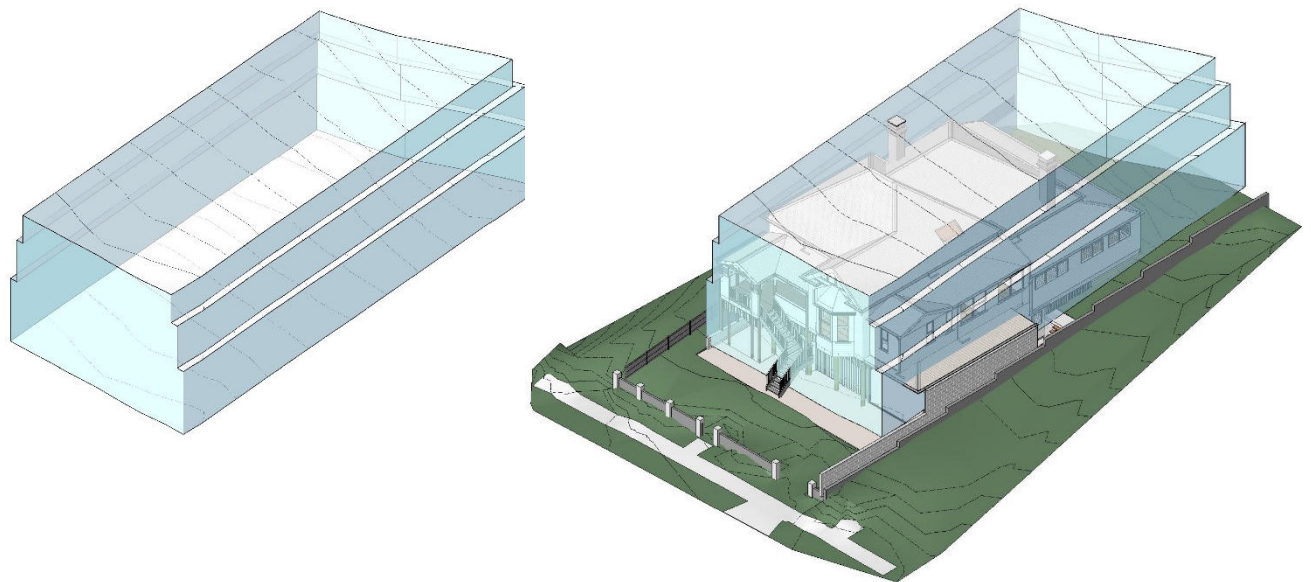# GARC Systems

Support Article:

Creating a Building Envelope

Updated: 8 July 2017

Original: 20 Mar 2017. This update contains a description of creating an angled envelope.

Examples of a building envelope file, left, and that file linked into a host file, right:

latemore
design

Most building projects must fit within a building envelope, as set by state and local authorities. It can be helpful to model this in 3D, and Revit is great at assisting you with this.

This tutorial shows you how to create a separate Revit project file, for the building envelope, which is then linked into your main project file.

Create File:
SaveAs Project File into new file

Strip out redundant views & sheets. Purge.

Create a glass toposurface for Natural Ground Surface (NGS).

Create toposurfaces for the Height Restrictions.

Adjust the Height Toposurfaces for Setbacks.

Add 'Walls' to the Building Envelope.

Adjust the Look of the Building Envelope, using VG.

Link Files. The Building Envelope file is 'linked' into the host file.

Manage the Link

Adjust the look of the Building Envelope link

Completed Building Envelope.

We always start a project and later make the building envelope, by saving a new file from the first file. This is a simple way to ensure both files share the same origin point, so when the files are linked, they fit together well. If you are familiar with linking Revit files, that may not be needed, as it is relatively easy to align a linked file once inserted.

This tutorial assumes you have already inserted a CAD survey file into your Revit project file, that has the NGS (Natural Ground Surface) in it, plus you have placed property boundaries. The NGS contours are usually required to make a building envelope, as most authorities use that definition to ensure height limits are maintained. On a greenfield site though, the actual contours are usually the ones to use. However you obtain the contours, you will make a 'new' glass toposurface as the basis for the building envelope. The process from that point on in this tutorial is the same. It is often a good idea to already have placed property lines, as these are a good cross check of position when you link the file.
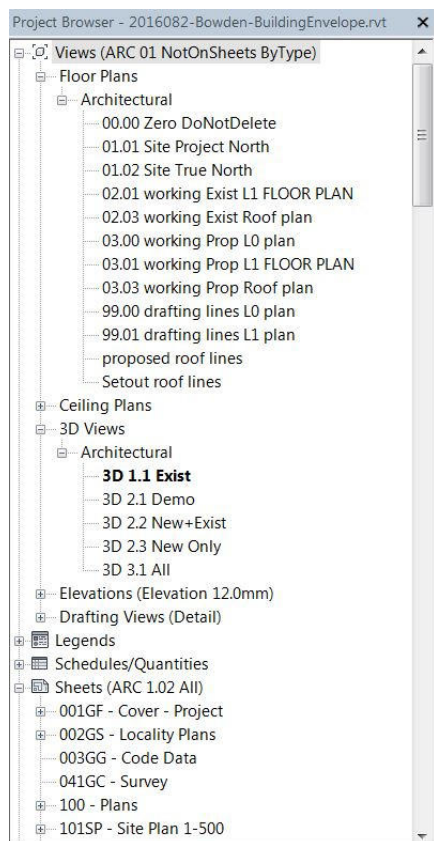
Save As

Save As your project file into a new file. *R* icon ➤ *SaveAs*. Call it something like *JobNo-Client-BuildingEnvelope*.

Strip out the new file

This will take a while, but it helps, as the new file needs to be simple, and small in size.

Firstly, go into 3D 3.1 All, and delete everything. Put the view into course mode, just to make sure you caught everything.

The Project Browser is the key here. At first it looks like at the left, in the ARChetype. Well populated with lots of working views, schedules and sheets.
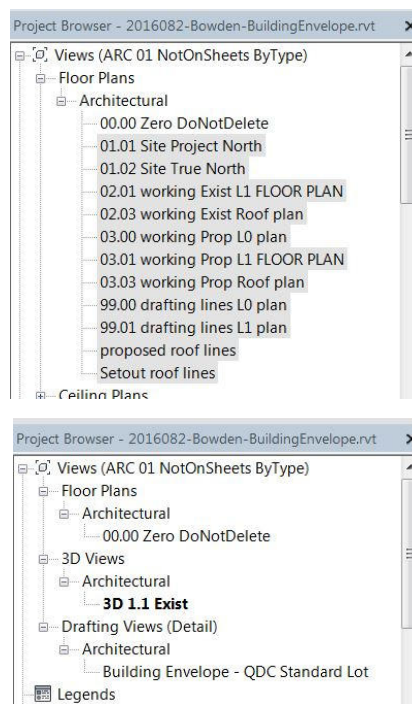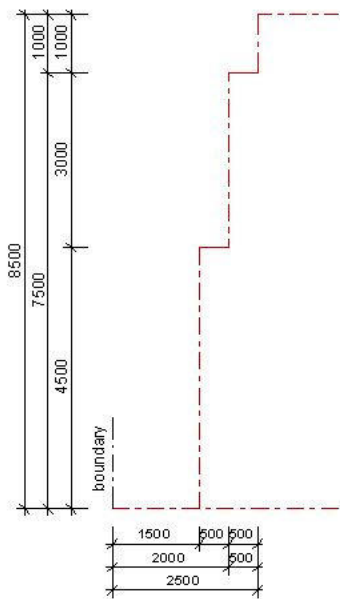

The next steps are repeated several times amongst the categories of views.

The idea here is to keep one plan view at least, one 3D view, and one section. All in the Existing phase. The plan view to keep is *00.00 Zero*, as the NGS contours are based on Sea Level.

Select all the Floor Plans, except 00.00 Zero, and delete.

Do this for the 3D views as well, keeping only *3D 1.1 Exist.*

Delete all Drafting Views, but consider keeping one of the ARChetype's Building Envelope detail views, as that may help you determine the shape of the building envelope you will be modelling. The example at left is *QDC Standard Lot*, the most common in Queensland. You may have different versions, including odd ones with sloping step-ups.

Addendum: *Refer end of this article for making sloped versions.*

Then, select all the Legend and Schedules. Delete. Repeat this for all the Sheets.
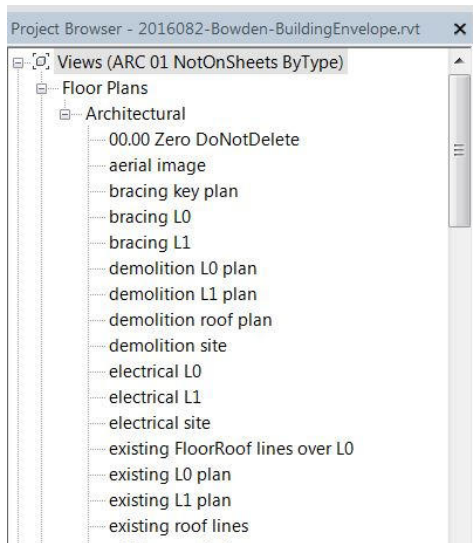
You will end up with a whole lot of views appearing, that were on sheets. Delete the lot, only keeping:

One plan view, ideally *00.00 Zero*,

One 3D view, and

One section.

See below for the ones we suggest.

There are quite a view Groups in the ARChetype. Delete the lot.

You should end up with the Project Browser looking like this.

You only need to keep:

- A plan view – we suggest *00.00 Zero*
- One 3D view – such as *3D 1.1 Exist*
- One section – in this example we have kept *existing long section*, as it is the most useful.
- And one *Building Envelope* detail view, if you like.

If not before, go into the section, and delete all levels, except *Sea Level*. This is essential, as the linked file will bring the levels into your host file, and those levels appear in elevations and sections, confusing matters. You must keep the level *Sea Level* as the linked file uses it as the base level
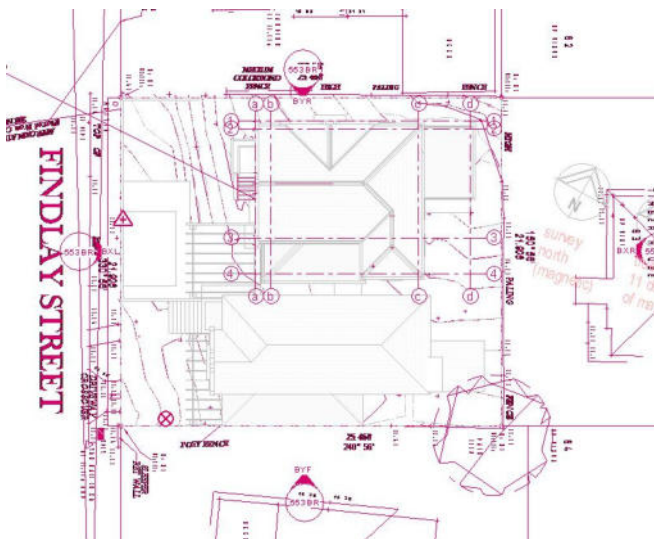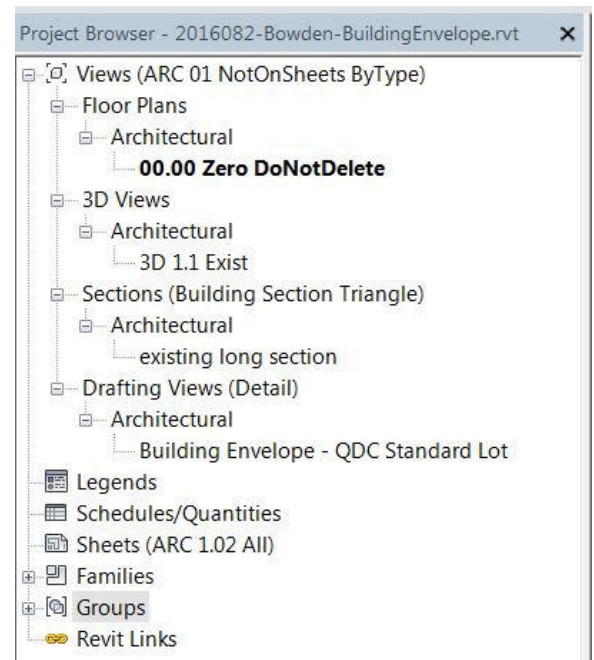
Also, if not before, you need to remove items like grids.

In the plan view *00.00 Zero*, click on the light bulb in the bottom bar of Revit
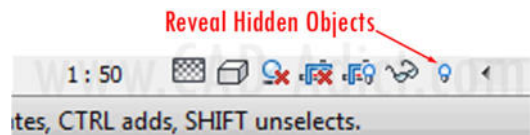
This ensures you see such things as grids, because they are usually 'hidden' in broader scale view.
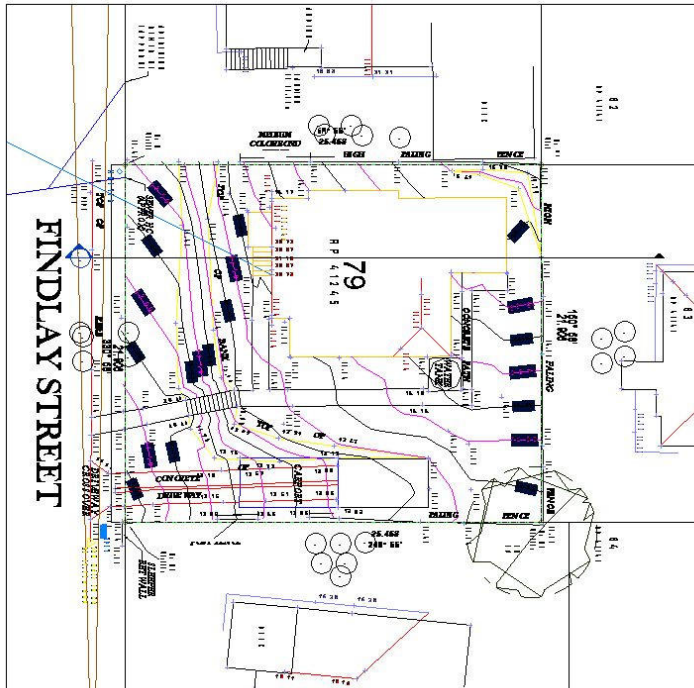
You may see odd items like elevation circles – delete those too.

Now for some fun. *Manage ➤ Purge Unused*

A lot of items will appear in the list. Select OK. Repeat the command, usually three times, and you will have a cleaner file. Don't forget to save your file as you go.

**Creating the NGS Toposurface**

Now to start the production of the building envelope. This begins with creating the base toposurface, from which the envelope is built.

At left is the example file's *00.00 Zero* plan. You can see the long section. Make sure the view is in the Existing phase. In this case the surveyor's CAD file combined the Detail & Contour with NGS. You may have been given two CAD files. Follow our Tip article *ARChetype Topo from Survey* for guidance on how to insert a CAD file.
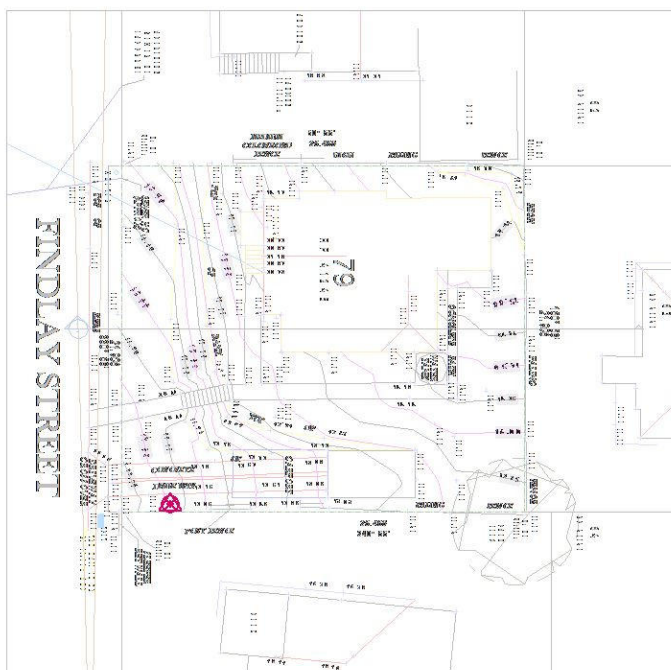
You do not need to do this step – it is mainly to show the origin point.
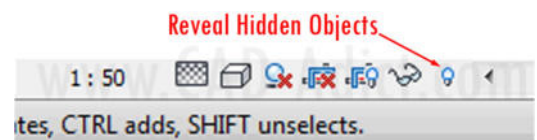
While in the plan view, click on the light bulb in the bottom bar of Revit.

You'll see the origin point become visible.

Revit uses the origin points in both the linked and host files to locate the linked file. If they match, it simplifies the linking process. This is why we suggest you create your building envelope file from your project file.

In the example file we are using, the surveyor placed the NGS set of contours in the same file as the current set of contours. So, the CAD import needs to relocated.
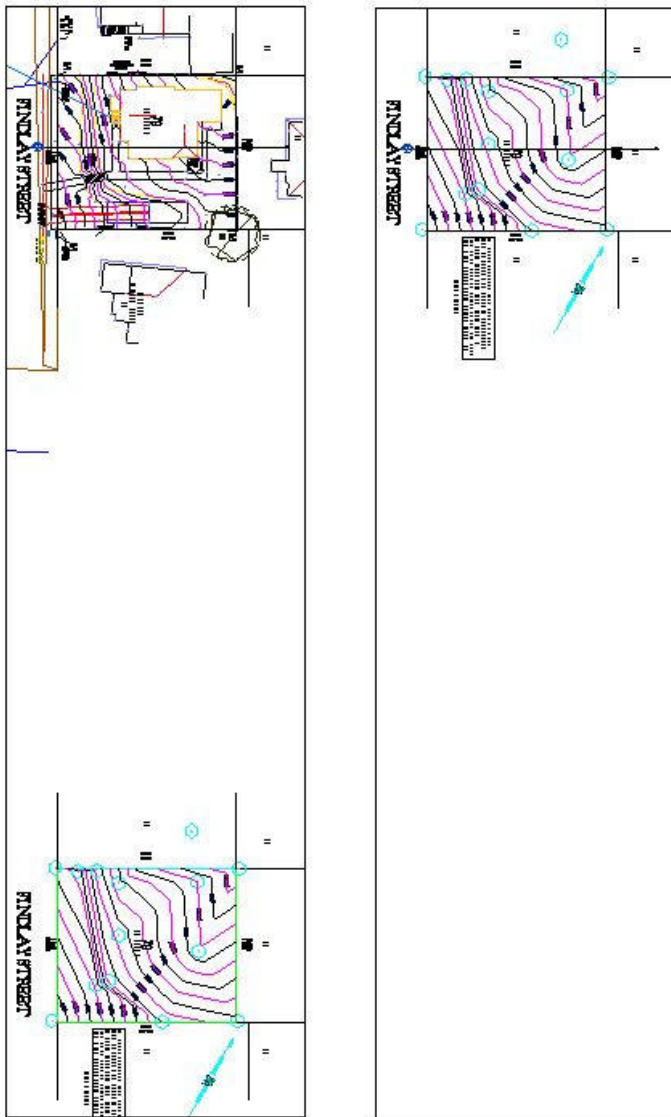
Here is a before and after of moving the CAD file.

Because we suggest you do not delete the property lines, this should be relatively easy.

If your surveyor has provided the NGS data in a separate file, import that into this file, after deleting the other CAD import. Ensure you bring it into the model and not just into the plan view, as you will be using it to create a toposurface.

If on the other hand, you have no CAD data, and you are basing your NGS on something like council contours, create the toposurface from first principals, as per Revit Help. We find the best way to do this is create an image from the council's online data and underlay that image in a plan and manipulate it to 'fit' the site.
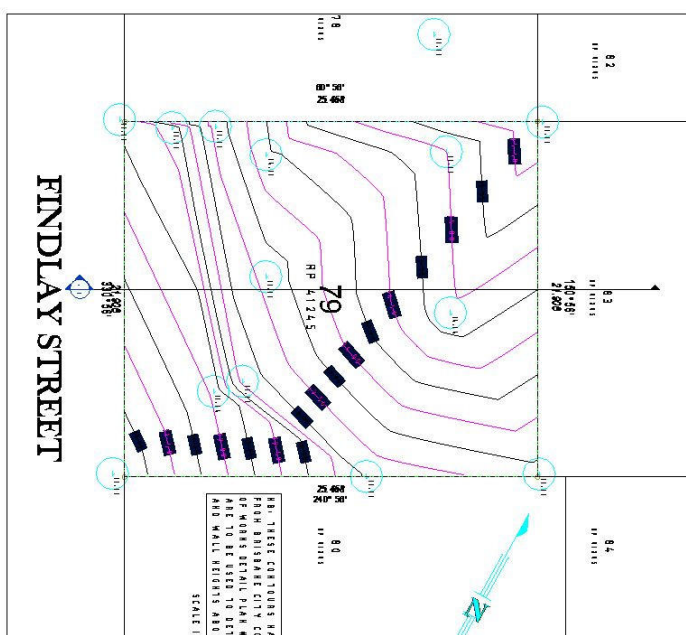
Here is a close up view of the plan showing the surveyor's CAD file in the correct location.
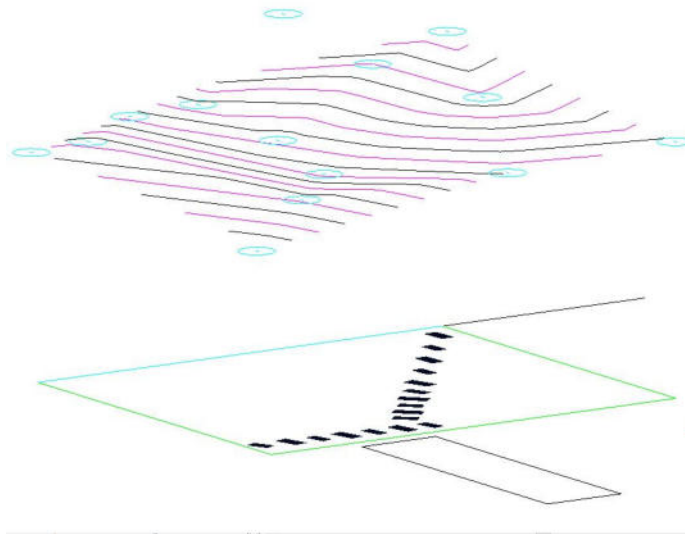
Now look in the 3D view *3D 1.1 Exist.*

It should look something like this, where you see the contours in 3D.

The survey file is likely to have some 'drafting' elements on zero level. Note that in this example the contours are around 20 metres above *Sea Level*. If your site is more elevated, you'll notice greater distance between the drafting elements and the contours.

Now to create the toposurface.
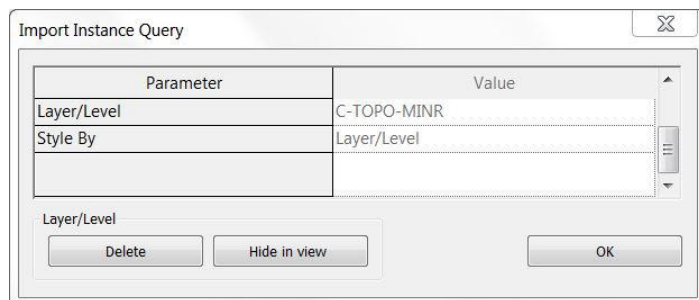
Before doing that, we recommend you investigate the CAD file a little. The reason is that you will be selecting layers in that CAD file to form the toposurface.

Select the CAD import while in the 3D view. In the menu bar at right will appear 3 options, choose the one called Query. And then click on the contours so you know which layers they are in. There are often two or three layers. And be aware some surveyors place their contours (or tri-mesh) in a x-ref or block, so you may need to explode the CAD file.
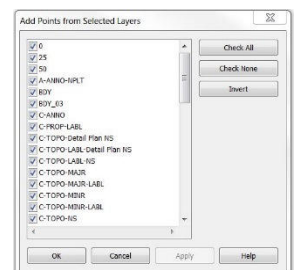
Back to making the toposurface . . .

Massing & Site ➤ Toposurface ➤ Create from Import ➤ Select Import Instance
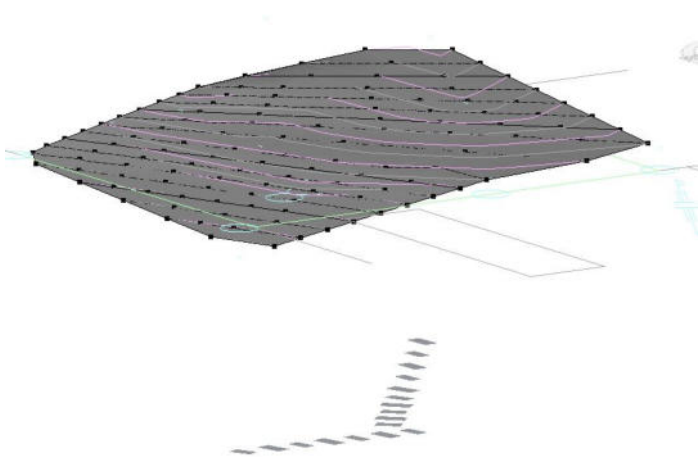


You obviously select the CAD import.

Revit will bring up a dialogue box of all the layers in the CAD File. Check only the ones you need based on the Query methodology above.


Hit OK and Revit will create a toposurface like at left. Accept it by choosing the green tick.

At this juncture we recommend you create a new 3D view with the CAD file hidden, otherwise it becomes annoying. You should keep the CAD import in this Revit file though in case you want to check it. We rename the first 3D view something like *3D 1.1 Exist SurveyOn* and the other *3D 1.1 Exist SurveyOff* . The latter one will be used from now on. Before proceeding, hide the CAD import.
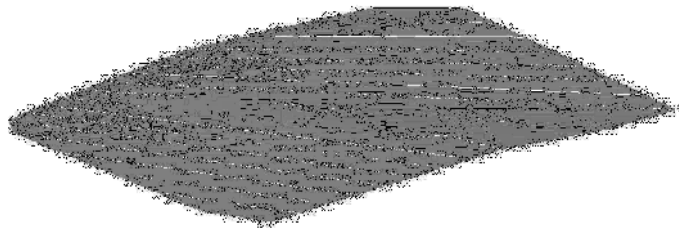
Your 3D view will look similar to this. A grey toposurface.
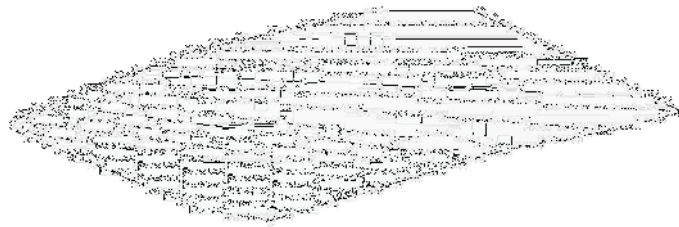
It needs to be 'glass', so change its material to glass. By this stage, it is likely you have purged out most materials. You may need to add the glass. Refer Revit help in how to create a material in your project. We recommend you name it something unique like *GlassBuildingEnvelope*.
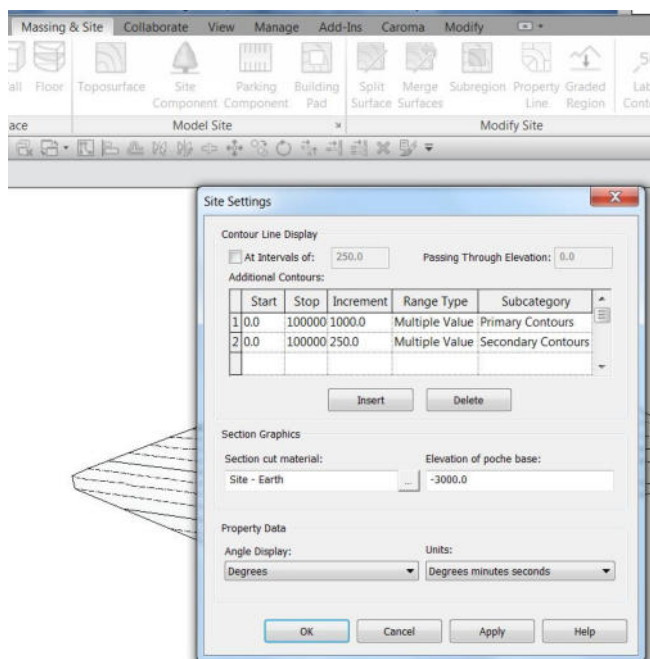
You will now need to adjust the Poche. This is one of the main reasons for creating a linked file, as each Revit project file can only have one set of parameters for the poche.

What is the poche? It is the 'ground' under the toposurface and has a material assigned to it.

Massing & Site ➤ Toposurface Model Site panel ➤ ⬃. (The little arrow to the right of *Model Site*)

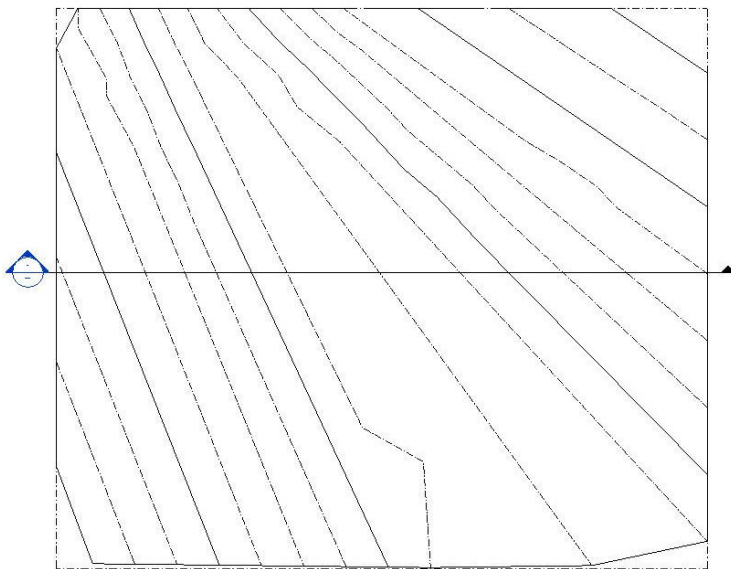Revit defaults with the elevation of the poche base at -3000, ie 3m under *Sea Level*.

You need to change the poche base to a positive number like 100,000, and the material to glass. This ensures that the poche does not obscure your building in the host file.
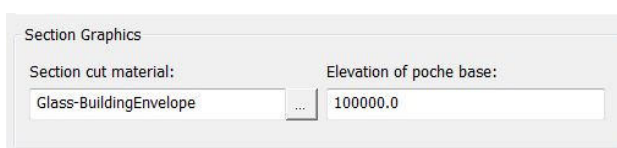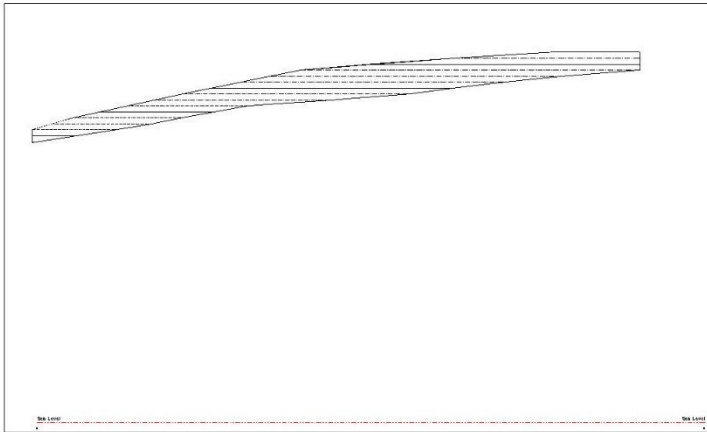
Go to the section to see what you've done so far.
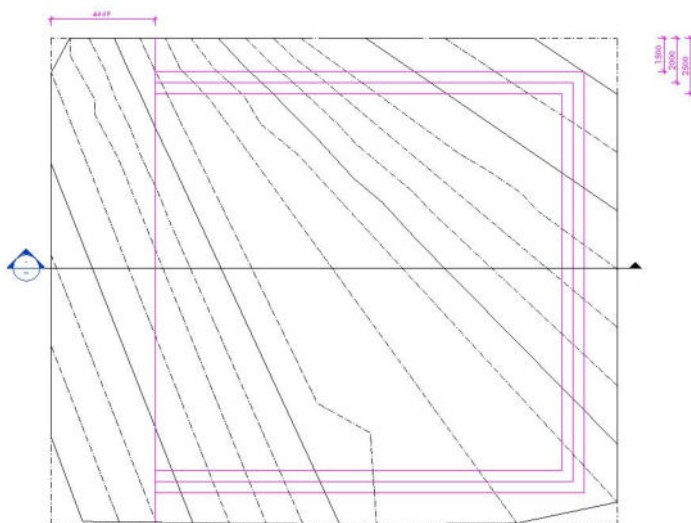
It should look similar to at left.

Return to the plan view.

You now have the basis of the building envelope, by having created the base NGS toposurface.
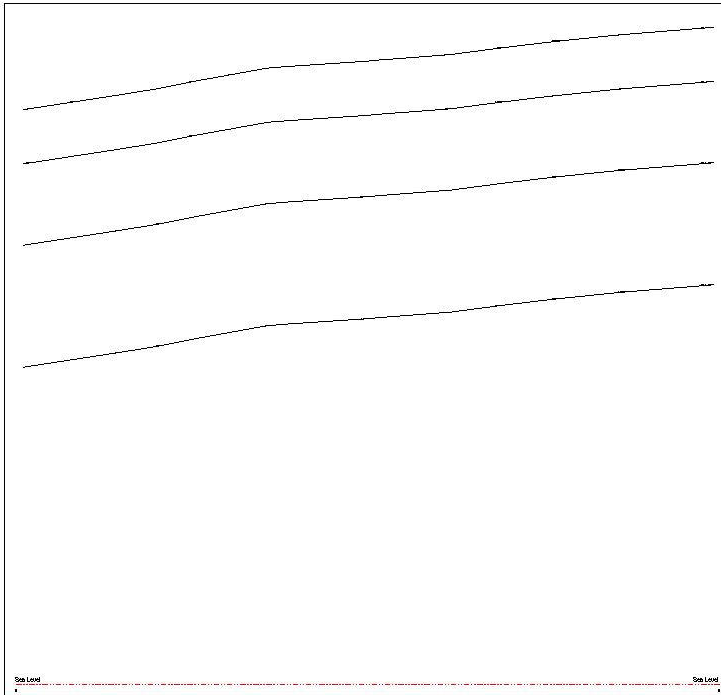
We now will be making the portions of the building envelope that are higher.

Create Toposurfaces for Height Restrictions

To start this we find it best to draw detail lines on the plan view indicating the various setbacks.
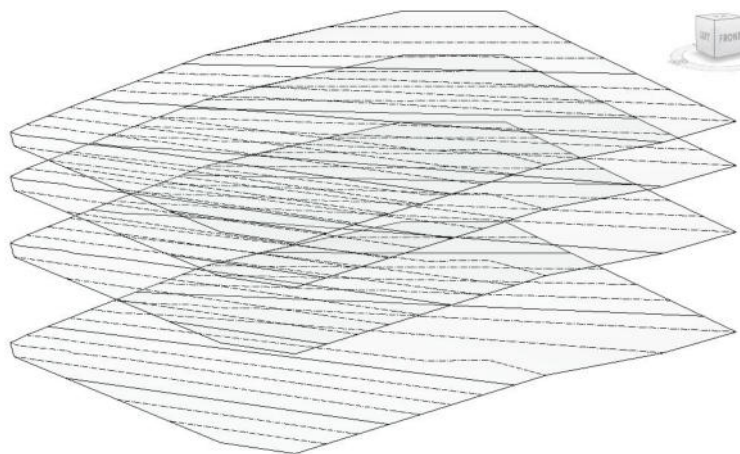
This tutorial is based on a stepped envelope – you may have other versions.

You now copy the toposurface up as many times as there are steps in the envelope.
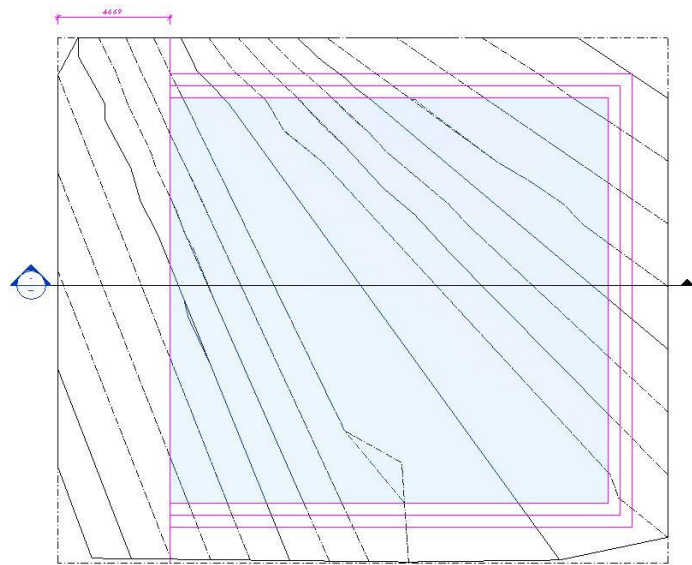
It is best done in the section as at left.

In this example the toposurface was copied up 4.5m, 7.5m and 9.5m.

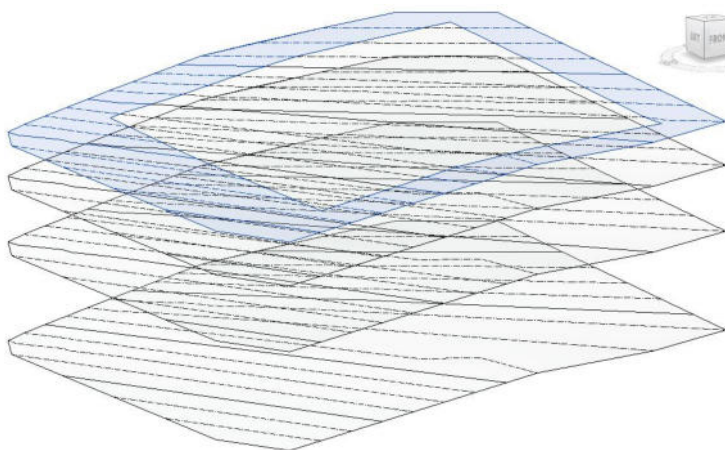This is what it will look like in 3D.

Adjust the Height Toposurfaces for Setbacks

Back in the plan view.

It is time to start splitting the toposurfaces into the ultimate portions needed for the envelope.
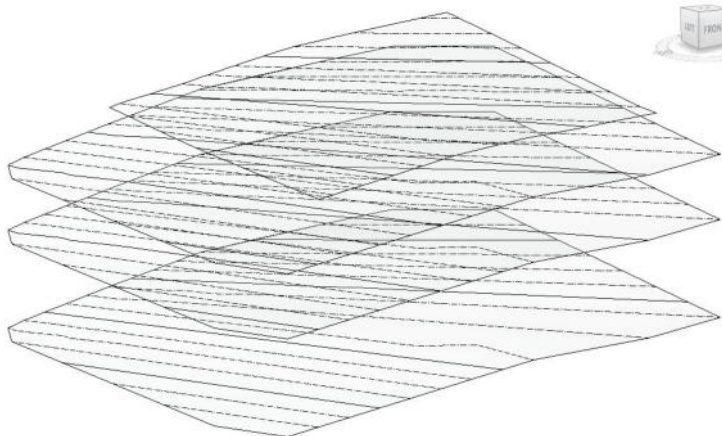
Starting at the higher one, split the toposurface, using the detail lines. At left you see the 'blue' rectangle. This has been selected, and is the part that will remain.
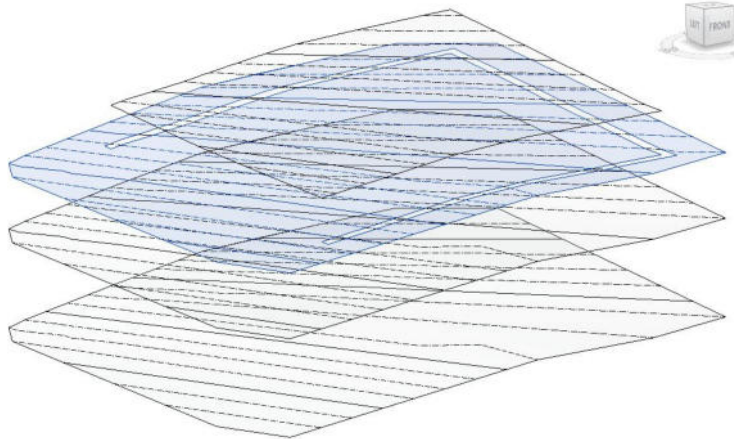

Now in 3D.

We will delete the outer portion. And this is selected in the view example.
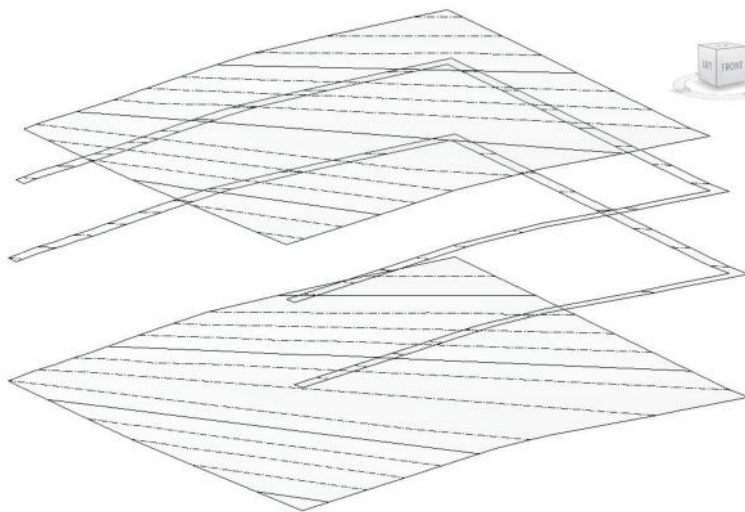
Delete.

The result.

Essentially you repeat this process for the other toposurfaces. At left you see the next level down has been split and the blue selected portion will be deleted.

And this is the final result of the splitting of the toposurfaces, four in this example.

The lowest toposurface is the 'ground' version, and the retained portion is wholly within the outermost setbacks.

Add 'Walls' to the Building Envelope
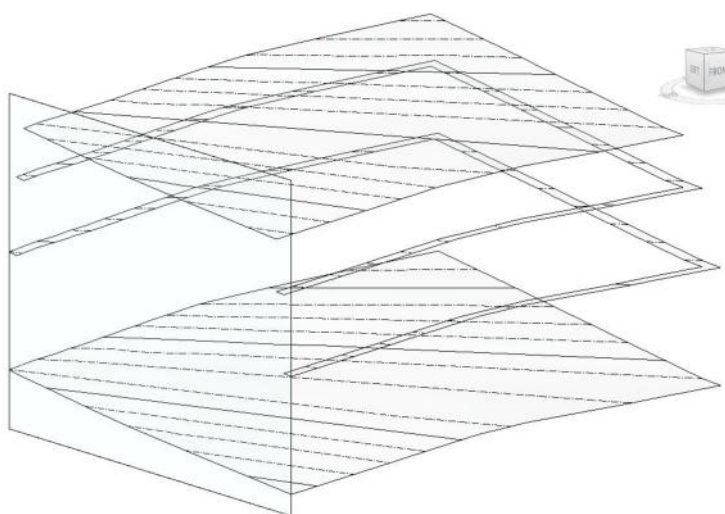
Now you start building the vertical 'wall' elements of the envelope. This is best using a thin glass wall. When using it, change its material to the same as the toposurface. And we change its thickness to 5mm.

At left you see the 'front' wall has been placed. This was done in the plan, with its outside on the detail line. In this 3D view its top and bottom were adjusted to fit to the extremities of the toposurfaces. When you first place a wall, its bottom will be on the Sea Level, as that is the only level in the file.

We are going to shape the wall now, to match the toposurfaces, utilizing *Edit Profile*. Back in the plan view, draw a section just in front of this wall, and adjust its extent to be just behind the wall. The reason for this is to ensure you only 'see' the toposurface, right at the wall.
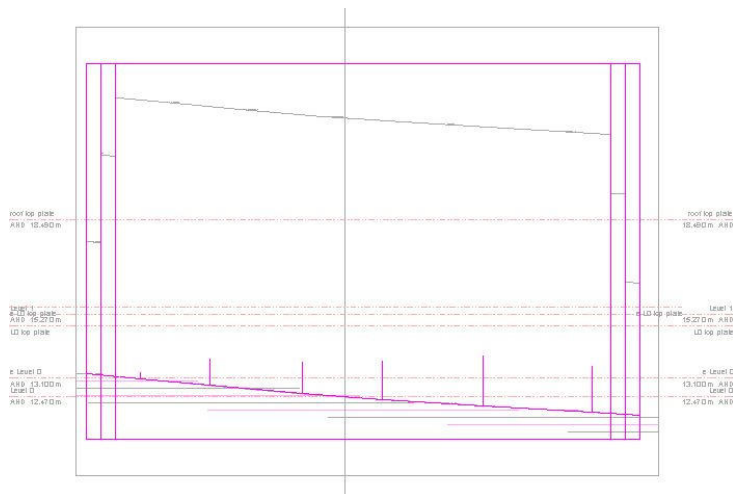
Select the wall and click on *Edit Profile*.

Start drawing sketch lines that match the vertical setbacks. You may need to go right in close to get these accurate.

Also, start drawing lines over the bottom toposurface. Because there are several lines gradually building up, we find it best to begin with short verticals, with one end at the changes in the toposurface and then draw the main lines. Use the keyboard short cut *SE (Snap End)* for this.
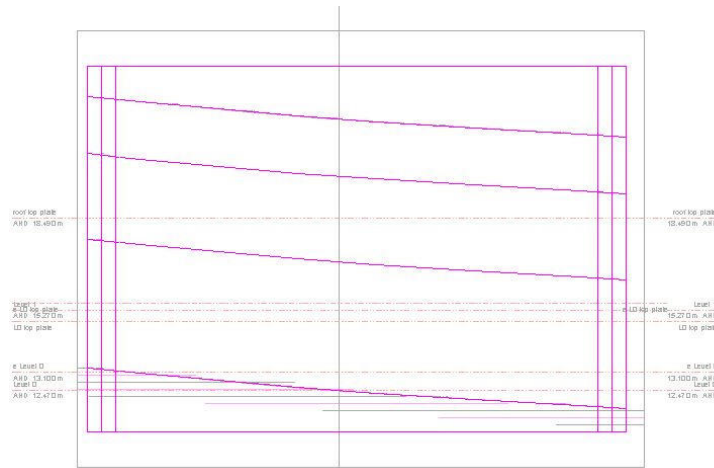
After completing the lines over the lowest toposurface, copy them up to match the other toposurfaces. In this example - 4.5m, 7.5m and 9.5m.
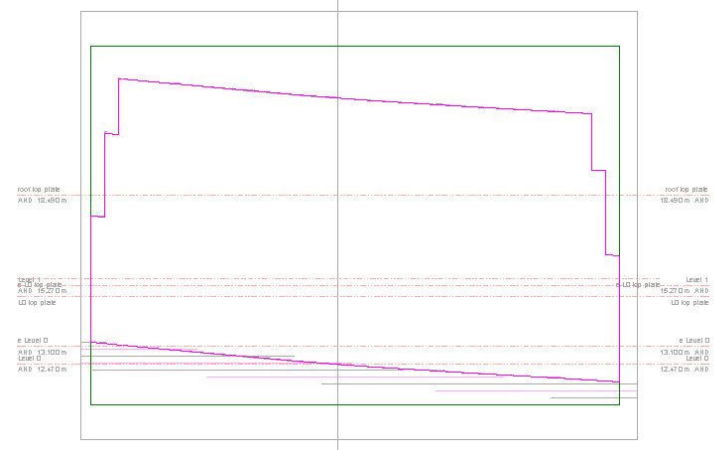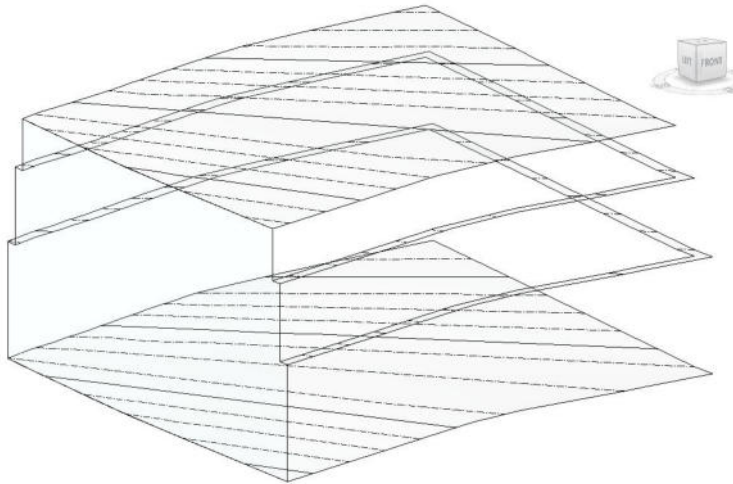
Trim everything, deleting extraneous sketch lines.
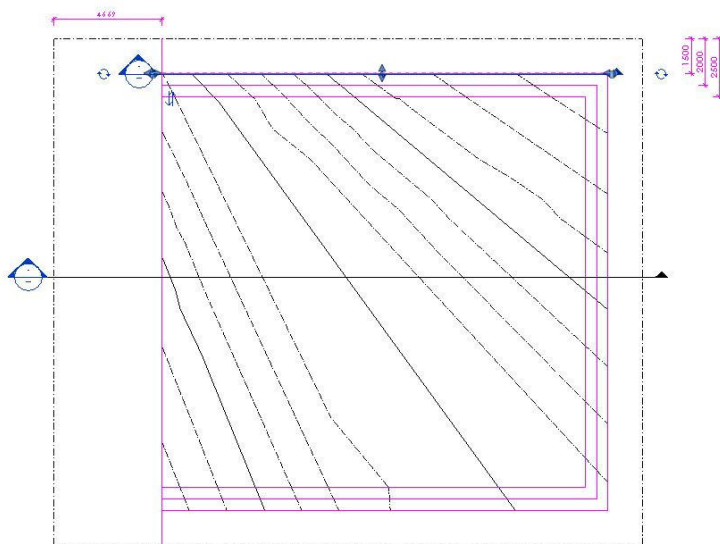
Click on the green tick.
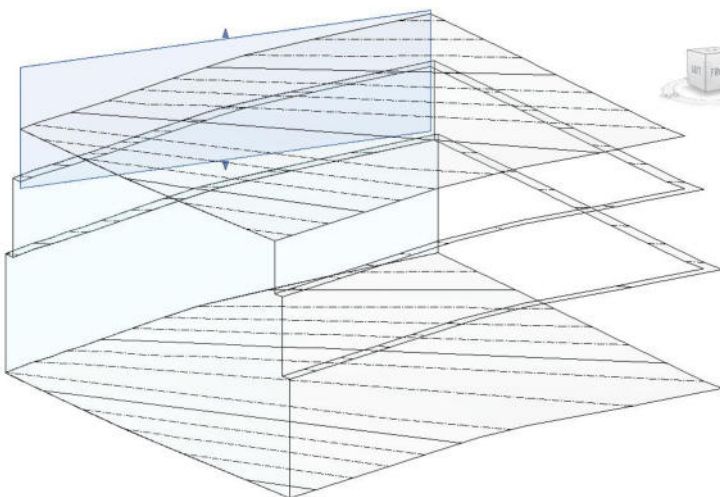
Back in 3D it will look something like this.

Now to continue all around the envelope. In the example there are 9 more walls to place and shape.

Essentially, repeat the process above, around the rest of the envelope.

First off, in the plan, place a glass wall based on the detail lines.

You'll need a section just like above, right up against the wall, with very short extent.

It helps to adjust the top and bottom extents of the walls, in 3D, before you return to the section, and edit the wall's profile. At left you can see two 'walls' are done and the top section is about to be edited in profile.

This is repeated several times, which can take a while, but it is worth it.
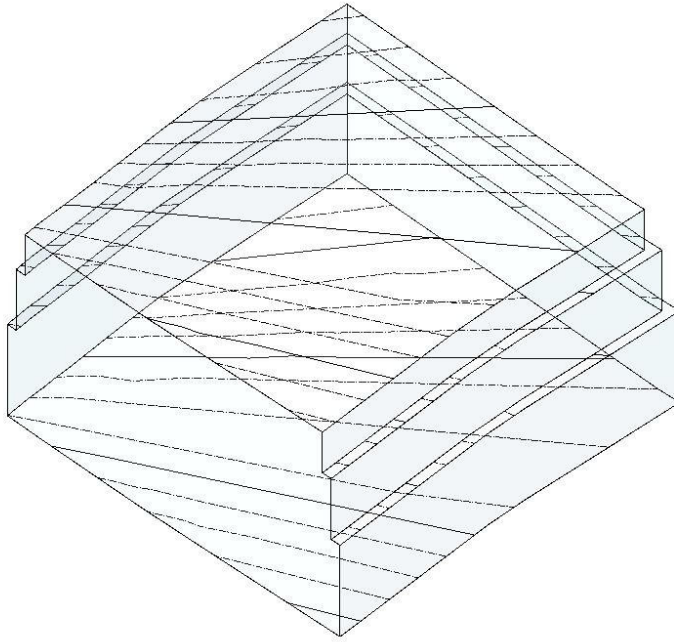
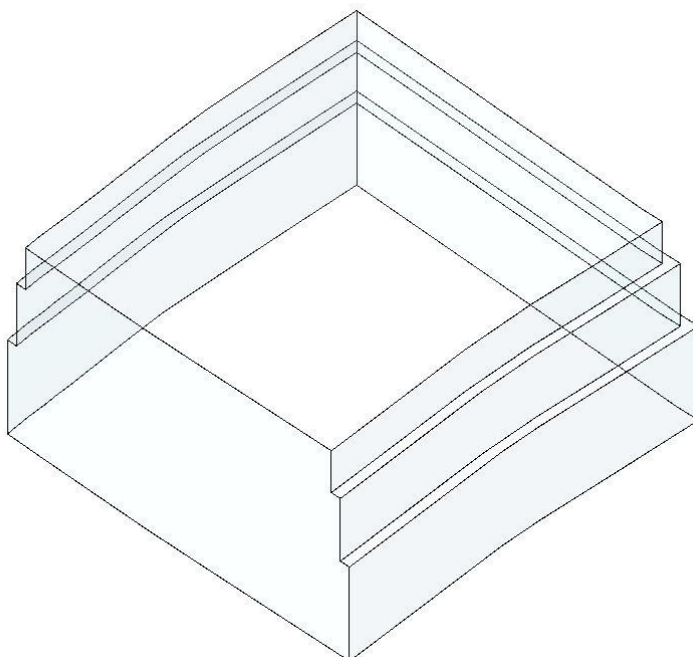The resultant envelope will look something like this.

Adjust the Look of the Building Envelope
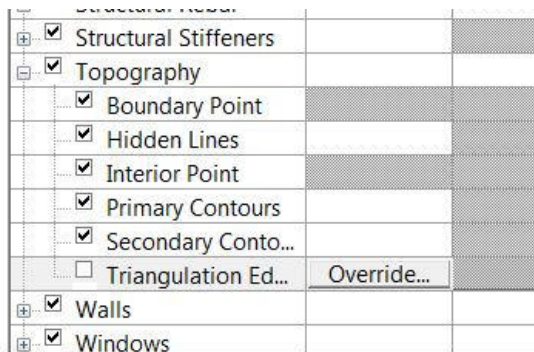
We suggest you adjust how the toposurfaces look in views, especially 3D.
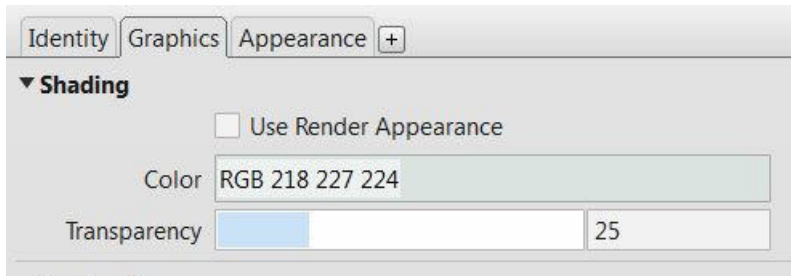
Go to Visibility Graphics within the properties for the view, or just type VG.

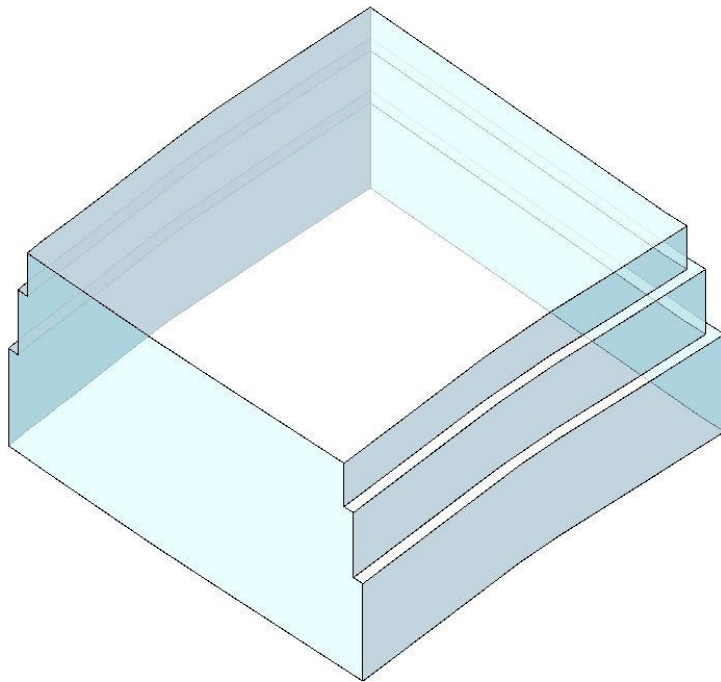Then turn off Primary & Secondary contours.

And then it looks like this.

By this stage, you will have sorted the material, as glass. But what is important when the Building Envelope is linked into the host file is that it does not appear too transparent. We suggest adjusting the transparency of the 'glass' material down to around 25%.
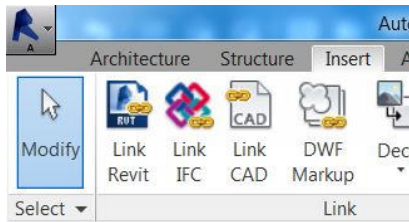

And then you have a lovely looking Building Envelope that will dazzle your clients, and impress the local authority, hopefully.

Save and close the file.

Link Files
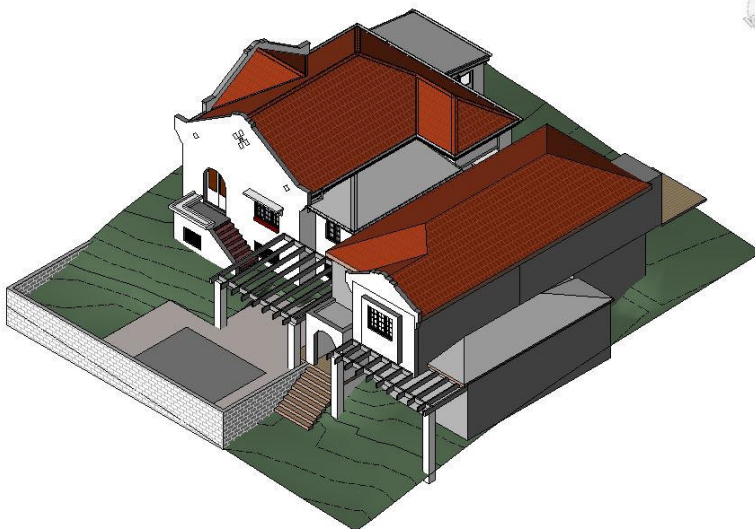
Open your host file. Here is the example project's main file, at an early stage of modelling. The Building Envelope was needed to cross check the design as it was developing.

Time for the fun part of bringing in the Building Envelope.

Insert ➤ Link Revit

You will be taken to a dialogue box similar to this. Usually Revit defaults to the same location as the host file, but if that is not where the Building Envelope is located, navigate to it.
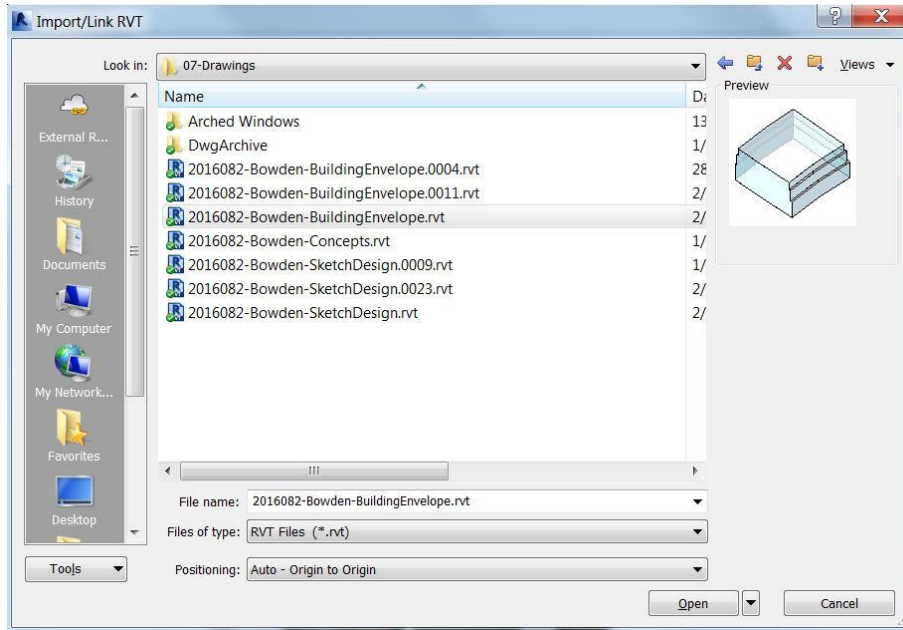
Click on the Building Envelope file and you'll see a preview.

Before selecting *Open*, cross check the items at the bottom. It should default to *Auto – Origin to Origin*. This is ideal, as it will ensure the linked file is perfectly located, as both files share the same origin points. When Revit files are linked, you have other choices in their Positioning, which is ideal for repeating buildings across a site.
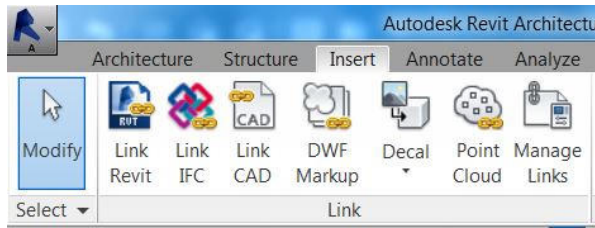
And then the magic of Revit is apparent.
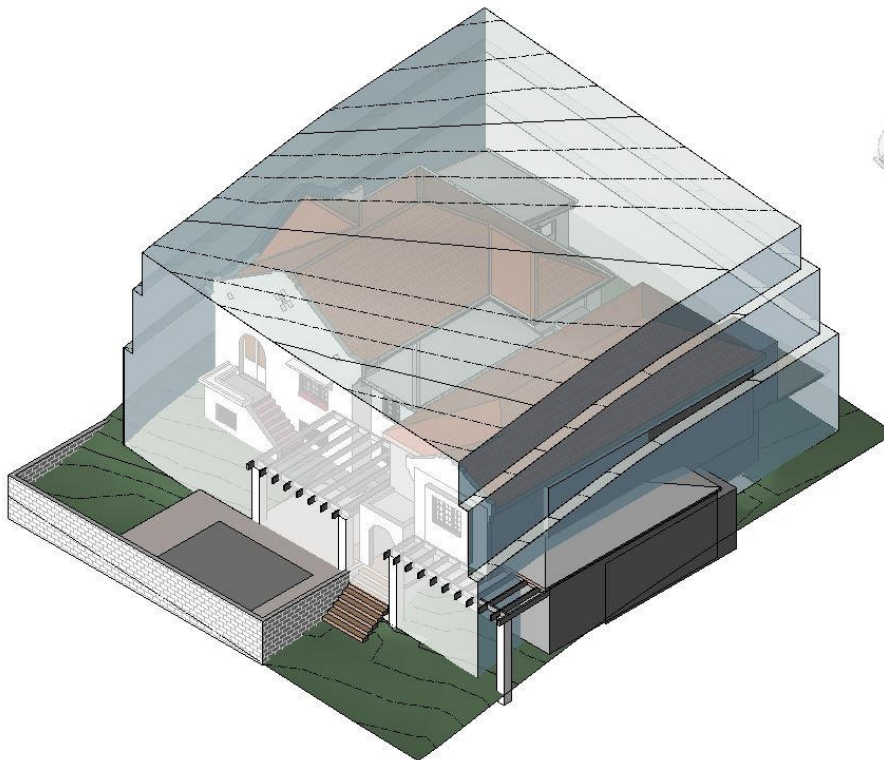
In the example, you can see that some pergola elements are outside the envelope. The garage is also outside the envelope, but in this project, a single storey garage is allowed on the boundary.
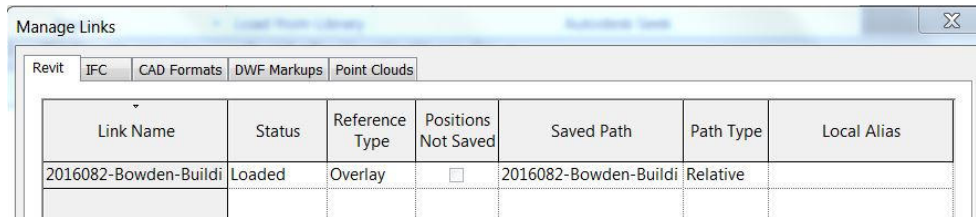
A couple more things to do though . . .

Managing Link

It is always a good idea to check on the link's connection to the host file.

Insert ➤ *Manage Links*

This dialogue box will appear. Choose the *Revit* tab, if it has not defaulted to it.

The most important thing to check is the *Path Type*. We find it best to have this as *Relative*, not *Absolute*, but up to you. *Relative* is better because each time you load the host file, all links are loaded too, and if you move any files, Revit can still load the links as long as they are sitting together.

You may need to come back to Manage Links if ever the linked file drops out, and simply reload under the *Status* column.

Adjust the Look of the Building Envelope link

And now a final step in making the envelope look good in the host file. The host file governs the look of everything, and so it can be necessary to adjust Visibility Graphics in the views within the host file that show the envelope. The contours on the topography portions will be visible and it is nice to hide them.
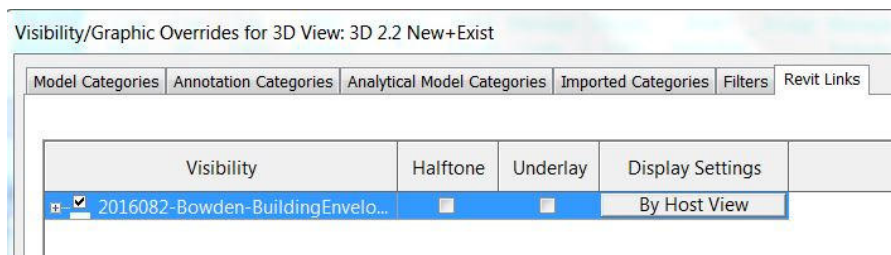
Type VG in the view that you want to see the envelope.
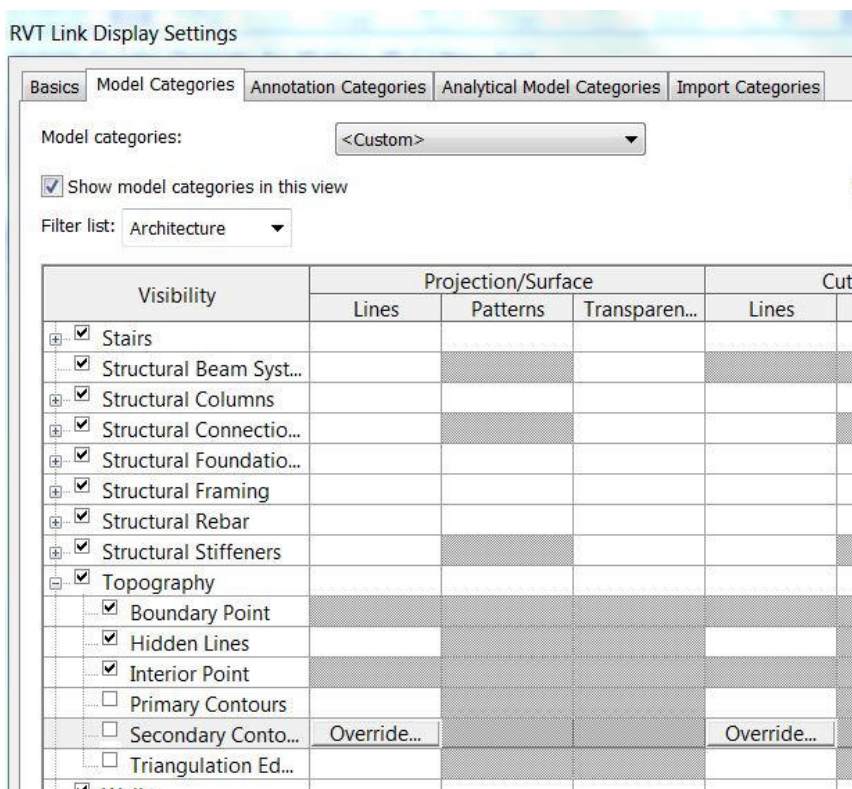
Select the *Revit Links* tab.

Click on *By Host View* under *Display Settings* (for the linked file).
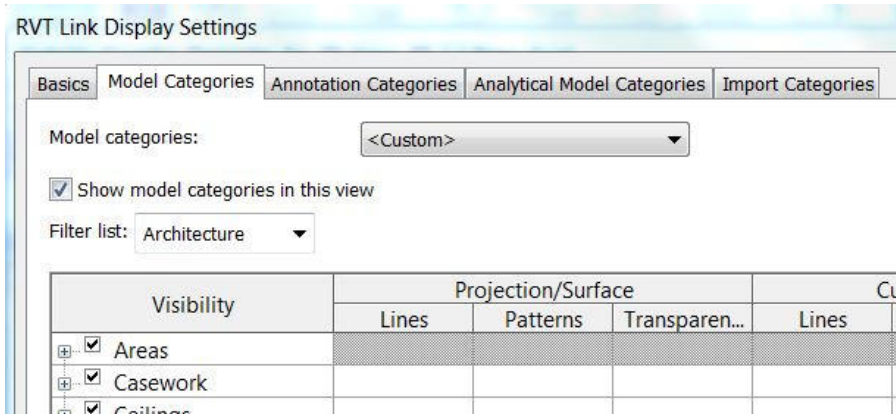
Up comes this dialogue box.

First Select the Basics tab, and choose Custom. This gives you access to how the linked file itself can be viewed.
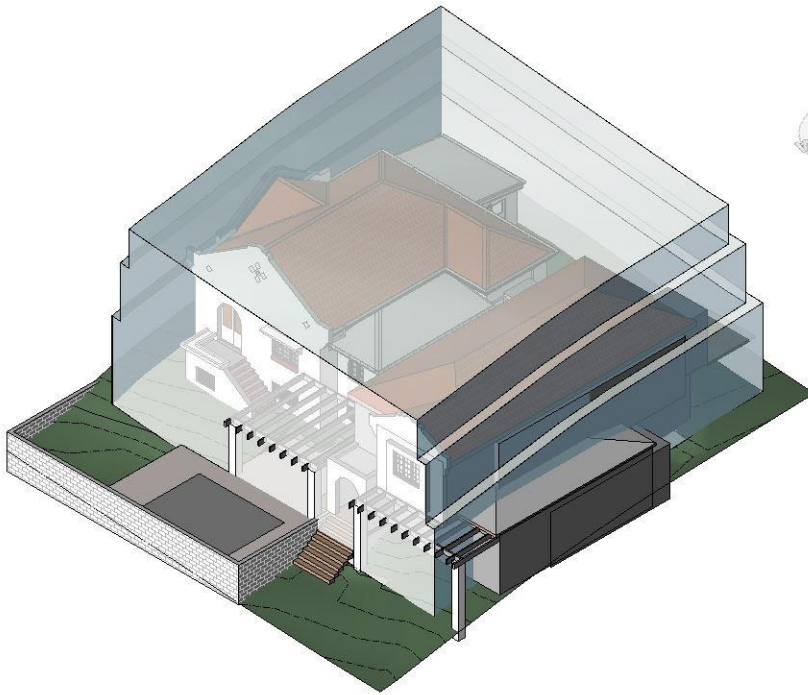
Then select the *Model Categories* tab and change the *Model categories* to *<Custom>*.

Scroll down to Topography and just like you did in the Building Envelope file, turn off the Primary and Secondary Contours.

Select OK.

Completed Building Envelope
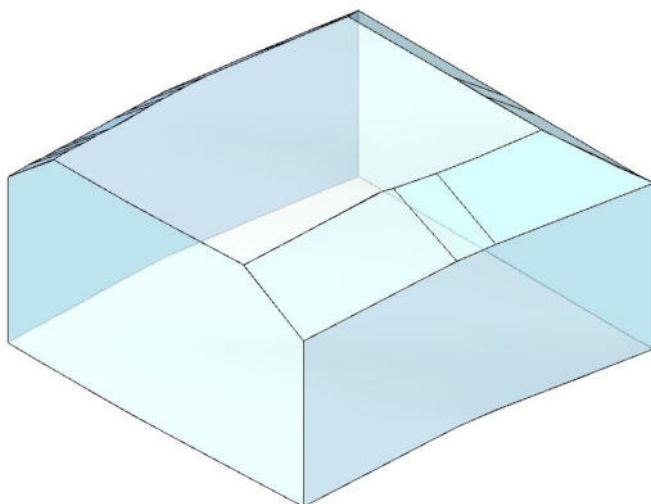
And it will look like this.

Perfect for proving your design works.

One last thing: You will have to hide the envelope in most views in the project, otherwise it gets in the way. Just leave it 'on' where you are wanting to show the authorities how cleverly you fitted your design within setbacks and height restrictions.

ADDENDUM

**Creating a Building Envelope with sloping portions.**

Some users asked us to describe how to make an envelope with sloping step-ups. So, following is a set of example instructions on how to produce one.

It will look like this at left. The example is based on the one used for the above tutorial.

The method below uses *Architecture* ➤ *Component* ➤ *Model In-Place* and is not available in Revit LT.
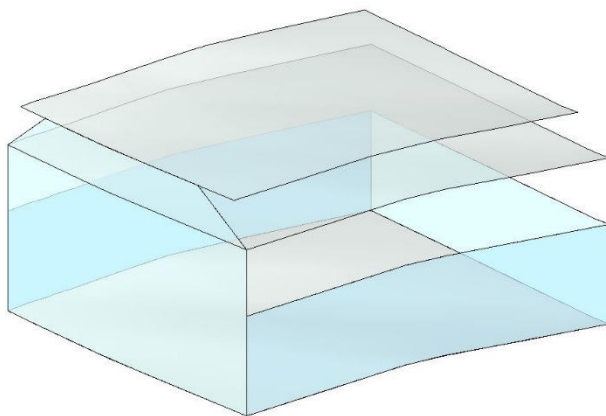
Envelope Setbacks – with Sloping Portions
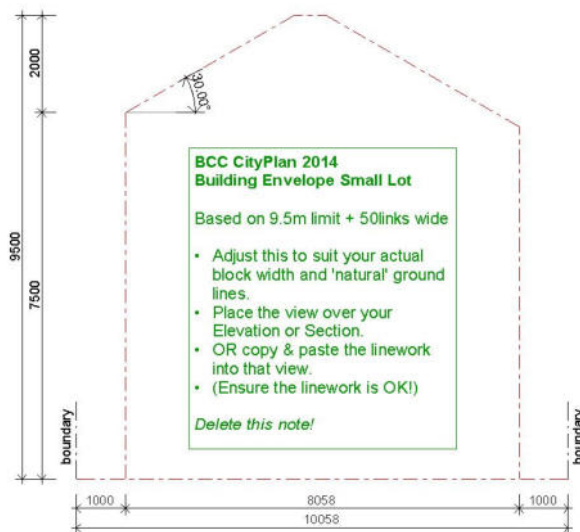
This Addendum is based on the Brisbane small lot code envelope, which has a 30° sloping portion at the top of a 7.5m high line, taken up to a 9.5m maximum height limit.

The diagram is in the ARChetype's drafting views.

Assumed Preliminary Process

This Addendum assumes some of the necessary steps have been taken prior to producing the sloping step-up.

Using the main tutorial above, create the base NGS toposurface, and then copy that up to the required height limits. In this example those are 7.5m and 9.5m. For the example, we have used the envelope from the above tutorial and adjusted it.

What has been kept are the three toposurfaces, the 'front' wall, and the three outermost walls to side and rear. We have already adjusted the profile of the 'front' wall to reflect the shape of the envelope, with the required 30° inward slopes that occur at the 7.5m line. This assumes, of course, that the 'front' of the envelope is vertical to the uppermost height limit. If it is not, use the later methods to produce a sloping step-up.
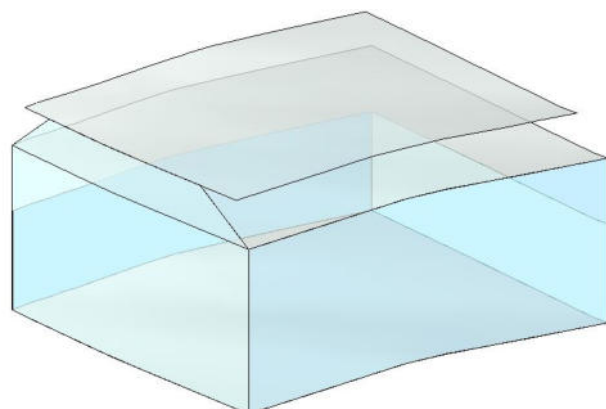
To get to the point of where you'd likely be ready to start adding the sloping portions, we adjusted the model and took the side walls up from 4.5m to 7.5m.

Use the methods described above at *Add 'Walls' to the Building Envelope* to produce the 'walls'.
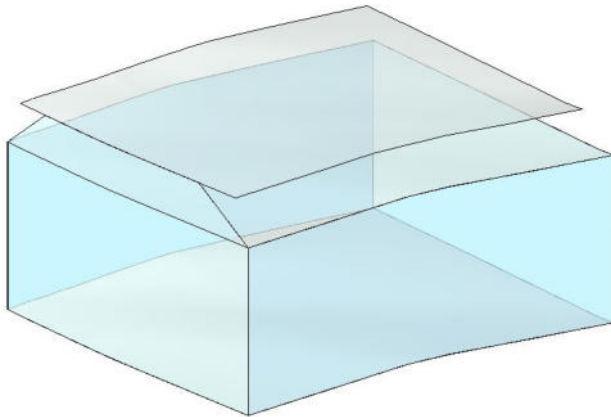
You should have something like this. There are three toposurfaces (in this example), plus four 'walls'. The base NGS toposurface is shaped to be within the envelope, and that is also up at 7.5m and 9.5m high. The front and other three 'walls' have been profiled to match the toposurfaces.

You could remove the 7.5m toposurface, but we suggest you keep it for now, as it helps you see what is emerging as you proceed.
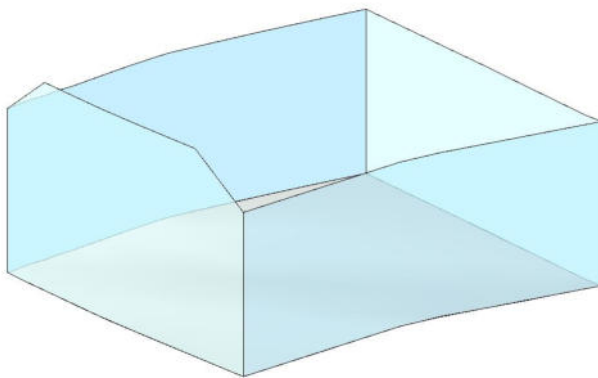
Hide the upper two toposurfaces, and this will prepare you to start creating the sloping upper portions of the envelope.

To produce the sloping portions, you will be creating a sweep using Revit's *Model In-Place* process. This is not available in Revit LT. Be in the 3D view. A sweep uses a path and a profile to produce the shape. You'll be using the top of the 'walls' to pick that path.
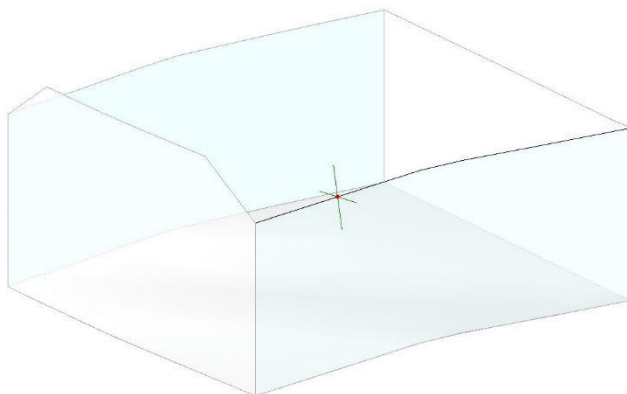
Architecture ➤ Component ➤ Model In-Place

Choose the Family Category and name the in-place family. Then *Sweep*.

The way we suggest you proceed from then on is use the *Pick Path* method. This allows you to pick the path of the sweep while in 3D.

Pick the top of the wall. You'll need to zoom right in to ensure you pick the outer line of the thin wall.

The first 'pick' produces the cross-hair, which sits at the mid-point of the sweep line. So be aware of this as you pick the top of the wall.
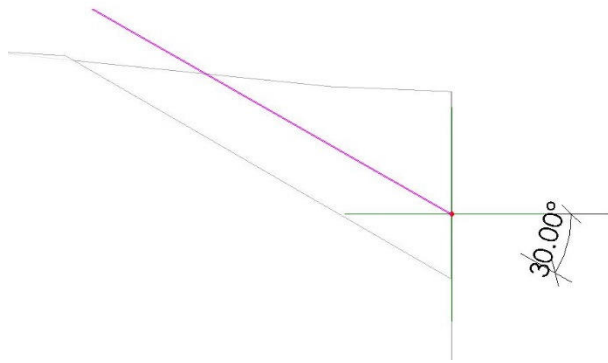
Now to create the profile. Using the View Cube, spin the model square on to view the sweep from the front. This is so you are perpendicular to the cross-hairs.
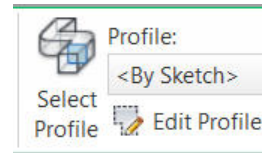
Up in the menu choose *Select Profile* ➤ *Edit Profile.* This starts the *<By Sketch>* process.

Draw sketch lines to create the profile. In this example, it is a long rectangle, 5mm wide, at 30˚ above horizontal. Drawing in 3D has great power, as you can use most 2D controls, including the 30˚ angular dimension you see. It works as the cross-hairs are like reference planes. Please note the top of the profile intersects with the top outermost point on the 'wall' so the outside of the envelope follows the setback lines. The top of the profile is a guess, but using the front 'wall' as a guide, you'll get it close enough for now. We'll be adjusting it later, anyway.

Click on the green tick a couple of times, to exit profile and sweep creation. And spin the model back to axonometric view.
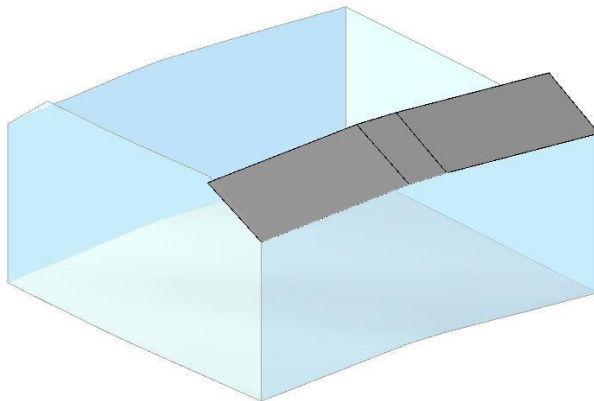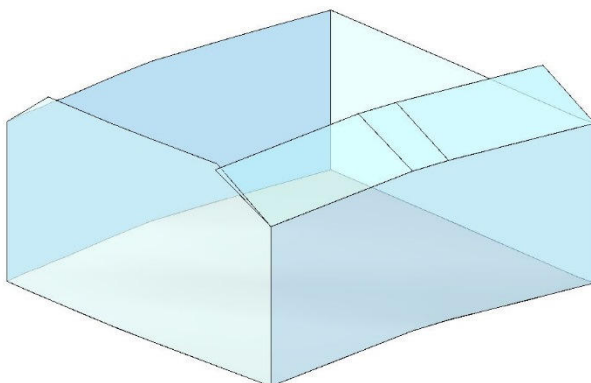

You will have something like this. You are still in the midst of creating a *Model In-Place*.

You will need to apply a material to the sweep. Choose the sweep, and in *Properties*, under *Material*, choose the same material as the walls, which is glass.


Click on the green tick to *Finish Model*.

The result will look like this. Do not worry that the ends and top of the sweep may not match things like a wall or another sweep – you will be using voids to cut the sweep, once you've modelled more.

In case you are wondering, why not run the sweep all-round the envelope? You can try, but the vertical walls have to match each other exactly at the corners, to then attempt placing the sweep lines, right around all the vertical walls. As part of preparing this example, we tried a few times to get the sweep to wrap, but it proved difficult.
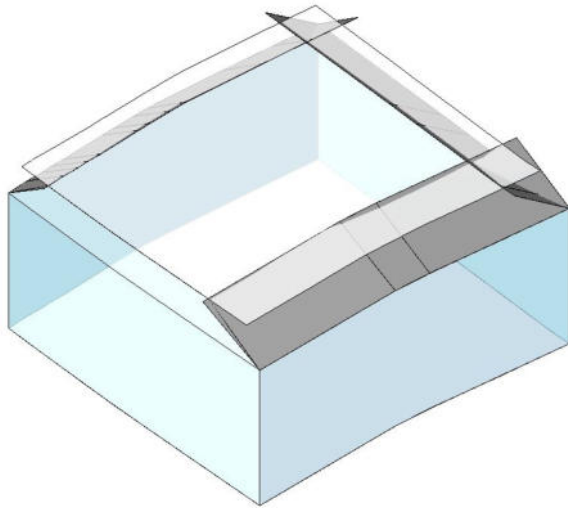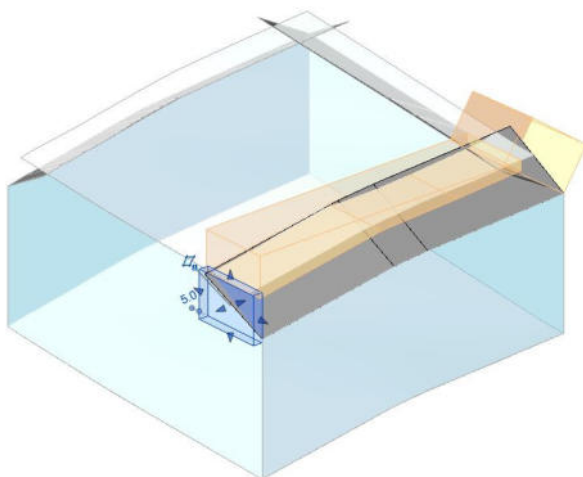
Repeat the above on any other sides needing a sloped step-up.

During this exercise, we found it useful to turn off material on the sweeps, as it proved easier to 'see' what we were doing. So, select each sweep, edit it and change the material to *<By Category>*.
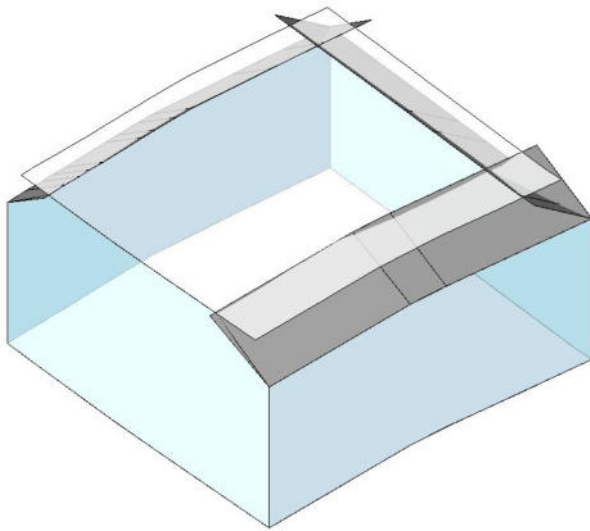
If you have any extraneous items left over, delete them. We have removed the 7.5m toposurface.

Now it is time to use voids to cut away unwanted pieces of the sweeps. In this exercise, we used Void Extrusions.

Select one of the sweeps, and choose *Edit In-Place*, or double-click on the sweep. You are now back in the In-Place editor.

We suggest you visit Help to understand how to make voids, as there are some little tricks, such as understanding how geometry cuts each other, and Work Planes.

We used three void extrusions to adjust the sweeps. They are the orange 'boxes'. The end ones are pure boxes cutting away the overhanging portions beyond the front vertical wall, and the piece outside the angled sweep at rear. The one along the top is like a box but its bottom is shaped to match the 9.5m toposurface. In each case you'll probably have to adjust the shapes a little as you go, or change the direction the extrusion is projected.
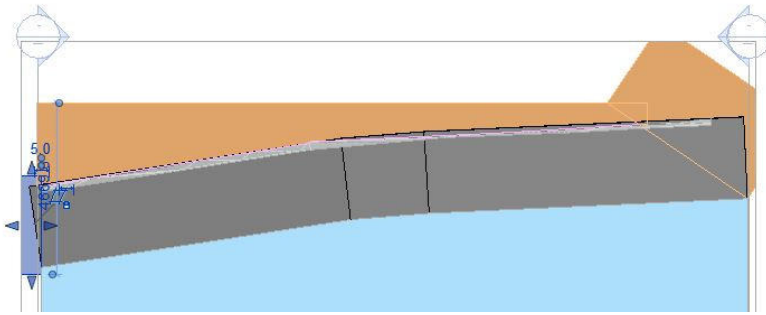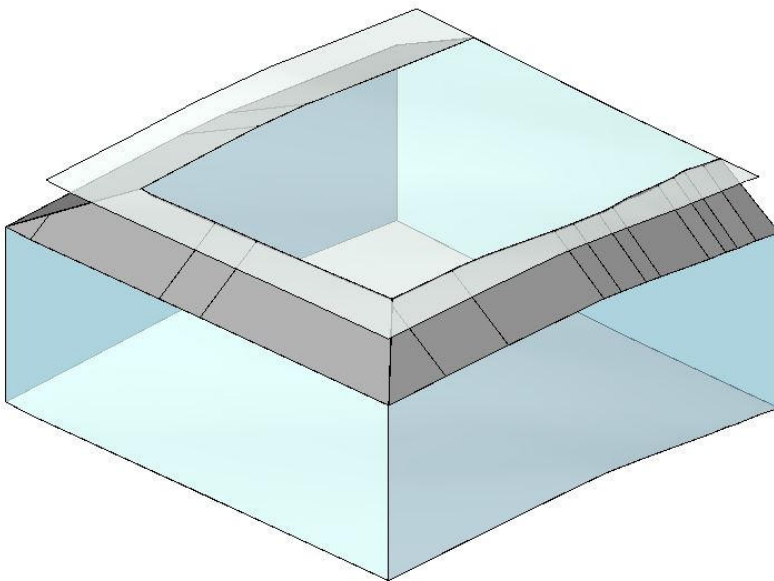
You will have to use the view cube to spin the model to get square on viewpoints of the voids. That way you can draw the void shape and adjust its blue triangle 'handles'.

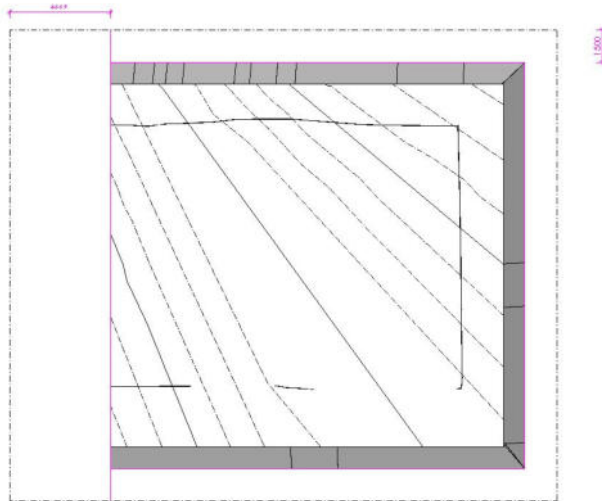In the first set of voids we used three shapes.
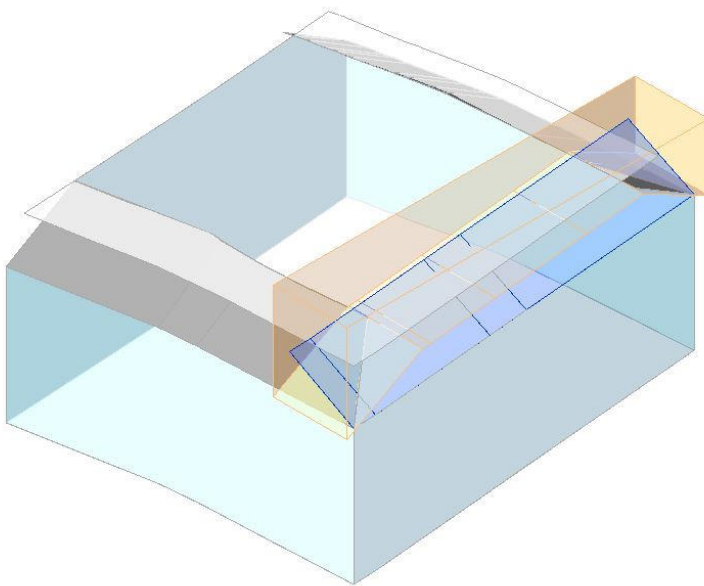
But you can just as easily use the one void shape as you see here, on the rear angled sweep.
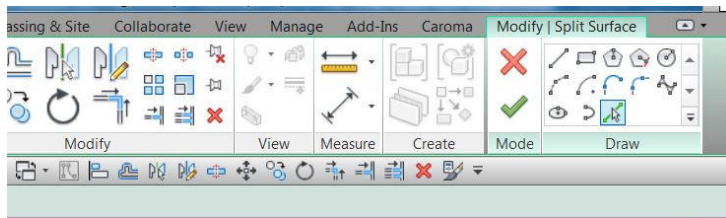

After you've adjusted all angled sweeps, it should look similar to this.
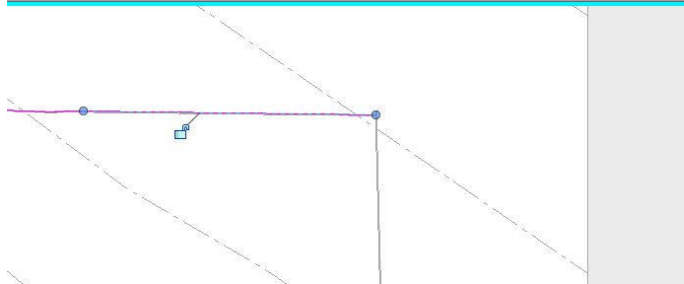
Now to adjust the top toposurface.

We suggest you Split the Toposurface, and to do that go to a plan view.
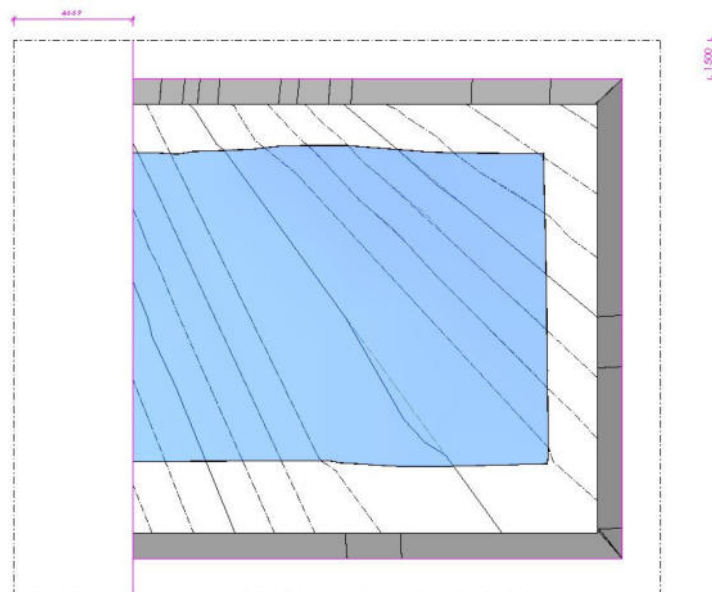

In the menu choose *Massing & Site* ➤ *Split Surface*, then select the toposurface.

The toposurface can then be split into two portions and we will be keeping the inner one.

Just like other sketching methods in Revit, use the *Pick Lines* option, and go around the walls picking their outer line. You may need to zoom in a bit.
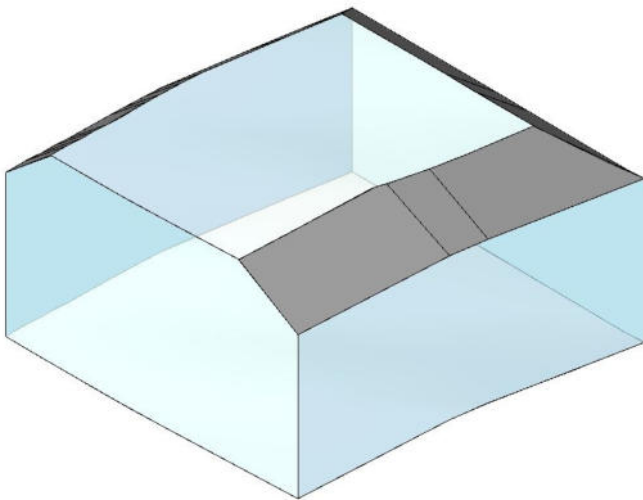

Once complete, choose the green tick, and you should have something like this, with the toposurface now in two pieces.
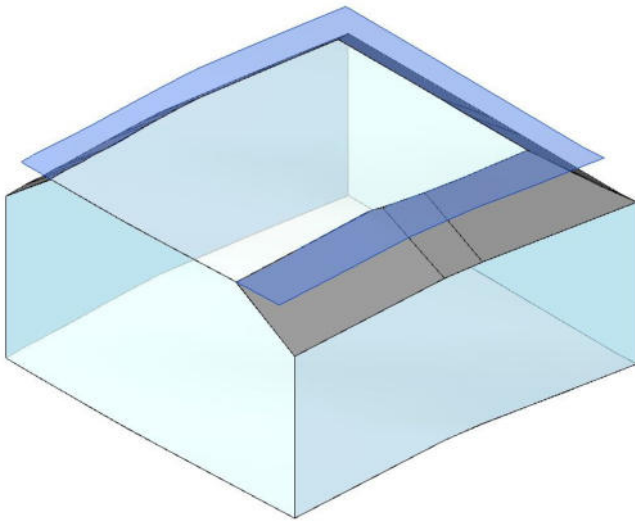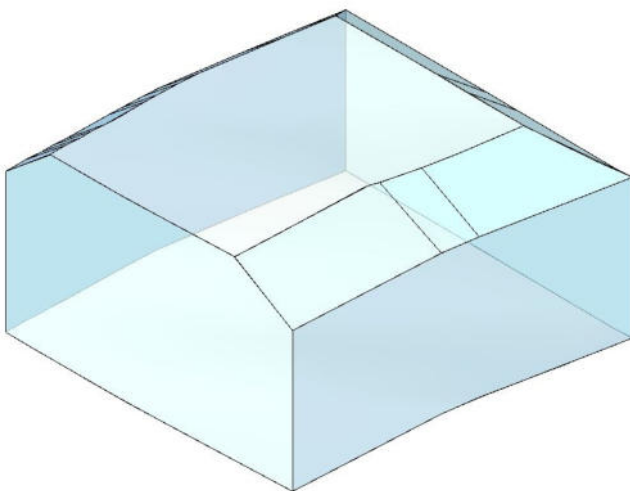
We suggest going to the 3D view just to check on how it is looking.

Then select the outer, unwanted, toposurface, and delete it.

The result will be like this.

Nearly done.

Turn the angled sweeps back into glass.

And now you have a full building envelope with sloping step-ups to totally dazzle your local authority's planning department.