



# Solids Tutorial

**Copyright © 2014 Dassault Systèmes GEOVIA Inc.**

All rights reserved. Dassault Systèmes GEOVIA Inc. publishes this documentation for the sole use of GEOVIA product licensees.

Without written permission, you may not sell, reproduce, store in a retrieval system, or transmit any part of this documentation. For such permission, or to obtain extra copies please contact your local GEOVIA office, or visit [www.3ds.com/GEOVIA](http://www.3ds.com/GEOVIA).

This software and documentation is proprietary to Dassault Systèmes GEOVIA Inc. and, except where expressly provided otherwise, does not form part of any contract. Changes may be made in products or services at any time without notice.

While every precaution has been taken in the preparation of this manual, neither the authors nor GEOVIA assumes responsibility for errors or omissions. Neither will be held liable for any damages caused or alleged to be caused from the use of the information contained herein.

Dassault Systèmes GEOVIA Inc. offers complete 3D software tools that let you create, simulate, publish, and manage your data.

GEOVIA, the GEOVIA logo, combinations thereof, and GEMS, Surpac, Minex, MineSched, Whittle, PCBC, InSite, and Hub are either trademarks or registered trademarks of Dassault Systèmes or its subsidiaries in the US and/or other countries.

**Product**

Surpac™ 6.6.1

Last modified: Tuesday, 1 April 2014

# Table of Contents

---

<b>Introduction</b> .....	<b>6</b>
Overview .....	6
Requirements .....	6
Workflow .....	6
<b>Solids concepts</b> .....	<b>7</b>
What is a solid model? .....	7
Terminology .....	7
Solids files .....	8
<b>Setting up for this tutorial</b> .....	<b>9</b>
Task: Set the work directory .....	9
<b>Preparing data</b> .....	<b>10</b>
Task: Combine string files into one file .....	10
Task: Check string file directions using string file summary .....	11
Task: Transform data from section view to plan view .....	12
Task: Check and remove foldbacks .....	13
Task: Highlight and remove duplicate points .....	15
<b>Creating a solid</b> .....	<b>16</b>
Triangulating using between segments .....	16
Task: Create a solid model .....	16
Triangulating using control strings .....	18
Task: Create control strings using the digitiser .....	18
Triangulating Using Many Segments .....	21
Task: Create a Solid by Specifying a Range of Strings .....	21
Triangulating using bifurcation techniques .....	23
Task: Perform bifurcation - one segment to many segments .....	23
Task: Perform one segment to two segments (bifurcation union) .....	25
Task: Perform bifurcation union – split parent .....	27
Task: Use one segment to two segments to model a bifurcation. ....	29
Task: Perform bifurcation using the triangulate shape tool .....	31
Triangulating using segment to a point .....	36
Task: Create points to triangulate using the digitiser .....	36
Task: Create a solid using segment to a point .....	41
Triangulating a fault .....	48
Task: Triangulate a fault by draping strings and triangulating .....	48
Preparing the data: .....	48
Draping the strings and triangulating: .....	53
Task: Triangulate a fault by extruding and clipping .....	58
<b>Triangulating using centre line and profile</b> .....	<b>66</b>

---

Task: Create a solid using centre line and profile. ....	66
Triangulating Using Inside Segment and One Triangle .....	72
Task: Triangulate Inside a Segment .....	72
Task: Triangulate Using the One Triangle Function .....	73
Triangulating using manual triangulation .....	74
Task: Triangulate using manual triangulation .....	74
<b>Editing solids .....</b>	<b>77</b>
Task: Renumber an object and trisolation .....	77
<b>Validating solids .....</b>	<b>78</b>
Task: Validate solids .....	78
<b>Setting an object to solid or void .....</b>	<b>80</b>
Task: Set an object (trisolation) to solid or void .....	80
<b>Repairing a solid .....</b>	<b>81</b>
Task: Repair a solid .....	81
Task: Repair a solid with complex problems .....	84
<b>Intersecting solids and DTM surfaces .....</b>	<b>87</b>
Intersecting solids .....	87
Task: Perform solids union .....	87
Task: Perform intersection of solids .....	89
Task: Perform outersection of solids .....	89
Task: Clip a solid above a DTM .....	90
Task: Clip a DTM outside a solid .....	92
Intersecting DTM surfaces .....	93
Task: Perform upper triangles intersection of two DTMs .....	93
Task: Perform lower triangles intersection of two DTMs .....	94
Task: Create a solid by intersecting two DTMs .....	94
<b>Viewing solids .....</b>	<b>97</b>
Task: Change solid display properties .....	97
<b>Creating sections .....</b>	<b>102</b>
Task: Create sections using the interactive method .....	102
Task: Create sections by range .....	106
Task: Create sections using a centre line .....	108
Task: Create sections using quick planes .....	111
<b>Reporting volumes of solids .....</b>	<b>113</b>
Task: Report volume of a solid .....	113
<b>Intersecting drill holes with solid models .....</b>	<b>114</b>
Task: Intersect drill holes with solid models .....	114
<b>Optimising trisolations .....</b>	<b>119</b>
Task: Optimise trisolations .....	119

---

<b>Modelling underground data</b> .....	<b>121</b>
Task: Model underground data .....	121
<b>Using the triangulation algorithm</b> .....	<b>131</b>
Task: Use the triangulation algorithm .....	131

## Introduction

### Overview

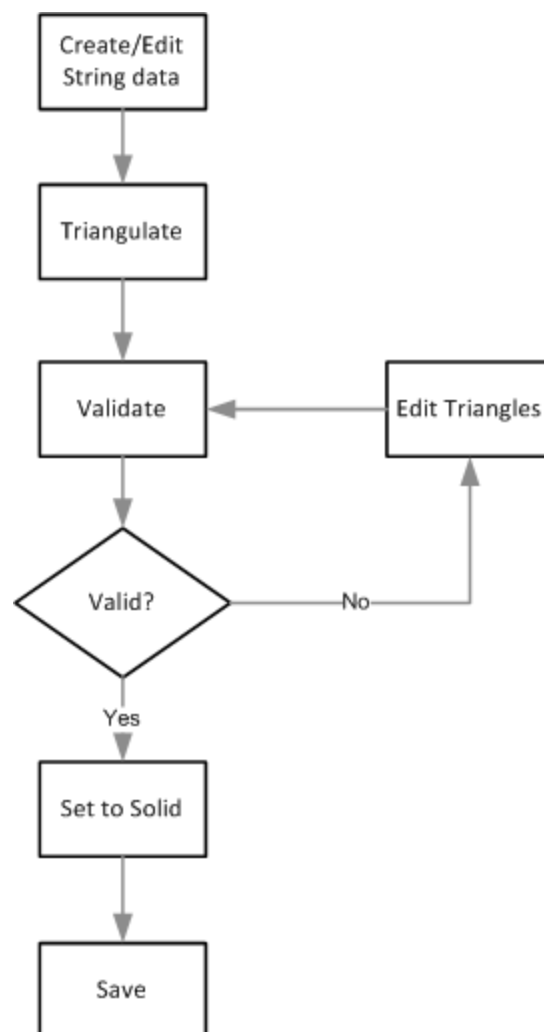
Solids modelling allows you to use triangulation to create three-dimensional models based on digital terrain models (DTMs) and string files. This tutorial introduces the theory behind the solids modelling process and provides detailed examples using the solids modelling functions in Surpac. By working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

### Requirements

Before you begin this tutorial, you must have:

- basic knowledge of Surpac  
It is recommended that you understand the procedures and concepts from the **Introduction to Surpac manual**. The **DTM Surfaces** tutorial may also be helpful in helping you understand some of the concepts in this tutorial.
- Surpac installed on your computer
- 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 can be formed by stitching triangles around strings that often represent sections through the shape being modelled.

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 based on their spatial location in the X - Y plane.

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

- geological structures
- stopes
- underground mine workings, such as declines, development drives, and draw points

A solid model is created by forming a set of triangles from the points contained in a string. These triangles may appear to overlap when you are in plan view, but they 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.

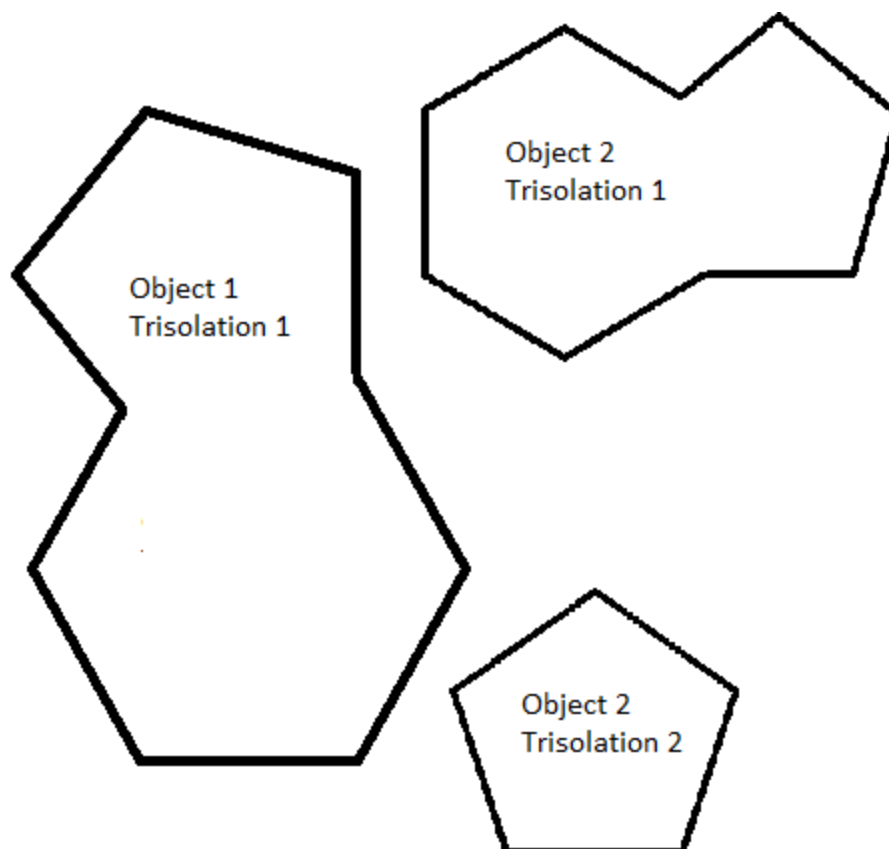
### Terminology

A solid model is made up of a set of non-overlapping triangles. These triangles form objects that have a numeric identifier between 1 and 32000. Objects represent discrete features in a solid model.

However, features such as ore bodies can consist of discrete parts, and you might want to give these parts the same *object number* to indicate that they are from the same structure. To identify each part separately, you can give each discrete part a different *trisolation number*, while keeping the same object number. A trisolation is a discrete part of a solid or surface. Like objects, trisolations are identified by a positive integer. Trisolations should be physically separated from each other. They should not share any points with other trisolations.

You can refer to all of the parts of a solid model using their object and trisolation numbers.

Example:



In this example object 1 represents the main orebody, and object 2 represents two discrete deposits of the secondary orebody.

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 reasons 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 data 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 as DTMs, in two ASCII text files, one **.str** and one **.dtm**.

## Setting up for this tutorial

A work directory is the default directory for saving Surpac files. Files used in this tutorial are stored in the folder `<shared_files>\demo_data\tutorials\solids`.

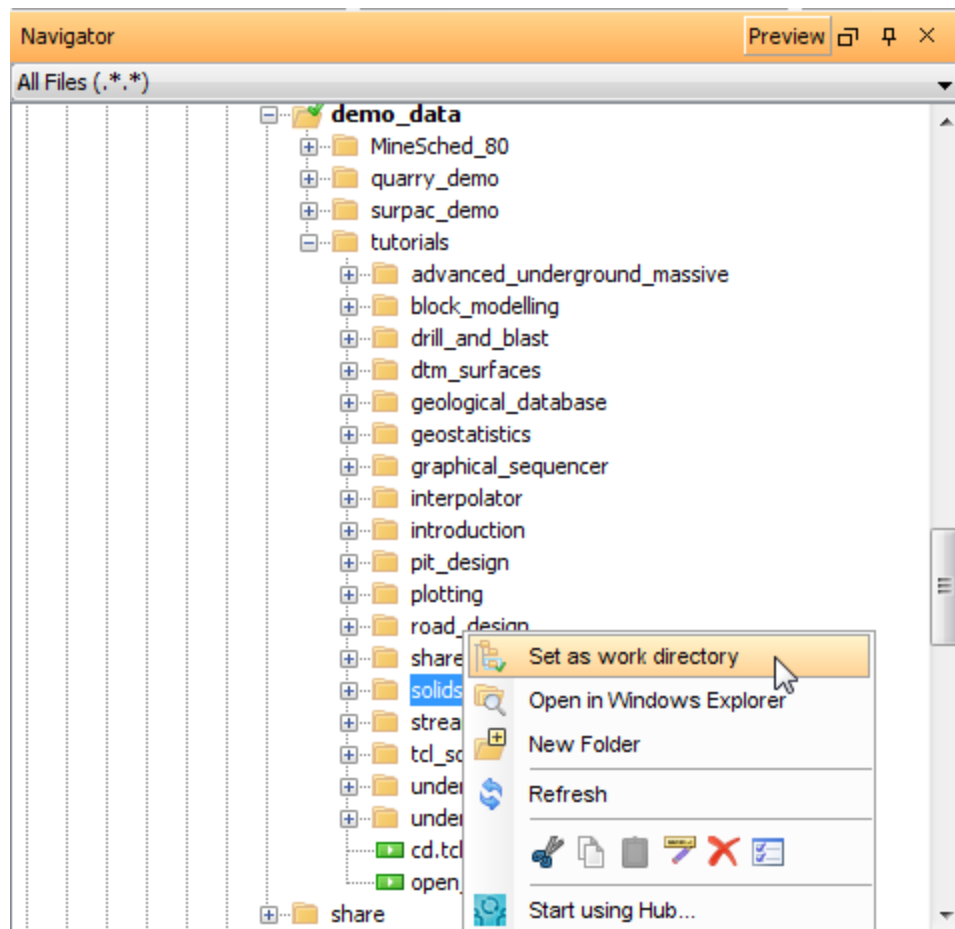
Where `<shared_files>` is the directory in which the Surpac shared files were installed.

In Windows 7, and Windows 8, the default path is

**C: \Users\Public\GEOVIA\Surpac\66\demo\_data\tutorials\solids.**

### Task: Set the work directory

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

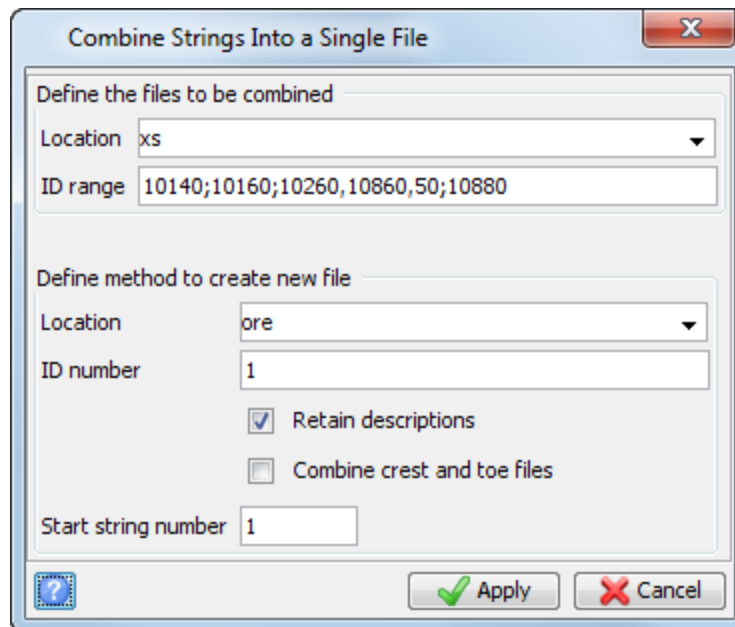


The name of the work directory is displayed in the title bar of the Surpac window.

## Preparing data

### Task: Combine string files into one file

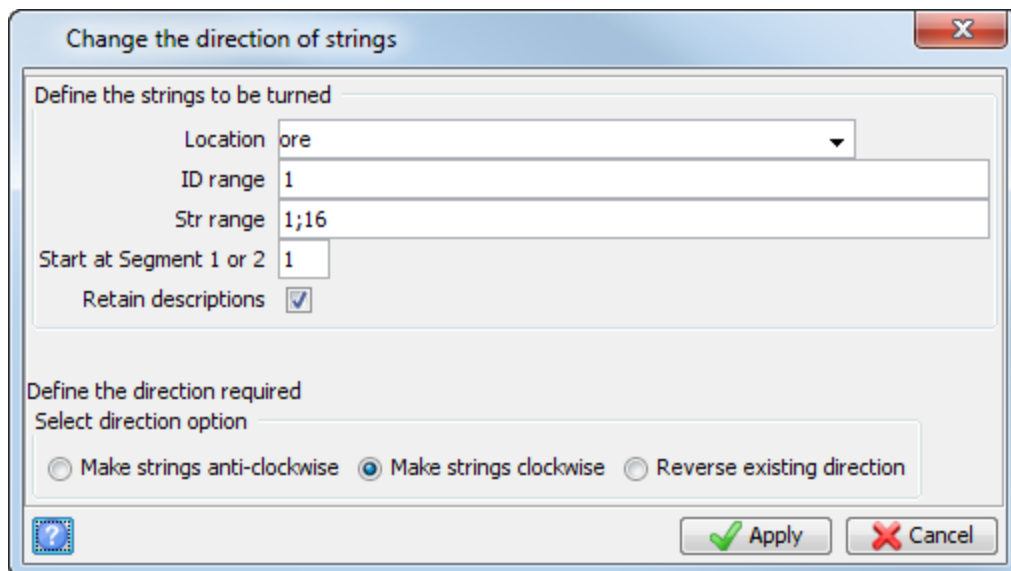
1. Choose **File tools > Combine/Split file options > Combine string files**.
2. Enter the information as shown, and click **Apply**.



The dialog box is titled "Combine Strings Into a Single File". It has two main sections. The first section, "Define the files to be combined", has a "Location" dropdown set to "xs" and an "ID range" text box containing "10140;10160;10260,10860,50;10880". The second section, "Define method to create new file", has a "Location" dropdown set to "ore" and an "ID number" text box set to "1". There are two checkboxes: "Retain descriptions" (checked) and "Combine crest and toe files" (unchecked). A "Start string number" text box is set to "1". At the bottom right are "Apply" and "Cancel" buttons.

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 click **Apply**.

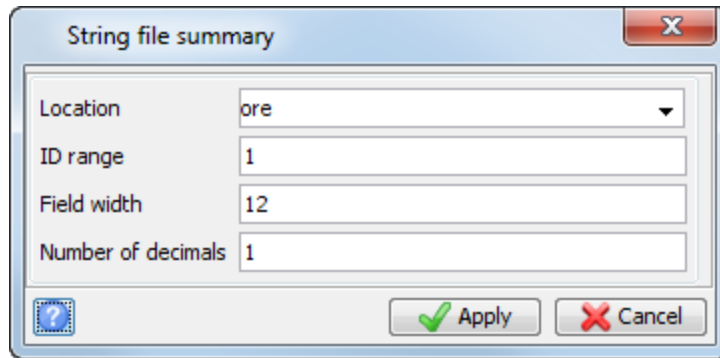


The dialog box is titled "Change the direction of strings". It has two main sections. The first section, "Define the strings to be turned", has a "Location" dropdown set to "ore", an "ID range" text box set to "1", a "Str range" text box set to "1;16", and a "Start at Segment 1 or 2" text box set to "1". There is a "Retain descriptions" checkbox which is checked. The second section, "Define the direction required", has a "Select direction option" group with three radio buttons: "Make strings anti-clockwise" (unchecked), "Make strings clockwise" (checked), and "Reverse existing direction" (unchecked). At the bottom right are "Apply" and "Cancel" buttons.

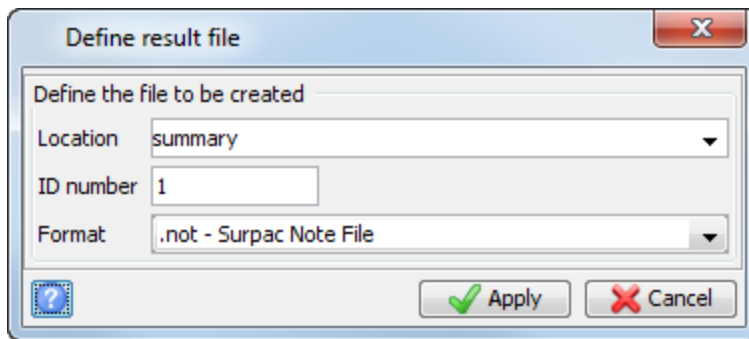
This will ensure that all digitised segments are set to clockwise. This string file is a series of sectional interpretations, representing a copper ore body.

### Task: Check string file directions using string file summary

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



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



File **summary1.not** is displayed.

String Summary Report

File: ore1.str  
Date: Purpose: Reversed strings

String	Segment	Direction	# Points	2d Len	3d Len	Area	X Min	X Max	Y Min	Y Max	Z Min	Z Max	C2dLen	C3dLen	C Area
1	1	Clockwise	98	782.3	782.3	10521.4	5234.6	5468.5	900.2	1071.1	10140.0	10140.0	782.3	782.3	10521.4
2	1	Clockwise	80	781.8	781.8	10510.2	5234.6	5468.5	900.2	1071.1	10160.0	10160.0	781.8	781.8	10510.2
3	1	Clockwise	66	619.9	619.9	7713.7	5251.3	5428.9	821.4	1074.8	10160.0	10160.0	619.9	619.9	7713.7
4	1	Clockwise	74	745.7	745.7	11972.0	5209.8	5412.8	849.7	1077.2	10310.0	10310.0	745.7	745.7	11972.0
4	2	Clockwise	74	745.7	745.7	11972.0	5209.8	5412.8	849.7	1077.2	10310.0	10310.0	1491.4	1491.4	23944.0
4			148	1491.4	1491.4	23944.0	5209.8	5412.8	849.7	1077.2	10310.0	10310.0	1491.4	1491.4	23944.0
5	1	Clockwise	73	722.5	722.5	10859.0	5206.4	5388.7	843.9	1074.0	10360.0	10360.0	722.5	722.5	10859.0
6	1	Clockwise	75	680.8	680.8	8671.2	5200.5	5387.0	858.2	1071.1	10410.0	10410.0	680.8	680.8	8671.2
7	1	Clockwise	78	731.5	731.5	10033.8	5194.6	5370.0	836.6	1070.3	10460.0	10460.0	731.5	731.5	10033.8
8	1	Clockwise	74	739.5	739.5	10804.8	5190.3	5385.6	839.8	1068.0	10610.0	10610.0	739.5	739.5	10804.8
9	1	Clockwise	87	767.2	767.2	9755.7	5184.8	5386.6	859.6	1063.3	10560.0	10560.0	767.2	767.2	9755.7
10	1	Clockwise	89	828.6	828.6	15658.5	5197.3	5408.2	849.6	1057.9	10610.0	10610.0	828.6	828.6	15658.5
11	1	Clockwise	81	745.3	745.3	10553.7	5233.6	5446.0	910.6	1053.9	10660.0	10660.0	745.3	745.3	10553.7
12	1	Clockwise	65	699.7	699.7	12890.8	5225.1	5477.5	915.1	1056.2	10710.0	10710.0	699.7	699.7	12890.8
13	1	Clockwise	71	704.9	704.9	11342.7	5260.6	5469.4	904.6	1057.0	10760.0	10760.0	704.9	704.9	11342.7
14	1	Clockwise	72	650.2	650.2	8518.4	5256.7	5463.9	924.9	1058.9	10810.0	10810.0	650.2	650.2	8518.4
15	1	Clockwise	26	178.8	178.8	417.3	5301.7	5372.3	1018.3	1051.4	10860.0	10860.0	178.8	178.8	417.3
15	2	Clockwise	18	174.8	174.8	928.1	5385.3	5434.1	990.0	1052.3	10860.0	10860.0	351.5	351.5	1345.4
15			44	353.5	353.5	1345.4	5301.7	5434.1	990.0	1052.3	10860.0	10860.0	11299.1	11299.1	143163.3
16	1	Clockwise	29	209.9	209.9	646.0	5301.7	5377.4	1015.9	1051.4	10880.0	10880.0	209.9	209.9	646.0
16	2	Clockwise	20	176.3	176.3	995.8	5385.3	5434.1	990.0	1052.3	10880.0	10880.0	386.2	386.2	1441.8
16			49	386.2	386.2	1641.8	5301.7	5434.1	990.0	1052.3	10880.0	10880.0	11685.3	11685.3	164805.0
			1260	11685.3	11685.3	164805.0	5184.8	5477.5	836.6	1078.8	10140.0	10880.0	11685.3	11685.3	164805.0

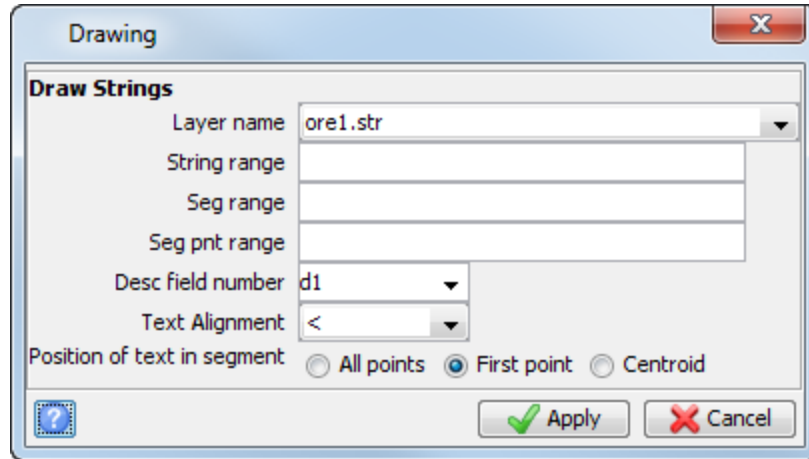
File Summary :-  
Location = ore  
ID range = 1

2d Len	3d Len	Area	X Min	X Max	Y Min	Y Max	Z Min	Z Max
11685.3	11685.3	164805.0	5184.8	5477.5	836.6	1078.8	10140.0	10880.0

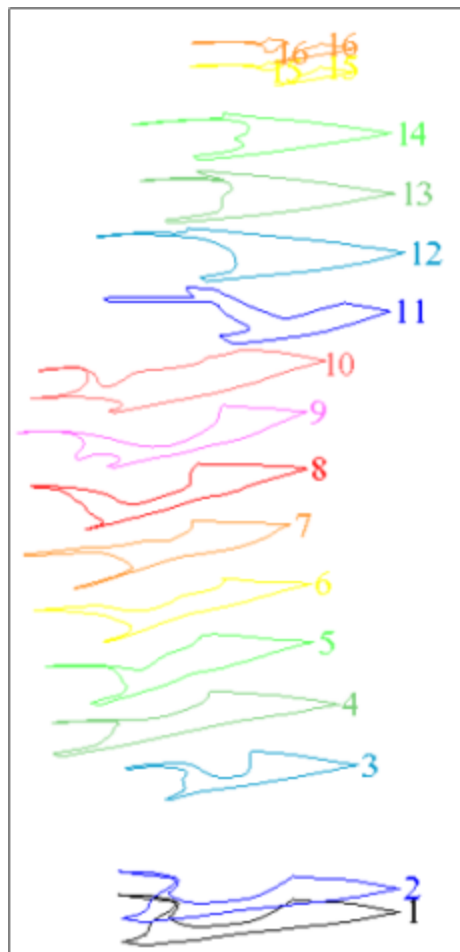
String Summary Report 1/1

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

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



Ore 1 string is displayed.



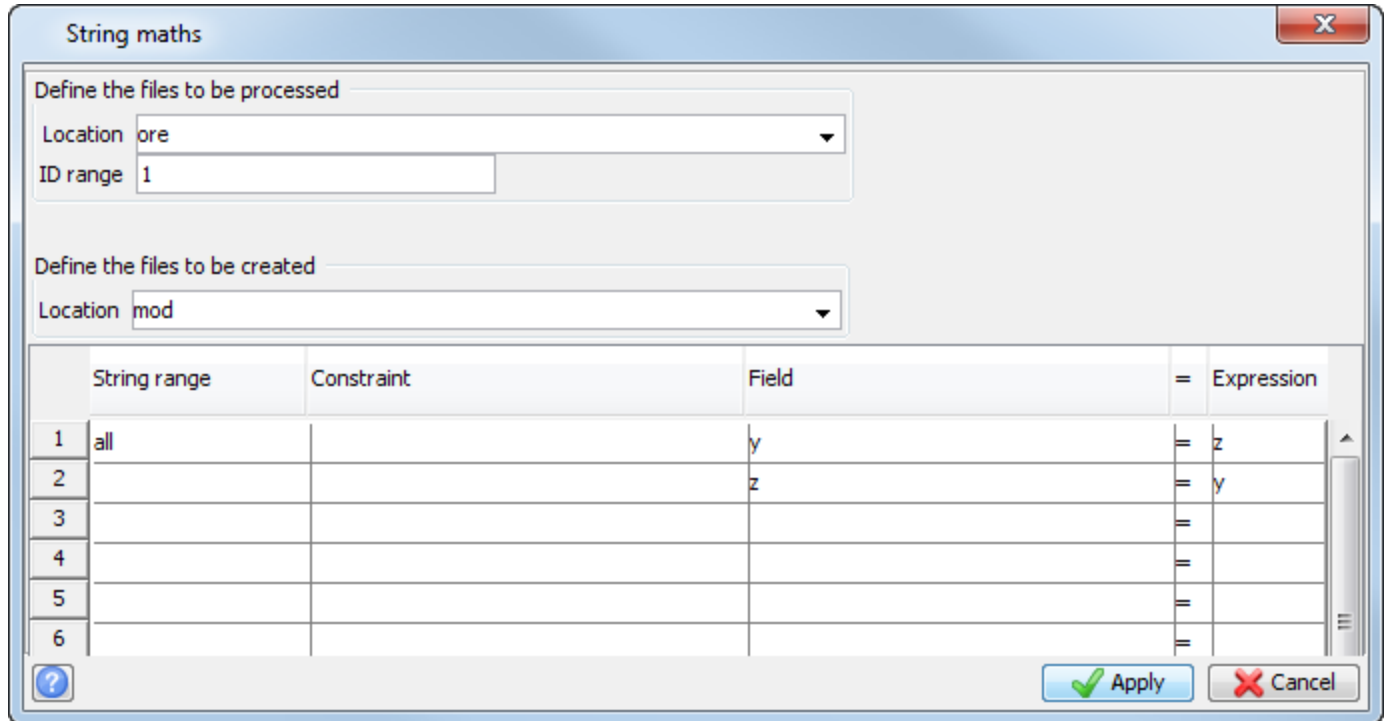
**Note:** The same results could be achieved by opening all the files into one layer and then saving the layer as **ore1.str**.

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

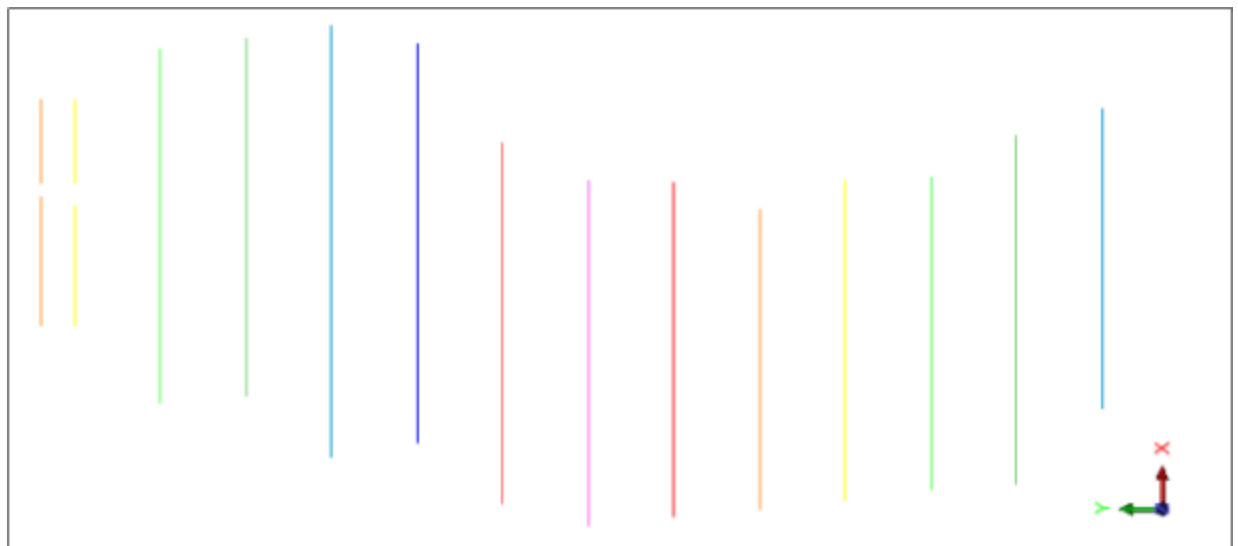
### Task: Transform data from section view to plan view

1. Click **Reset graphics** .
2. Choose **File tools > String maths**.


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



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



**Task: Check and remove foldbacks**

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

- Enter the information as shown, and click **Apply**.

**Clean layer**

Function

Function: Spikes

Action:  mark  remove  warn

Marker colour: red

Target: segment

Trap angle: 5.0 degrees

Measure distances and angles in:  2D space  3D space

Projection plane

The tests will be carried out after projection onto the specified plane.

Plane to use: The XY plane

After performing the clean operation, change the current plane to the best-fit plane.

Apply Cancel


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

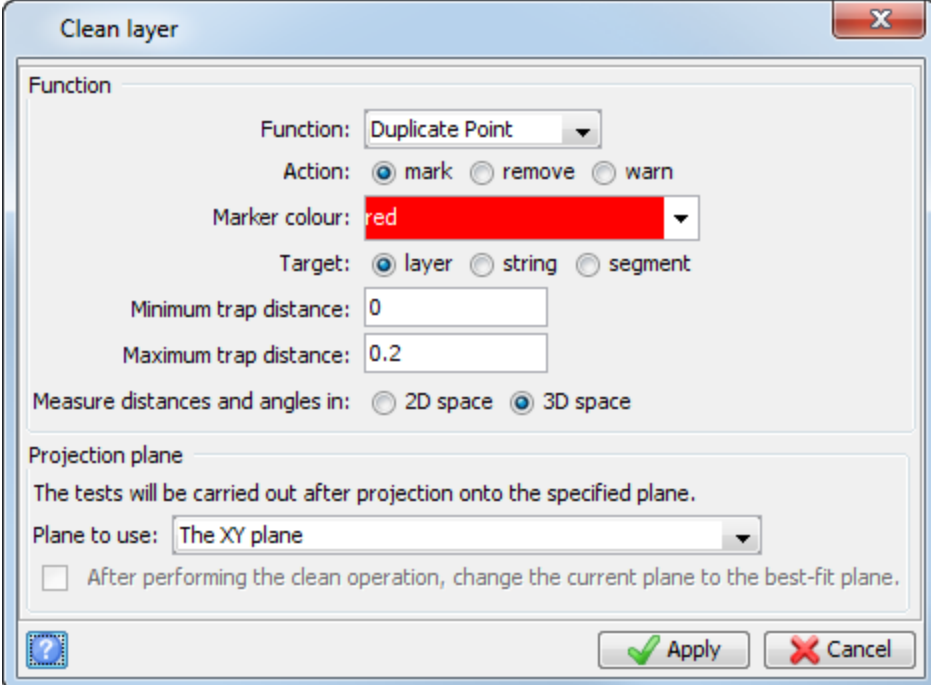
- Zoom in on the highlighted area to view the foldback.




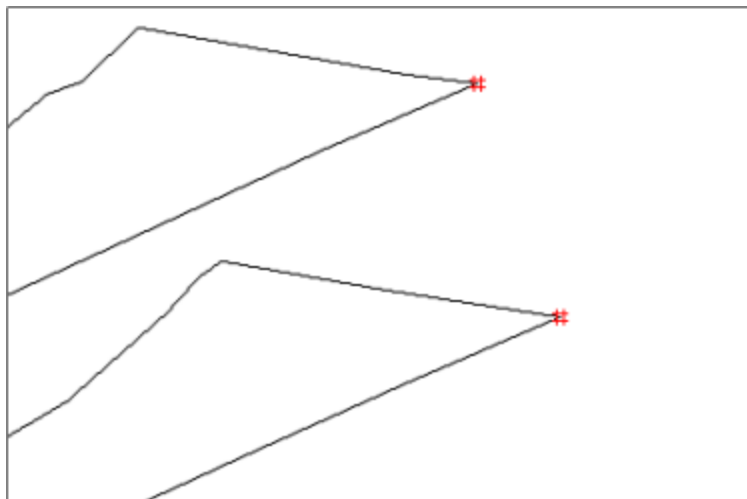
- Re-run the **Clean** function with **Action** set to **remove**. This will automatically remove the foldback.
- Save **mod1.str**.  
 ✎ **Note:** Any errors highlighted by the **Clean Layer** function can also be manually edited if preferred.

### Task: Highlight and remove duplicate points


1. Click **Reset graphics** .
2. Open **mod1.str** in **Graphics**.
3. Choose **Edit > Layer > Clean**.
4. Enter the information as shown, and 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.
6. Save **mod1.str**.


 **Note:** To see all of the steps performed in this section, run **\_01\_data\_preparation.tcl**. You need to click **Apply** on any forms presented.

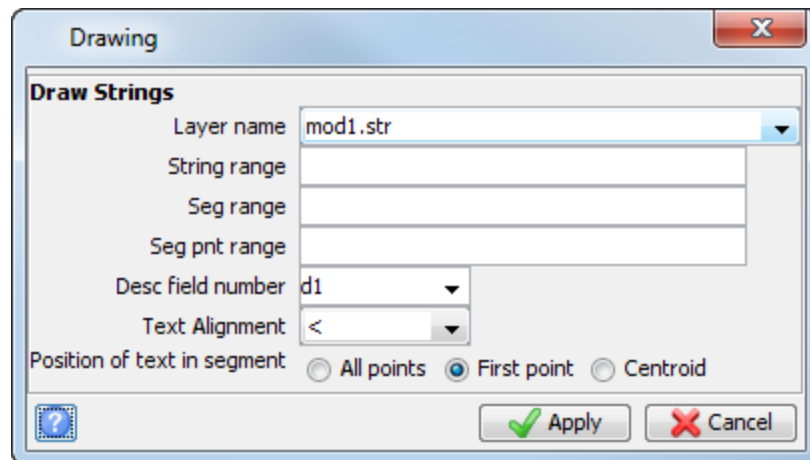
## Creating a solid

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

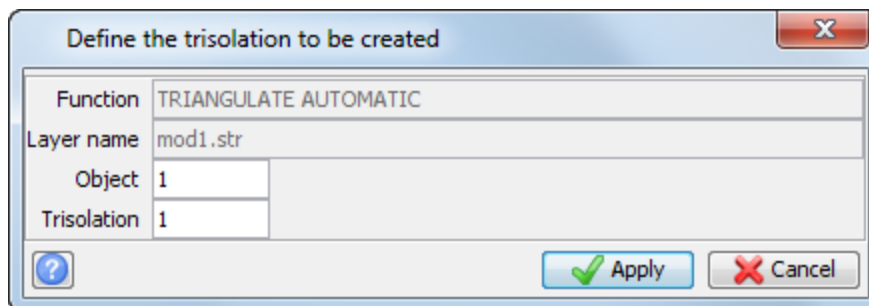
### Triangulating using between segments

#### Task: Create a solid model

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



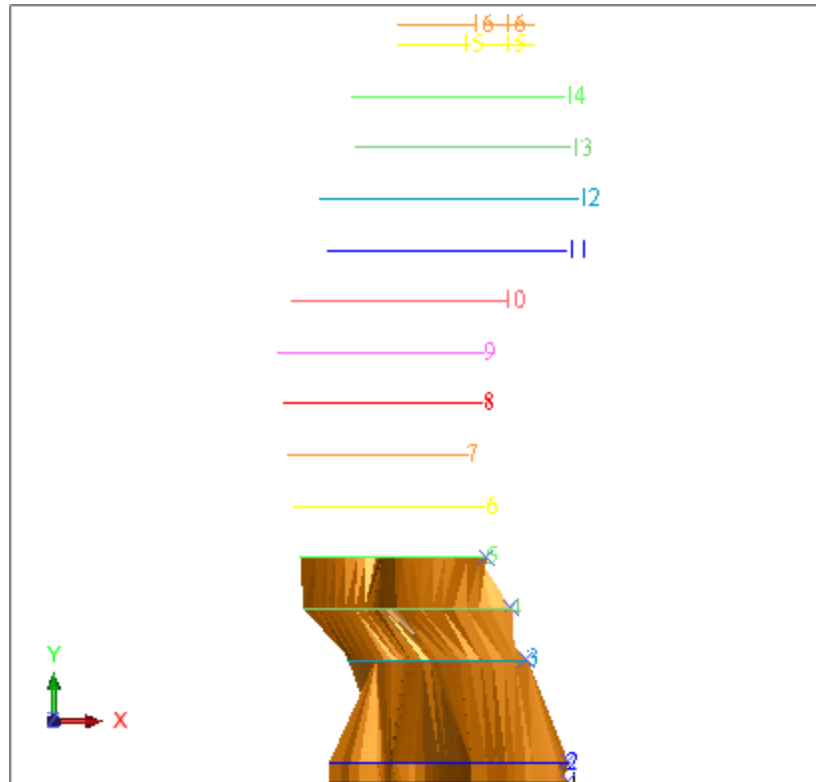
5. Choose **Solids > Triangulate > Between segments**.
6. Enter the information as shown, and click **Apply**.



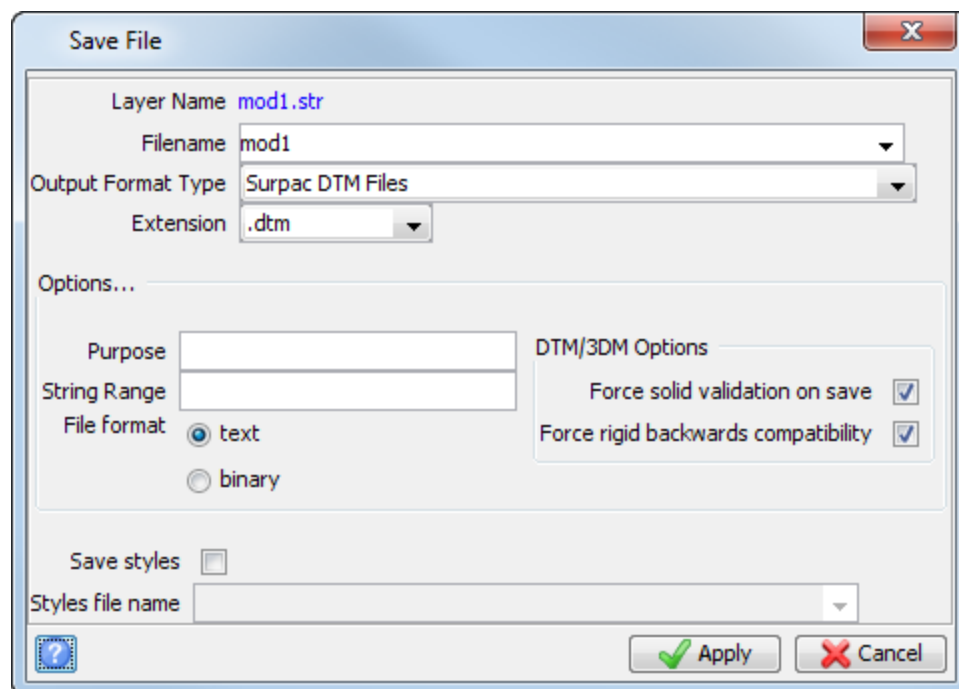
You are prompted to **Select a point on the first segment to be triangulated**.

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**.




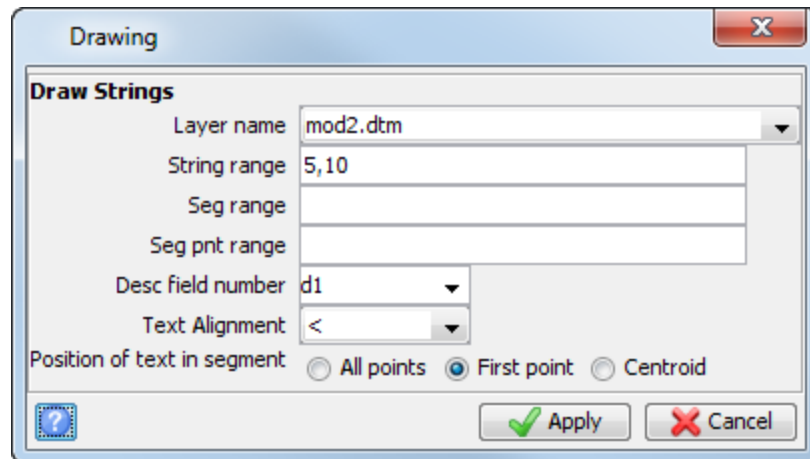
**Note:** You can use the **Between segments** function indefinitely as long as the selected strings are still in the same active layer as the first string selected.

**Note:** To see all of the steps performed in this task, run **\_02a\_create\_solid\_automatic\_triangulation.tcl**. You need to click **Apply** on any forms presented.

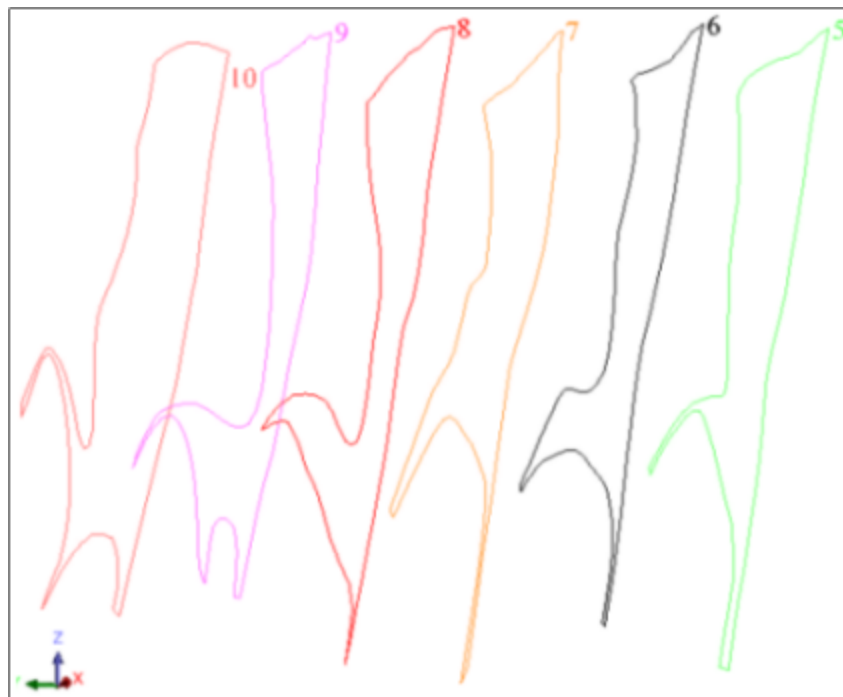
## Triangulating using control strings

### Task: Create control strings using the digitiser

1. Click **Reset graphics** .
2. Open **mod2.dtm** in **Graphics**.
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 click **Apply**.

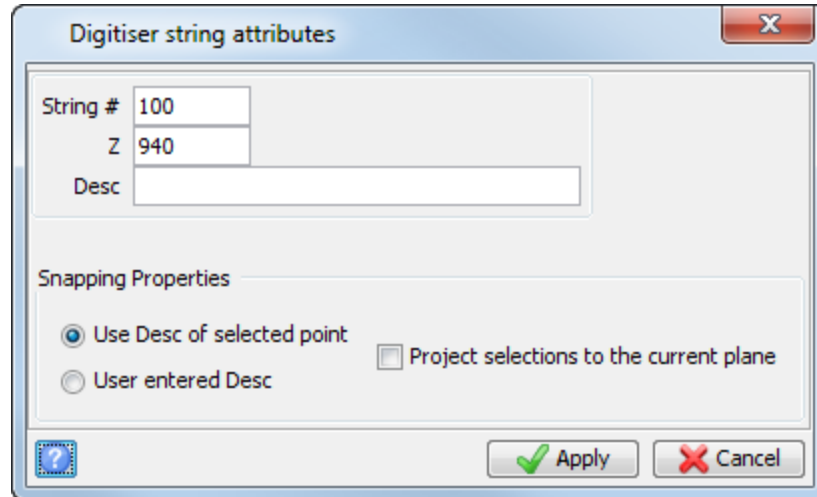


Strings 5 to 10 are displayed.

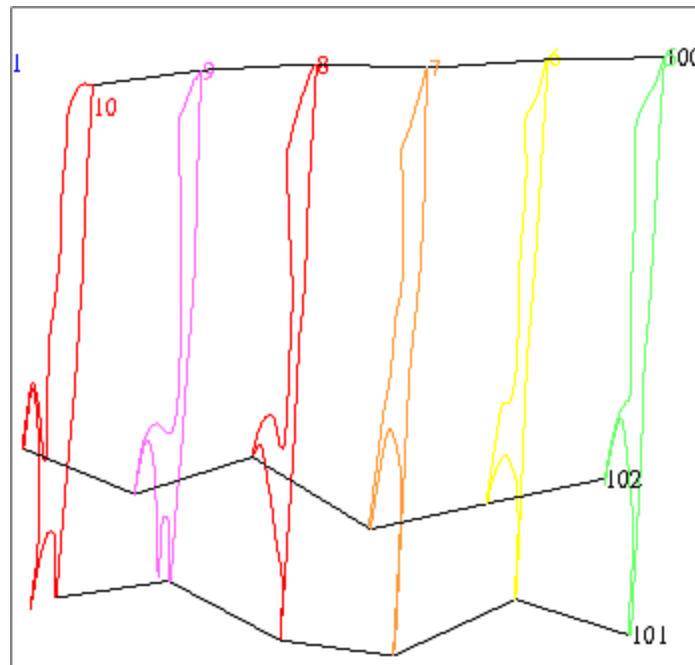


6. Right-click in **Graphics**, and choose **Snap mode > Point**.
7. Choose **Create > Digitise > Start new string**.


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



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

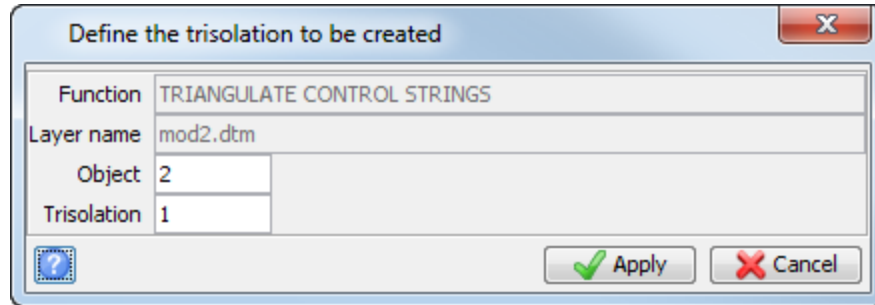


11. Choose **Create > Digitise > Start next string**.
12. Choose **Create > Digitise > New point** and digitise string 101.
13. Choose **Create > Digitise > Start next string**.
14. Choose **Create > Digitise > New point** and digitise string 102.
15. Press **ESC**.
16. Choose **Solids > Triangulate > Using control strings**.
17. Click on String 100.

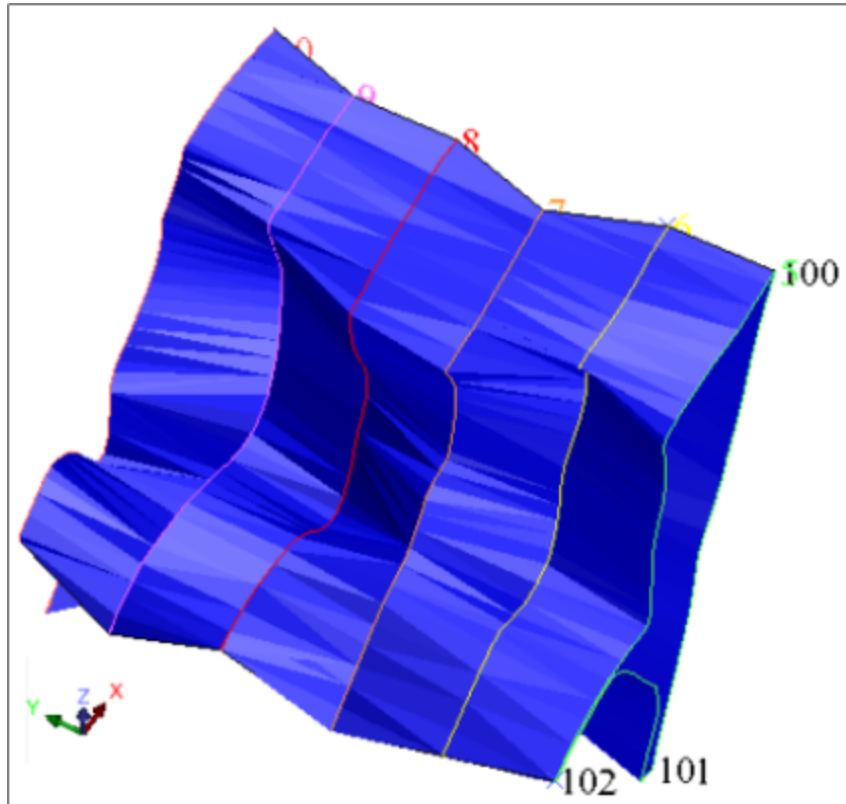
 **Tip:** When selecting each control string graphically, click on the string midway between the polygons. This will ensure that the control string is correctly selected.

18. Next, click String 101 and then click String 102.
19. Press **ESC**.

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

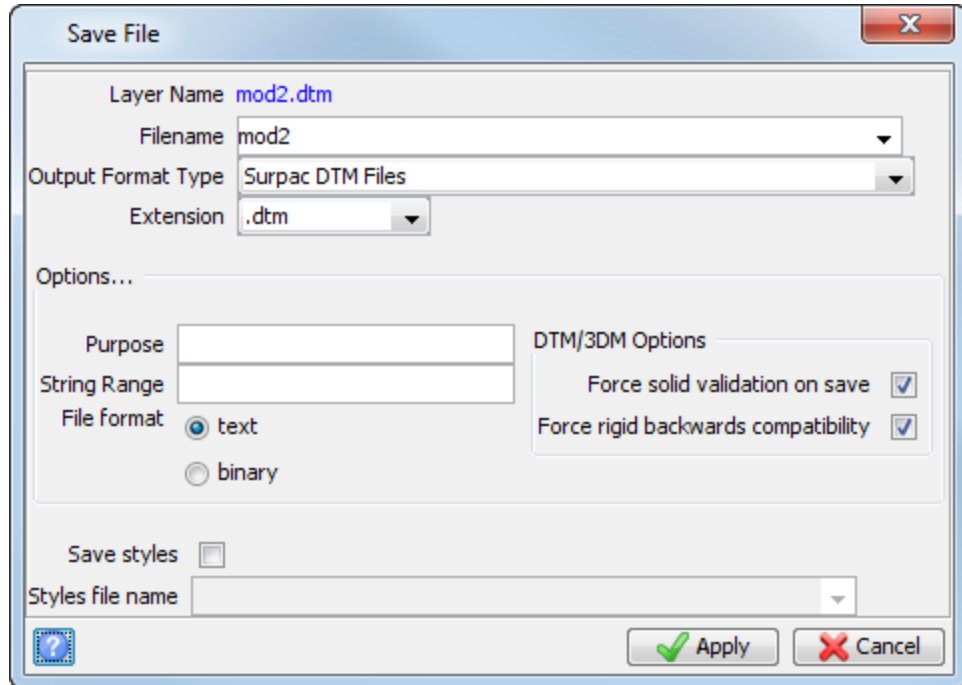


The part of the solid which uses control strings is displayed.

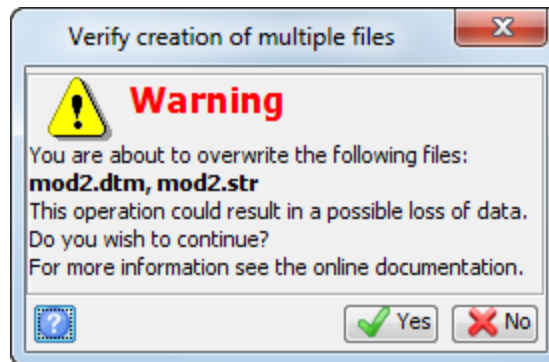


21. Choose **File > Save > string/DTM** to save this part of the model as **mod2.dtm**.

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



23. When you see the following warning, click **Yes**.




**Note:** If you want to run manually through the material again, you will need to copy **original\_mod2.dtm**, and save it as **mod2.dtm**.

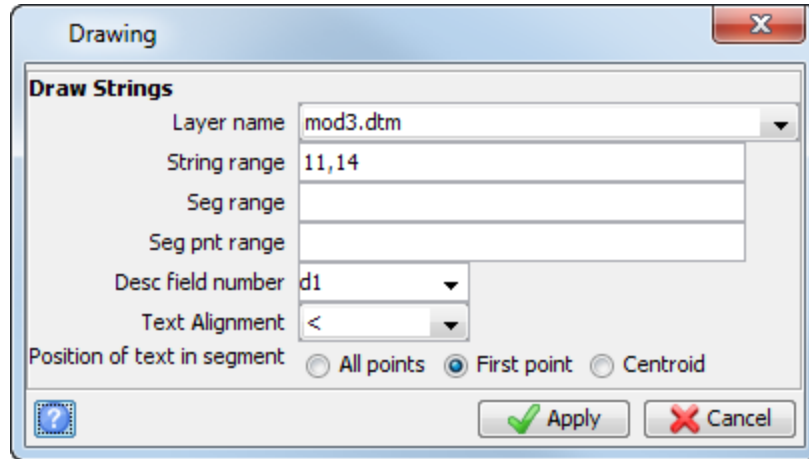
**Note:** To see all of the steps performed in this task, run **\_02b\_create\_solid\_control\_strings.tcl**. You need to click **Apply** on any forms presented.

## Triangulating Using Many Segments

### Task: Create a Solid by Specifying a Range of Strings

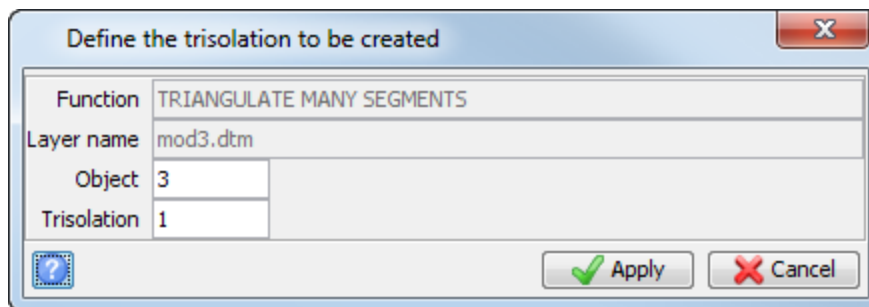
1. Click **Reset graphics** .
2. Open **mod3.dtm** in **Graphics**.
3. Choose **Display > Hide everything** to erase all strings and objects.
4. Choose **Display > Strings > With string numbers**.

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

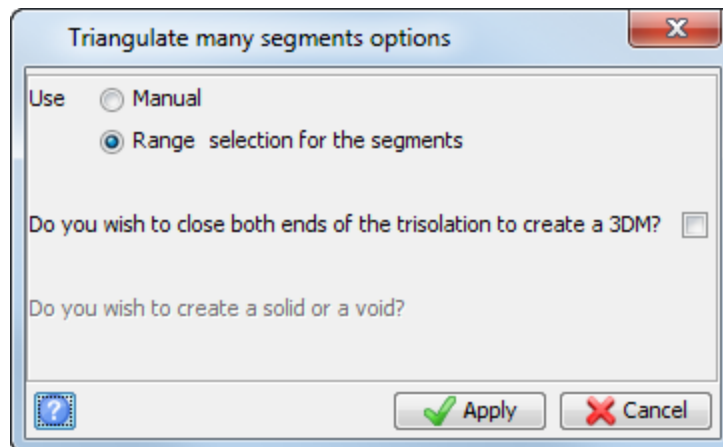


**Note:** The range definition form could be applied with a blank string range to triangulate all strings in the current graphic layer.

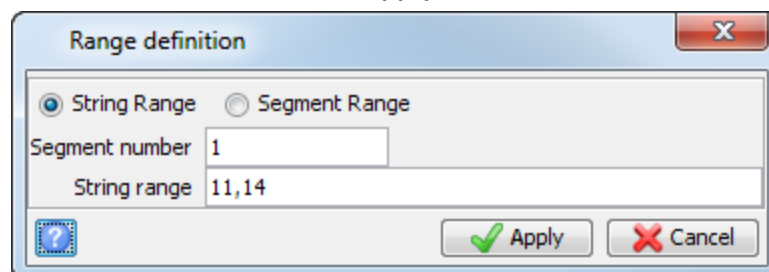
6. Choose **Solids > Triangulate > Many segments**.
7. Enter the information as shown, and click **Apply**.



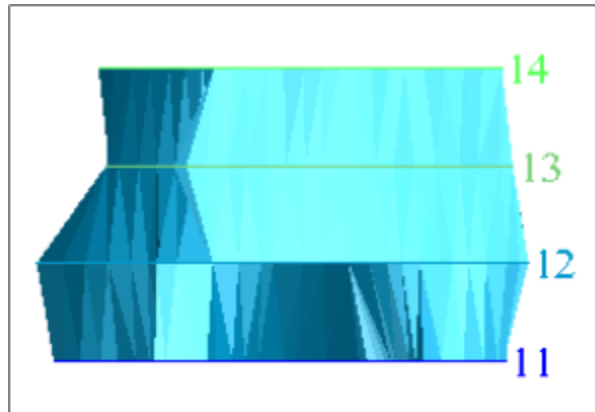
8. Enter the information as shown, and click **Apply**.



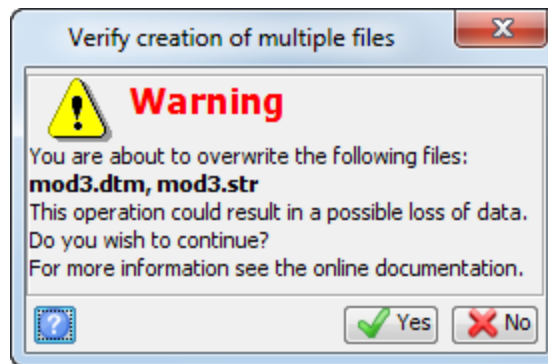
9. Enter the information as shown, and click **Apply**.



Selected segment image is displayed.



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




11. Click **Yes**.

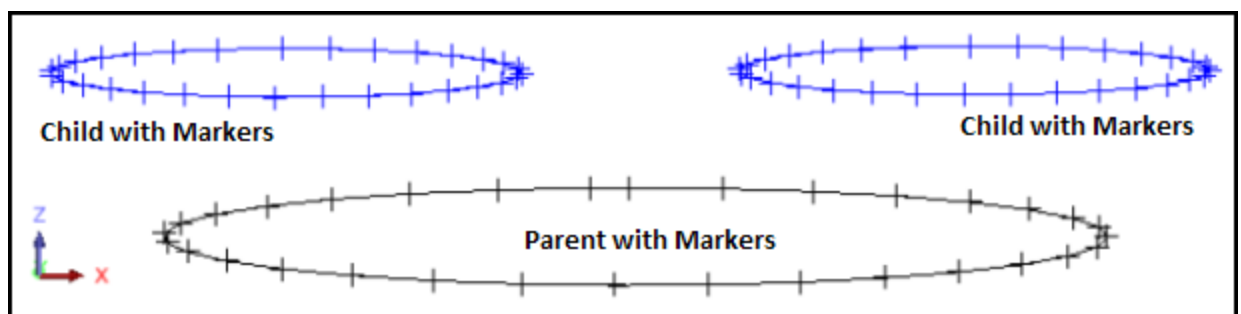
**Note:** If you want to run manually through the material again, you will need to copy **original\_mod3.dtm**, and save it as **mod3.dtm**.

**Note:** To see all of the steps performed in this task, run **\_02c\_create\_solid\_triangulate\_many\_segments.tcl**. You need to click **Apply** on any forms presented.

## Triangulating using bifurcation techniques

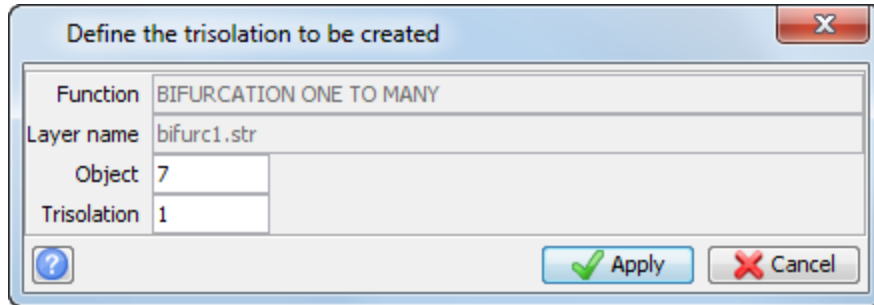
### Task: Perform bifurcation - one segment to many segments

1. Click **Reset graphics** .
2. Open **bifurc1.str** in **Graphics**.
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 Parent and Child segments with Markers are displayed:

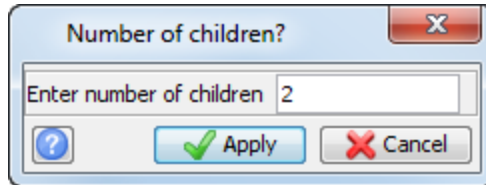


5. Choose **Solids > Triangulate > One segment to many segments**.

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

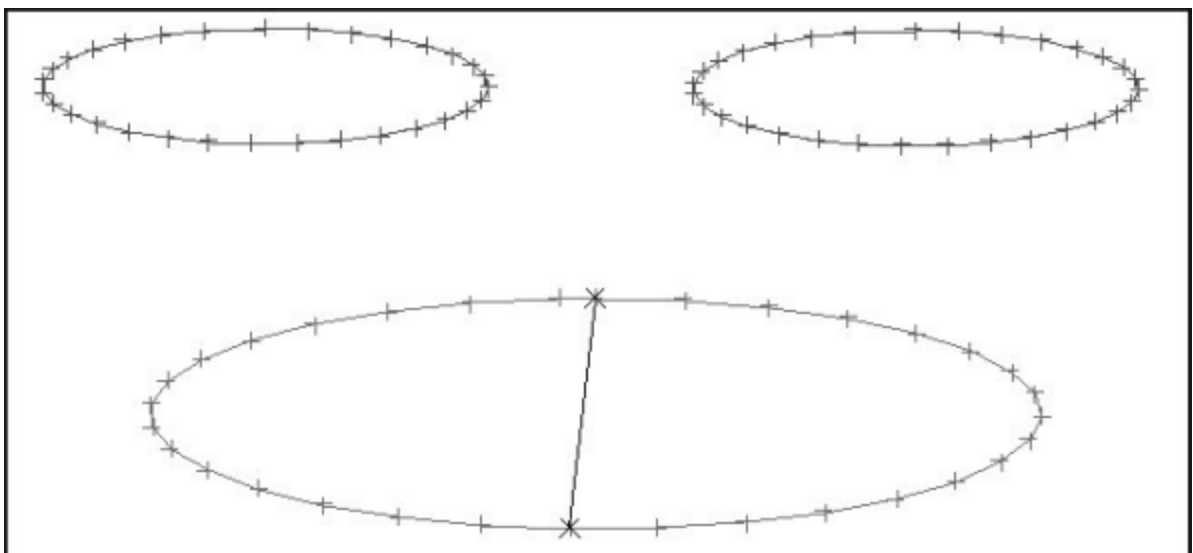


7. Enter the information as shown, and click **Apply**.



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

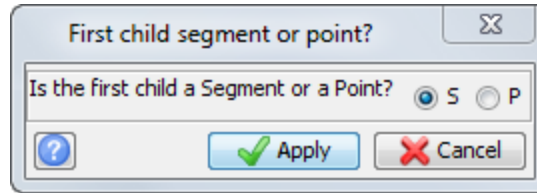
8. Click the parent segment.  
Here you are being asked to select where you are going to perform the bifurcation,  
You are prompted to select the second break point on the parent segment for the first child.
9. Click the opposite side of the parent segment.  
The bifurcation example is displayed.



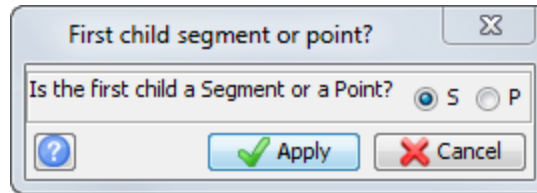
You are asked to select the portion of the parent segment to join to the first child. This means which side of the parent will you join up with which child.

10. Click the left side of the parent segment.

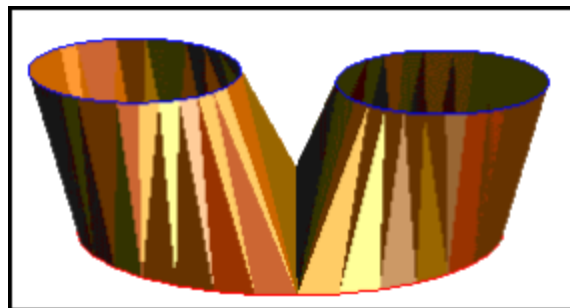
11. Enter the information as shown, and click **Apply**.



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




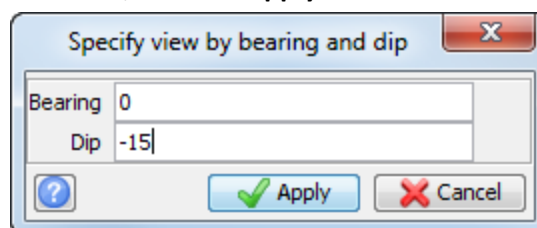
13. Click **Apply** on this form and click the right child.  
The bifurcation example is displayed.



**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.

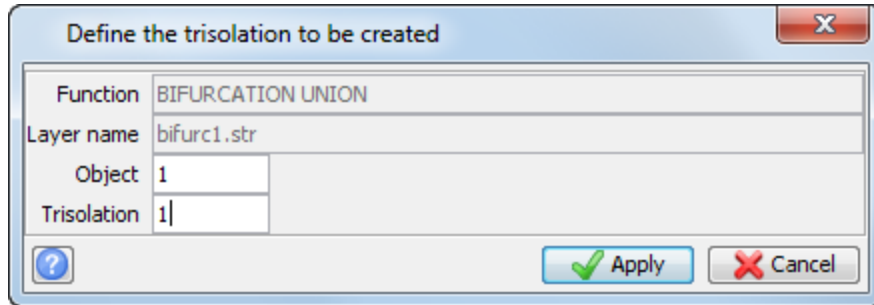
**Task: Perform one segment to two segments (bifurcation union)**

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

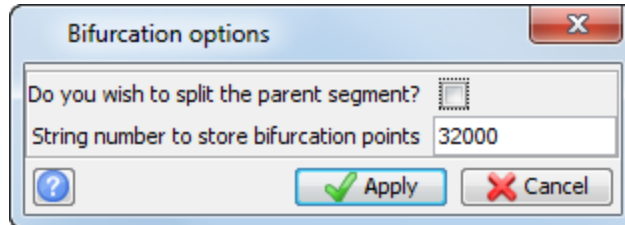


5. Choose **Solids > Triangulate > One segment to two segments**.

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

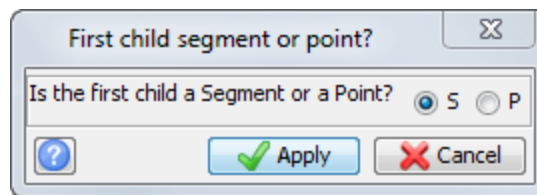


7. Enter the information as shown, and click **Apply**.



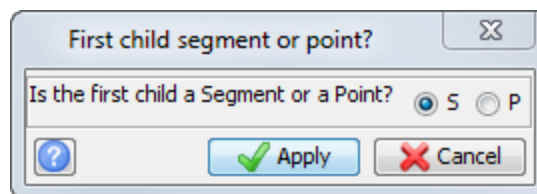
You are prompted to select the parent segment.

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.

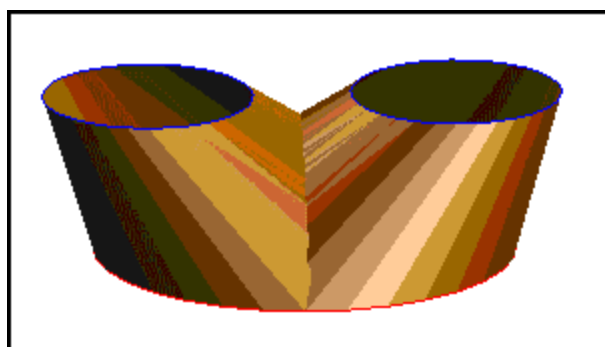


You are then prompted to choose whether the second child is a **(S)egment** or **(P)oint**.


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

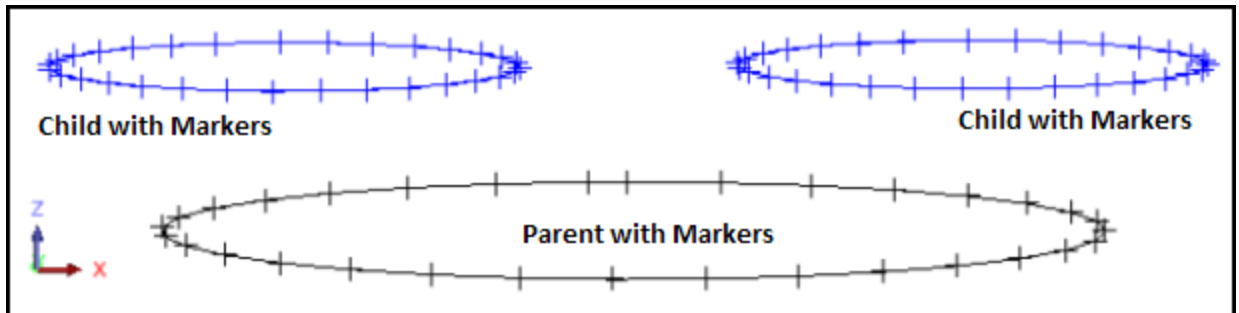


The bifurcation example is displayed.

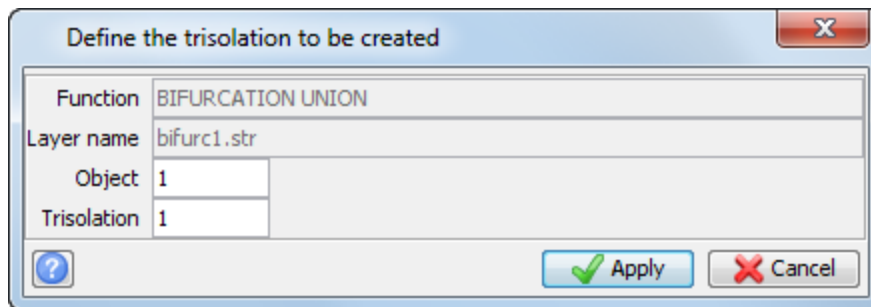


**Task: Perform bifurcation union – split parent**

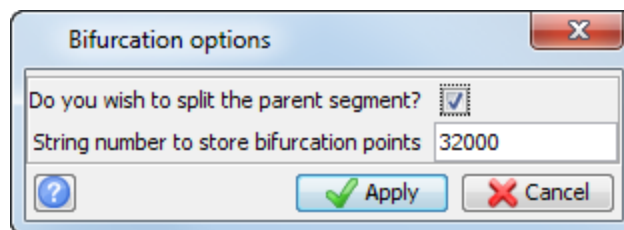
1. Click **Reset graphics** .
2. Open **bifurc1.str** in **Graphics**.
3. Put it in a suitable view so that you can see all three shapes.
4. Choose **Display > Point > Markers** to display all points as markers.  
The bifurcation example is displayed.




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

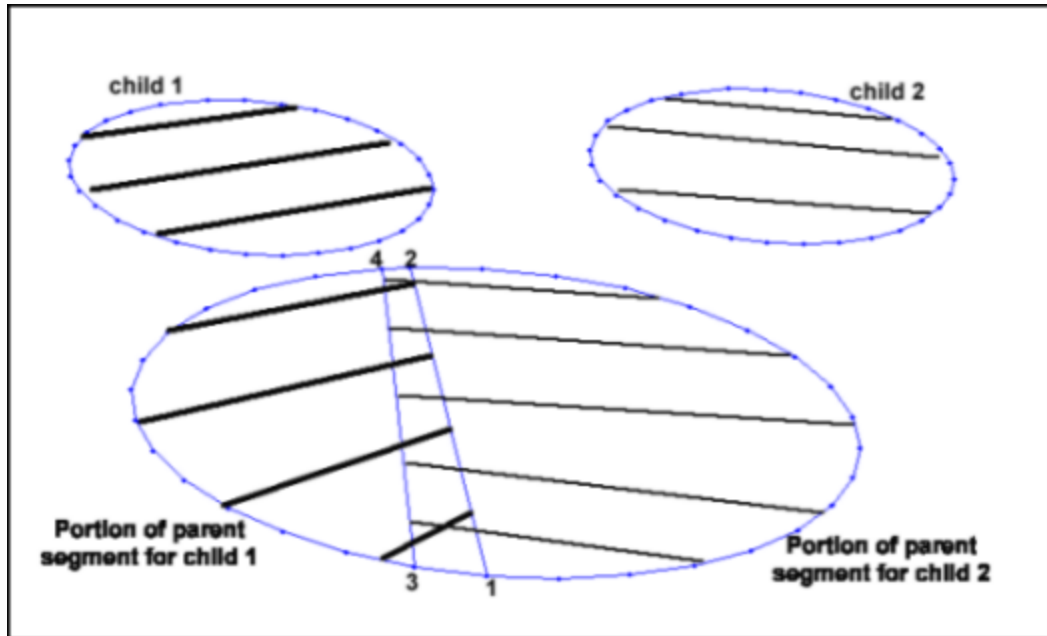



7. Enter the information as shown, and click **Apply**.



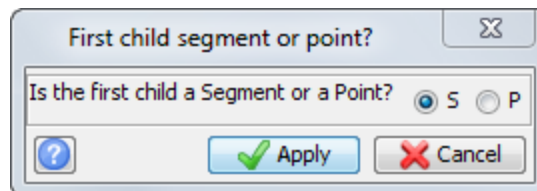
The position of the line of bifurcation is controlled by splitting the parent segment in different ways.


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



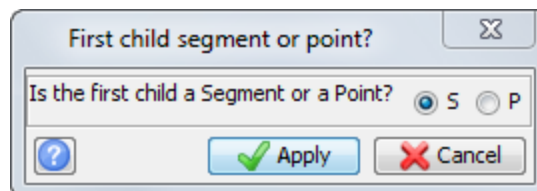
 **Note:** The first series of prompts will define a portion of the parent segment to be assigned to the first child.

8. Click the first break point on the parent segment for the first child (for example, point 1 as shown).
9. Click the second break point on the parent segment for the first child (for example, 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.

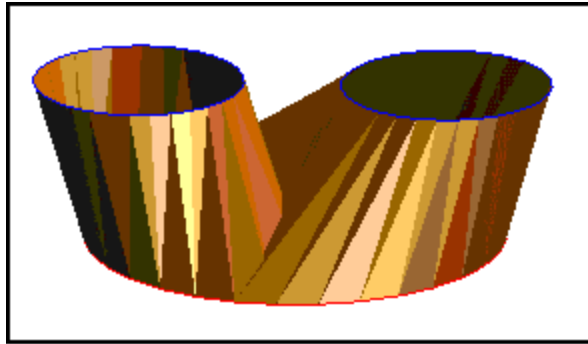


 **Note:** The next series of prompts will define a portion of the parent segment to be assigned to the second child.

12. Click the first break point on the parent segment for the second child (for example, point 3 as shown).
13. Click the second break point on the parent segment for the second child (for example, 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.




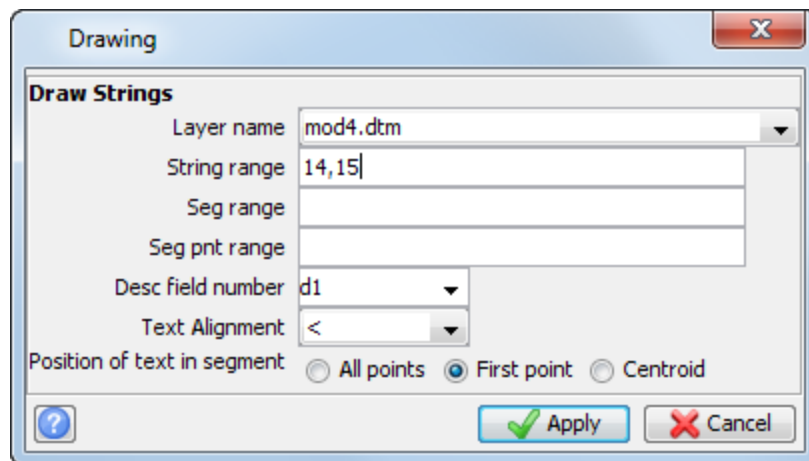
The bifurcation example is displayed.



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

**Task: Use one segment to two segments to model a bifurcation.**

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

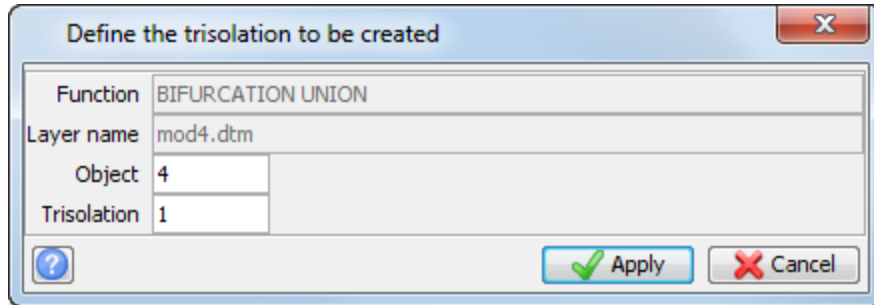


**Note:** String 14 will be the parent segment and the two segments of string 15 will be the child segments.

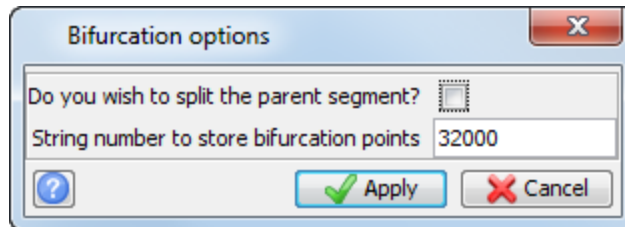


6. Choose **Solids > Triangulate > One segment to two segments**.

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

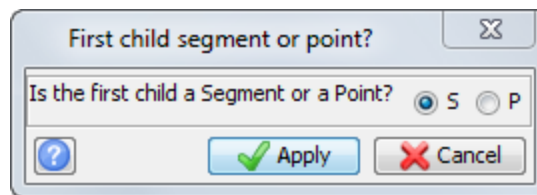


8. Enter the information as shown, and click **Apply**.

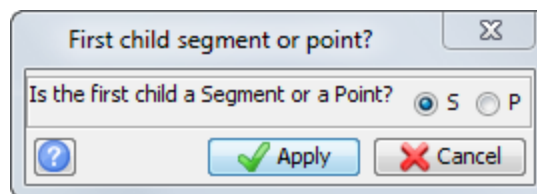



You are prompted to select the parent segment.

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 click **Apply**.

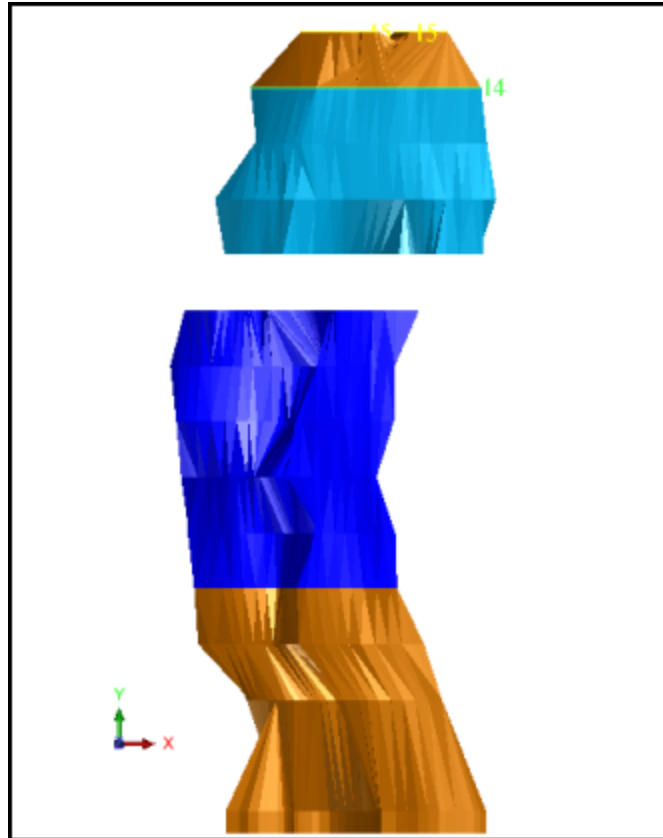


11. Click the left child segment of string 14.  
A prompt will appear asking whether the second child is a **(S)egment** or **(P)oint**.
12. Enter the information as shown, and click **Apply**.




13. Click the right child segment of string 15.
14. Choose **Display > All layers**.
15. Click **Zoom to data extents** .


The following image is displayed.

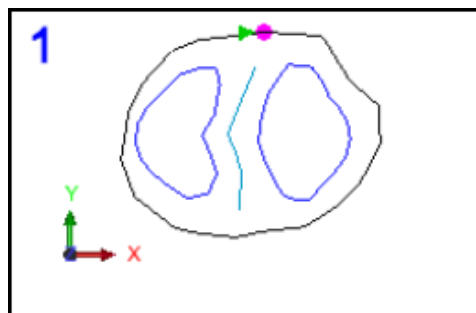


16. Save as **mod4.dtm**.

 **Note:** To see all of the steps performed in this section, run **\_03b\_bifurcation\_on\_model.tcl**. You need to click **Apply** on any forms presented.

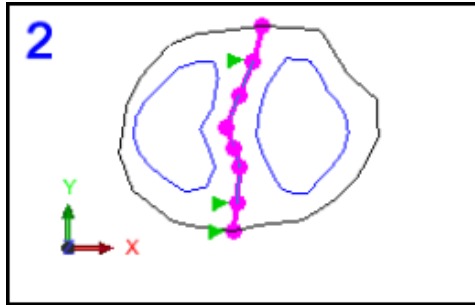
### Task: Perform bifurcation using the triangulate shape tool

1. Start the triangulation.
2. Open **bifurc4.str** in **Graphics**.
3. Zoom out.
4. On the **Tools** toolbar, click **Triangulate Shape** .
5. Click the start point as shown.



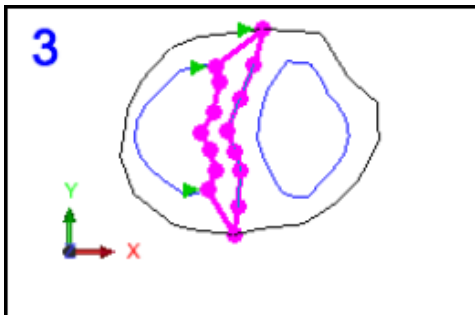
Notice that the point is highlighted as you hover over it, or if you click the point.

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

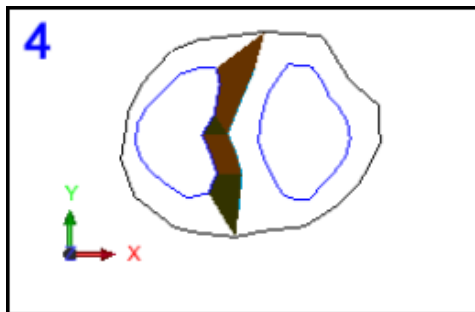


**Tip:** When selecting the points in a segment, Surpac chooses the shortest path between two points. This sometimes gives unwanted results by either skipping intermediate points or flipping to the opposite side of the segment. This is easily fixed by clicking on the intermediate points, which anchors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

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

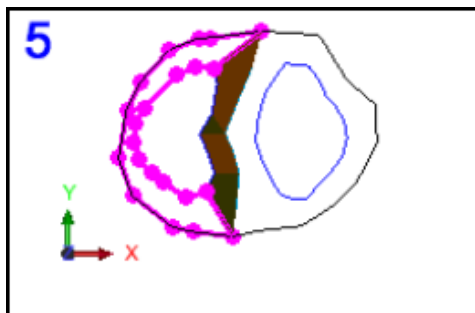


After the shape is joined up by clicking at the start point, that part of the model is triangulated as shown.



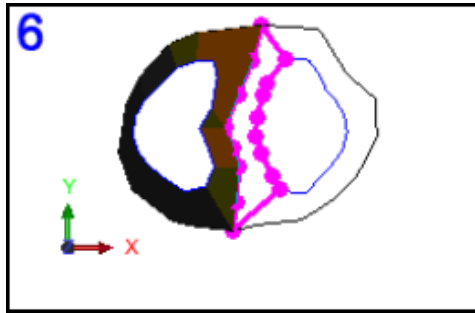
You have now triangulated the right side of the left child and next you will triangulate the left side of the left child.

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



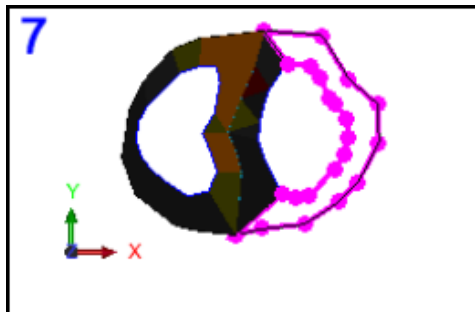
You have now finished the triangulation for the left child

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

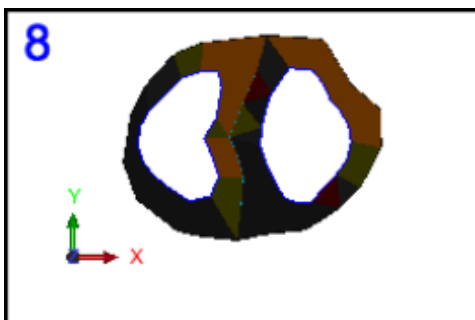


You have now triangulated the left side of the right child.

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

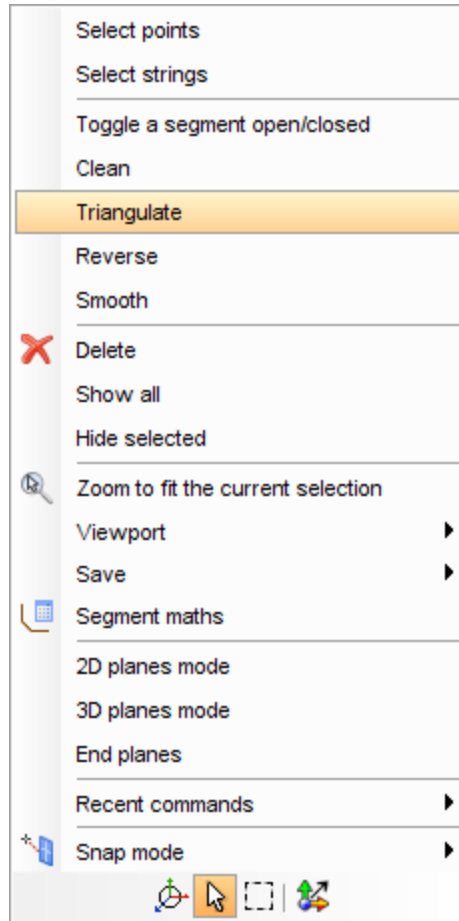


11. You have now finished triangulating the bifurcation using the Triangulate Shape tool. The bifurcation example is displayed.



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

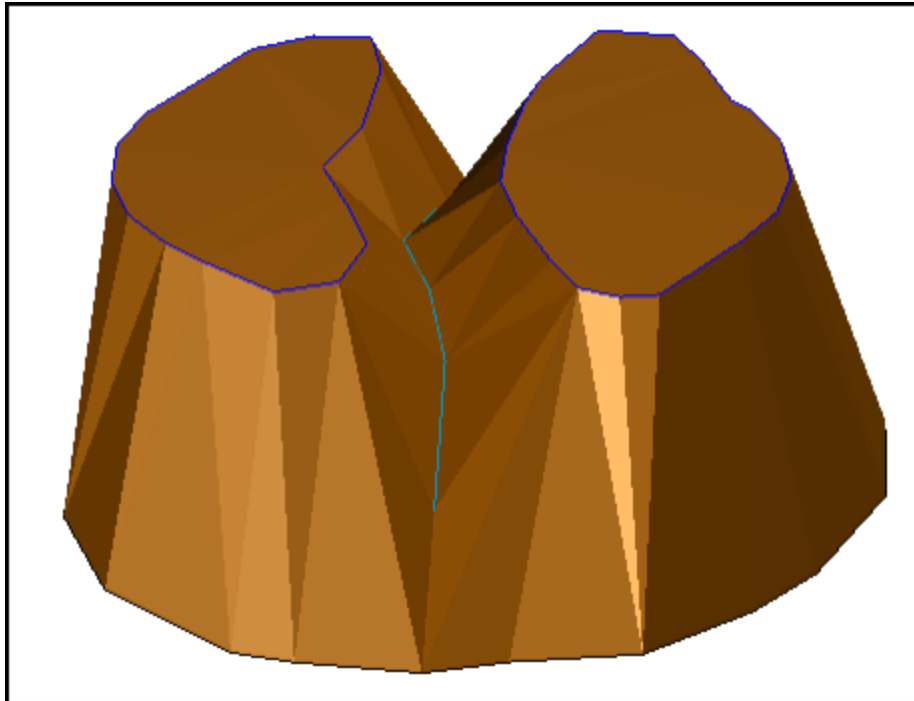
12. From the **Select tool** drop-down on the **Tools** toolbar, click **Select Segment/Trisolation**.
13. Click the parent segment to select it, and then right-click to display a shortcut menu.

14. Choose **Triangulate**.

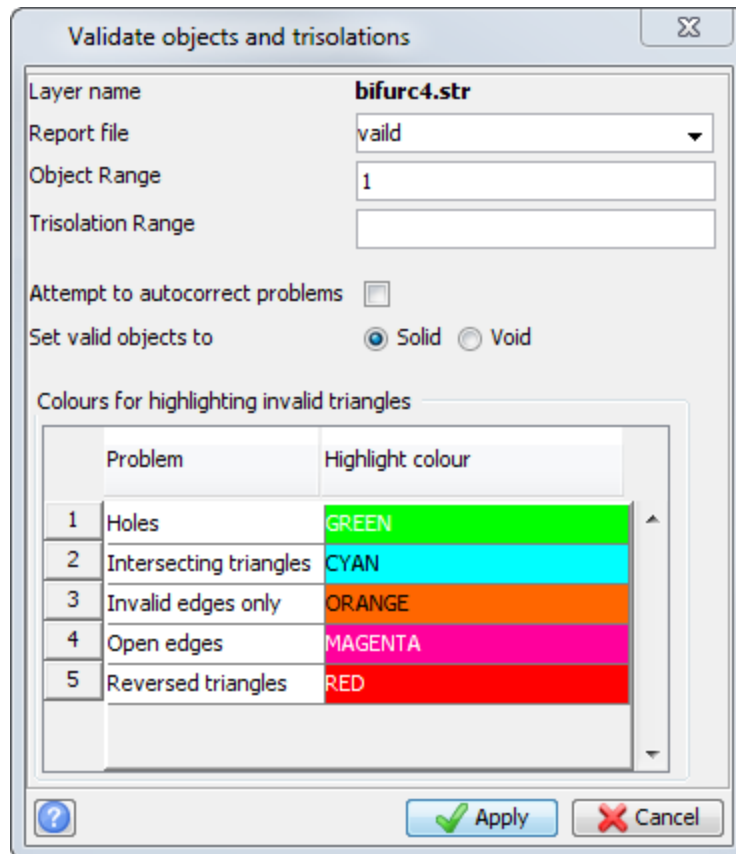
Notice that the parent segment has become closed.

15. Click the left child segment to select it, and then right click to display a popup menu.
16. Choose **Triangulate**.
17. Click the right child segment to select it, and then right click to display a popup menu.
18. Choose **Triangulate**.

The closed solid is displayed.



19. Save the solid model as **bifurc4finished.dtm**.
20. Choose **Solids > Validation > Validate object/trisolation**.
21. Enter the information as shown, and click **Apply**.



22. Open the file **valid1.not** in a text editor.

The Solids Modelling Validation report is displayed.

Solid validation report									
Layer:bifurc4.str									
Object	Trisolation	Valid	Open/closed	Connected	Duplicate (removed)	Invalid Edges	Intersecting	Reversed	
1	1	Valid	Closed	Connected	0	0	0	0	0
Totals					0	0	0	0	0
Solid validation report						1/1			


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

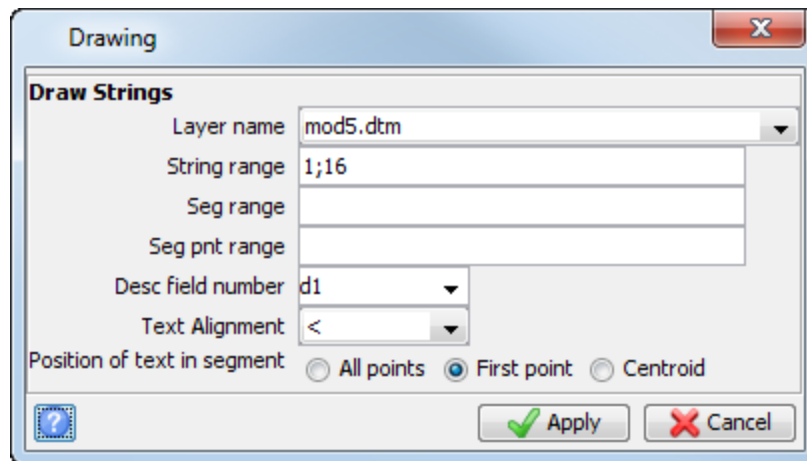
### Triangulating using segment to a point


**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**

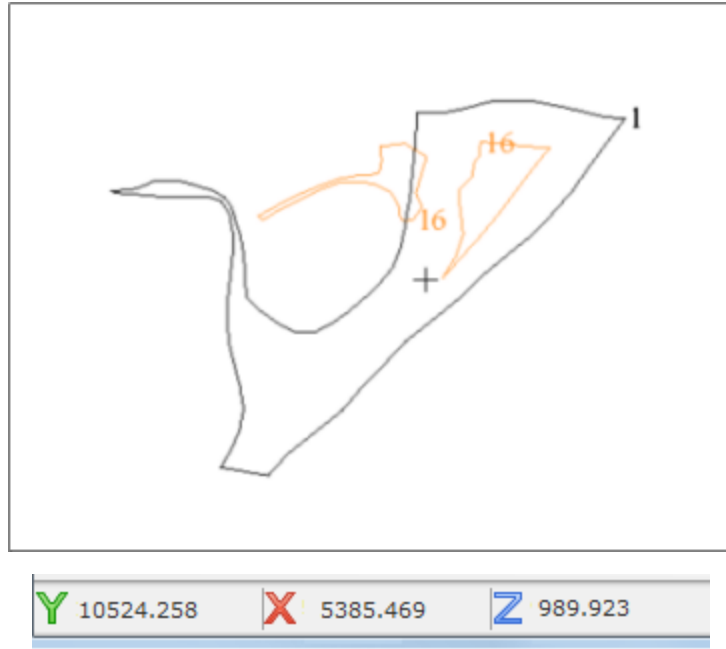
#### Task: Create points to triangulate using the digitiser

1. Click **Reset graphics** .
2. Open **mod5.dtm** in **Graphics**.
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 click **Apply**.



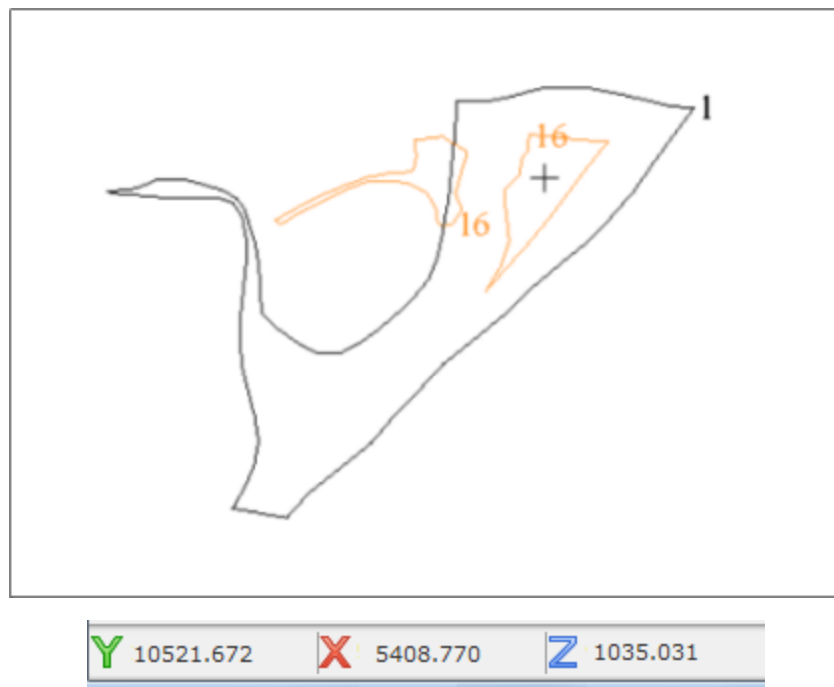
6. Click **Section view**  to put the data in section view. The strings are displayed.

7. Move the pointer to the centre of string 1 as shown.



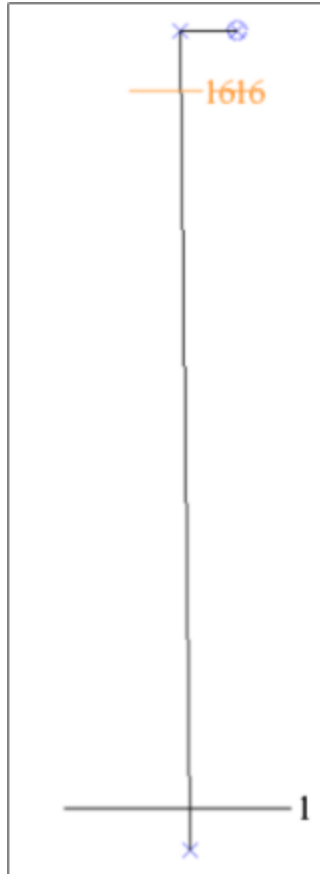
Notice that the elevation (z) of the centre point of string 1 is at approximately 990m.


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.

Digitise string 1001 as shown to use as end points for the model.



9. Click **Zoom to data extents**  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 click **Apply**.

Digitiser string attributes	
String #	1001
Z	990
Desc	
Snapping Properties	
<input checked="" type="radio"/> Use Desc of selected point	<input type="checkbox"/> Project selections to the current plane
<input type="radio"/> User entered Desc	
<input type="button" value="Apply"/> <input type="button" value="Cancel"/>	

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**.
15. Click the southern most point.

16. Enter the information as shown, and click **Apply**.

Digitiser string attributes

String # 1001

Z 990

Desc

Apply Cancel

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

Digitiser string attributes

String # 1001

Z 1035

Desc

Apply Cancel

19. Click the final point on string 1001.
20. Enter the information as shown, and click Apply.


Digitiser string attributes

String # 1001

Z 1035

Desc

Apply Cancel

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

Drawing

**Draw Point attributes**

Layer name mod5.dtm

String range 1001

Seg range

Seg pnt range

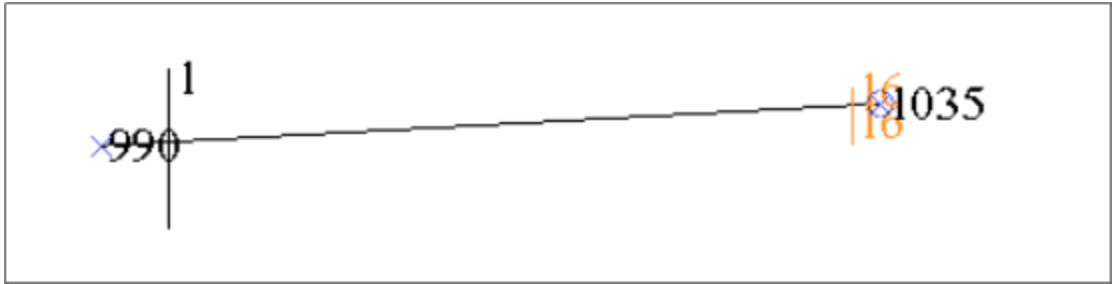
Desc field number z

Text Alignment <

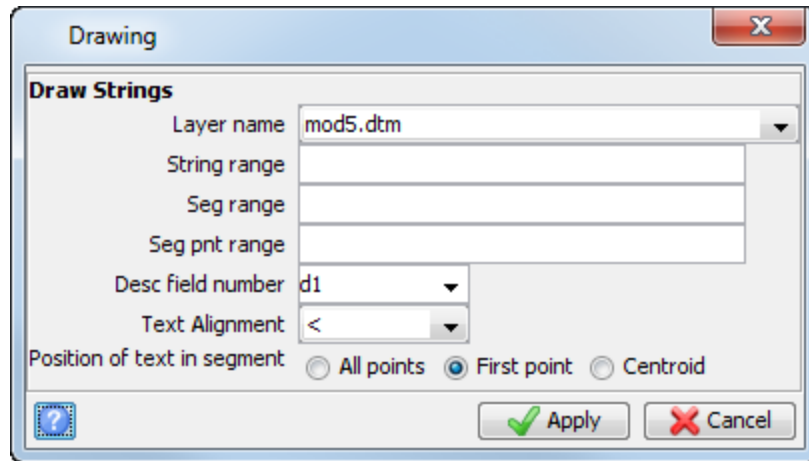
Position of text in segment  All points  First point  Centroid


Apply Cancel

The data is displayed as shown.

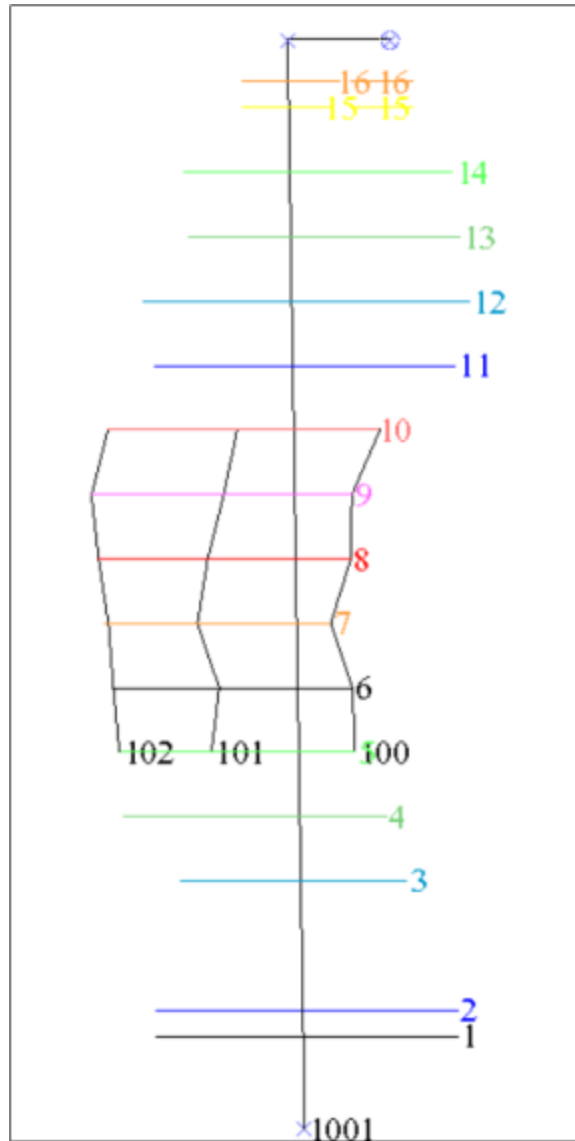


- Choose **Display > Strings > With string numbers**.  
Enter the information as shown, and click **Apply**.




- Click **Zoom to data extents**  to zoom to the extents of the data and return the data to plan view.

The strings are displayed as shown.

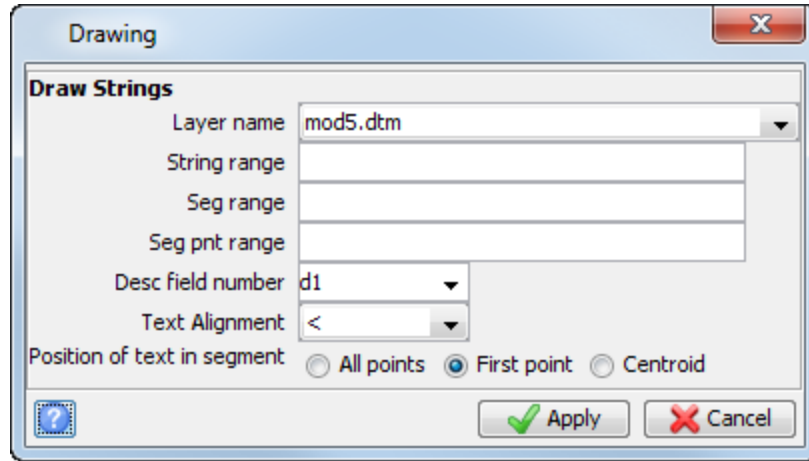


27. Save **mod5.dtm**.

#### Task: Create a solid using segment to a point

1. Click **Reset graphics** .
2. Open **mod5.dtm** in **Graphics**.
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 click **Apply**.

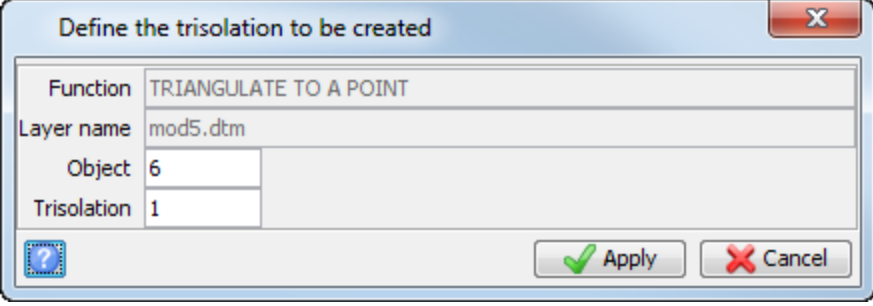


6. Display the northern end of the model as shown.  
✔ **Note:** You need to see the points on string 1001 and also both segments of string 16.



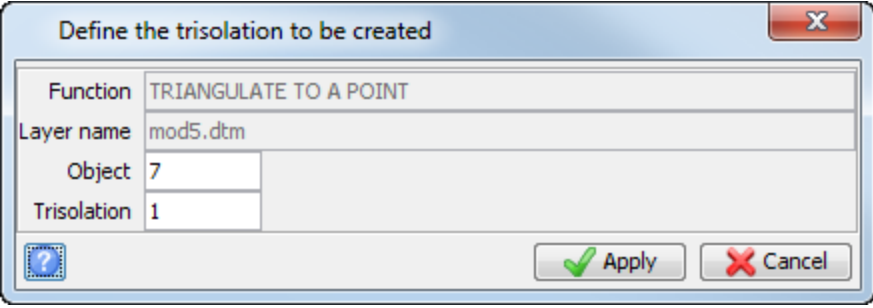
7. Choose **Solids > Triangulate > Segment to a point**.

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



Define the trisolation to be created	
Function	TRIANGULATE TO A POINT
Layer name	mod5.dtm
Object	6
Trisolation	1

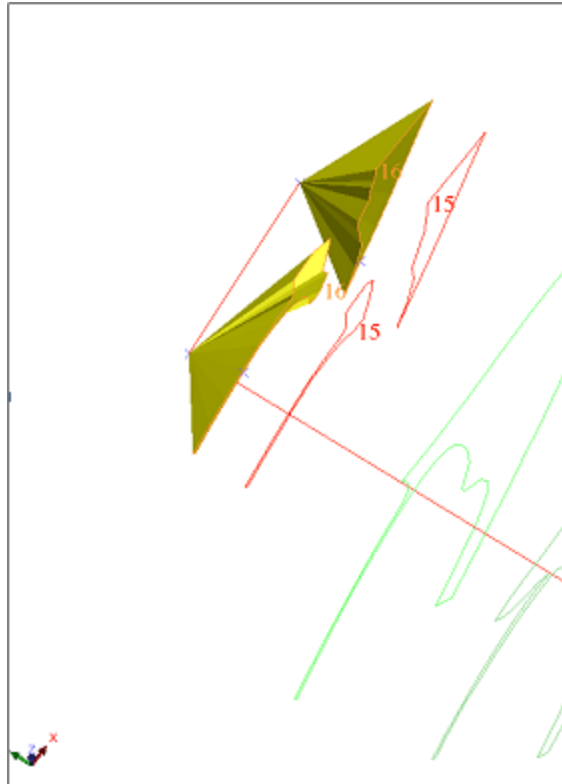
9. Click a point of string 1001 (for example, the one you just digitised).
10. Click the matching segment of string 16.
11. Press ESC.  
You have now finished the first triangulation.
12. Choose **Solids > Triangulate > Segment to a point**.
13. Enter the information as shown, and click **Apply**.



Define the trisolation to be created	
Function	TRIANGULATE TO A POINT
Layer name	mod5.dtm
Object	7
Trisolation	1

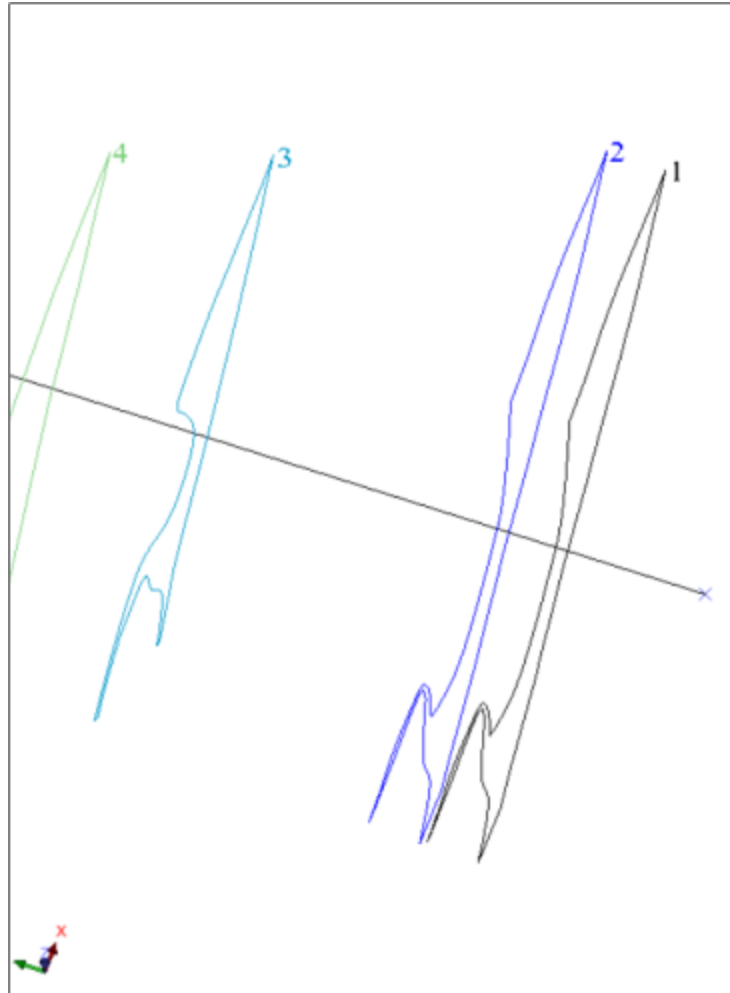
14. Click the second Northern point of string 1001.
15. Click the second matching segment of string 16.
16. Press ESC.

The northern end will look like the image shown.



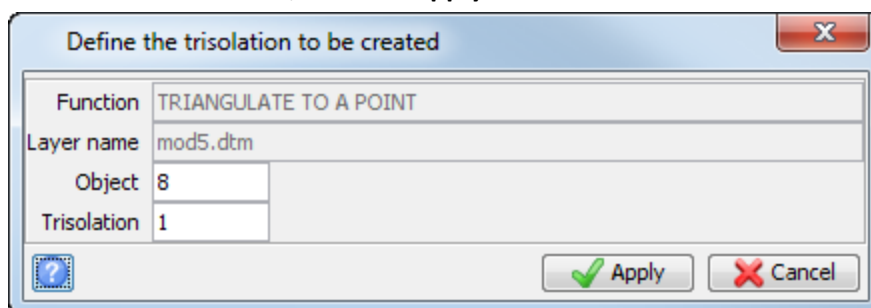
Repeat this process on the other end of the data.

17. Change to the view as shown.



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

19. Enter the information as shown, and click **Apply**.



20. Click the southern point of string 1001, and click string 1.

21. Press ESC to finish the triangulation.

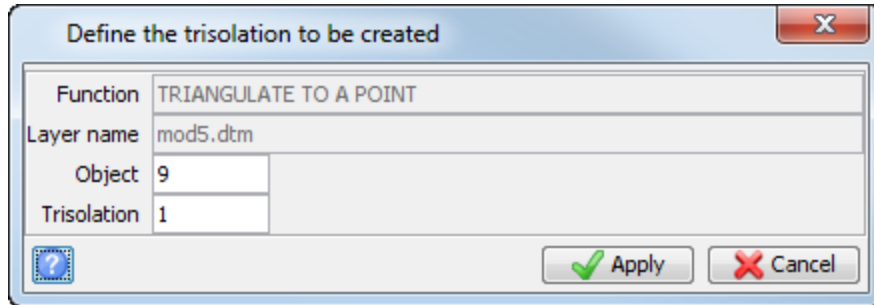
22. Click **Zoom to data extents**.

23. Choose **Display > All layers**.

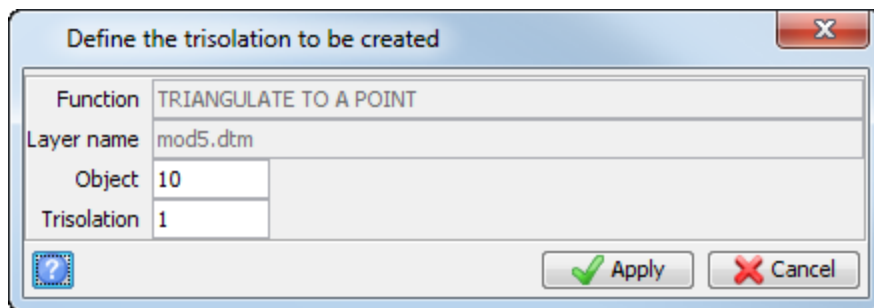
Notice that there is still a gap between strings 15 and 16. You will now create objects 9 and 10 to fill these gaps.

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

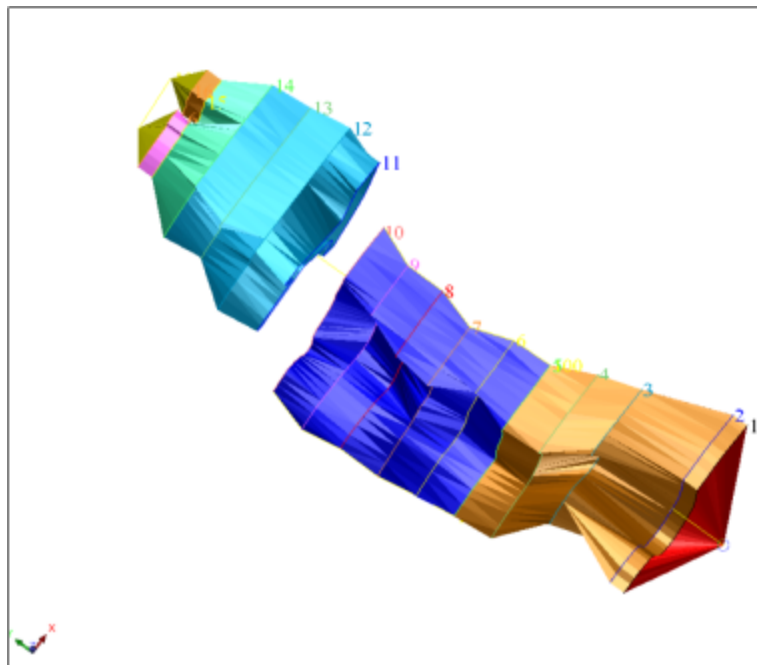
25. Enter the information as shown, and click **Apply**.

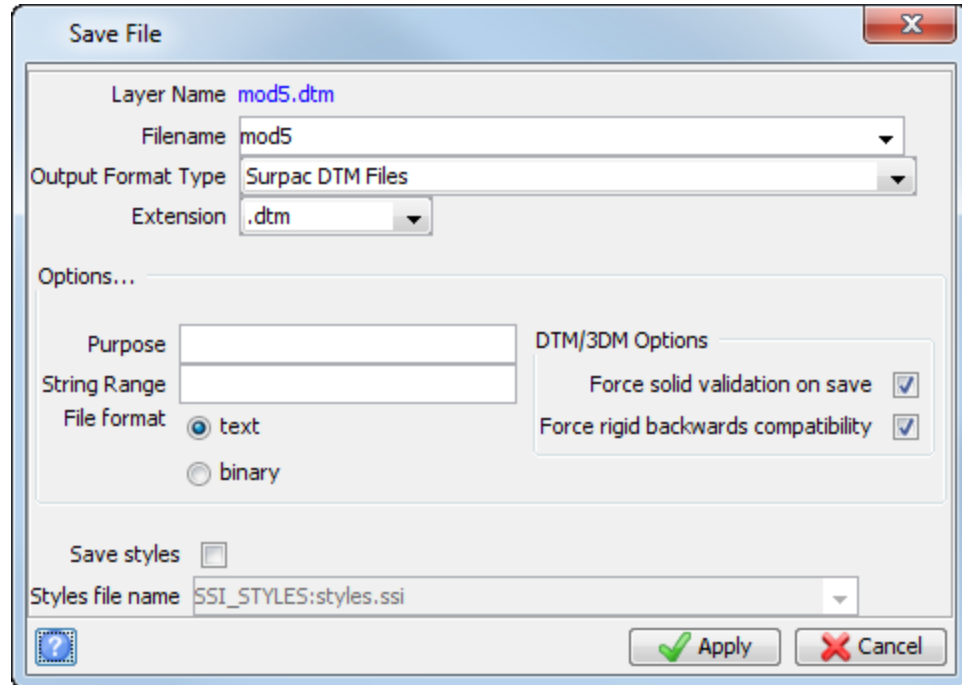
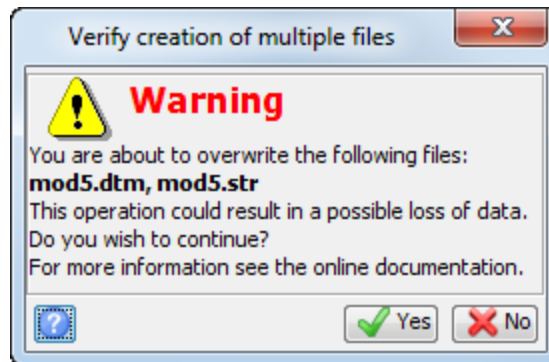


26. Click a segment on string 15.
27. Click the corresponding segment on string 16.
28. Press ESC.
29. Choose **Solids > Triangulate > Between segments**.
30. Enter the information as shown, and click **Apply**.



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 run manually through the material again, you will need to copy **original\_mod5.dtm**, and save it as **mod5.dtm**.

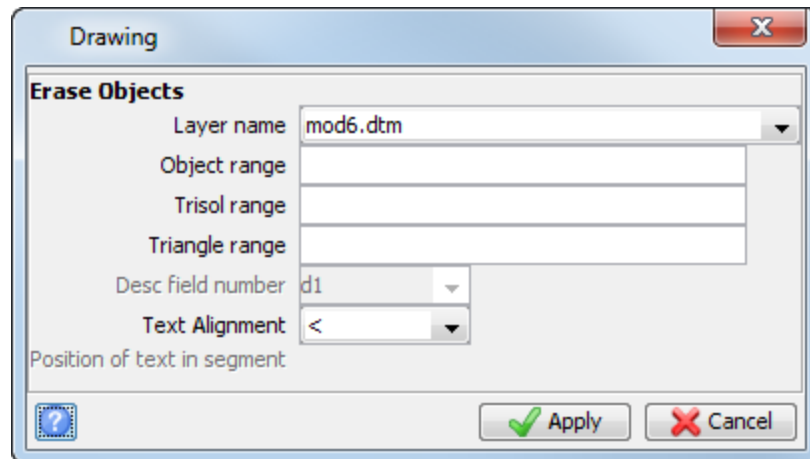
📌 **Note:** If you want to see all of the steps performed in this section, run **\_04a\_segment\_to\_a\_point.tcl** . You need to click **Apply** on any forms presented.

## Triangulating a fault

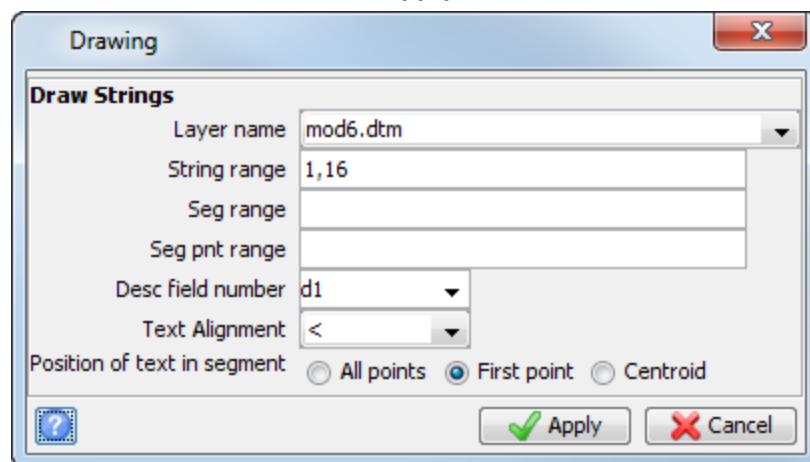
### Task: Triangulate a fault by draping strings and triangulating

#### Preparing the data:

1. Click **Reset graphics** .
2. Open **fault1.str** in **Graphics**.
3. Open **mod6.dtm** in **Graphics**.
4. Choose **Display > Hide surface/solid**.
5. Enter the information as shown, and click **Apply**.

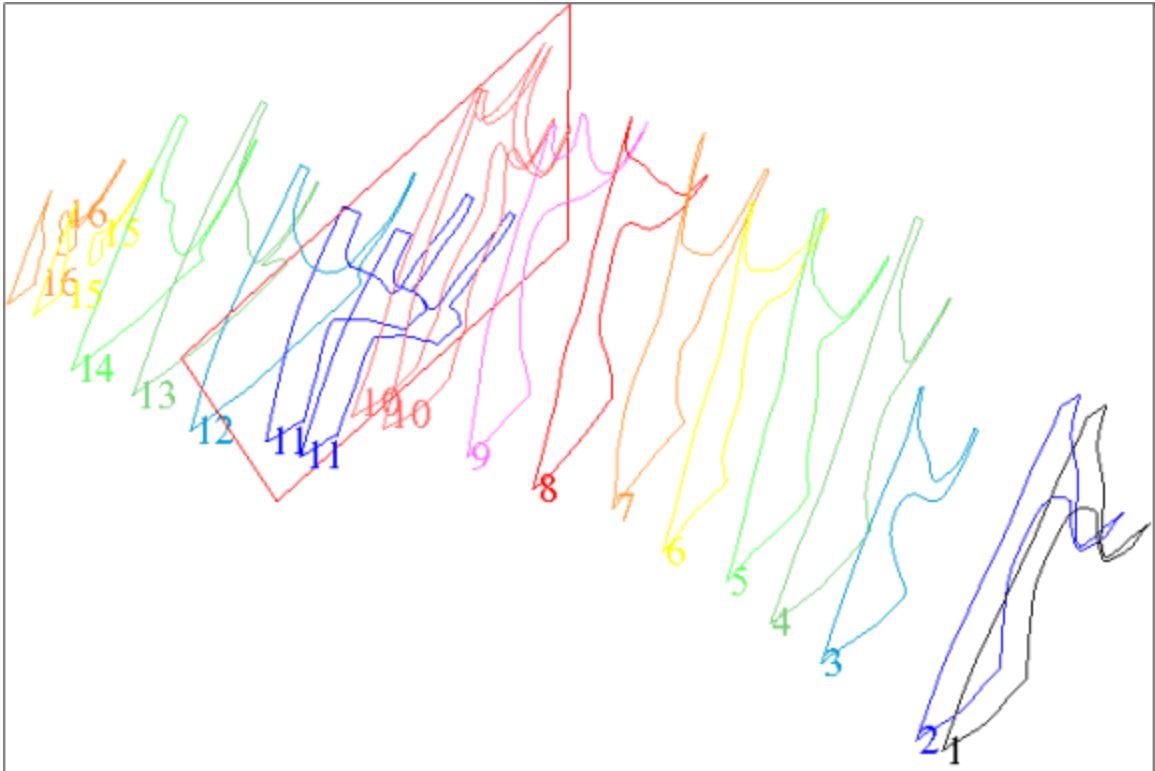


6. Choose **Display > Strings > With string numbers**.
7. Enter the information as shown, and click **Apply**.



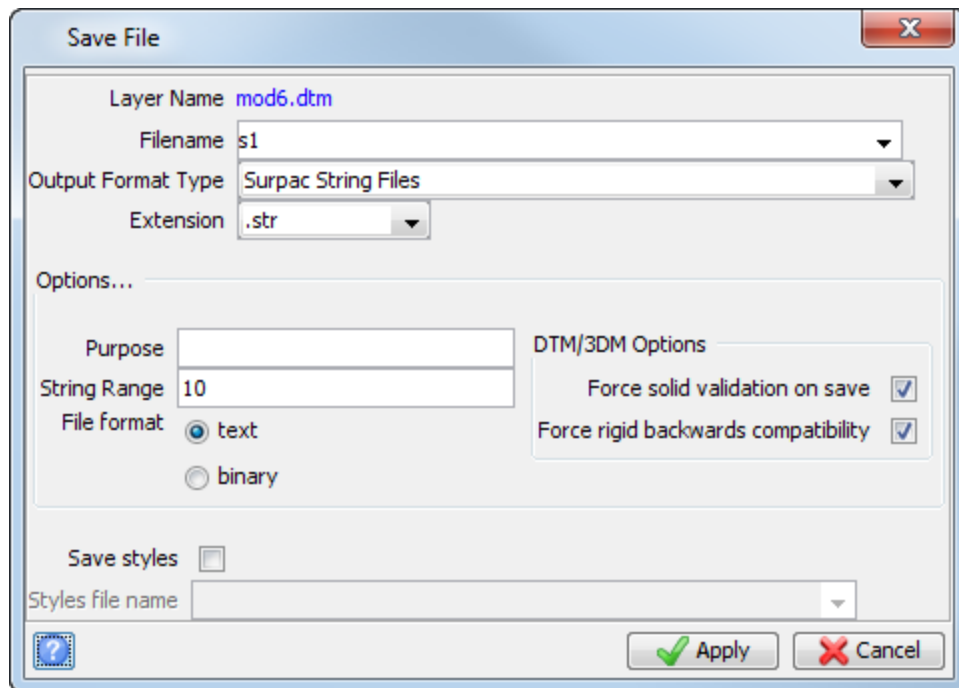
8. Rotate the data as shown to view the fault plane.

The section strings and fault are displayed.



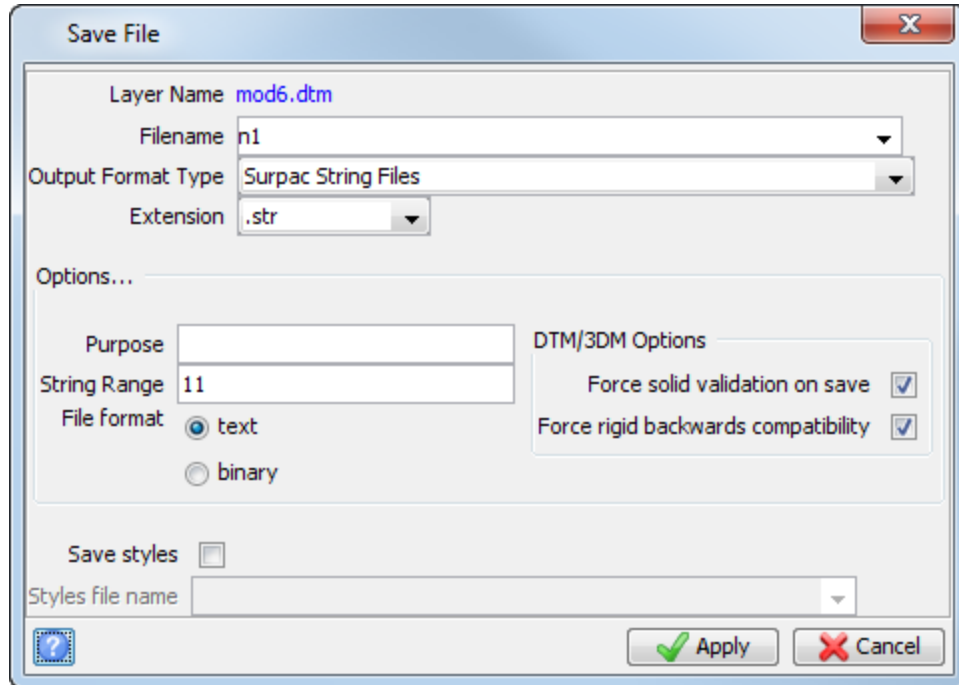
The string **fault1.str** represents the fault through this area. Ideally, you need two shapes that coincide with the fault on either side of the fault. The following steps illustrate one way of doing this.


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

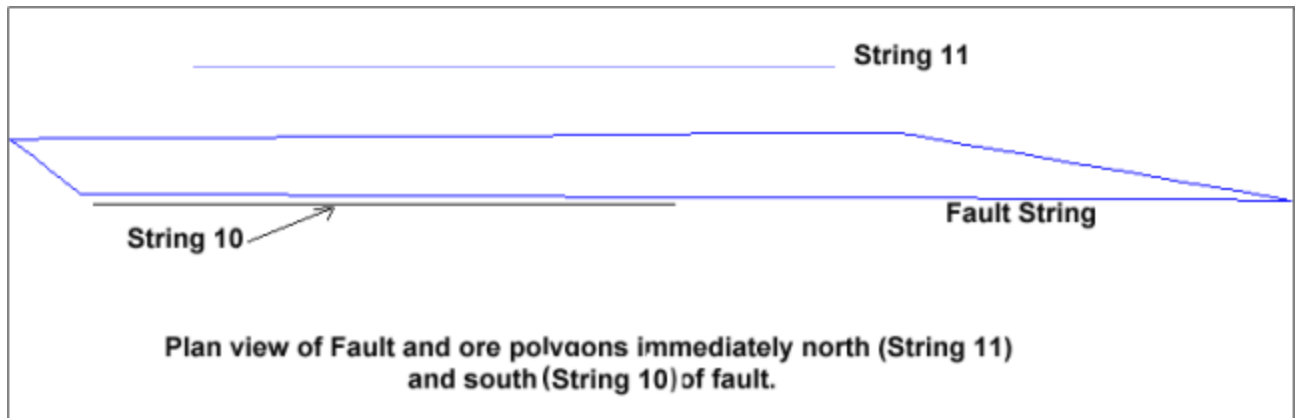


11. Choose **File > Save > string/DTM**.

- Enter the information as shown, and click **Apply**.



- Click **Reset graphics** .
- Open **s1.str**, **n1.str**, and **fault1.str** in **Graphics**.  
The plan view of the fault is displayed.

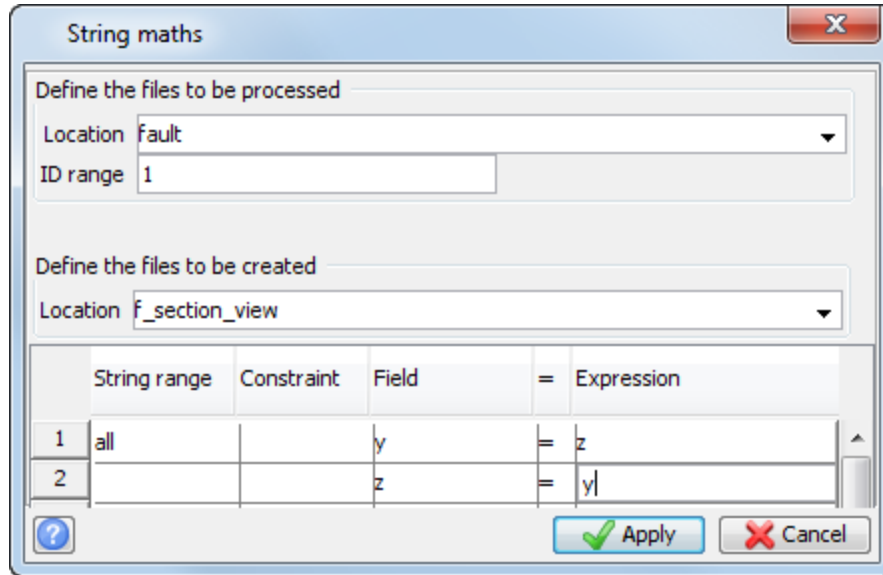


You now need to press these strings onto the surface of the fault.

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 (for example, go to section view).

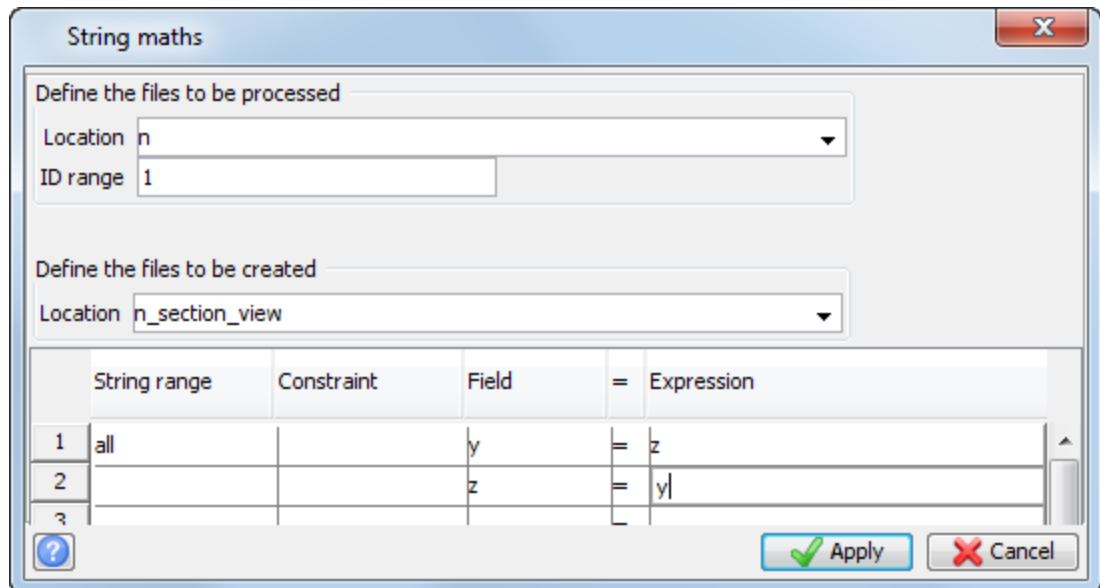
- Choose **File tools > String maths**.

16. Enter the information as shown, and click **Apply**.



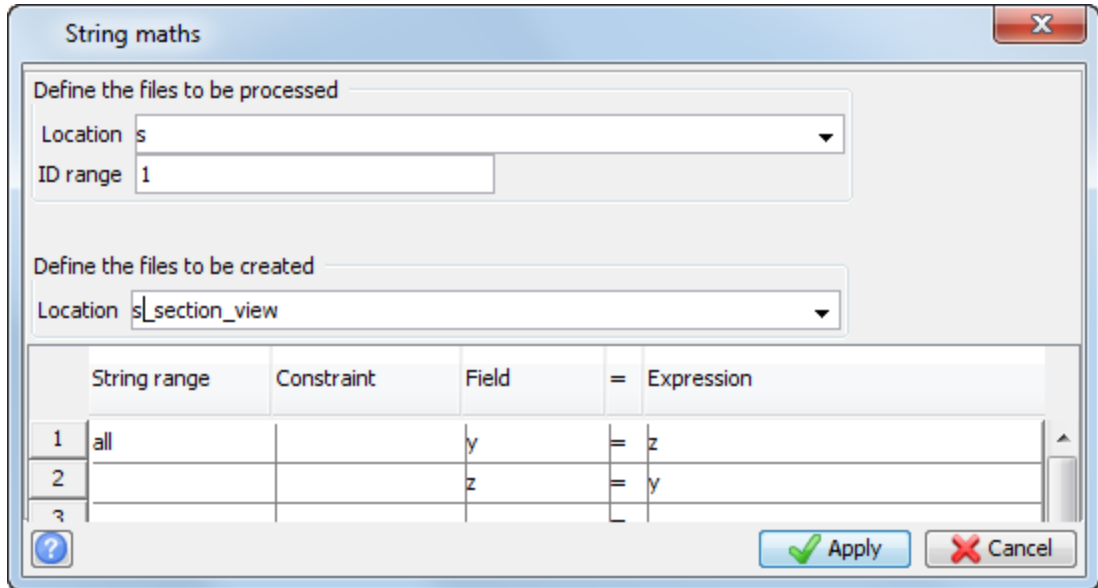
17. Choose **File tools > String maths**.

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



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

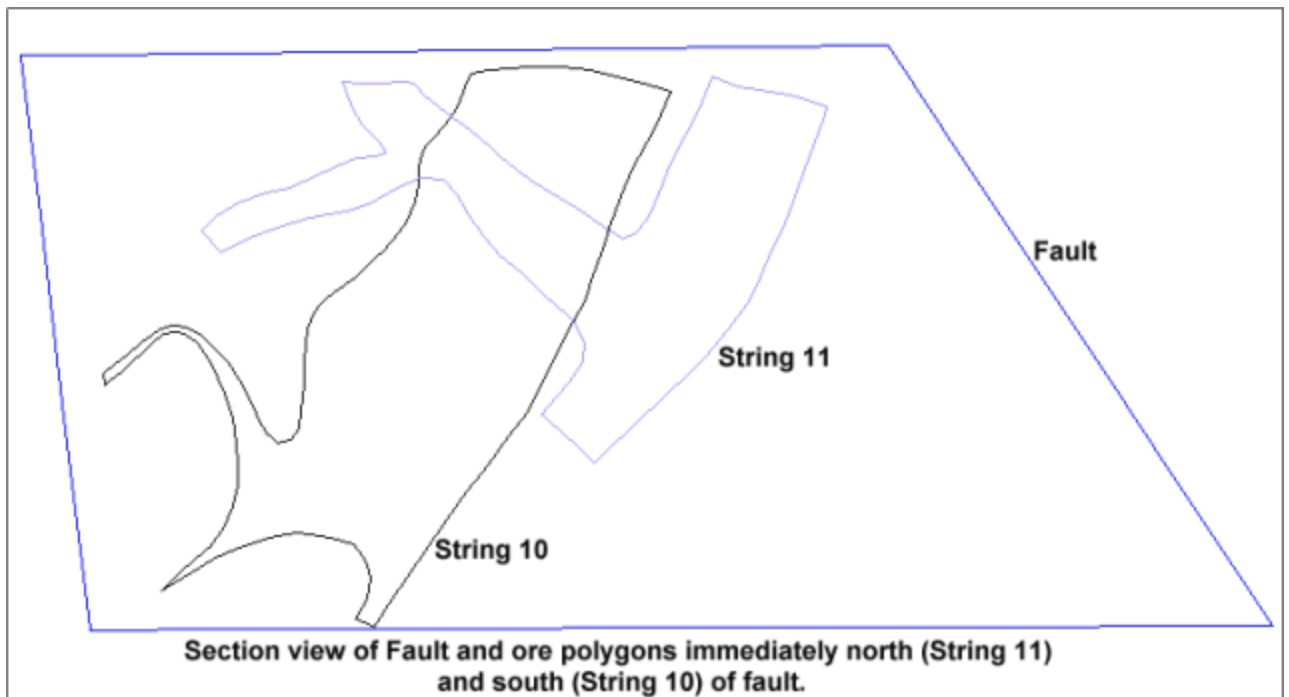
20. Enter the information as shown, and click **Apply**.



21. Click **Reset graphics** .

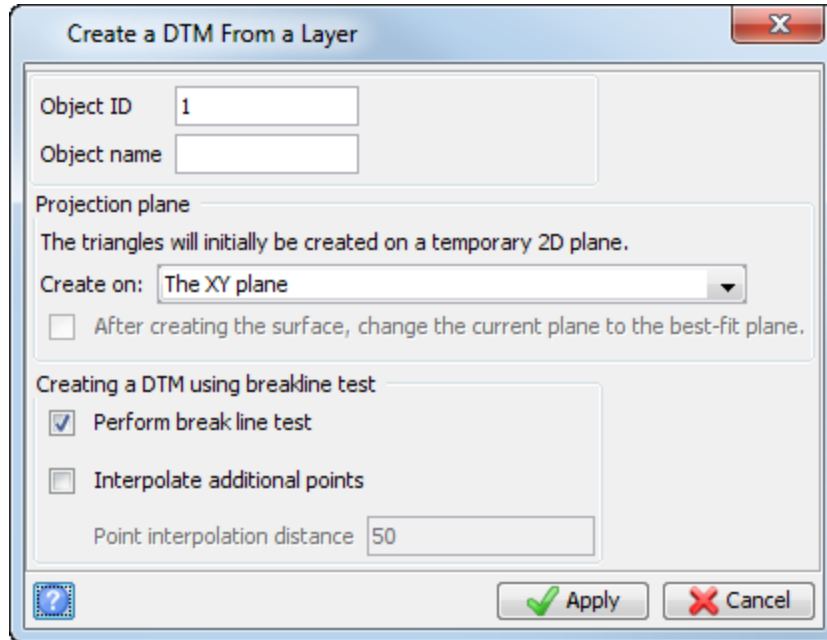
22. Open **n\_section\_view1.str**, **s\_section\_view1.str**, and **f\_section\_view1.str** in that order in **Graphics**.

The fault with Ore Polygons is displayed.



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

24. Enter the information as shown, and click **Apply**.

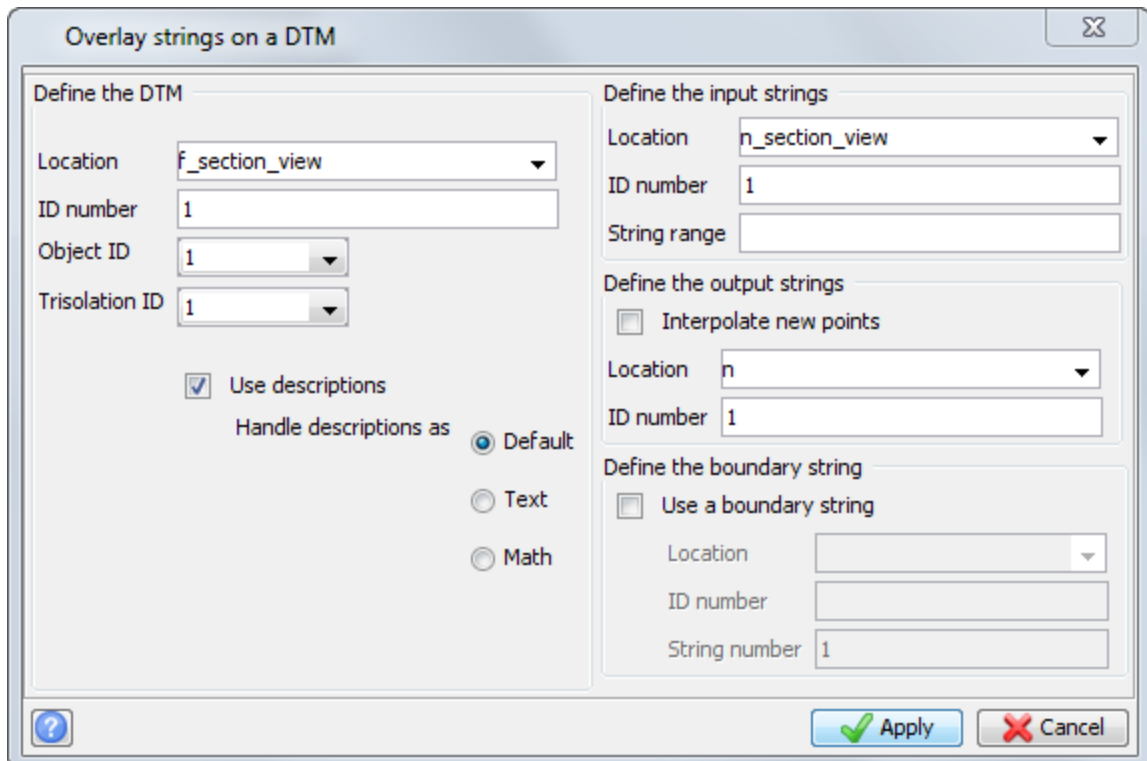


25. Save as **f\_section\_view.dtm**.

**Note:** To see all of the steps performed in this task, run **\_04b\_triangulate\_fault\_data\_preparation.tcl**. You need to click **Apply** on any forms presented.

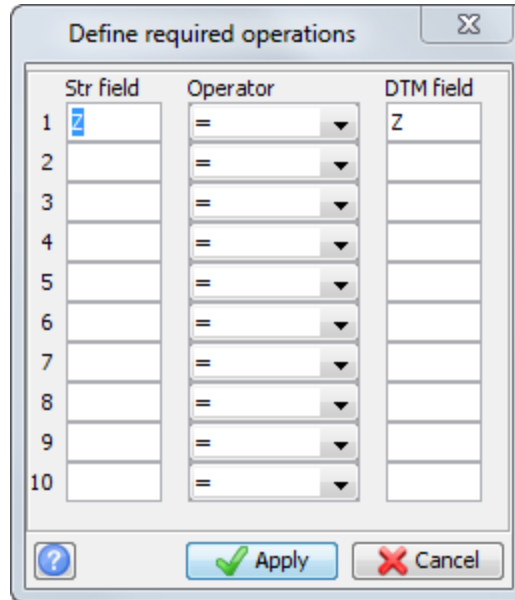
**Draping the strings and triangulating:**

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




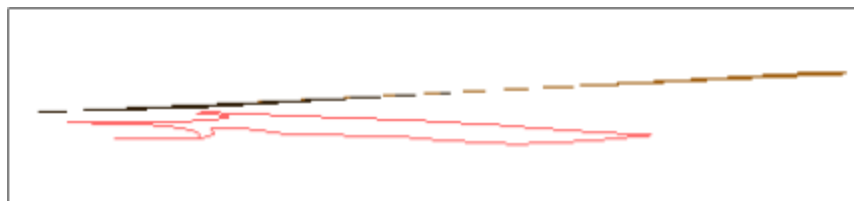
The operation to be performed is  $Z = Z$  and this is the default operation displayed.

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

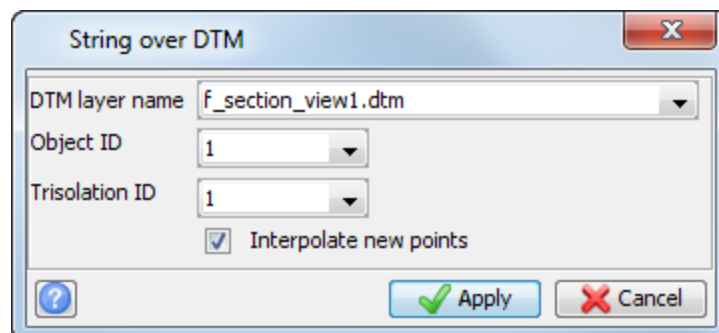


Strings can also be pressed onto a DTM by opening the DTM into one layer and the string file to be pressed into another. You will now press string 10 in file **s1.str** against the fault plane.

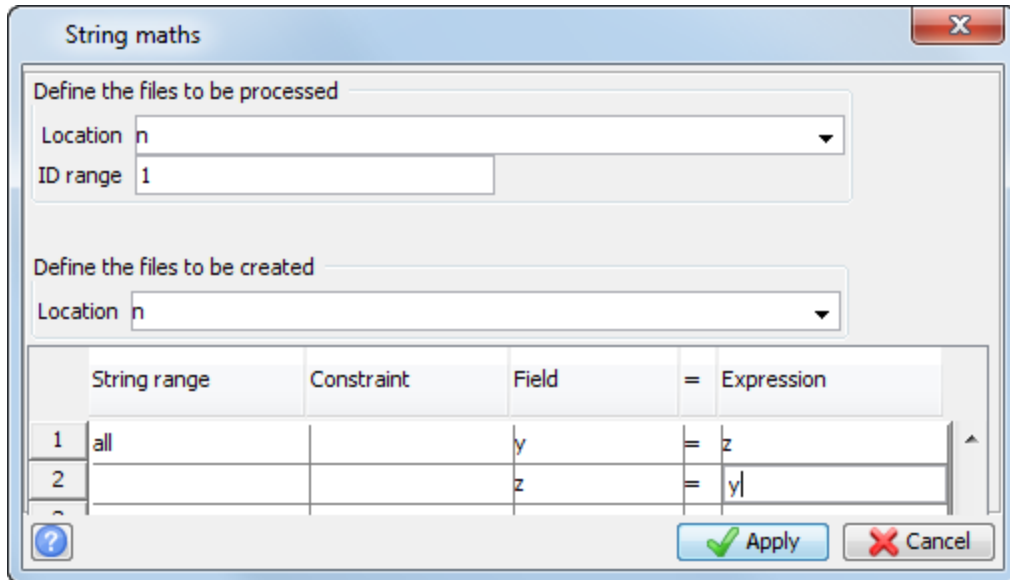
4. Click **Reset graphics** .
5. Open **f\_section\_view1.dtm** in **Graphics**.
6. Open **s\_section\_view1.str**, which contains string 10 in **Graphics**.
7. Rotate the view so you can clearly see the string.



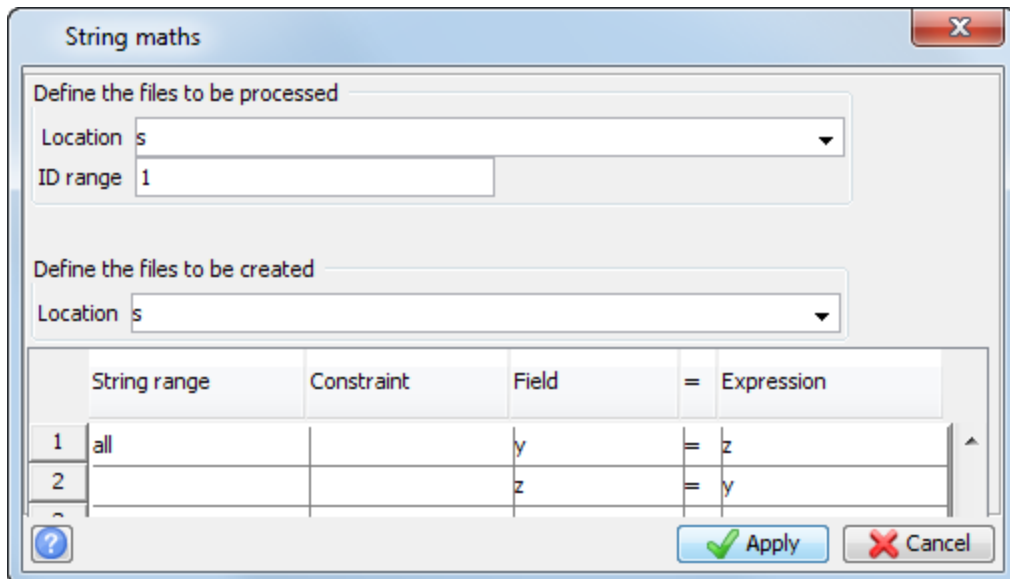
8. Choose **Surfaces > Drape string over DTM**.  
You are prompted to select the string to be draped over the DTM.
9. Click string 10.  
You will be prompted to select the layer that contains the DTM file.
10. Enter the information as shown, and click **Apply**.




- ✔ **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.

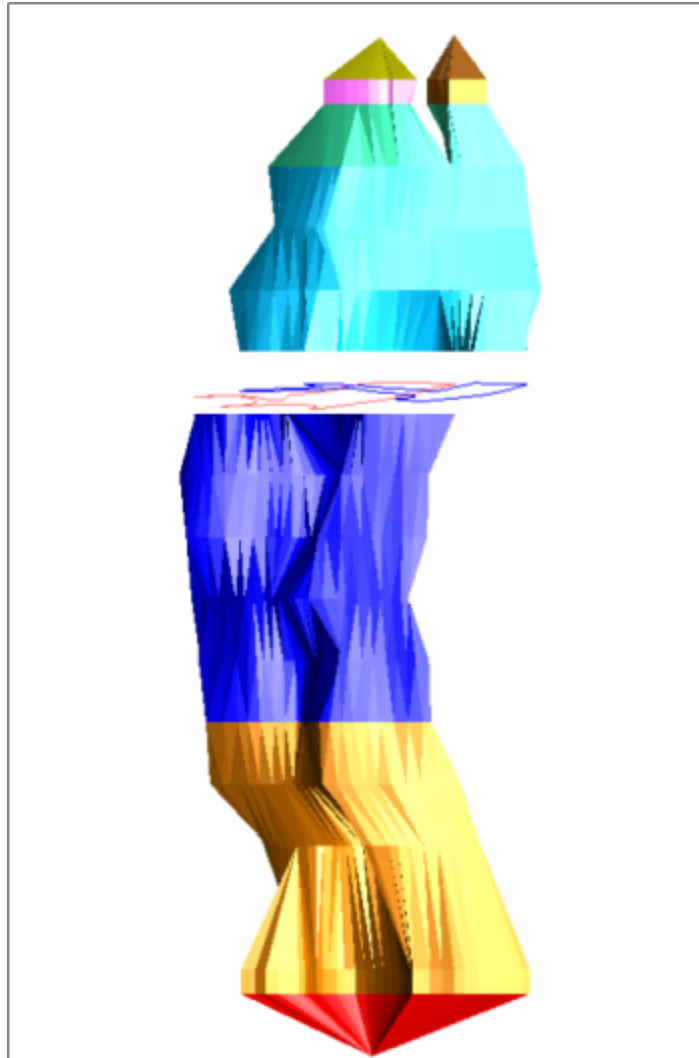


Now you are ready to incorporate the newly created strings into your solid model.

- 14. Click **Reset graphics** .
- 15. Open **s1.str** in **Graphics**.
- 16. Open **n1.str**, appending it to the same layer.
  - ✔ **Note:** Hold the **CTRL** key while dragging **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.



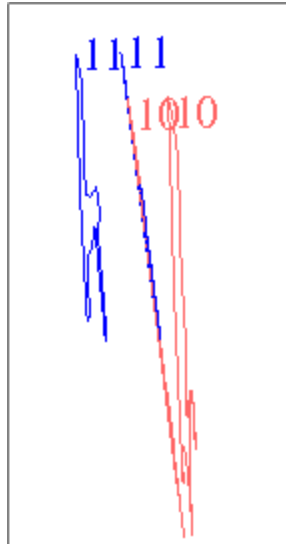
18. Choose **Display > Hide everything**.
19. Choose **Display > Strings > With string numbers**.
20. Enter the information as shown, and click **Apply**.

Drawing

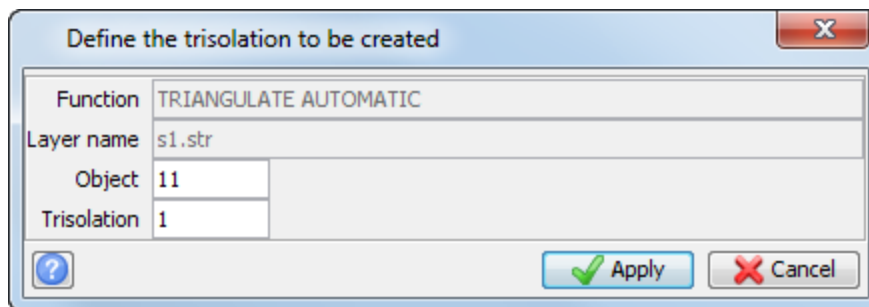
**Draw Strings**

Layer name	s1.str
String range	10,11
Seg range	
Seg pnt range	
Desc field number	d1
Text Alignment	<
Position of text in segment	<input type="radio"/> All points <input checked="" type="radio"/> First point <input type="radio"/> Centroid

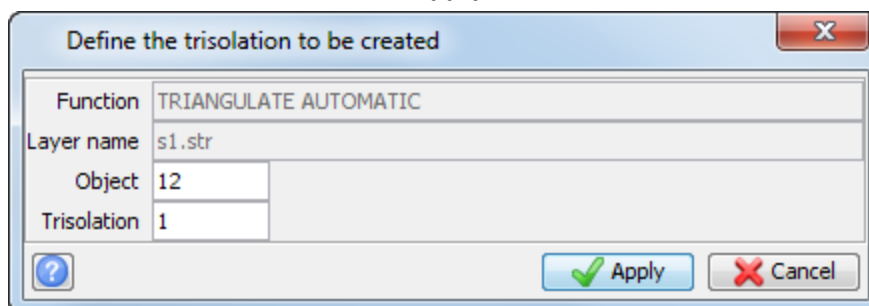
21. Zoom in and adjust the view as necessary to see the data clearly.



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

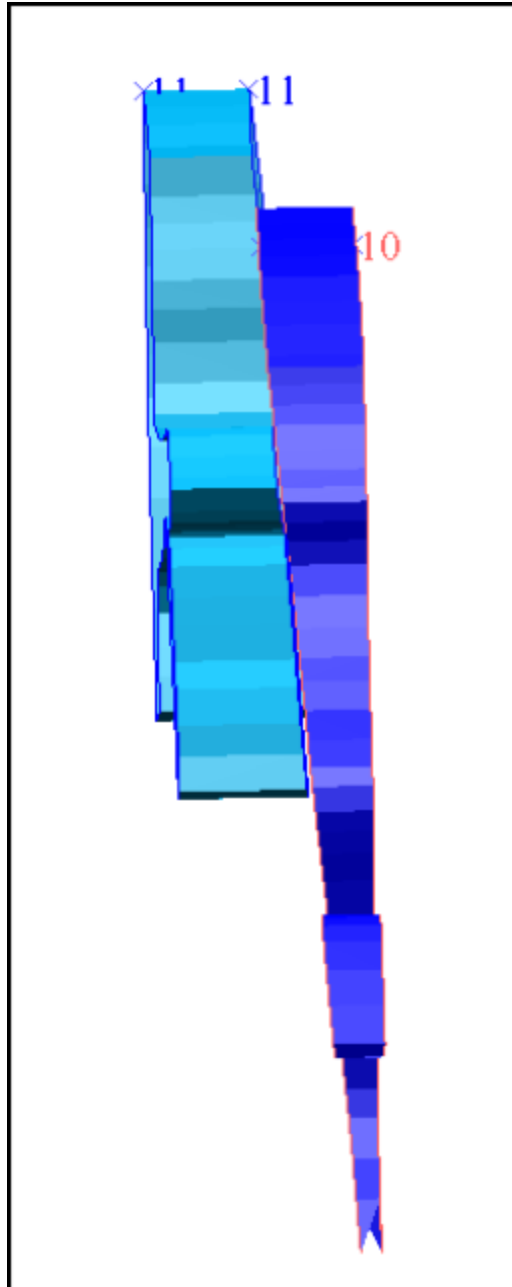


24. Click string 10, segment 1 and then string 10, segment 2.
25. Press ESC.
26. Choose **Solids > Triangulate > Between segments**.
27. Enter the information as shown, and click **Apply**.





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

The following image is displayed.




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

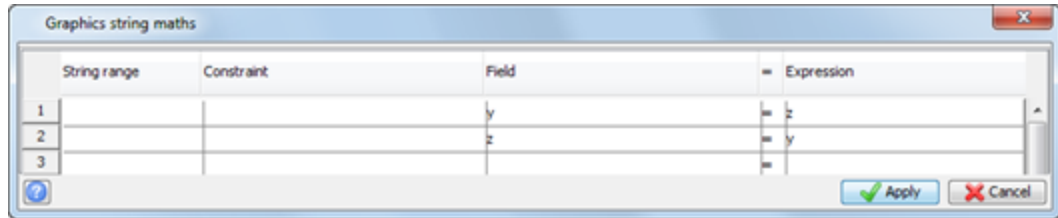
 **Note:** If you want to run manually through the material again, you will need to copy **original\_mod6.dtm**, and save it as **mod6.dtm**.

 **Note:** To see all of the steps performed in this task, run **\_04c\_draping\_strings\_and\_triangulating\_fault.tcl**. You need to click **Apply** on any forms presented.

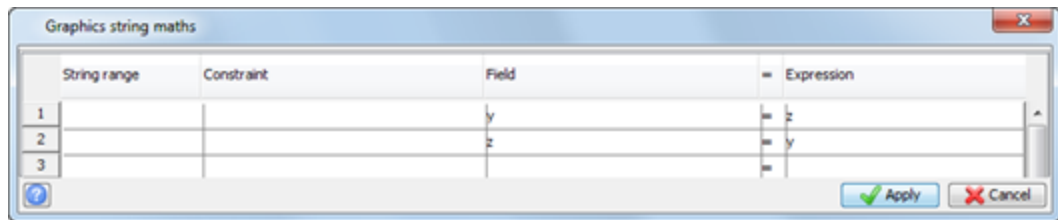
### Task: Triangulate a fault by extruding and clipping



1. Click **Reset graphics** .
2. Open **fault1.dtm** in **Graphics**.
3. Open **mod5.dtm** in **Graphics**.
4. In the **Layer** pane, right click on **fault.dtm** and select **Layer maths**.

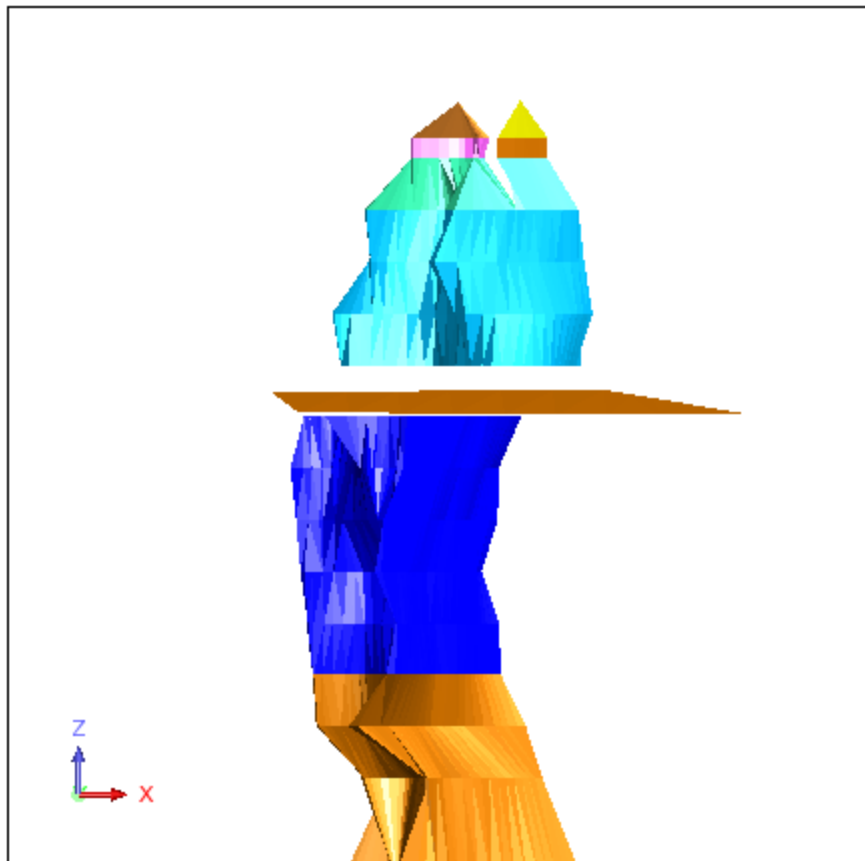
5. Enter the information as shown, and click **Apply**.



6. In the **Layer** pane, right click on **mod5.dtm** and select **Layer maths**.
7. Enter the information as shown, and click **Apply**.

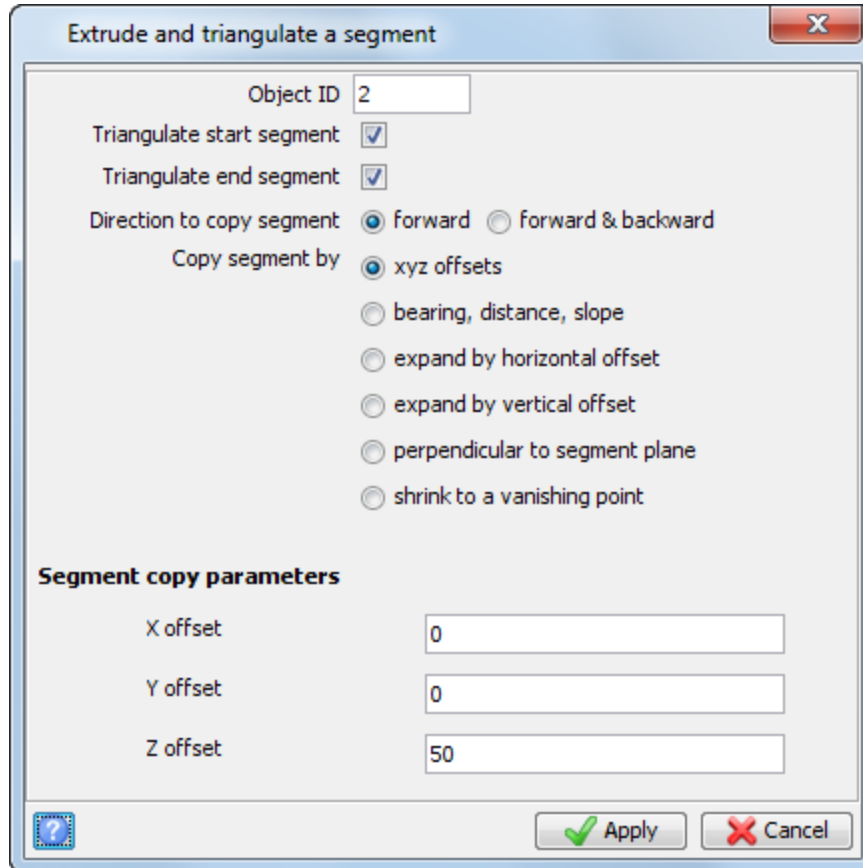


8. Click **Zoom to data extents** .
9. Click **Section view** .



10. Choose **Solids > Triangulate > Extrude and triangulate a segment**.
11. Click the segment below the fault in **Graphics**.

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

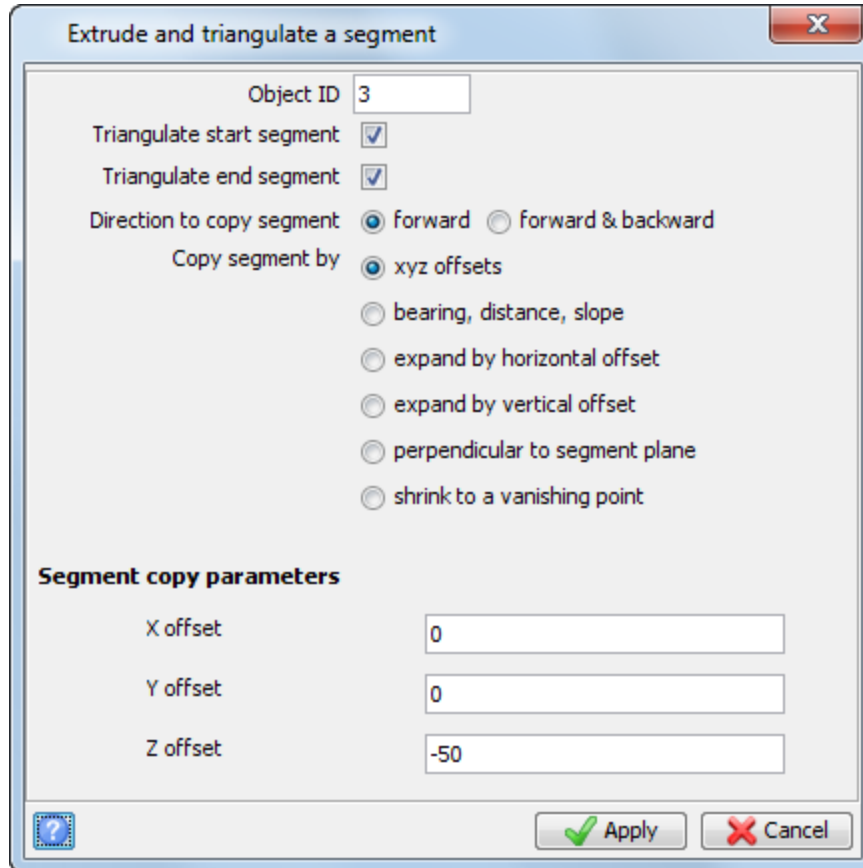


The section is extended above the fault.

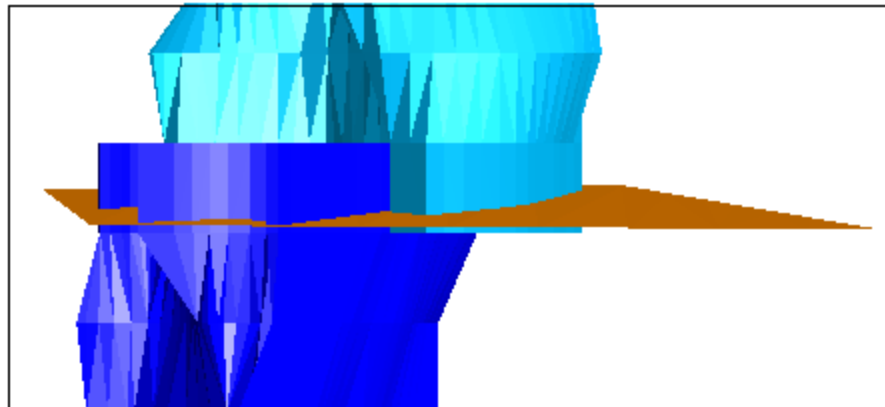


13. Choose **Solids > Triangulate > Extrude and triangulate a segment**.  
14. Click the segment above the fault in **Graphics**.

15. Enter the information as shown, and click **Apply**.

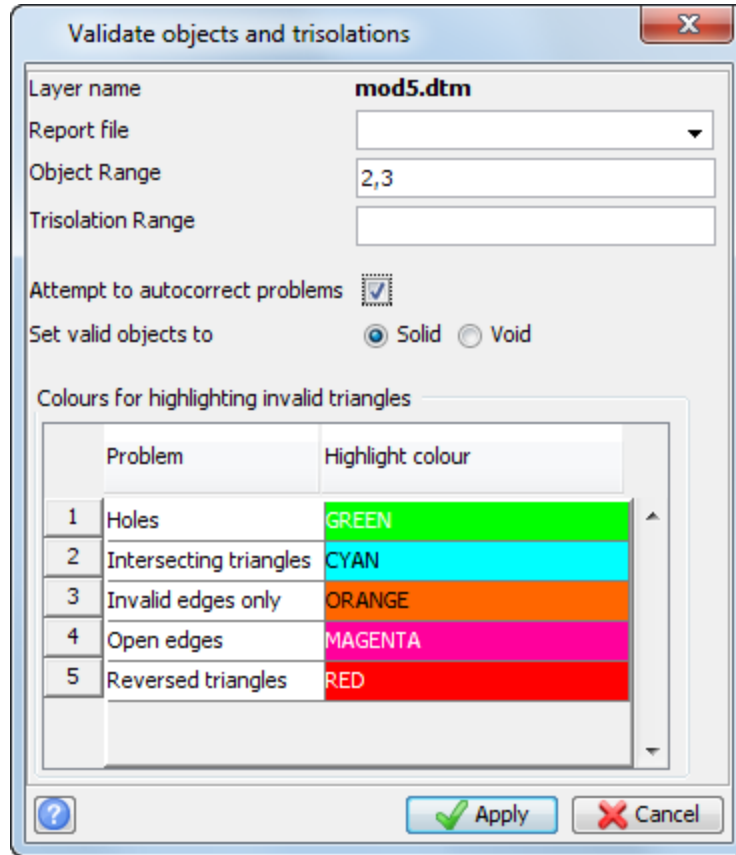


The section is extended below the fault.



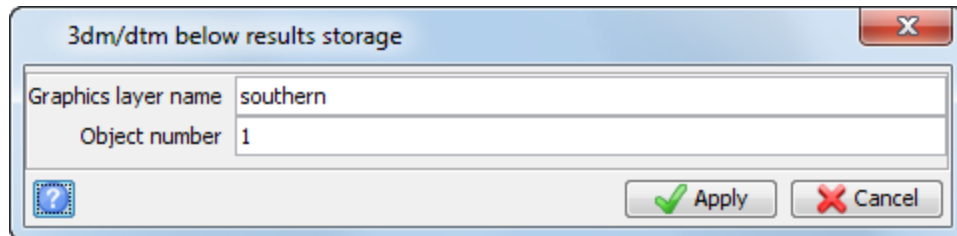
16. Choose **Solids > Validation > Validate object/trisolation**.

17. Enter the information as shown, and click **Apply**.



18. Choose **Solids > Solids tools > Clip solid below a DTM**.

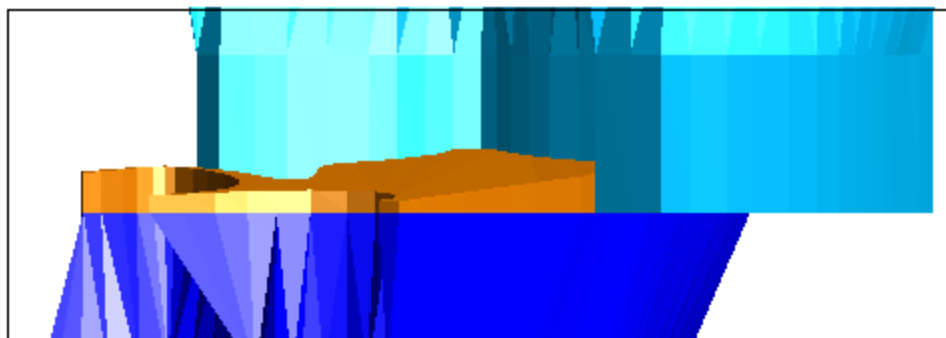
19. Enter the information as shown, and click **Apply**.



20. Click on the segment of the southern solid that spans the fault in **Graphics**.

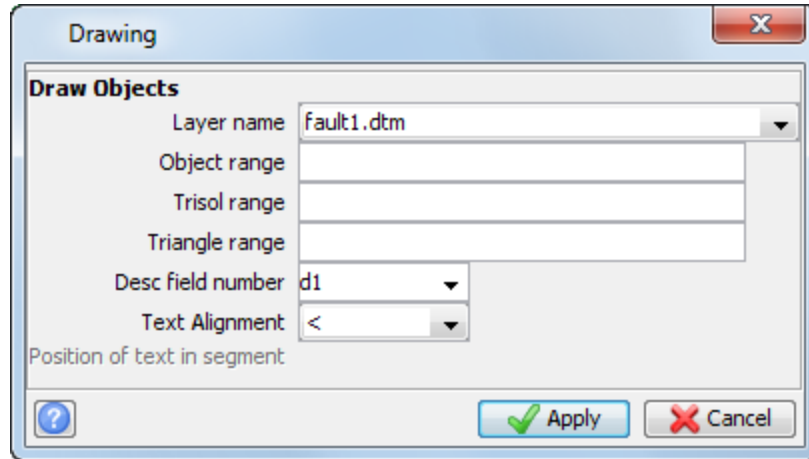
21. Click the fault in **Graphics**.

The section of the segment below the fault DTM is retained.

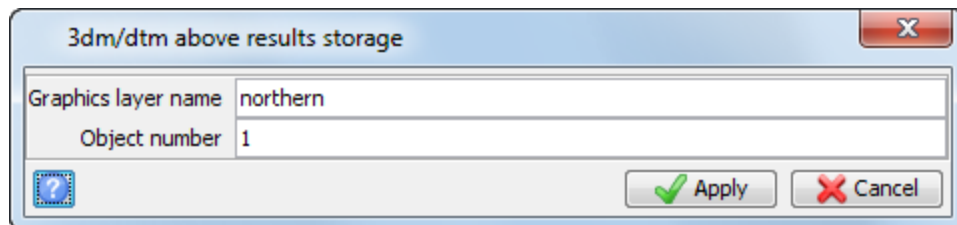


22. Choose **Display > Surface or Solid**.

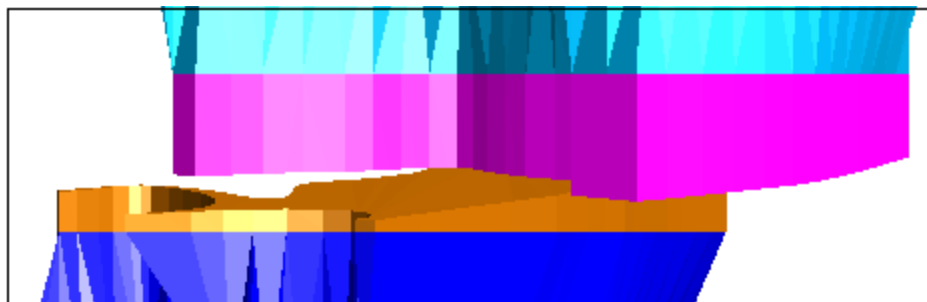
23. Enter the information as shown, and click **Apply**.



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

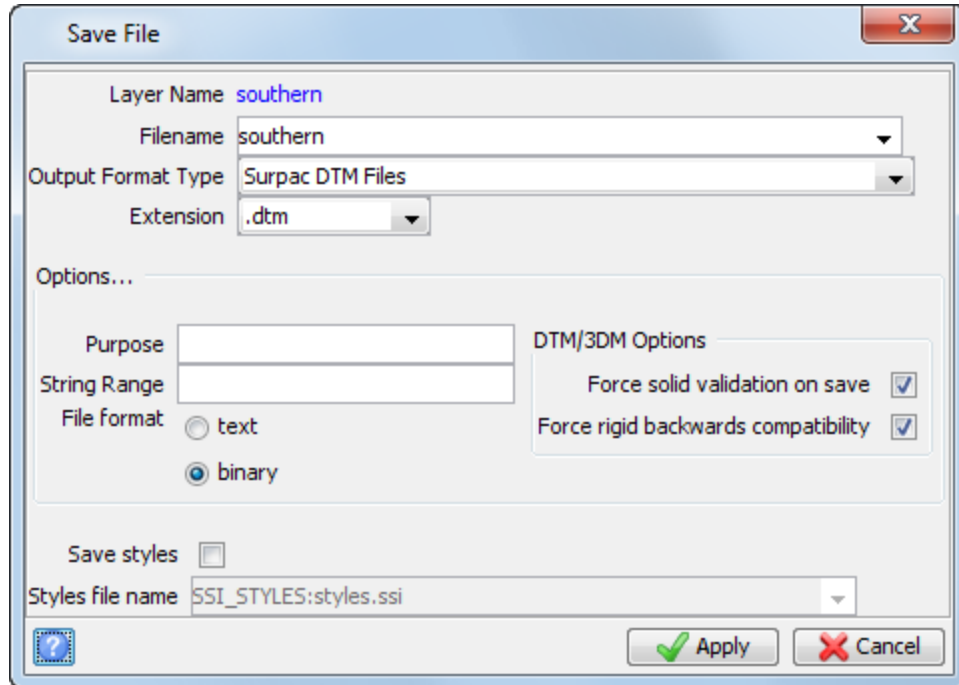


26. Click on the segment of the northern solid that spans the fault in **Graphics**.
27. Click the fault in **Graphics**.  
The section of the segment above the fault DTM is retained.



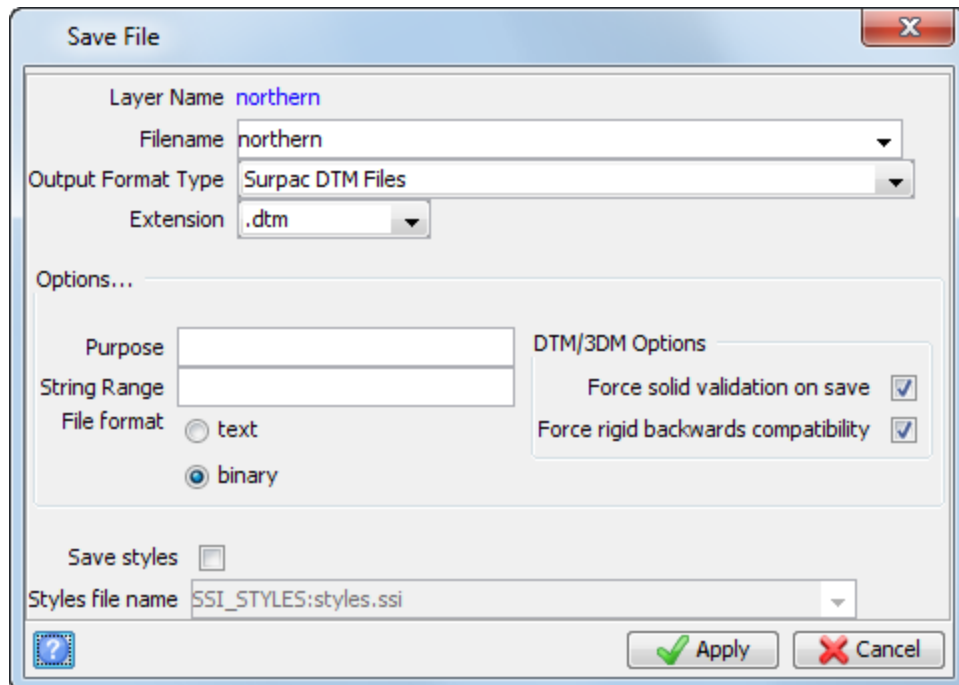
28. In the **Layers** pane, right-click the southern layer, and select **Save layer**.

29. Enter the information as shown, and click **Apply**.



30. In the **Layers** pane, right-click the northern layer, and select **Save layer**.

31. Enter the information as shown, and click **Apply**.



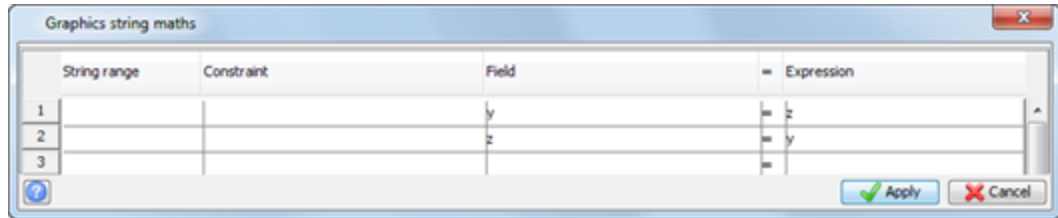
32. Click **Reset graphics** .


33. Open **southern.dtm** in **Graphics**.

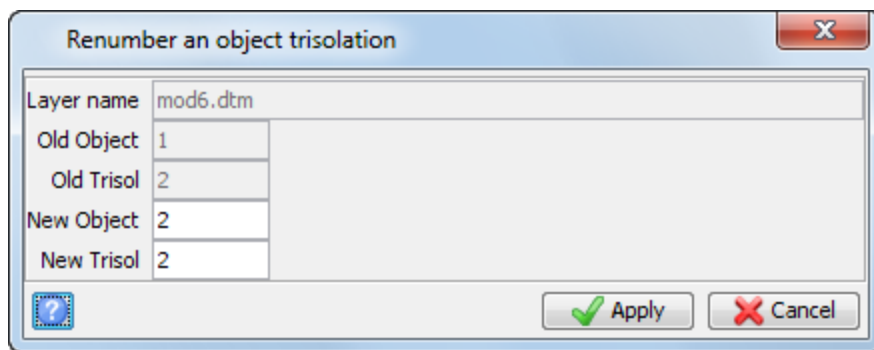
34. Append **northern.dtm** to the same layer by holding CTL and dragging the file into **Graphics**.

35. In the **Layers** pane, right-click on **southern.dtm** and select **Layer maths**.

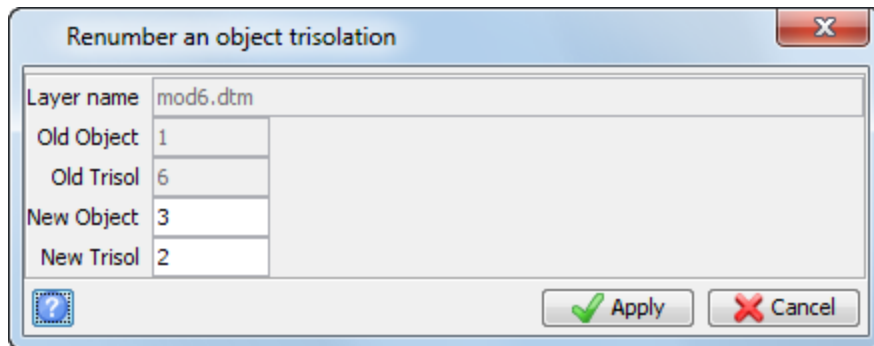
36. Enter the information as shown, and click **Apply**.



37. Append **mod5.dtm** to the same layer by holding CTL and dragging the file into **Graphics**.
38. Save the combined data as **mod6.dtm**.
39. Click **Reset graphics** .
40. Open **mod6.dtm** in **Graphics**.
41. Choose **Solids > Edit trisolation > Renumber**.
42. Click the solid below the fault in **Graphics**.
43. Enter the information as shown, and click **Apply**.




44. Click the solid above the fault in **Graphics**.
45. Enter the information as shown, and click **Apply**.

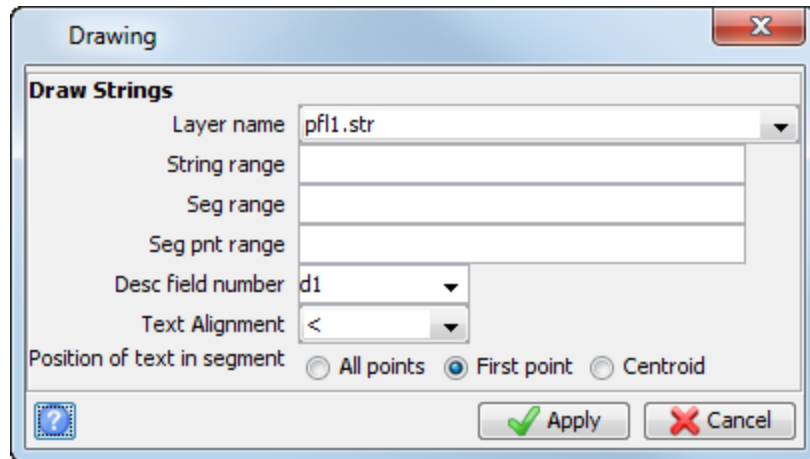


46. Save **mod6.dtm**.

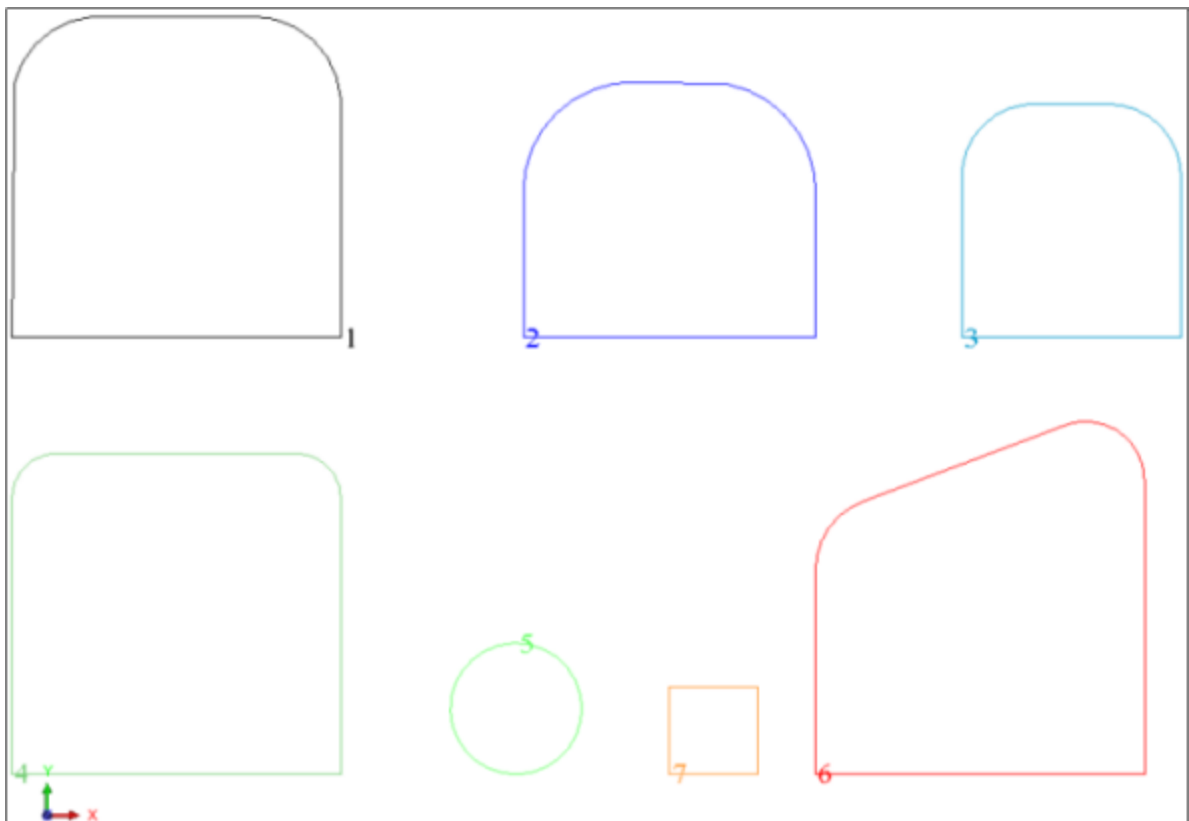
## Triangulating using centre line and profile

**Task: Create a solid using centre line and profile.**

1. Click **Reset graphics** .
2. Open **pfl1.str** in **Graphics**.  
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 click **Apply**.





The profiles examples are displayed.



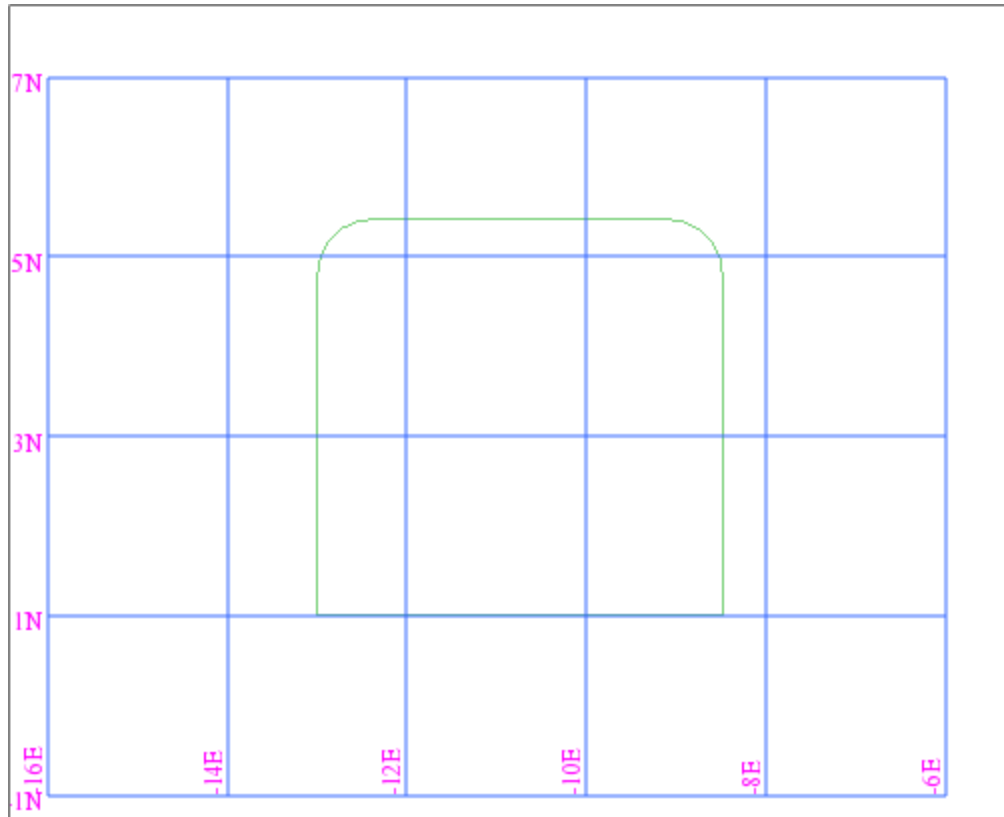
5. Choose **File > Save > string/DTM**.

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

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

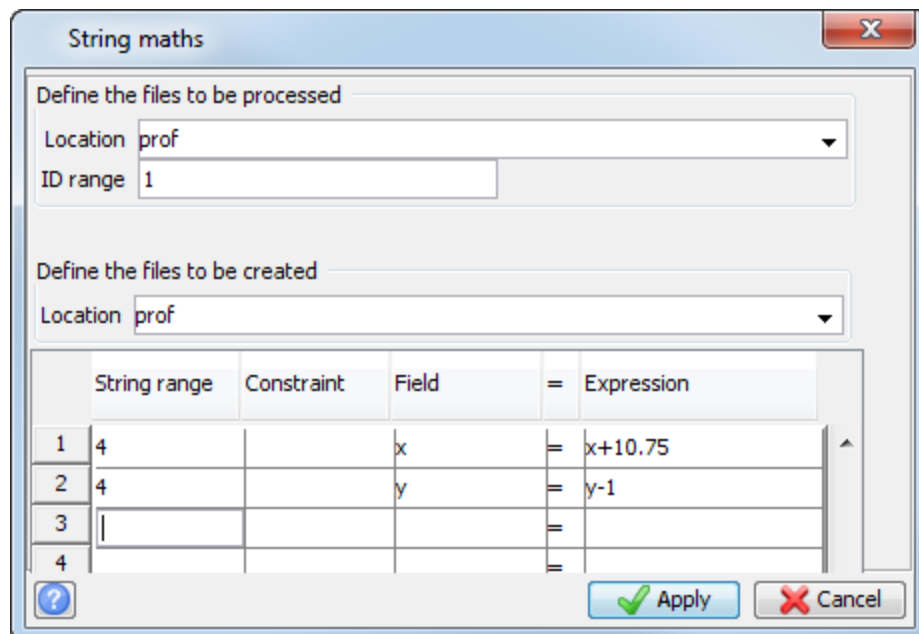
 **Note:** In order for the profile to be correctly applied to a centre line, the centre, bottom point of the profile needs to have coordinates of  $X = 0, Y = 0$ .


The profile example is displayed.



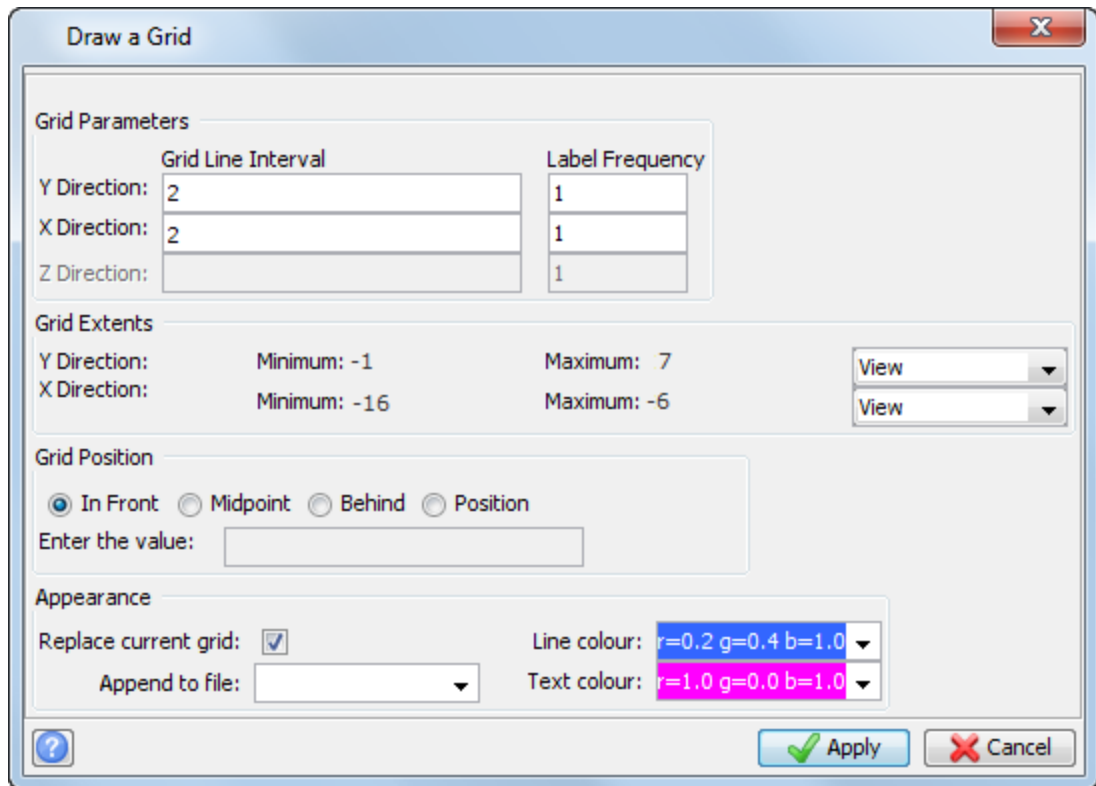
**Note:** The profile needs to move 10.75 in the x direction and -1 in the y direction to have its bottom centre at (0,0)

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

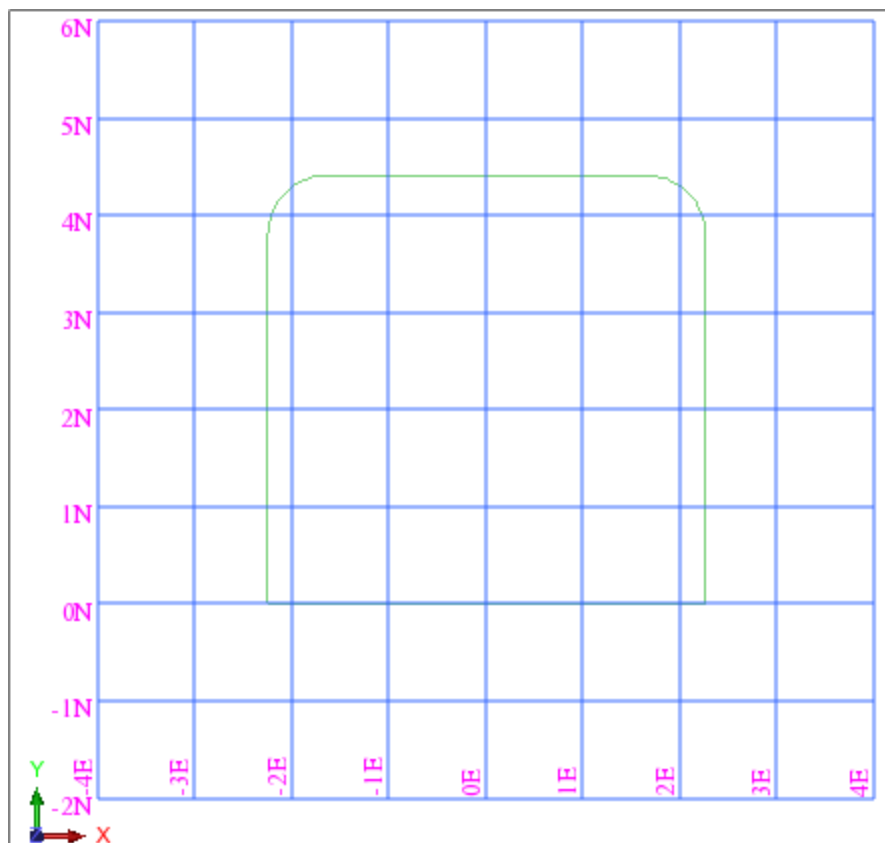


14. Click **Reset graphics** .
15. Open **prof1.str**.
16. Choose **View > Zoom > Out**.


17. Choose **Display > 2D grid**.
18. Enter the information as shown, and click **Apply**.

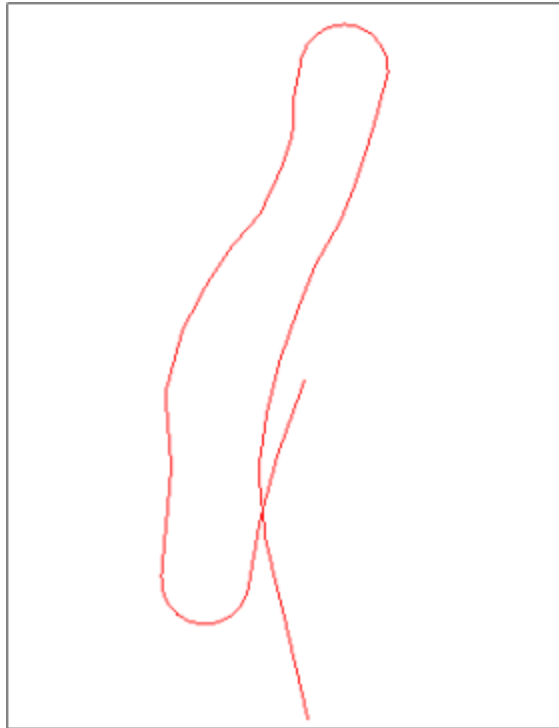


The profile is displayed.



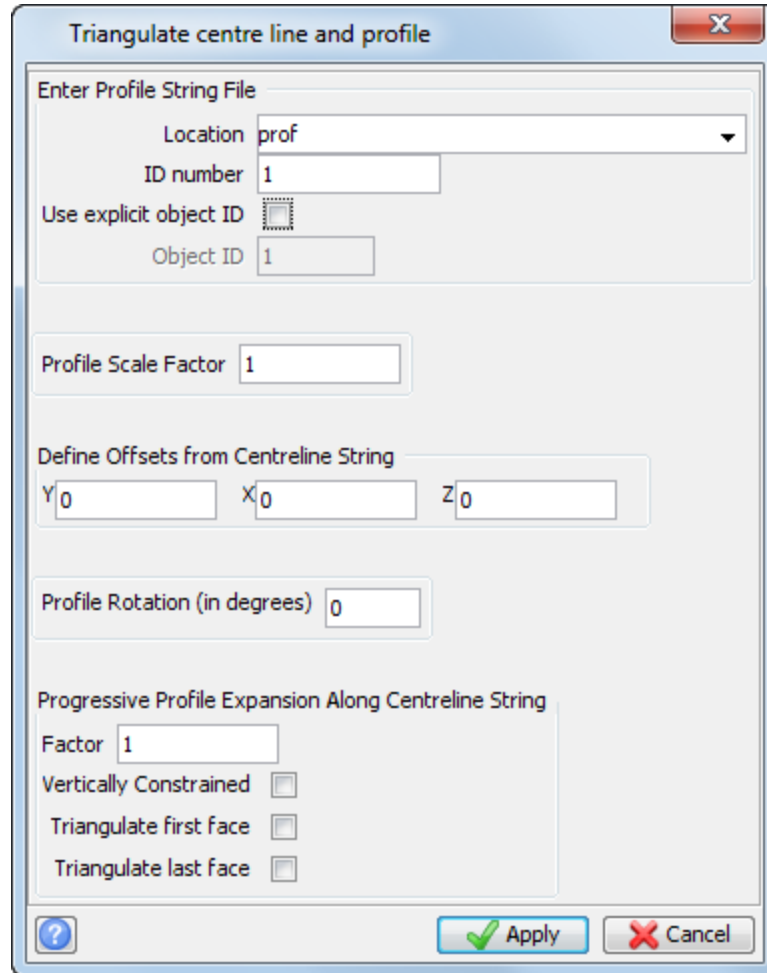
Notice that the centre, bottom point of the profile is now at (0,0)

19. Click **Reset graphics** .
20. Open **dcl100.str**, which represents the centre line of a decline.

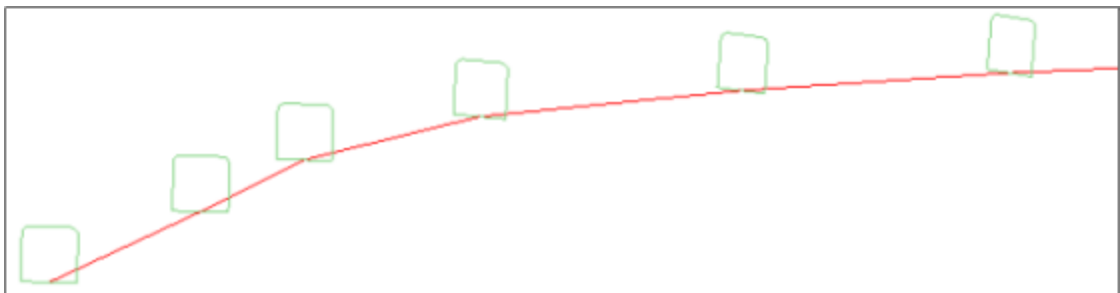


21. Choose **Solids > Triangulate > Using centre line & profile.**

22. Enter the information as shown, and 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 centre line are displayed.




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

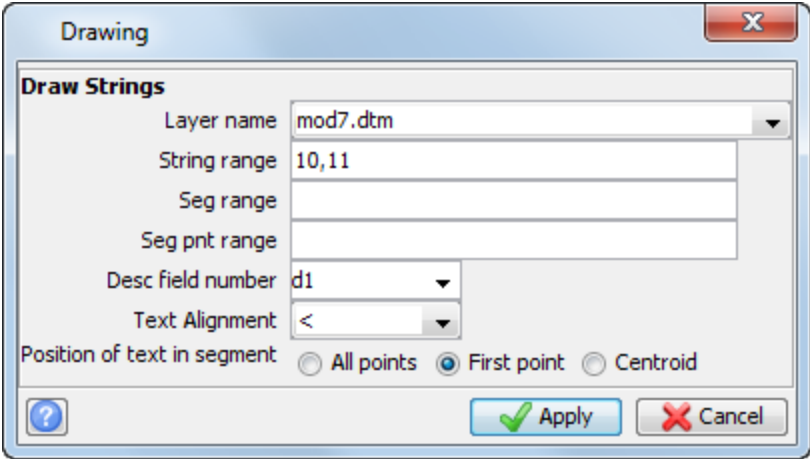
⚠ **Note:** The centre line and profile function does not save the new file automatically. If you want the file saved, you must specify a new file name.

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

## Triangulating Using Inside Segment and One Triangle

### Task: Triangulate Inside a Segment

1. Click **Reset graphics** .
2. Open **mod7.dtm** in **Graphics**.
3. Choose **Display > Hide surface/solid**, and click **Apply**.
4. Choose **Display > Strings > With string numbers**.
5. Enter the information as shown, and click **Apply**.

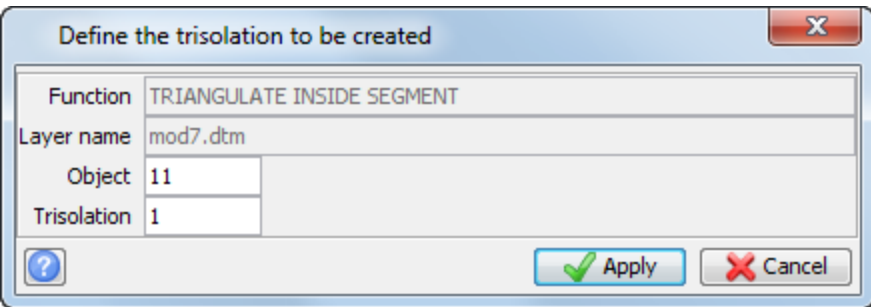


The 'Drawing' dialog box is shown with the 'Draw Strings' section active. The fields are filled with the following values:

- Layer name: mod7.dtm
- String range: 10,11
- Seg range: (empty)
- Seg pnt range: (empty)
- Desc field number: d1
- Text Alignment: <
- Position of text in segment:  All points  First point  Centroid

Buttons for 'Apply' and 'Cancel' are visible at the bottom right.

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

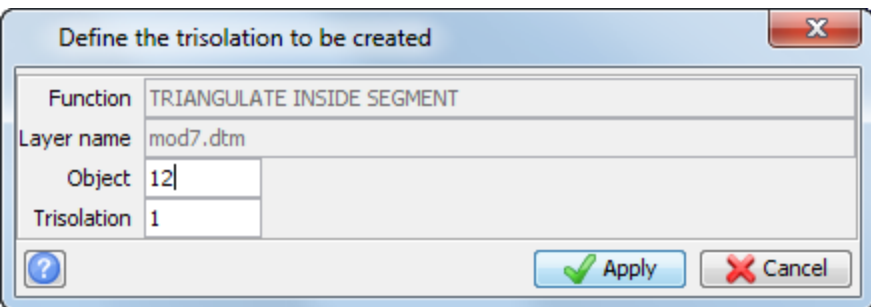


The 'Define the trisolation to be created' dialog box is shown with the following values:

- Function: TRIANGULATE INSIDE SEGMENT
- Layer name: mod7.dtm
- Object: 11
- Trisolation: 1

Buttons for 'Apply' and 'Cancel' are visible at the bottom right.


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




The 'Define the trisolation to be created' dialog box is shown with the following values:


- Function: TRIANGULATE INSIDE SEGMENT
- Layer name: mod7.dtm
- Object: 12
- Trisolation: 1

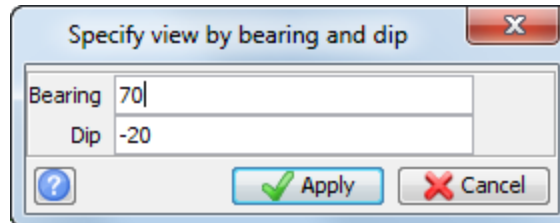
Buttons for 'Apply' and 'Cancel' are visible at the bottom right.

11. Click string 11, segment 2. (For example, the segment located on the fault)
12. Press ESC.
13. Save the result as **mod7.dtm**.
  -  **Note:** If you want to run manually through the material again, you need to copy **original\_mod7.dtm**, and save it as **mod7.dtm**.

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

### Task: Triangulate Using the One Triangle Function

1. Click **Reset graphics** .
2. Open **mod1.str** in **Graphics**.
3. Zoom in on any part of the file.
4. Choose **Display > Point > Markers** and click **Apply** 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 click **Apply**.

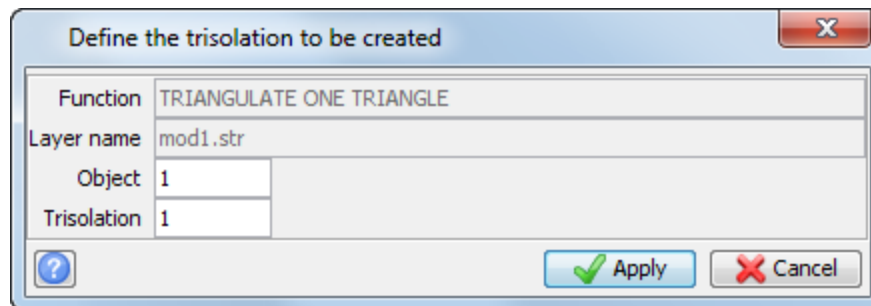


Specify view by bearing and dip

Bearing	70
Dip	-20

Apply Cancel

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



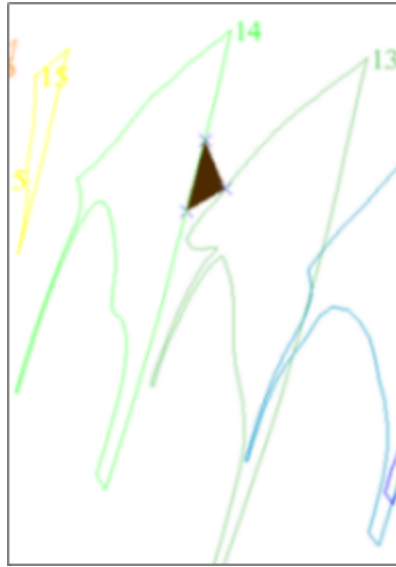
Define the trisolation to be created

Function	TRIANGULATE ONE TRIANGLE
Layer name	mod1.str
Object	1
Trisolation	1

Apply Cancel

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.

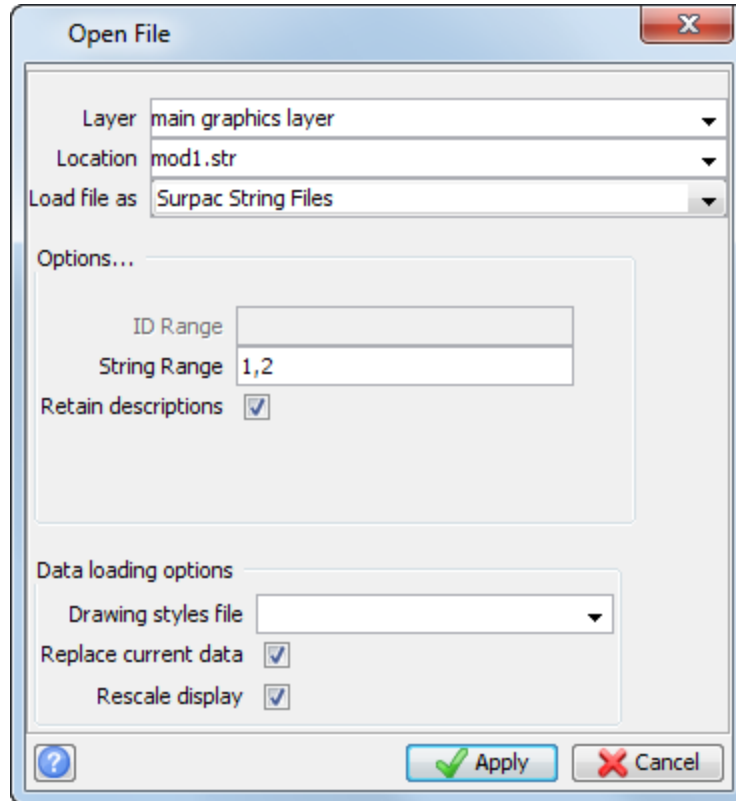
📌 **Note:** To see all of the steps performed in this task, run `_04e_triangulate_one_triangle.tcl`. You need to click **Apply** on any forms presented.

## Triangulating using manual triangulation

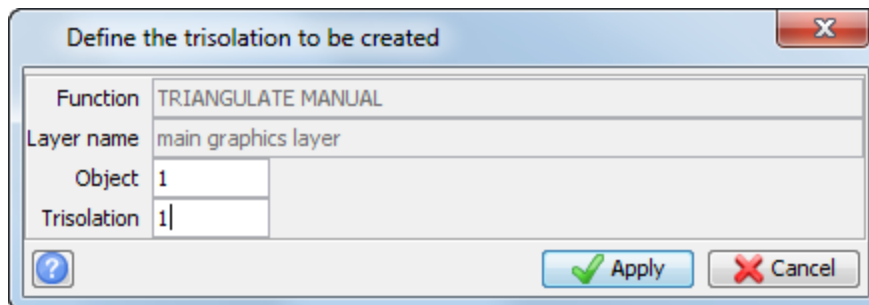
### Task: Triangulate using manual triangulation

1. Click **Reset graphics** .
2. Choose **File > Open > String/DTM file**.

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



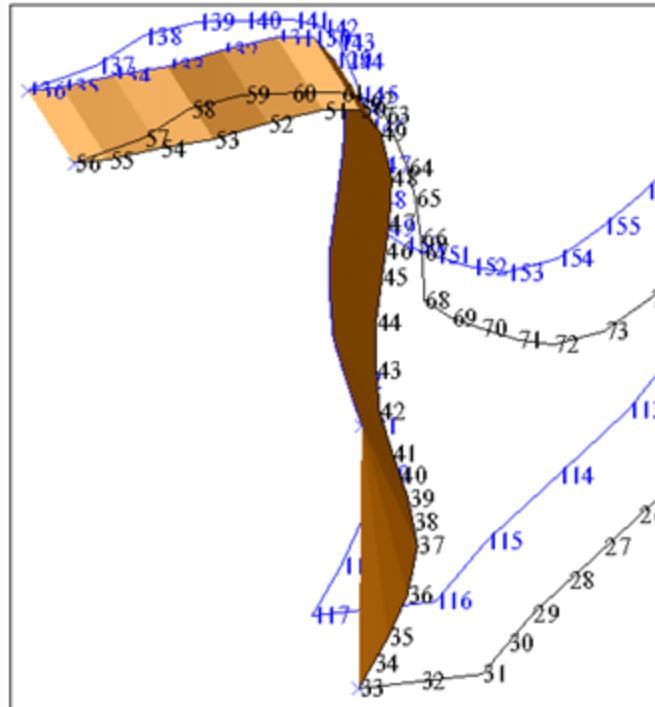
4. Choose **View > Data view options > View by bearing & dip** to change the view to Bearing = 70, Dip = -20.
5. Zoom in on strings 1 and 2.
6. Choose **Display > Point > Numbers** to display the numbering sequence of strings 1 and 2.
7. Choose **Solids > Triangulate > By manually selecting points**.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




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

9. Click point 33 on string 1 and then the corresponding point 117 on string 2.
10. Click point 56 on string 1 and then the corresponding point 136 on string 2.
11. Press ESC.



The triangulated image is displayed.

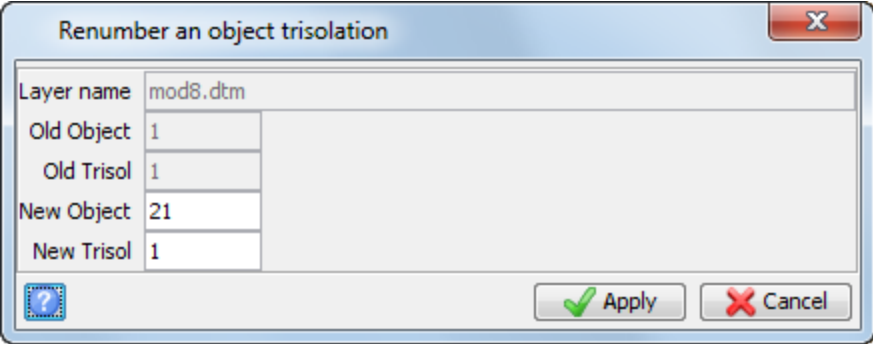


 **Note:** To see all of the steps performed in this task, run `_04f_triangulate_manual.tcl`. You need to click **Apply** on any forms presented.

## Editing solids

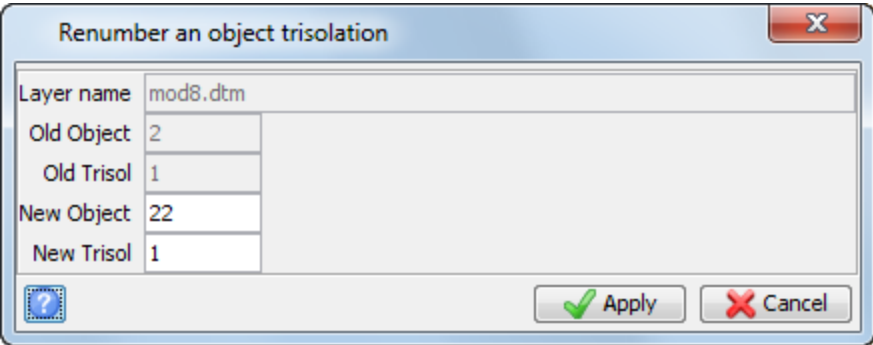
### Task: Renumber an object and trisolation

1. Click **Reset graphics** .
2. Open **mod8.dtm** in **Graphics**.
3. Choose **Solids > Edit trisolation > Renumber**.
  -  **Note:** This function allows you to renumber a trisolation by pointing to and clicking on triangles.
4. Click the trisolation in the lower part of the solid, enter the following information to renumber all the trisolations south of the fault to Object = 21, Trisolation = 1, and click **Apply**.





Layer name	mod8.dtm
Old Object	1
Old Trisol	1
New Object	21
New Trisol	1

5. Click the trisolation in the upper part of the solid, enter the following information to renumber all the trisolations north of the fault to Object = 22, Trisolation = 1, and click **Apply**.




Layer name	mod8.dtm
Old Object	2
Old Trisol	1
New Object	22
New Trisol	1

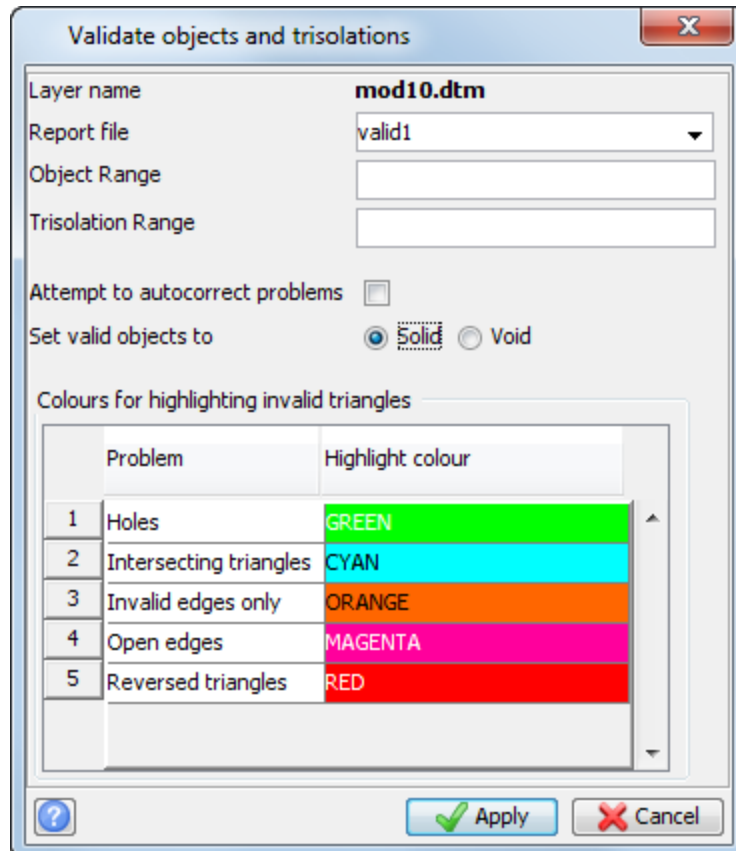
6. Press ESC.  
You will see two objects displayed on the screen.
7. Save the file as **mod8.dtm**
  -  **Note:** If you want to run manually through the material again, you will need to copy **original\_mod8.dtm**, and save it as **mod8.dtm**.


 **Note:** To see all of the steps performed in this section, run **\_06\_edit\_solid.tcl**. You need to click **Apply** on any forms presented.

## Validating solids

### Task: Validate solids

1. Click **Reset graphics** .
2. Open **mod10.dtm** in **Graphics**.  
This is a solid model that contains objects 1 and 2.
3. Choose **Solids > Validation > Validate object/trisolation**.
4. Enter the information as shown, and click **Apply**.




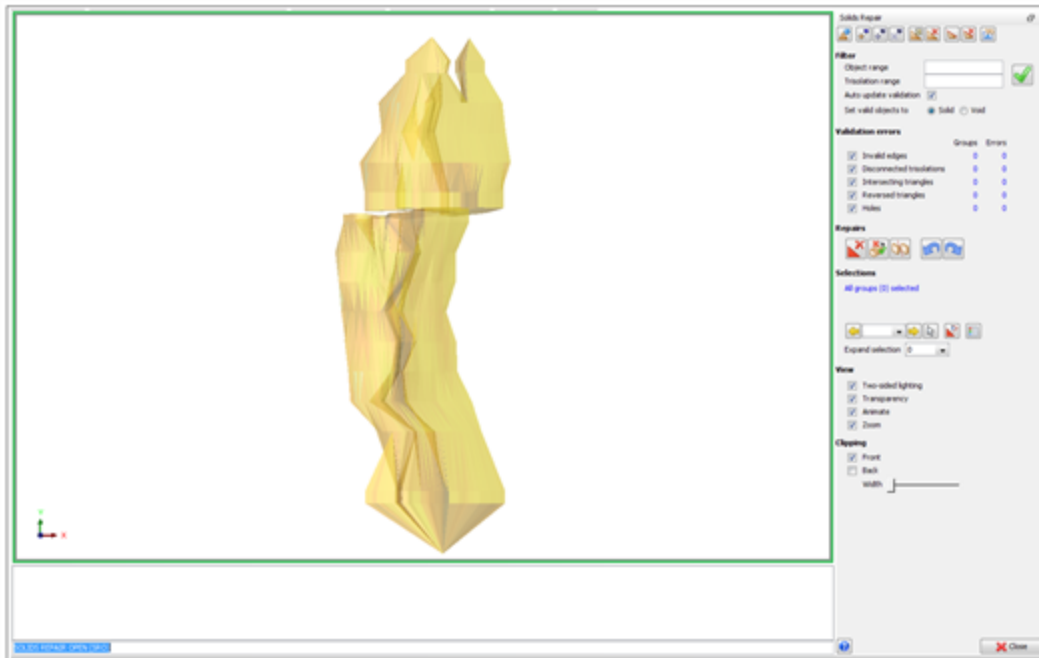
 **Note:** Leaving the object number blank means that all objects, in this case object 1 and object 2, are validated.


5. Open **valid1.not**.  
The validation report is displayed.

Solid validation report									
Layer: mod10.dtm									
Object	Trisolation	Valid	Open/closed	Connected	Duplicate (removed)	Invalid Edges	Intersecting	Reversed	
1	1	valid	Closed	Connected	0	0	0	0	0
2	1	valid	Closed	Connected	0	0	0	0	0
Totals					0	0	0	0	0
Solid validation report						1/1			

6. Close **valid1.not**.


 **Tip:** You can also validate your solid using the solids repair functions (**Solids > Validation > Solids repair**).

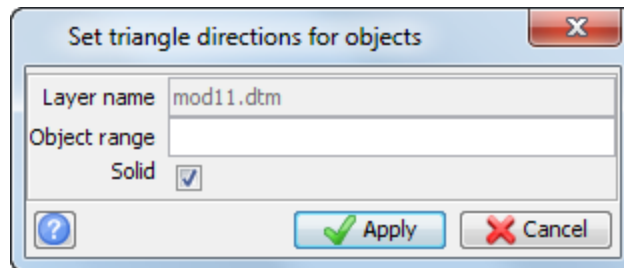


The **Solids Repair** panel is displayed. The green check mark  at the top of the panel means that the solid is valid.

## Setting an object to solid or void

### Task: Set an object (trisolation) to solid or void

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



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


#### **Note:**

- You can now use this solid to calculate a volume, or as a constraint in block model filling. Later, you will use the model you have created in this task to demonstrate viewing solid models, intersecting drill holes, and performing volume calculations.
- If you want to perform this task again, you will need to copy **original\_mod11.dtm** and rename it as **mod11.dtm**.
- To see all of the steps performed in this task, run **\_07a\_solids\_validation.tcl**. You need to click **Apply** on any forms presented.

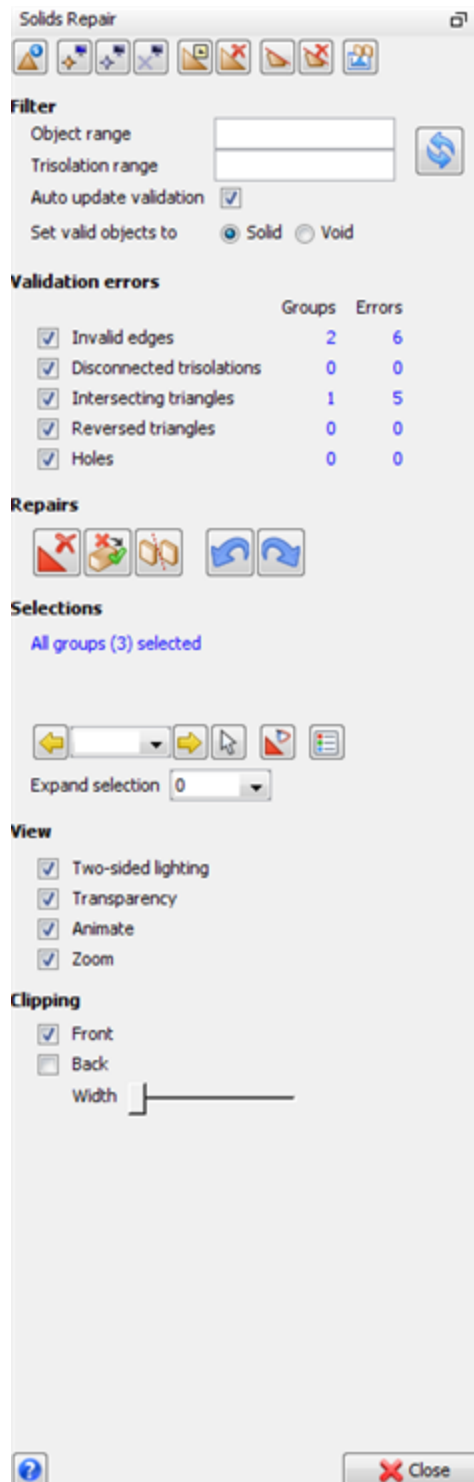
## Repairing a solid

When a solid is valid it does not contain geometric or topological errors. Some solids functions, such as reporting solids volumes, require the solids to be valid. If a solid is not valid, you can use the Solids Repair panel to repair the errors, and validate the solid.

### Task: Repair a solid

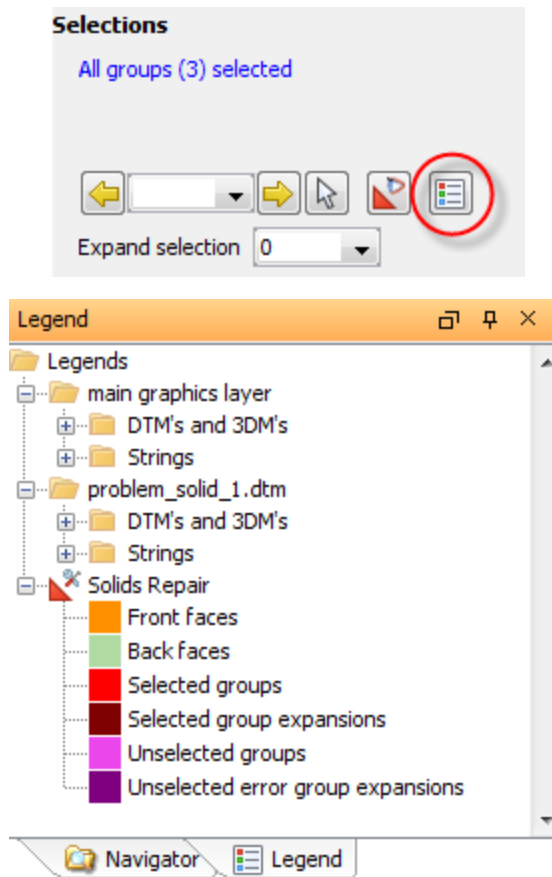
1. Click **Reset graphics** .
2. Open **problem\_solid\_1.dtm** in **Graphics**.
3. Choose **Solids > Validation > Solids repair**.

The Solids Repair panel is displayed in the right hand side of **Graphics**. The number of groups and individual errors triangles are identified in the **Validation Errors** table.



- In **Selections**, click **Move to next problem group** to zoom into each group of problem geometry in this solid.

**Note:** The groups of trisolation that contain validation errors are coloured for the types of problems they contain. To see a key for the which colours identify the different problem types, click the **Legend** button on the far right of the **Selections** options. The legend is displayed in the **Legend** pane on the left-hand side.





5. In the **Selections** drop-down, select **All**.

6. Click **Delete and fill** .

The problem geometry has been corrected.

**Validation errors**

	Groups	Errors
<input checked="" type="checkbox"/> Invalid edges	0	0
<input checked="" type="checkbox"/> Disconnected trisolations	0	0
<input checked="" type="checkbox"/> Intersecting triangles	0	0
<input checked="" type="checkbox"/> Reversed triangles	0	0
<input checked="" type="checkbox"/> Holes	0	0


 **Note:** The refresh icon changes to a green check mark  to show that the solid is valid.

7. Choose **File > Save > string/DTM**, and save your model as **corrected\_solid\_1.dtm**.


 **Note:**

- You can now use this solid to calculate a volume, or as a constraint in block model filling.
- To see all of the steps performed in this task, run **\_07b\_solids\_repair\_simple.tcl**. You need to click **Apply** on any forms presented.


### Task: Repair a solid with complex problems

1. Click **Reset graphics** .
2. Open **problem\_solid\_2.dtm** in **Graphics**.
3. Choose **Solids > Validation > Solids repair**.  
The number of groups and errors in geometry are identified in the **Validation errors** table.


Validation errors		
	Groups	Errors
<input checked="" type="checkbox"/> Invalid edges	0	0
<input checked="" type="checkbox"/> Disconnected trisolations	0	0
<input checked="" type="checkbox"/> Intersecting triangles	4	11
<input checked="" type="checkbox"/> Reversed triangles	1	12
<input checked="" type="checkbox"/> Holes	0	0

4. Click **Delete and Fill** .  
Some of the errors are corrected and the **Validation errors** table is updated.

Validation errors		
	Groups	Errors
<input checked="" type="checkbox"/> Invalid edges	1	3
<input checked="" type="checkbox"/> Disconnected trisolations	1	1
<input checked="" type="checkbox"/> Intersecting triangles	2	2
<input checked="" type="checkbox"/> Reversed triangles	0	0
<input checked="" type="checkbox"/> Holes	0	0

5. Click **Split disconnected trisolations** .  
The disconnected trisolation is corrected and the **Validation errors** table is updated.

Validation errors		
	Groups	Errors
<input checked="" type="checkbox"/> Invalid edges	3	9
<input checked="" type="checkbox"/> Disconnected trisolations	0	0
<input checked="" type="checkbox"/> Intersecting triangles	2	2
<input checked="" type="checkbox"/> Reversed triangles	0	0
<input checked="" type="checkbox"/> Holes	0	0


6. Click **Delete and Fill** .  
Some of the errors are corrected and the **Validation errors** table is updated.

Validation errors		
	Groups	Errors
<input checked="" type="checkbox"/> Invalid edges	0	0
<input checked="" type="checkbox"/> Disconnected trisolations	0	0
<input checked="" type="checkbox"/> Intersecting triangles	2	2
<input checked="" type="checkbox"/> Reversed triangles	0	0
<input checked="" type="checkbox"/> Holes	0	0

7. Click **Delete invalid triangles** .

The intersecting triangles are corrected, and only holes remain.

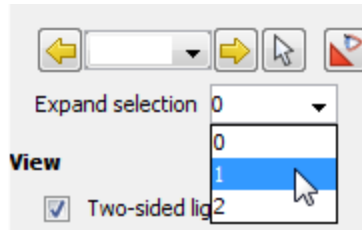
Validation errors		
	Groups	Errors
<input checked="" type="checkbox"/> Invalid edges	0	0
<input checked="" type="checkbox"/> Disconnected trisolations	0	0
<input checked="" type="checkbox"/> Intersecting triangles	0	0
<input checked="" type="checkbox"/> Reversed triangles	0	0
<input checked="" type="checkbox"/> Holes	2	6

8. Click **Delete and fill** .

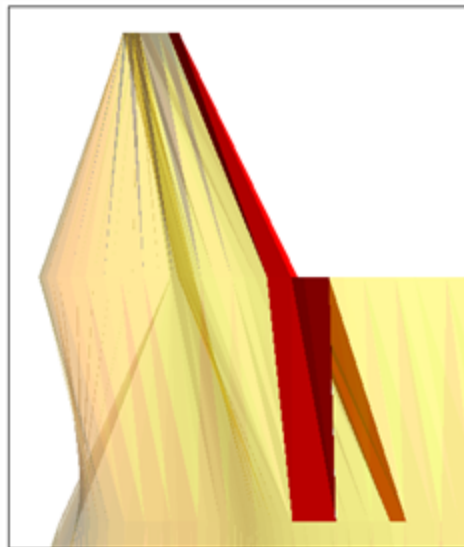
The holes are filled, but the intersecting triangles have been created again when filling the holes. This situation will continue if you keep using these functions with the current settings.

Validation errors		
	Groups	Errors
<input checked="" type="checkbox"/> Invalid edges	0	0
<input checked="" type="checkbox"/> Disconnected trisolations	0	0
<input checked="" type="checkbox"/> Intersecting triangles	2	2
<input checked="" type="checkbox"/> Reversed triangles	0	0
<input checked="" type="checkbox"/> Holes	0	0

9. In **Selections**, click the **Expand selection** drop-down, and choose **1**.



The expanded selection is displayed in **Graphics**.



10. Click **Delete and fill** .

All errors are corrected and the solid is valid.

**Filter**

Object range


Trisolation range

Auto update validation

Set valid objects to  Solid  Void

**Validation errors**



	Groups	Errors
<input checked="" type="checkbox"/> Invalid edges	0	0
<input checked="" type="checkbox"/> Disconnected trisolations	0	0
<input checked="" type="checkbox"/> Intersecting triangles	0	0
<input checked="" type="checkbox"/> Reversed triangles	0	0
<input checked="" type="checkbox"/> Holes	0	0

 **Note:** To see all of the steps performed in this task, run `_07c_solids_repair_multi_step.tcl`. You need to click **Apply** on any forms presented.

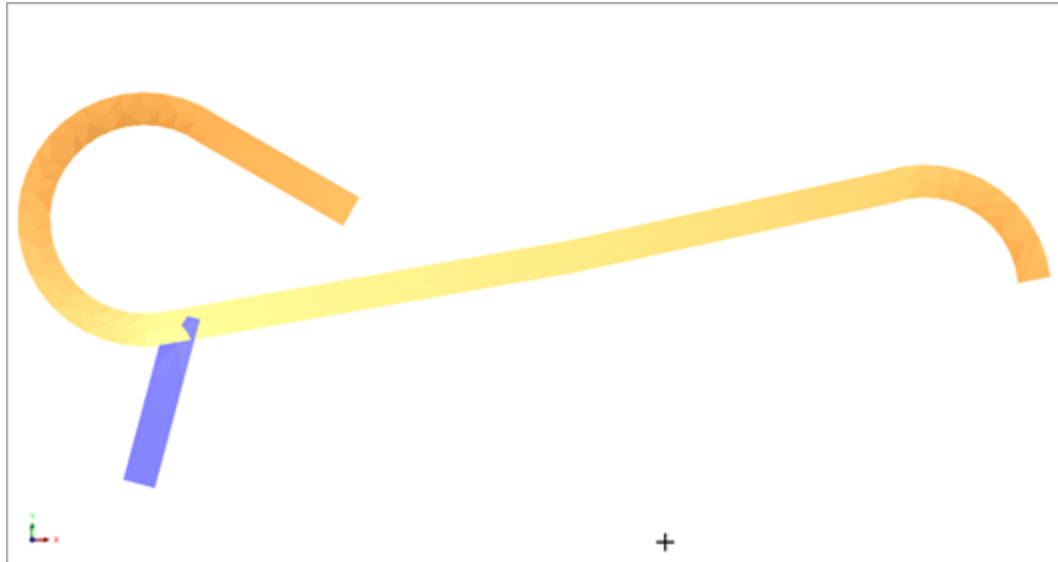
## Intersecting solids and DTM surfaces

### Intersecting solids

#### Task: Perform solids union


1. Click **Reset graphics** .
2. Open **decline1.dtm** in **Graphics**.
3. Open **crosscut1.dtm** in **Graphics**.
4. Click **Zoom all** .

The solids are displayed.



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

3dm/3dm union results storage	
Graphics layer name	union_example
Object number	1
Additional object number	2
<input type="button" value="Apply"/> <input type="button" value="Cancel"/>	

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

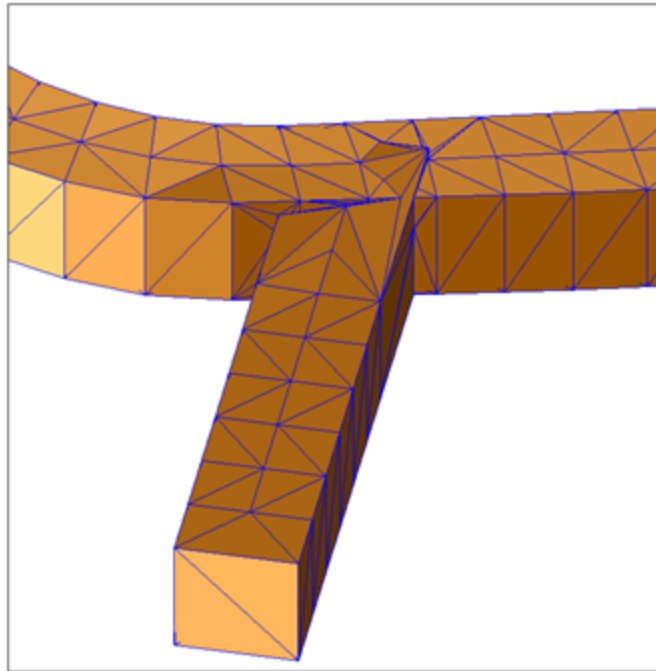
7. Follow the prompts and click each of the solids.

 **Note:**

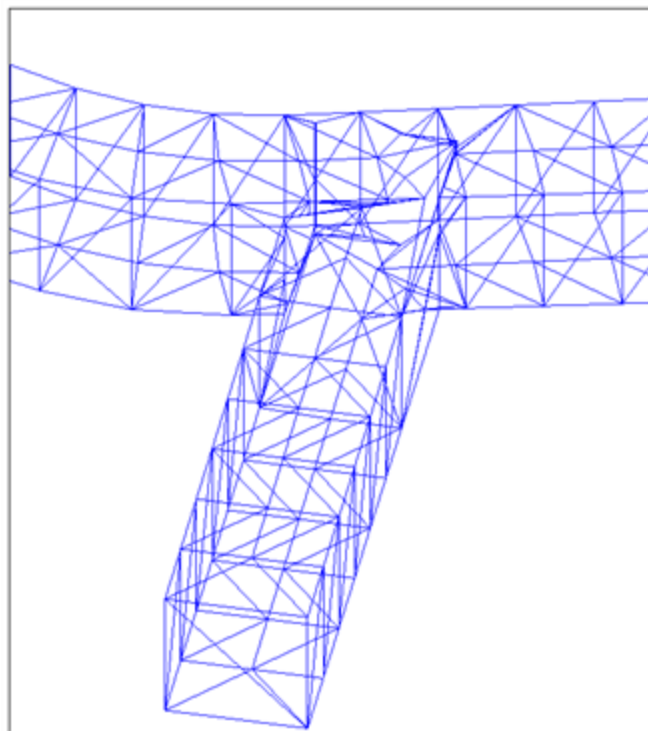
- The order you use to select the solids is not important. Surpac will union the solids in the same way regardless of the order they are selected.
- After the solids are unioned, the previous objects are erased from **Graphics**, and the active layer is the layer you specified, with the unioned solid displayed.
- The solid is not saved in the layer until you use the save function.


8. Choose **View > Surface view options > Hide triangle edges**.
9. The triangle edges are displayed, more effectively displaying the union.

10. Zoom in to the area of contact, and confirm the result of the union.  
The union of the drives is displayed.



11. Choose **View > Surface view options > Hide triangle faces**.  
The union triangles are displayed and you can see the way that the underlying strings have been changed.

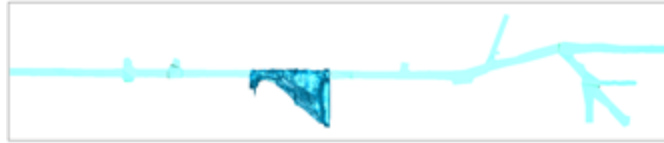


 **Note:** To see all of the steps performed in this task, run `_08a_solids_union.tcl`. You need to click **Apply** on any forms presented.

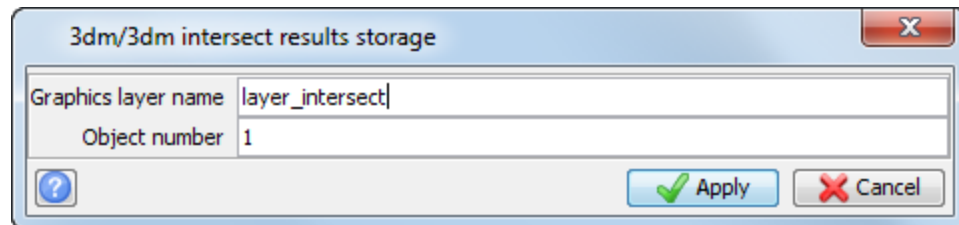
### Task: Perform intersection of solids





1. Click **Reset graphics** .
2. Open **lev1.dtm** in **Graphics**.
3. Open **stope1.dtm** in **Graphics**.
4. Click **Zoom all** .


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 click **Apply**.




3dm/3dm intersect results storage		
Graphics layer name	layer_intersect	
Object number	1	
		



7. Follow the prompts and click each of the solids in turn.
-  **Note:** The order in which you select the solids is not important.

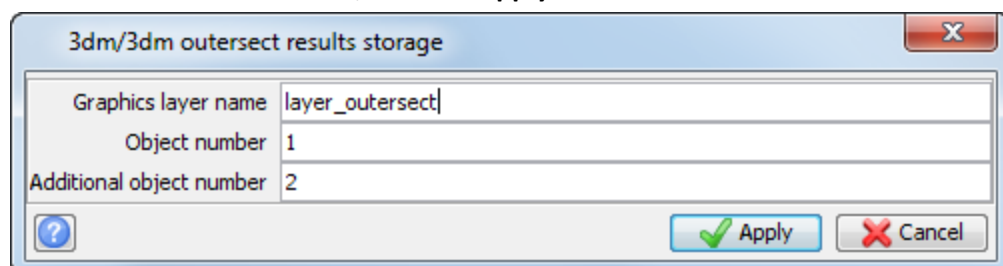
The active layer is now the layer you specified with the intersected solid displayed. The result is the area of the decline that fell within the stope.







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

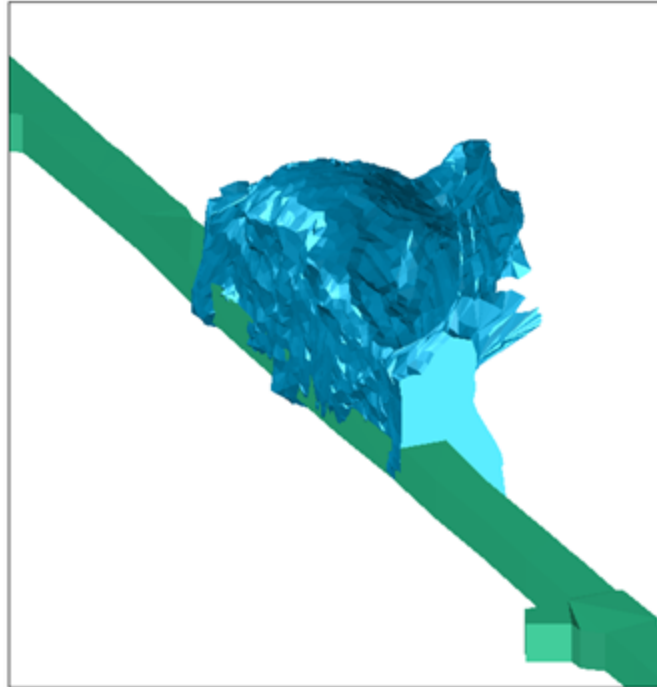
### Task: Perform outersection of solids

1. Click **Reset graphics** .
2. Open **lev1.dtm** in **Graphics**.
3. Open **stope1.dtm** in **Graphics**.
4. Click **Zoom all** .
5. Choose **Solids > Solids tools > Outersect solids**.
6. Enter the information as shown, and click **Apply**.



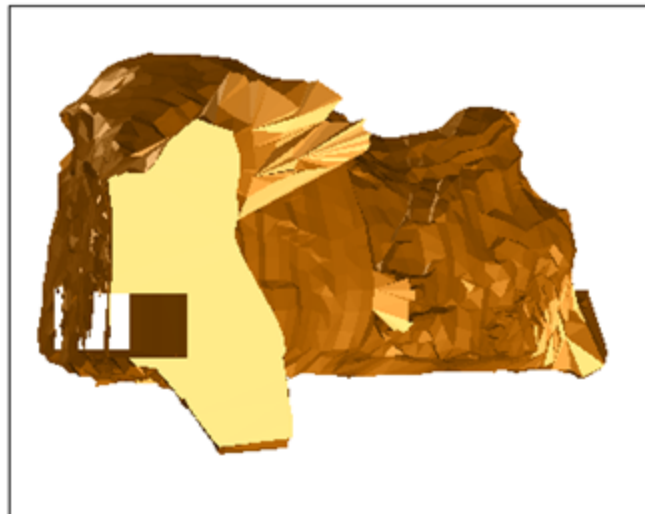
3dm/3dm outersect results storage		
Graphics layer name	layer_outersect	
Object number	1	
Additional object number	2	
		


7. Follow the prompts and click 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 (that is, that one that will cut into the outersected solid) is selected second.

The active layer is now 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.

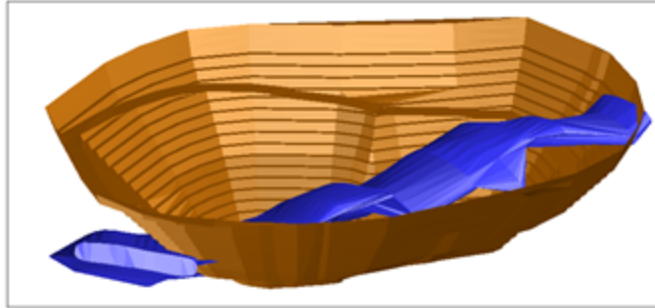


 **Note:** To see all of the steps performed in this task, run `_08c_solids_outersection.tcl`. You need to click **Apply** on any forms presented.

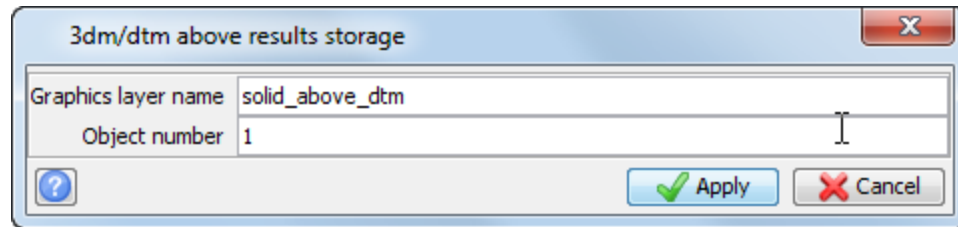
#### Task: Clip a solid above a DTM

1. Click **Reset graphics** .
2. Open `pit4.dtm` in **Graphics**.
3. Open `ore4.dtm` in **Graphics**.

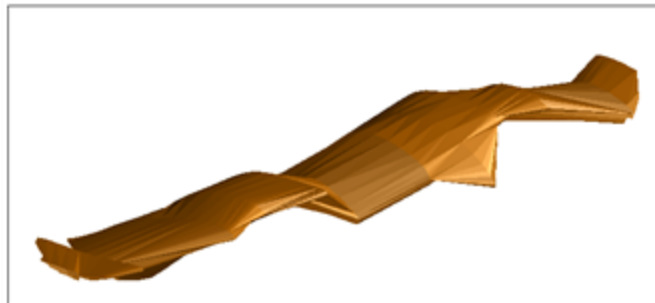
The ore body is displayed.



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




6. Click the ore solid and then click the pit.  
The section of the ore body that is above the pit is displayed.



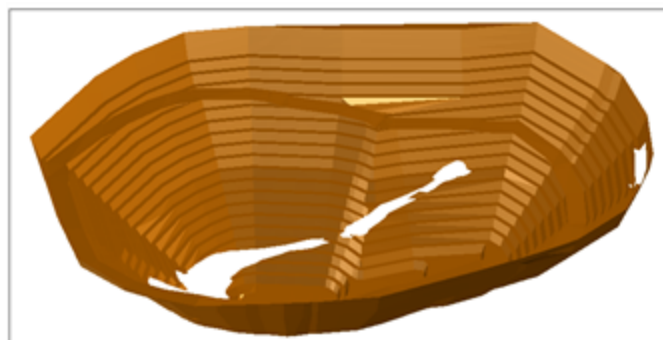
- To save the result, choose **File > Save > string/DTM**.

**Note:** To see all of the steps performed in this task, run `_08d_solid_above_dtm.tcl`. You need to click **Apply** on any forms presented.

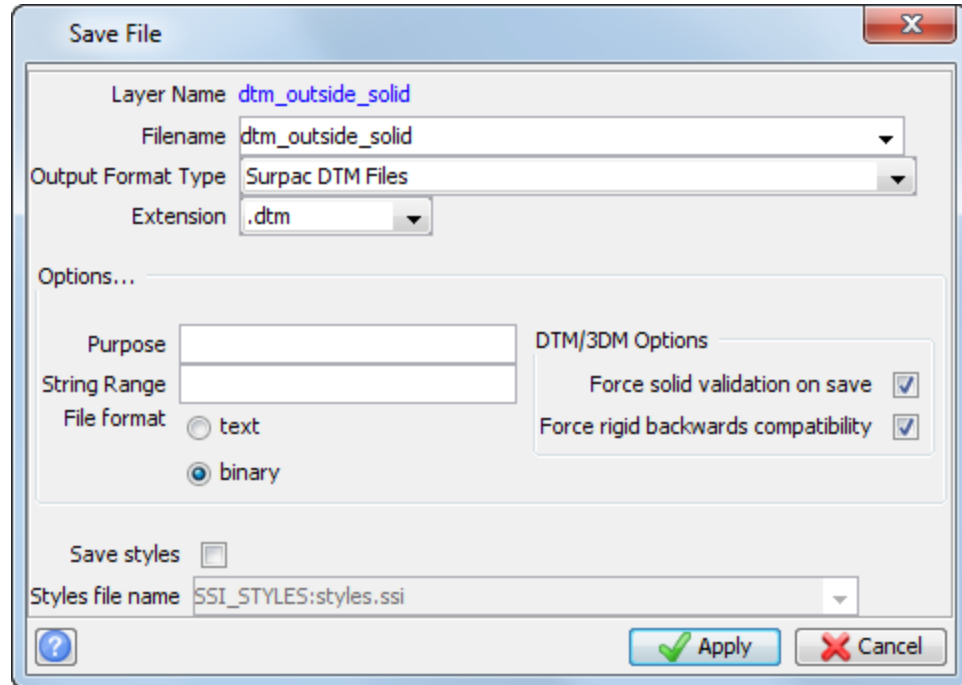
#### Task: Clip a DTM outside a solid

- Click **Reset graphics** .
- Open **pit4.dtm** in **Graphics**.
- Open **ore4.dtm** in **Graphics**.
- Choose **Solids > Solids tools > Clip DTM outside a solid**.
- Enter the information as shown, and click **Apply**.

- Click the orebody, and then click the pit.  
The active layer is now the layer you specified, and the pit cut by the ore body displayed.




- To save the result, choose **File > Save > string/DTM**.



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

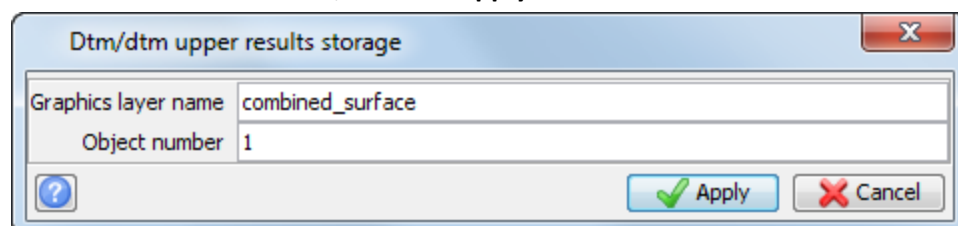
## Intersecting DTM surfaces

### Task: Perform upper triangles intersection of two DTMs

- Click **Reset graphics** .
- Open **topo2.dtm** in **Graphics**.
- Open **dump1.dtm** in **Graphics**.

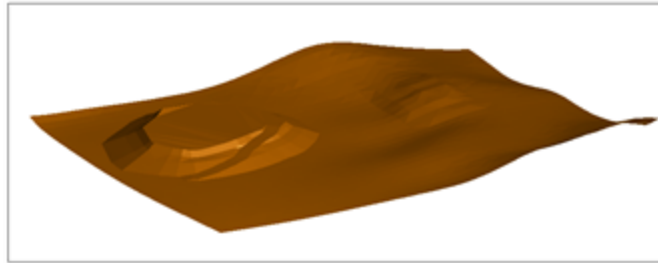



- Choose **Surfaces > Clip or intersect DTMs > Upper triangles of 2 DTMs**.
- Enter the information as shown, and click **Apply**.




- Follow the prompts and click on each DTM.  
**Note:** The order in which you select the DTMs is not important.

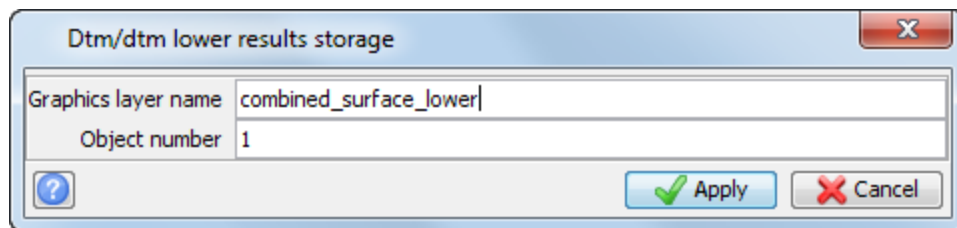
The active layer is the layer you specified, with the DTM displayed. The result is the waste stockpile surface incorporated into the topographic surface.




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

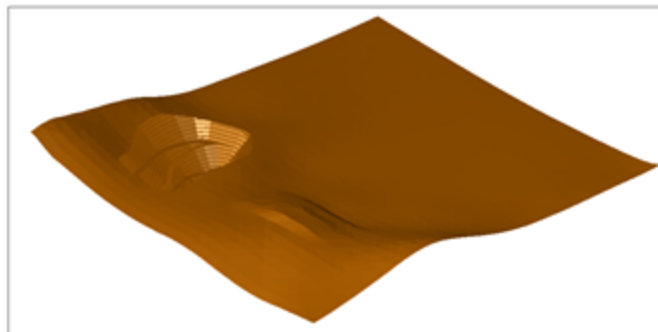
### Task: Perform lower triangles intersection of two DTMs


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



6. Follow the prompts and click on each DTM.
-  **Note:** The order in which you select the DTMs is not important.

The pit below the topography is displayed.



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

### Task: Create a solid by intersecting two DTMs

1. Click **Reset graphics** .
2. Open `topo2.dtm` in **Graphics**.
3. Open `pit2.dtm` in **Graphics**.
4. Choose **Surfaces > Clip or intersect DTMs > Create solid by intersecting 2 DTMs**.

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

Dtm/dtm intersect results storage

Graphics layer name: solid\_intersection

Object number: 1

Apply Cancel

6. Follow the prompts and click the upper DTM, and then the lower DTM.

**Note:** The upper DTM (topography) must be selected first.

The active layer is 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 click **Apply**.

Save File

Layer Name: solid\_intersection

Filename: pit\_below\_topo\_solid

Output Format Type: Surpac DTM Files

Extension: .dtm

Options...

Purpose: [ ]

String Range: [ ]

File format:  text  binary

DTM/3DM Options

Force solid validation on save

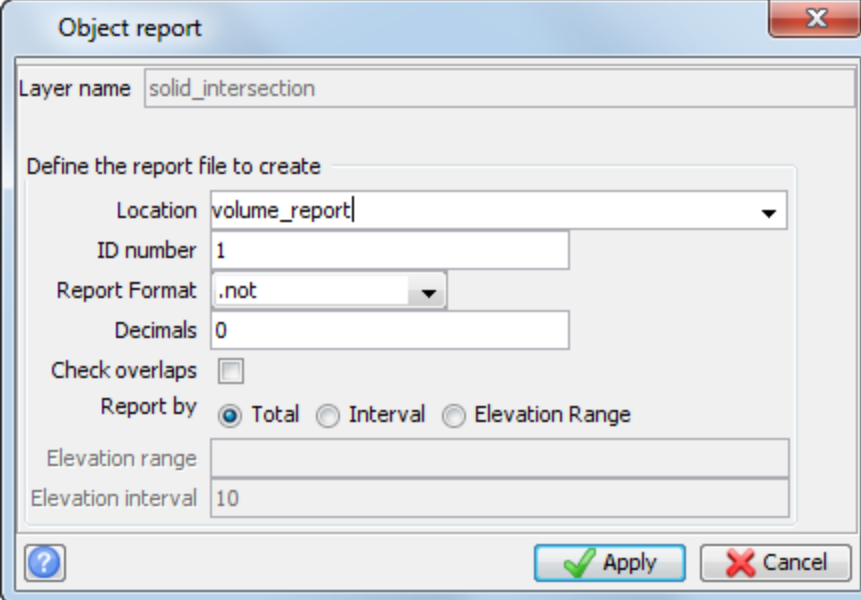
Force rigid backwards compatibility

Save styles

Styles file name: SSI\_STYLES:styles.ssi

Apply Cancel

9. To determine the volume of the pit below the topography, choose **Solids > Solids tools > Report volume of solids**.
10. Enter the information as shown, and click **Apply**.




The solid modelling object report is displayed.

```
SOLID MODELLING OBJECT REPORT
Layer Name: solid_intersection


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

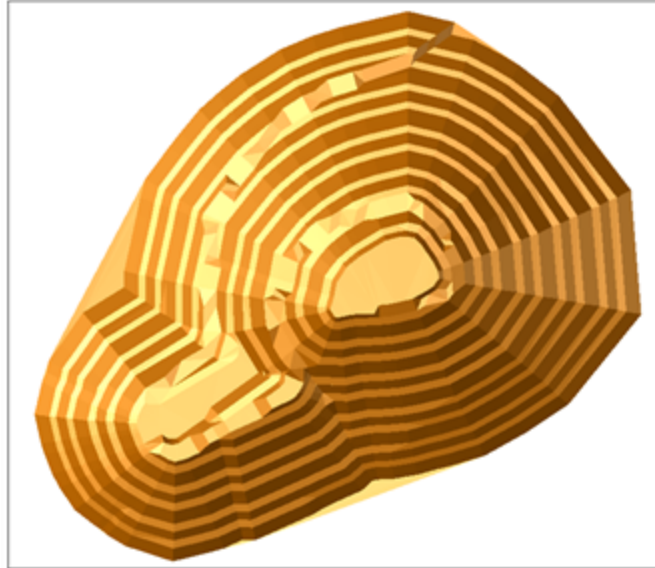
Trisolation Extents
X Minimum: 430420.150 X Maximum: 430811.370
Y Minimum: 25353.422 Y Maximum: 25884.625
Z Minimum: -38.634 Z Maximum: 120.170
Surface area: 374888
Volume : 7878905
```

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

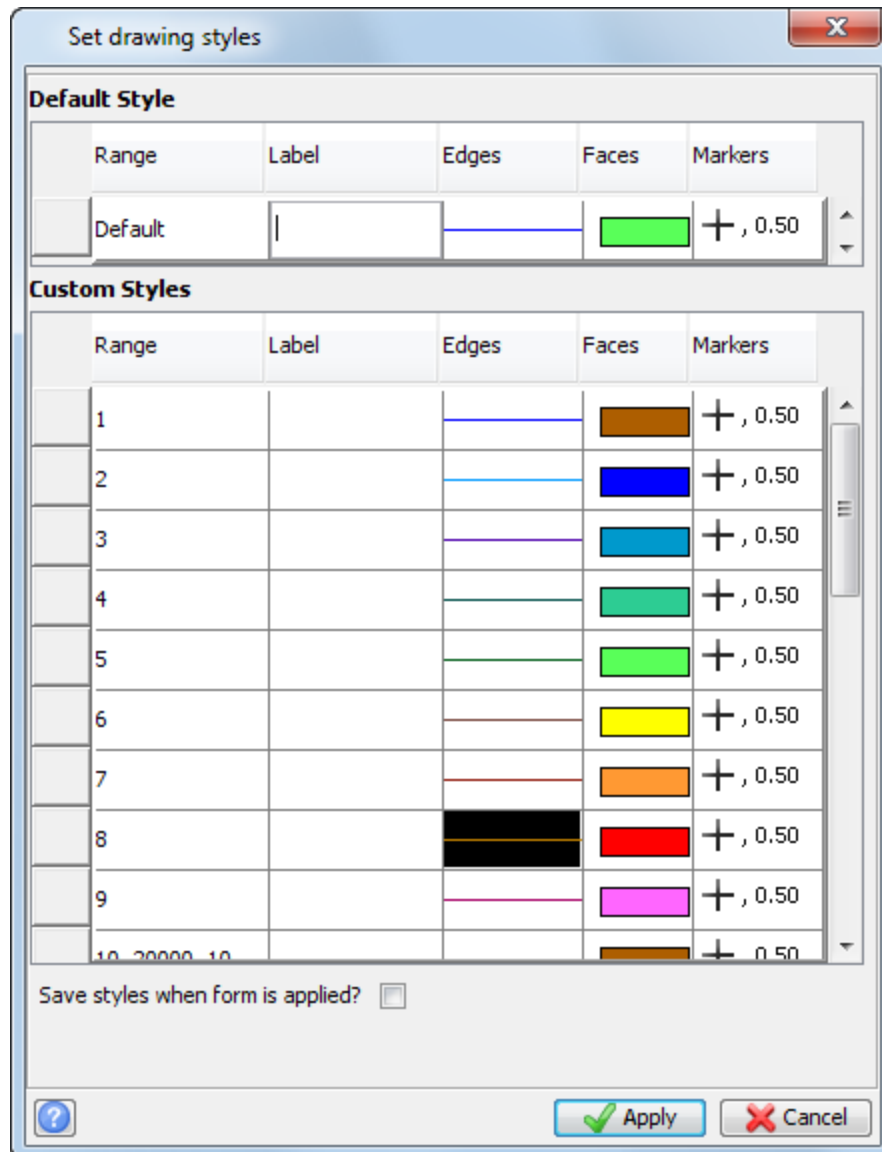
## Viewing solids

### Task: Change solid display properties

1. Click **Reset graphics** .
2. Open **pit1.dtm** in **Graphics**.  
The pit is displayed.

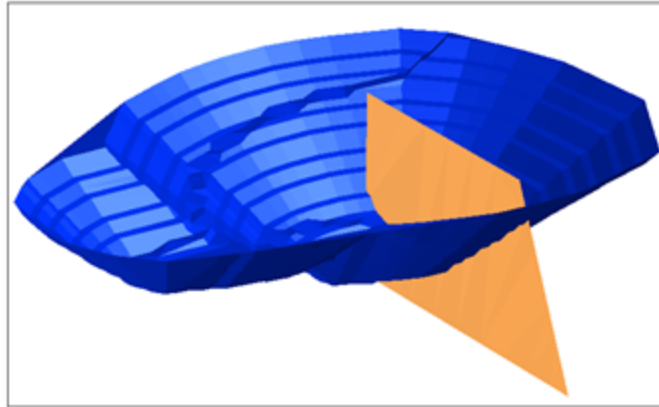


- Choose **Customise > Display properties > DTM's and 3DM's**.



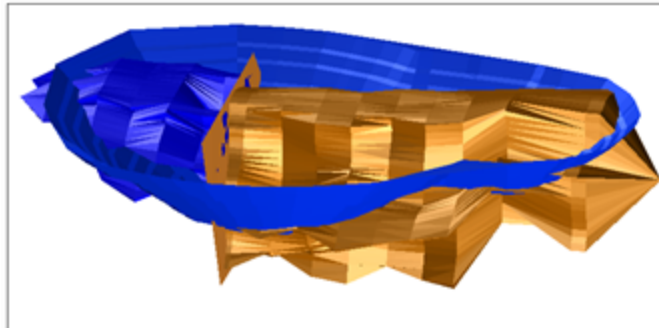
- Click **Faces** for Object 1, and then click **Properties**.
- Choose a blue colour, and click **Apply**.
- Open **fault1.dtm** in **Graphics**.
- Choose **Customise > Display properties > DTMs and 3DMs**.
- Click **Faces** for object 10, and then click **Properties**.
- Choose an orange colour, and click **Apply**.

The pit and fault line are displayed.



The changes are reflected in the active layer; the pit remains the same colour.

10. Open **mod12.dtm** in **Graphics**.  
The solid, the pit, and the fault are displayed.



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

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

Surface or solid colour banding

Draw Shells

Display Properties

Layer name mod12.dtm

Object Range

Trisol Range

Triangle Range

Field to colour by Z

Banding Type

none

bands of specified size

set number of bands

range for bands

using algebraic expressions

Set colour range

Size of bands 50

Band Range 800; 1100

Starting colour Blue

Ending colour Red

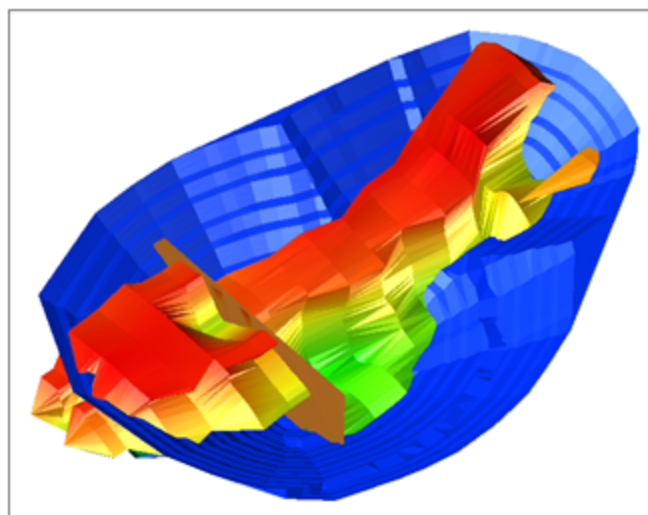
Number of colours 5

Reset colour range

Colour	
1	blue
2	green
3	yellow
4	red
5	
6	
7	

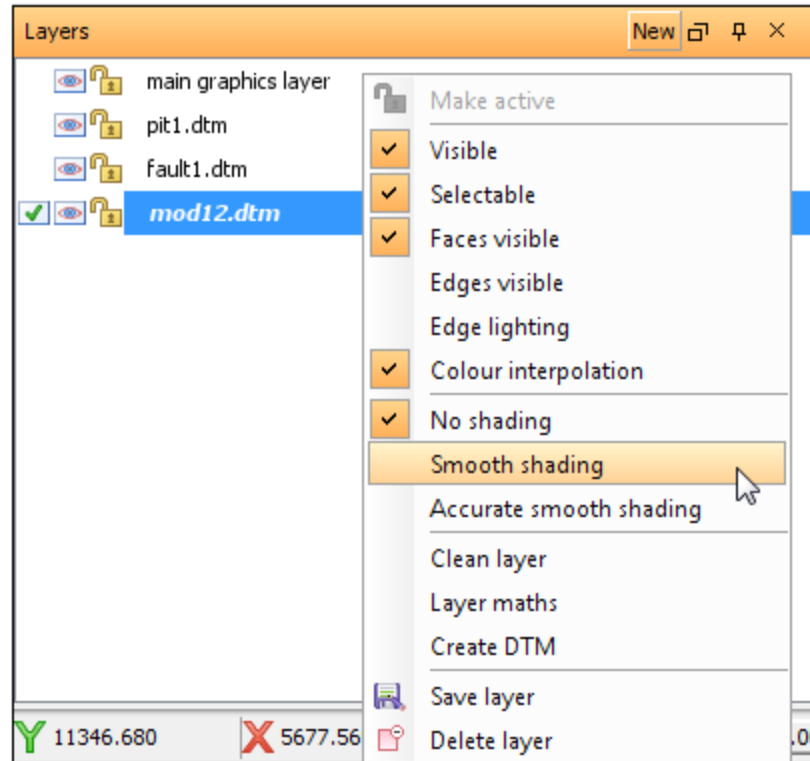
Apply Cancel

The solid with sharp colour banding is displayed.

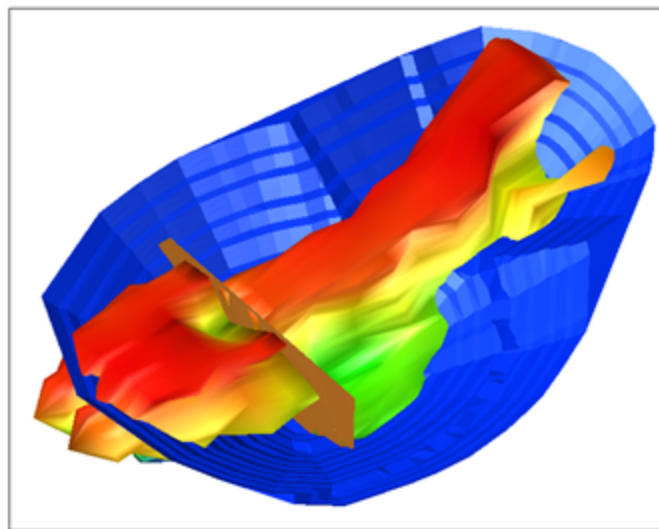


Next you will display the solid with smooth contours.

13. Right-click on the file **mod12.dtm** in the **Layers** pane.



14. Select **Smooth shading**.  
The solid with smooth colour banding is displayed.

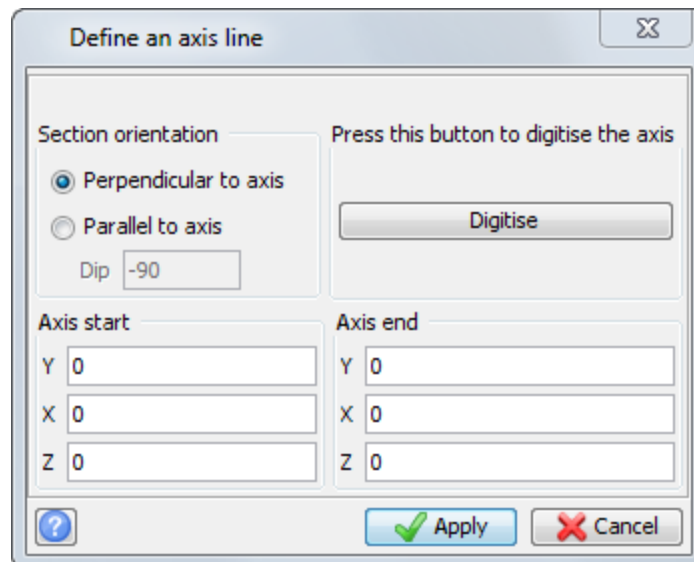


**Note:** To see all of the steps performed in this task, run `_09_view_solid_model.tcl`. You need to click **Apply** on any forms presented.

## Creating sections

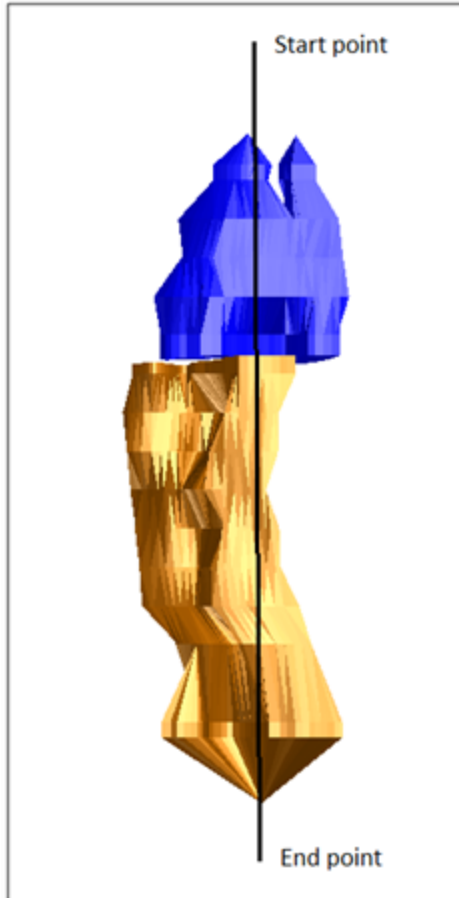
### Task: Create sections using the interactive method

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



4. Click **Digitise** to use your mouse for defining the axis.
5. Click a start point below the bottom centre of the ore body and drag the pointer vertically to the end point of the axis line above the solid.

The solid with a centreline is displayed.



**Note:** When you create the axis, the *Define and axis line form* is displayed with the real world coordinates of your axis line. You can adjust the coordinates manually using the digitised axis start and end points as a guide. In this case, the Eastings and elevations for the axis line are kept the same to produce slices that are oriented as Northings.

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

**Define an axis line** ✕

---

Section orientation

Perpendicular to axis

Parallel to axis

Dip

Press this button to digitise the axis

Axis start

Y

X

Z

Axis end

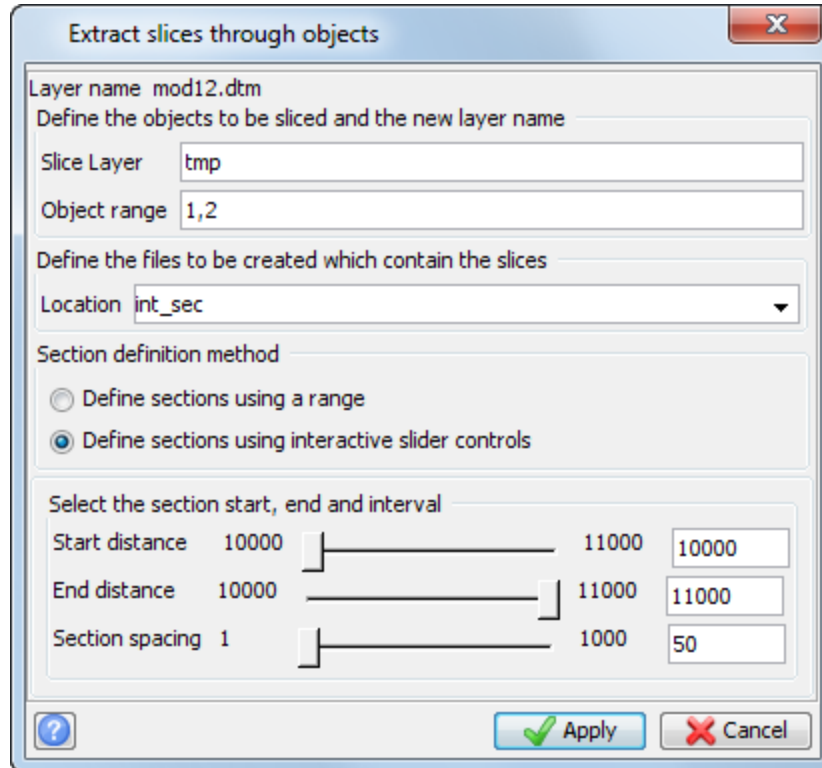
Y

X

Z

?

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



Extract slices through objects

Layer name mod12.dtm

Define the objects to be sliced and the new layer name

Slice Layer tmp

Object range 1,2

Define the files to be created which contain the slices

Location int\_sec

Section definition method

Define sections using a range

Define sections using interactive slider controls


Select the section start, end and interval

Start distance 10000 11000 10000

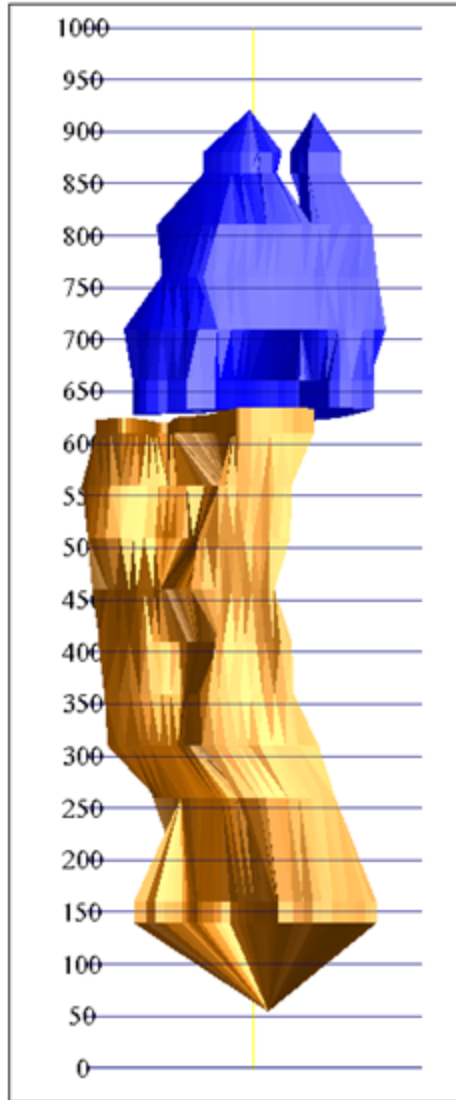
End distance 10000 11000 11000

Section spacing 1 1000 50

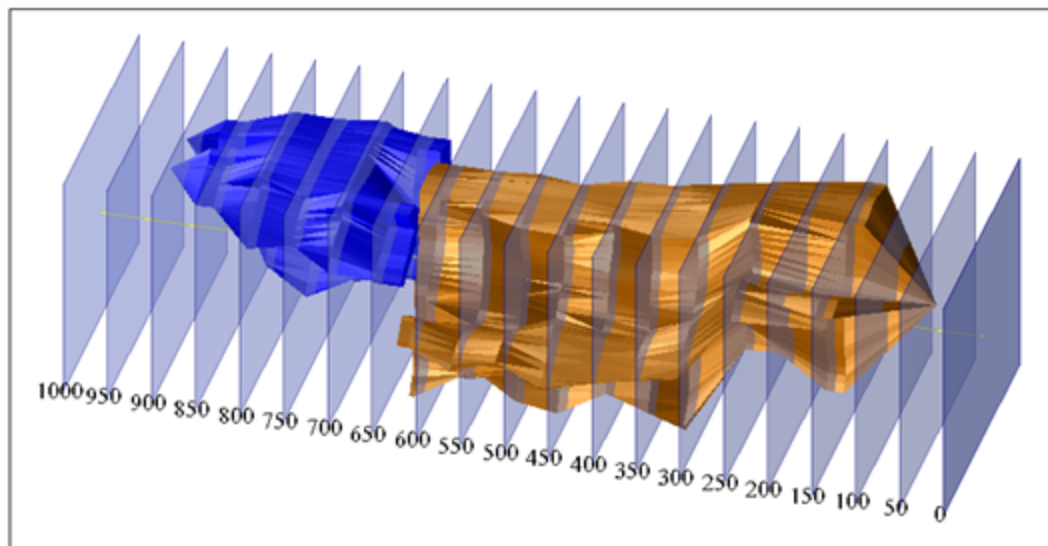
Apply Cancel


 **Note:** To display your slices in real time, click **Interactive slider controls**. The slide controls enable you to adjust the start and end points of your axis, and the distance between slices. Move the slide controls up and down to see the effect of your changes. When you click **Apply**, the slices are taken using the values in the boxes on the right side of the slider bar. You can also type the values into these boxes manually.

The solid object with slices is displayed.




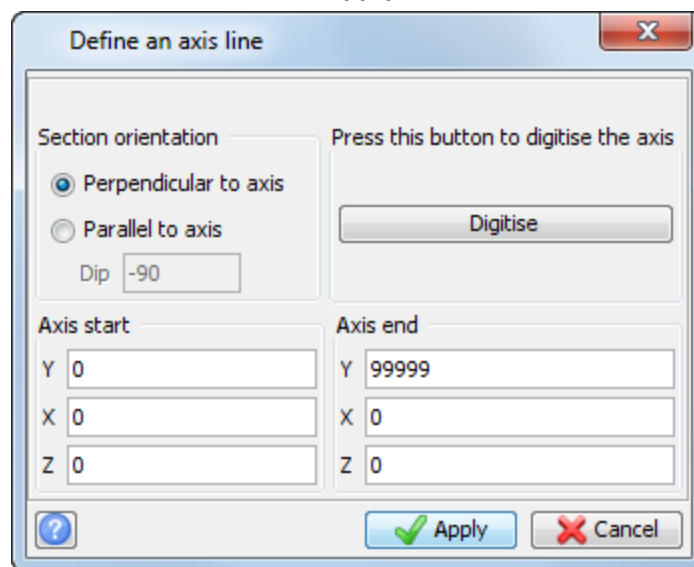
8. Click and drag the pointer to move the object in 3D space and view how the slices relate to the solid.



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

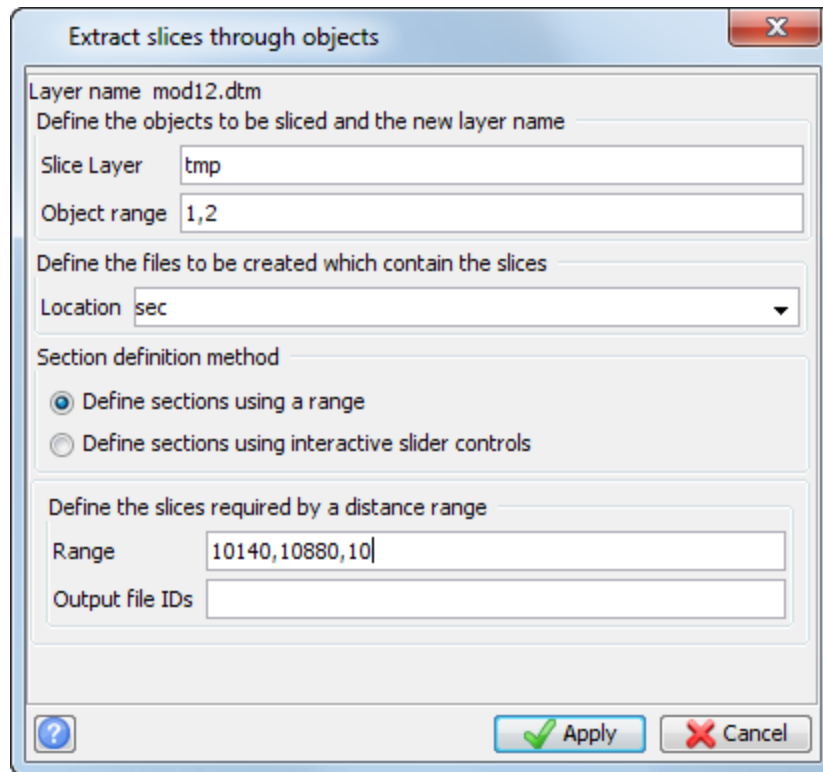
### Task: Create sections by range

1. Click **Reset graphics** .
2. Open `mod12.dtm` in **Graphics**.
3. To determine the Maximum and Minimum Y, X, and Z coordinates, choose **Inquire > Report layer extents**.  
The data shown in the window extends from 10055 North to 10920 North. You can slice the objects by defining a north-south axis.
4. Choose **Solids > Solids tools > Create sections**.  
For this task you will slice this model on Northings (Y). To do this you will define a vertical axis.
5. Enter the information as shown, and click **Apply**.

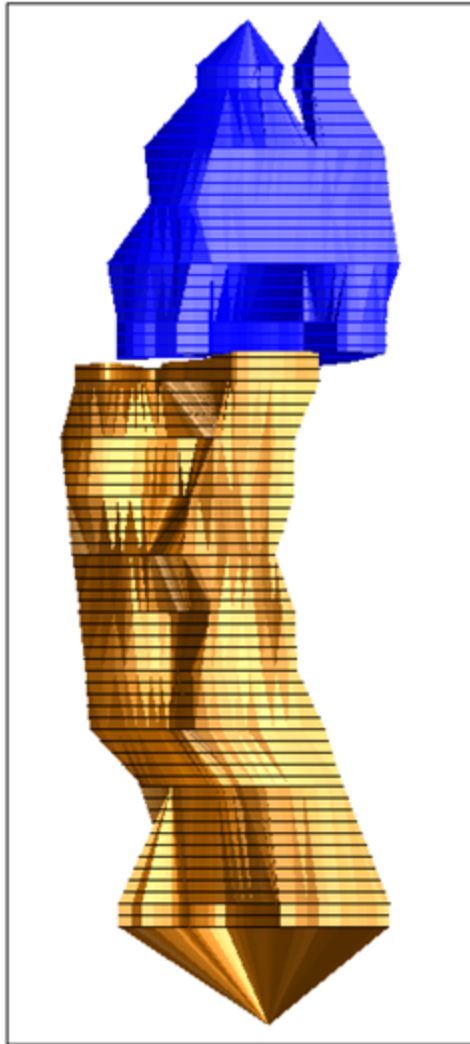



Define an axis line	
Section orientation	Press this button to digitise the axis
<input checked="" type="radio"/> Perpendicular to axis	<input type="button" value="Digitise"/>
<input type="radio"/> Parallel to axis	
Dip -90	
Axis start	Axis end
Y 0	Y 99999
X 0	X 0
Z 0	Z 0
<input <="" td="" type="button" value="?"/> <td><input type="button" value="Apply"/> <input type="button" value="Cancel"/></td>	<input type="button" value="Apply"/> <input type="button" value="Cancel"/>

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



The solid with sections is displayed.




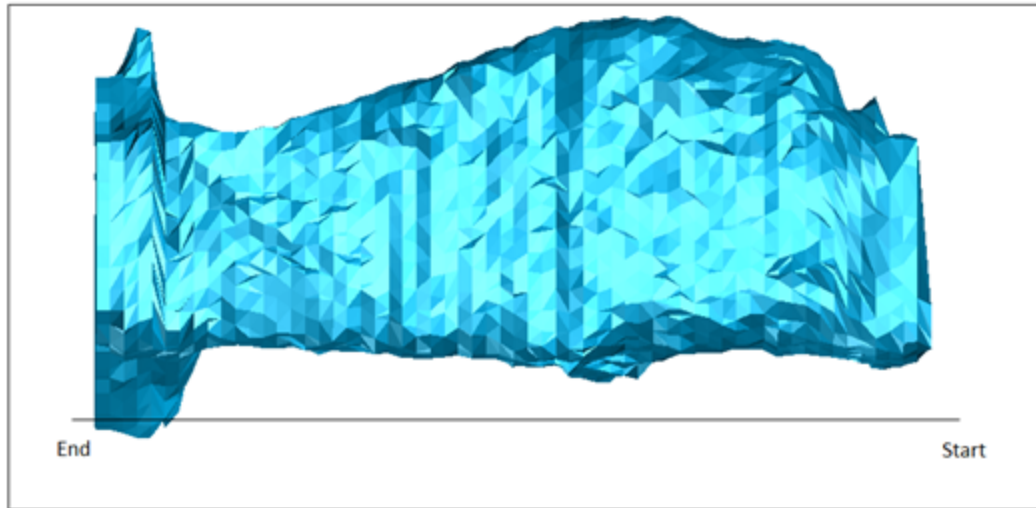
 **Note:** To see all of the steps performed in this task, run `_10b_slice_objects_by_range.tcl`. You need to click **Apply** on any forms presented.

### Task: Create sections using a centre line

1. Click **Reset graphics** .
2. Open `stope2.dtm` in **Graphics**.
3. Open `cl2.str` in **Graphics**.

When slicing a solid, the centre line string and the objects that are sliced can be in separate layers or in the same layer. To view the sections in **Graphics**, it is usually clearer if you use separate layers.

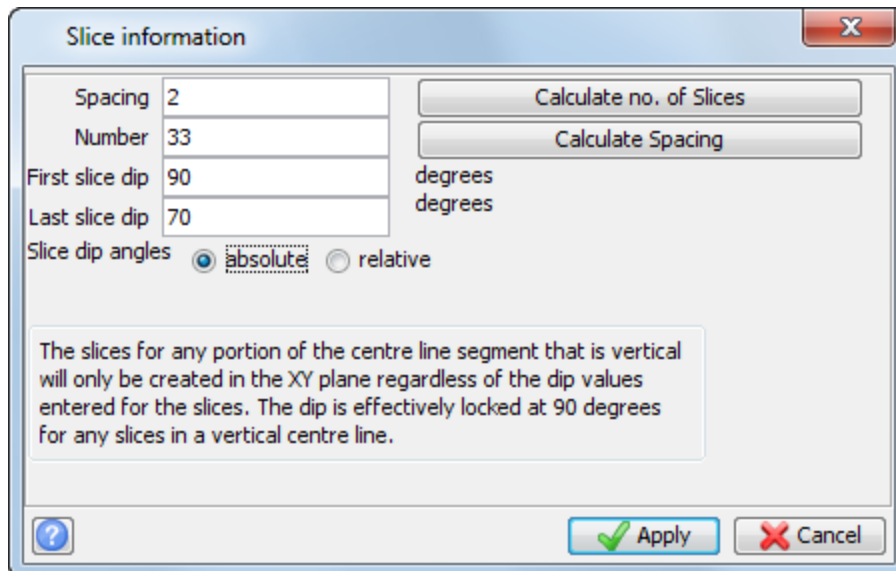
 **Note:** If the centre line string and the objects are in separate layers, the layer containing the solids must be the active layer.



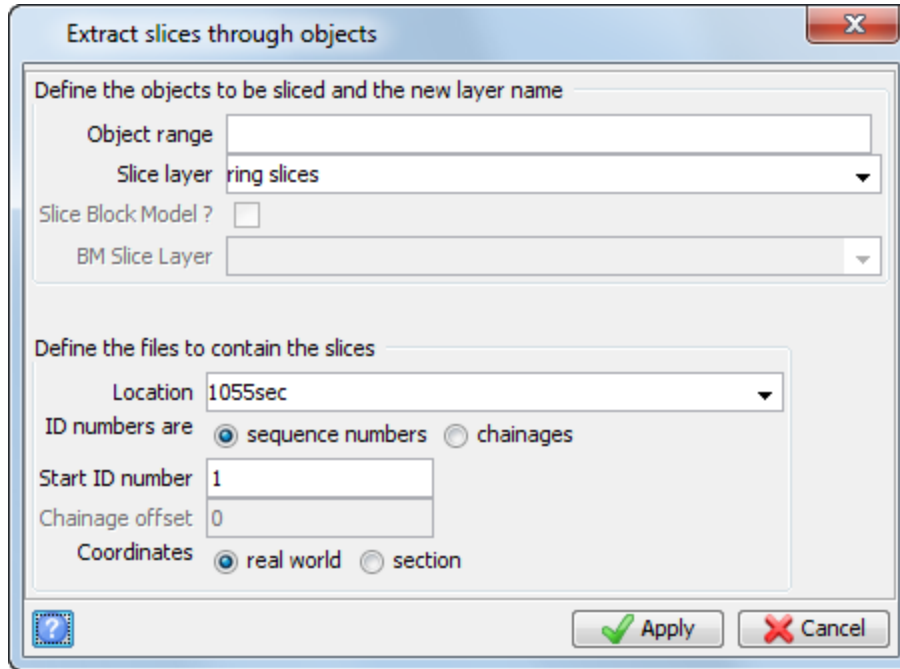
4. In the **Layers** pane, make **stope2.dtm** the active layer.



5. Choose **Solids > Solids tools > Section using centre line**.
6. Click the start and end points of your centre line, as shown on the previous image.
7. Enter the information as shown, and click **Apply**.



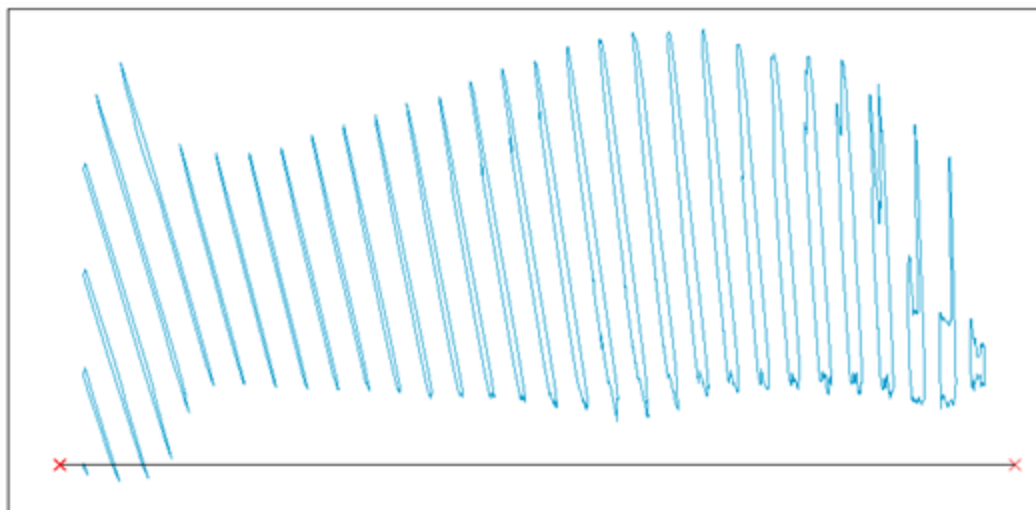
8. Enter the information as shown, and click **Apply**.



9. In the **Layers** pane, make **stope2.dtm** invisible.




The ring slice is displayed.

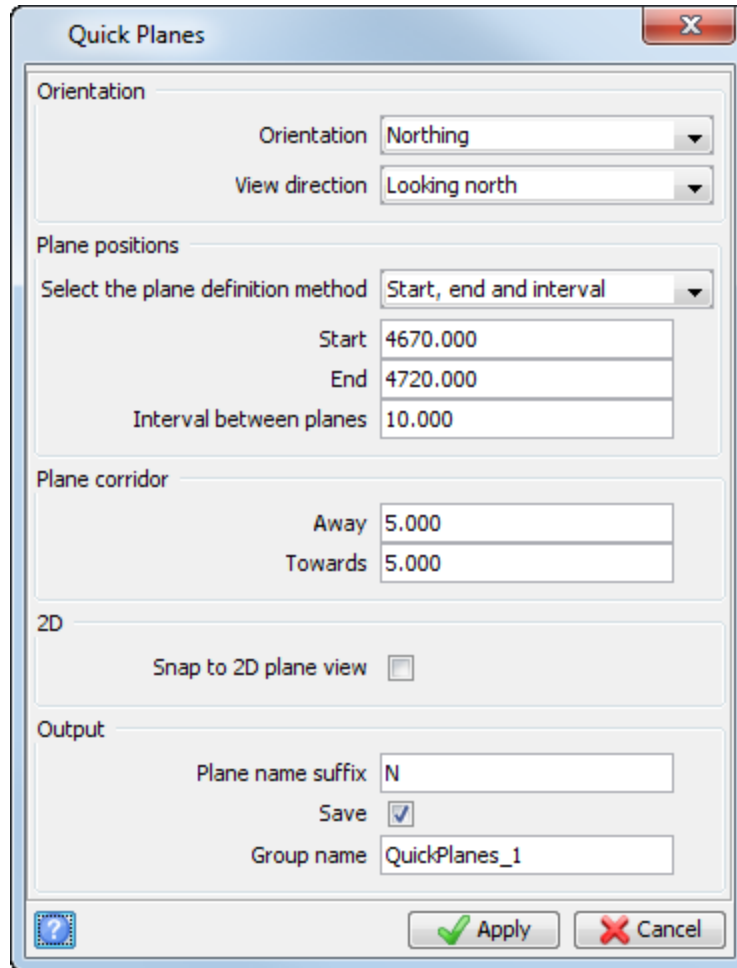


The slices start at 90 degrees and the last slice is at 70 degrees.

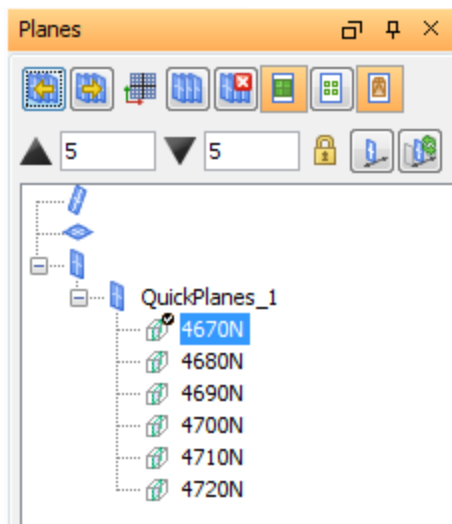
**Note:** To see all of the steps performed in this task, run `_10c_centre_line_slice.tcl`. You need to click **Apply** on any forms presented.

### Task: Create sections using quick planes

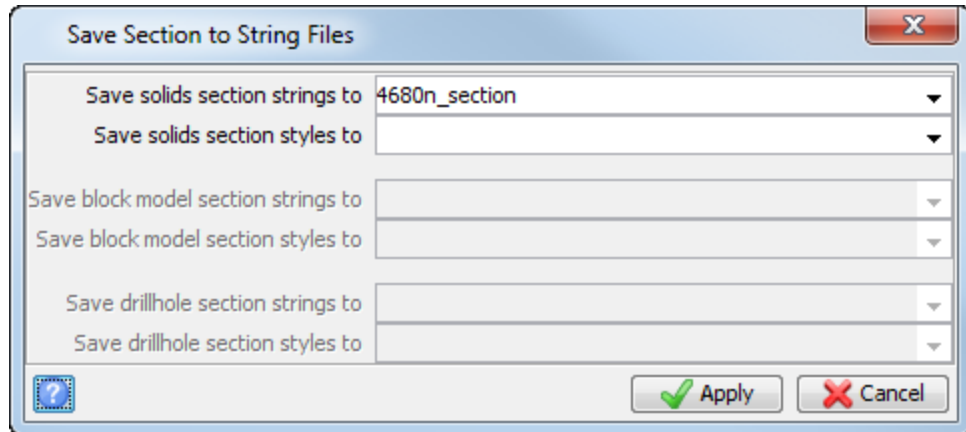
1. Click **Reset graphics** .
2. Open **stope2.dtm**.
3. Choose **Planes > Quick planes**.
4. Enter the information as shown, and click **Apply**.




5. Click the **Planes** tab, and click the **Toggle auto-hide** button to pin the **Planes** panel to the interface.
6. Expand the **QuickPlanes\_1** group.

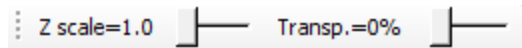


7. Press F12 to move to the next plane, and F11 to move to the previous plane.
8. Choose **Planes > Save section to string files**.
9. Enter the information as shown, and click **Apply**.

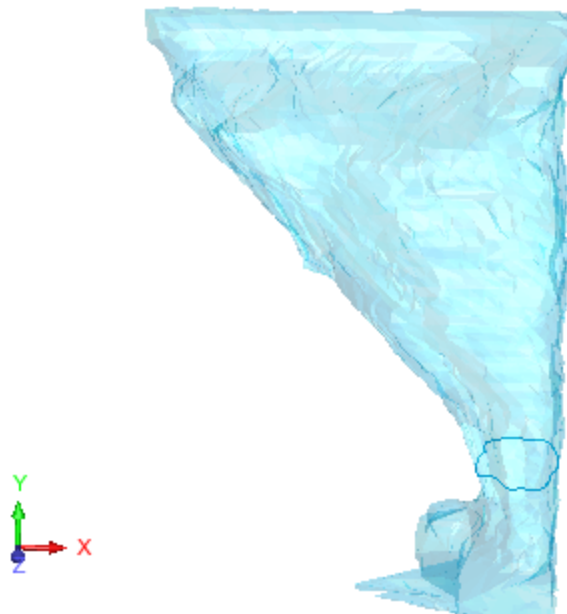



The plane cross sectional outline is saved to the string file specified.

10. Click **Reset graphics** .
11. Open **4680n\_section.str**.
12. Open **stope2.dtm**.
13. Right-click to the right of the toolbars and choose **Toolbars > Scale and transparency**. The **Z scale** and **Transp.** sliders appear under the current toolbars.



14. Set the **Transp.** slider to **80%**.
15. Rotate the data in **Graphics** so that you can see the string outline at plane 6480N on the DTM.

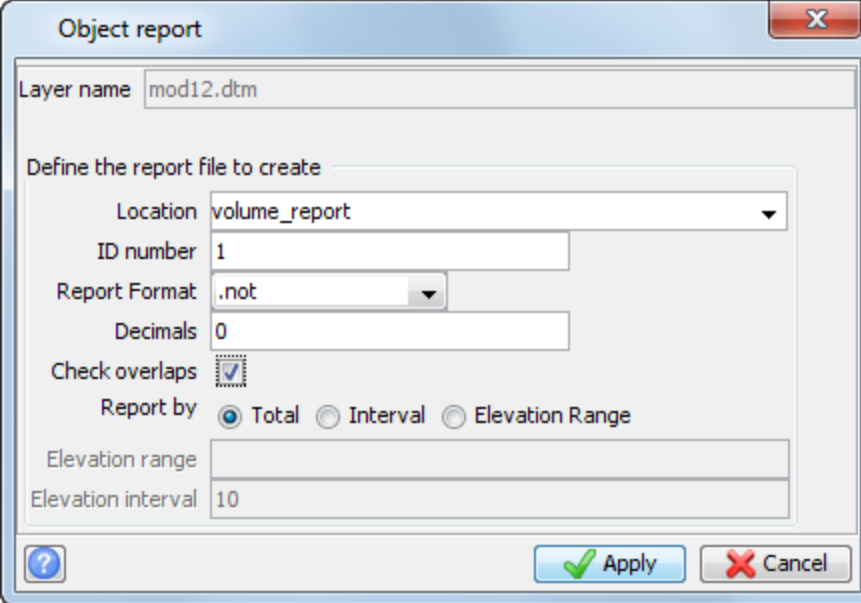


 **Note:** To see all of the steps performed in this task, run **\_10d\_section\_with\_quick\_planes.tcl**. You need to click **Apply** on any forms presented.

## Reporting volumes of solids

### Task: Report volume of a solid

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



The file **volume\_report1.not** is displayed.


```
SOLID MODELLING OBJECT REPORT
Layer Name: mod12.dtm

Object: 1
Trisolation: 1
This trisolation intersects with the Object 2, Trisolation 1
validated = false

Object: 2
Trisolation: 1
This trisolation intersects with the Object 1, Trisolation 1
validated = false


Totals
Surface area: 0
Volume : 0
```

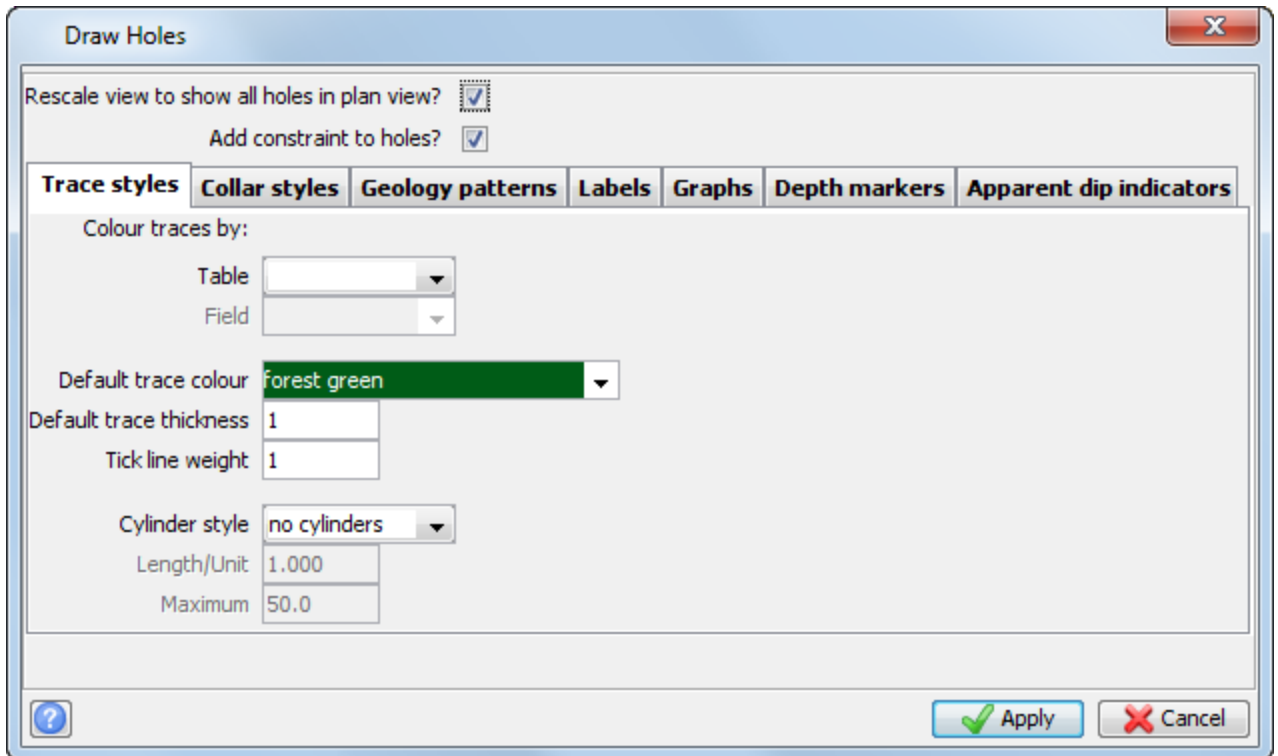
5. Close the report file.

 **Note:** To see all of the steps performed in this task, run **\_11\_solids\_volume\_report.tcl**. You need to click **Apply** on any forms presented.

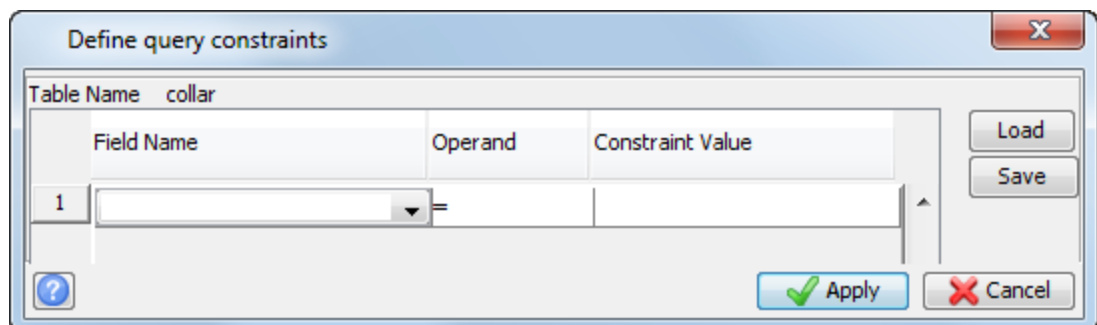
## Intersecting drill holes with solid models

### Task: Intersect drill holes with solid models

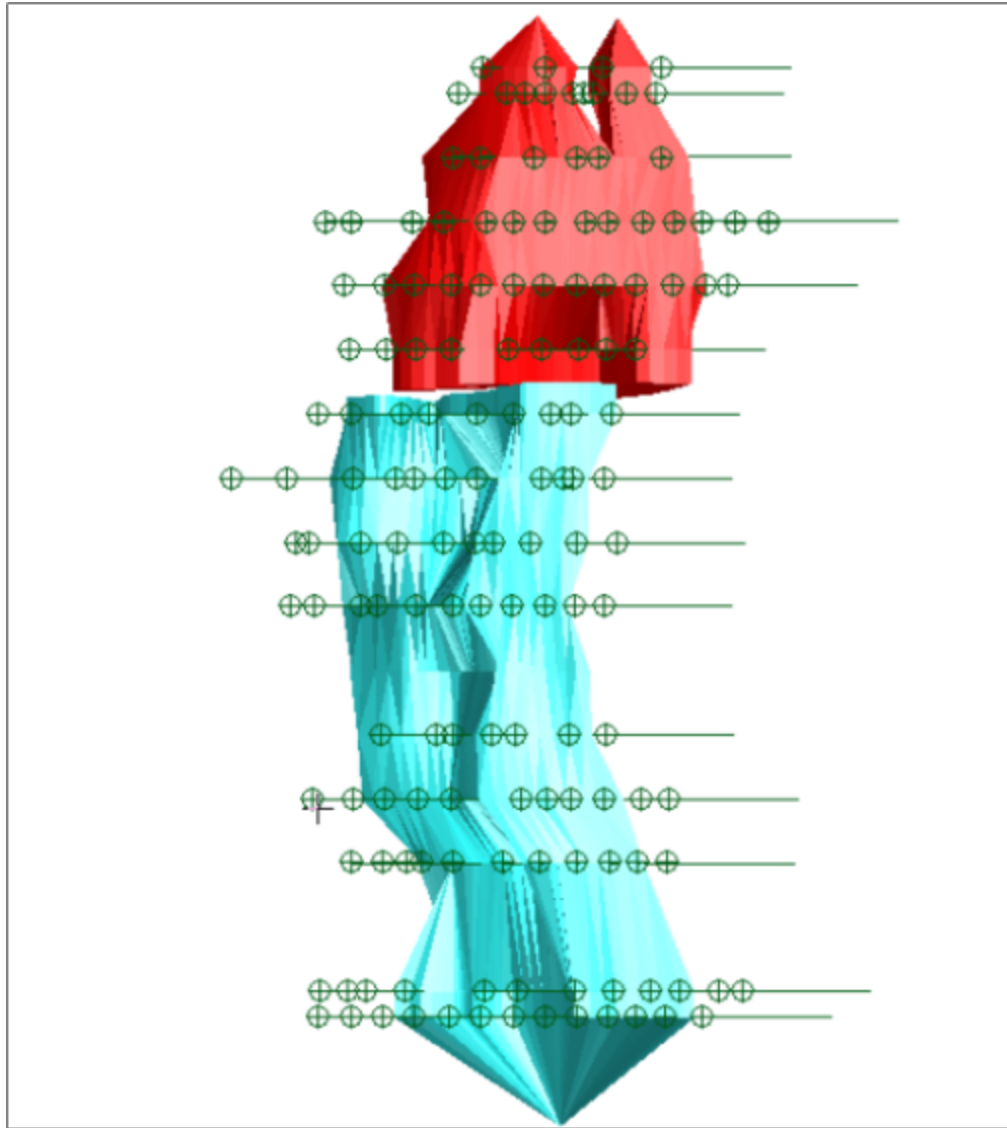
1. Click **Reset graphics** .
2. Open **mod12.dtm** in **Graphics**.
3. Open **solids.ddb**.
4. Choose **Database > Display > Drillholes**.
5. Accept the default values, and click **Apply**.



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

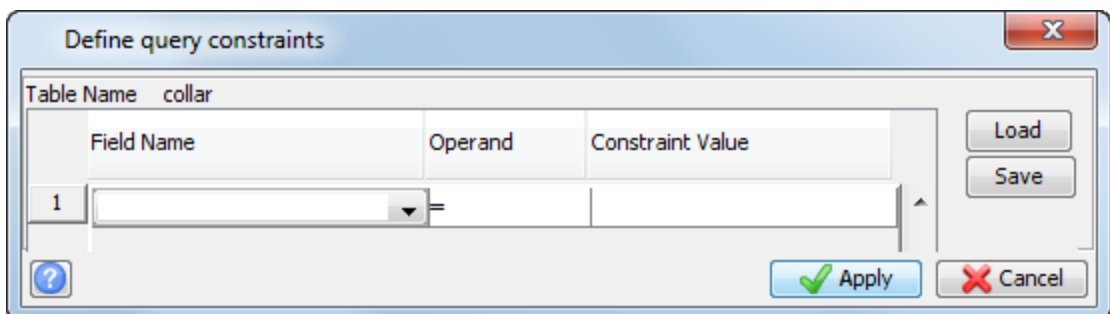


The solid with drillholes is displayed.

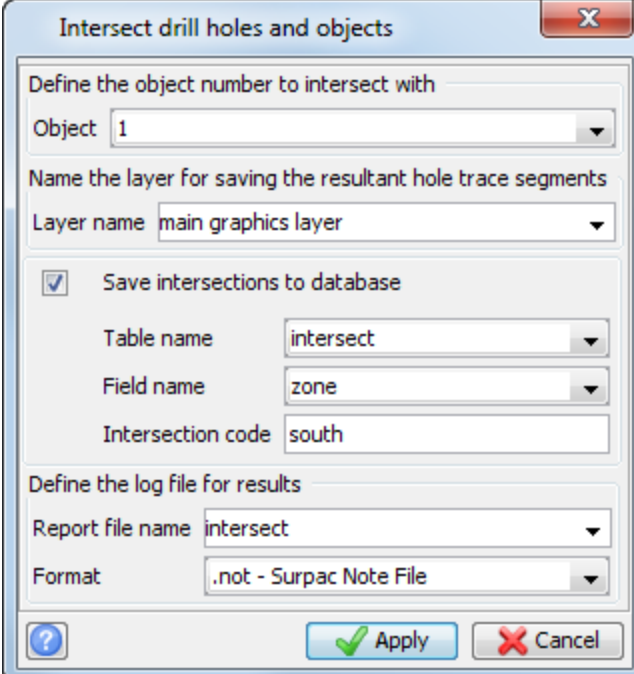


The database has an optional table called **Intersect**, where you will store the results of this processing.

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



9. Enter the information as shown, and 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, 2011				
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 click **Apply**.

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

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

	Field Name	Operand	Constraint Value
1		=	

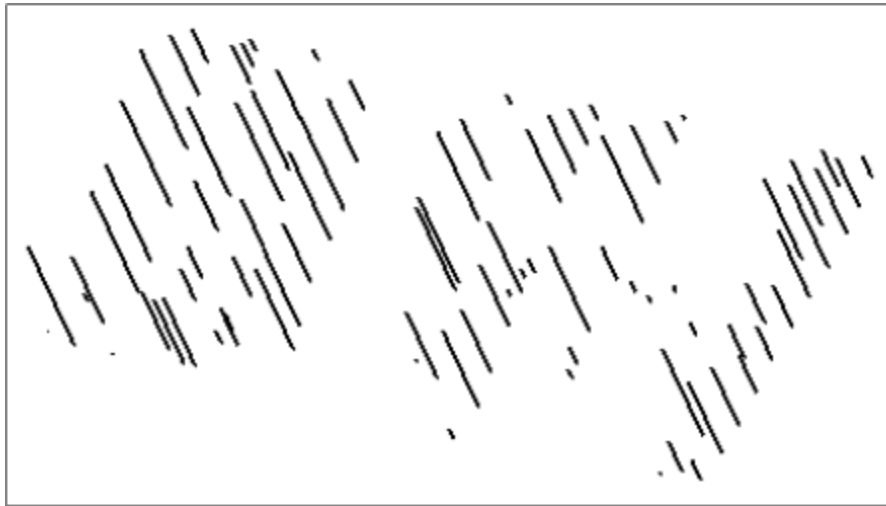
The intersections will be displayed.

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

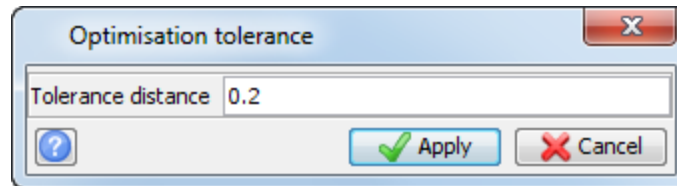


📌 **Note:** To see all of the steps performed in this task, run `_12_intersect_drillholes_solids.tcl`. You need to click **Apply** on any forms presented.

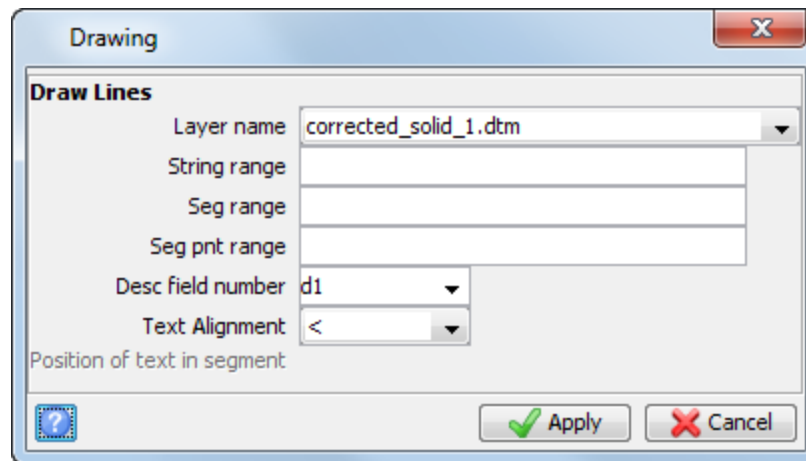
## Optimising trisolations

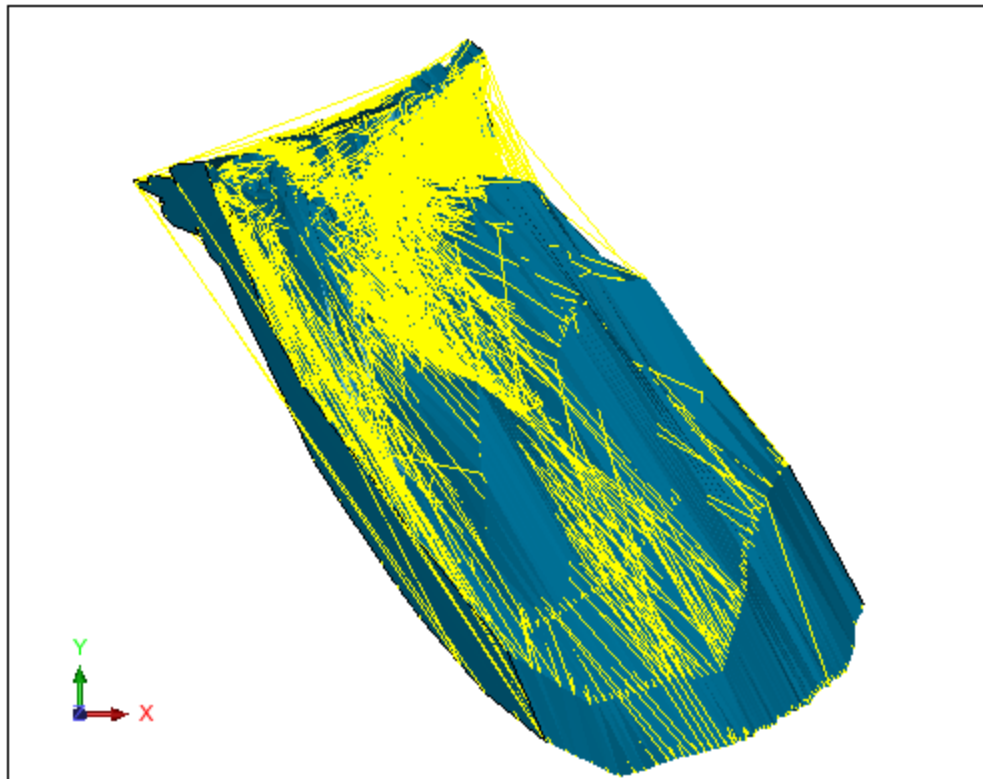
### Task: Optimise trisolations

1. Click **Reset graphics** .
2. Open **corrected\_solid\_1.dtm** in **Graphics**.
3. Choose **Solids > Edit trisolation > Optimise**.
4. Click anywhere on the object.
5. Enter the information as shown, and click **Apply**.

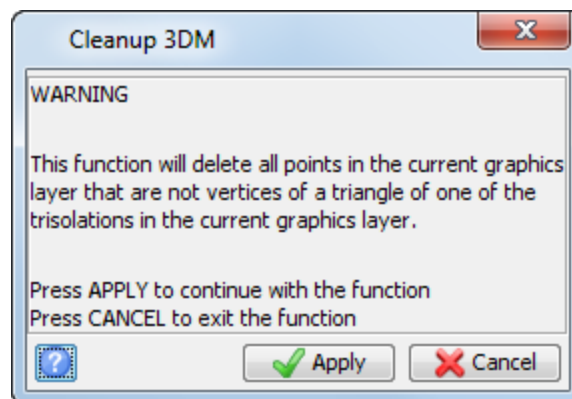


6. Choose **Display > Strings > As lines**.
7. Enter the information as shown, and click **Apply**.





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



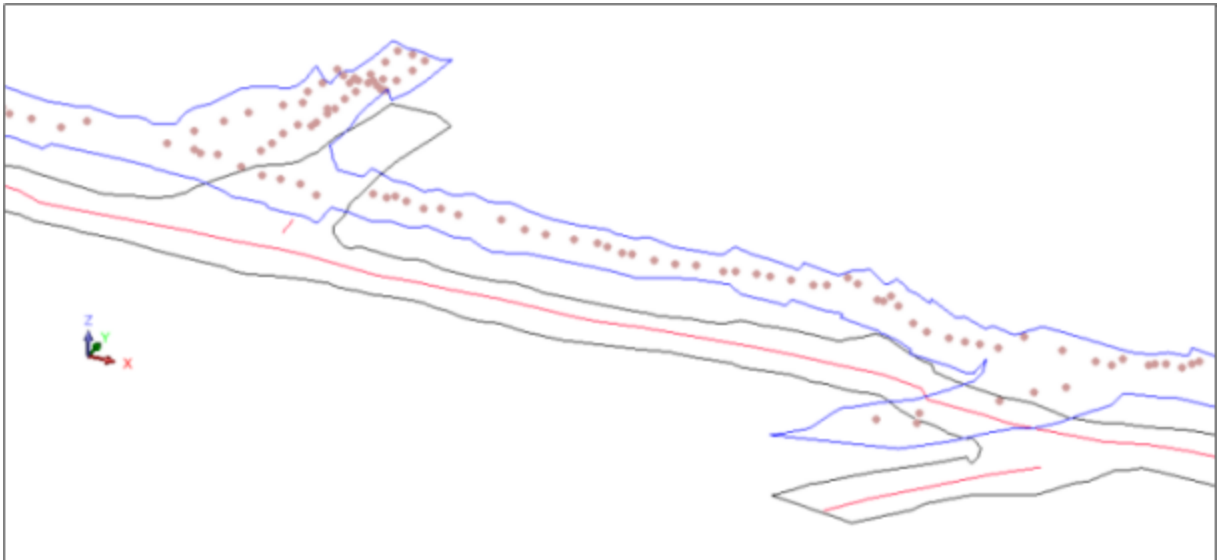
202, or 7.14%, of the points in the solid are deleted.

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

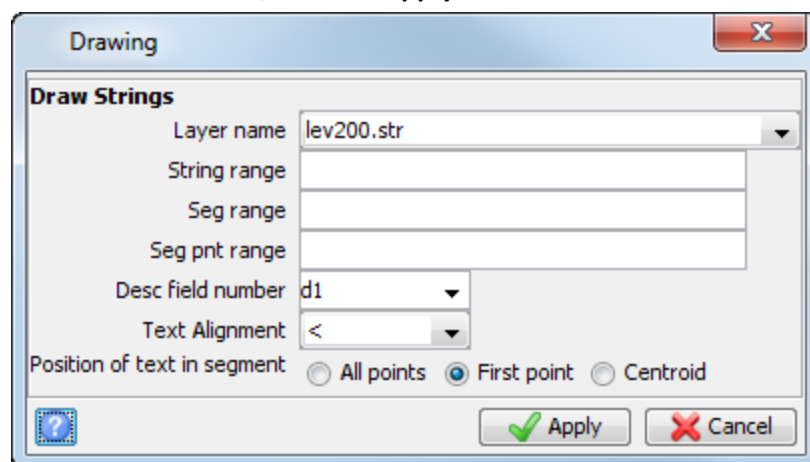
## Modelling underground data


### Task: Model underground data

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



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

Save File

Layer Name lev200.str

Filename back1

Output Format Type Surpac String Files

Extension .str

Options...

Purpose

String Range 2;30003

File format  text  binary

DTM/3DM Options

Force solid validation on save

Force rigid backwards compatibility

Save styles

Styles file name

Apply Cancel

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

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

Save File

Layer Name lev200.str

Filename floor1

Output Format Type Surpac String Files

Extension .str

Options...

Purpose

String Range 1;1001

File format  text  binary

DTM/3DM Options

Force solid validation on save

Force rigid backwards compatibility

Save styles

Styles file name

Apply Cancel

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

9. Click **Reset graphics**
10. Open **back1.str** in **Graphics**.

Strings 2 and 30003 are displayed.

11. Choose **Inquire > Segment Properties**, and click on each segment to check its direction. 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 click **Apply**.

**Create a DTM From a Layer**

Object ID

Object name

Projection plane  
The triangles will initially be created on a temporary 2D plane.

Create on:

After creating the surface, change the current plane to the best-fit plane.

Creating a DTM using breakline test

Perform break line test

Interpolate additional points

Point interpolation distance

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

**Apply a boundary to a DTM**

DTM layer name

Selected boundary string

Layer name

String number

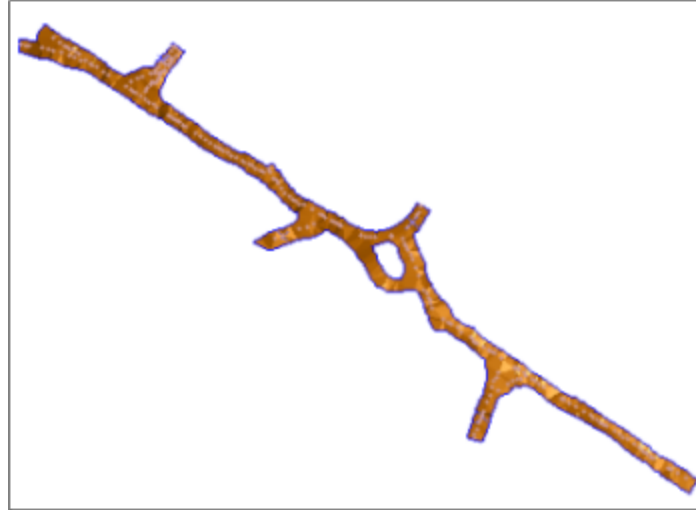
Define results


Retain triangles  Inside the boundary

Outside the boundary

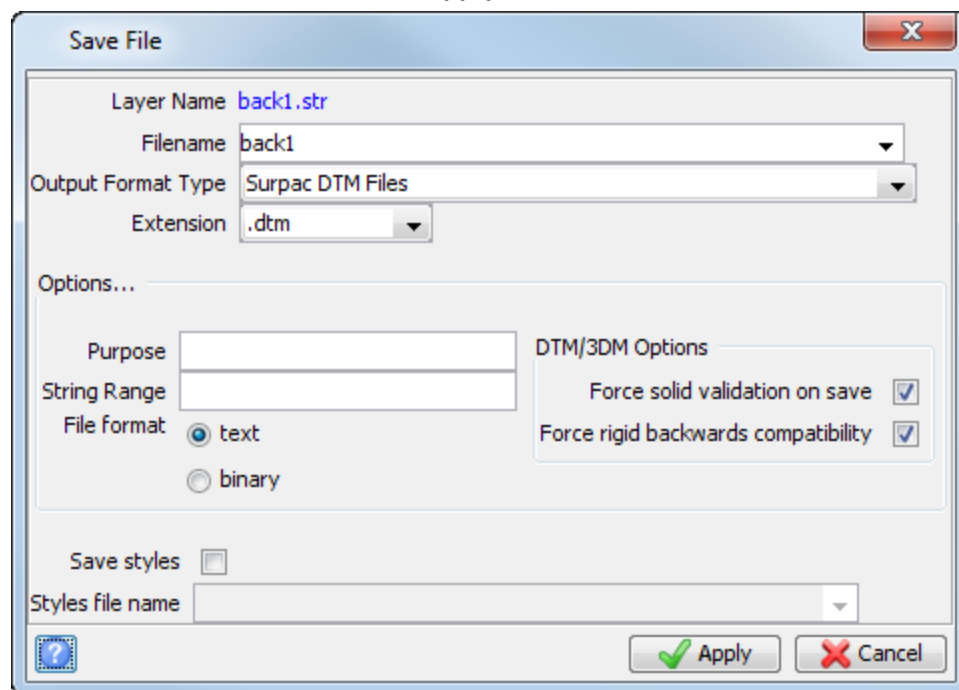
New boundary layer

The underground spot height string is displayed.



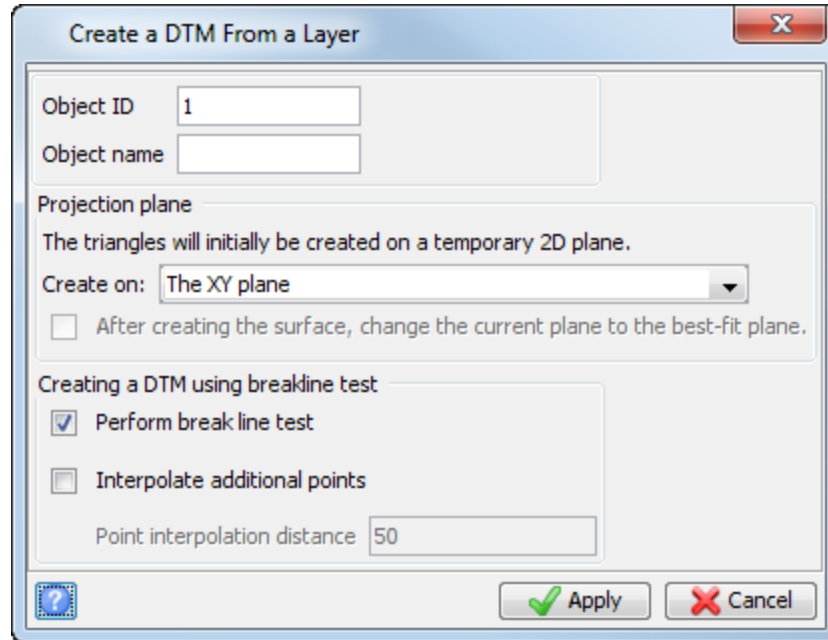
 **Note:** The DTM has been clipped correctly because of the string directions set for the walls and pillars.

17. Choose **File > Save > string/DTM**.
18. Enter the information shown, and click **Apply**.



19. Click **Reset graphics** .
20. Open **floor1.str** in **Graphics**.
21. Choose **Surfaces > Create DTM from layer**.

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

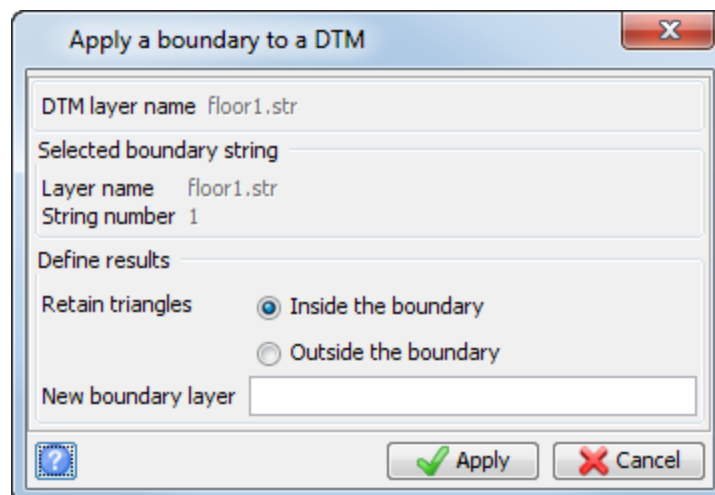


The dialog box is titled "Create a DTM From a Layer". It contains the following fields and options:

- Object ID: 1
- Object name: (empty)
- Projection plane: The triangles will initially be created on a temporary 2D plane.
- Create on: The XY plane (dropdown menu)
- After creating the surface, change the current plane to the best-fit plane.
- Creating a DTM using breakline test:
  - Perform break line test
  - Interpolate additional points
- Point interpolation distance: 50

Buttons: ? (Help), Apply (green checkmark), Cancel (red X).

23. Choose **Surfaces > Clip or intersect DTMs > Clip DTM with string**  
You are prompted to select the trisolation, and then a string.
24. Click string 1.
25. Enter the information as shown, and click **Apply**.

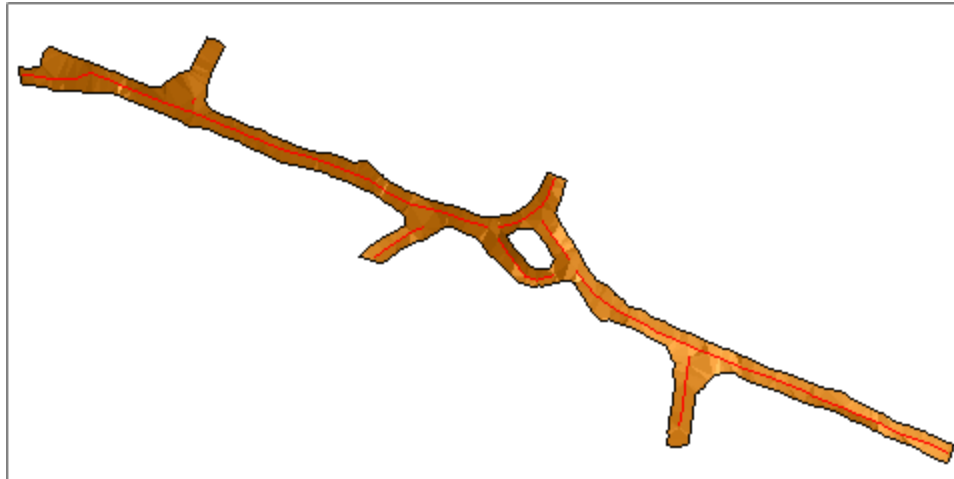



The dialog box is titled "Apply a boundary to a DTM". It contains the following fields and options:

- DTM layer name: floor1.str
- Selected boundary string:
  - Layer name: floor1.str
  - String number: 1
- Define results:
  - Retain triangles:
    - Inside the boundary
    - Outside the boundary
- New boundary layer: (empty)


Buttons: ? (Help), Apply (green checkmark), Cancel (red X).

The underground backs are displayed.






26. Save **floor1.dtm**.
27. Click **Reset graphics** .
 

Now that both clipped DTMs have been created, you will stitch together the sides to create a closed, valid solid model.
28. Open and append **back1.dtm** and **floor1.dtm** into the main graphics layer.
 



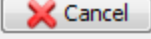
 **Note:** To append the DTMs to the same layer, hold down the **CTRL** key and drag the files into **Graphics**.
29. Choose **Solids > Edit trisolation > Renumber**.
30. Click **back1.dtm**.
31. Enter the information as shown, and click **Apply**.

Renumber an object trisolation	
Layer name	main graphics layer
Old Object	1
Old Trisol	1
New Object	1
New Trisol	1


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

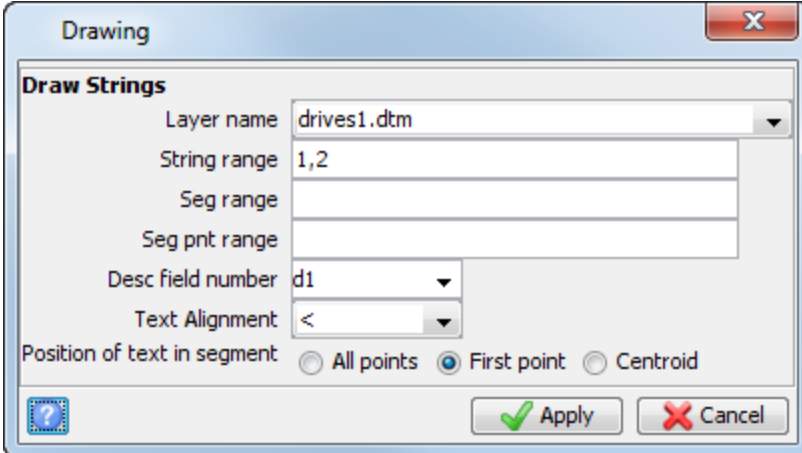
Renumber an object trisolation	
Layer name	main graphics layer
Old Object	1
Old Trisol	2
New Object	1
New Trisol	1

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. Open **drives1.dtm** in **Graphics**.
38. Choose **Display > Strings > With string numbers**.
39. Enter the information as shown, and click **Apply**.



**Drawing**

**Draw Strings**

Layer name: drives1.dtm

String range: 1,2




Seg range:

Seg pnt range:

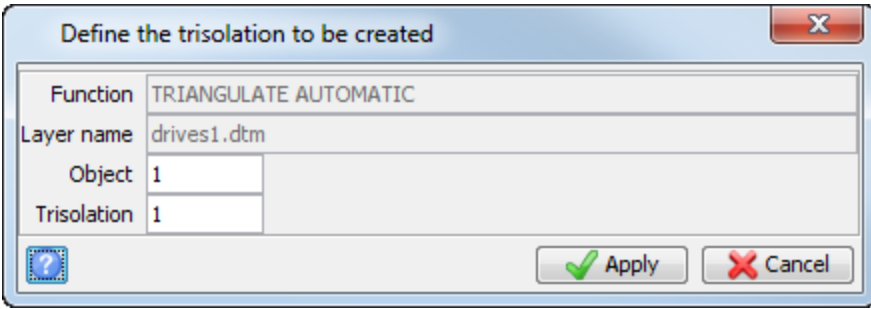
Desc field number: d1

Text Alignment: <

Position of text in segment:  All points  First point  Centroid

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






**Define the trisolation to be created**

Function: TRIANGULATE AUTOMATIC

Layer name: drives1.dtm

Object: 1

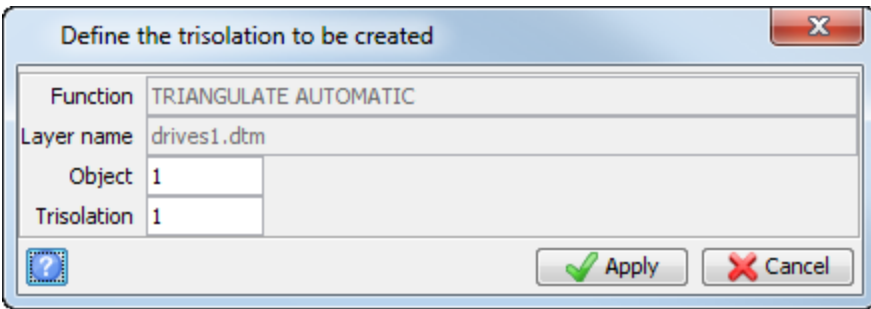
Trisolation: 1

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

Repeat the process for the pillar.

44. Choose **Solids > Triangulate > Between segments**.
45. Enter the information as shown, and click **Apply**.






**Define the trisolation to be created**

Function: TRIANGULATE AUTOMATIC

Layer name: drives1.dtm

Object: 1

Trisolation: 1

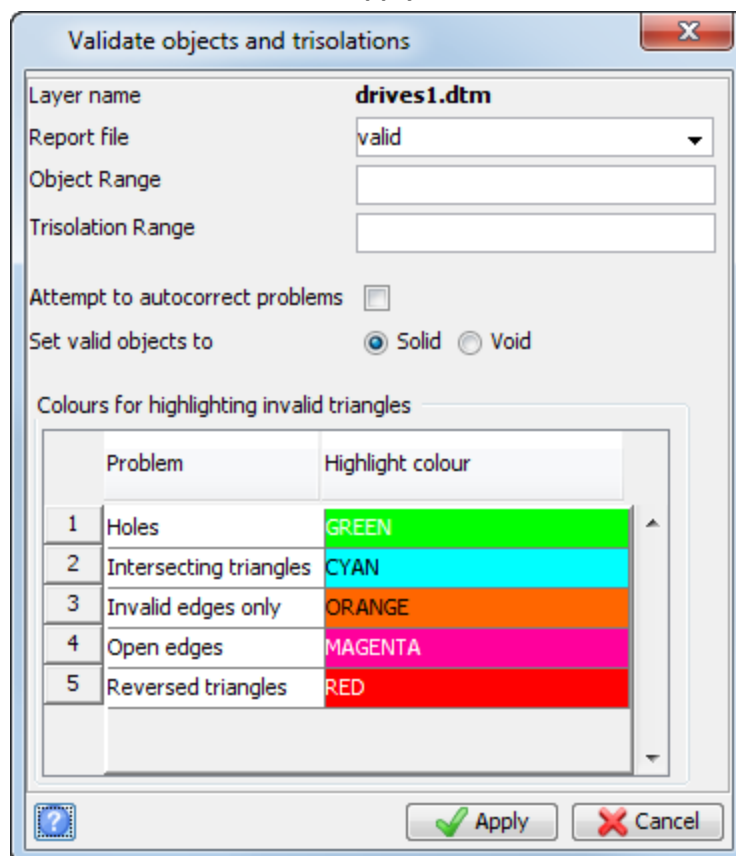
  

46. Following the prompt from the function line, click first the top string of the pillar, and then the bottom string of the pillar.
47. Press ESC.

The underground result is displayed.



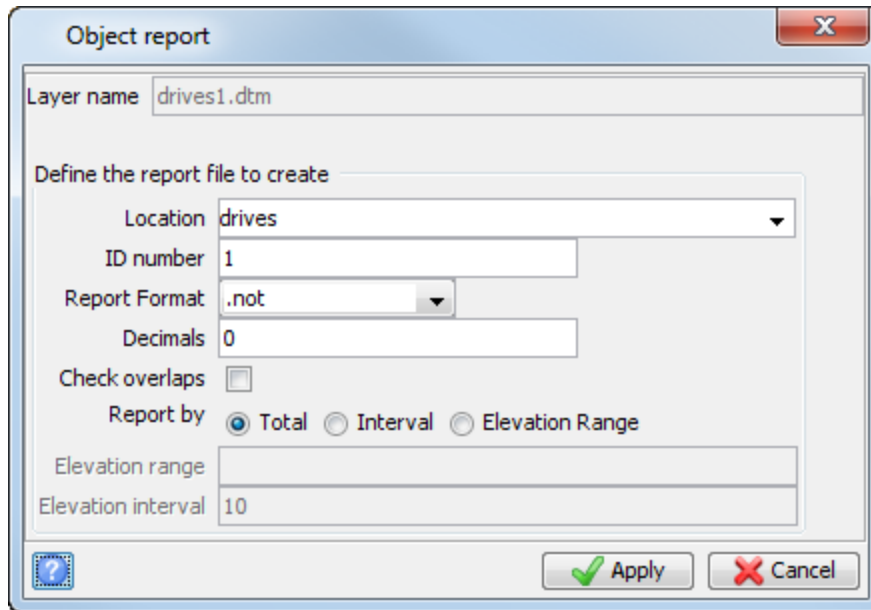
48. Save **drives1.dtm**.
49. Choose **Solids > Validation > Validate object/trisolation**.
50. Enter the information as shown, and click **Apply**.



The validation report is displayed.

Solid validation report										
Layer: mod10.dtm										
Object	Trisolation	Valid	Open/closed	Connected	Duplicate (removed)	Invalid Edges	Intersecting	Reversed		
1	1	Valid	Closed	Connected	0	0	0	0		
2	1	Valid	Closed	Connected	0	0	0	0		
Totals					0	0	0	0		
Solid validation report						1/1				

51. Choose **Solids > Solids tools > Report volume of solids**.
52. Enter the information as shown, and 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

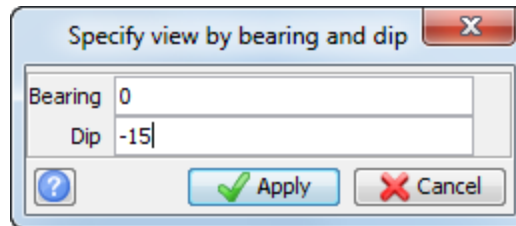
Trisolation Extents
X Minimum: 14147.967 X Maximum: 14401.569
Y Minimum: 11613.344 Y Maximum: 11702.817
Z Minimum: 716.840 Z Maximum: 745.155
Surface area: 8349
Volume : 12027
```

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

## Using the triangulation algorithm

### Task: Use the triangulation algorithm

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



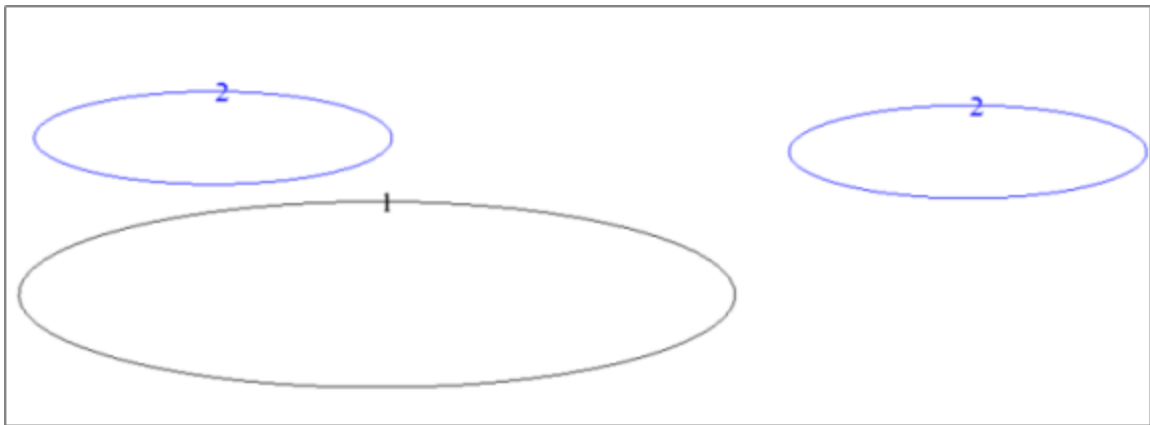
Specify view by bearing and dip

Bearing 0

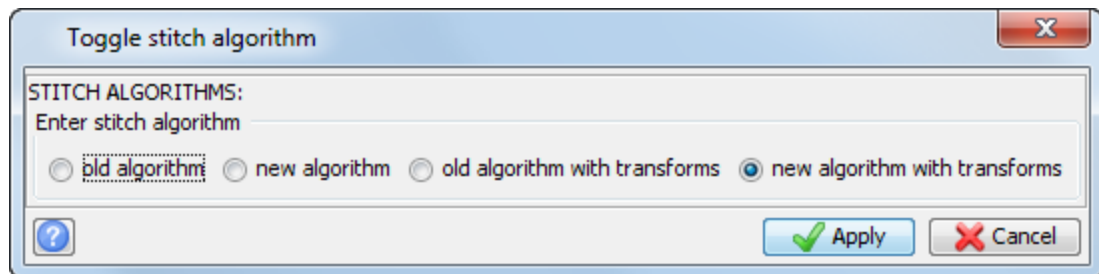
Dip -15

Apply Cancel

5. Choose **Display > Strings > With string numbers**, and click **Apply** without making any changes to the form.  
The bifurcation example is displayed.



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



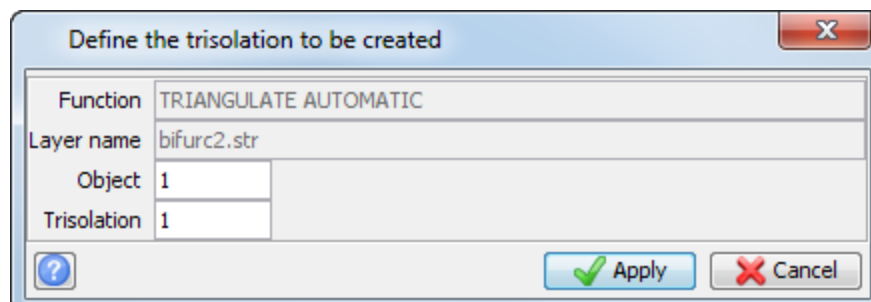
Toggle stitch algorithm

STITCH ALGORITHMS:  
Enter stitch algorithm

old algorithm  new algorithm  old algorithm with transforms  new algorithm with transforms

Apply Cancel

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

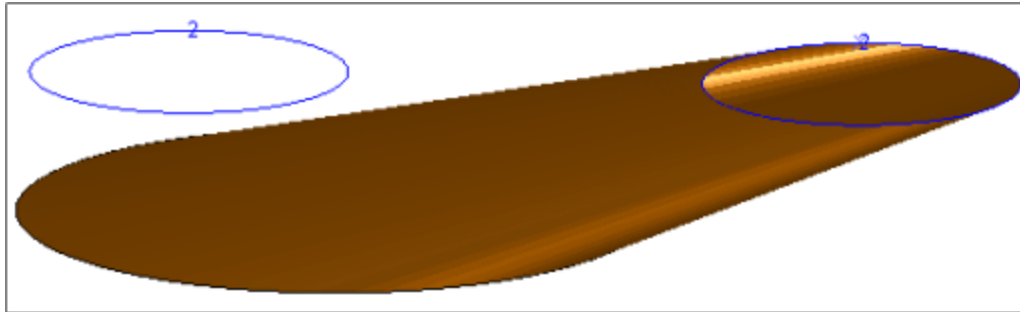



Define the trisolation to be created

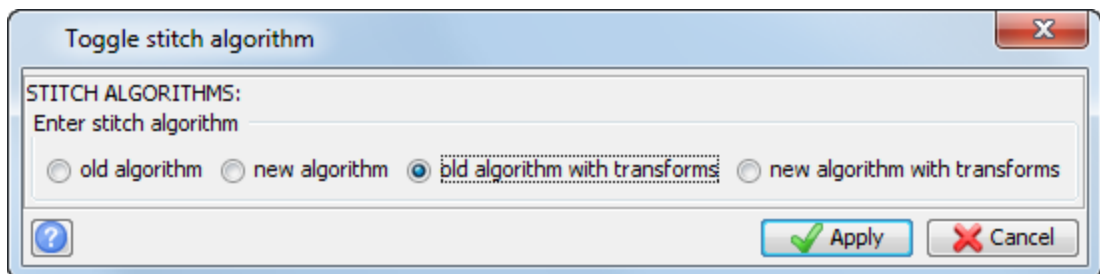
Function	TRIANGULATE AUTOMATIC
Layer name	bifurc2.str
Object	1
Trisolation	1

Apply Cancel

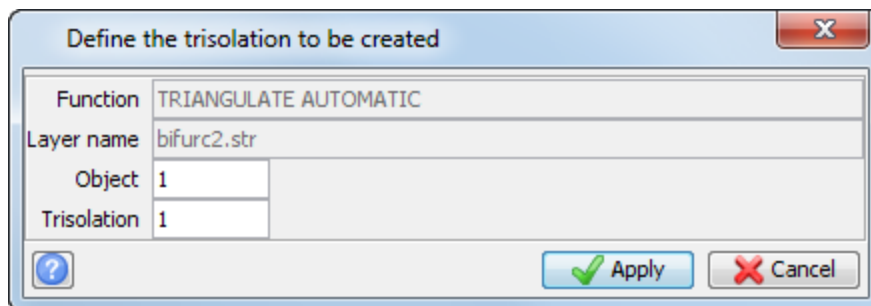
10. Click string 1 and then click the rightmost segment of string 2 as shown:



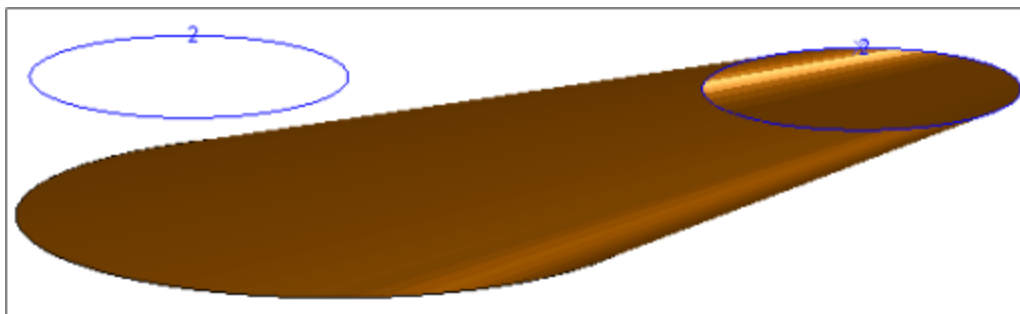
11. Press ESC.  
 12. Click **Reset graphics**   
 13. Open **bifurc2.str** in **Graphics**.  
 14. Choose **Solids > Triangulate > Triangulation algorithm**.  
 15. Ensure that **old algorithm with transforms** is selected and click **Apply**.





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

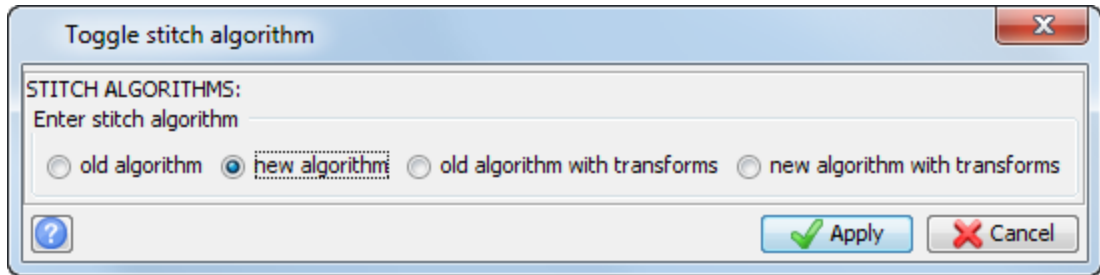


18. Click string 1 and then click the rightmost segment of string 2 as shown:

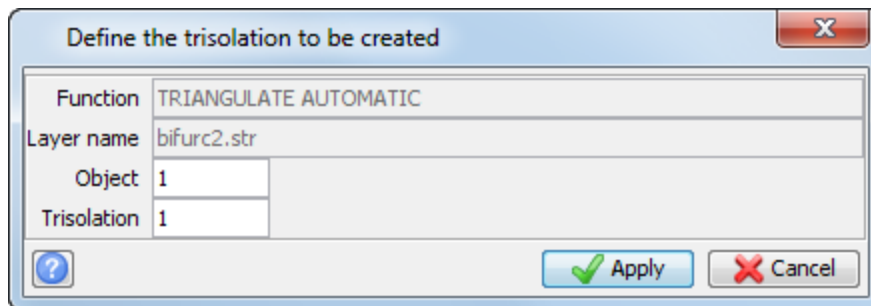


19. Press ESC.  
 **Note:** The old algorithm with transforms also achieved a successful result but took significantly longer. This demonstrates the principal difference between the new and old algorithms (that is, the new one is much faster).  
 20. Click **Reset graphics** .

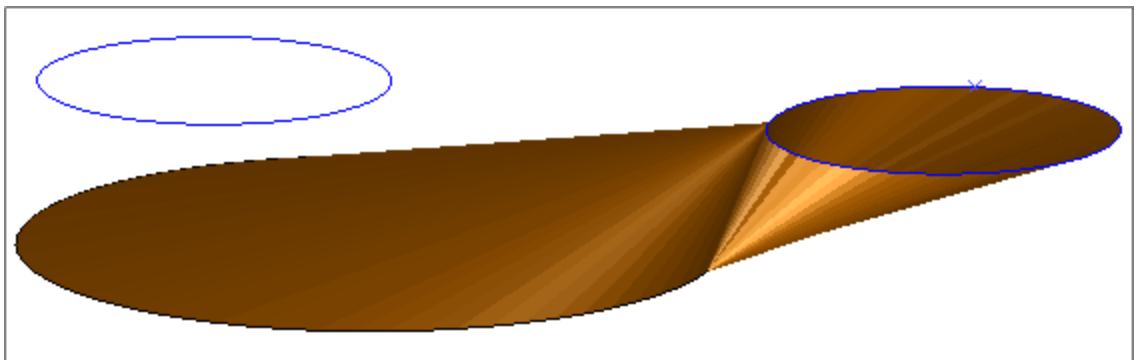
21. Open **bifurc2.str** in **Graphics**, and choose a similar view to that used before.
22. Choose **Solids > Triangulate > Triangulation algorithm**.
23. Ensure that **new algorithm** is selected.



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



26. Click the same segments as in the previous task.  
The bifurcation example is displayed.

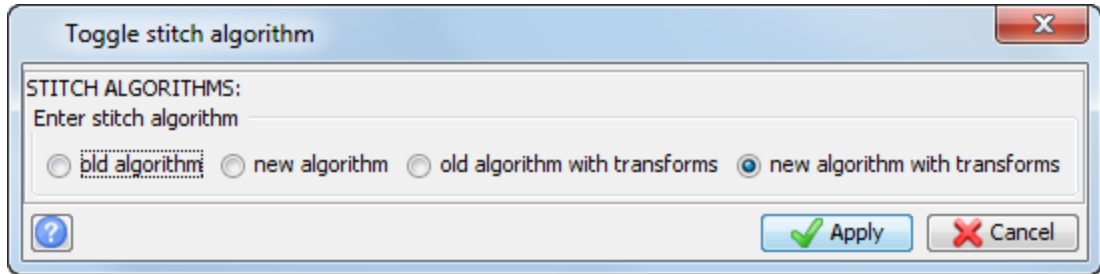



In this case the segments are too far apart geometrically for either the old algorithms or new algorithms (options 0 and 1 respectively) to work and the options with transforms should be chosen in preference.

Finally, restore the triangulation algorithm to its original value.

27. Click **Reset graphics** .
28. Choose **Solids > Triangulate > Triangulation algorithm**.

29. Enter the information as shown, and click **Apply**.



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