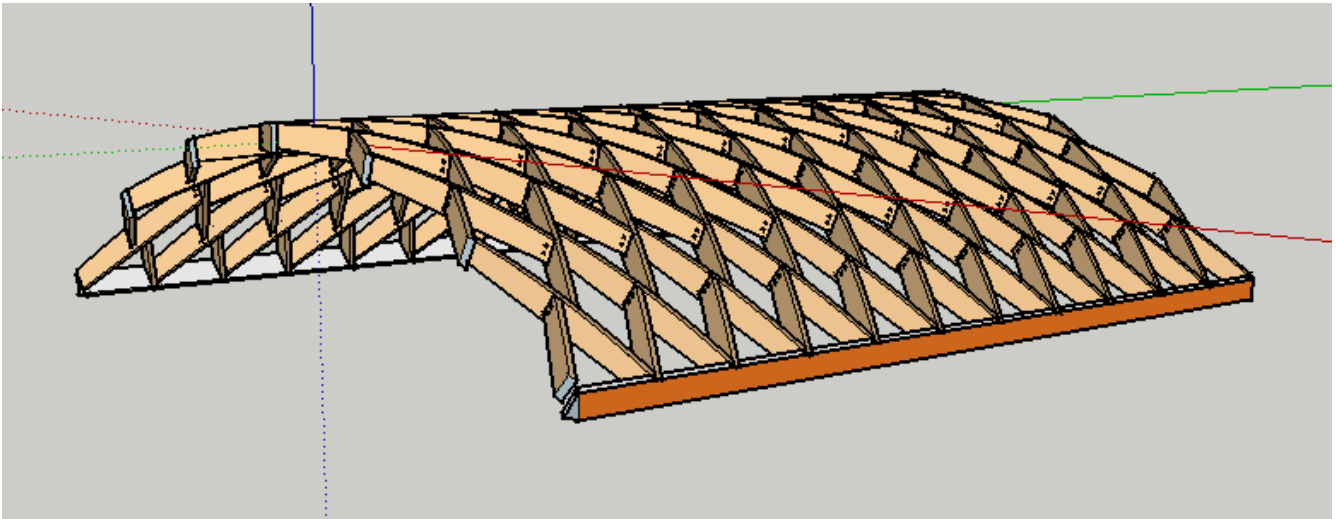


Lamella_roof Sketchup plugin

Introduction

This plugin is conceptually simple: it draws a lamella roof for an arbitrarily-sized rectangular space, and creates the underlying Sketchup model.¹ The plugin also produces all the dimensions of the lamella roof components.



The architectural design parameters are the curvature of the roof, expressed as its height relative to its lowest point, and the number of lamellas per arch. But these interact with engineering considerations, such as the material for the lamellas, their cross-section and length, how they will be joined together, and how they will be secured to the rest of the building. You will need an engineer to review all these specifications, including the kind of bolts and washers you will use, and the torque on the bolts. This plugin leaves all engineering design to you, and makes no claims or representations for the strength of any roof it draws – think of it as *just a drawing tool*.

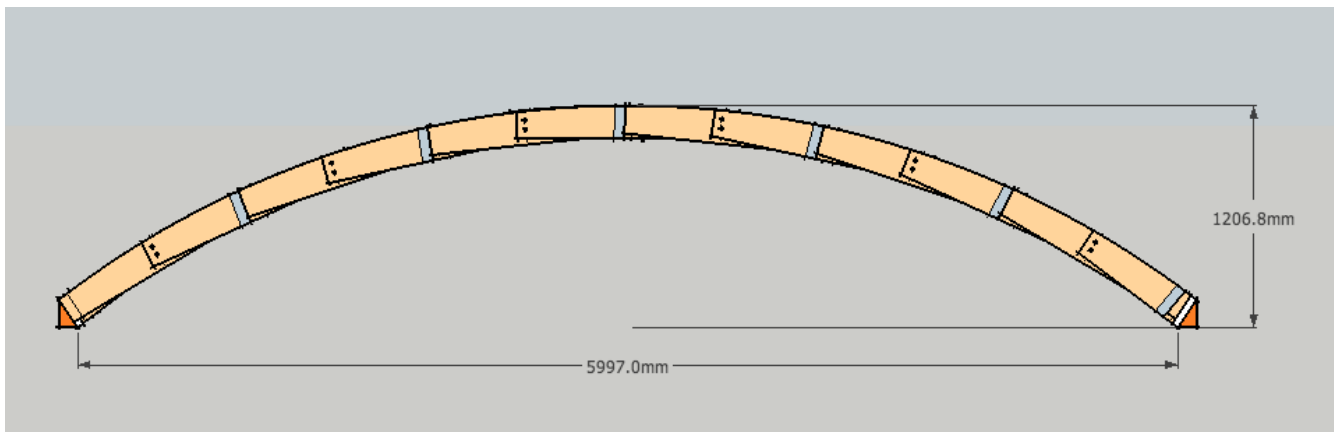
One of the attractions of the lamella roof is that the staggered nature of the way lamellas intersect allows a very simple connection mechanism (e.g., ordinary bolts). A later version of this plugin will allow the possibility of lamellas of a different kind of connector, with the lamellas in a particular arch aligned with each other.

The parameters of roof span and height are approximate with respect to the actual dimensions.² This is because there isn't an easy way to relate the underlying geometry of the roof to a specific, exact set of dimensions.

¹ For examples of lamella roofs, see here. For the underlying geometry, see here. [Note: refs to be provided.]

² All dimensions are expressed in millimeters.

An example will clarify this. Suppose your building / room is 6,000mm wide, and suppose you want the roof to rise 1,000mm above the sills. Now the exact dimensions of the roof this plugin produces will vary depending on the number of lamellas per arch you choose, on the cross-section of the lamella, the skew_angle (see below), and even the diameter of the bolts. Running the plugin with 6 arches and (roughly) 2" x 8" section lamellas returns a lamella roof that is 5,997mm edge-to-edge, with an outside height of 1207mm – numbers that are pretty close but not exact. (These ignore the roof cladding, which adds further height). So the roof parameters roughly describe the results in terms of the inner form of the roof. Since you can play around with the parameters until you get an exact fit this is not too much of an impediment.



Use

The plugin installs itself in the Sketchup Plugins drop-down menu as “Lamella roof”.

Input

Input is by way of dialog boxes in the Sketchup window. There are two dialog boxes, one for the roof parameters, the second for the lamella parameters.

Roof settings

Height: (roughly) the required interior height of the roof (the bottom of the lamellas, say) measured from the sills.

Span: the distance between the sills, measured from the inner edges.

Skew angle: the angle between an arch and a transverse section of the space (or, twice this angle is the angle between lamellas at any node). Engineering considerations suggest this should be in a narrow range, around 20 degrees.

Lamellas: the number of whole lamellas in each arch.

Arches: not a critical quantity, but the Sketchup model that results will replicate the basic geometry this number of times, so you can get an idea how the roof will look. The length of the computed roof will be roughly this multiple of the distance between the nodes (which of course you can't know until you've done this computation. It is tempting to try and make the nodes of the roof coincide with the gables at

each end. Some judicious tweaking of the input parameters (particularly the height) will get a roof that meets this criterion.

```
Roof Settings
Height 1000.0mm
Span 6000.0mm
Skew 22.5
Lamellas 8
Arches 10
```

Lamella settings

Thickness: the thickness of a lamella (e.g., 1.5”), but note that default dimensions for inputs and outputs are in millimeters.

Width: a tricky parameter, since there isn't a good way to specify the width. One could try and use the maximum width of the lamella blank, since a natural way to think about the lamella is that it is fabricated from some prescribed dimension lumber, such as 2x6. The problem is that you don't know in advance how much the curvature of the roof affects the required width of the lamella, or, conversely, how much such curvature will affect the amount of wood at each end of a lamella, where the bolts go. My solution is to specify the width in terms of the minimum width of a lamella – how much you need to support the connectors. The plugin will then compute the exact dimensions of the lamella.

Bolts: If you are using a simple bolt connector (which the plugin assumes) then this parameter is the number of bolts at each connector. Two bolts seem to be preferred for stiffness, although I constructed a non-load-bearing ceiling spanning a 12' space with 1x4 pine lamellas and one 1/4” bolt at each node, and the ceiling hasn't fallen down yet.

Bolt diameter: obvious.

```
Lamella Settings
Thickness 40.0mm
Width 150.0mm
Bolts 2
Bolt diameter 10.0mm
```

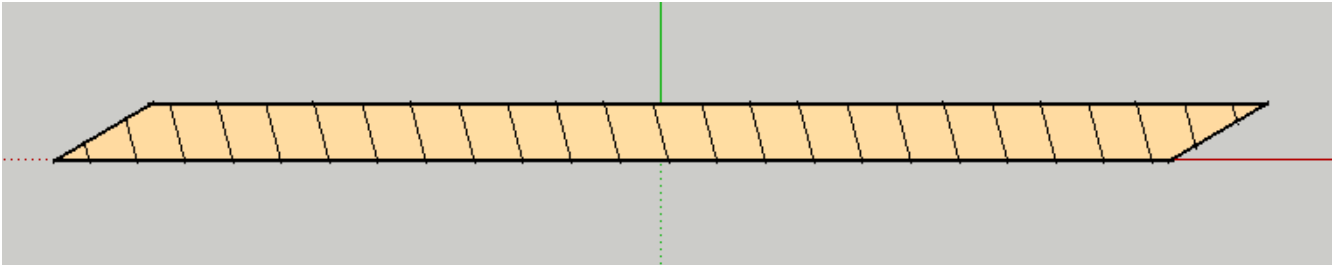
Output

Of course the plugin's primary output can be thought of as the Sketchup model of the roof. This can be modified by anyone with reasonable Sketchup knowledge, and incorporated into a larger model (e.g., of the whole building). It also produces a complete set of cutting specifications for the roof components.

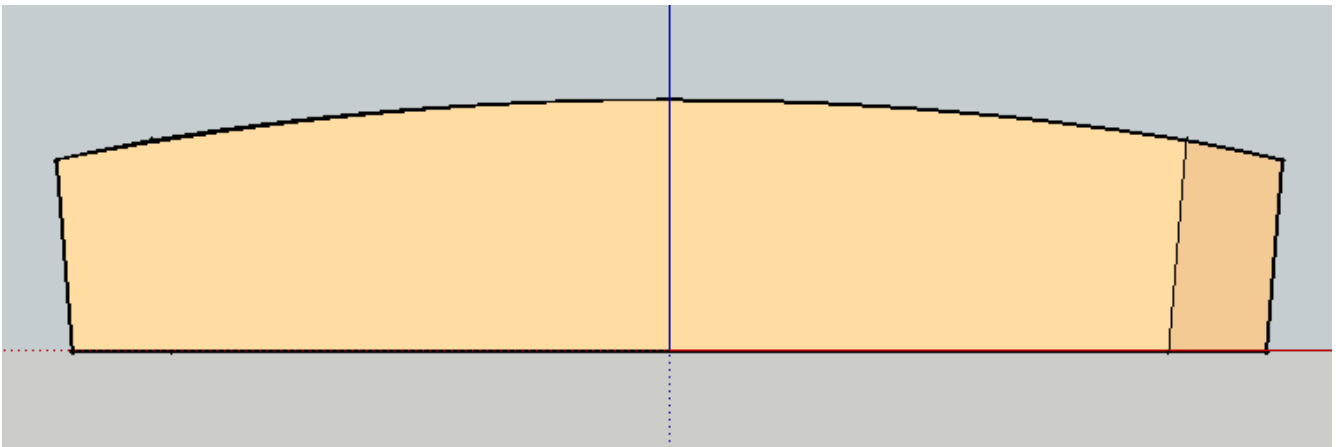
All the specification output is written to the Ruby Console. At present the formatting is crude, but it is easy enough to copy the output to some other more friendly environment, like Excel, and rearrange it.

Lamella specifications

The lamella is described as centered on $x=0$, with one face at $y=0$:



Then the base of the lamella is at $z=0$:



The two major faces of the lamella are identical, but the lamella is rotationally symmetrical, i.e., the back of the lamella is the same as the front, but rotated around the center of the lamella).

The first set of output describes the lamella:

- 1 The lamella blank length – a useful number to know in the design stages, to see if the roof can be constructed without waste. Think of the blank as the squared-off piece of lumber you will use to cut the lamella.

Lamella blank length 1012.43

- 2 The eight corners of the lamella blank – useful in laying out the cuts (although it obviously makes sense to cut all the lamellas on a jig). The lamellas come in two basic forms, a left and a right, that are mirror images of each other. The convention for this plugin is that all the whole lamellas will be “left” lamellas (see above drawing for clarification). The coordinates for the points assume an origin in the center of the lamella.

Lamella blank upper and lower corners

```
-506.22,0.00,171.38
466.13,0.00,171.38
506.22,40.00,171.38
-466.13,40.00,171.38
-498.75,0.00,0.00
458.66,0.00,0.00
498.75,40.00,0.00
```

-458.66,40.00,0.00

- 3 Compound mitre saw angles – these come in two pairs, since how you might choose to cut the lamellas depends on how your saw can be configured.

Compound mitre saw cuts (Option A)

Horizontal angle 44.93
Vertical angle 91.76

Compound mitre saw cuts (Option B)

Horizontal angle 2.49
Vertical angle 44.96

- 4 Points on the curved upper edge of the lamella, in the same coordinate system as the lamella blank. This curve can be laid out exactly, since it is a defined ellipse, with half-axes as described below, but Sketchup creates a polygon to approximate this curve, and the plugin writes out the corners of this polygon.

(x,y) coordinates of vertices on the face of the lamella

-505.11, 145.98
-498.75, 0.00
-422.88, 152.56
-336.77, 158.19
-250.58, 162.57
-164.33, 165.70
-78.03, 167.58
8.28, 168.21
94.60, 167.58
180.90, 165.70
267.15, 162.57
353.34, 158.19
439.44, 152.56
458.66, 0.00
465.22, 150.50

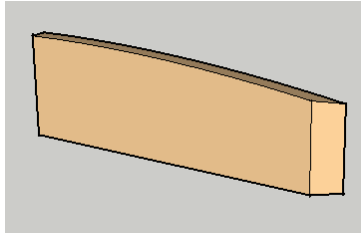
- 5 Exact specification of the elliptical upper edge. The upper edge is an arc of an ellipse with a center at the roof-axis. In the plane of the lamella's face the center is described by its (x,y) coordinates. The ellipse has a major (horizontal) axis (conventionally, the half-axis is called “a”), and a minor (vertical) axis.

Exact description of elliptical upper edge

Center of roof in plane of front of lamella: $x = 8.28$, $y = -5058.83$

Ellipse half-axes: major = 5495.35, minor = 5077.04

- 6 The roof will have reduced lamellas at the sills and at the gables. The plugin writes out the coordinates of the end face of each (to be cut from a right lamella).

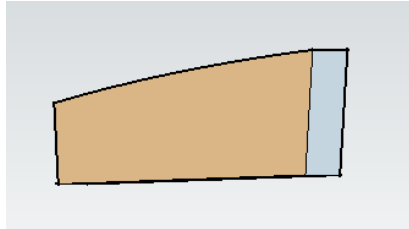


End face of the half-lamella, relative to lamella blank

```
-80.27, 40.00, 171.38
-87.73, 40.00, 0.00
-71.16, 0.00, 0.00
-63.70, 0.00, 171.38
```

Compound mitre saw cuts

```
Horizontal angle 67.52
Vertical angle 87.51
```



End face of the gable lamella, relative to the lamella blank

```
-71.16, 0.00, 0.00
-63.70, 0.00, 171.38
-23.61, 40.00, 171.38
-31.07, 40.00, 0.00
```

(The end face of the gable lamella is only useful to know if you plan to end the roof as shown in the drawing above. You might prefer to have both the left and right gable lamellas intersect the gable directly, in which case the end-face is a vertical slice through the lamella at an angle equal to the skew-angle.)

- 7 Bolt hole positions and angles. Note the bolts through the middle of the lamella are at an angle equal to twice the skew-angle with respect to the lamella, whereas the end-holes in each lamella are only at slight angles (not exactly perpendicular). The effect is slight, and for fabrication purposes might be dealt with by drilling a slightly over-size hole. Early lamella roof builders used to cut a center slot rather than a hole.

Bolt 1

Centre hole position: Front -20.00, 40.00, 69.66

Centre hole position: Back 20.00, 0.00, 69.66

End hole position:

Z front and back 52.52, 51.29

Z angle = 88.24

X front and back 455.29, 455.25

X angle = 89.93

```

Bolt 2
Centre hole position: Front -20.00, 40.00, 119.66
Centre hole position: Back 20.00, 0.00, 119.66
End hole position:
Z front and back 102.41,101.18
Z angle = 88.24
X front and back 459.01, 458.96
X angle = 89.93

```

Beam specification

The plugin assumes that the arches spring from a bevelled beam at the sill – bevelled to be approximately orthogonal to a tangent to the roof (or, if you like, aligned with a radial line drawn from the geometric center of the roof). The plugin writes out the beam angle – the angle the bevelled sill makes with the horizontal. Also, if you chose to finish the gable end of the roof with a timber arch, the plugin prints out the radii of two transverse sections through the roof, aligned with the beam, which would define this arch.

```

Beam angle: 34.57
Section at gable end: inner radius = 4909.4; outer radius = 5077.0

```

Brace specification

The plugin assumes that braces are placed between the lamellas at the beam, to keep them in place, and it writes out the coordinates of the corners of the brace. For convenience it is assumed these braces have the same thickness as the lamellas. The extension to a thicker brace is straightforward, since the plugin gives you the bevel angle at each end of the brace.

```

Brace specifications (coordinates of corners)
167.68, 2.79, 0.00
0.00, 0.00, 0.00
0.00, -404.88, 0.00
167.68, -402.09, 0.00
167.68, -13.76, 40.00
0.00, -16.55, 40.00
0.00, -388.32, 40.00
167.68, -385.53, 40.00

```

```

Brace bevel: 67.52

```

Support

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