AUTODESK UNIVERSITY 2013

Modeling and Visualizing Substrata Data with Autodesk® AutoCAD® Civil 3D®

Gary Morin – Keynetix Ltd.

CI2243-L

In this class we are going to look at how we can use the surfaces created by the Autodesk® Geotechnical Module in Autodesk AutoCAD Civil 3D software to model and present geological data. The class covers some general tips on editing the surfaces to generate geotechnical features such as lenses and faults. Next we look in detail at how these can be presented in a fence diagram. A fence diagram is a 3D geologic cross-section that allows easy visualization of the stratigraphic changes in the subsurface. The 3D sections are displayed in position on the 3D model, a great aid for understanding and presenting geotechnical data; it also looks cool. This class is designed to assist you in understanding the techniques in modeling and visualizing substrata to better understand and present information.

Learning Objectives

At the end of this class, you will be able to:

- Manipulate substrata surfaces
- Explain the principles of modeling faults
- Explain the principles of modeling lenses and other geotechnical features
- Create fence diagrams to easily visualize substrata data

About the Speaker

Gary is the Technical Director and Co-founder of Keynetix, formed in 2000 to specialise in Geotechnical Data Management software. He is responsible for the development and support services for the range of products designed to manage the Geotechnical data journey including HoleBASE SI, Pocket SI and KeyLAB.

Gary originally trained as a Civil Engineer and has over 27 years' experience of working in the production and support of a range of GIS and CAD software.

Whilst he was at Allied Images he was part of the team that developed DeskMapper, the forerunner of AutoCAD Map in the UK and was the first AutoCAD Map distributor in the UK.

In recent years he has specialised in all aspects of geotechnical BIM, from information gathering, data validation, data management, geotechnical modeling, sharing and collaboration.

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Manipulate Substrata Surfaces

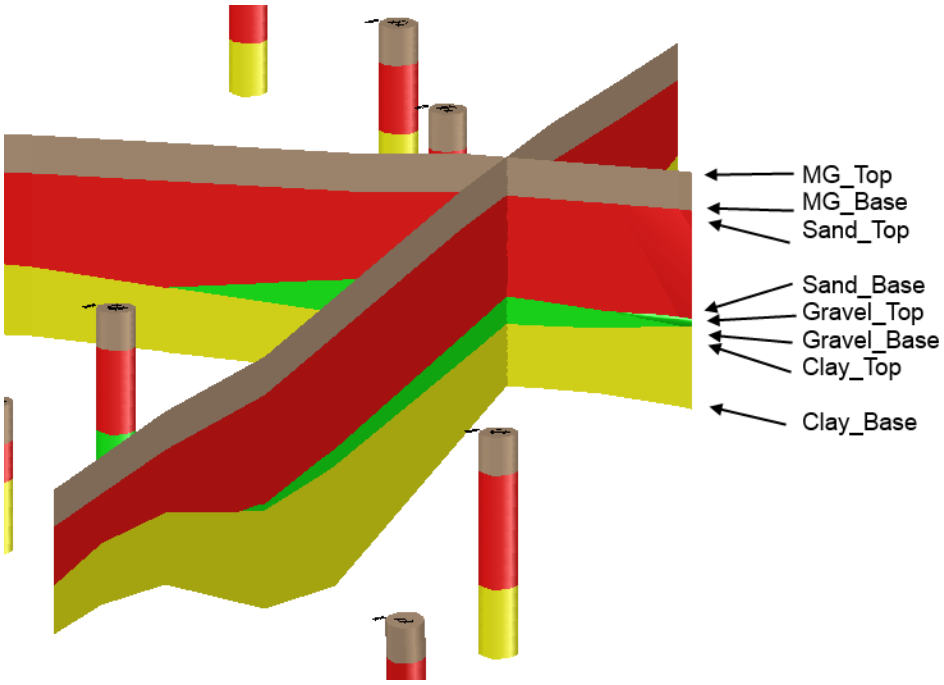
In this session we are going to look at how to manipulate substrata surfaces using standard AutoCAD and AutoCAD Civil 3D functionality. The majority of the surface manipulations will be created by using:

- 3D Polylines
- Feature lines
- Break lines

The three examples given will provide an insight on how to go forward and model substrata surfaces.

Lab sample data

The diagram below lists the strata surfaces available in the tutorial datasets, note the coincidental surfaces:



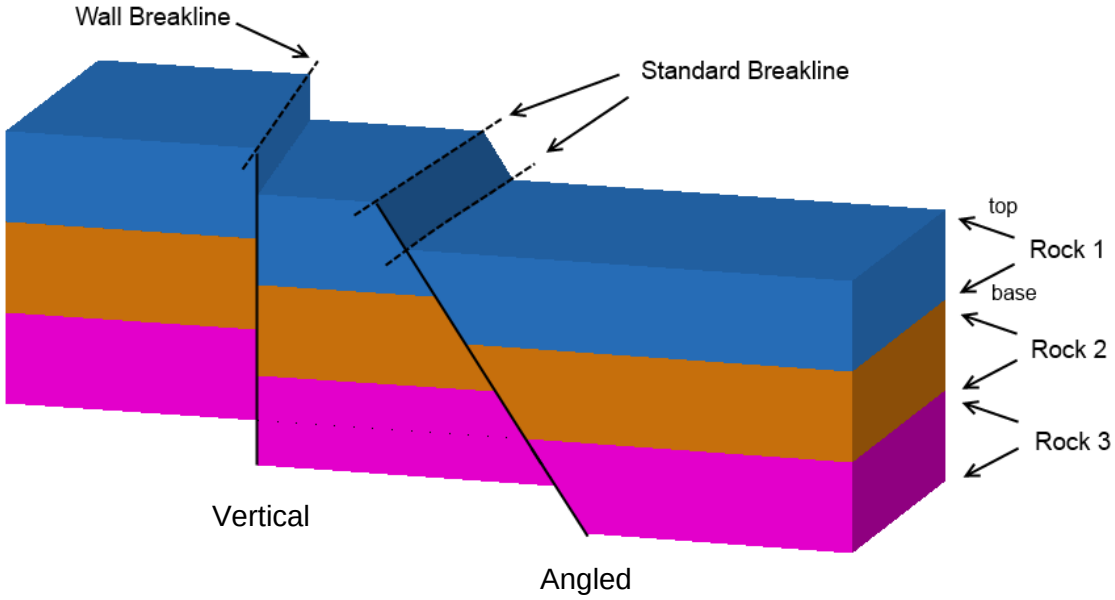
Unable to find database linked to this file

When opening each tutorial drawing you will be prompted to select the database file:

Select the SDF file in the same directory as the DWG and with the same name as the DWG.

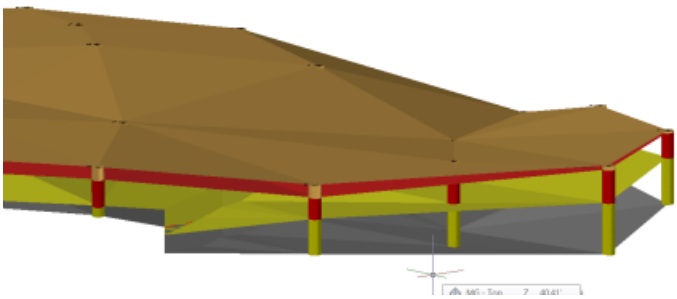
Explain the principles of modeling faults

Definition: (geology) a crack in the Earth's crust resulting from the displacement of one side with respect to the other.



Faults

In our worked example we will produce a vertical fault in the clay strata.



This means we will need to work on three surfaces in the location of the fault:

- Sand_base
- clay_top
- clay_base.

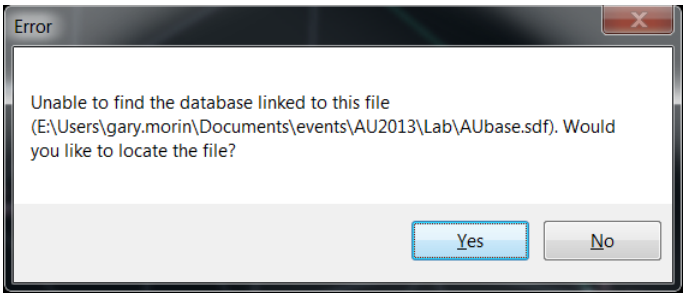
We will assume the other strata surfaces have just been filled in over time.

The outline steps to create a fault are:

1. Draw a polyline in plan representing the fault location
2. Assign the elevation of the surface to the polyline
3. Add the polyline as a “Wall” break line to the surface
4. Repeat for each surface

Detail steps

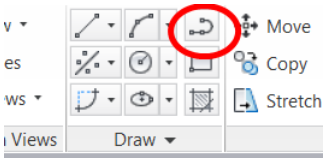
1. Start AutoCAD Civil 3D
2. Open tutorial drawing C:\Datasets\CI2243-L\AU1\AU1_1\AU1_1.dwg
3. If prompted to, select database file:



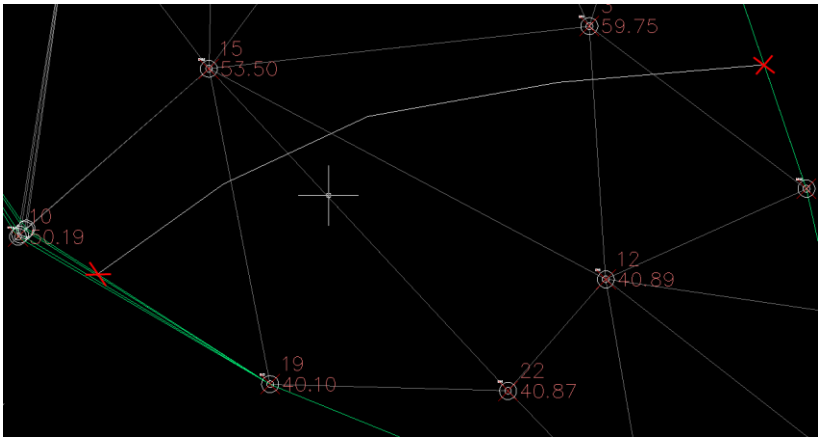
   a. Press Yes
   b. Browse and select file C:\Datasets\CI2243-L\AU1\AU1_1\AU1_1.sdf and click open

4. Ensure “Top” view is selected 

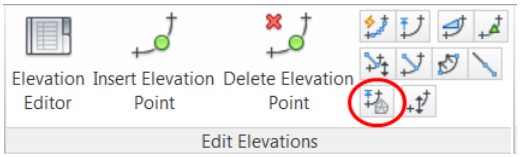
5. Draw a polyline representing the top of the fault



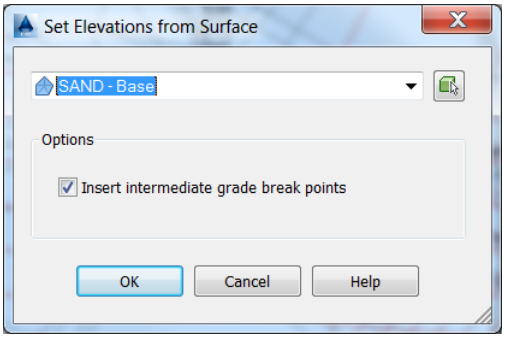
   a. Either type PL or pick from Home ribbon
   b. Ensure Nea snap is used on the inner surface boundaries and draw location of Fault



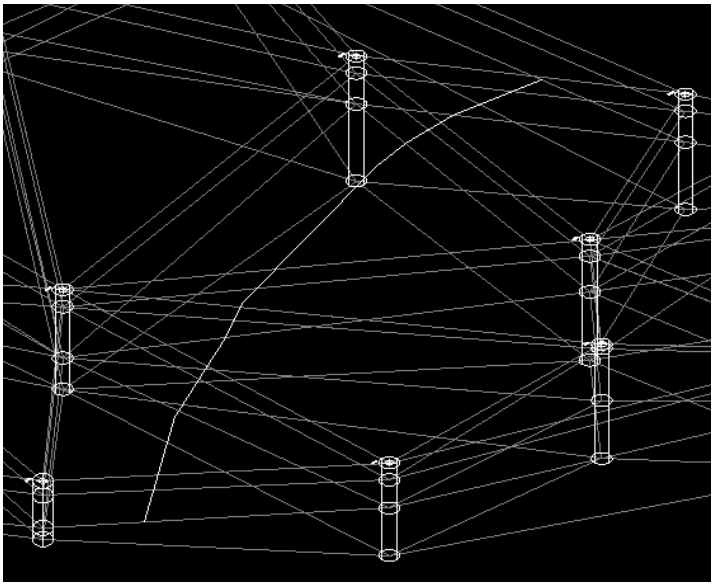
6. The fault polyline needs to be moved to the Sand–base surface elevation
    a. (Optional) Open drawing C:\Datasets\CI2243-L\AU1\AU1_2\AU1_2.dwg and link the corresponding SDF file.
    b. From the Modify ribbon pick Elevations from Surface:



    c. Select Sand–base for surface
    d. Check on Insert intermediate grade break points

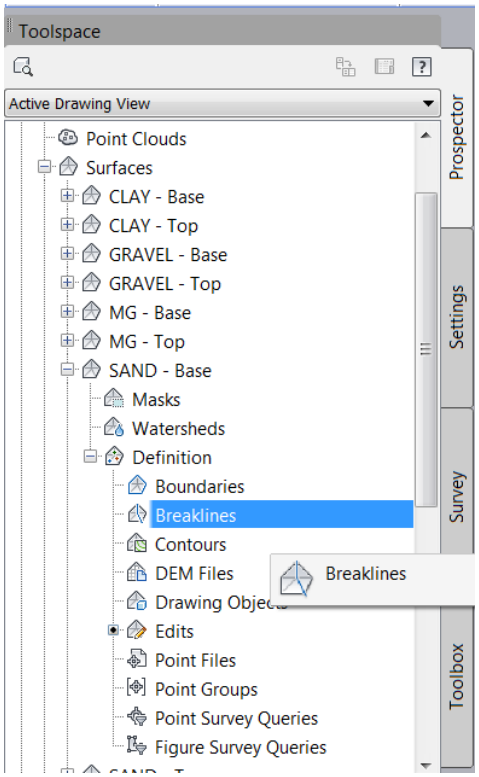


    e. Select the Fault polyline just drawn and press enter
7. To confirm polyline has been moved to the correct surface, use the viewport control and change view to SW isometric:

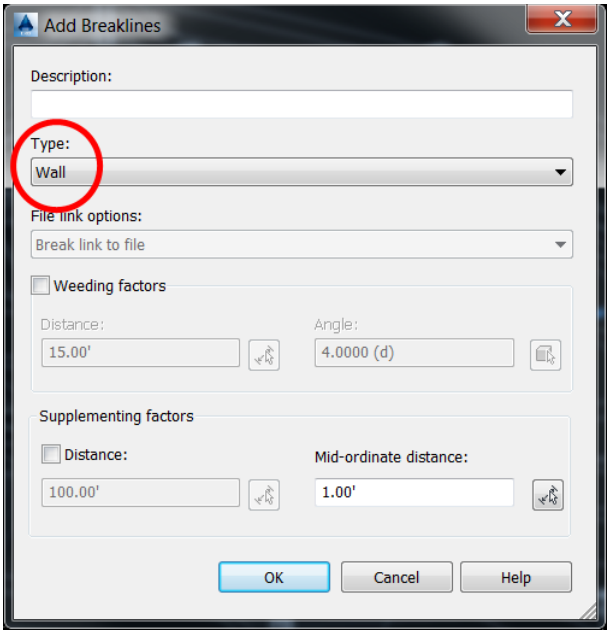


8. We now need to add the polyline as a Break line

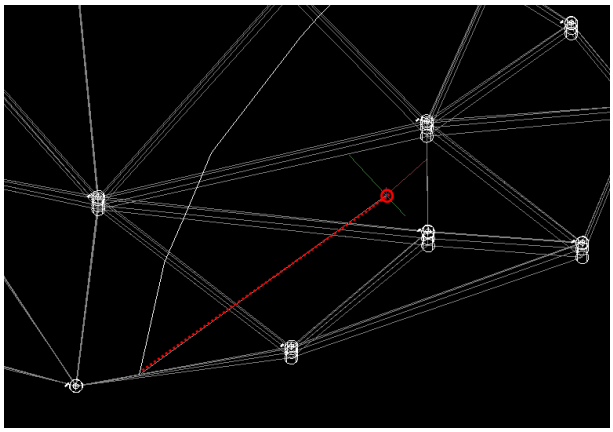
a. (Optional) Open drawing C:\Datasets\CI2243-L\AU1\AU1_2\AU1_2.dwg and link the corresponding SDF file.
b. From the tool prospector, right click on Surfaces> Sand – Base> Definitions> Breaklines and pick Add



c. Select Type: Wall and press okay

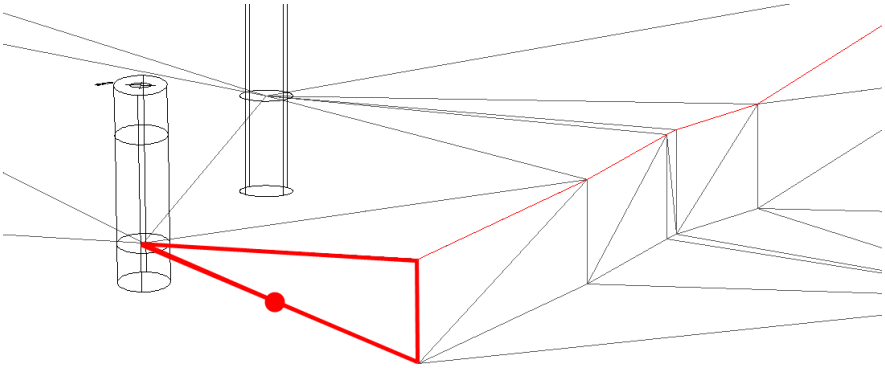


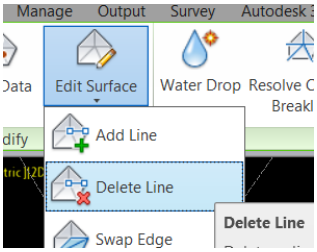
d. At the select objects prompt, select the Fault polyline.
e. For pick offset side, ensure you pick a point on the right, see image below:



f. For Wall height option press Enter for All
g. Type -10 for offset
h. A wall bright line is created representing a fault at the base of Sand

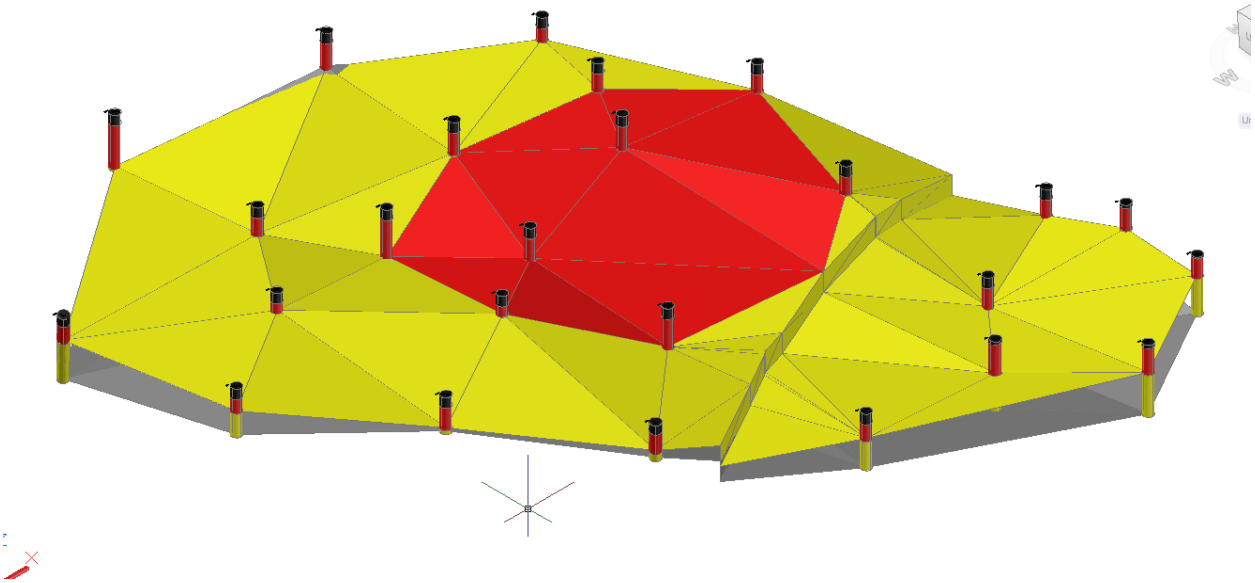
9. Now repeat step 8 for Clay-top
    a. Note: we do not need to do step 7 as both Sand-base and Clay-top surfaces are coincidental at the Fault line location.
10. Repeat steps 7 and 8 for Clay–base
    a. For Clay-base, step 7 also has to be repeated, as the polyline elevation needs to be moved to the Clay–base surface
11. We may find extra triangles at the boundary of the fault, as indicated in red below. To remove the triangles:



a. Select the Surface from the drawing so the Surface Tab appears in the ribbon.
b. Click Edit surface > Delete Line 

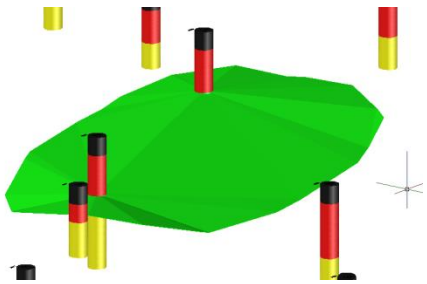
c. Select edge of triangle to remove as indicated above.
d. Repeat for all surplus triangles.

12. Finally change the Navigation Viewport to SW isometric and 2D Wireframe to Realistic to view model
    a. (Optional) Open drawing C:\Datasets\CI2243-L\AU1\AU1_4\AU1_4.dwg and link the corresponding SDF file.

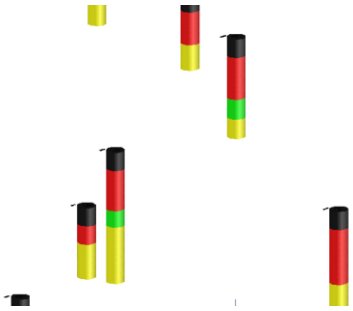


Explaining the principles of modeling lenses and other geotechnical features

In this exercise we are going to look at the principles of generating a Lens: a body of rock or ore that is thick in the middle and thinner toward the edges.

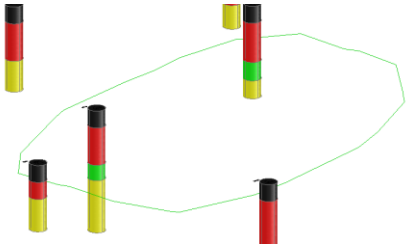


The above Lens can be identified by the green sections in the boreholes below.

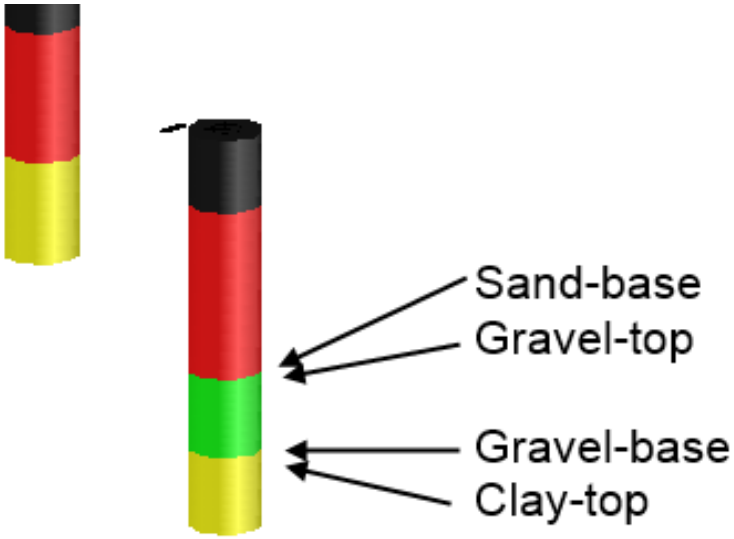


The outline steps to create a Lens are:

1. Digitise the “extents” of the Gravel Lens and geology in plan



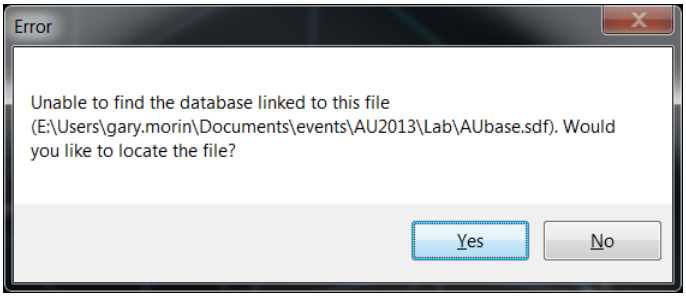
2. Drape the “extents” on an appropriate surface
    a. in our case it will be clay-top
3. Add the “extents” as a breakline to the **four** surfaces



4. (Optional) Use the extents to add boundaries to only show the geology in the correct areas (we do not do this in this example)

Detail steps

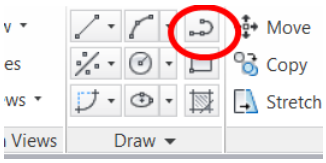
1. Start AutoCAD Civil 3D
2. Open tutorial drawing C:\Datasets\CI2243-L\AU2\AU2_1\AU2_1.dwg
3. If prompted to, select database file:



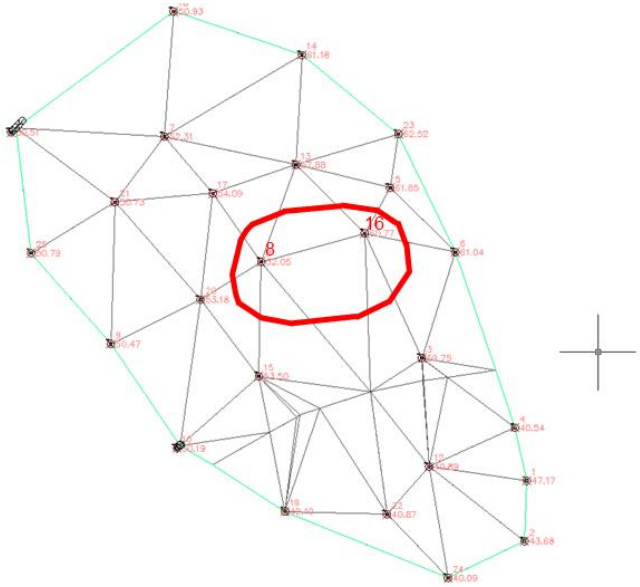
   a. Press Yes
   b. Browse and select file C:\Datasets\CI2243-L\AU2\AU2_1\AU2_1.sdf and click open

4. Ensure “Top” view is selected 

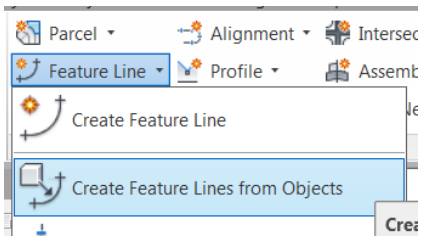
5. Draw a polyline representing the top of the fault



   a. Either type PL or pick from Home ribbon
   b. Digitise the extents of the Lens with a closed polyline (it must go round two correct boreholes)

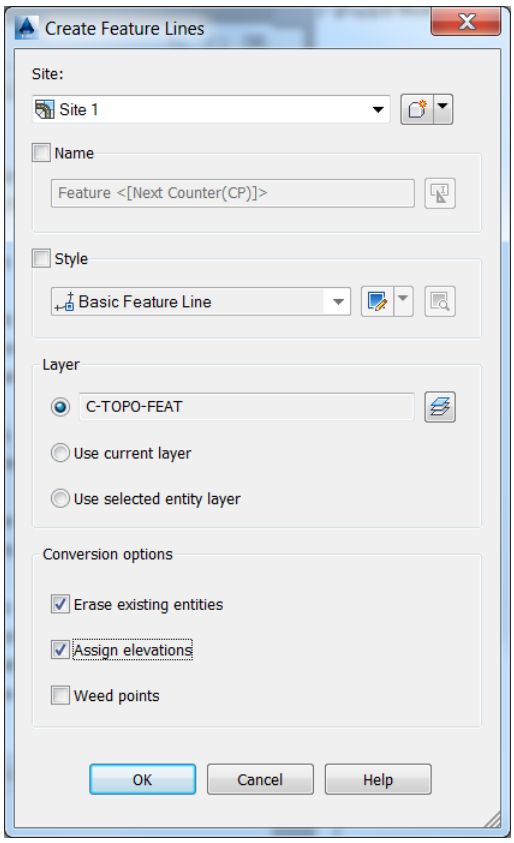


6. Create a Feature line based on the polyline
   a. (Optional) Open drawing C:\Datasets\CI2243-L\AU2\AU2_2\AU2_2.dwg and link the corresponding SDF file.
   b. From the Home ribbon select Feature Line> Create Feature Lines from Objects



   c. Select the digitized lens polyline and press Enter
   d. In the create feature lines dialog, check on
      i. Assign Elevations

ii. Erase Existing Entities

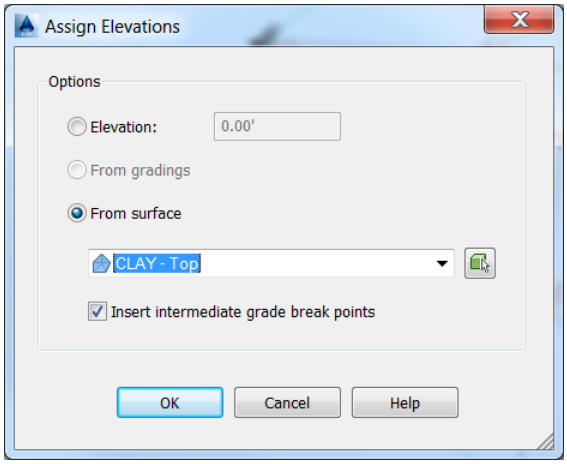


iii. Press Okay

e. In the Assign Elevations dialogue,

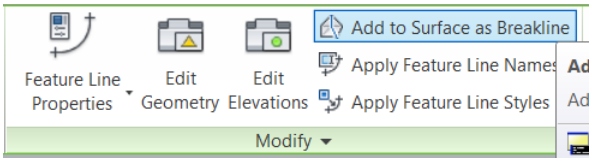
i. Select surface Clay-top

ii. Check on Insert intermediate grade break points

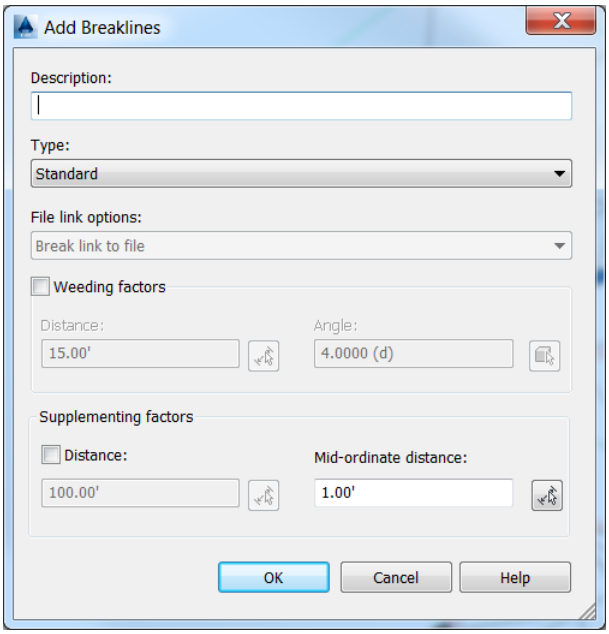


iii. Press okay

7. Now add the feature line as a Break line
    a. (Optional) Open drawing C:\Datasets\CI2243-L\AU2\AU2_3\AU2_3.dwg and link the corresponding SDF file.
    b. Select the newly created Feature line
    c. From the Feature Line ribbon select Add to the Surface as Breakline

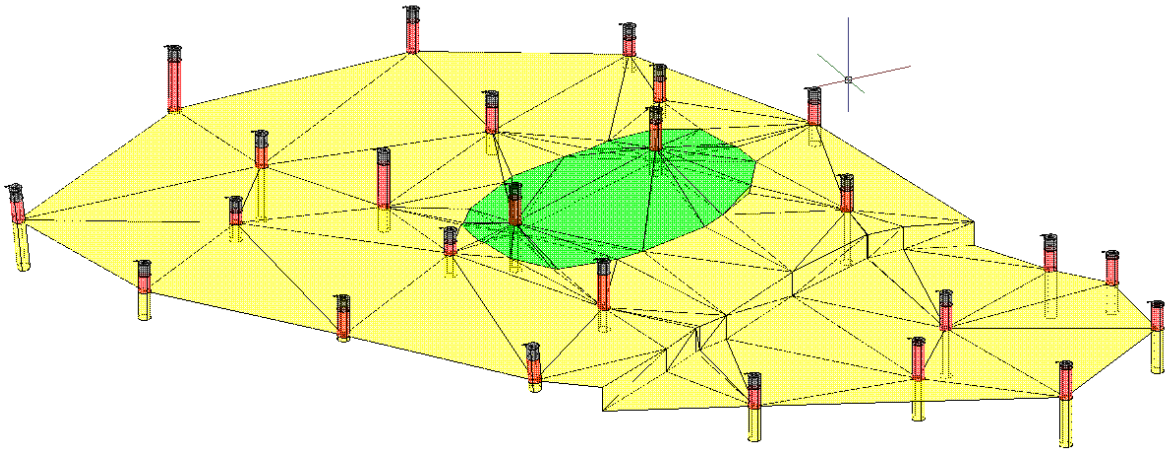


    d. In the Select Surface dialog
        i. Select surface Sand–base
        ii. Press okay
    e. In the Add Breaklines dialog
        i. Ensure the defaults are set, as shown below



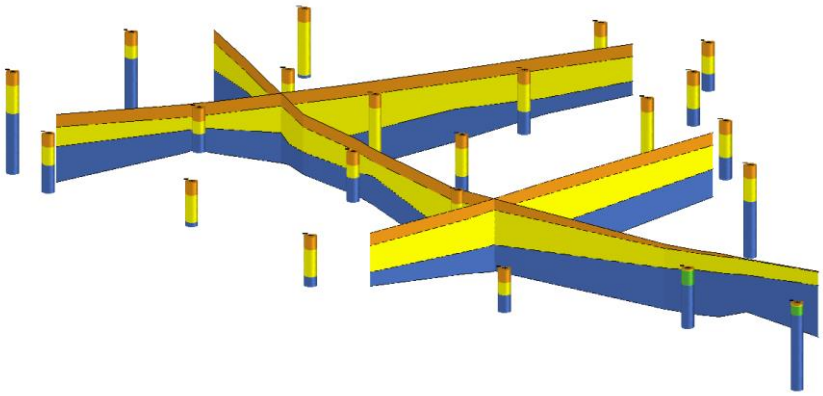
        ii. Press okay
    f. The Sand-base surface will be updated using the common Feature line as a Breakline
8. Repeat step 7 (in the same drawing) for the 3 other strata surfaces affected
    a. Gravel-top
    b. Gravel-base
    c. Clay-top
9. Finally change the Navigation Viewport to SW Isometric and 2D Wireframe to X-Ray to view the model.

a. (Optional) Open drawing C:\Datasets\CI2243-L\AU2\AU2_4\AU2_4.dwg and link the corresponding SDF file.



Create a Fence Diagram to easily visualize substrata data

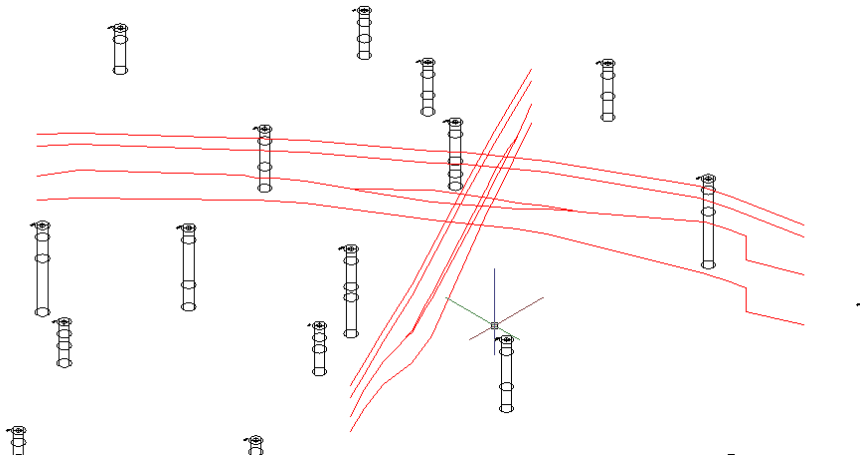
In the final exercise we are going to look at how to create a Fence Diagram. A Fence Diagram can be considered a profile in model space and is an excellent way of presenting and visualising substrata data.



Fence Diagrams are relatively easy to create if you follow some basic steps, although complications are added by including Lenses in this exercise, we will create a Fence Diagram which passes through the Lens and the Fault created in previous exercises.

The outline steps to create a fence diagram are:

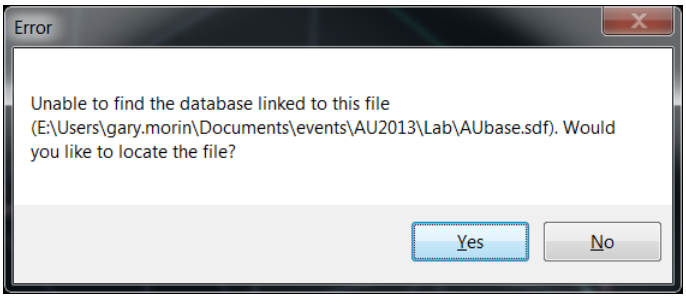
1. In plan, draw polylines for the location of the Fence Diagrams
2. Array copy the fence polylines for easy selection.
3. For each strata top and base surfaces, assign the polylines elevations from the appropriate surface



4. For each strata Loft the corresponding pair of polylines
5. Finally correct any problems

Detail Steps

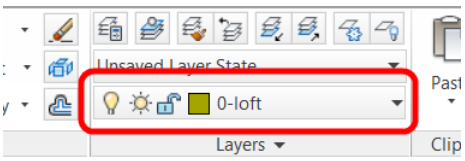
1. Start AutoCAD Civil 3D
2. Open tutorial drawing C:\Datasets\CI2243-L\AU3\AU3_1\AU3_1.dwg
3. If prompted to, select database file:



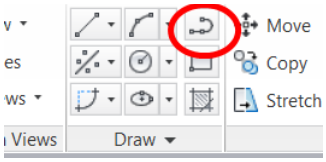
   a. Press Yes
   b. Browse and select file C:\Datasets\CI2243-L\AU3\AU3_1\AU3_1.sdf and click open

4. Ensure “Top” view is selected 

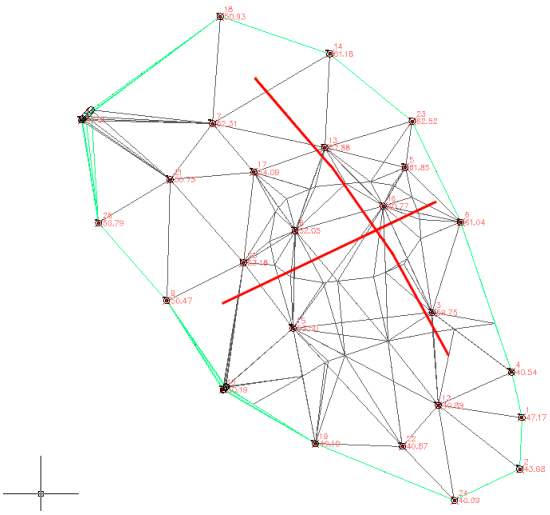
5. Set the current layer to 0–loft



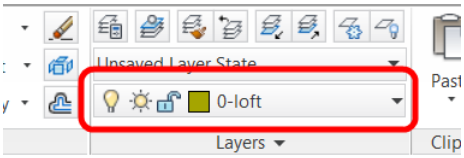
6. Draw a polyline representing the top of the fence



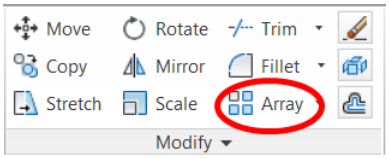
a. Either type PL or pick from Home ribbon
b. Digitise the location of the Fence Diagram, ensuring that the polyline goes through the lens and over the fault



7. A separate polyline must now be created for each surface
    a. (Optional) Open drawing C:\Datasets\CI2243-L\AU3\AU3_2\AU3_2.dwg and link the corresponding SDF file.
    b. Ensure the current layer is 0–loft



    c. On the command line type Arrayrect or select Array from the Home ribbon



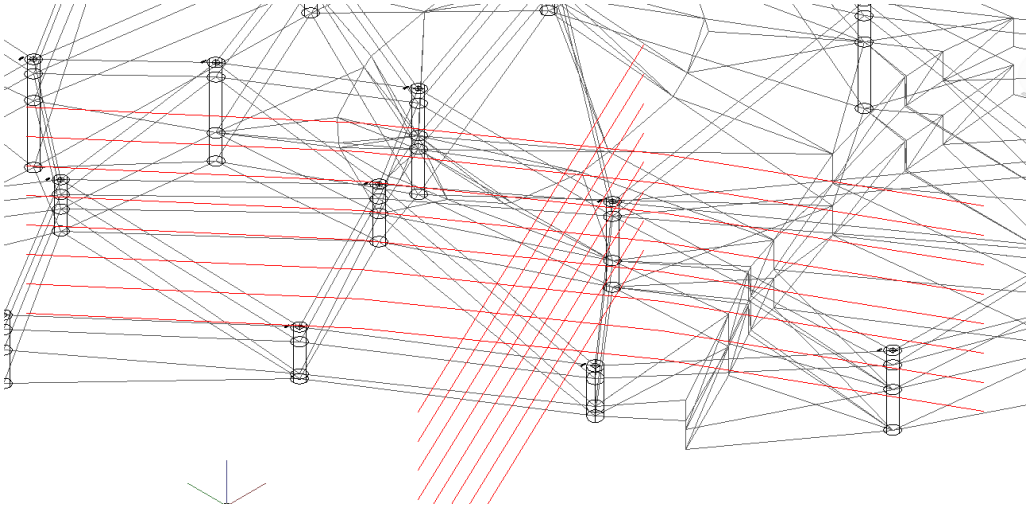
    d. Select the two fence polylines previously drawn and press Enter
    e. Type COU or select the Count option and enter
        i. Enter the number of columns = 1
        ii. Enter the number of rows = 1
    f. Type L or select the Levels option and enter

i. Enter the number of levels = 8,(one level for each strata surface)

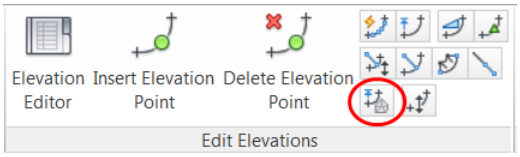
g. Specify the distance between levels = -10

h. Press enter to exit command

i. To confirm the polylines have been arrayed correctly, use the viewport control and change view to SW Isometric:

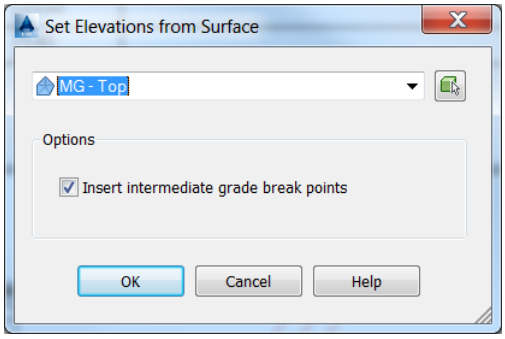


8. Explode the arrayed polylines
    a. Type “Explode” on the command line and pick the arrayed polylines
9. To simplify the drawing, use the Strata Manager command from the Geotechnics ribbon
    a. Check off all strata surfaces
10. We now need to repeat the following process for each stratum, assigning the surface elevation for both the top and base surface to pairs of polylines created above.
    a. (Optional) Open drawing C:\Datasets\CI2243-L\AU3\AU3_3\AU3_3.dwg and link the corresponding SDF file.
    b. From the Modify ribbon pick Elevations from Surface:

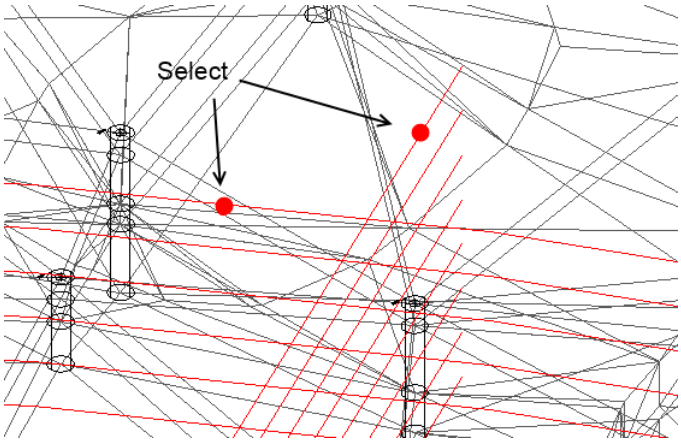


i. Select MG–top for surface

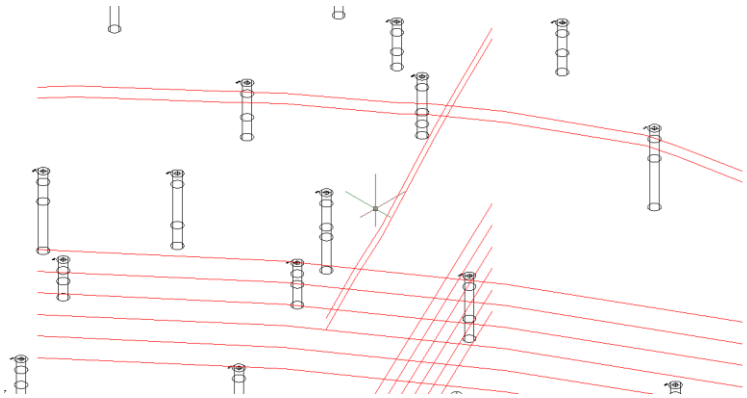
ii. Check on Insert intermediate grade breakpoints



c. Select the two top polylines

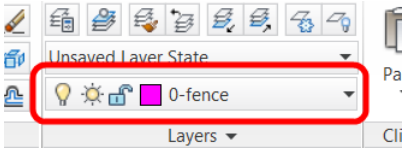


d. From the Modify ribbon pick Elevations from Surface again
   i. Select MG–base for surface
   ii. Check on Insert intermediate grade breakpoints
e. Select the next two top polylines
   i. the drawing should now look similar to below:

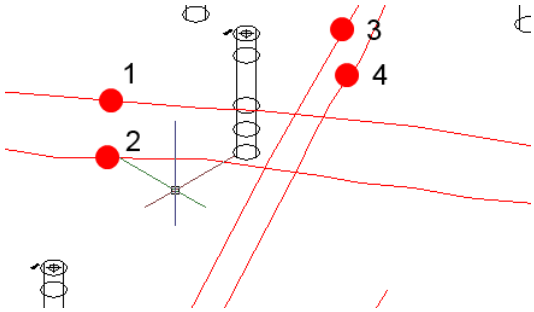


11. We now need to Loft, between the pairs of polylines.

a. Set the current layer to 0–fence

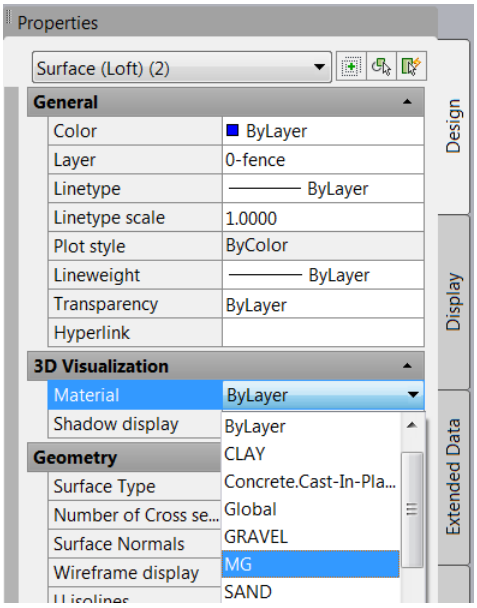


b. Type “LOFT” on the command line
c. Select the top and base strata polyline, indicated by 1 and 2 in diagram below.

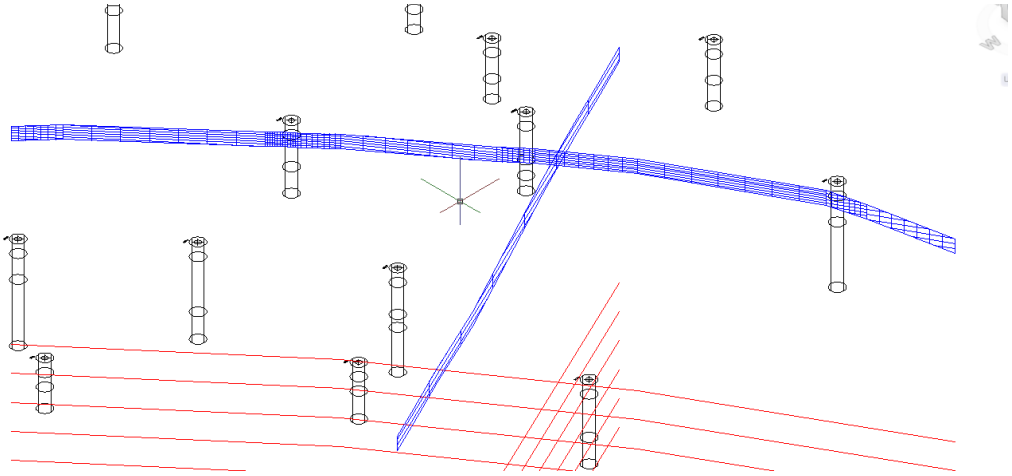


d. Press Enter
e. Press Enter again
f. Repeat steps B to E for polylines 3 and 4

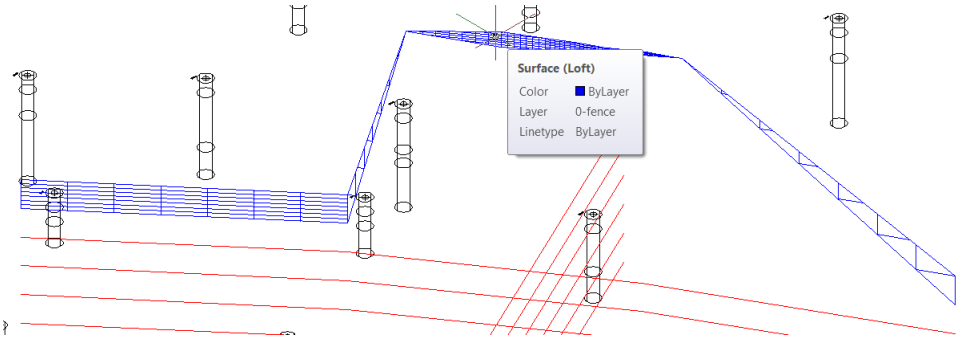
12. Type CH or Cntr 1 to display the properties dialog
    a. Select the two newly created Loft surfaces



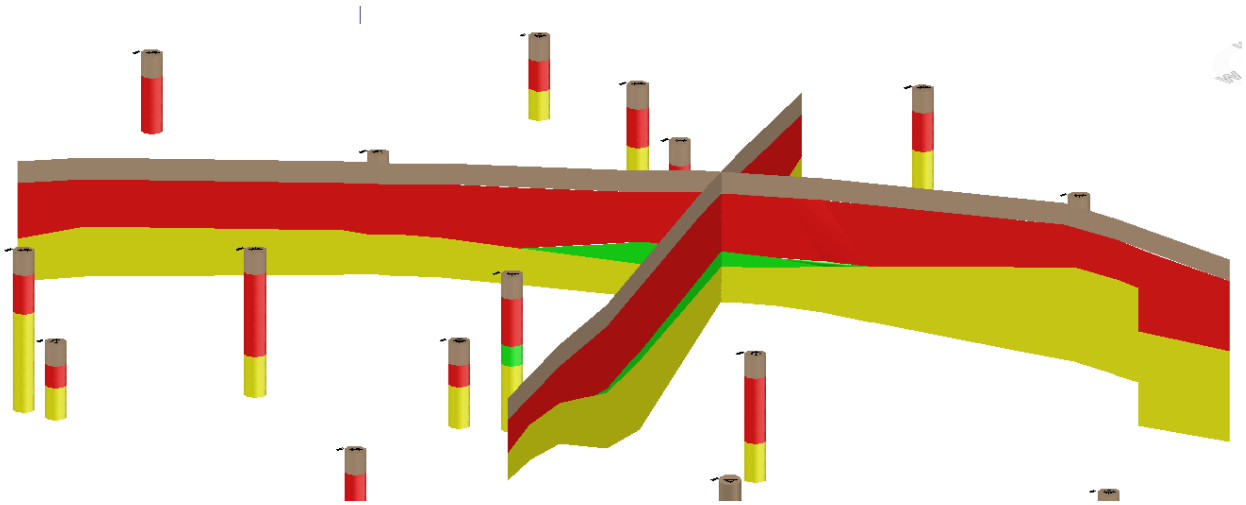
    b. In the materials drop-down list pick MG



13. We now need to repeat steps 8 to 10 for the other strata
    a. Sand
    b. Gravel
    c. Clay
    d. To aid selecting the lines to Loft, turn off layer 0-fence
14. The Gravel strata may cause problems, the Loft surfaces will probably look like this:



    a.
    b. The Loft surface needs to be cleaned up
        i. Type “Explode" on Command line
            1. Select the Gravel loft surface
            2. Press Enter to explode the surface
        ii. Use Erase to delete the spurious faces
15. Finally, use the viewport controls and switch to Realistic mode
    a. (Optional) Open drawing C:\Datasets\CI2243-L\AU3\AU3_6\AU3_6.dwg and link the corresponding SDF file.



Further Information

Please check out www.keynetix.com/fromthegrounddown for further videos and tutorials and www.Keynetix.com/holebase for companion products.