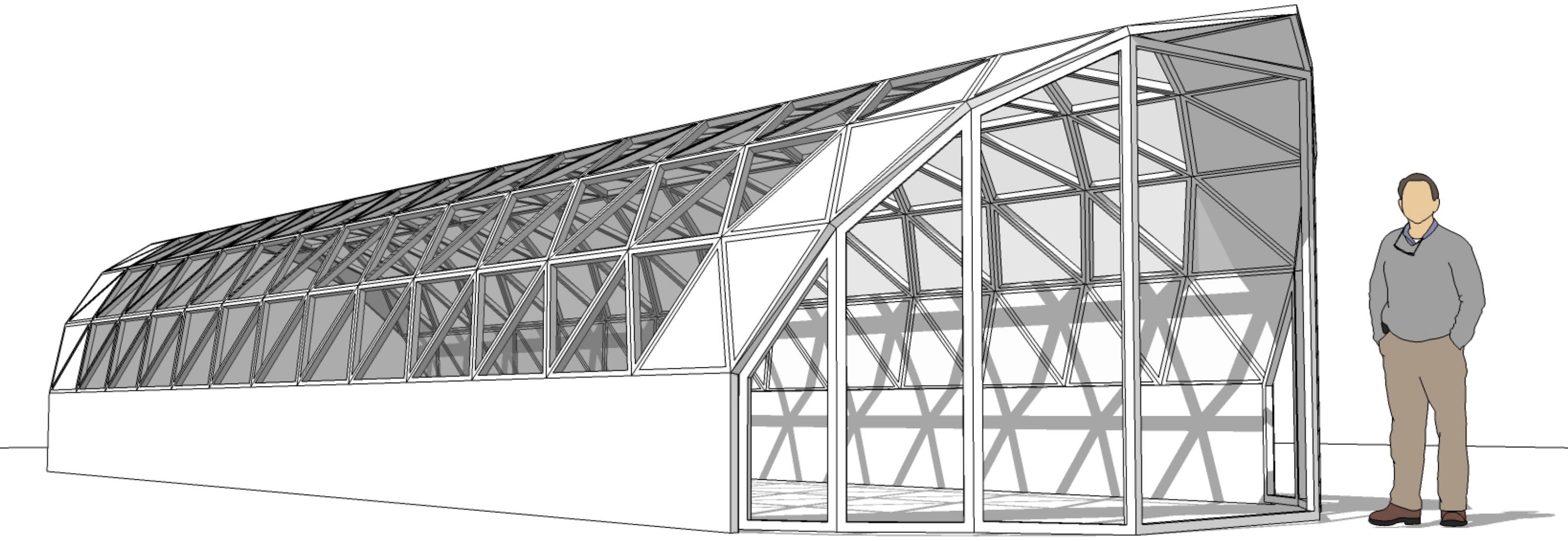
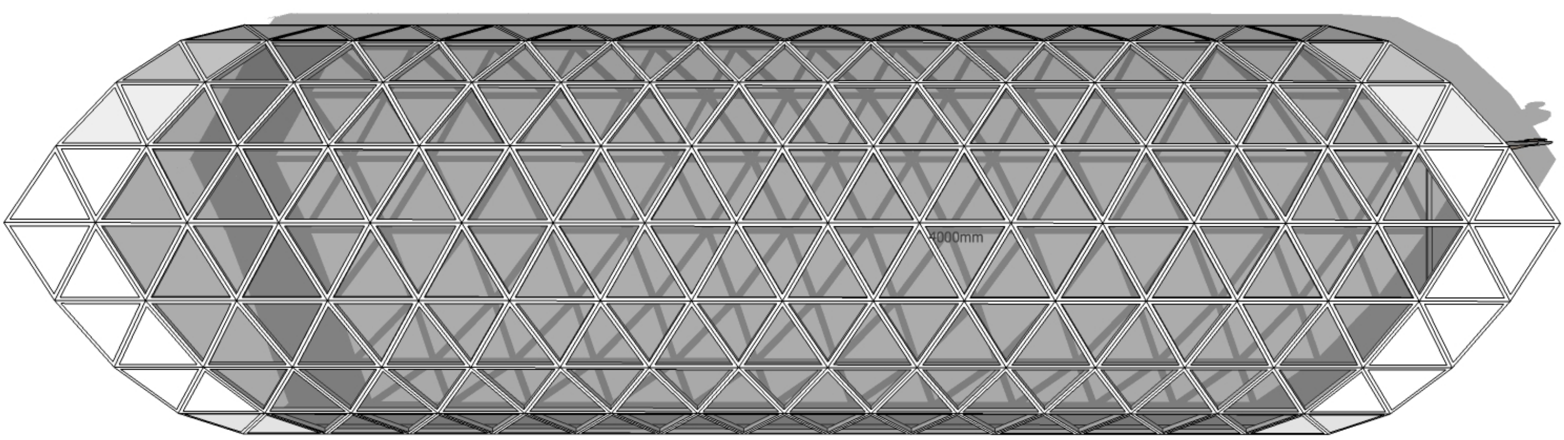
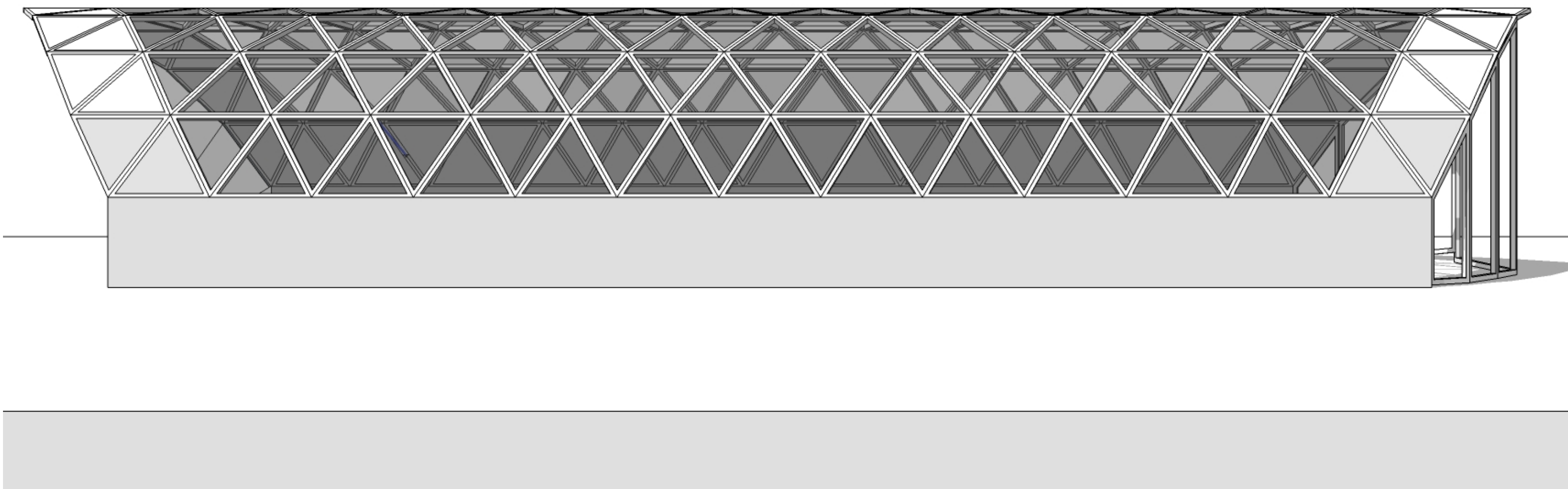


Intro:
A triangulated tunnel structure inspired by the Network Rail station at Canary Wharf, London. Using equilateral beveled frame or flattened conduit triangles, this design can be covered in polythene, glass, plywood and many other materials. There is only one size and type of triangle frame in this design and it can be made to any length. Note: (the conduit version can only be covered in polythene)



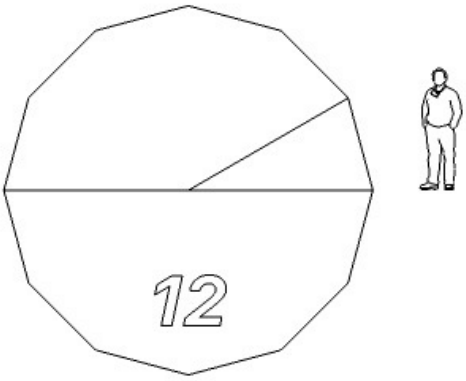


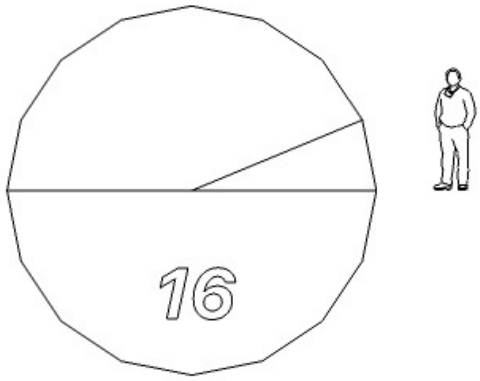
This example structure is based on an 18 sided polygon, many other regular polygons can be used to construct this design, the only difference is the bevel angle on the bottom and tip of each triangle. Bevel angles for 10, 12, 14, 16 and 18 sided polygons are shown below including the equations to calculate for any other number of sides. (see page 3.)

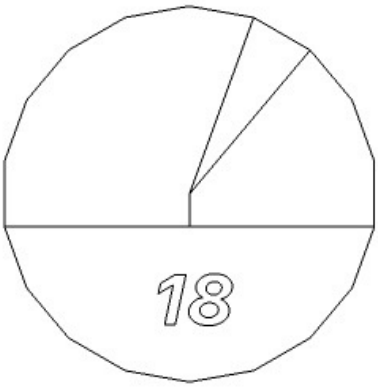
Depending on the size required different regular polygons can be used, for smaller tunnels under 3m wide a 12 sided regular polygon will work fine, as width increases the triangle frame size would also increase unless a polygon with more sides is used as the template.

Structures with fewer number of sides tend to be stiffer because the dihedral angle is larger, so making the triangles larger rather than increasing the number of frames is preferred unless some sort of subframe is made to add stiffness.

Bevel Angle Calculation







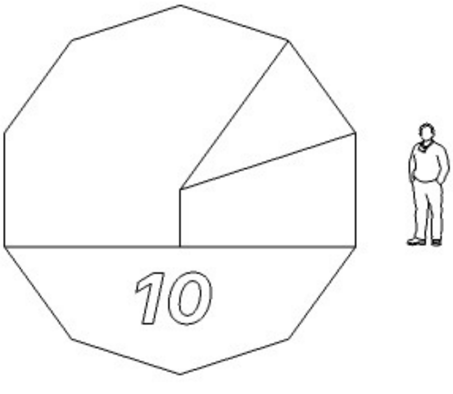
N= Number of sides on polygon

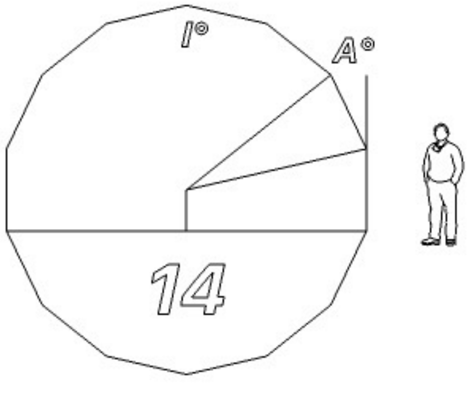
$360 \div N = A^\circ$

$N - 2 \times 180 \div N = I^\circ$

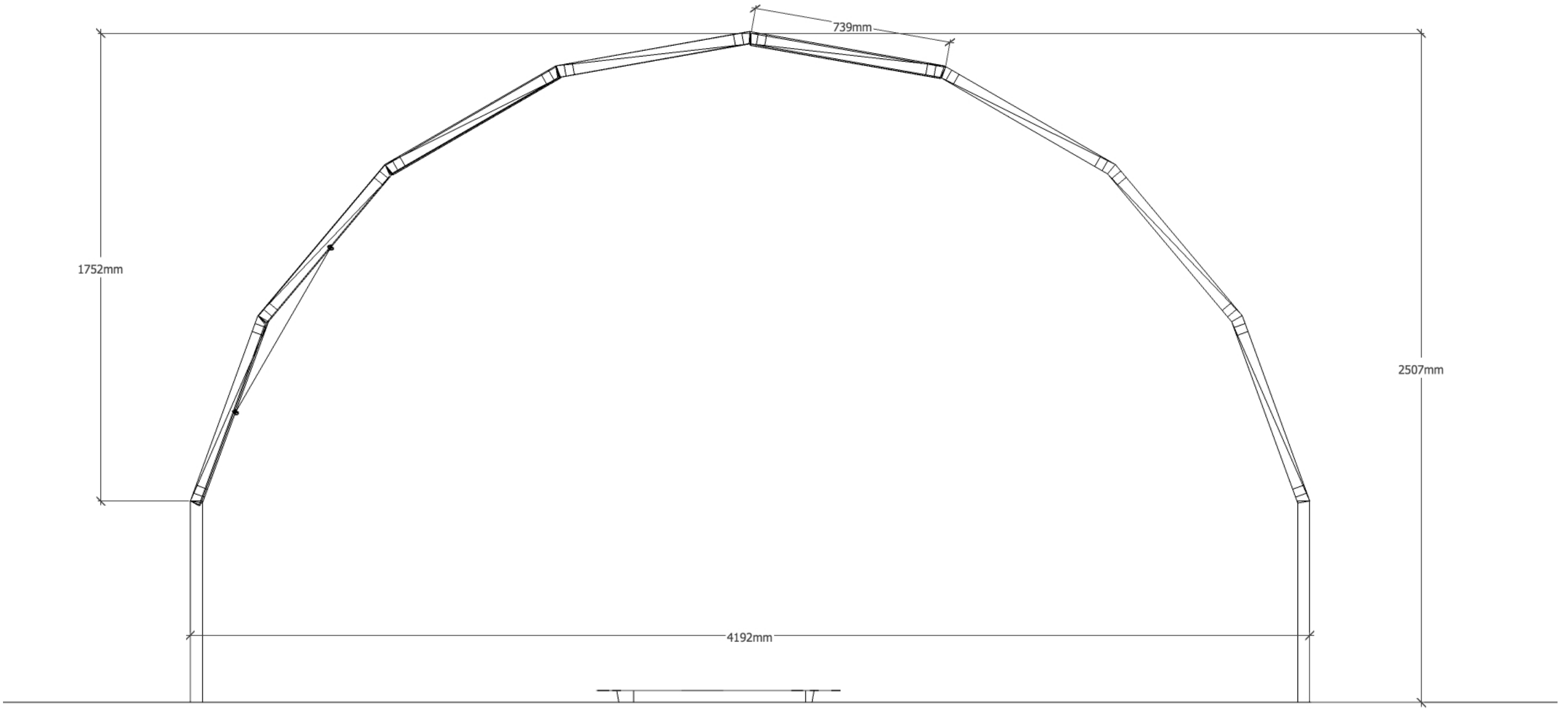
I° = Dihedral Angle

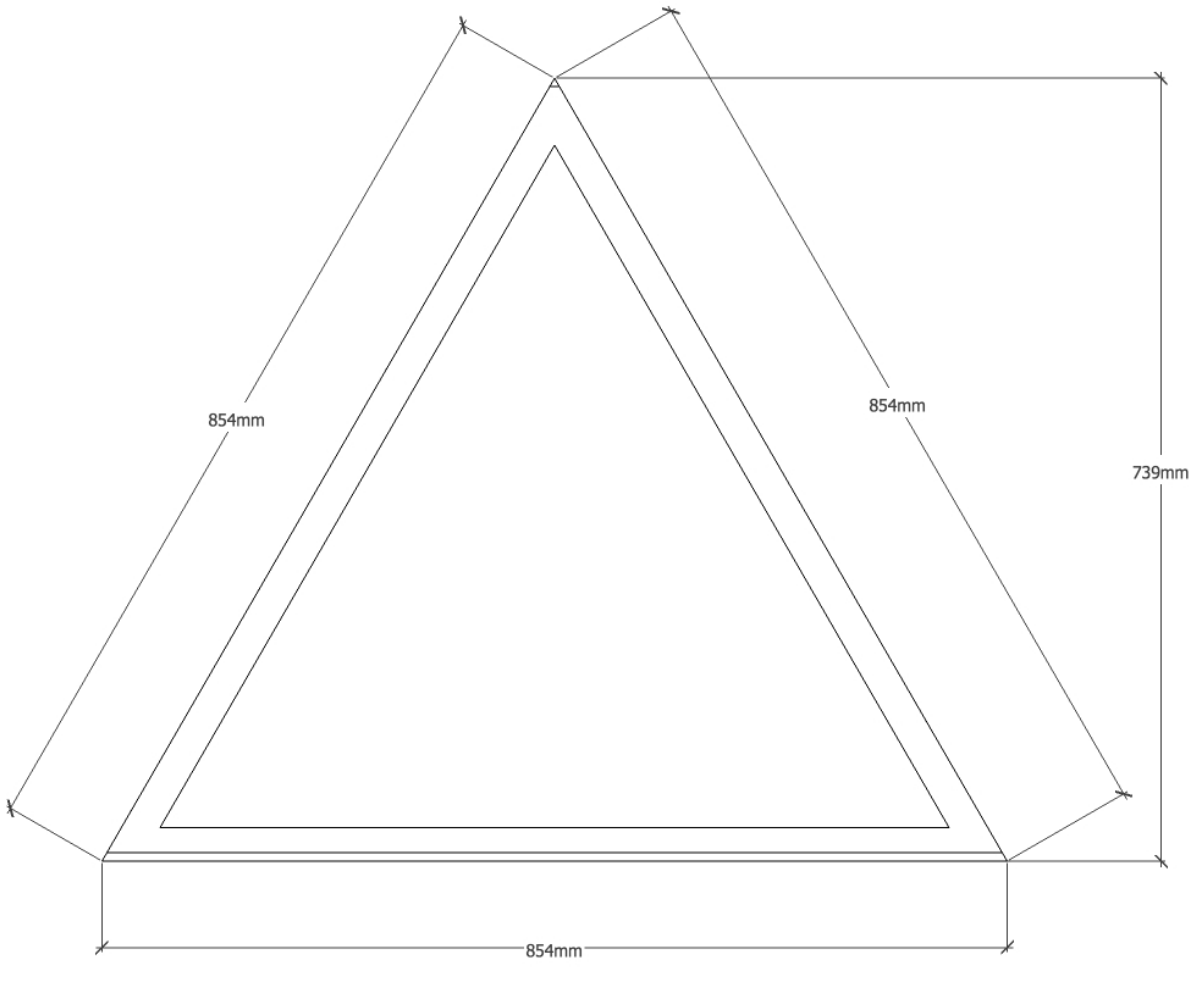
$I^\circ \div 2$ = Bevel Angle



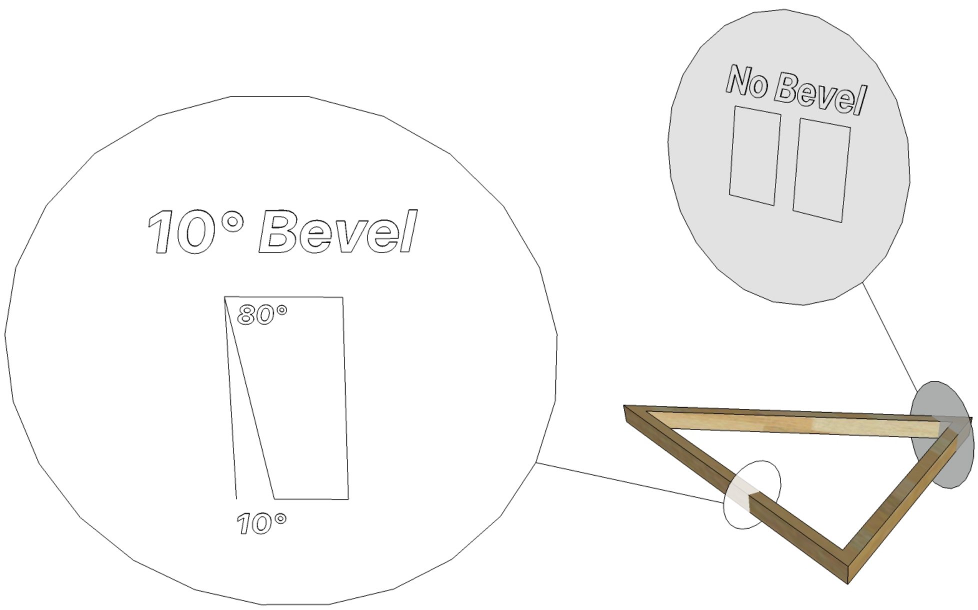


Measurements of the cross section for this example are shown below,
Tunnel width: 4192mm
Height inc base: 2507mm
Height frames: 1752mm
Triangle frame: 854mm (equilateral triangle)

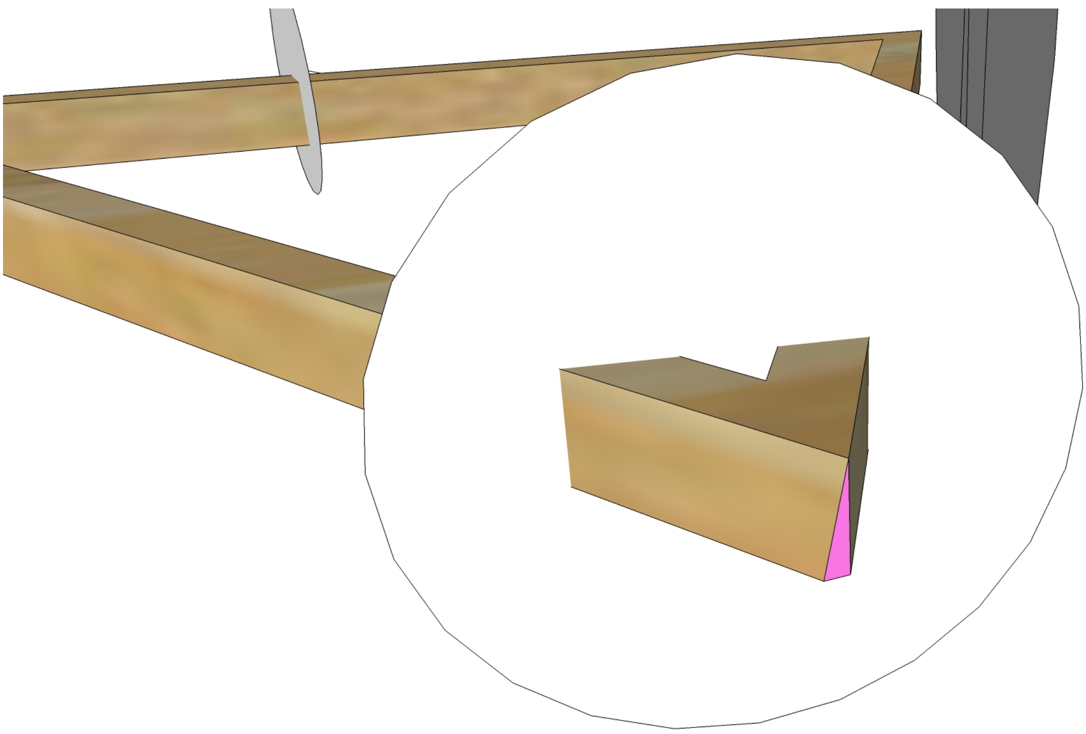




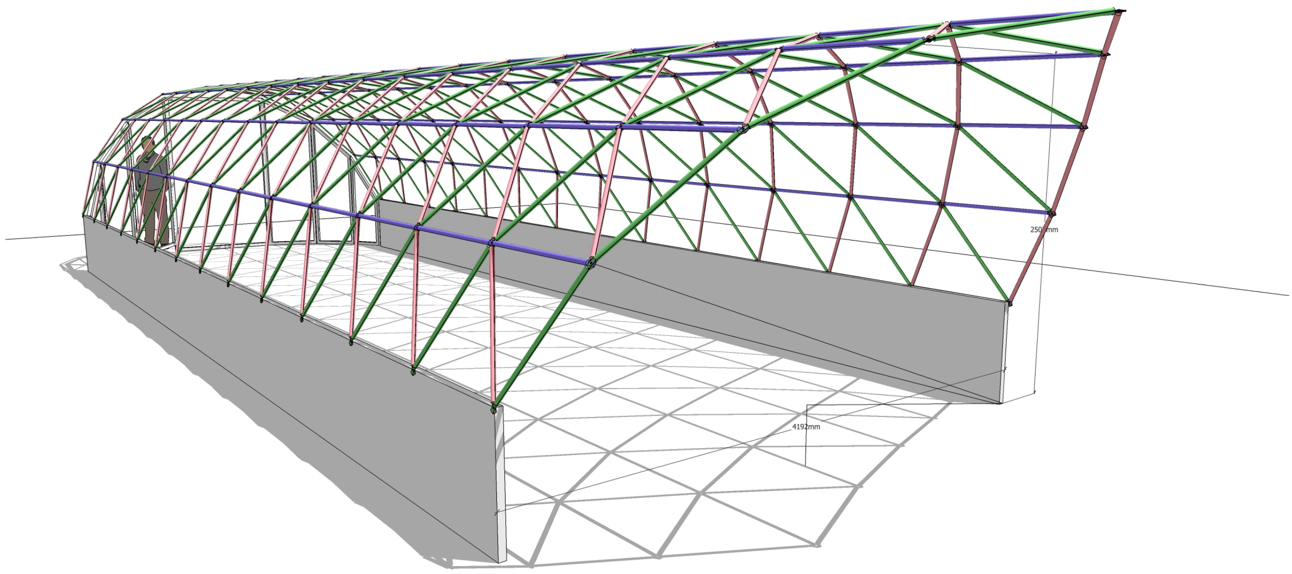
The bevel angle of 10° is only cut along the base rail and the tip of each triangle frame, there are no bevel cuts on the two side rails. All rails should be of the same dimensions at there widest point



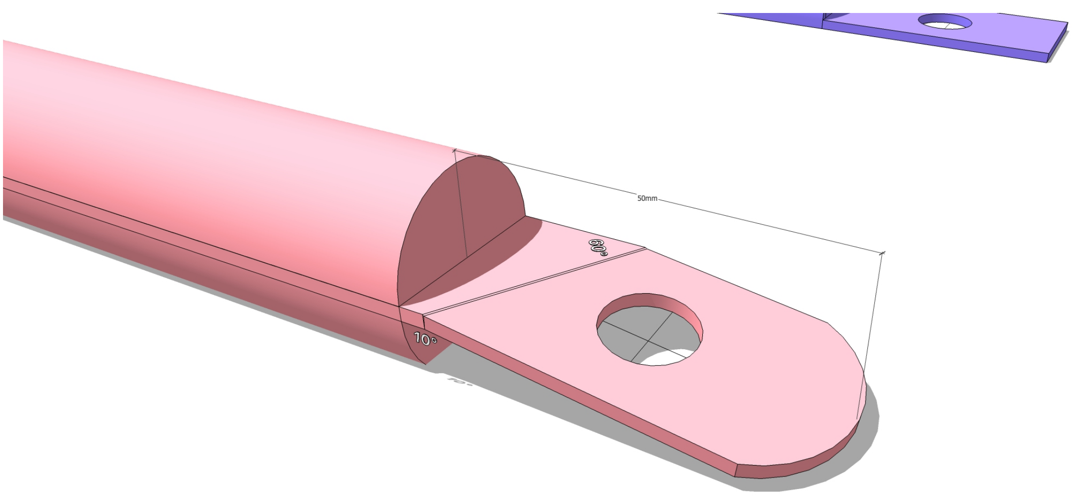
There is also a 10° cut just on the tip of the top point.



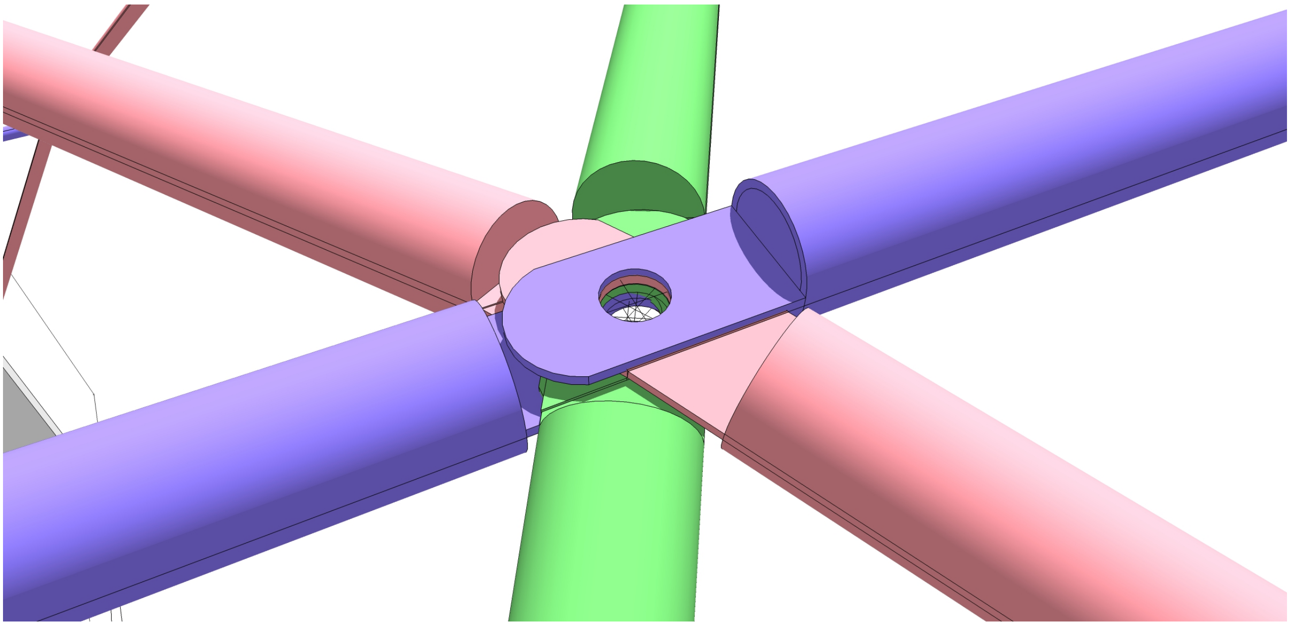
Building the frame:
There is only one type of frame in this design, timber batten or conduit with flattened ends can be use effectively, the diagram below shows colour coded conduit struts and there relative positions. Although there is only one length of strut in used in this design the end-bend angles differ, one has no bend at all the second has a crease at 60° and a bed angle of 10° the final one is a mirror image of the second strut.



Detail of the crease angle and bend angle are shown below.



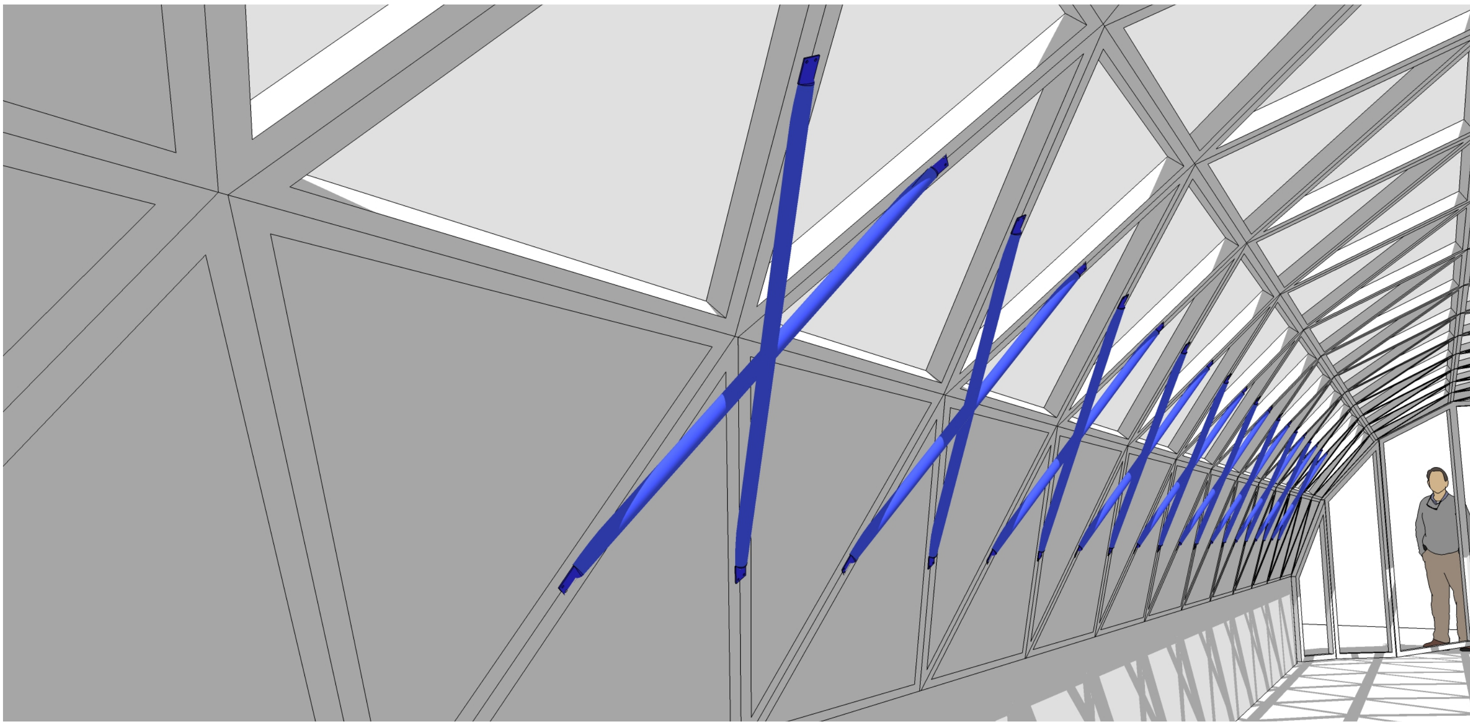
Detail of how all conduit struts meet ready for bolting, it doesn't really matter in what order the strut ends overlap but for neatness a cosiest ant overlap pattern would look best.



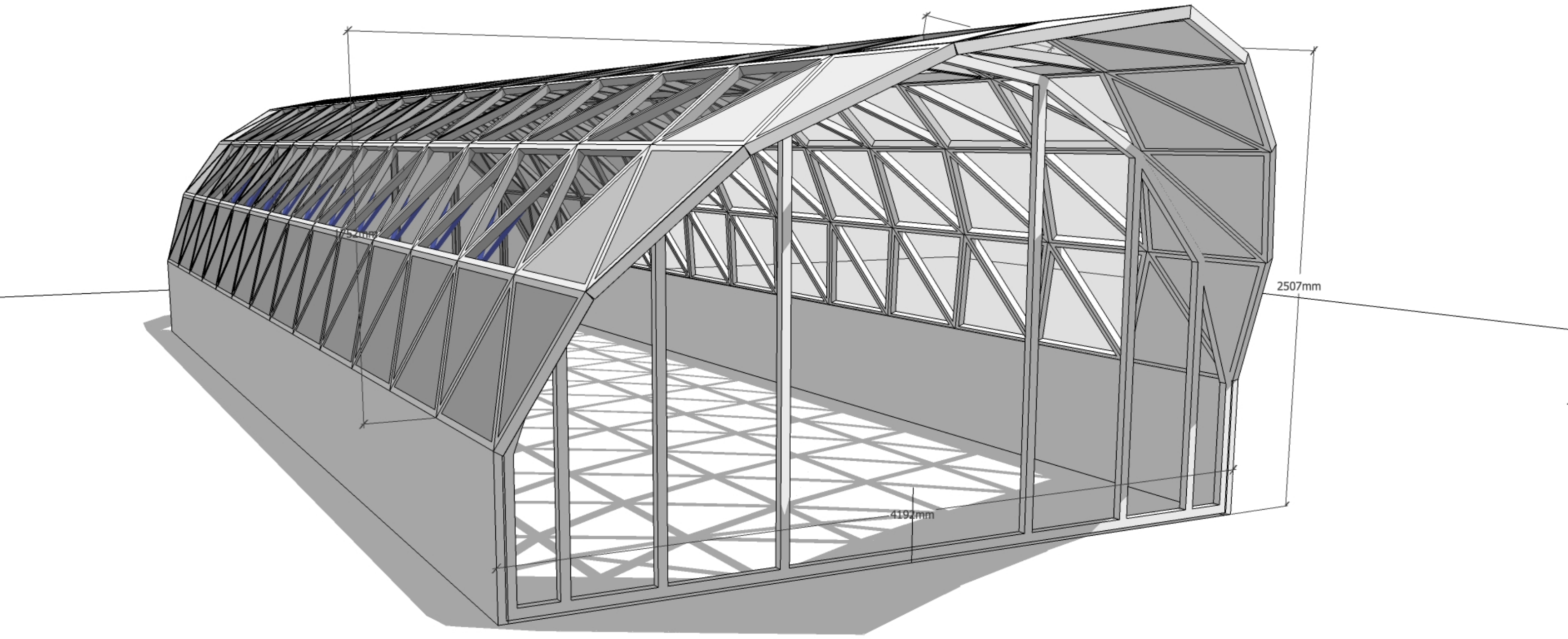
Strut hub joints.

Diagram showing colour coded struts, all measure 854mm between end hole centres, all the struts can be made exactly the same then the green studs can be made by adding the crease angle and bend angle required. After marking or placing green struts in a separate location the red struts can have there crease and bend angle added. Colour coding the end will make it easier to assemble

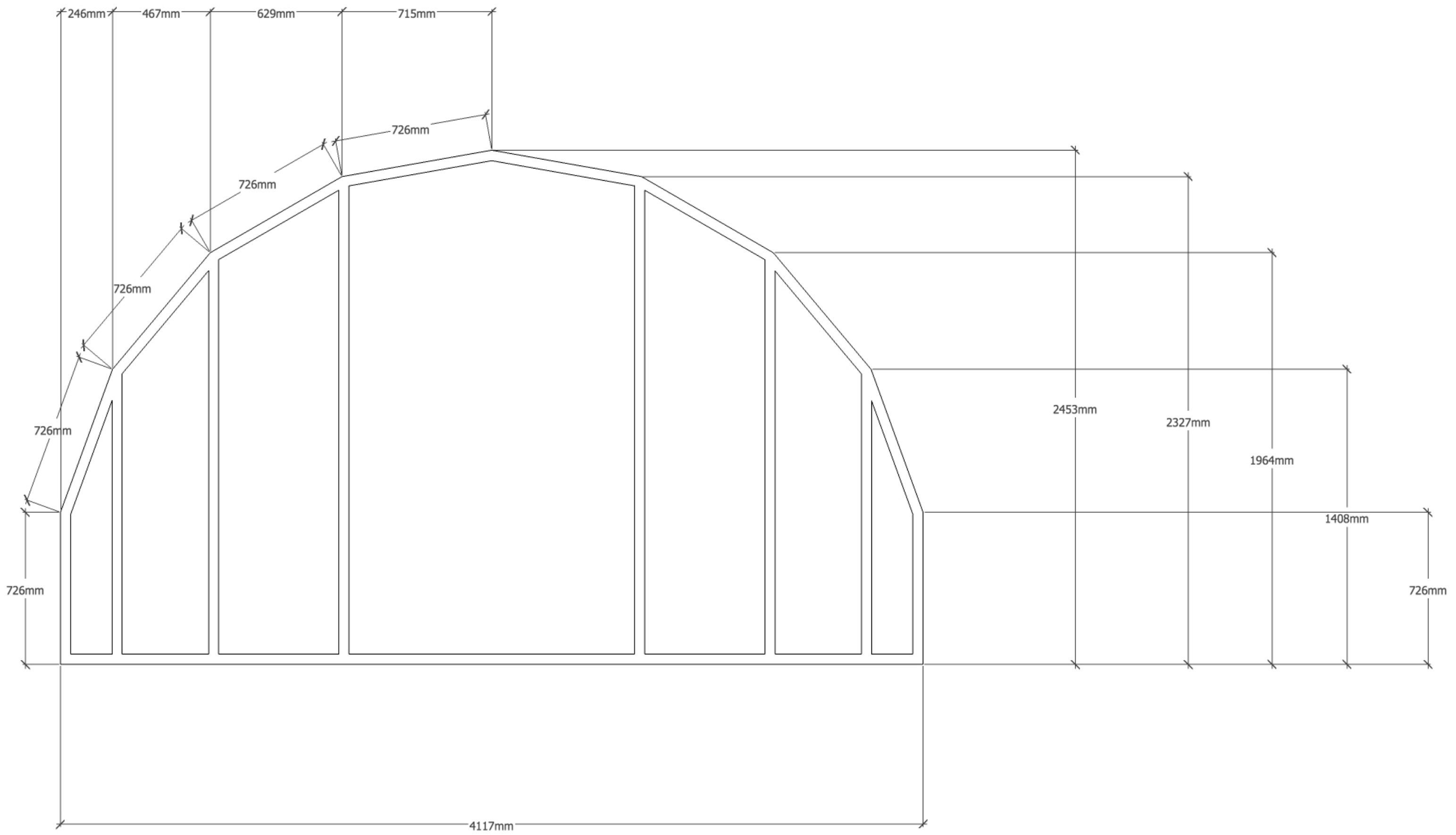
Structural stability.
Because of the curving section across the tunnel there would be a good amount of structural strength but because this structure curves in only one plane, unlike a dome which curves in two planes there may be some structural elasticity along the tunnel. This can be minimised by making the tunnel from large triangle frames, adding some conduit braces on the inside or posts to the ground. The end walls will also add stiffness



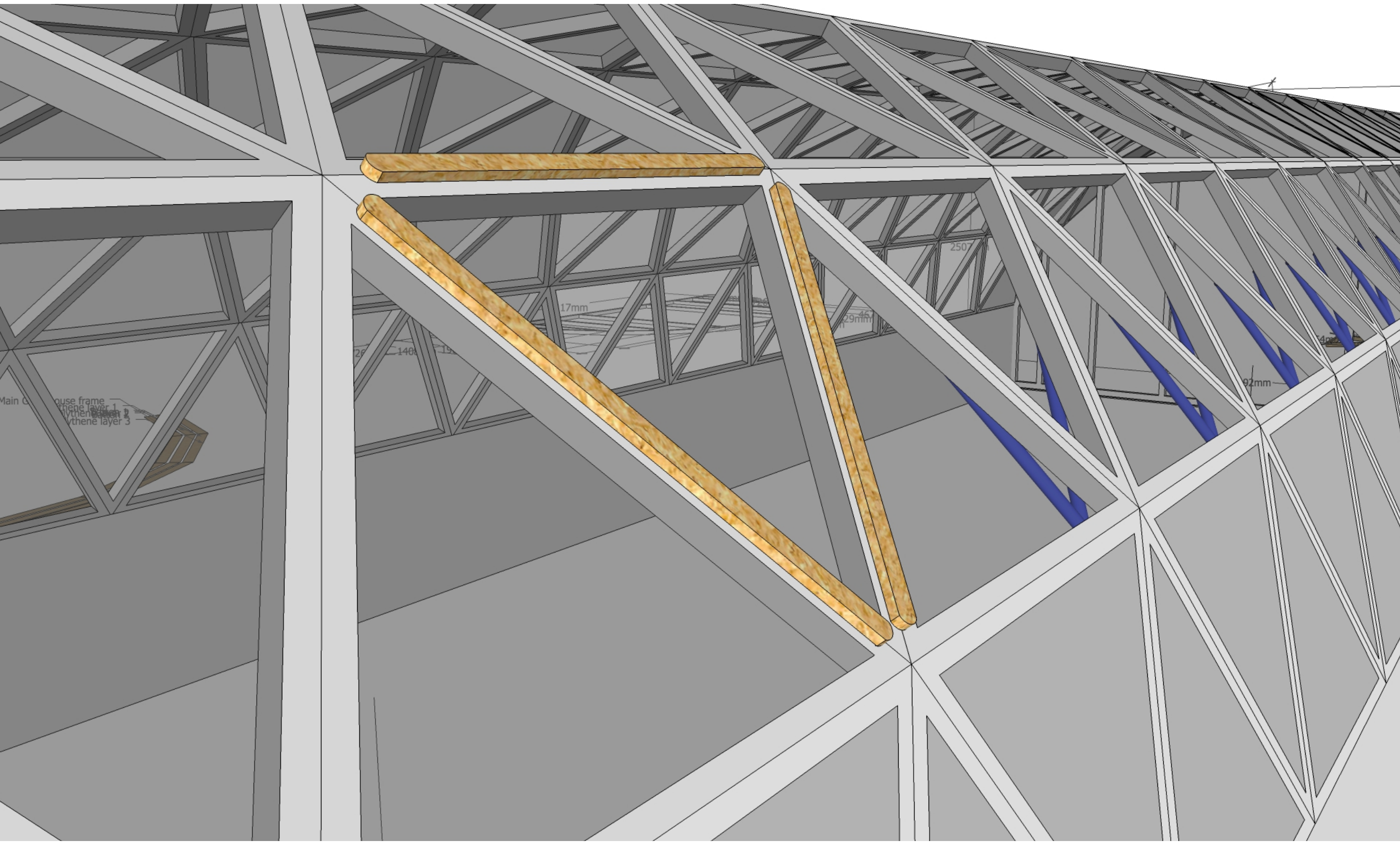
Making the tunnel ends:
Below are details for making a flat end wall, this is the easiest to make but there is some loss of space and the structural stability of the overhanging roof needs to be checked



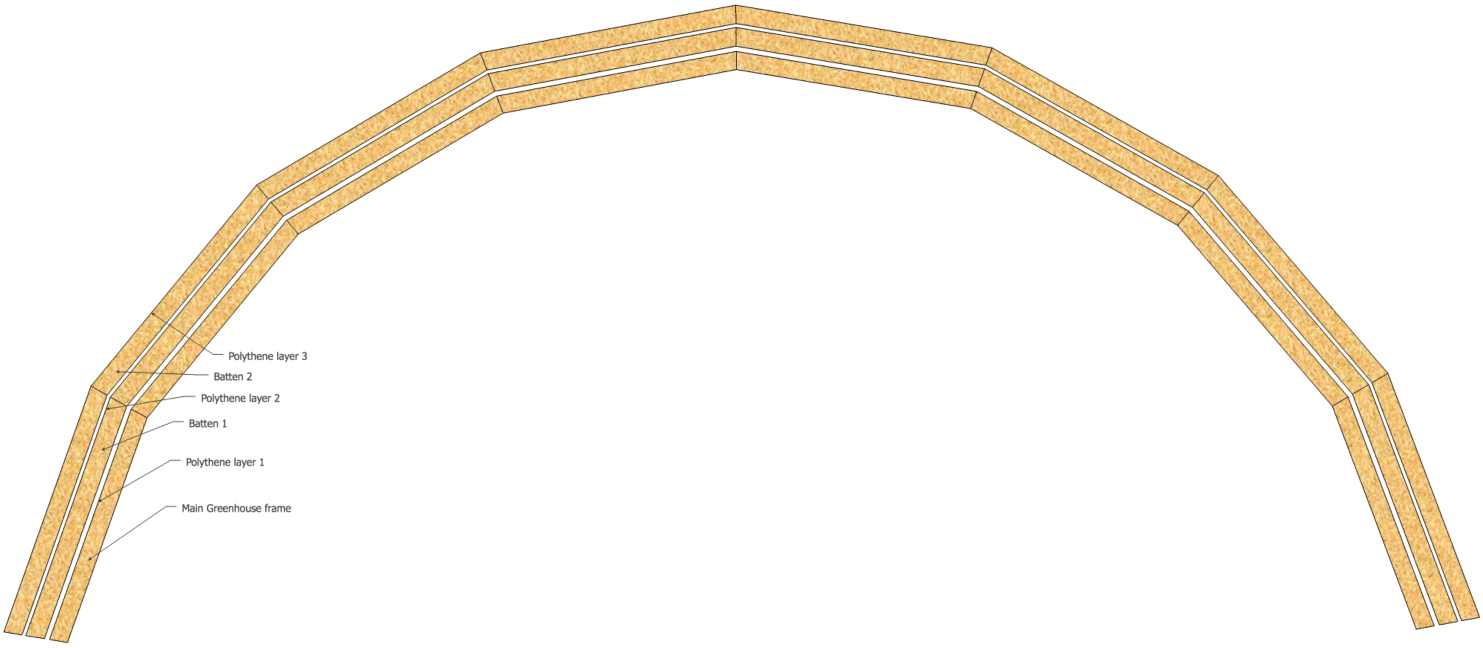
Measurements for the flat end walls.



Covering with polythene:
This structure can be covered with a single piece of polythene after the frame is complete, an advantage of the timber frame version makes it possible to add more layers of polythene as required. Double skinned polythene structures have better thermal insulation and as such are becoming more popular, having the ability to add even more layers without the use of blower fans can further increase the thermal efficiency which is essential for modern passive greenhouse design.



To add another layer of polythene a batten is fixed to the already covered frame so that the second layer does not come in to contact with the first layer, this process can be repeated to add more layers to the greenhouse.


Polythene layer 3
Batten 2
Polythene layer 2
Batten 1
Polythene layer 1
Main Greenhouse frame