Autodesk University 2012

Using Geotechnical Data in AutoCAD Civil 3D

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C14020

The class will introduce the new AutoCAD Civil 3D Geotechnical extension to display and model subsurface data for infrastructure design work. This class will show how borehole data can be imported and used within AutoCAD Civil 3D software to greatly increase productivity for geotechnical engineers. Users will be able to plot hole locations, create 3D sticks modeling strata data at hole locations, and model strata top and base surfaces using geotechnical styling and hatching. The class will also see how the extension is used to quickly manipulate a strata surface by specifying what hole data should or should not be included and how to rapidly create geotechnical sections and automatically create borehole logs (strips) on the profile view.

Learning Objectives

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

- Format and import Geotechnical Data
- Create, style and manage Boreholes and Strata surfaces
- Create dynamic geotechnical Profiles with Borehole logs
- Use AutoCAD Civil 3D functionality to edit and manipulate strata surfaces
- Understand BIM concepts in relation to Geotechnics

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.

Since then he has specialised in MapGuide and AutoCAD Map and has implemented many award winning sites. Highlights include the creation and development of HAGDMS which went on to, and continues to, be a very successful solution creating offshoots of HDDMS and WAGDMS.This is still today one of the most advanced MapGuide enterprise sites

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What is the new Geotechnical extension?

The new Geotechnical extension for AutoCAD Civil 3D 2013, has been made to ease the task of creating and viewing geological and sub surface information.

Geotechnical design is like any other engineering practice, the designs need to be revised and refined. In many respects this is more the case with geotechnics as the engineer with limited information tries to interpret the data to best fit the site. In this respect the tool has been designed to quickly display data in AutoCAD to allow the user to start modelling and interpreting the site.

The Geotechnical extension is designed to work with hole locations and geology data, the functionality includes:

Import and connection to geotechnical data, both AGS and CSV

Creating and managing Boreholes in both plan and model space

Creating and managing sub strata surfaces

Producing dynamic profiles with projected borehole logs on to them

Geotechnical hatch and style management

Expectations should be set at the right level, the tool will not interpret the geotechnical data, it does not analyse or predict soil strengths, specialist tools are needed for that, nor does it create perfect geological models. However it is a great starting point for the modelling and visualisation process.

The geotechnical extension is still under development so some of the notes in this handout still need to be finalised at the time of writing. I hope to include the information in this class and add more in the help and online tutorials of the product, and of course you can always contact me.

Format and import Geotechnical Data

The extension is designed to display and band various types of strata not just the geology, so for instance it will display the surfaces of Legend code, shape and many more unique values.

Data can be imported from two formats, AGS and CSV

AGS

- Association of Geotechnical and Geoenvironmental Specialists)
- Used in UK, Australia, New Zealand, Hong Kong...
- Support version 3.1 and 4
- Geotechnical Data transfer format
- Well established, 20 +years

For more info http://www.ags.org.uk

```
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"DATA","TP159","0.300","1.400","Dense grey-brown SAND with medium poorly graded gravel of mudstone
"DATA","TP159","1.400","4.400","Firm brown very sandy CLAY with a little subangular to subrounded

"GROUP","LOCA"
"HEADING","LOCA_ID","LOCA_TYPE","LOCA_NATE","LOCA_NATN","LOCA_GL","LOCA_REM","LOCA_FDEP","LOCA_STA
"UNIT","","","","","m","","m","dd/mm/yyyy","dd/mm/yyyy"
"TYPE","ID","PA","2DP","2DP","3DP","X","3DP","DT","DT"
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"DATA","BH128","CP","399809.58","301145.90","13.690","","11.750","29/09/1991","29/09/1991"
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```

Example of AGS 4

CSV

CSV import requires two files, location and strata, the contents of these are explained below.

Location:

Contains a row for each individual hole location

Column Heading	*Description*	*Mandatory*
LocID	Location unique ID	Yes
X	Easting or longitude of the location of hole	Yes
Y	Northing or latitude of the location	Yes
GL	Ground level relative to datum of location or start of traverse	
FDEP	Final length of hole	
Orientation	Bearing of the hole	
Inclination	Inclination, the angle to ground	

Strata

Contains the strata data per location of stratum

Column Heading	*Description*	*Mandatory*
LocID	Location ID	Yes
Top	Depth to the TOP of stratum	Yes
Base	Depth to the BASE of description	Yes
GeolCode	Geology code	
Desc	General description of stratum	
LegCode	Legend code	
Angularity	Angularity	
Shape	Shape	
Colour	Colour	

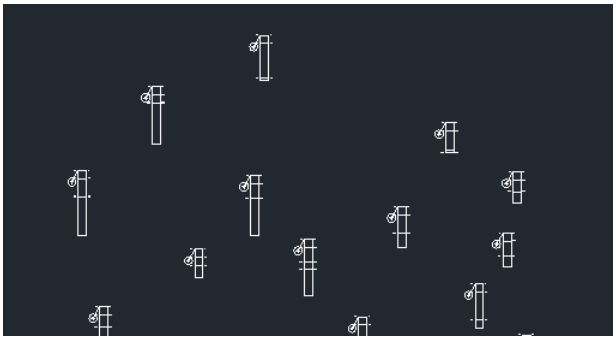
Import command

Press Import to display the Import Data dialog

Select file **Type** to import, either: AGS4, AGS 3.1 or CSV

Use **Browse** to select the files to import

Press **Import** to validate and import the files



The files are validated and if all is okay the data will be imported. At the end of the import the display will be zoomed to the extents of the new data. You will see the hole locations together with the strips displayed on plan. Changing the view to 3D will display cylinders representing the different strata in the borehole.

Create, style and manage Boreholes

Boreholes have three main elements:

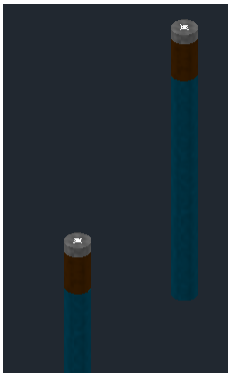
Plan symbol: the borehole block SH shown on plan

Model stick: cylinders representing the borehole in 3D

Strip: the log drawn beside the borehole in plan and on the profile.

The way the elements look are defined by styles.

In a 3D view, changing the **Visual Style** too **Realistic** will display the cylinders of the borehole rendered with materials matching the geology / strata.



Note: the materials used need to be named identical to the geology name, if a material is found with the same name it will be used. The same materials are also used for strata surfaces and profile hatches.

Borehole Manager

The borehole manager is used to define which boreholes are displayed and how. For each borehole you can define if it is displayed in plan, with or without a log, and in the model. You can change the display style for the holes as well.

The Borehole Manager displays all boreholes from the import in a grid with each row representing a borehole.

The grid can be sorted by clicking on the header of any column.

Plan, Strip, Model: Turn the display of the elements off and on

Zoom: **Zooms** to the extents of the borehole

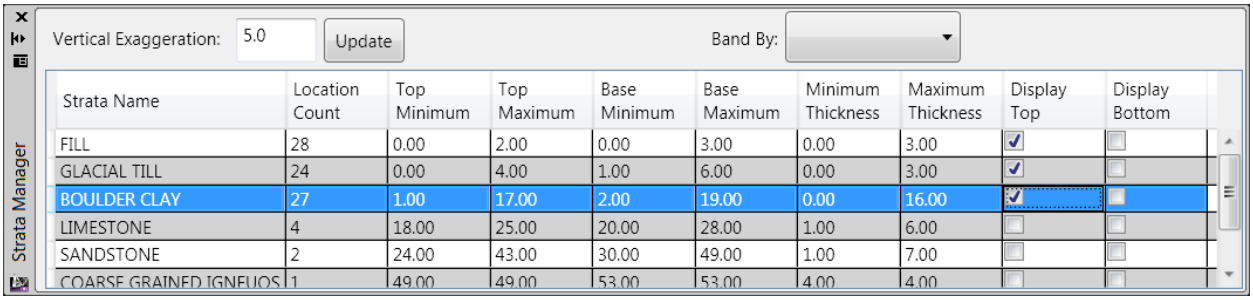
Style: Changes the display style of the borehole.

Include: The **Include exclude** check is used to prevent the hole data being used in any surface created. Toggled on the hole will be used, off it will not be used. This may be required for holes when the data is not reliable.

Strata Manager

The strata manager is used to create and display strata surfaces. The surfaces created are standard Civil 3D surfaces, they can be edited and manipulated using Civil 3D commands and are displayed in the tool prospector like any other surface.

The manager is designed to make it fast and easy to switch between strata surfaces, the display of each surface can be checked on or off, there is no need to change the display style to hide the surface.



The grid lists all strata in the imported data and gives some summary information for the strata.

The grid can be sorted by clicking on the header of any column.

Display Top, Display Base: The check boxes are used to rapidly show and hide individual surfaces, the surfaces will be created if they do not already exist.

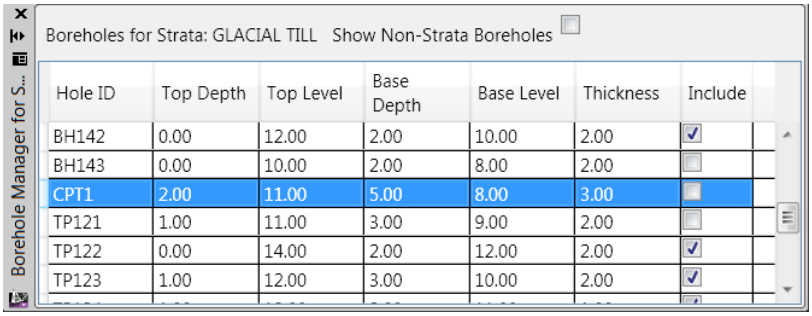
Locations: The locations button will display a list of all the holes used in to creating the surface, individual holes can be checked on and off so their data is not used in creating the surface.

Vertical exaggeration :This is used to specify the amount of vertical scale, by changing the exaggeration the boreholes, strips and surfaces will all have their vertical scale changed.

Band by: The banding option is used to specify the data to be used to create the surfaces. Changing the banding will not affect current surfaces but will allow new surfaces to be created.

Boreholes per strata

By double clicking on a stratum record the borehole of strata list will be displayed. This lists all the boreholes used in the creation of the specified strata, the strata can be tuned by including or excluding certain hole data.



Include: The Include exclude check is used to prevent the hole data being used in the surface. Toggled on the hole will be used, off it will not be used.

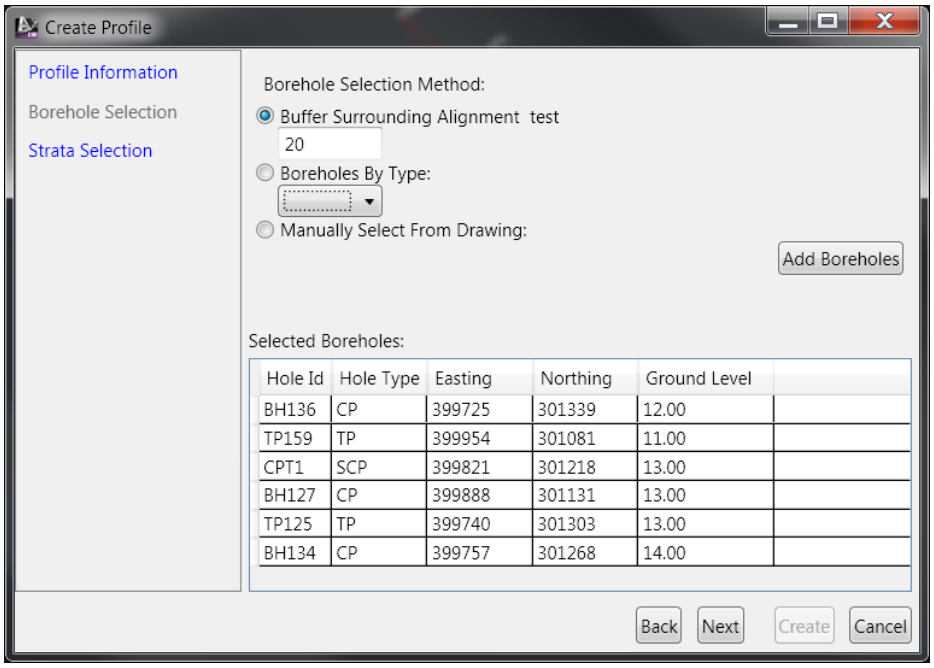
Show Non-Strata Boreholes: As default **Boreholes for strata** will only show the holes used in the strata surface, holes with no data for the current strata will not be displayed, by checking on this option the other holes will be listed, this is a good way of seeing any anomalies in the data.

Create dynamic geotechnical Profiles with Borehole logs

The aim of the geotechnical extension is to quickly see and understand the site, creating dynamic profiles of the geology strata and being able to see logs projected on to the profile view is an excellent aid.

Create profile

Create profile works in the same way as the standard Civil 3D profiles, however they have the extra ability to project the required boreholes on to the profile view and automatically the strata areas.



The command uses a wizard to create a new profile and alignment if necessary.

Borehole selection: Provides three methods to select boreholes to display on the profile.

Buffer : A distance is specified to find all boreholes within the distance from the alignment

Boreholes By Type: From the pull down list select the hole type to use

Manual: The user can select the individual boreholes

Strata selection: Select the strata surfaces to be displayed in the profile and whether to hatch strata areas.

Using AutoCAD Civil 3D functionality to edit strata surfaces

In this section we discuss how Civil 3D functionality can be used to manipulate the created surfaces to model the geology. We are only using standard commands standard so in this section we will only cover the pseudo steps in the tasks.

Videos for these examples can be found here www.keynetix.com/fromTheGroundDown

How to create zones

In a large site investigation boreholes are often clustered in areas, when looking at surfaces for the whole area you may find a lot of meaningless triangulation for areas where no data is available. The same problem can also be seen on smaller sites where you have pockets of strata or outcrops. We need a method to divide the site into appropriate areas. This can be done by using boundaries.

Surface boundaries can be used to create zones but one major limitation is you can only have one outer boundary, however there is a method to sub divide the site.

1. Create a surface as normal
2. Select a surface and add a boundary, set type to **hide** and check on non-destructive breakline, Press OK. When prompted select objects or surface, choice surface and select the surface being worked on. The surface will disappear.
3. Now draw polylines around the areas to be shown.
4. Again select the surface and pick add boundary set type to **show** and check on non-destructive breakline, Press OK.
5. Now select the polylines just drawn.
6. The surface will be displayed with only the areas required showing.

How to draw a fault line

This is a simple example of how to use a **wall breakline** to model a fault in the geology.

1. Draw a polyline where the fault line occurs
2. Create a feature line from the fault line object and use **Apply level** and select the surface being modified.

3. Now add a breakline to the surface, set breakline type to **Wall** and press OK.
4. Now select the feature line just created, select the offset direction and choose **All**, enter the level distance, negative for downwards.
5. A breakline will be created simulating the fault line, repeat the process for other surfaces and strata.

How to model a lens

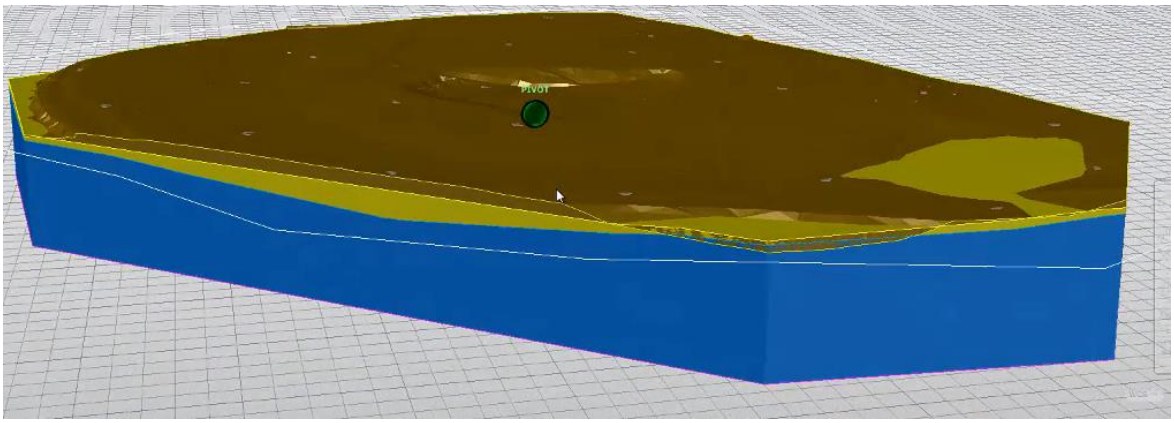
When material sporadically appears over the site and only down the odd borehole it can really affect the look of surfaces created however the surfaces can be modeled by use of breaklines and boundaries to create lenses and outcrops.

From  to 

1. First identify where the lenses are and draw polylines around them in plan.
2. Convert the polylines into feature lines applying the level of the adjacent surface above the lens
3. Repeat the process but for the surface below the lens. You should now have two sets of the feature lines, one for the surface directly above the lens and one for the surface below
4. Now use the feature line as a standard breakline and add it to the lens top surface and the surface above the lens, you are adding the breakline to two surfaces.
5. Repeat, adding a breakline but this time for the lens base surface and the surface below the lens, again you add in the breakline to two surfaces
6. Now to finish the process use the boundary show and hide technique above to only show the lens locations for the lens strata.

How to create a fence and solid block diagrams

The AutoCAD Civil 3D functionality can be used to create both fence and solid block diagrams from the strata surfaces.



This can be done by using either boundaries or by exploding profile chain lines and then using the loft command. There are limitations with this method, for instance the diagrams are static and exaggeration is ignored, however they can be very helpful in presenting data.

Steps To Be Completed

Again a video showing the procedure is on www.keynetix.com/fromTheGroundDown

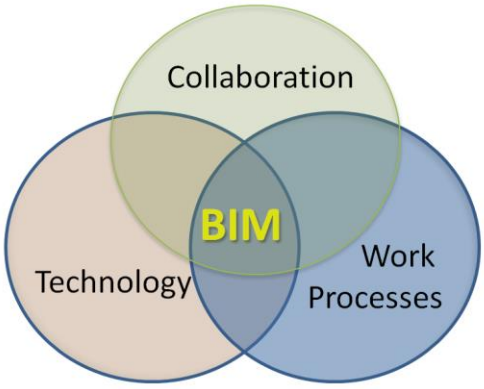
Geotechnical Extension Training and Video site.

Videos from this class and further videos and training material I hope to create in the near future will be put on the “FromTheGroundDown” website.

The hope is people will comment on the videos and make their own suggestions. If you know a work flow or how a method can be improved please let me know, I will record a training movie to show others the process to share your knowledge. I will also be very keen to hear new feature requests and wish list items.

Understand BIM concepts in relation to Geotechnics

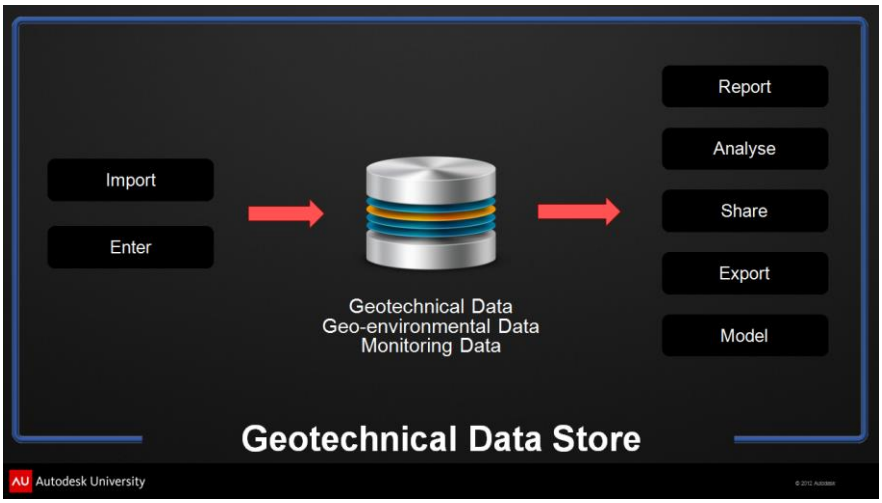
A quick recap of the main BIM principals, is to share and manage data for the whole life of the project, from initial feasibility, through initial design, detailed design, construction and maintenance. To be able to do this you need good processes and data management in place so the latest model and the latest information can be accessed for one location and errors are reduced.



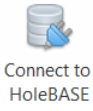
The same is true for geotechnical data, it needs to be managed and controlled through the lifetime of the projects. Geotechnical data is constantly being updated with new additions coming in from site, updates to the geotechnical report, results from the geotechnical labs and the latest interpretation of the data. All of these changes and updates need to be managed to help reduce errors and risk.

HoleBASE SI

HoleBASE SI is a geotechnical data management software, designed as a central store for the reporting, analysing, sharing, exporting and modelling of geotechnical information.



Like the principles of BIM, data is collected and managed from which a quick output can be generated, including reports, logs and cross sections.



Connecting the Geotechnical Extension to HoleBASE SI

As well as importing data the extension can also connect and access data directly from a central database, HoleBASE Si. This starts to bring the advantages of BIM, changes can be made in

the central database and the updates are shared with all. This means the Civil 3D extension will have access to the latest geotechnical data, this will help reduce errors and mistakes from importing the wrong file.

The tool will also have an option to check the database for updates, if found these can be merged with the strata surfaces already in the drawing.