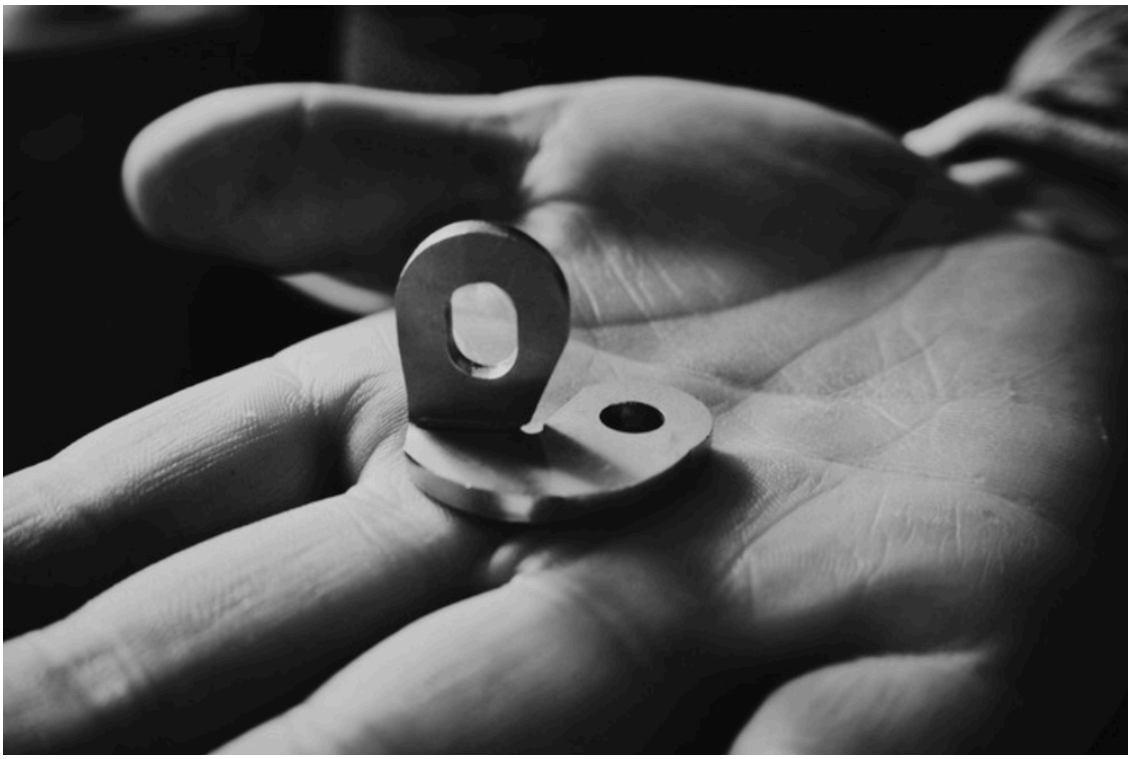
THE WangerFlange COMPANY

Thank you for purchasing WangerFlanges, to help you start building and designing structures this book contains instructions and 21 projects to inspire you.



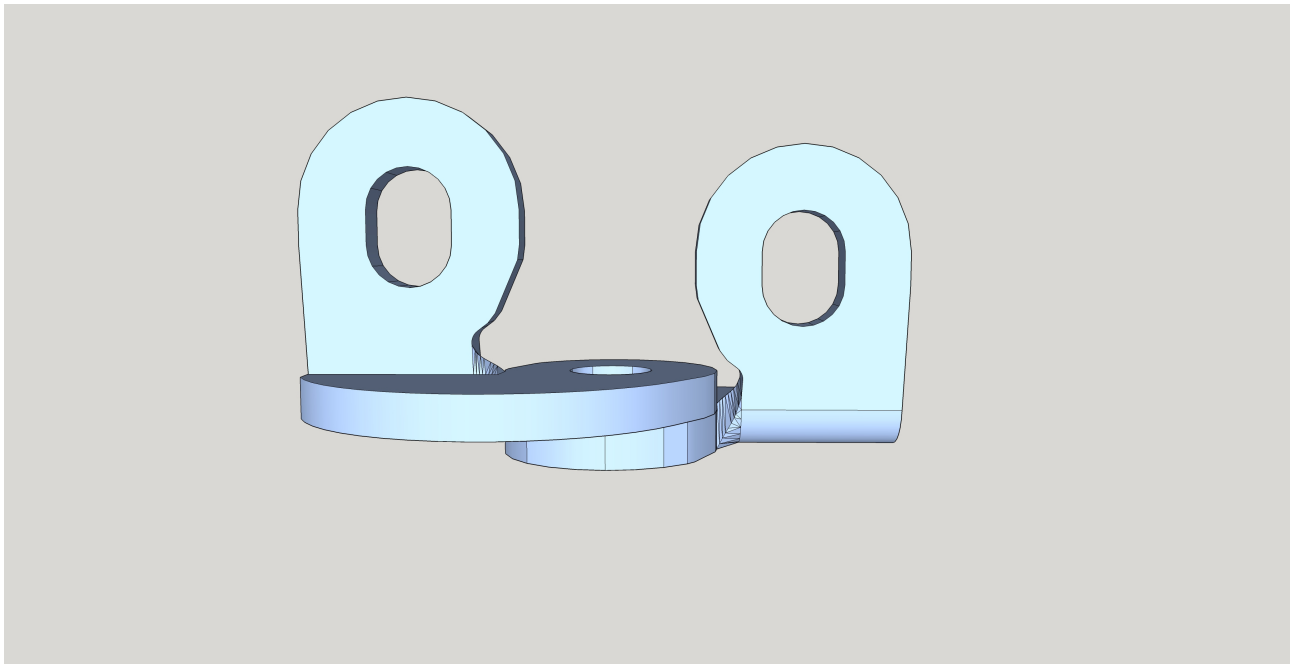
Best of luck with your WangerFlange building,

Paul

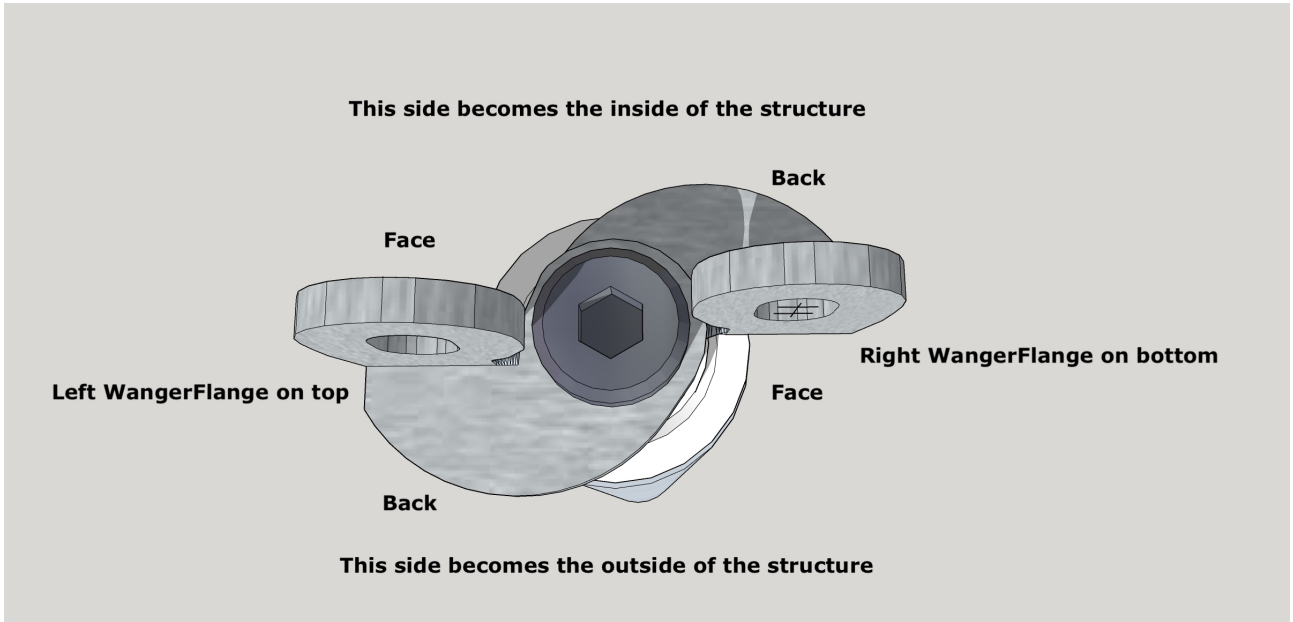
Specifications:

Material: 3mm stainless steel 304 (A2) grade
Hole size: 7mm will fit 1/4” or M6 bolts
Slot size: 7mm x 10mm

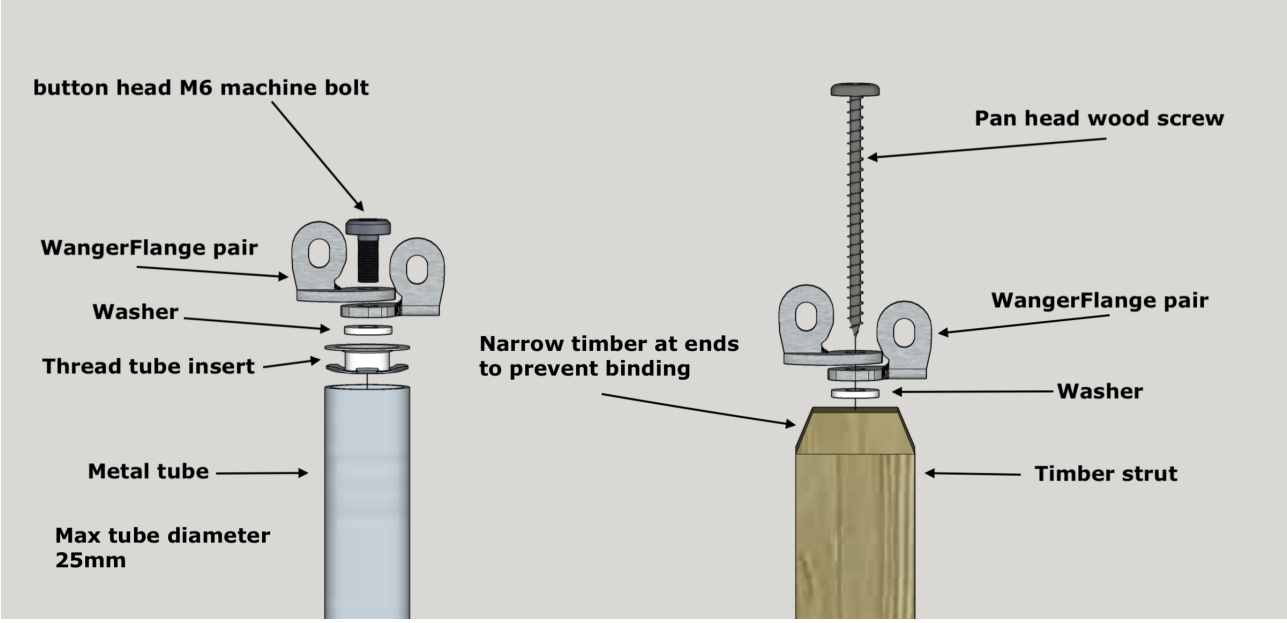
Front view of WangerFlange pair



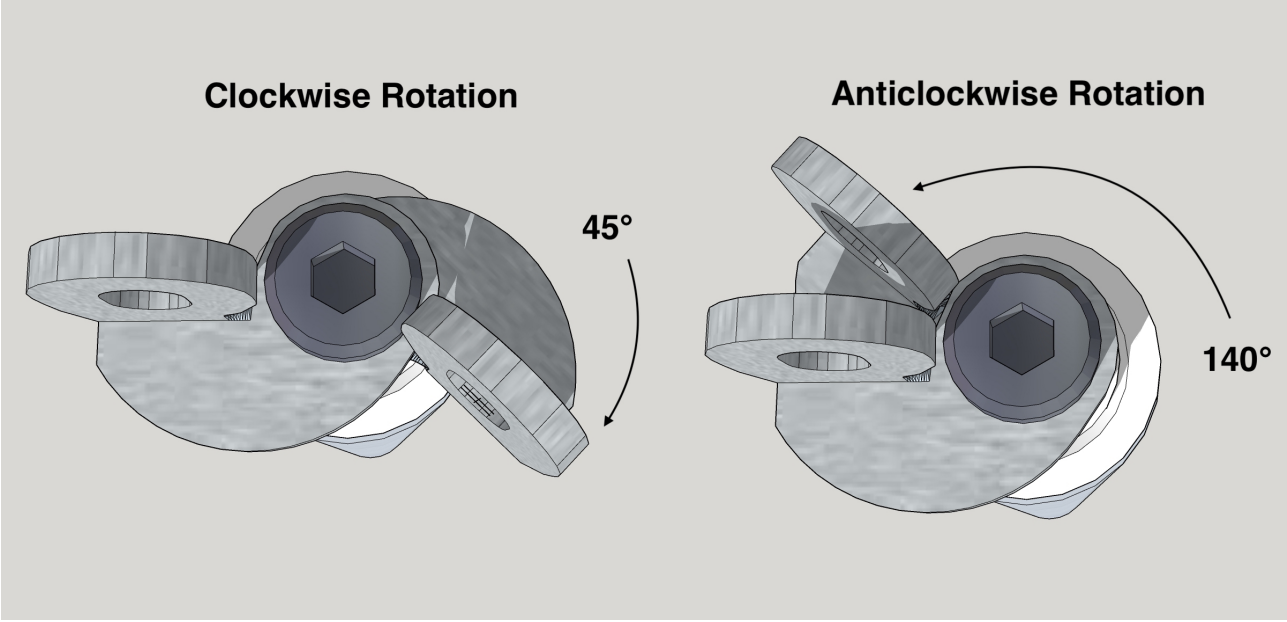
Top View



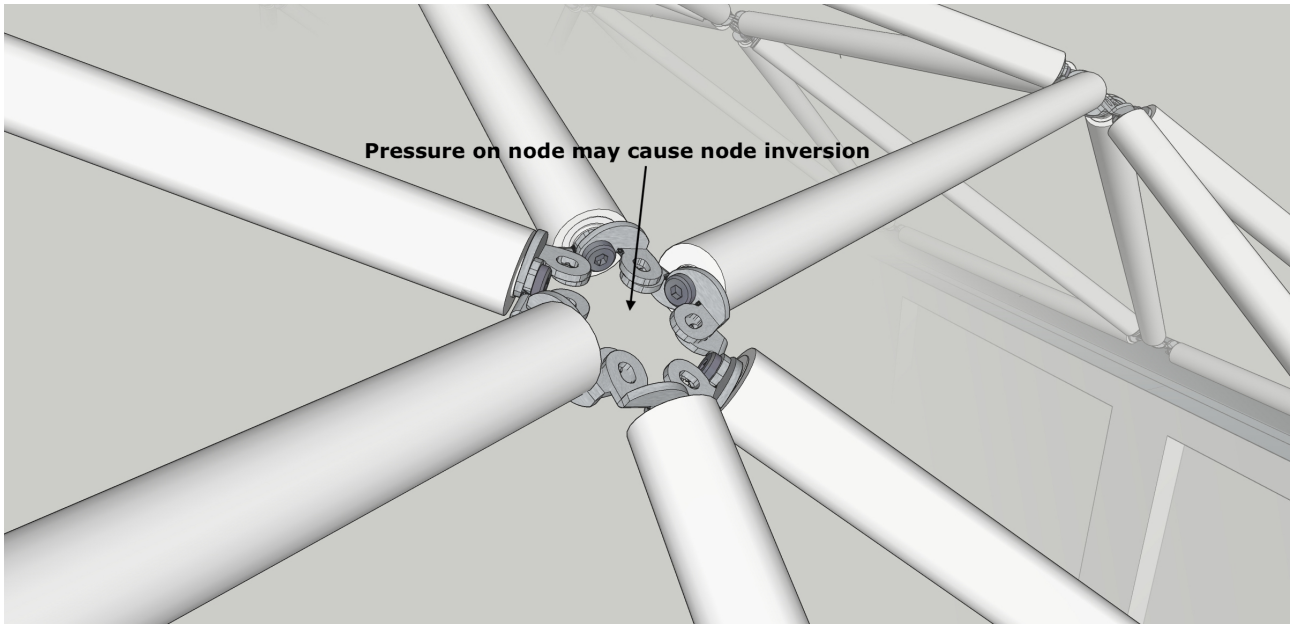
Example of connecting WangerFlanges to metal tube and timber struts. WangerFlanges will work on any strut material with a solid M6 or 1/4” fixing in the end.



Note: Diagram shows left Wanger placed on top of right wanger, rotation is 45° toward and 140° away from view point. To avoid binding on acute angled hubs make sure to arrange WangerFlanges correctly.

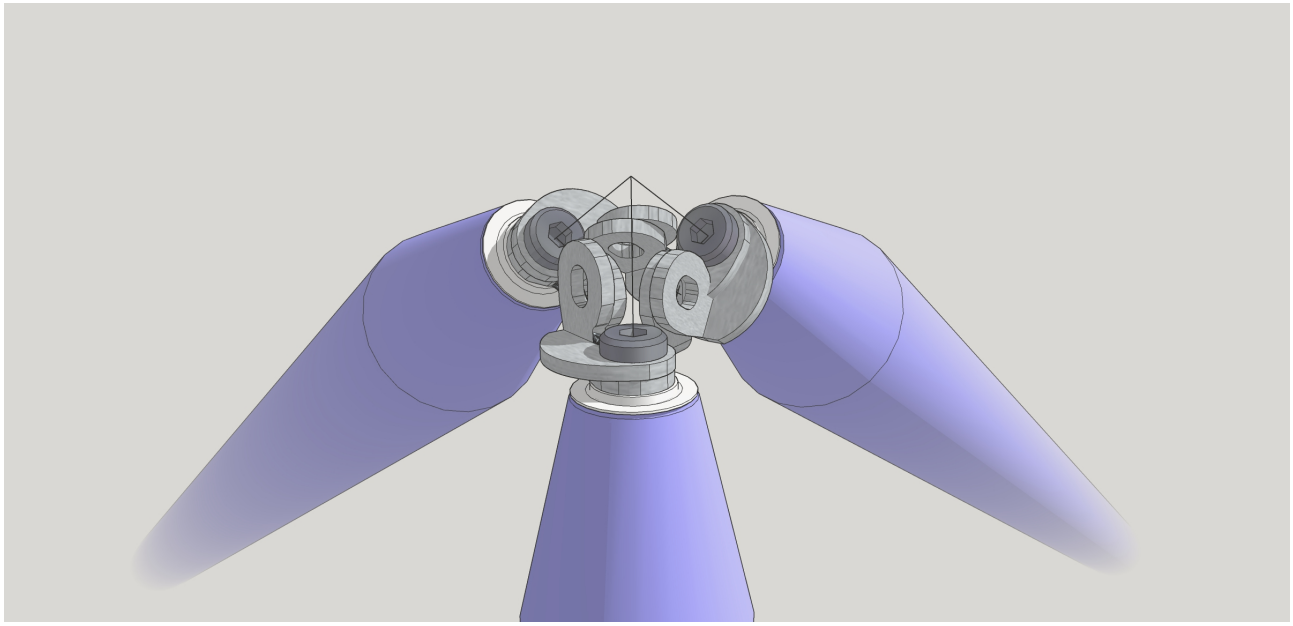


Note 2: When building structures care should be taken with joints that have a very low angle of incidence as these joints may need extra support to prevent node inversion.

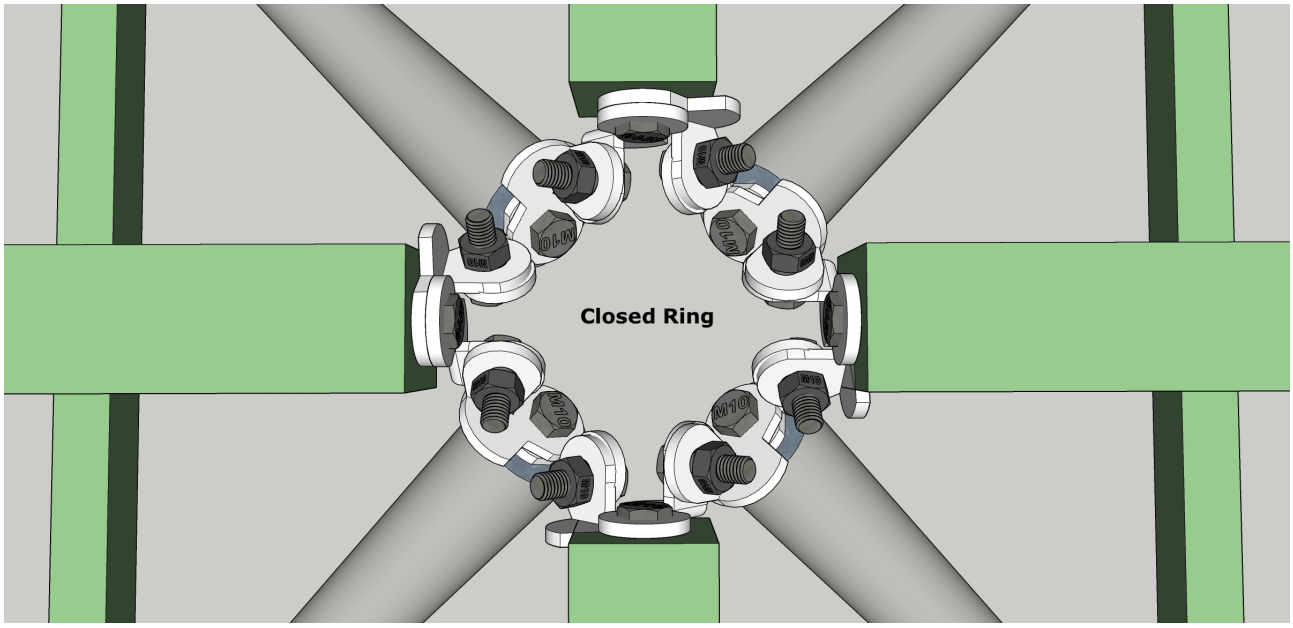


As a rule a structure should hold its own weight and be stable before the nuts and bolts are tightened.

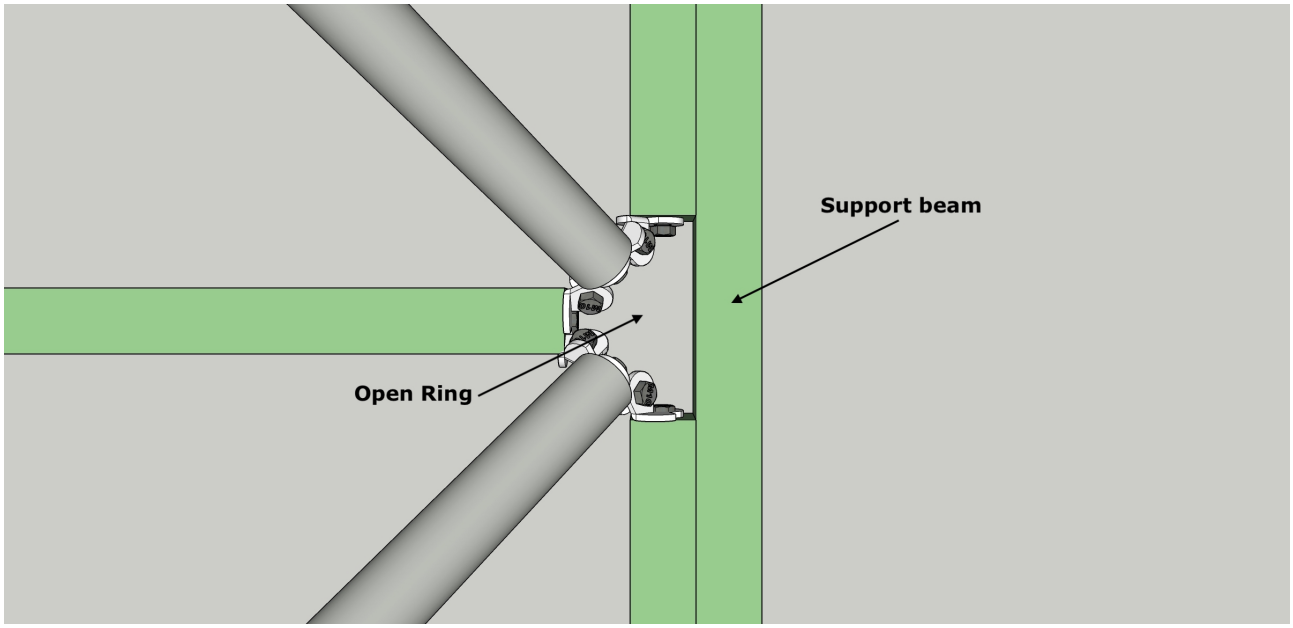
Hubs that have an acute angle of incidence tend to be structural stiff by nature.



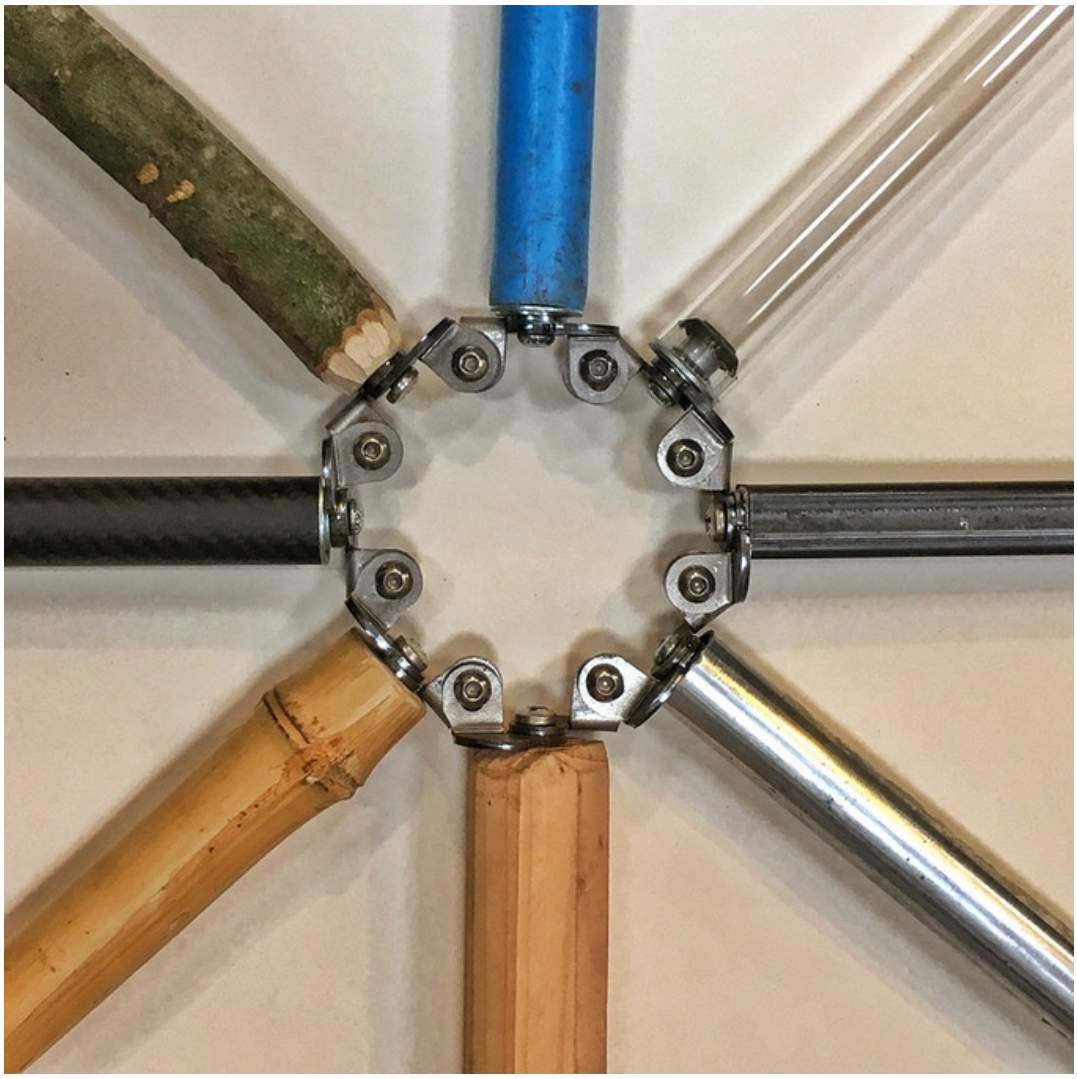
Note 3: Hubs should form a closed ring if at all possible, when this is not possible, for example on edges, extra support or bracing may be required.



Bracing can be attached to the side or bottom for extra support.



Any strut material can be used as long as you can get a strong fixing in the end. The WangerFlange hole diameter is 7mm so screws and bolts up to 6mm (1/4”) in diameter can be used. No problem to mix strut types as it makes hardly any difference, very thick wood may need a pencil end to prevent pinching.



Strut material (clockwise from the top)

- Blue alchathene water pipe with tube insert.
- Clear acrylic tube (25mm diameter) with threaded tube insert.
- 20mm steel box section with wood jammed in the end.
- 25mm conduit with tube insert.
- Timber with wood screw.
- Bamboo with a glued wooden bung and a wood screw.
- Carbon fibre 22mm tube with threaded tube insert.
- A length of stick cut from the garden with wood screw in the end.

Example of a small stool using a mixture of conduit and timber struts.

Tetrahedron

Now we've got the specifications and some technical information about basic building practice let's get started building. I would recommend everyone build the tetrahedron first to get a feel for how WangerFlanges work.

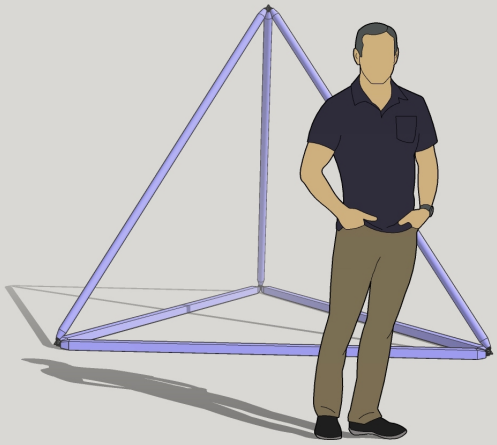
Tetrahedron

Struts X 6. only one kind

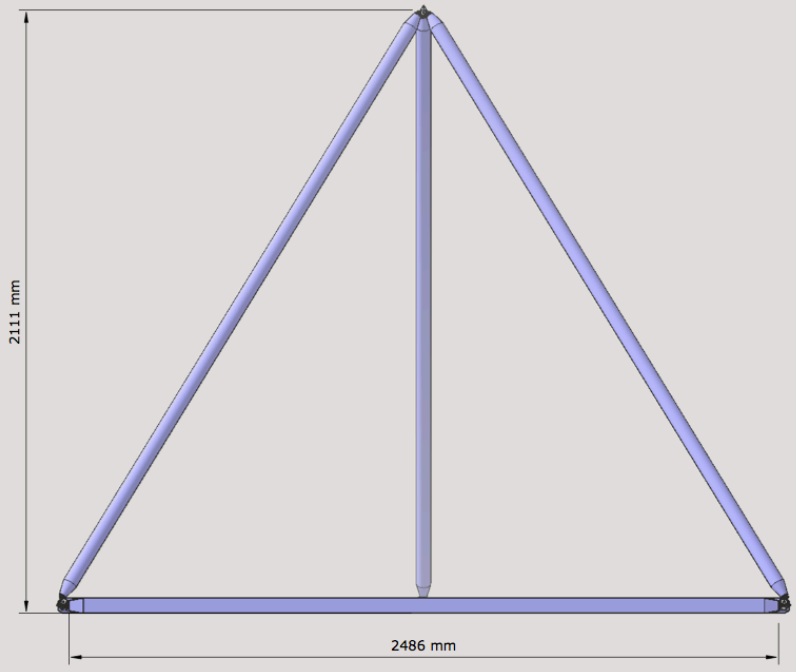
WangerFlanges X 24.

Screws X 12

Nuts/bolts X 12.

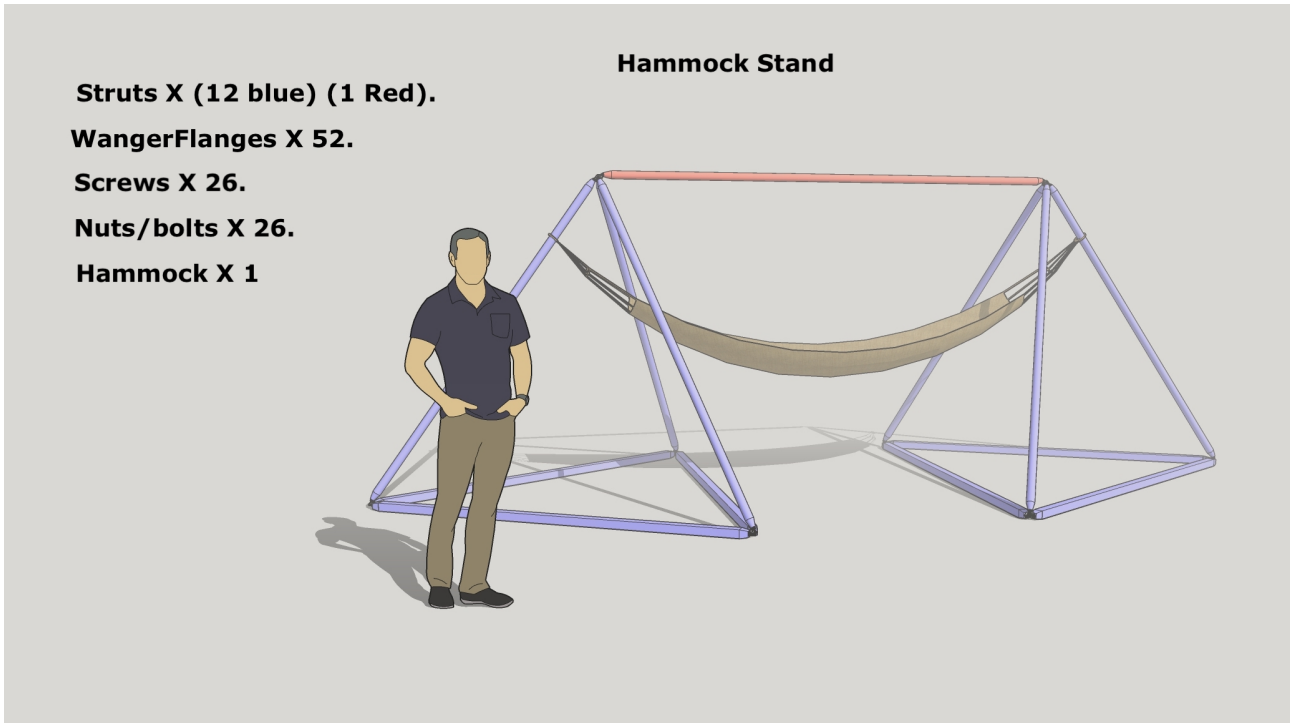


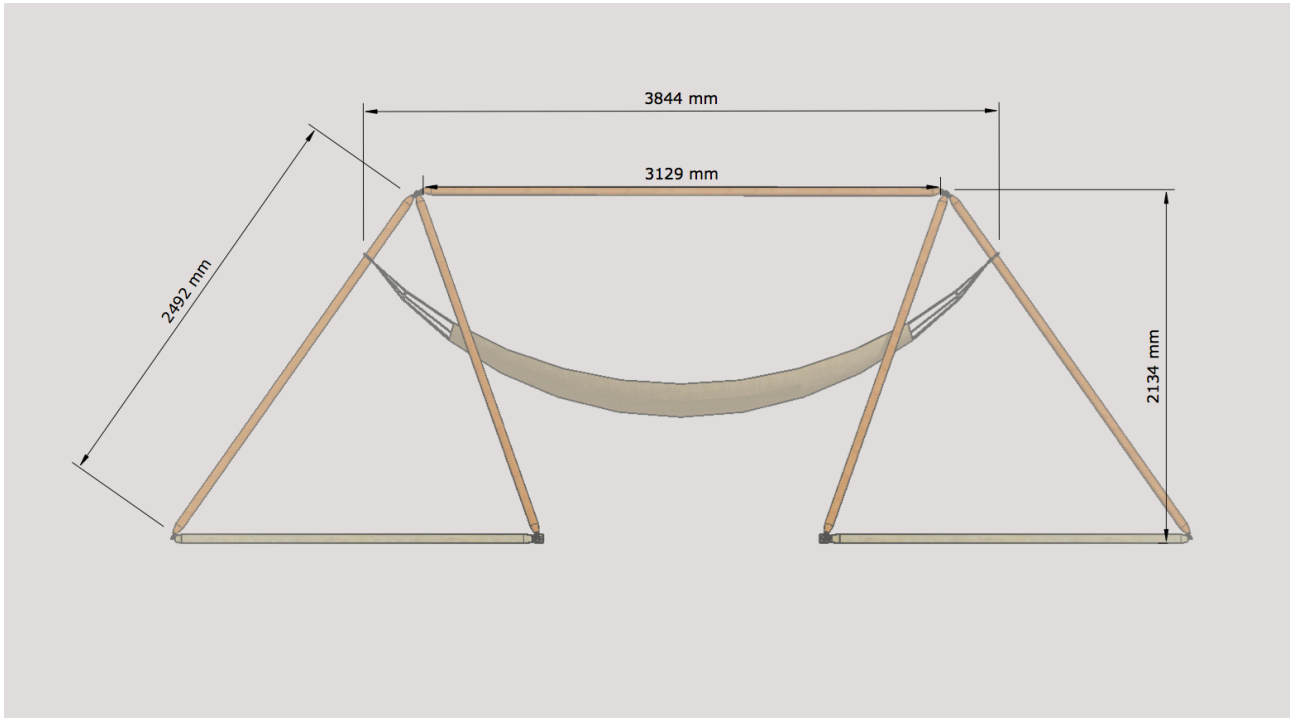
You can build the Tetrahedron any size you like as long as all 6 lengths are the same, a small tetrahedron will have the same geometric and strength properties as the big one so you can build small as a test.



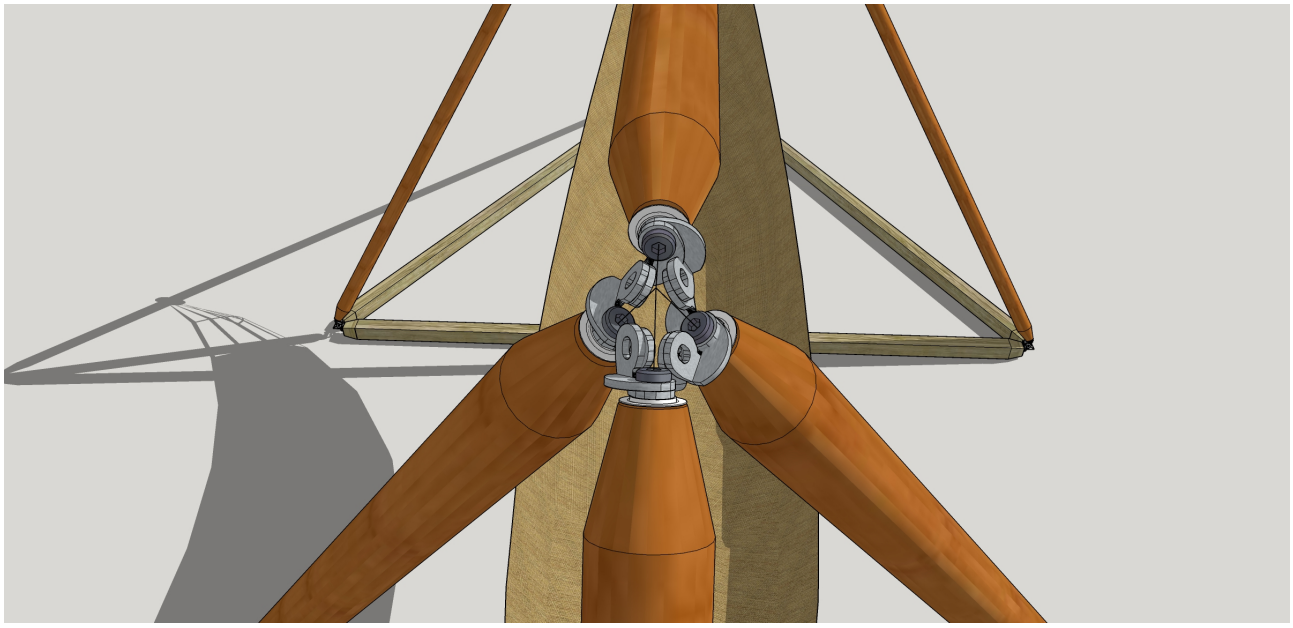
Hammock Stand

Now that we have mastered the tetrahedron let's make something useful using it as a base.





Detail of top bar joint showing pencil ends on 60mm struts

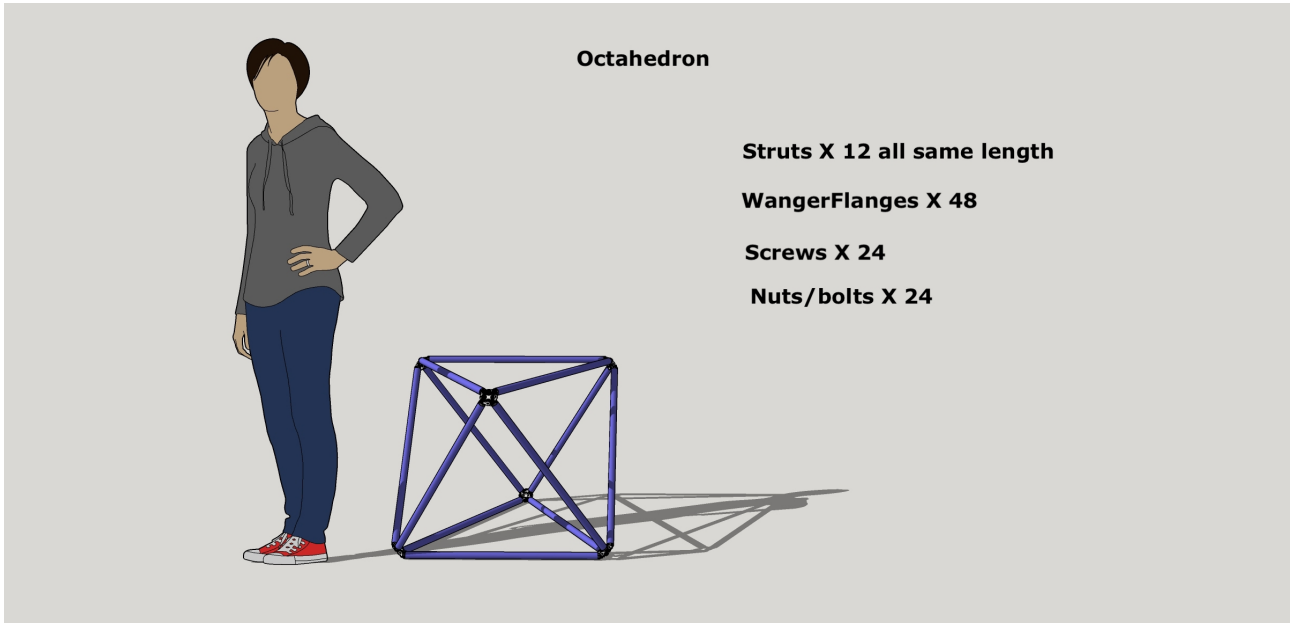


This design can easily be rescaled to fit any size hammock, simply increase or decrease the top bar length to suite.

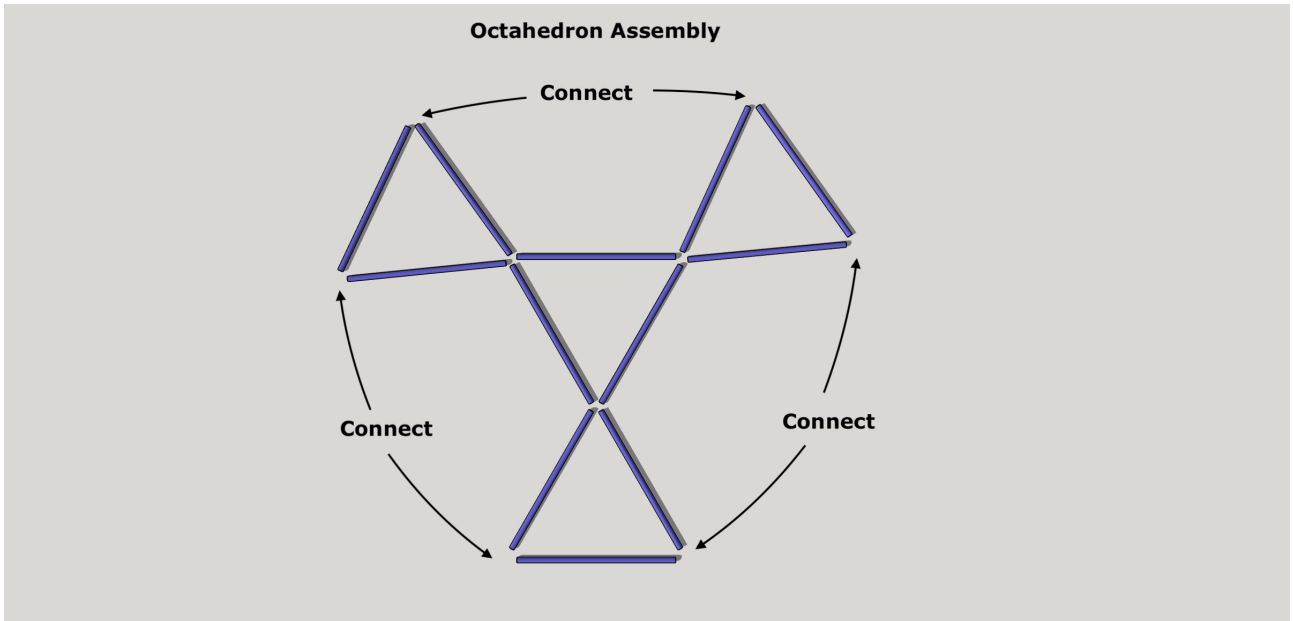
To reduce WangerFlanges the bottom 6 bars can be removed, however the six feet should be placed on a solid surface with foot plates fixed into the ground to prevent movement. This would reduce the Wanger count from 52 to 16 but you would need to supply foot plates as extras.

Octahedron

The Octahedron like the Tetrahedron is a fully triangulated convex solid so is inherently stable, this makes it ideal as a base structure to build many other things.

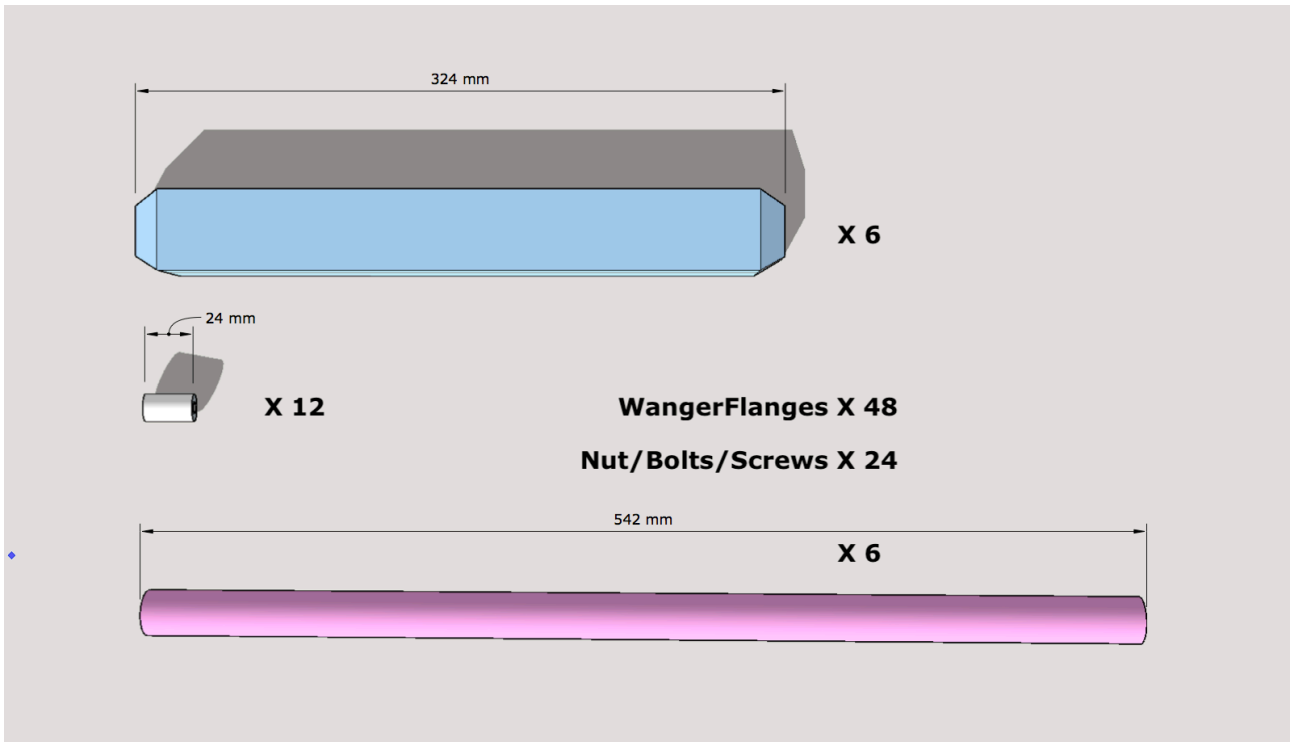


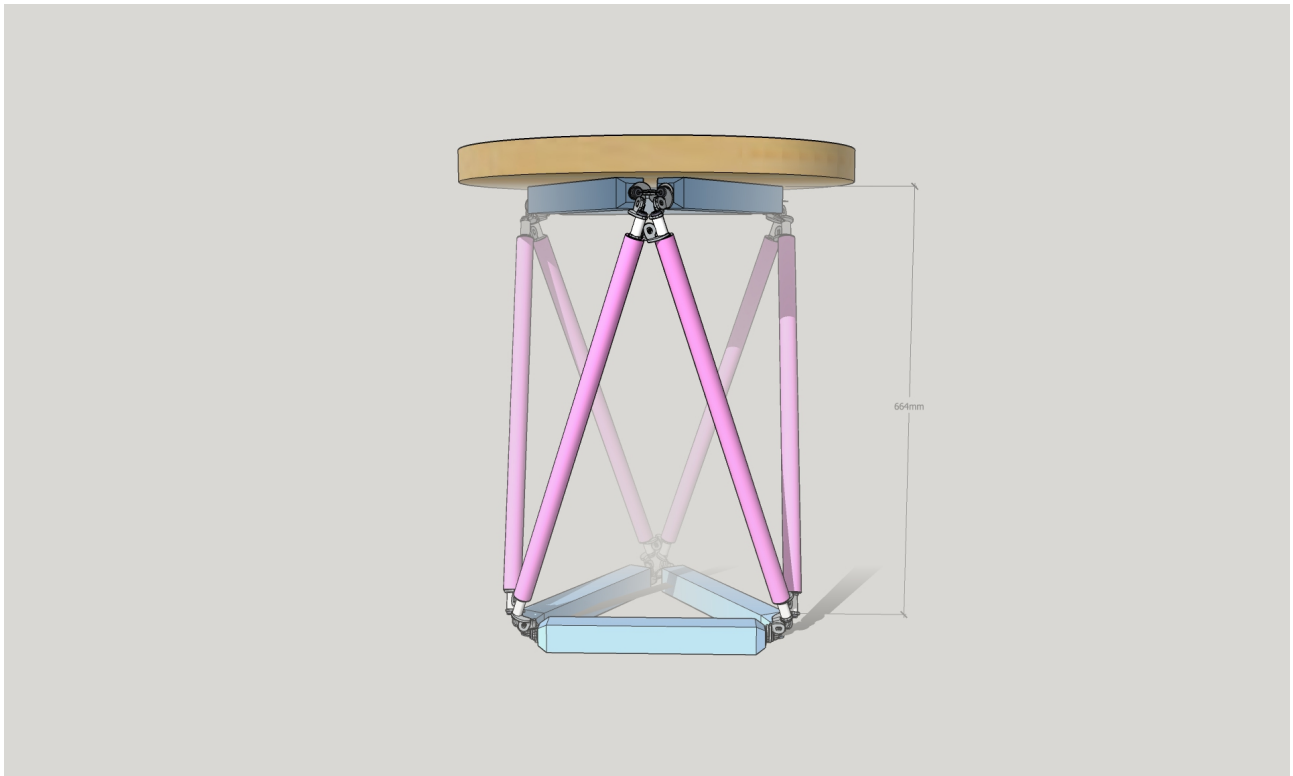
It can be helpful to join as many hubs rings together as possible, flat on the ground before connecting the 3D structure together.



OctaTable

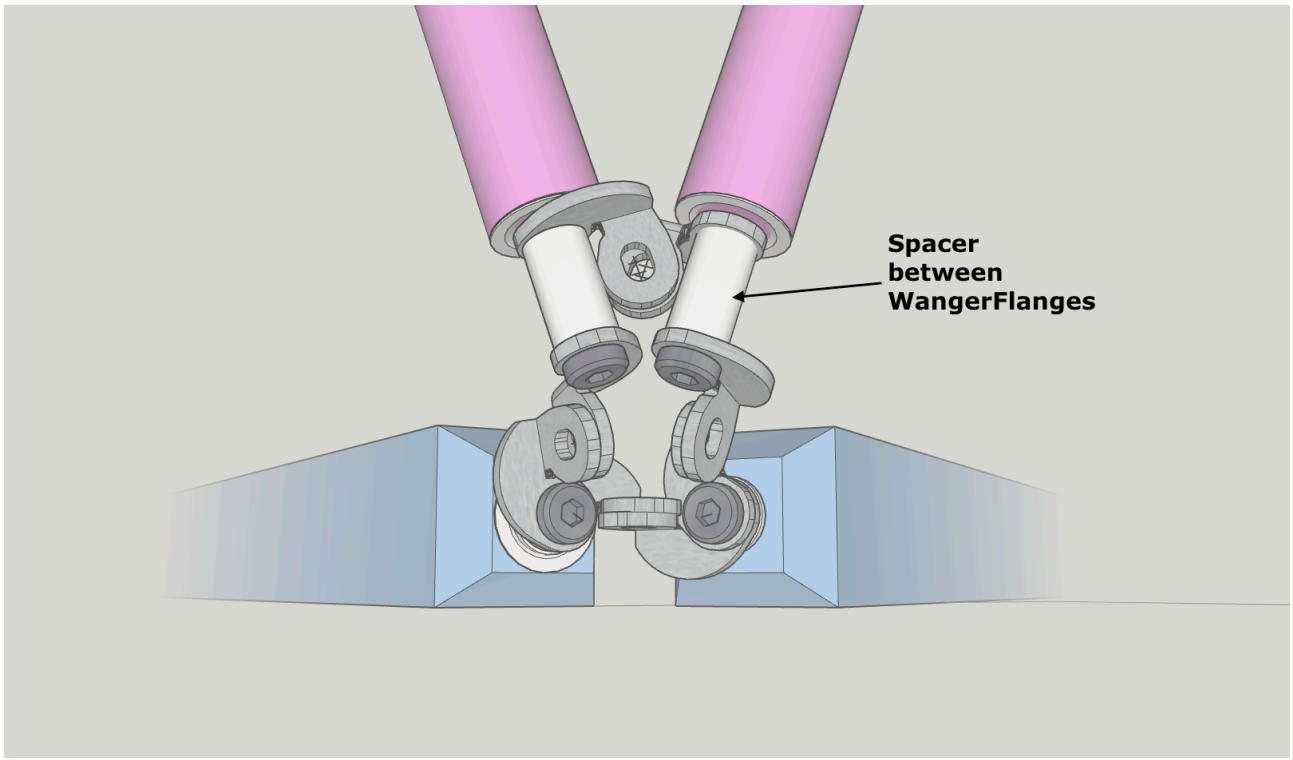
Another version of the Octahedron could be made to make a side table.





To make this table we have to use the WangerFlanges in a slightly different way. Because a four way joint likes to maintain symmetry (if you make one up can can see) we have a problem with the taller joints on this octahedral table design, we have 2 normal joints and a narrow angle because we stretched the octahedron into the taller table form.

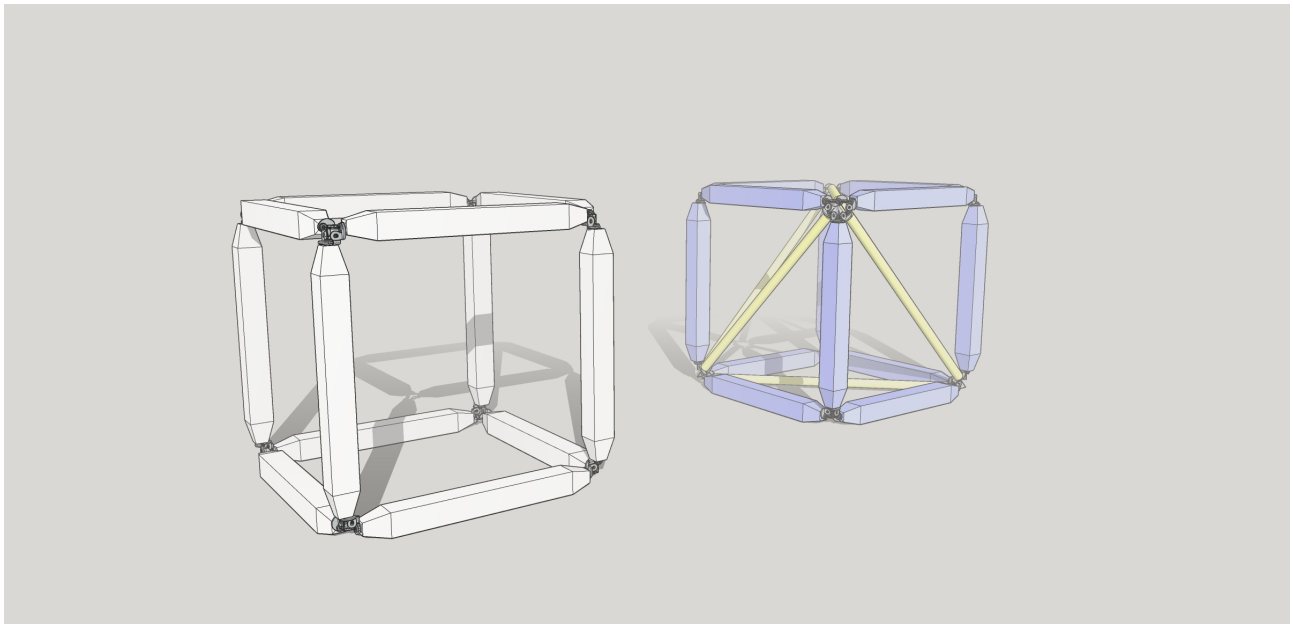
We need a spacer between WangerFlages to allow for this acute angle, see diagram below:



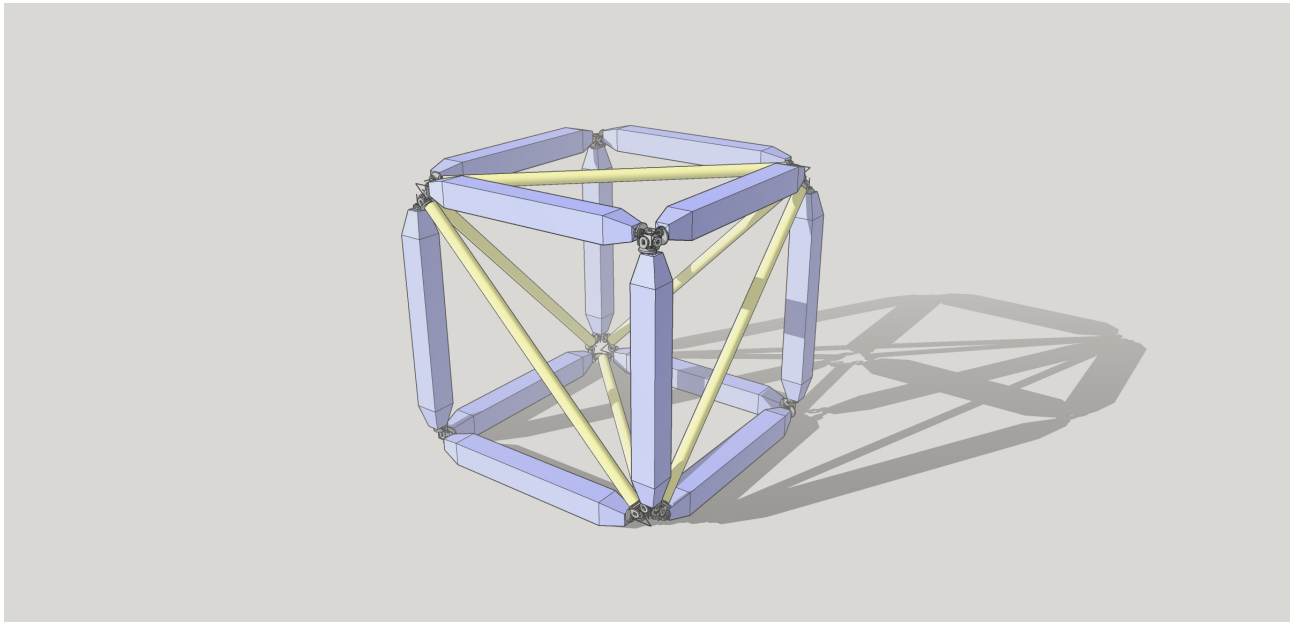
I have made the taller table without using spacers but I couldn't get the drawings to connect so it would be worth trying i with and whiteout spacers.

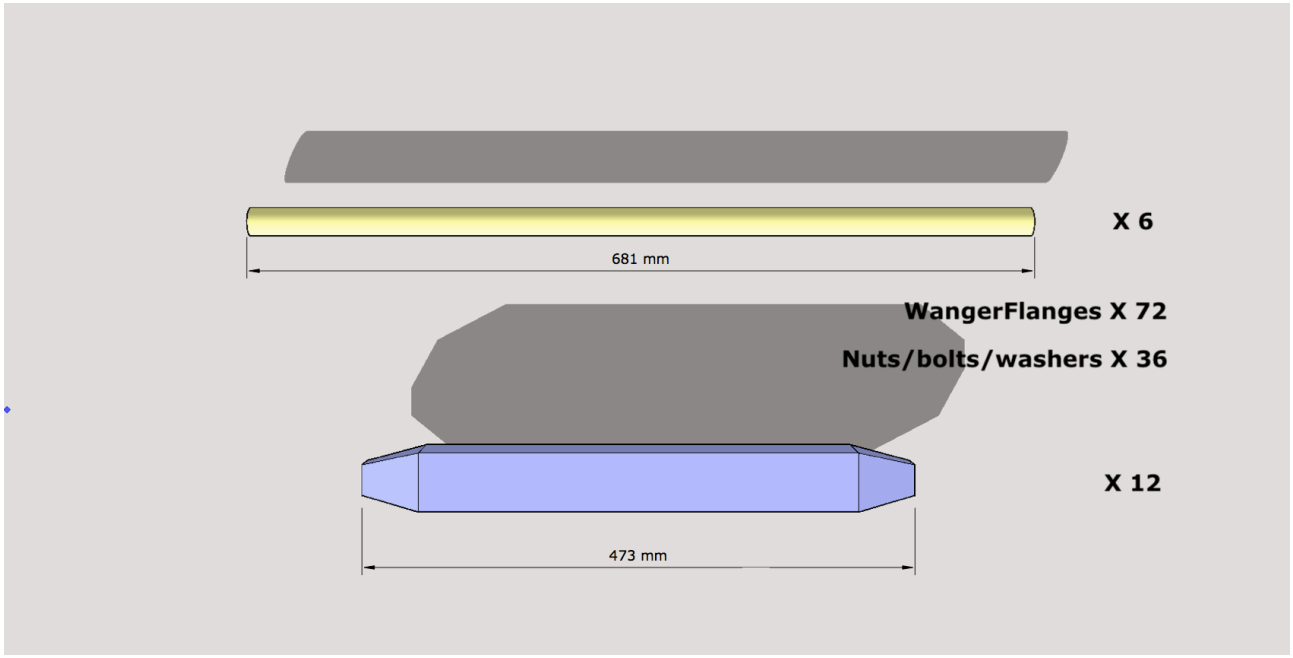
Cube

The first thing we need to think about when building cubes is that they are not inherently stable structures, so if we made a cube by fixing 12 struts together it could distort with heavy loads or fall into a heap if the bolts are loose. A good rule of thumb is, if a structure will maintain its shape when the bolts are loose then it will be very strong when the bolts are tight.



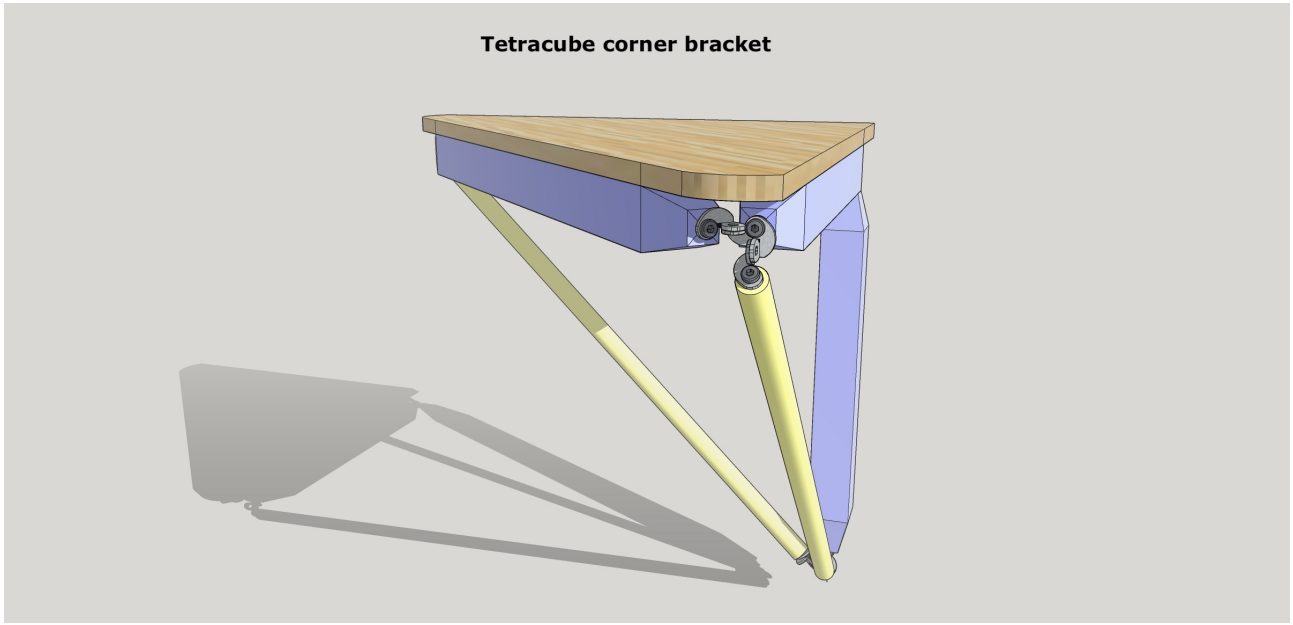
To fix this issue we simply add some cross members to triangulate the cube, the cross member shape turns out to be a tetrahedron, so you could say this is a tetrahedron, cube hybrid.





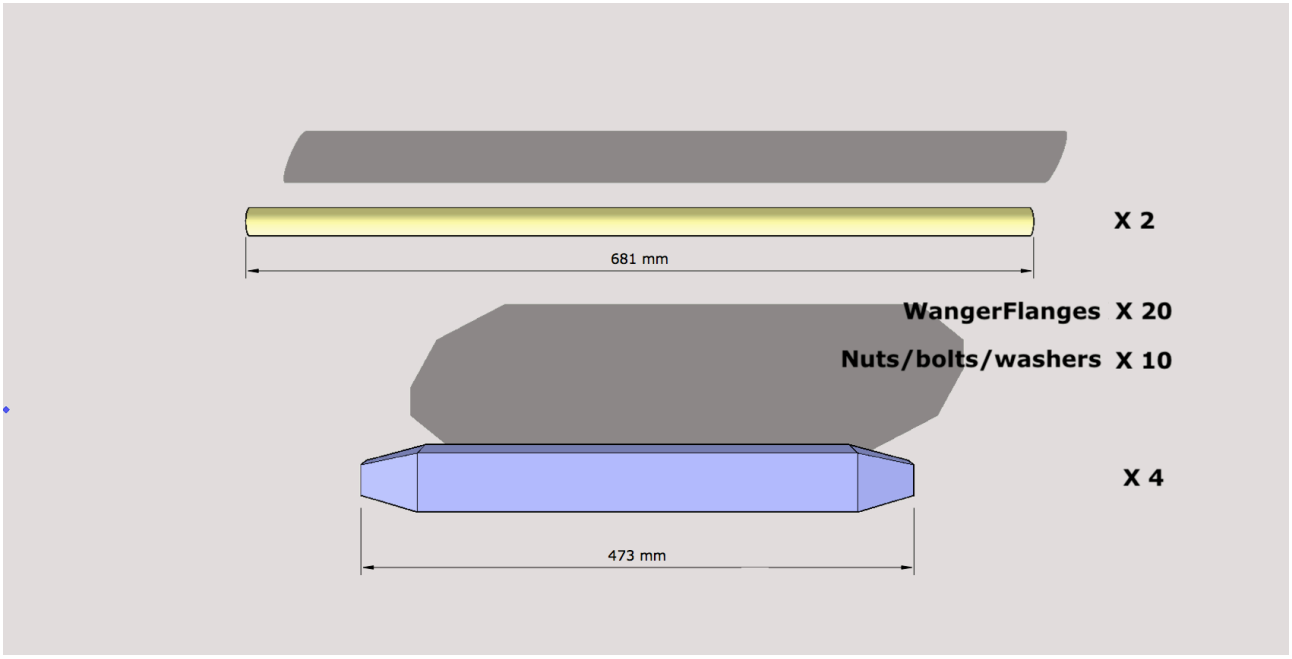
I have shown the yellow bracing as rods but you could make these wire and tension them to form a tensegrity type structure that would be just as stable.

Corner bracket

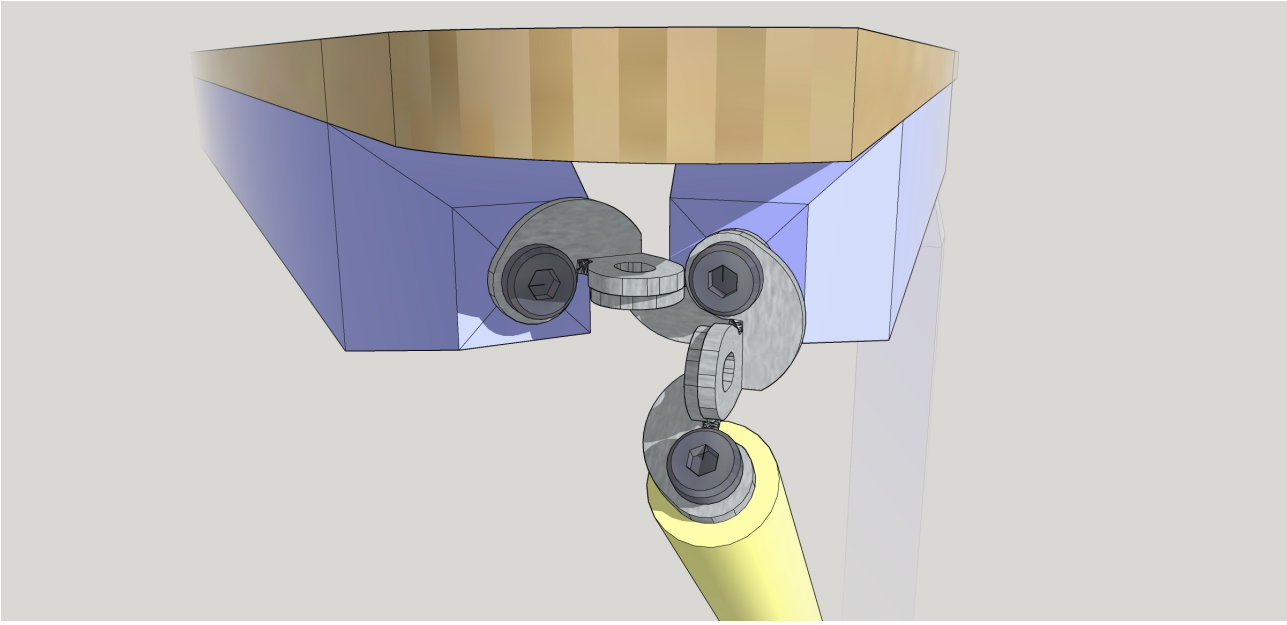


Using the same geometry as the cube with tetrahedron bracing we can also make a simple corner bracket that will be both strong and a bit better looking than standard wall brackets you can buy in stores.

The cutting list and number of WangerFlanges is much reduced.



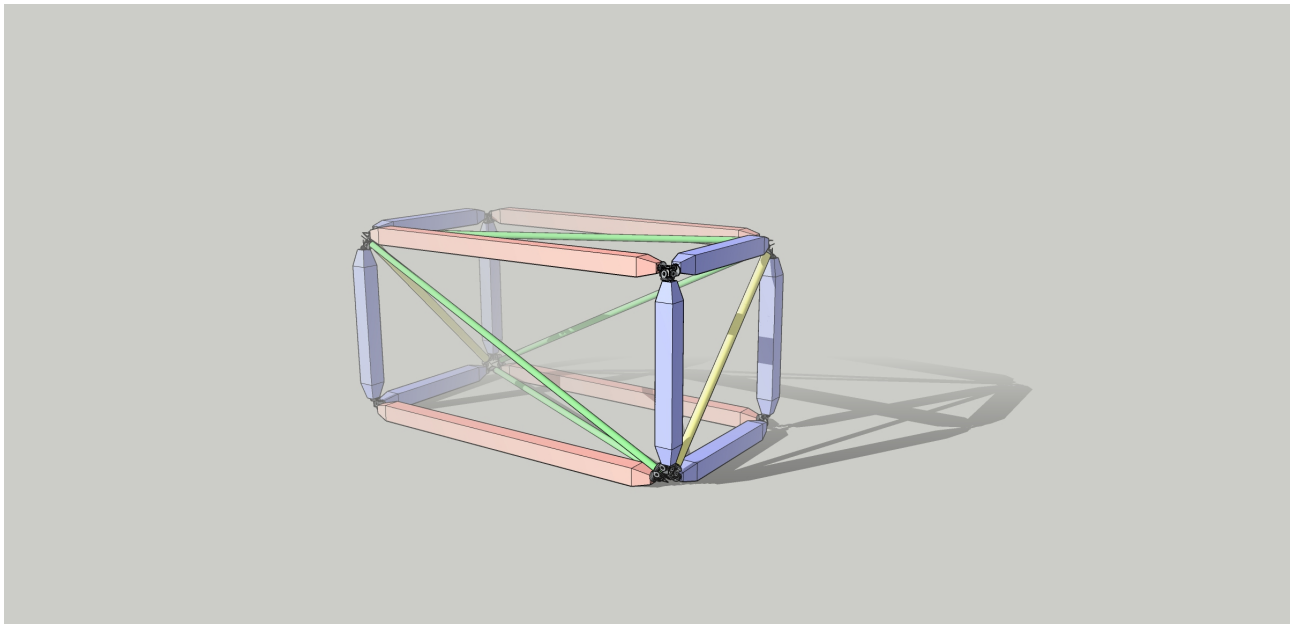
Because this is not under undue stress you can make corner joints that don’t have a closed ring.



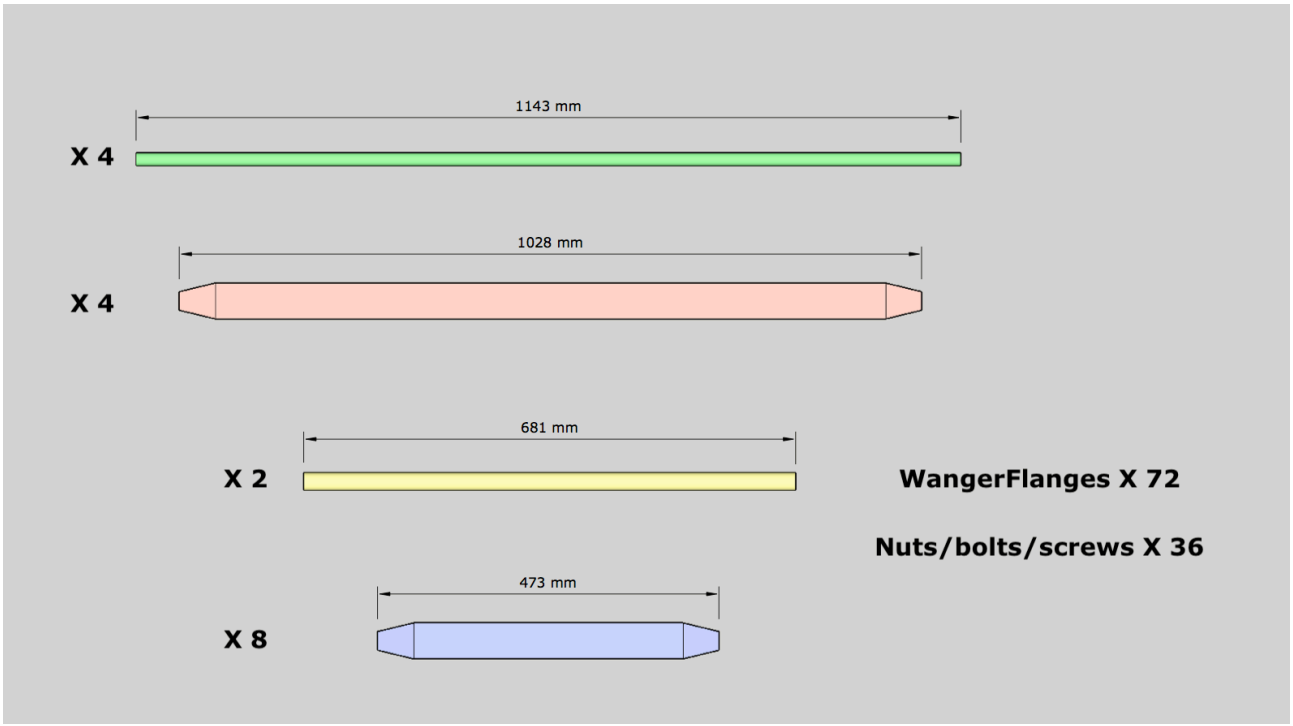
Notice how the yellow strut has only one WangerFlange instead of the usual two.

Boxahedron

It’s not a cube because all the sides aren’t the same length, so when you need something cubic but longer try the boxahedron.

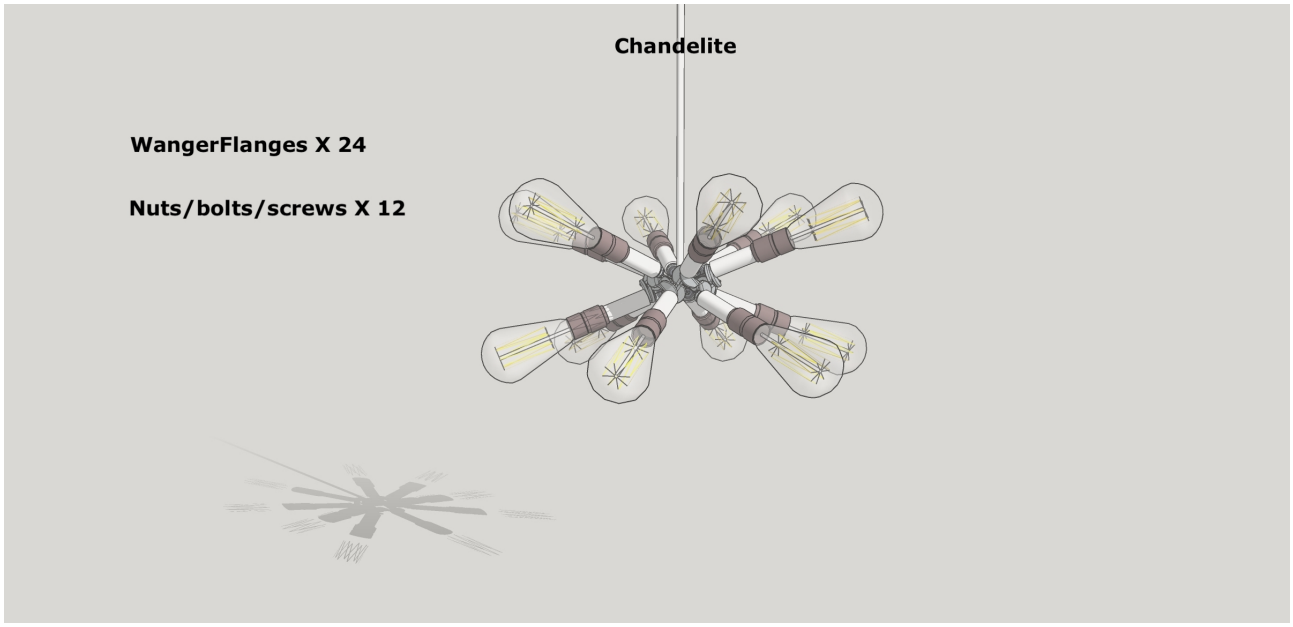


It has the same number of WangerFlanges as the cube and the same blue/yellow struts but another two unique lengths are needed to make it longer.



Chandelite

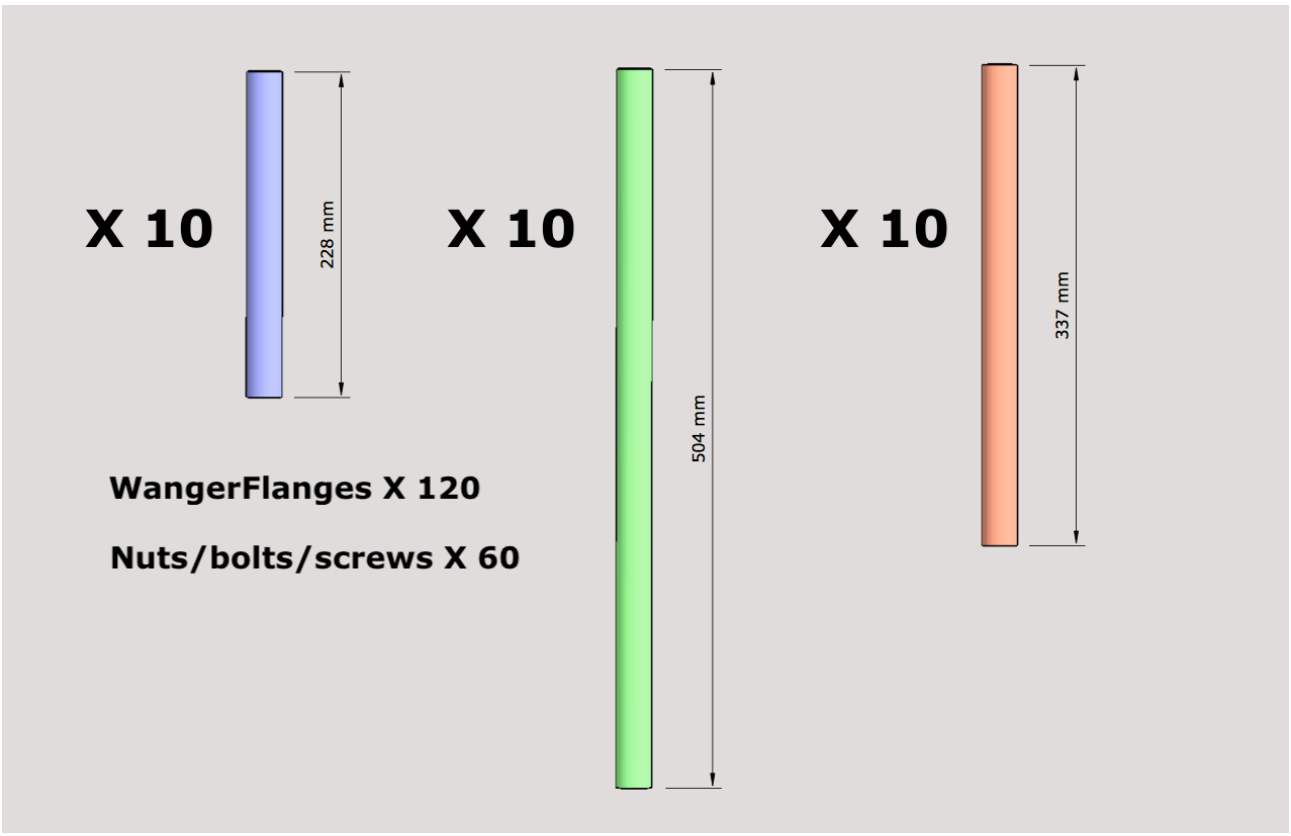
Join a WangerFlange pair onto 12 short tubes and simply join like spokes in a wheel to make an adjustable light fitting.



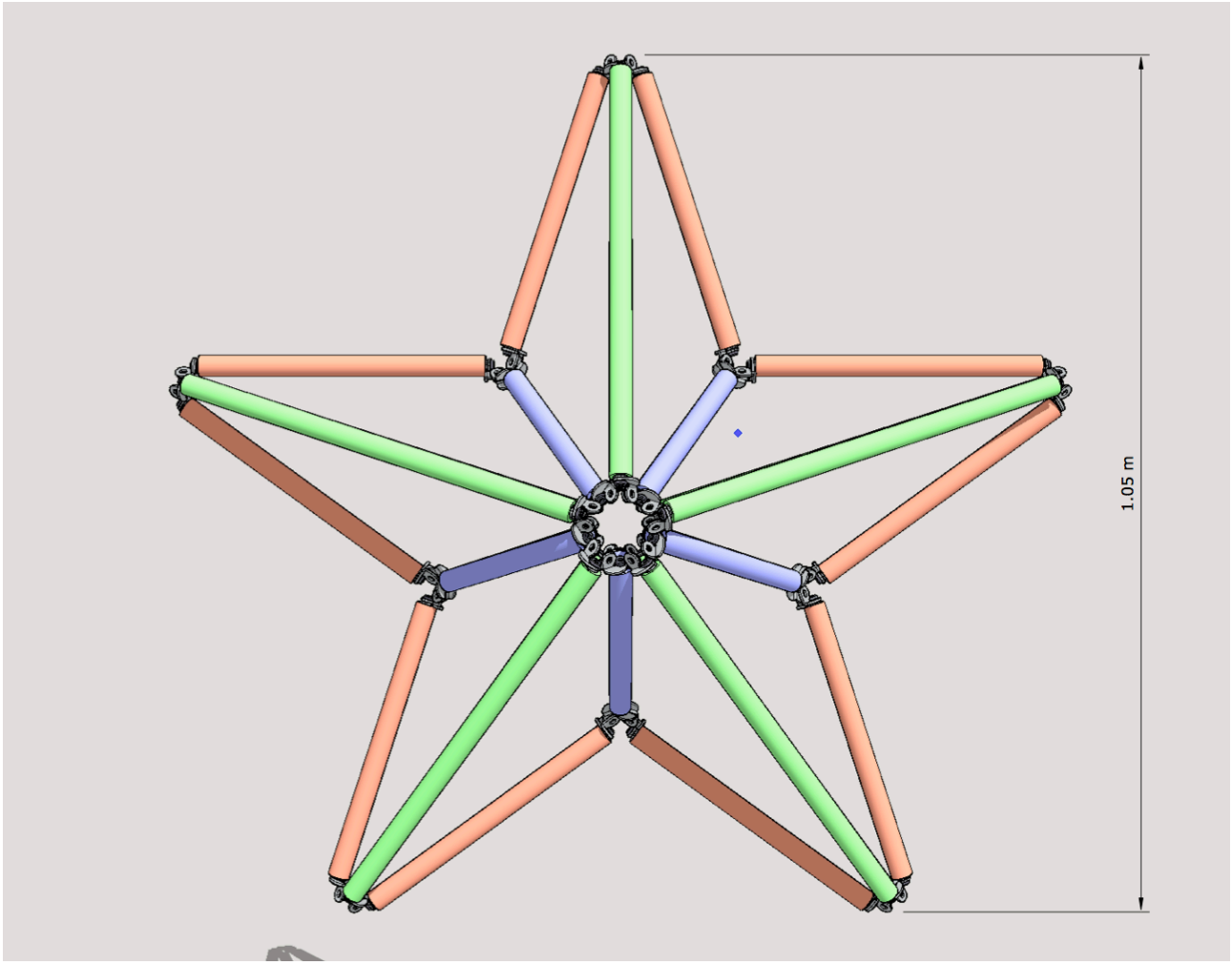
You can make many different light fitting with any number of bulbs like this.

Plan View

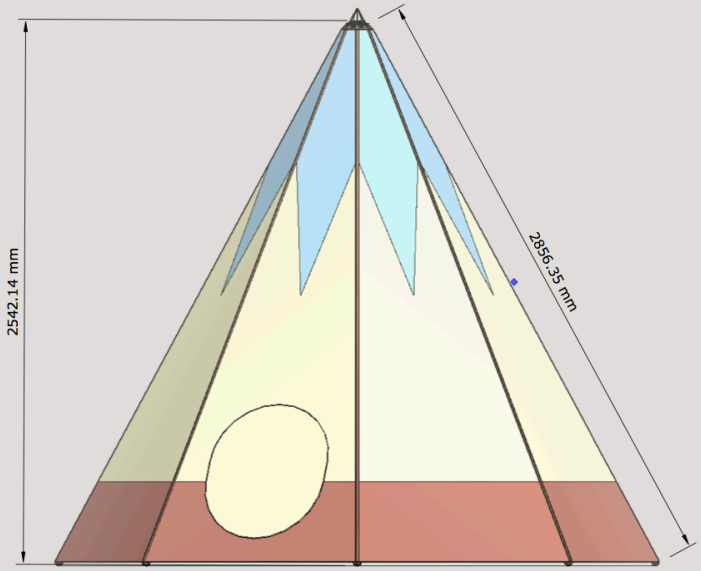
Star


X 10
228 mm
X 10
504 mm
X 10
337 mm
WangerFlanges X 120
Nuts/bolts/screws X 60

I used sticks gathers from the garden for free to make this decorative star, the fact that the sticks are not entirely straight doesn't make any difference, just cut the sticks to the length in the diagram and build as usual.



Teepee

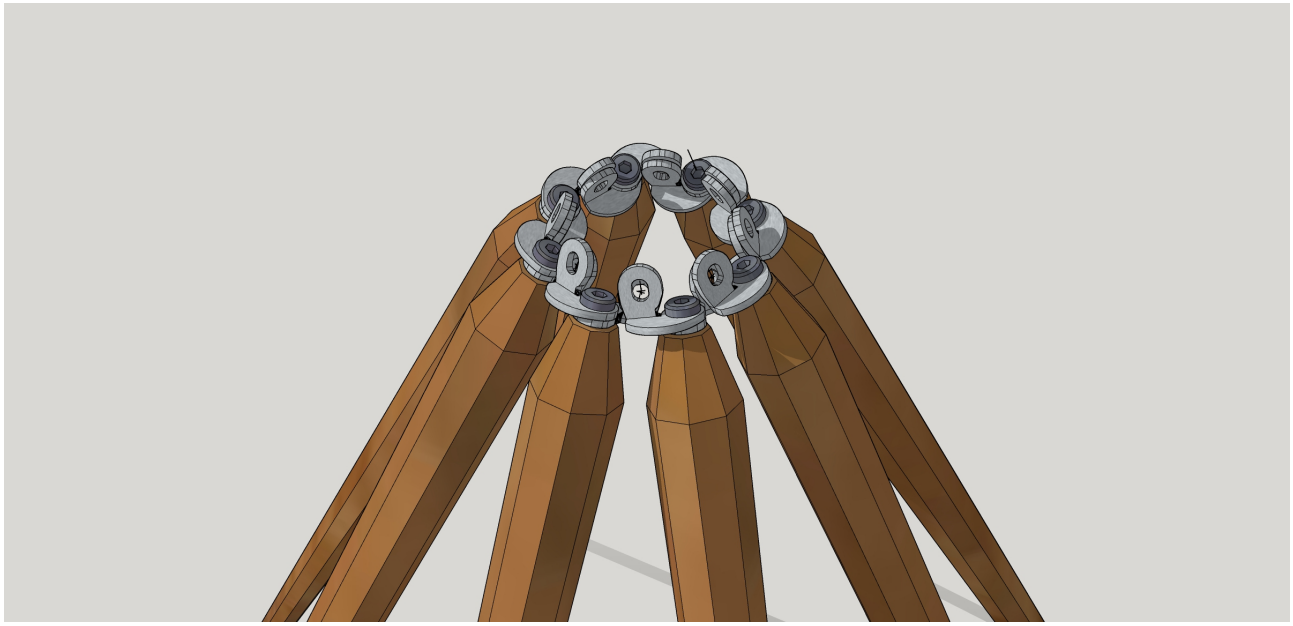


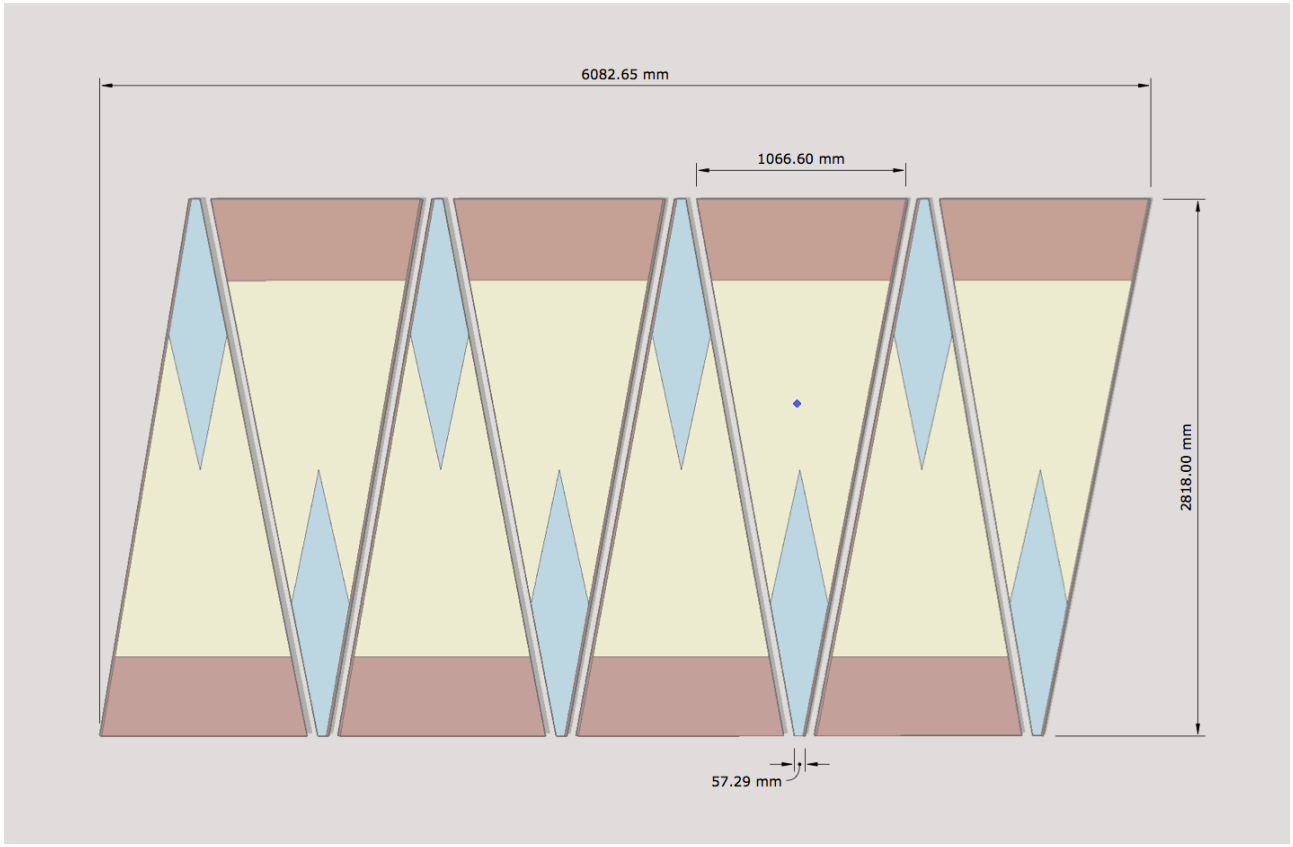
WangerFlanges X 16

Struts X 8 @2856mm

Bolts/nuts/screws X 8

Canvas 6m x 3m

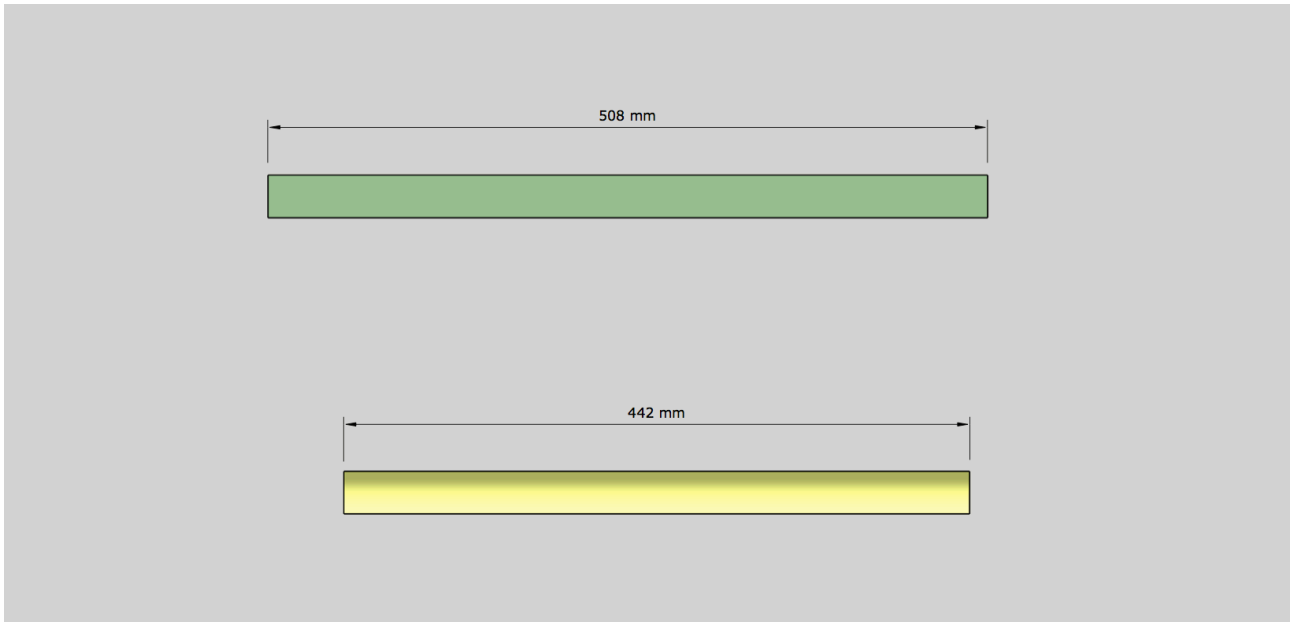



6082.65 mm
1066.60 mm
2818.00 mm
57.29 mm

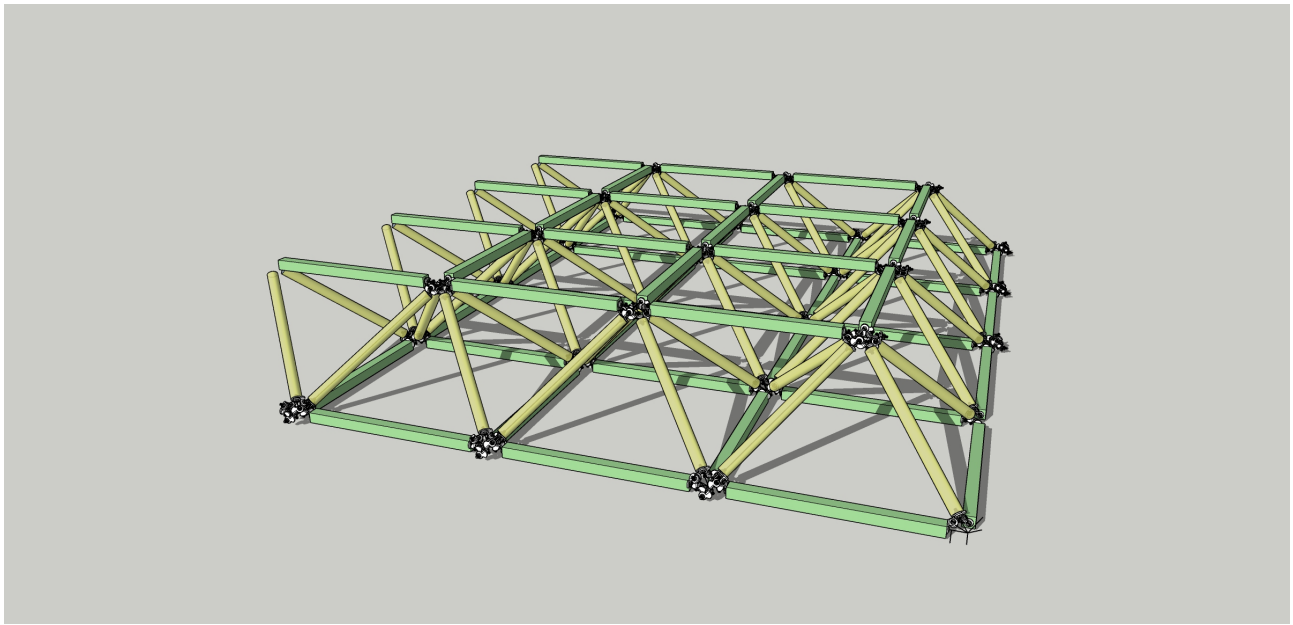
Box Truss

Space frame trusses are used in modern buildings because they offer great weight to strength properties but they can be complex and difficult to make… Well not any more, building space frames with WangerFlanges is super easy.

This trussed roof has only two different lengths of strut (shown below)

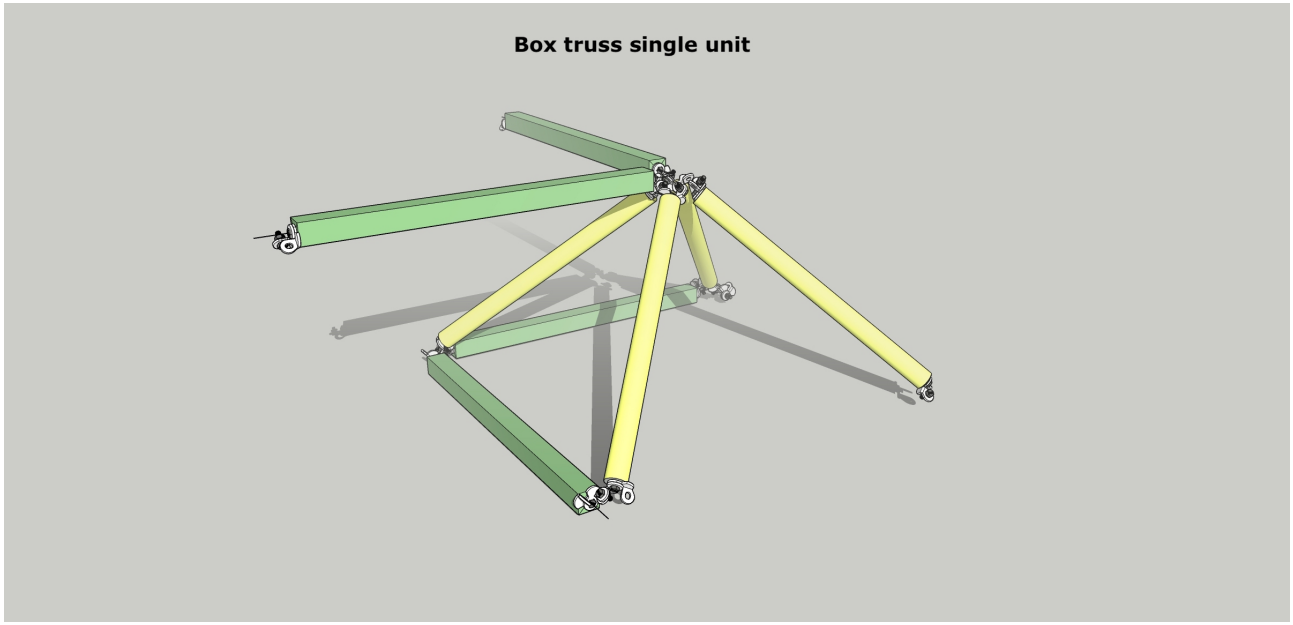


and will also work with other sizes, for example if the yellow struts where 10% - 20% shorter the only change would be a slightly thinner truss depth.

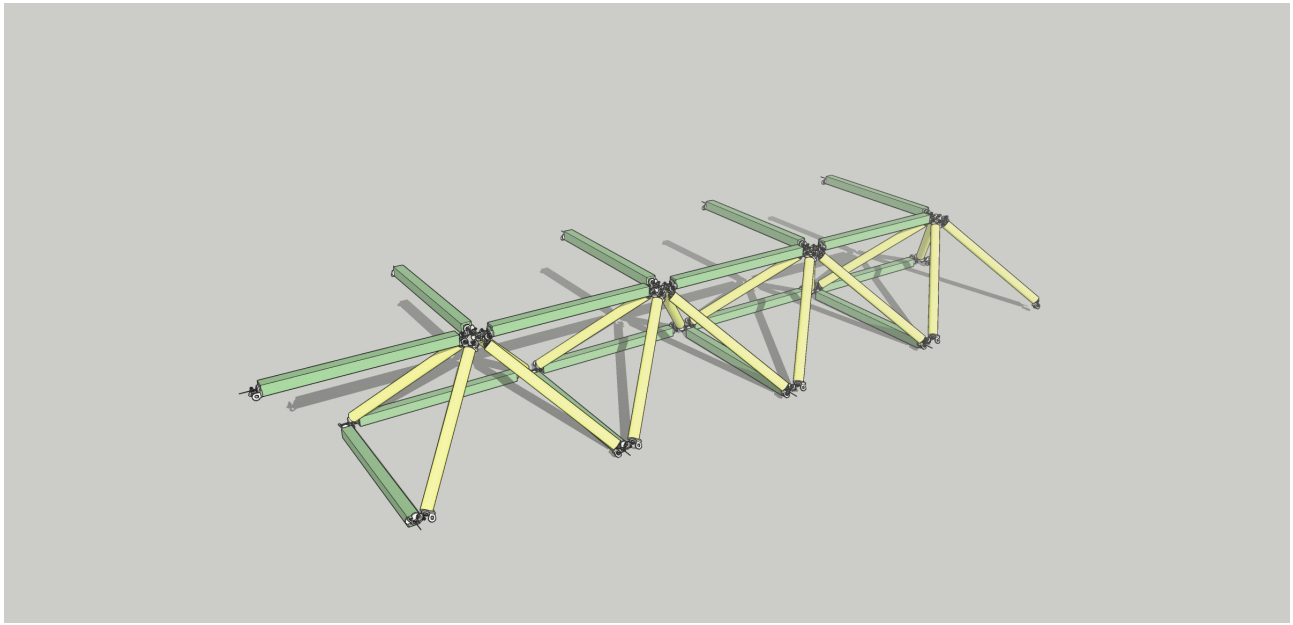


To build a box truss type space frame we need to break it down into a single element that ca be joined in a row first then joined across the rows to produce the desired size square or rectangular roof.

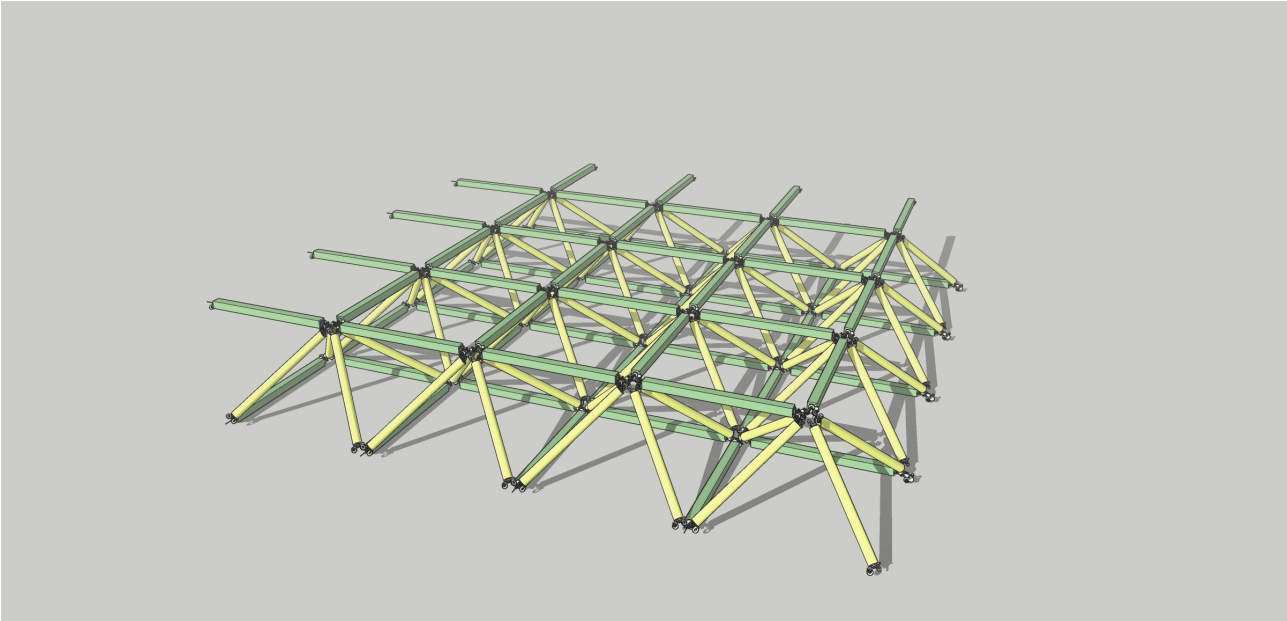
As we can see a single unit has 4 green and 4 yellow struts, from here we just need to know how many units in a row and how many rows in total,



This is a row of 4 units, notice 4 spare greens at the back need to be moved to the open yellow space at the front, green spare on left goes top right yellow triangle. This makes it easy to calculate how many parts required.



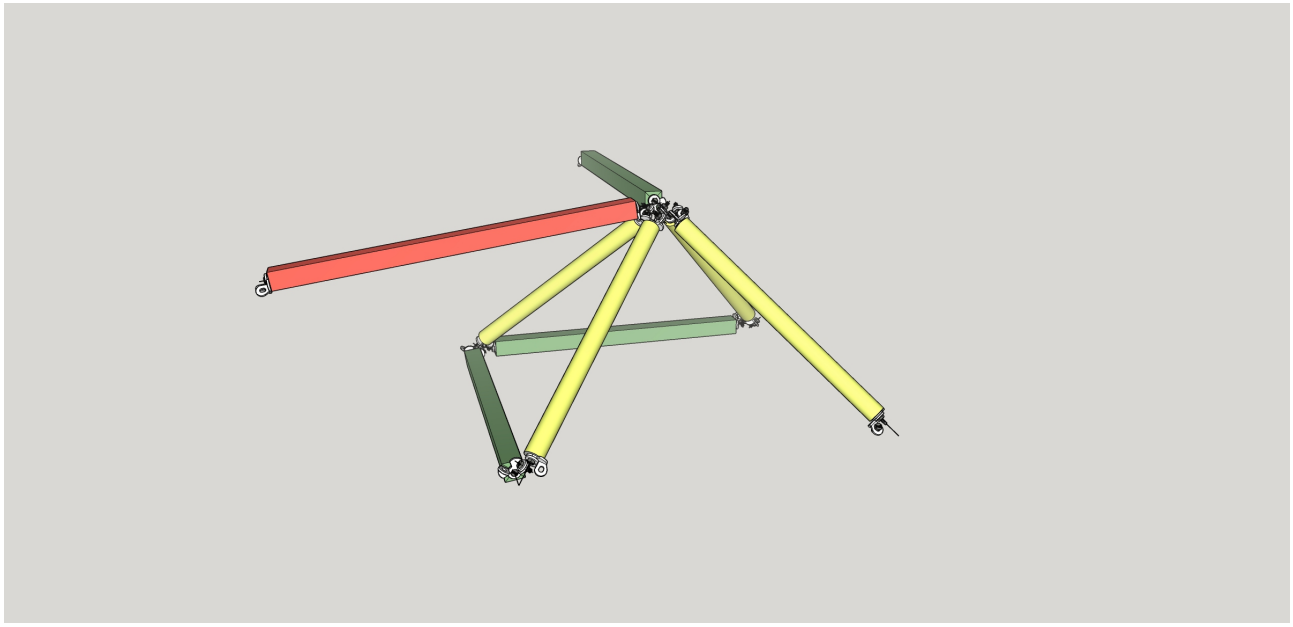
Now we can join several rows together to make the final roof.



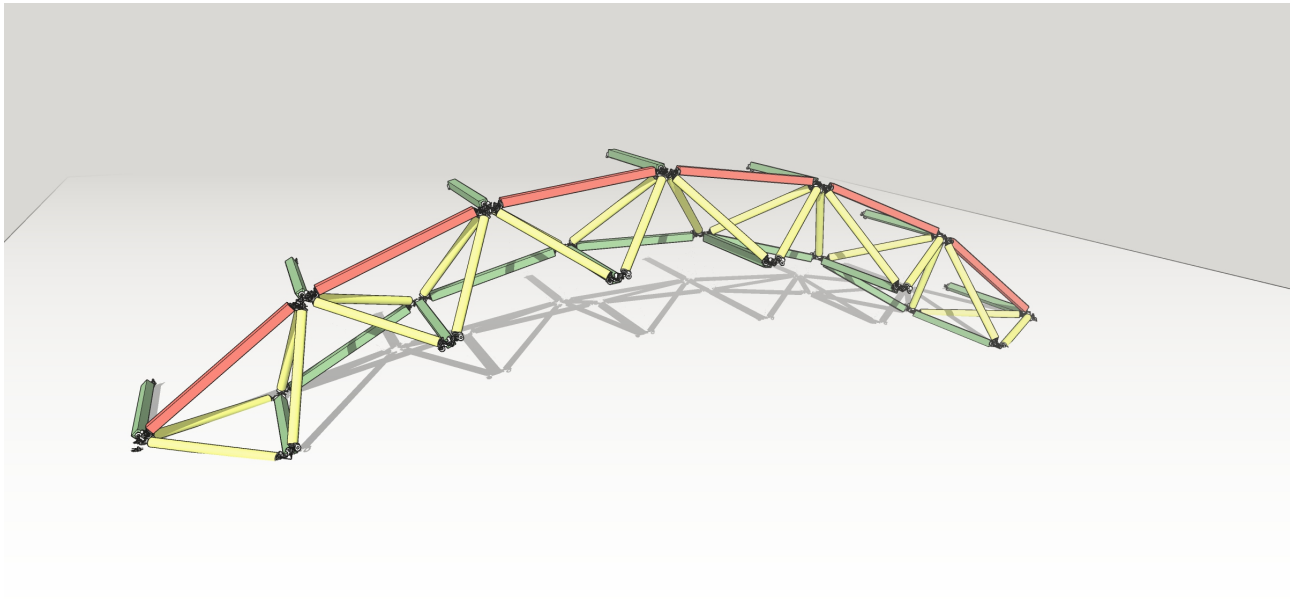
This roof has 16 units (each unit has 4 yellow and 4 red struts so to build this roof you would need 64 yellow and 64 green struts and 512 WangerFlanges.

Each unit has a 600mm square footprint so this roof would measure 2.4m x 2.4m (to centre of struts) on the bottom and 1.8m x 1.8m at the top.

Curved Roof truss

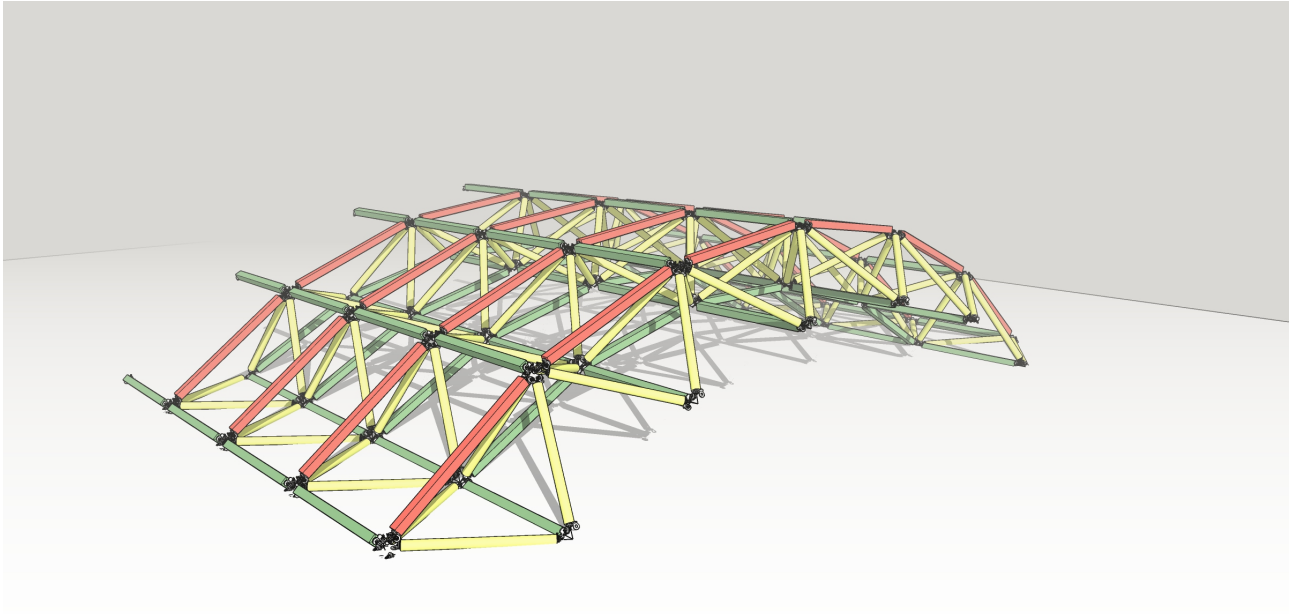


Just like the flat space frame truss we make a single unit that can be copied down a row then joined across rows to form the finished roof truss. This has the same green and yellow struts but an extra red strut has been added to form the curve.



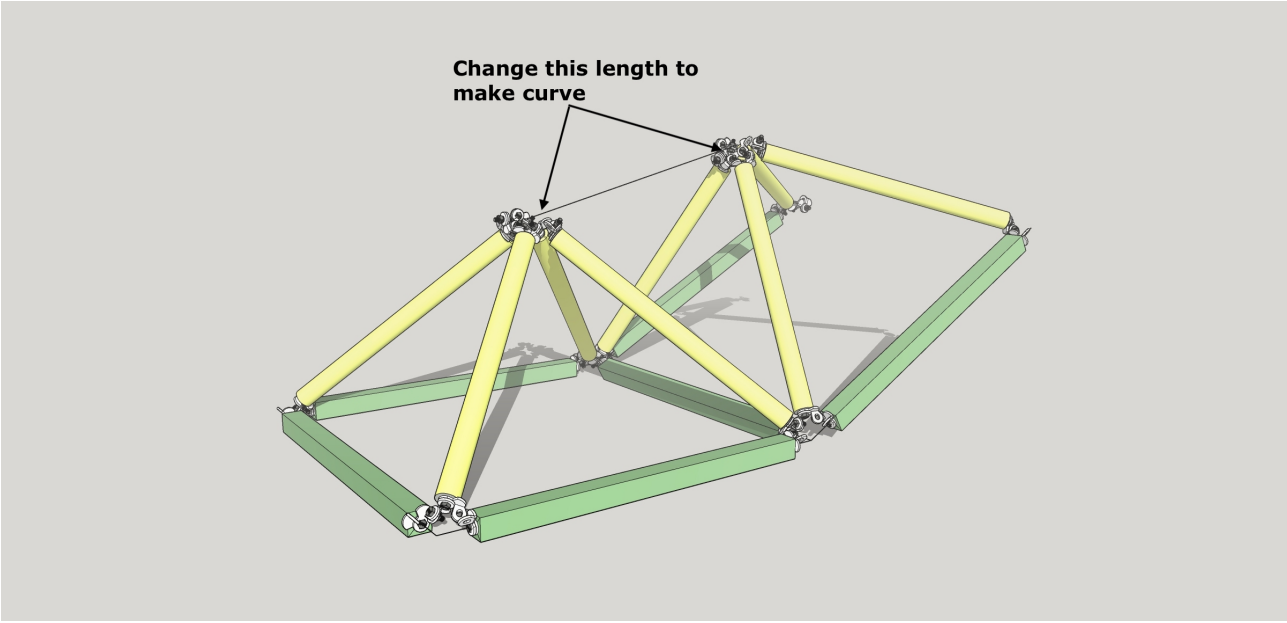
The spare green struts still fit the missing space at the front so the quantities of red, green and yellow struts still work out to be:
4 yellow
3 green
1 red
Just multiply this by the number of units in your structure.

This roof is 5 units by 3 units to make total of 15 units so you would need 120 struts, 480 WangerFlanges.

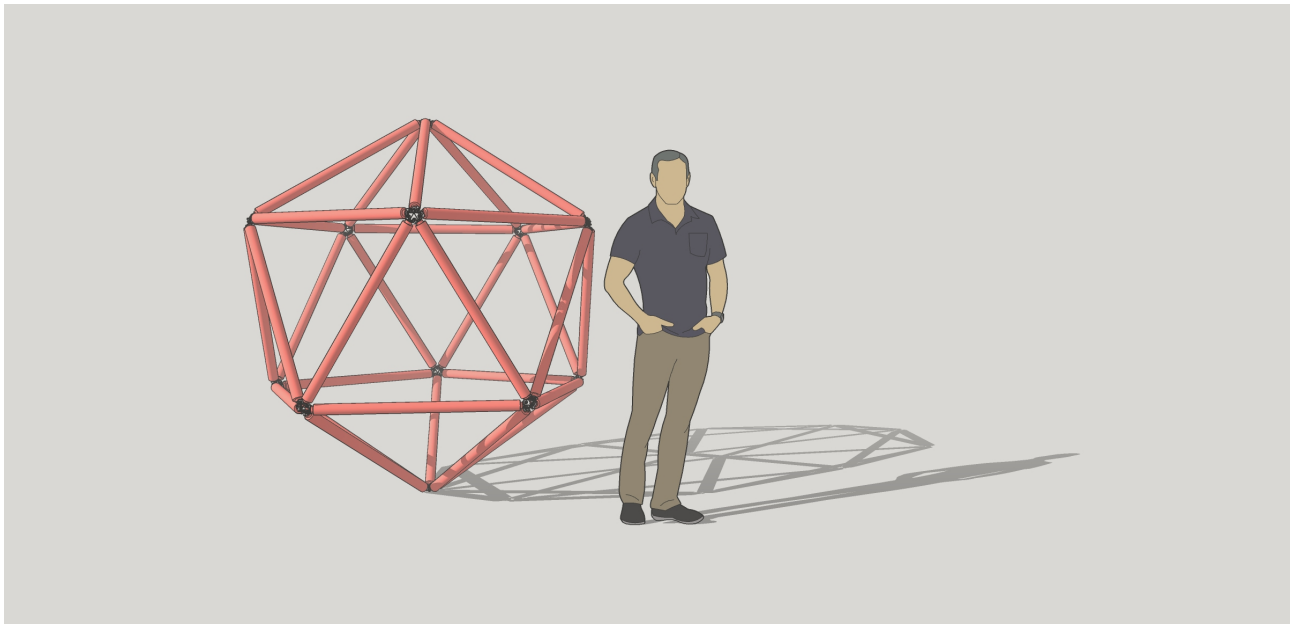


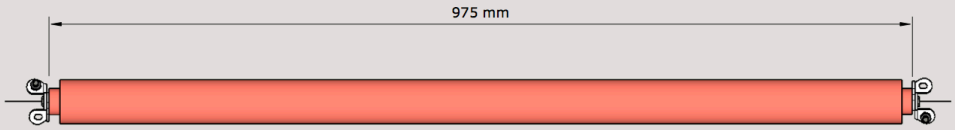
It would be just as easy to reduce the red length to under the green strut length, this would make it curve inwards instead of outwards.

For experimental purposes you only need enough struts to make two units.



Icosahedron



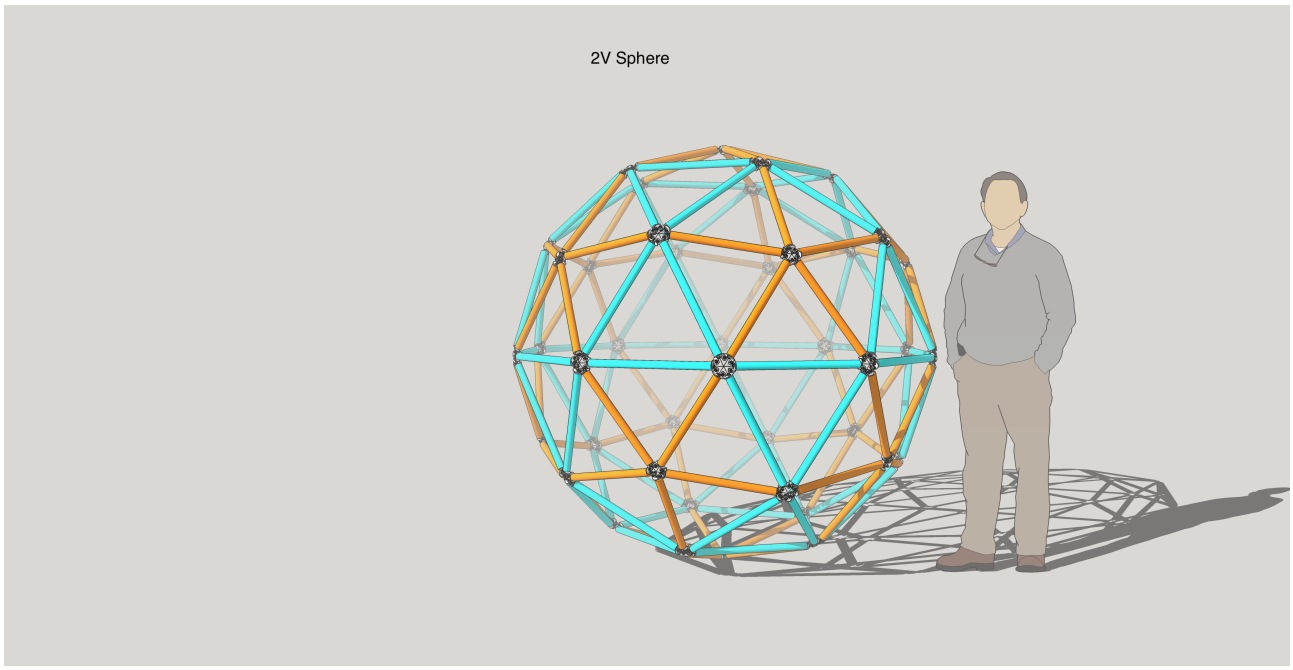


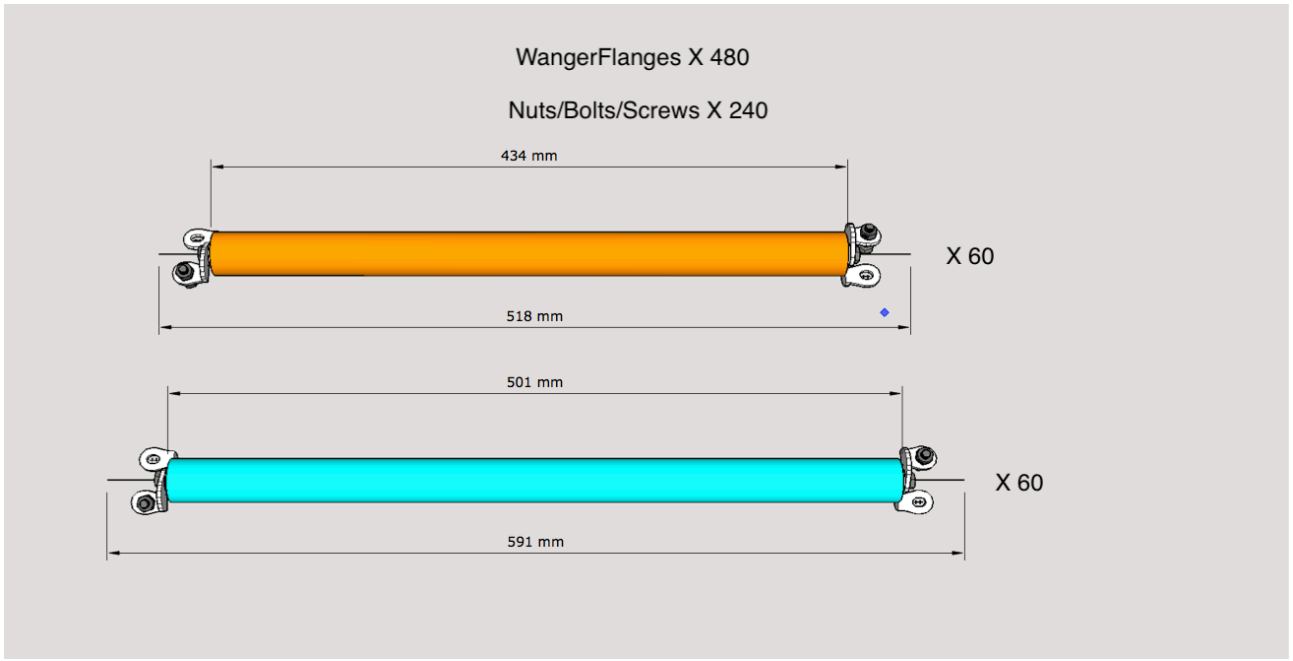
X 30

WangerFlanges X 120

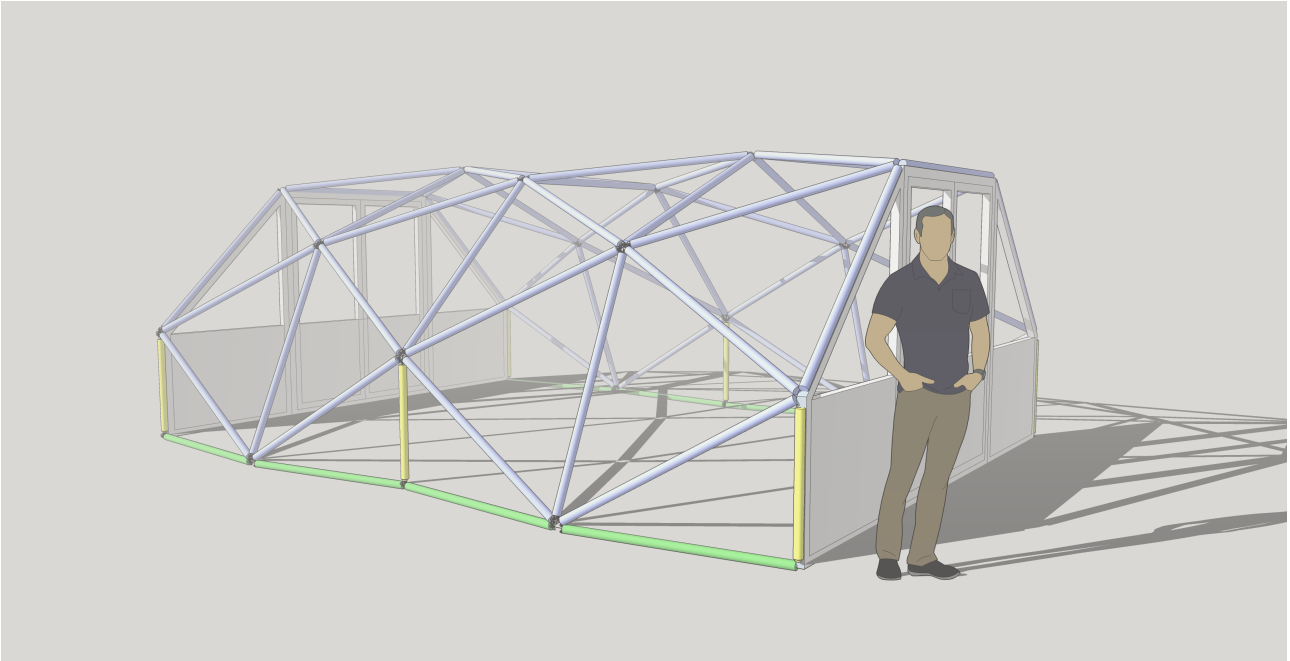
Nuts/bolts/screws X 60

2V Geodesic sphere





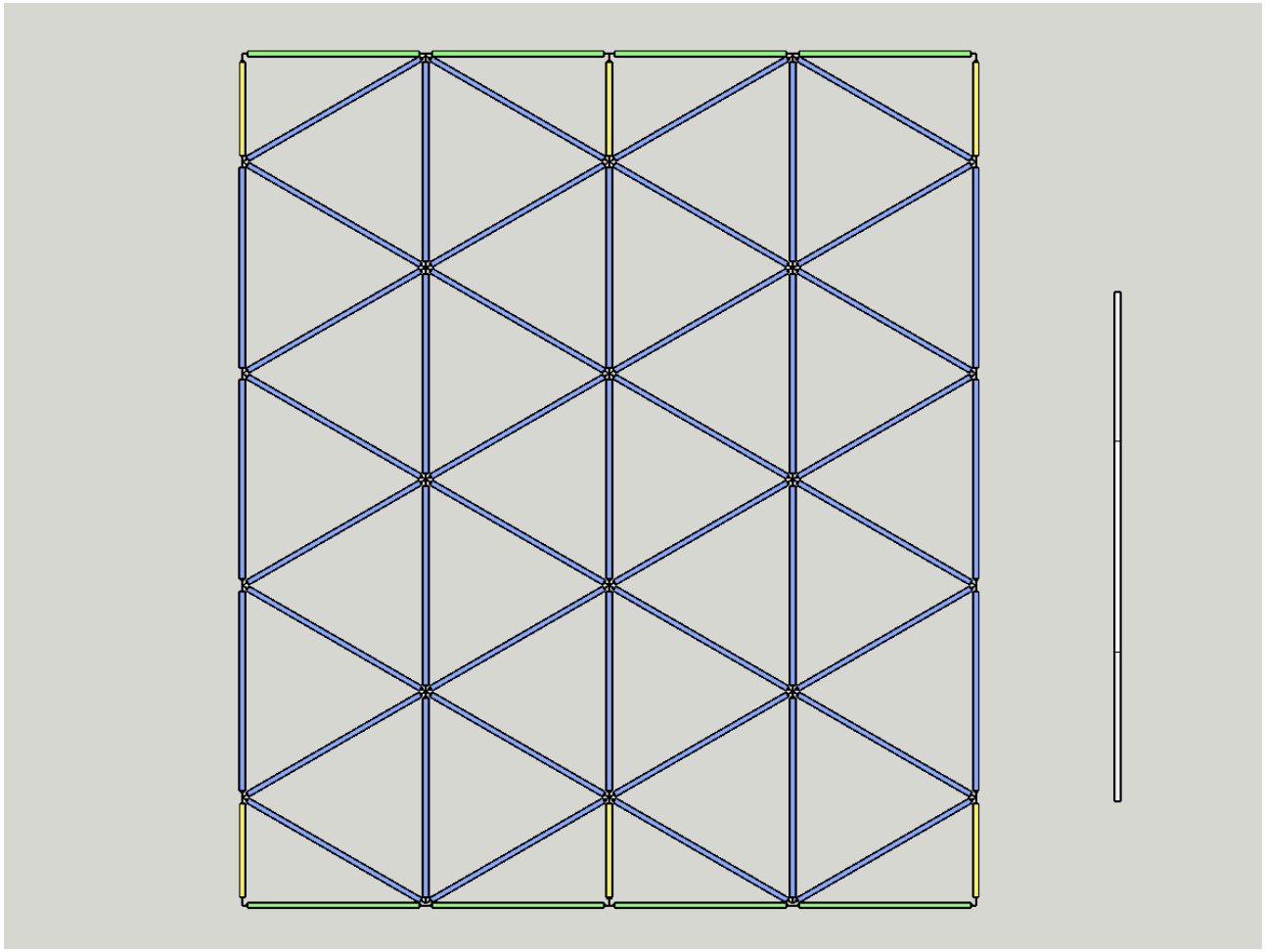
Octo-tunnel (A)

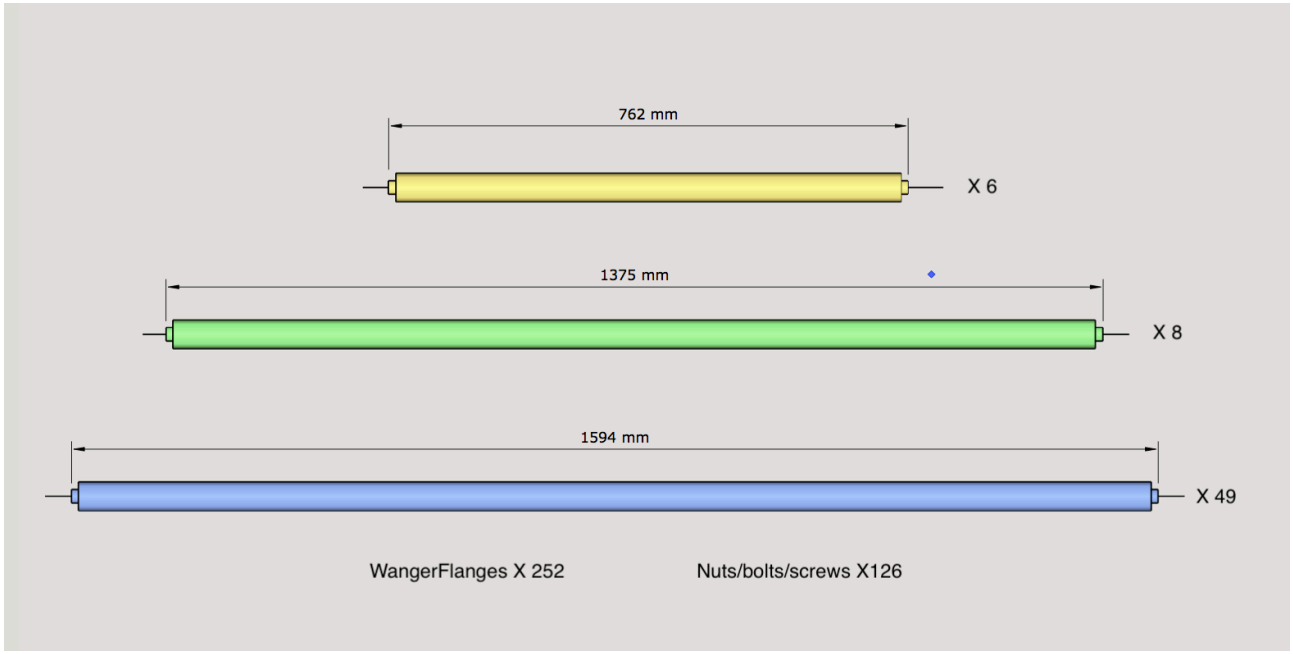


This is a small tunnel based on a octahedron or half an octagon to be exact. It's pretty unique in the way that you can change the orientation to make two different types.

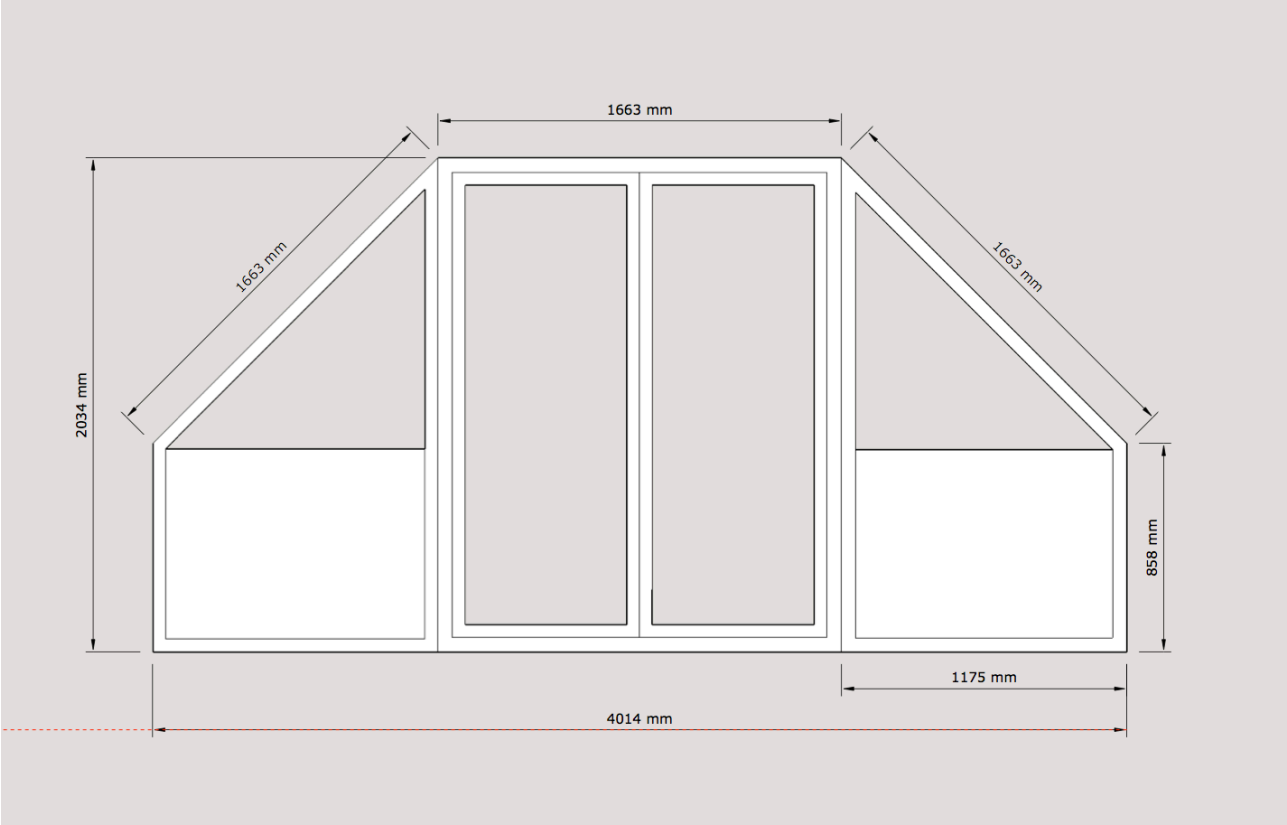
The best way to make this is to layout and join together all the struts on the ground, like the diagram, leave the nuts and blots loose so you can manipulate the framework. You may need to have some support to hold it in place until the screws/nuts/bolts are fully tightened.

Note: depending on which way you rotate the struts can make two different forms. If you curve horizontally you get blue struts at the ends and green ones on the ground. If you rotate vertically you get green struts on the ends and blue struts all the way round to the ground.




762 mm
X 6
1375 mm
X 8
1594 mm
X 49
WangerFlanges X 252
Nuts/bolts/screws X126

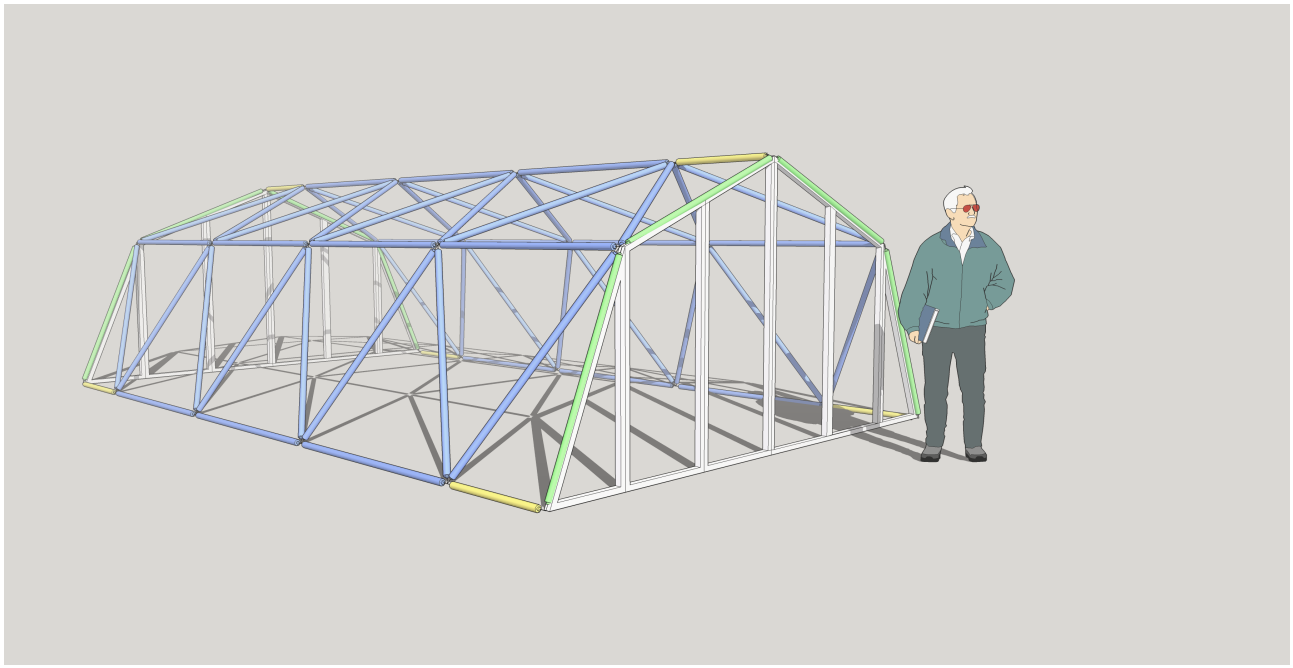
Measurements for the end wall

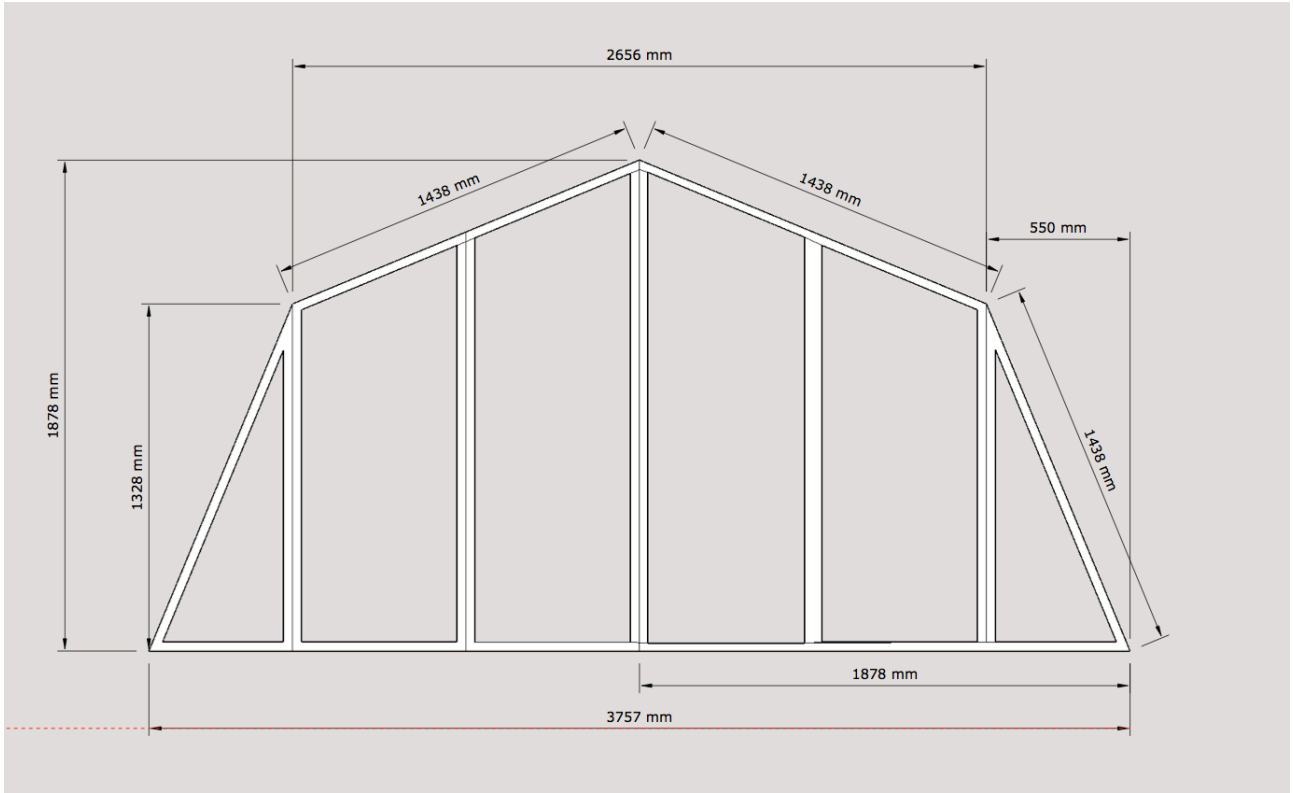


You will need to make two end walls with can be a challenge to get the right measurements. If you use thicker struts the end wall needs to be a little smaller. Lay out your blue struts in an accurate octahedron shape then measure the inside edges to check the measurements above.

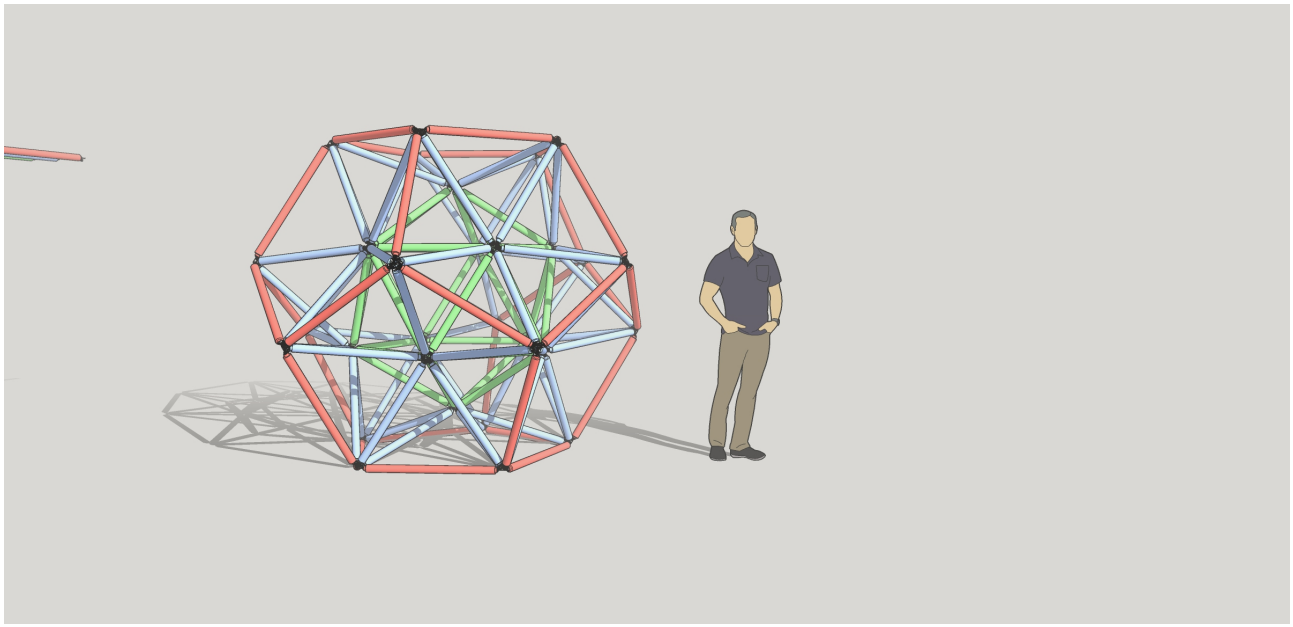
Octo tunnel (B)

All measurements, WangerFlanges, struts are the same for this version only change is a different end wall.





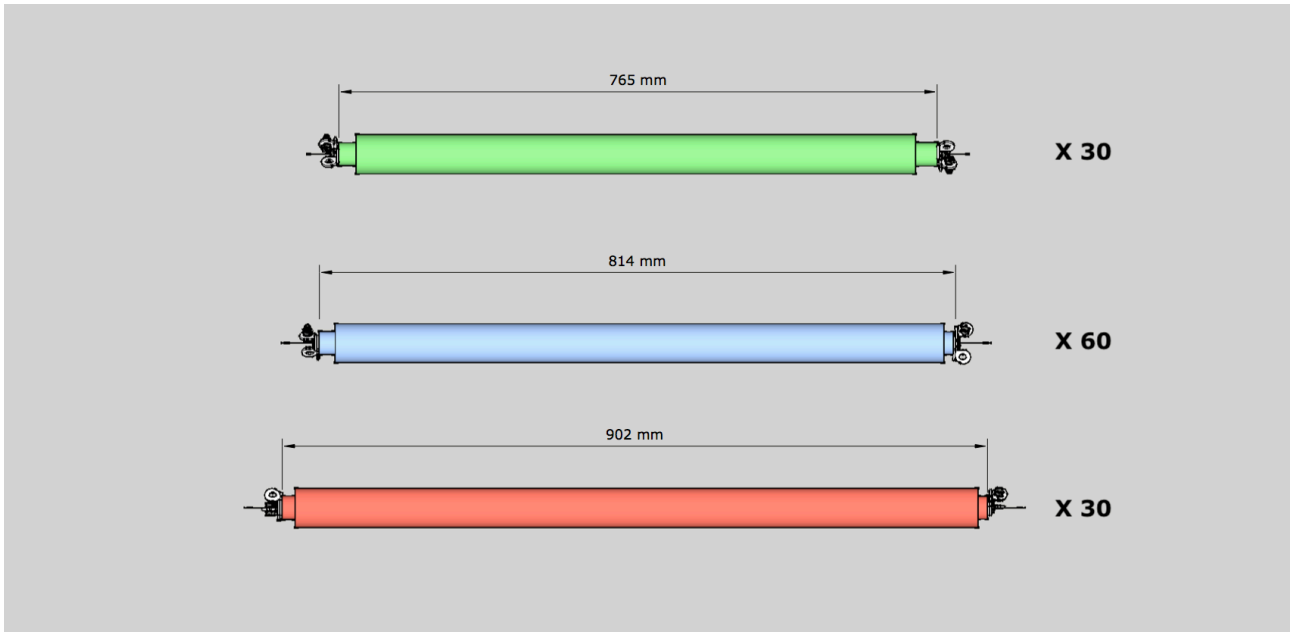
Trussed Dodecahedron

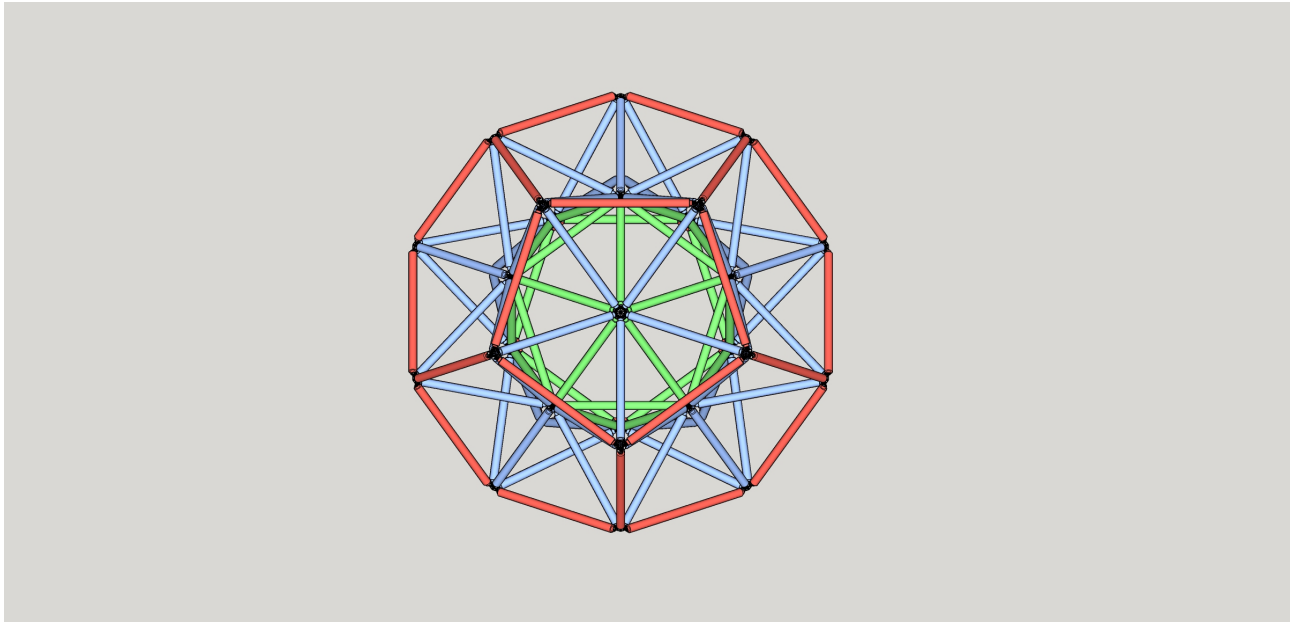


We've done all the platonic solids except the dodecahedron, like the cube the dodecahedron isn't inherently stable so we could take a look at triangulating it.

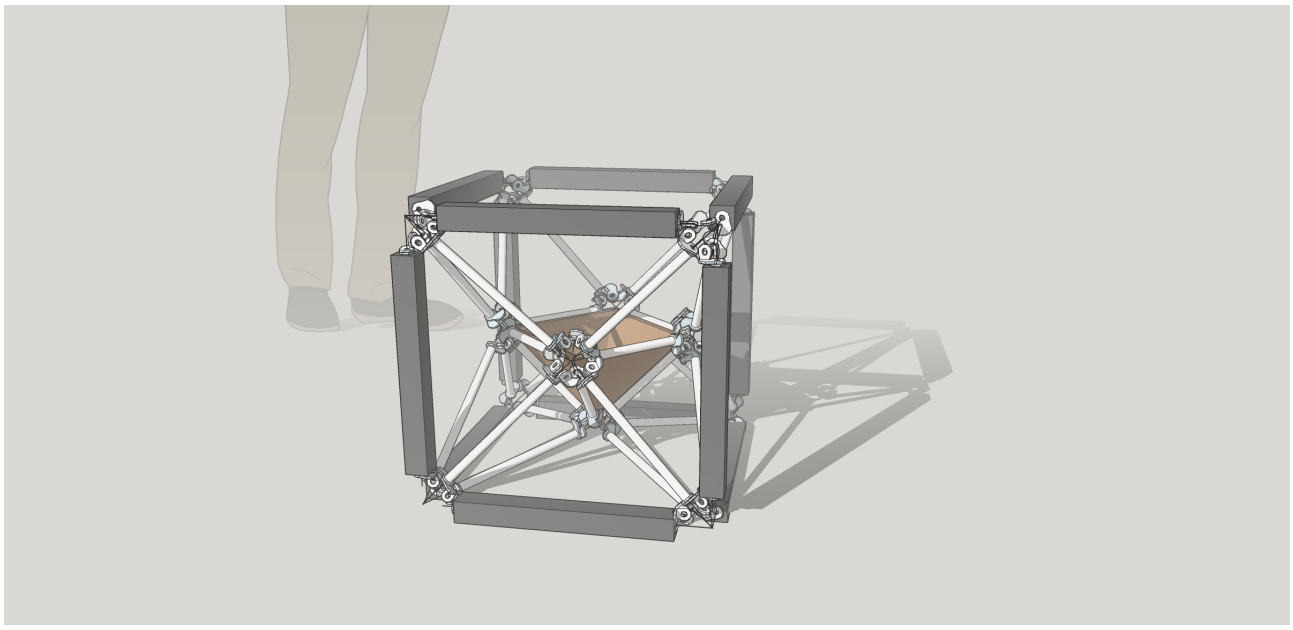
The picture above shows a dodecahedron in red struts, you could make this and see how stable it is all you need are 30 struts all the same size. If we triangulate the faces of the dodecahedron we get a pentakis dodecahedron, I've inverted the blue triangulation so it does not protrude outside the dodecahedron. We can finally add an icosahedron inside the dodecahedron joined to the blue struts this makes a full space frame truss

There are 120 struts and 480 WangerFlanges required to make this

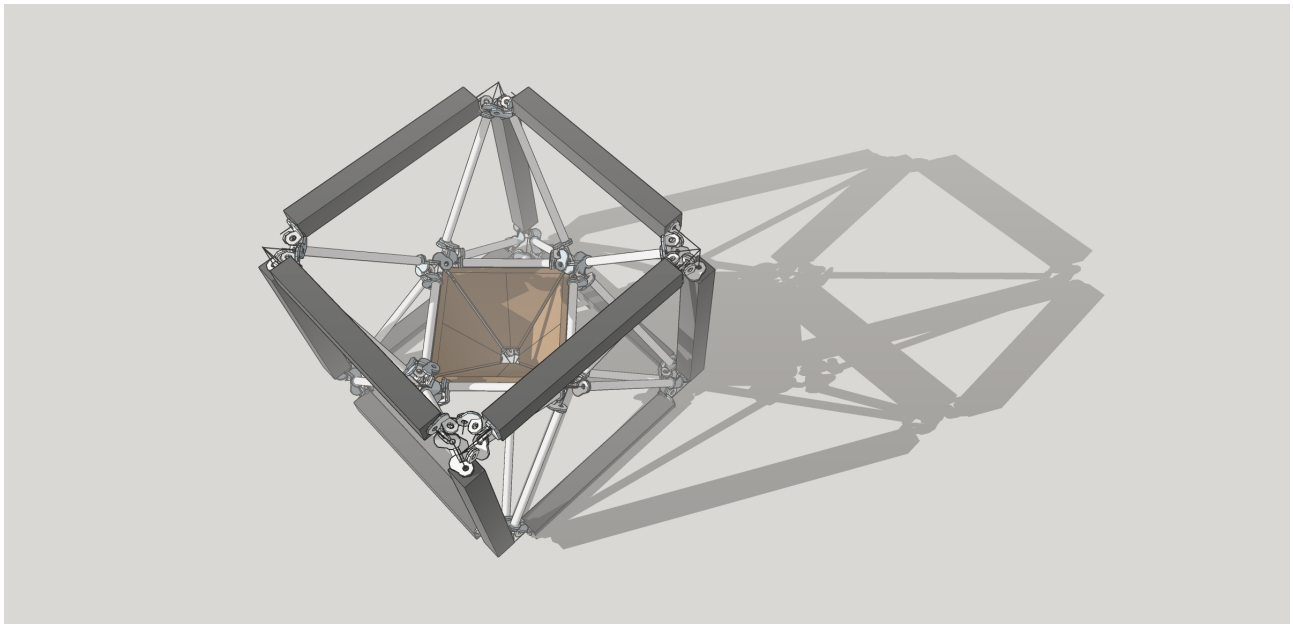

765 mm
X 30
814 mm
X 60
902 mm
X 30

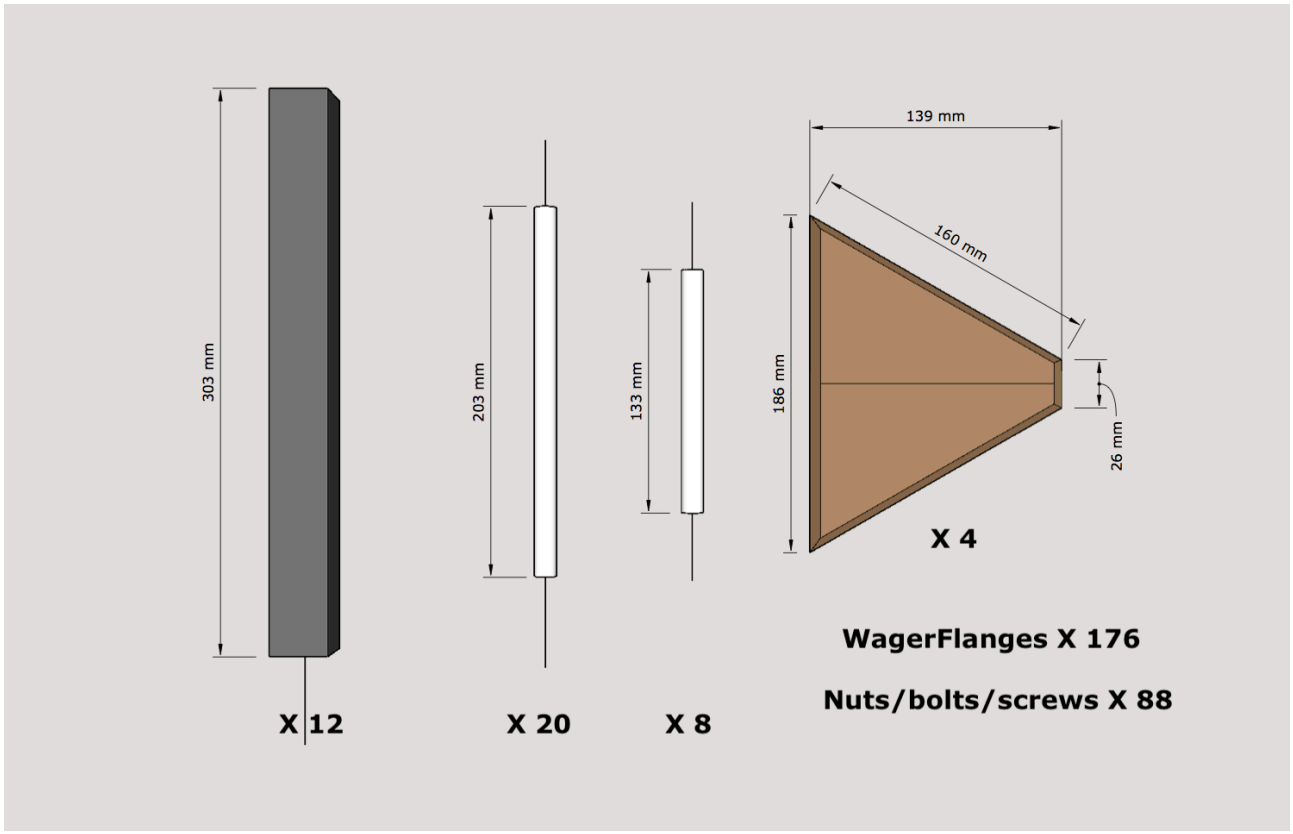


Fire pit

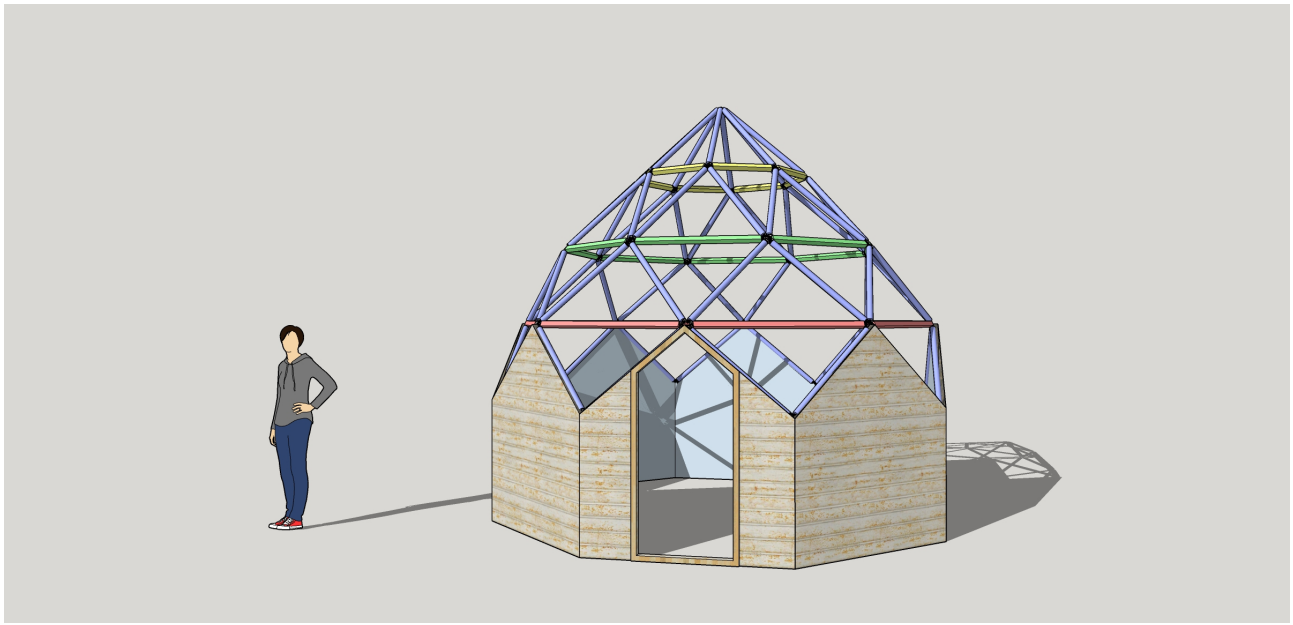


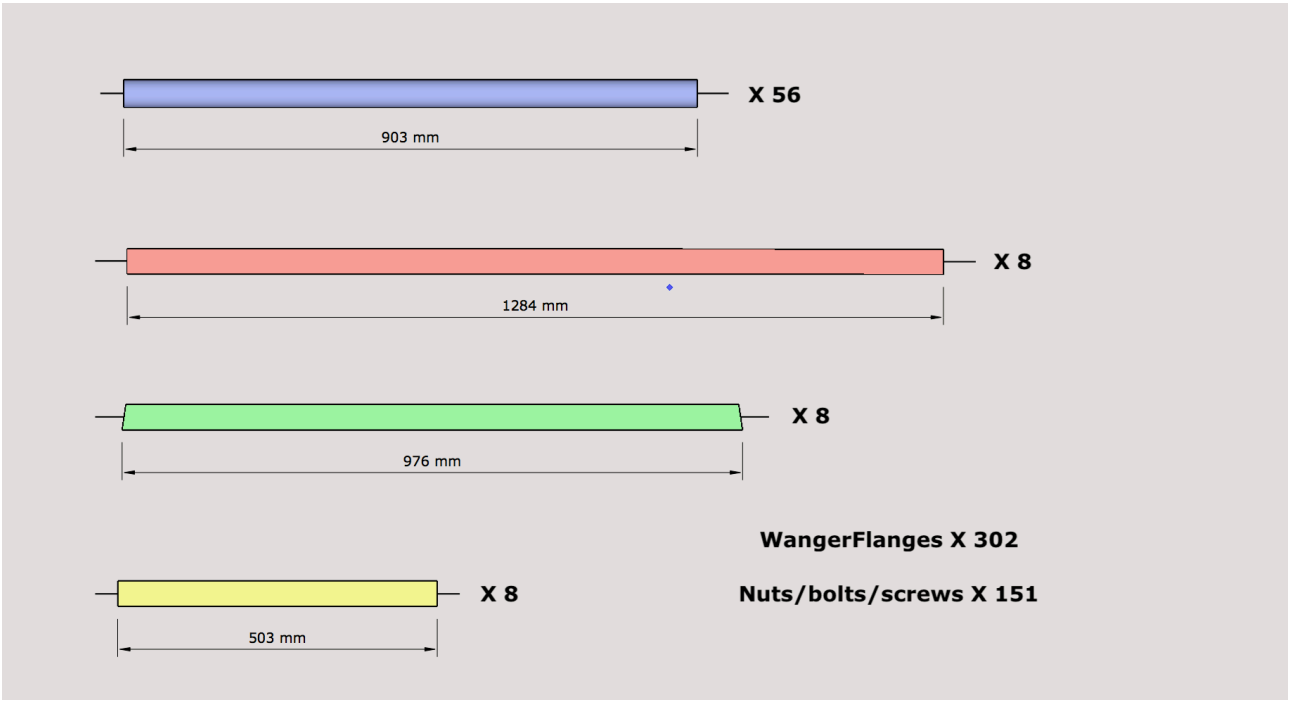
This is a cube with a octahedron fire grate suspended by metal struts

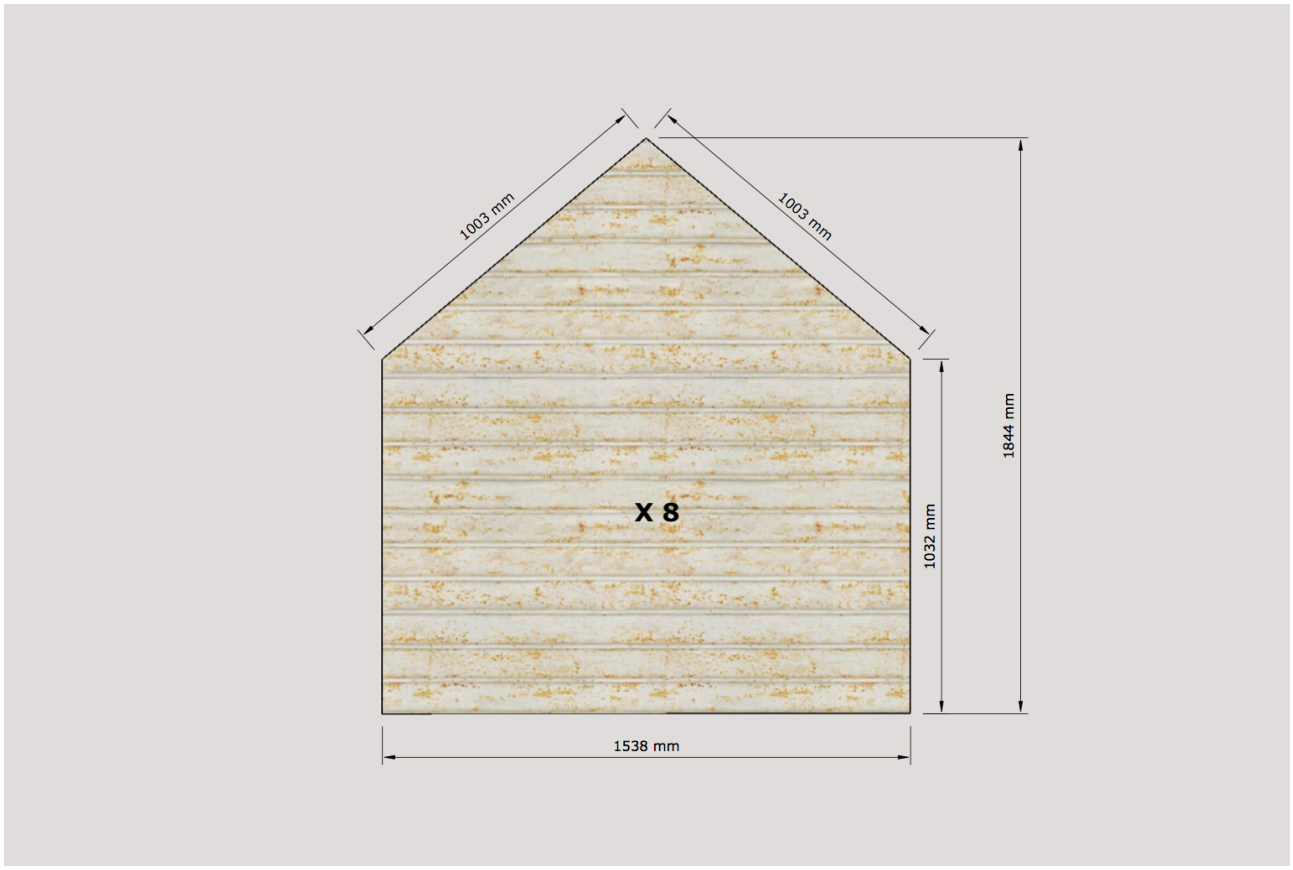


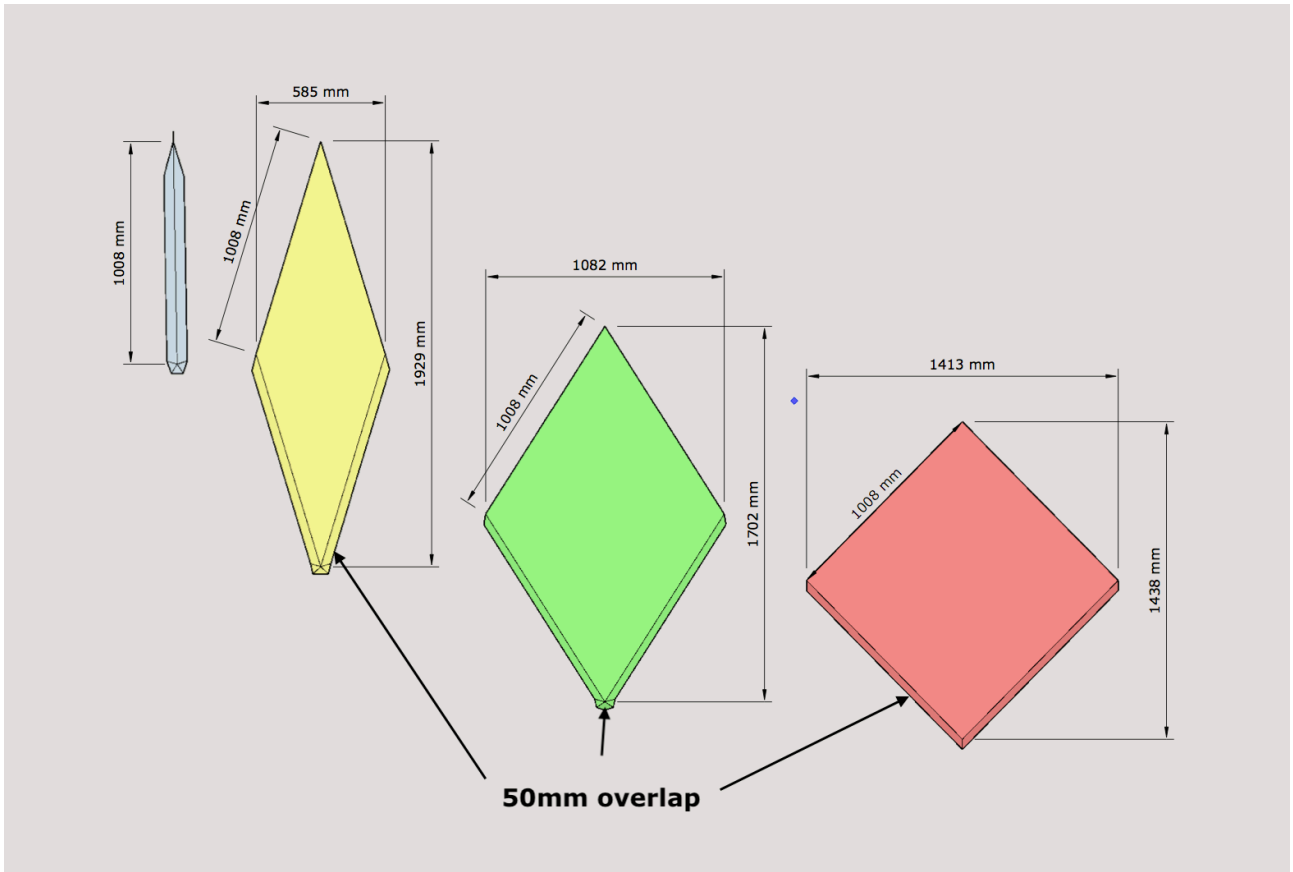

303 mm
X 12
203 mm
X 20
133 mm
X 8
139 mm
160 mm
186 mm
26 mm
X 4
WagerFlanges X 176
Nuts/bolts/screws X 88

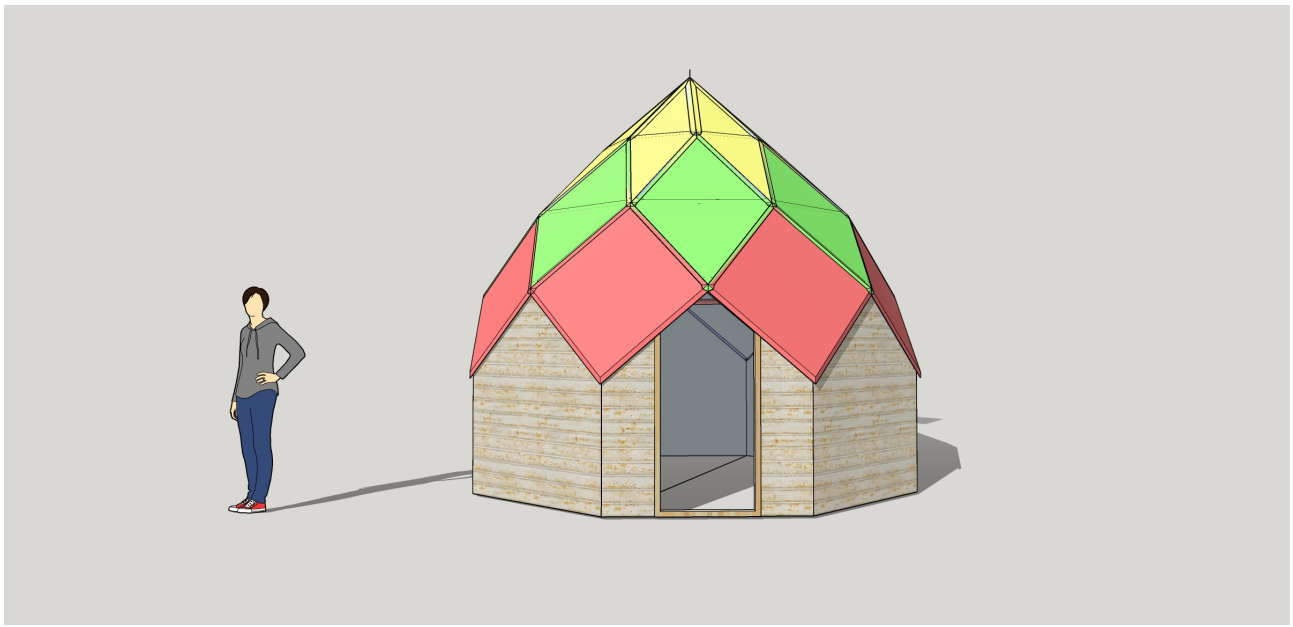
Hobbit house



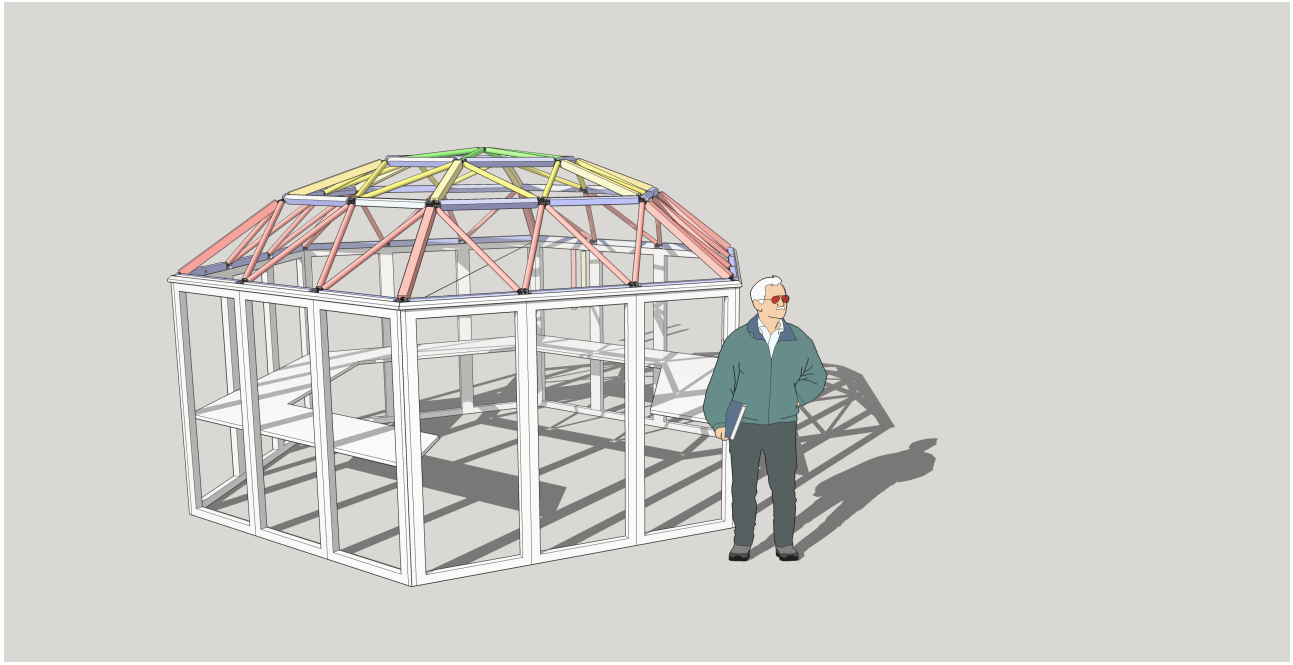


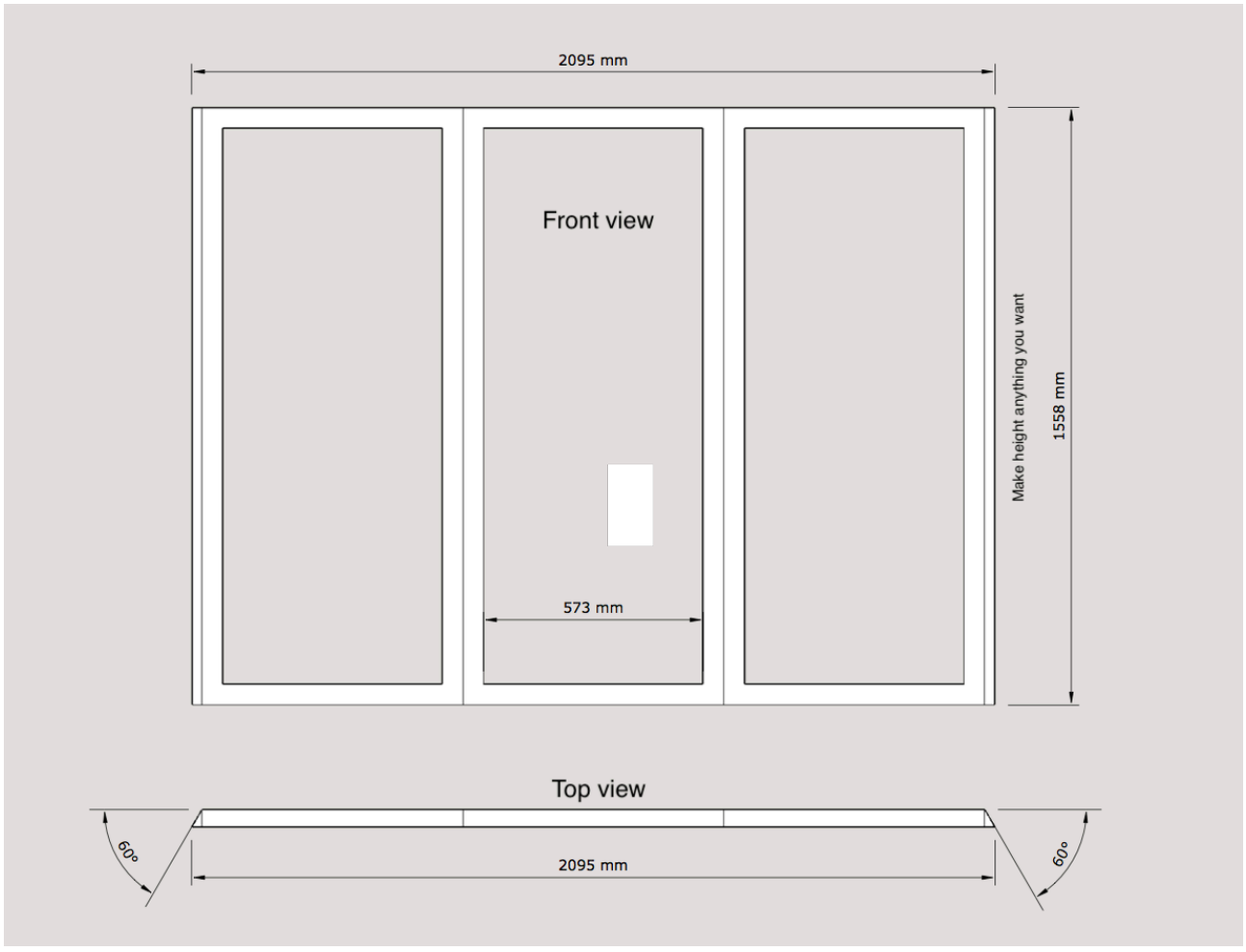

1003 mm
1003 mm
1844 mm
X 8
1032 mm
1538 mm

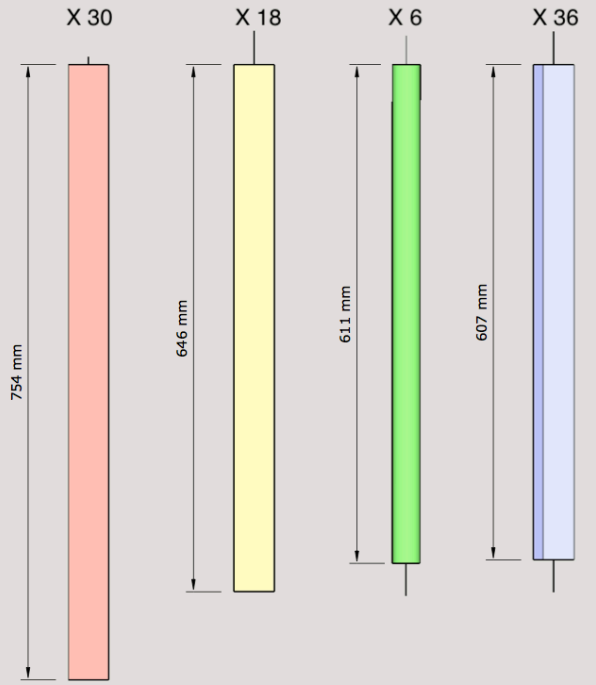

585 mm
1008 mm
1008 mm
1929 mm
1082 mm
1008 mm
1702 mm
1413 mm
1008 mm
1438 mm
50mm overlap



Hex - Greenhouse

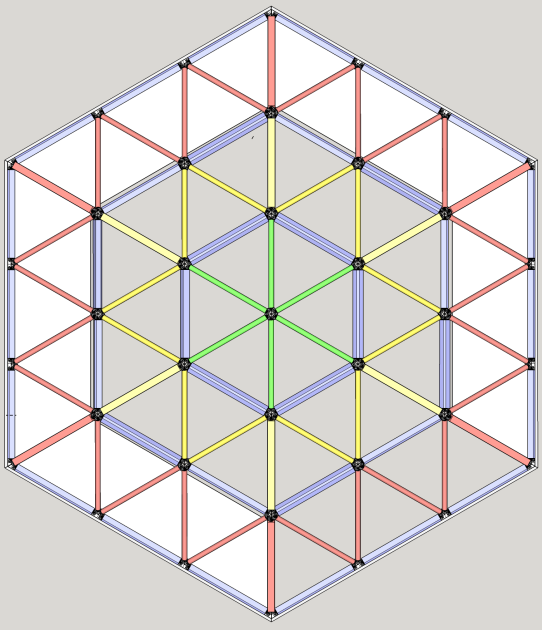




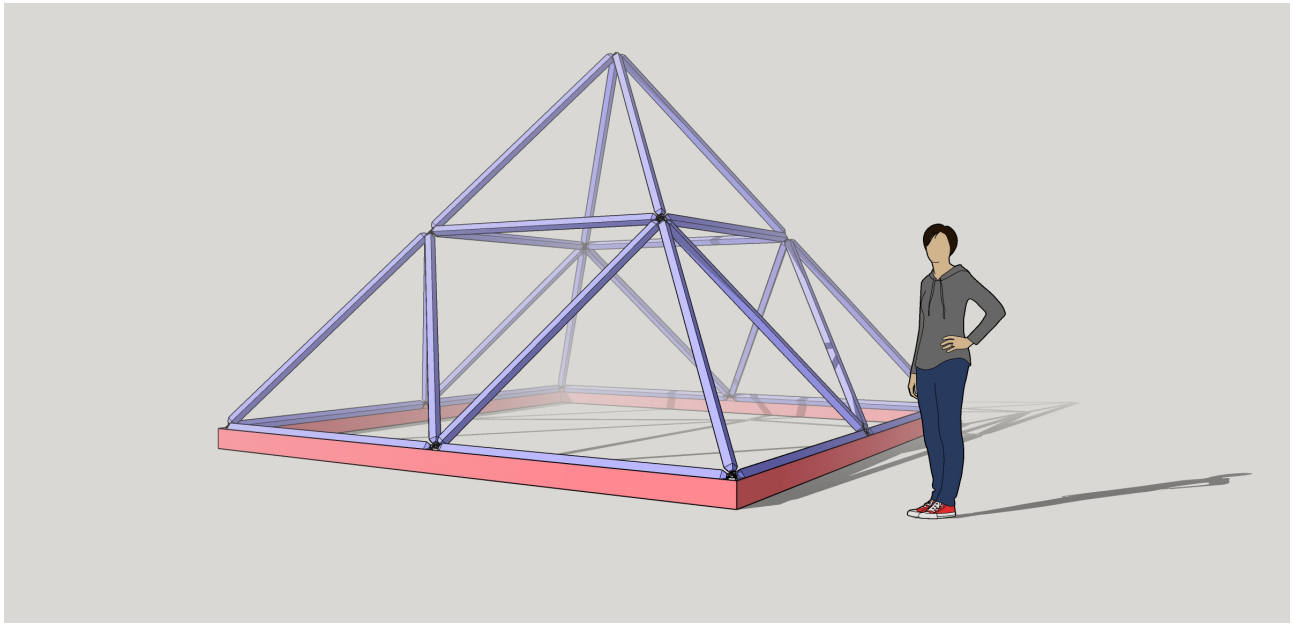


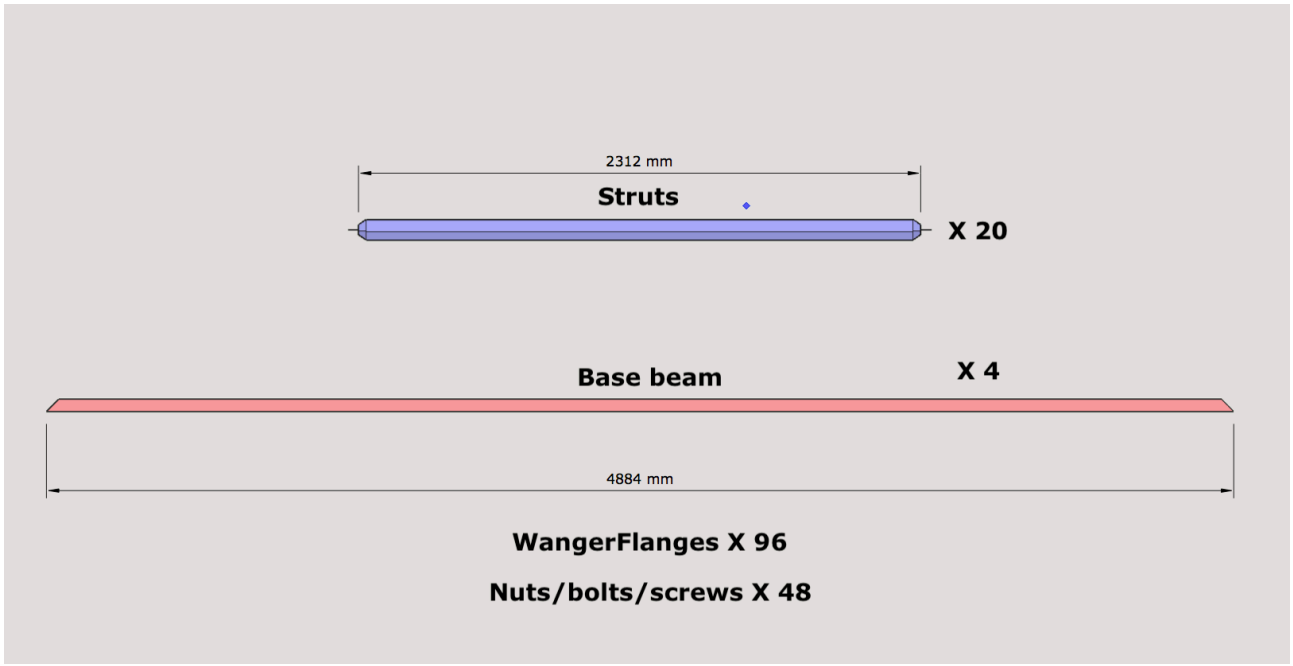
WangerFlanges X 360

Nuts/bolts/screws X180

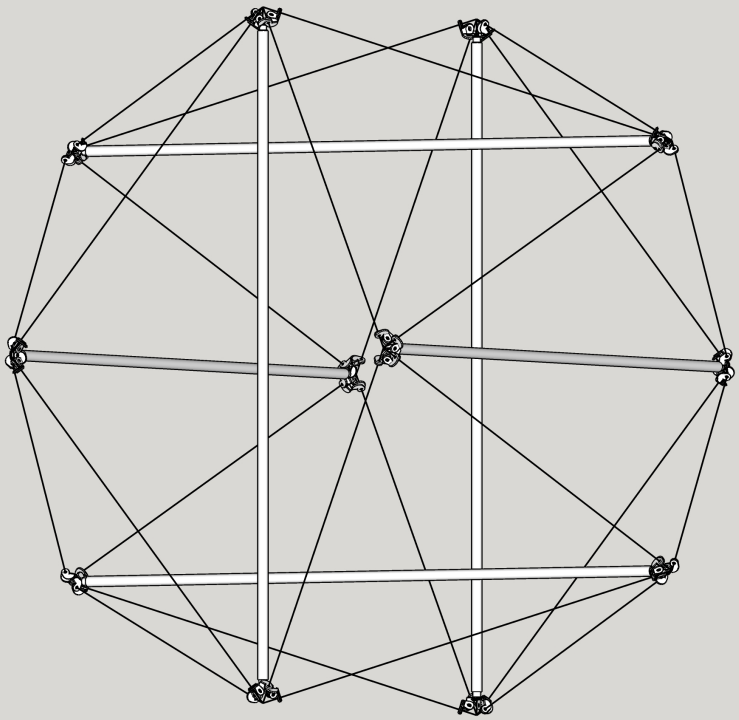


Pyramid




2312 mm
Struts
X 20
Base beam
X 4
4884 mm
WangerFlanges X 96
Nuts/bolts/screws X 48

Tensegrity Icosahedron



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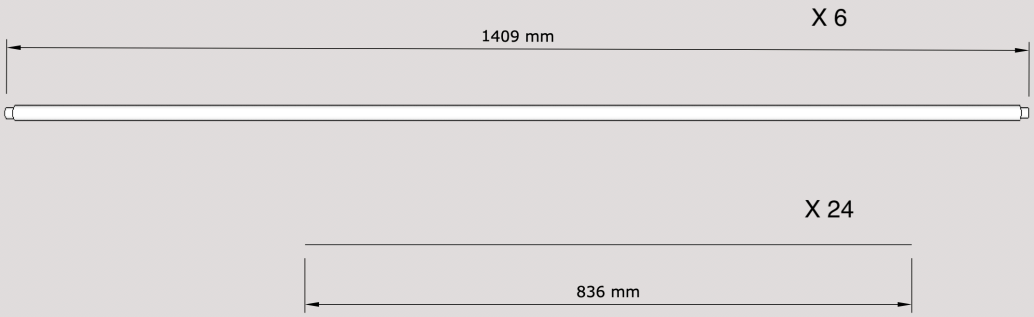
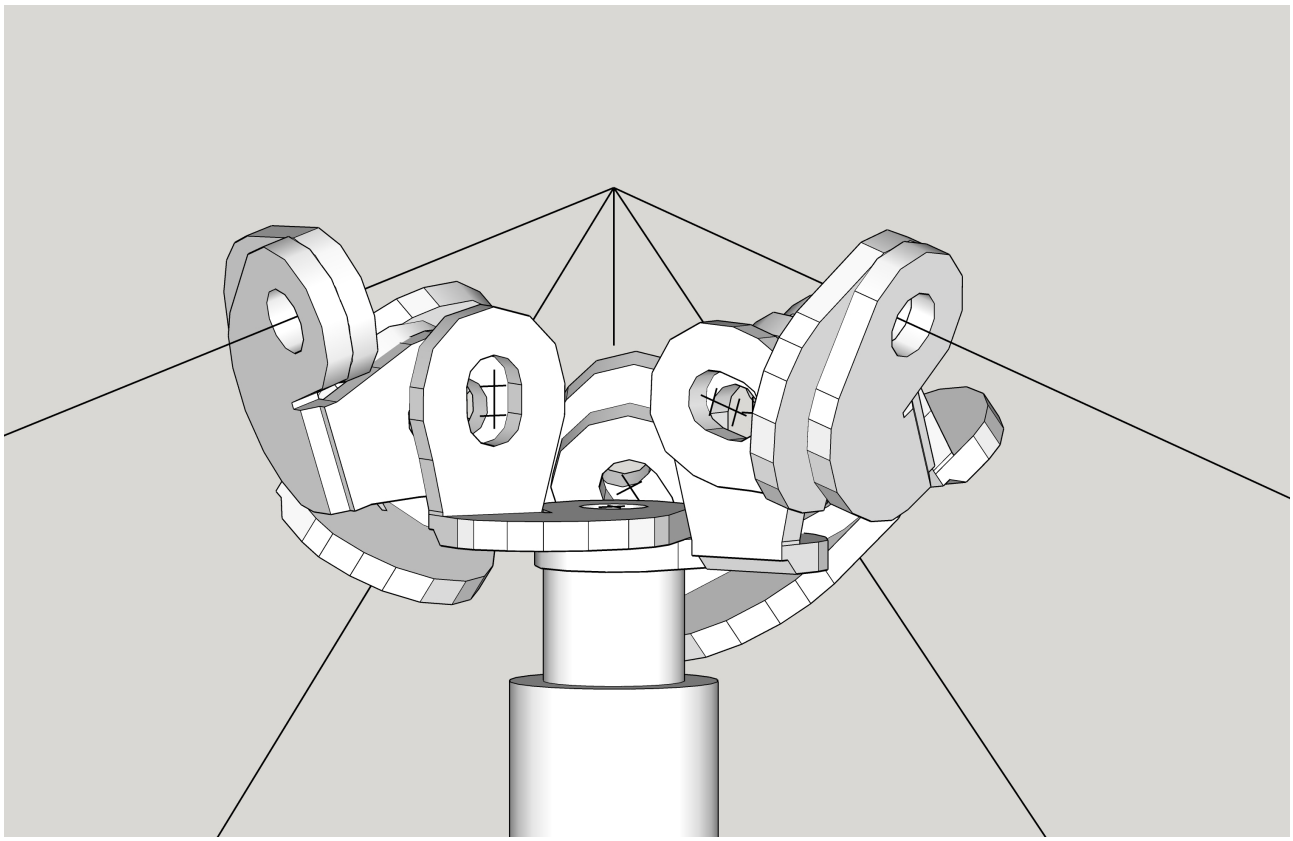


WangerFlanges X 120

Nuts/bolts/screws X 60



This was a tricky one, although all the hubs are the same, 5 way struts one of the struts (the fat one) is folded under as the compressive member. this should be possible to make but you need to make the end of the thick rod quite a small diameter so the wangerFlanges don’t bind. I would recommend making one collection of struts and testing it to make sure it doesn’t bind.

Double tetrahedron star

Can you work out how to build this double tetrahedron star?
You'll need 48 WangerFlanges and 12 twigs all the same length.