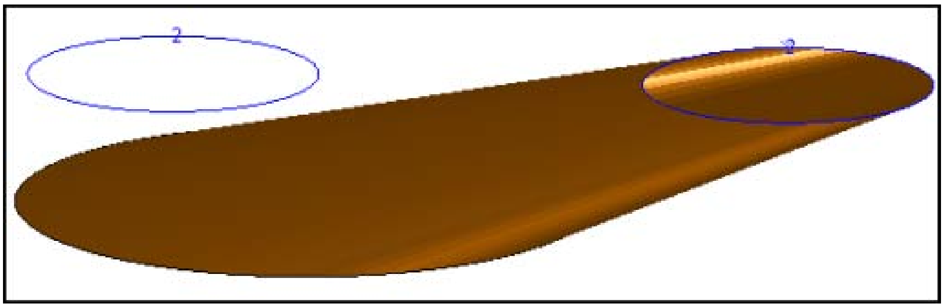
6. Choose **Solids > Triangulate > Triangulation algorithm**.
7. Ensure that **new algorithm with transforms** is selected.



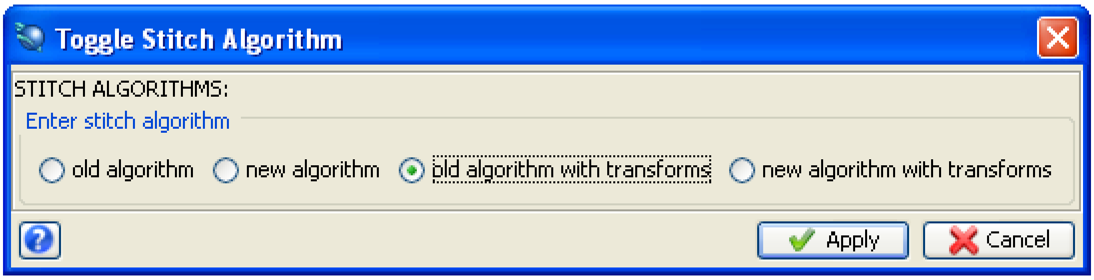
8. Choose **Solids > Triangulate > Between segments**.
9. Enter the information as shown, and then click **Apply**.



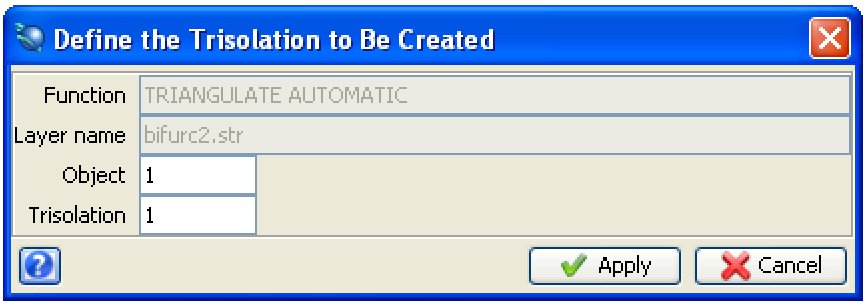
10. Click string 1 then the right hand segment of string 2 as shown:



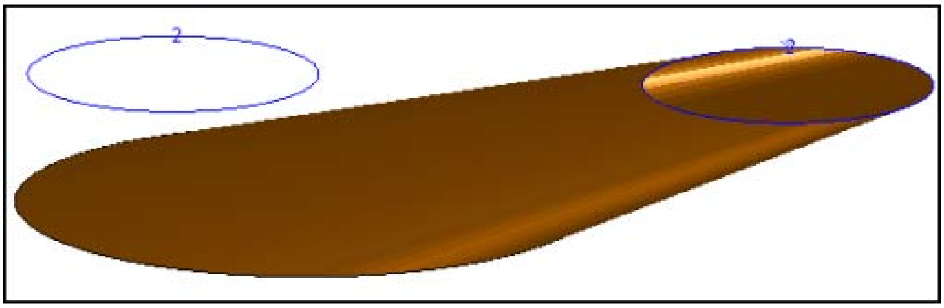
11. Press **ESC**.
12. Click the **Reset graphics** icon .
13. Open **bifurc2.str**.
14. Choose **Solids > Triangulate > Triangulation algorithm**.
15. Ensure that **old algorithm with transforms** is selected.



16. Choose **Solids > Triangulate > Between segments**.
17. Enter the information as shown, and then click **Apply**.



18. Click string 1 then the right most segment of string 2 as shown:

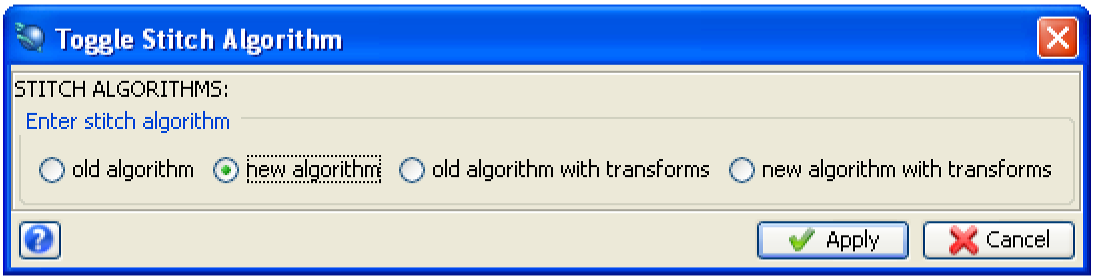


19. Press **ESC.**

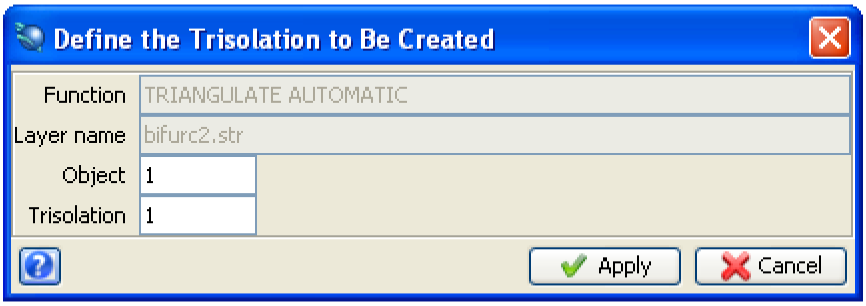
   Note: The old algorithm with transforms also achieved a successful result but took significantly longer. This demonstrates the principal difference between the new and old algorithms, ie. the new one is much faster.

20. Click the **Reset graphics** icon .
21. Open **bifurc2.str** and choose a similar view to that used before.

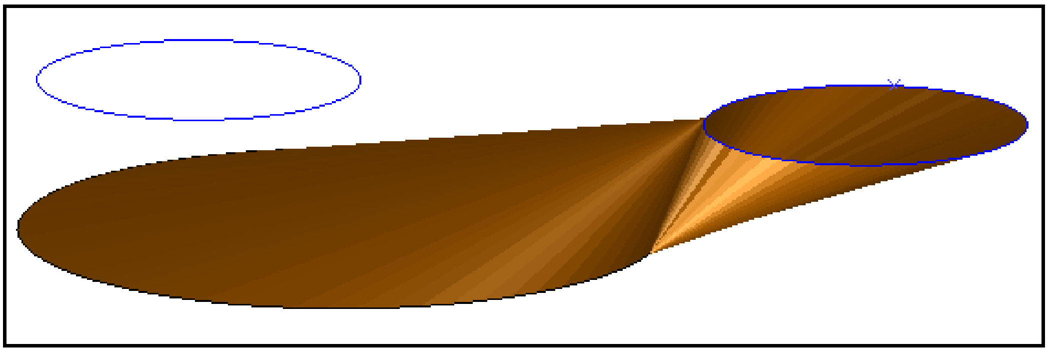
22. Choose **Solids > Triangulate > Triangulation algorithm**.
23. Ensure that **new algorithm** is selected.



24. Choose **Solids > Triangulate > Between segments**.
25. Enter the information as shown, and then click **Apply**.



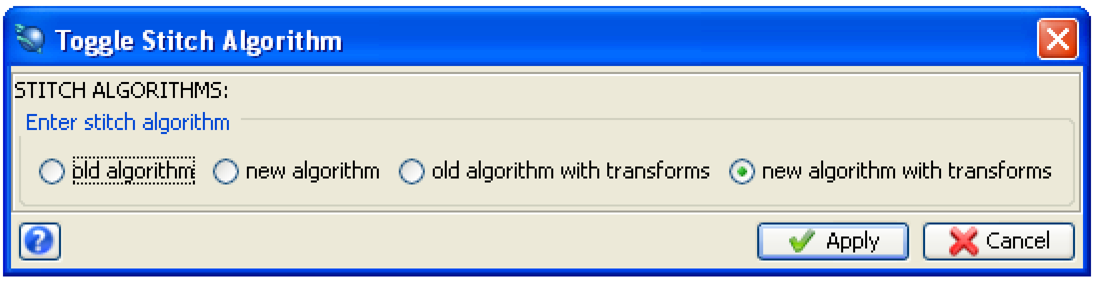
26. Click the same segments.
    The bifurcation example is displayed.



In this case the segments are too far apart geometrically for either the old algorithms or new algorithms (options 0 and 1 respectively) to work and the options with transforms should be chosen in preference.

Finally, restore the triangulation algorithm to its original value.

27. Click the **Reset graphics** icon.
28. Choose **Solids > Triangulate > Triangulation algorithm**.
29. Enter the information as shown, and then click **Apply**.



Note: To see all of the steps performed in this section, run **_16_triangulation_algorithm.tcl.** You will need to click **Apply** on any forms presented.

References

For further information on this topic and related articles, log onto Gemcom's Knowledge Base at www.gemcomsupport.com