The build of 4.2 m wind turbine

Frame design and build

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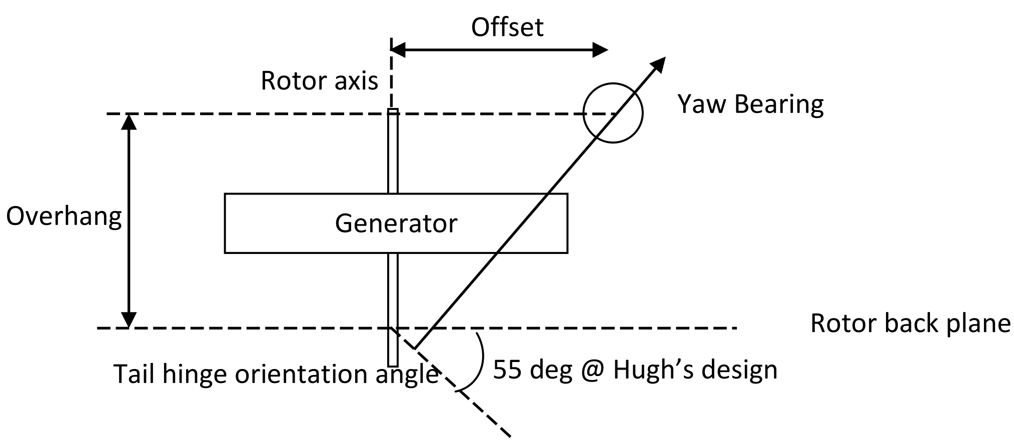
It is the role of the sun and the wind to generate energy. It is the role of the people to work to harvest this energy together without any borders

The following manual is completely based on Hugh Piggott "Wind turbine recipe Book". We at Comet-Me decided to modify the construction of the turbine frame to match our tools and needs. We maintained all the important dimensions.

We already made 6 turbines according to this design, few are charging batteries and few are connected to the SMA Windy Boy 2500.

We based the design on accurate cutting and drilling of holes in a 100X 100 mm RHS profile. We use laser cut technology for the magnet disks and for the stator holder. This makes it very easy to replace stator or magnet disks on an existing turbine without worries.



The important dimensions of the turbine are:

- Offset between the yaw bearing center and the rotor axis center
- Over Hang distance
- Angle and orientation of tail hinge
- Tail's dimensions (boom length, area and weight of tail)

These parameters governs the furling mechanism

The following table includes the frame parameters values in Hugh Piggott's design and in Comet-Me design

Parameter	**Hugh Piggott design**	**Comet-me design**
Offset	250 mm	250 mm
Overhang	430 mm	430 mm
Tail hinge orientation angle	55 degrees	45 degrees
Tail hinge tilt angle	18 degrees	18 degrees

The tail hinge orientation angle governs the initial forces to start lifting the tail to furling position. In Hugh Piggott design this angle is 55 degrees and higher forces are required to lift the tail to start furling, then in our design in which this angle is only 45 degree. We have chosen 45 degree since it makes the frame structure a bit nicer and easier to make. We compensate for the difference in forces by increasing a little the tail weight.

Tail weight is an important parameter. It is based on the tail metal parts dimension and wooden tail vane dimensions. Tail vane area should be at least 10% of the turbine blades sweeping area. We here use standard plywood that comes in 240X 120 cm plates and we thus used half a plate of 120X 120 cm. this is a little more than 10% of the 2.1 m long blades. We are using 10 mm thick plywood.

We compared the required moment to lift the vane by hooking a spring weight to the tail and measure the force that is required to lift it when spring weight is hooked two meters from the hinge, 4 kg are required to start lifting the tail.

Overhang is an important parameter in the furling mechanism. It mainly governs the rate of lift and fall of the tail as the wind speed changes. In our experience, the overhang value should be a bit smaller than twice the offset. This way the tail will fall back at a bit lower wind speed than it was lifted. It will keep the generator and blade safe in high wind gusts. For a good article about this please look at: "Analysis of the furling behavior of small wind turbines" by Etienne Audierne, Jorge Elizondo, Leonardo Bergami, Humberto Ibarra, Oliver Probst , Applied Energy 87 (2010) 2278–2292

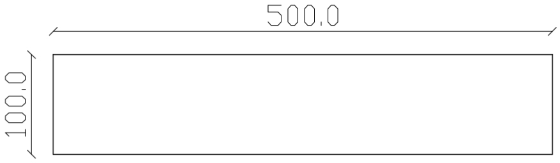
Many thanks to Hugh for providing the technical support and advices through so many emails and chats.

Following are the drawings for all the parts and the sequence of construction.

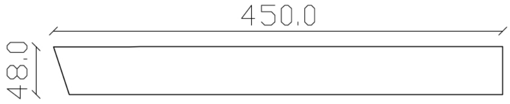
Parts list


Tail hinge locking screw
Main frame
Back cover
Tail hinge
Yaw Bearing
top cover
Rotor Spindle
Stator Holder
Yaw Bearing
Tail bearing
Stator Holder ribs
Tail hinge bracket

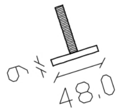
PART LIST



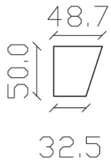
main frame 100X500X500mm



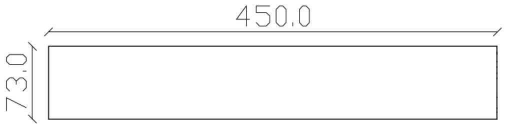
tail hinge Ø48 450mm



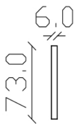
tail hinge cover + 10mm screw
Ø48 6mm thick



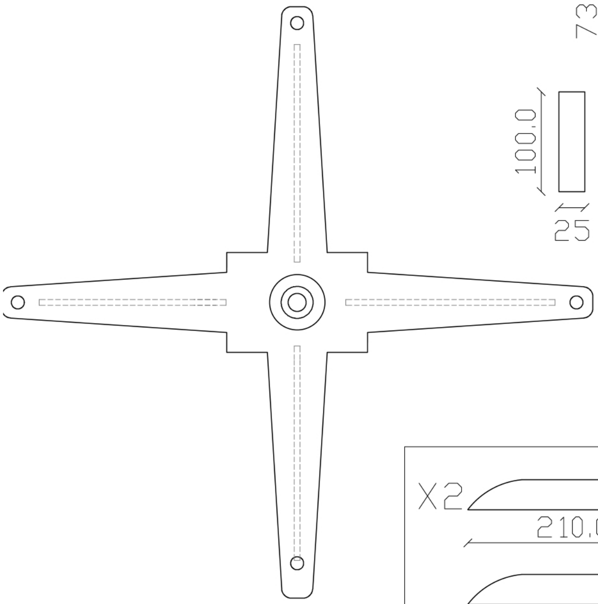
tail hinge bracket 8mm



yaw bearing Ø73



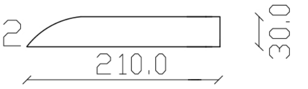
yaw bearing cover Ø73



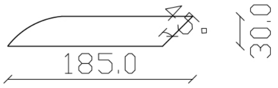
main frame cover 6mm thick
X2

stator holder&bearing axis

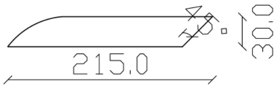
stator ribs 6mm thick

X2 

top+bottom

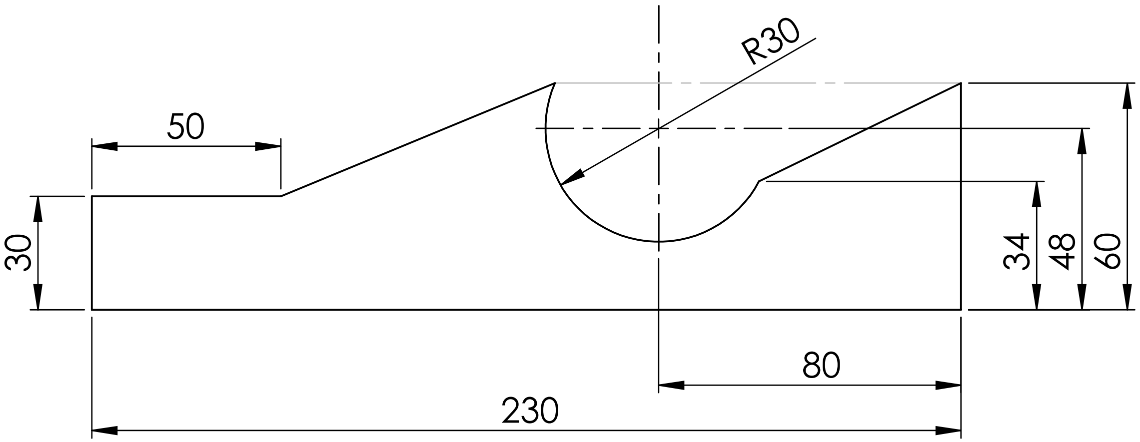


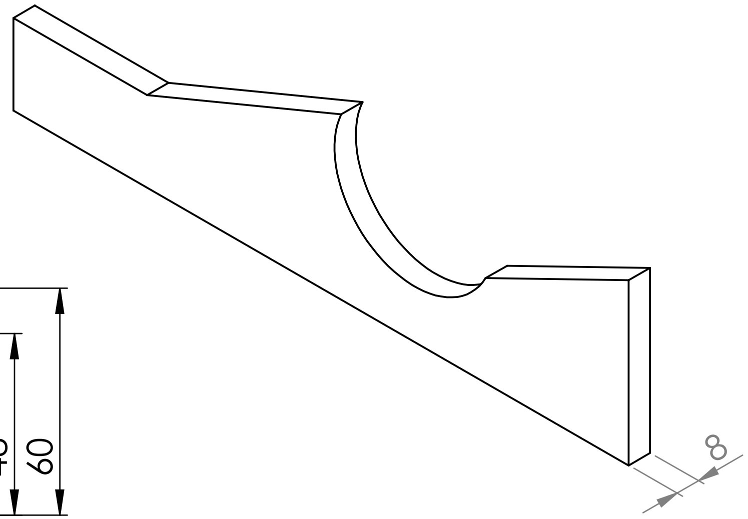
right



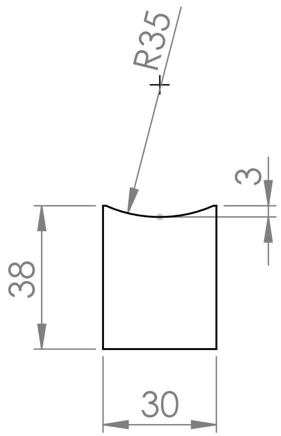
left

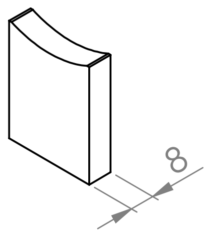
TAIL LOW STOP





TAIL HIGH STOP





Preparing the main frame RHS profile

The main part of the turbine frame is made from 100X100 RHS profile with wall thickness of at least 5 mm and length of 500 mm. The RHS is marked and cut according to the following drawings and images:

1. Cut the 45 degrees plan
2. Cut the 45 degree plan at 4 degrees, so the blade plan is at 4 degrees to the tower and prevents blades collision to tower at high winds.
3. Drill the 73 mm holes on both sides of the RHS to accommodate the yaw bring turbe.
4. Drill the 32 mm diameter elliptical hole for the turbine spindle. This holes id drilled when the RHS is positioned on the drill press where the 45 deg plan is facing the drill plan. It is helpful to start the drill center at normal incidence so the drill does not slide.
5. Prepare the notch for the tail hinge. It may be useful to start with a bit longer RHS profile and drill the complete 42 mm diameter hole and than cut it to proper dimensions.

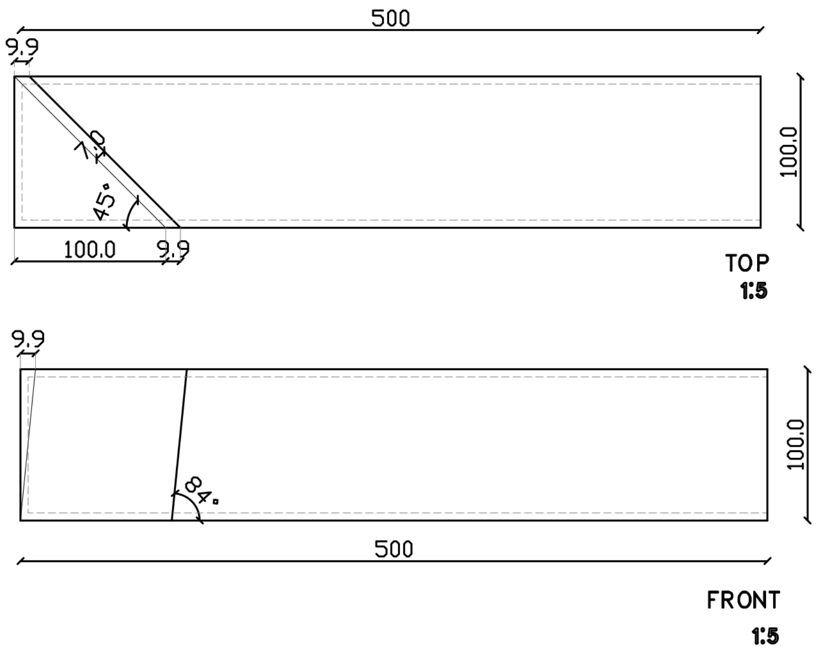
Top view image of the main frame

Image of the main frame ready for welding: 45 dg is cut, 4 deg is cut, yaw bearing hole is drilled and the circular notch for the tail hinge axis is cut.

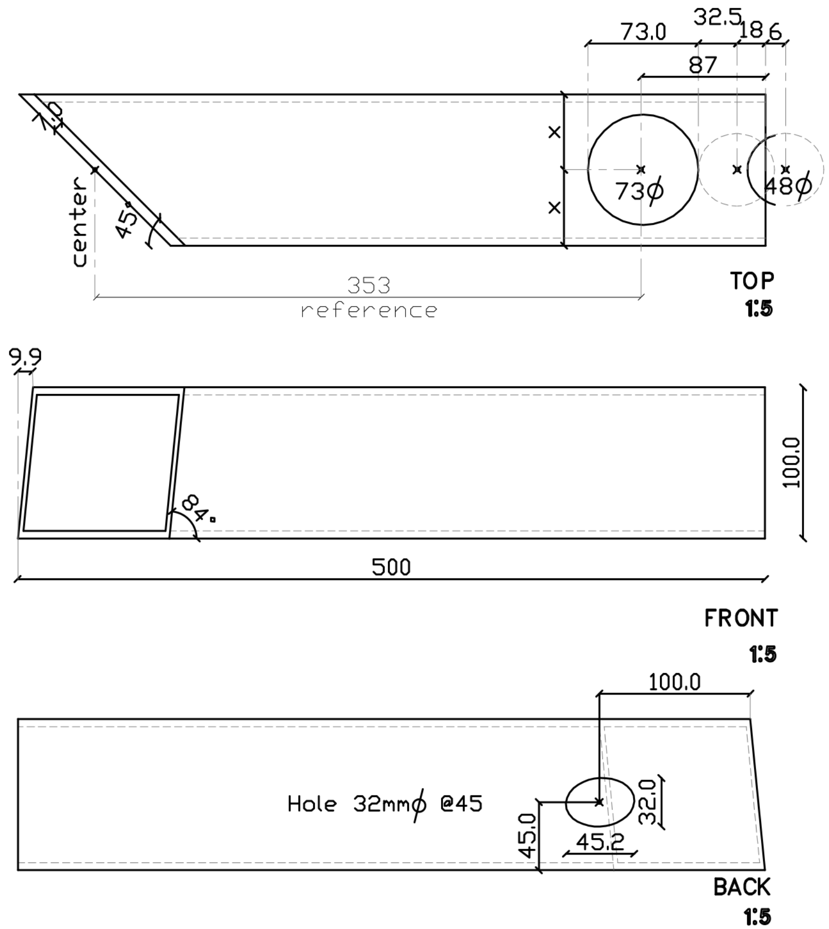
View of the Back side of the main frame. The elliptical hole for the turbine spindle is drilled at 45 deg. The 45 deg plan is cut at 4 deg to tilt the blades plane away from the tower.

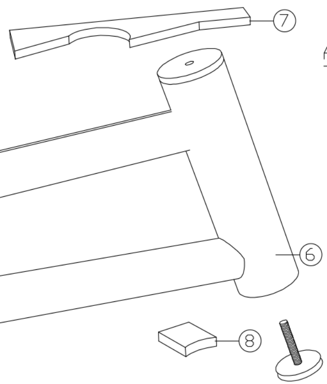
MAIN FRAME

Marking the angle cut



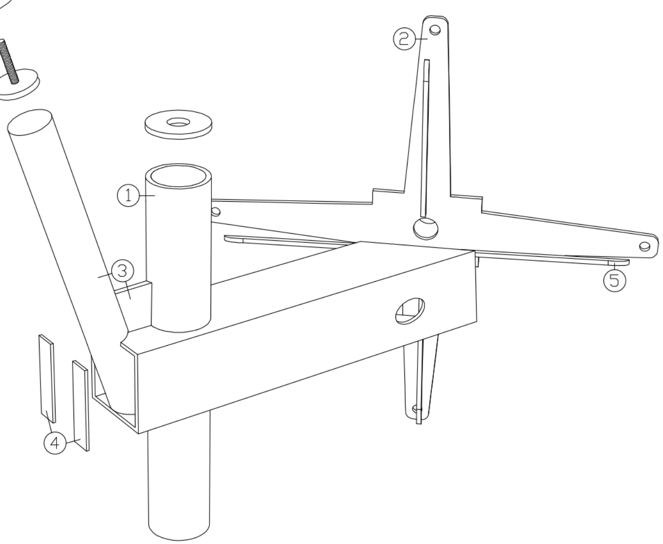
Drill yaw bearing & tail hinge

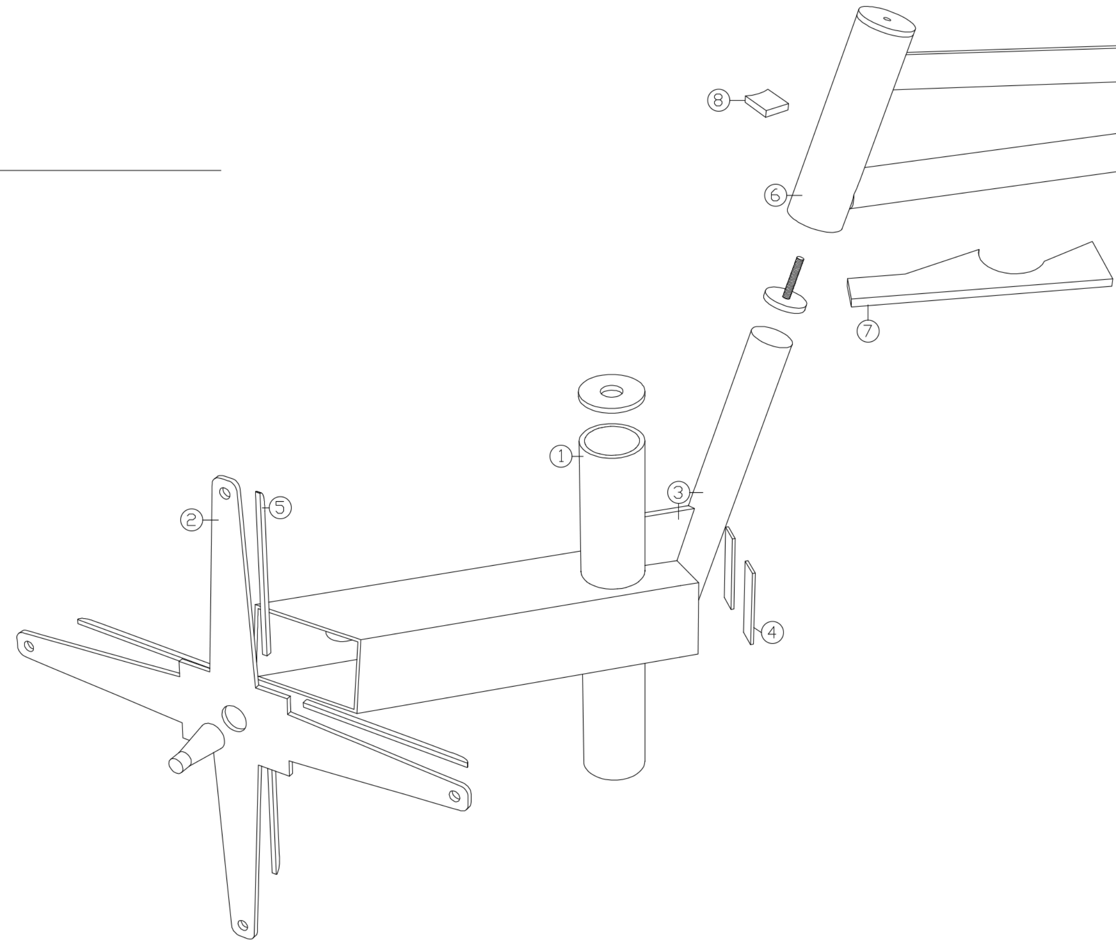




ASSEMBLY ORDER perspectives

1. yaw bearing
2. stator holder & rotor spindle
3. tail hinge & bracket
4. tail back cover
5. stator ribs
6. tail
7. tail low stop
8. tail high stop





Assembly

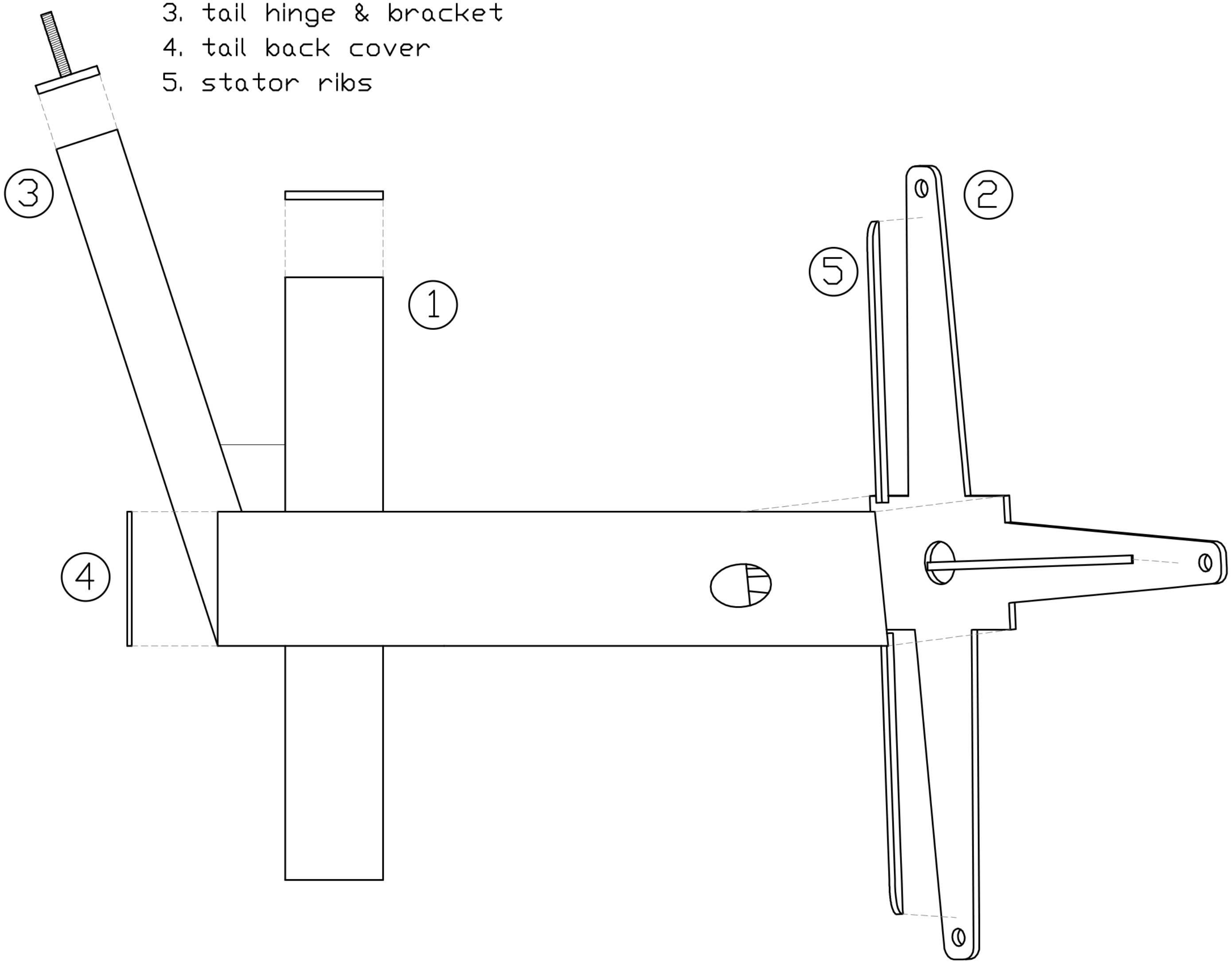
Following are the images and drawings of the turbine frame assembly.

First step of the assembly: tack the yaw bearing to the main frame body. The yaw bearing is 450 mm long and extend 175 mm from both sides of the 100X100 profile. It is very helpful to build a short stub and clamp it to your working table.

Second step: Insert the spindle into the stator holder. The bearing house should be about 20 mm away from the RHS. Mark the 45 degree line on the spindle at the back of the RHS and cut it. Insert the cut spindle through the stator holder and tack the stator holder and the turbine spindle to the RHS profile.

ASSEMBLY ORDER back view

1. yaw bearing
2. stator holder & rotor spindle
3. tail hinge & bracket
4. tail back cover
5. stator ribs



Third step: weld the tail hinge axis in place. It is a good idea to prepare an 18 degree wooden triangle as a template to align the hinge accurately in place before tacking it.

Fourth step: Weld the tail hinge axis bracket

Fifth step: Preapare the back plate parts and weld them to cover the back of the turbine. Cutting the back cover can be done before or after welding.

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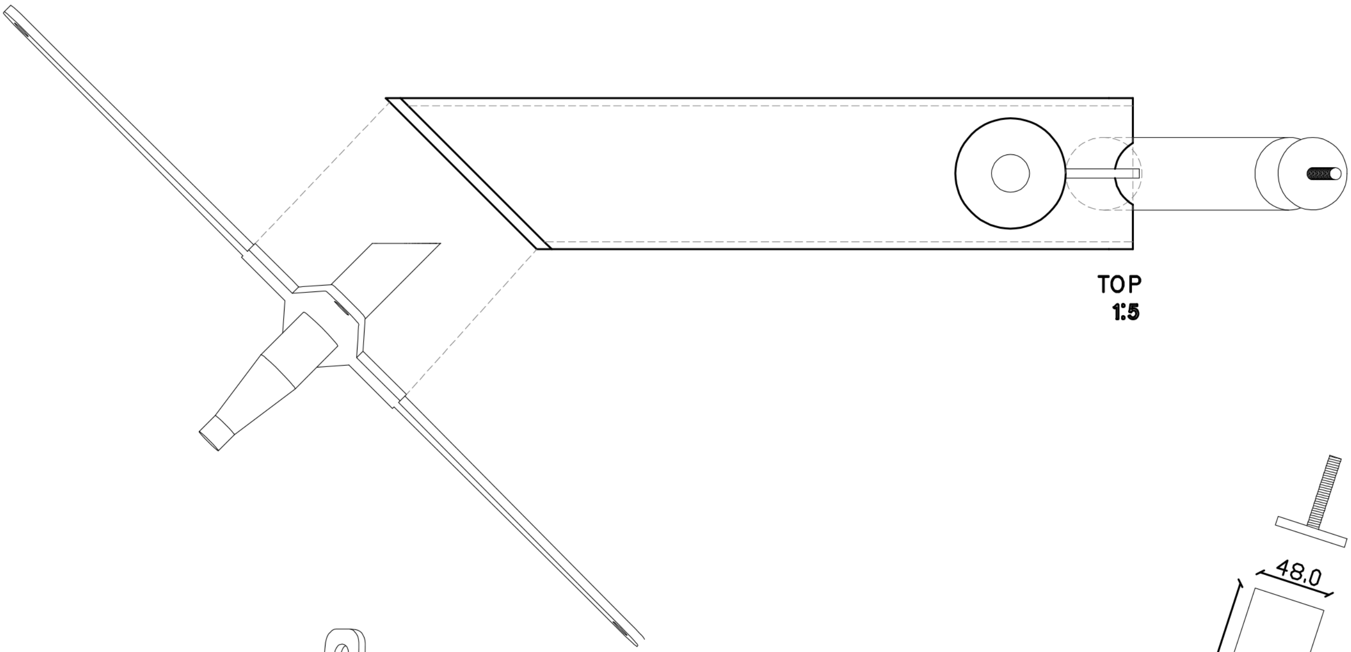
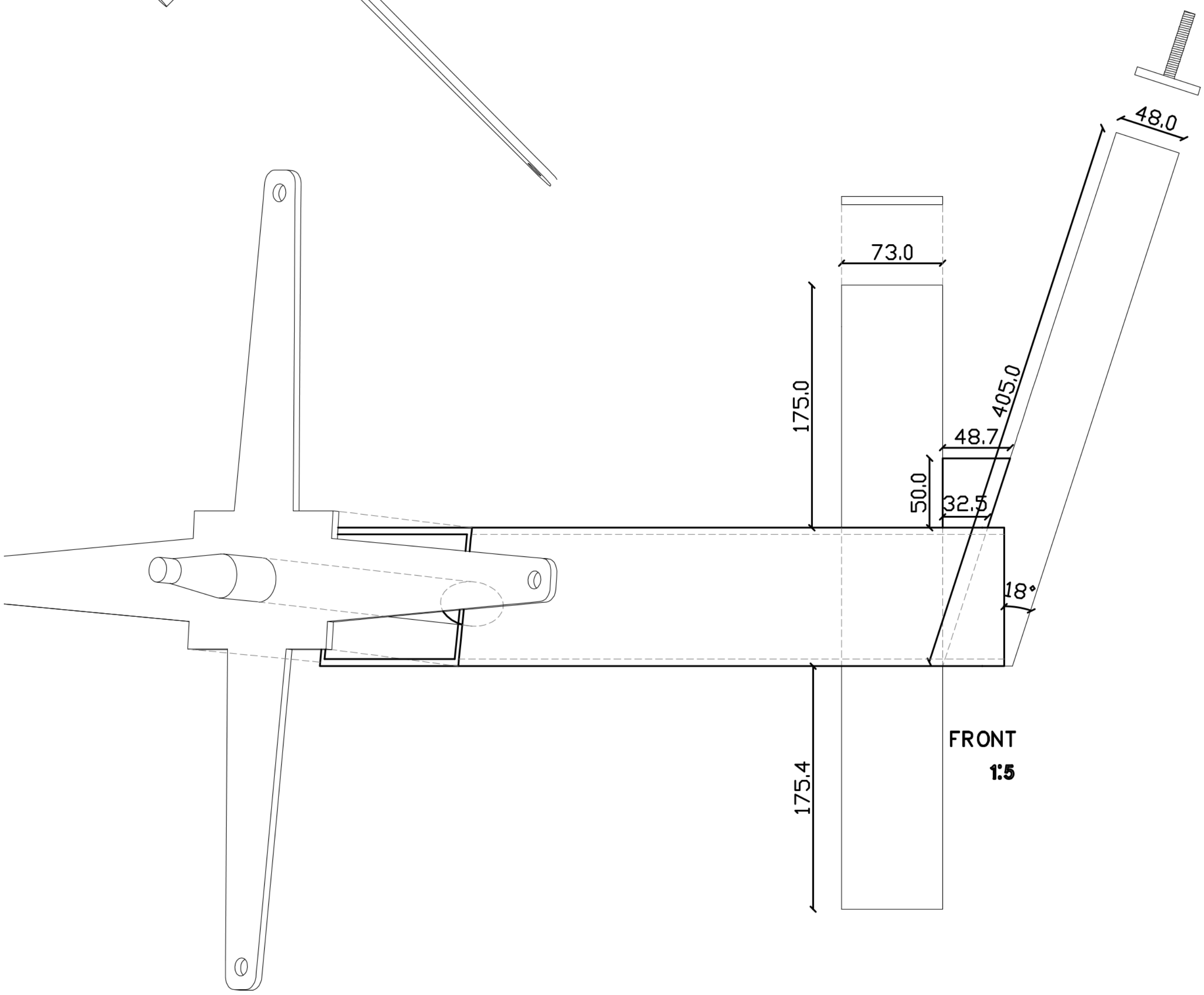
IN THE MIDDLE EAST

Weld a cover to the tail hinge axis with a 10 mm screw welded from the inner side. This screw will hold the tail and prevent it from flying off over the blades at extreme conditions.

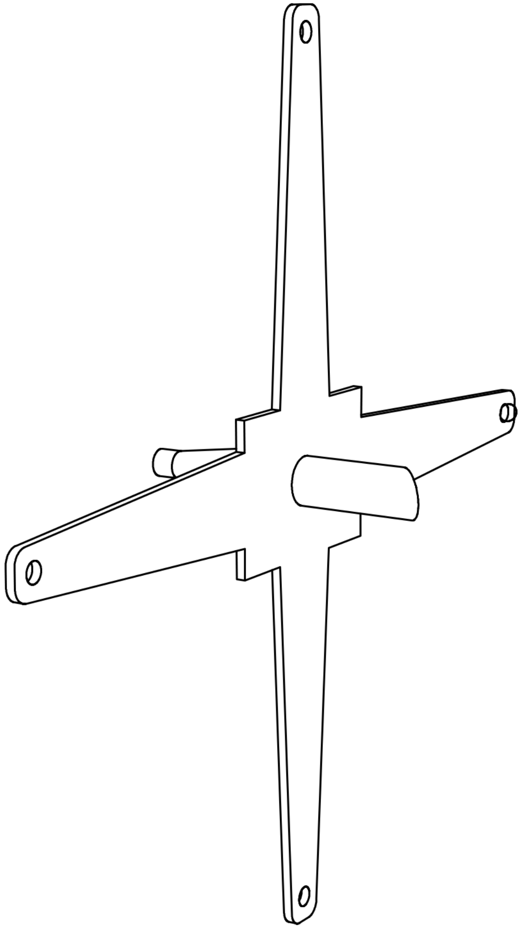
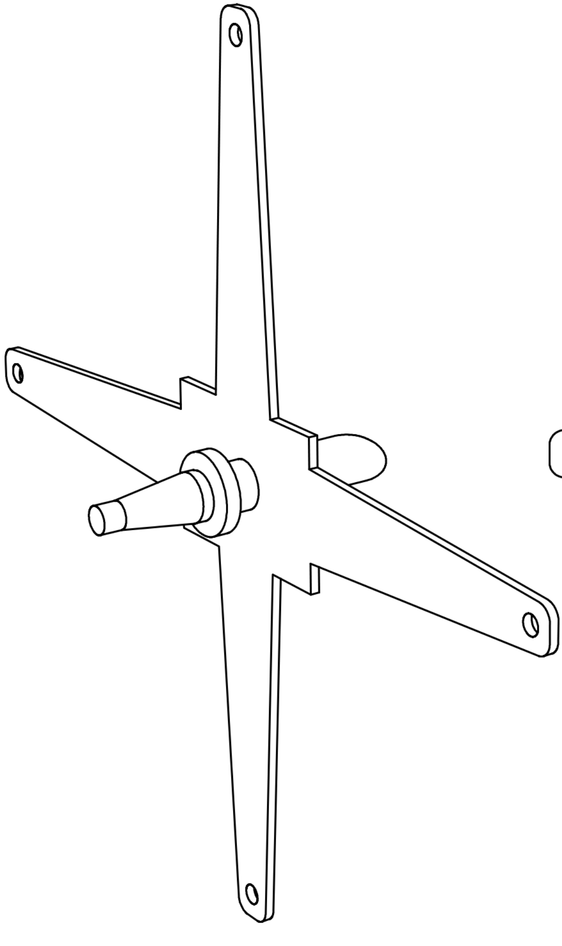
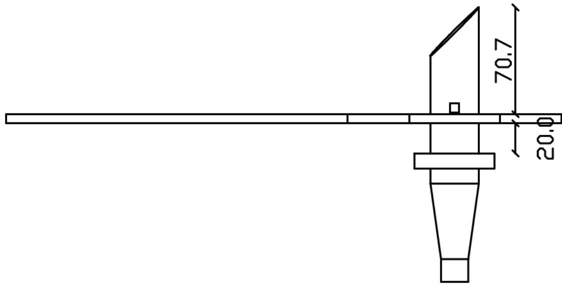
Step sixth: welding the stator ribs to the stator holder. These ribs prevent the stator holder from bending and keep the stator in the right place inside the air gap at all times.

STATOR HOLDER ASSEMBLY

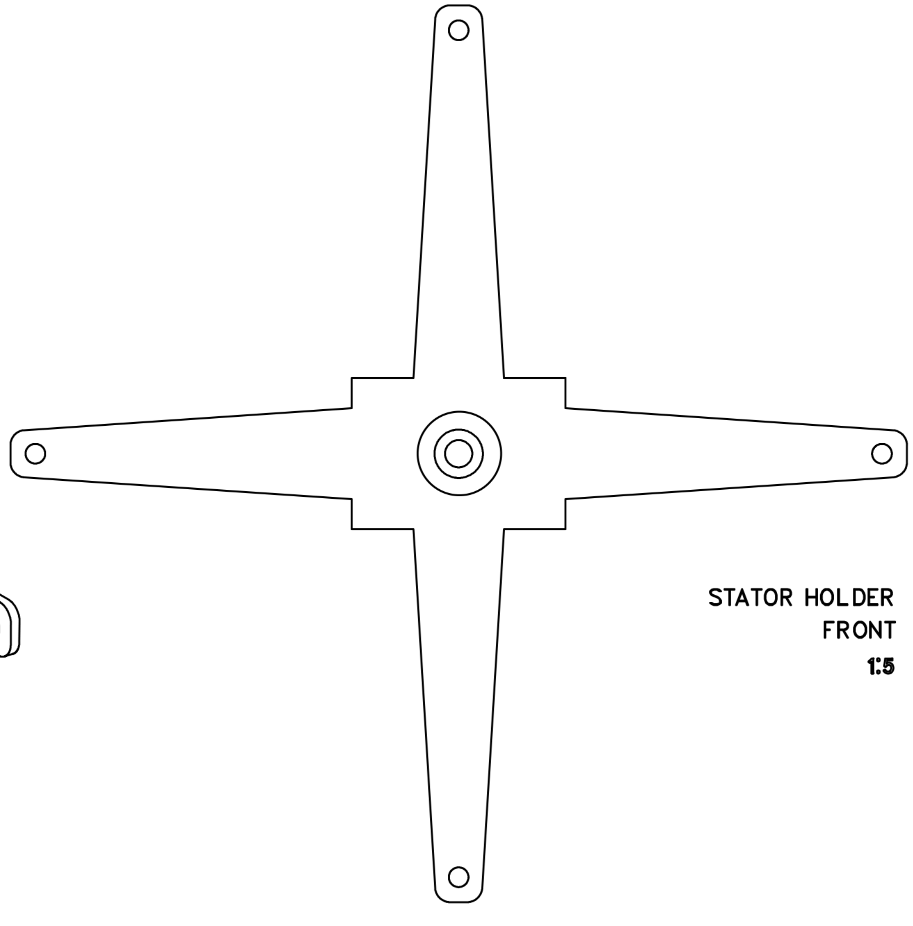




STATOR HOLDER & ROTOR SPINDLE

TOP
1:5



STATOR HOLDER
FRONT
1:5

Tail Assembly

Step seven: Welding the tail parts in place. We build a simple bench to align the tail direction in the low furling stop, weld the 42 mm boom and the 6 mm tail bracket. The cover of the tail hinge outer part has a 12 mm hole in the center to allow easy installation of the tail with the 10 mm locking screw. It is possible to make a 10 mm thread tap in the hinge axis cover and just screw a 10 mm screw through the hole in the cover of the tail hinge outer part.

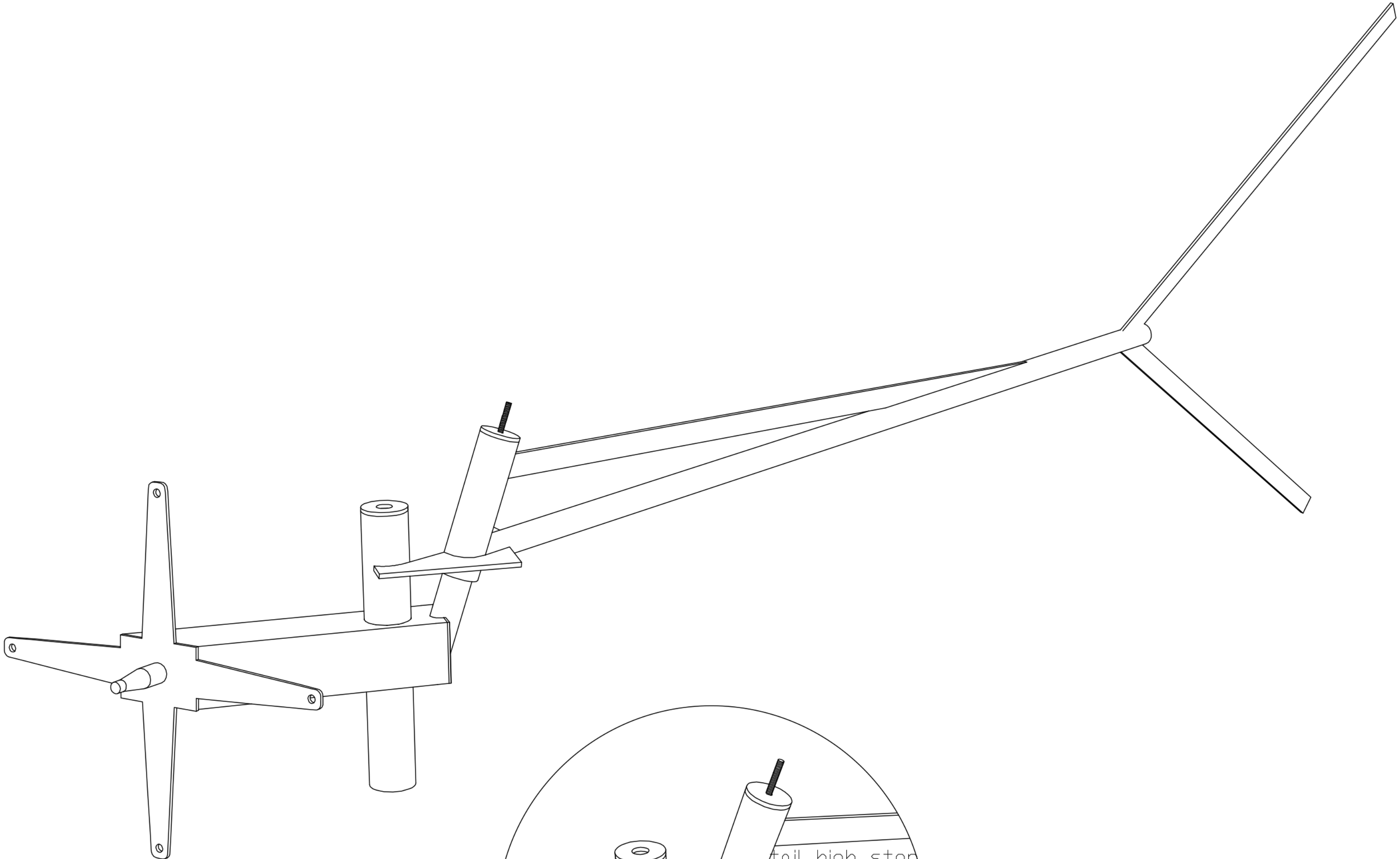
Step 8: Welding the tail low stop. This bracket is welded both on the tail hinge outer part and the tail boom. It strengthens the tail boom connection to the hinge. The stop action is carried out on the yaw bearing itself.

View of turbine frame and tail low stop.

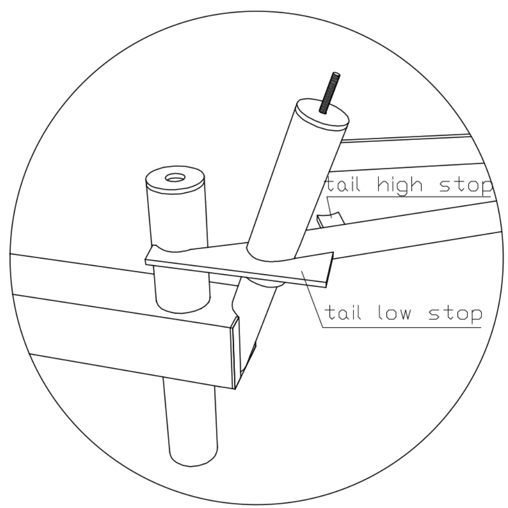
The high stop is a 35 mm long 30X8 mm steel bar welded to the boom to stop it against the yaw bearing at the high furling point.

Turbine frame painted and tail with stops assembled at normal tail angle

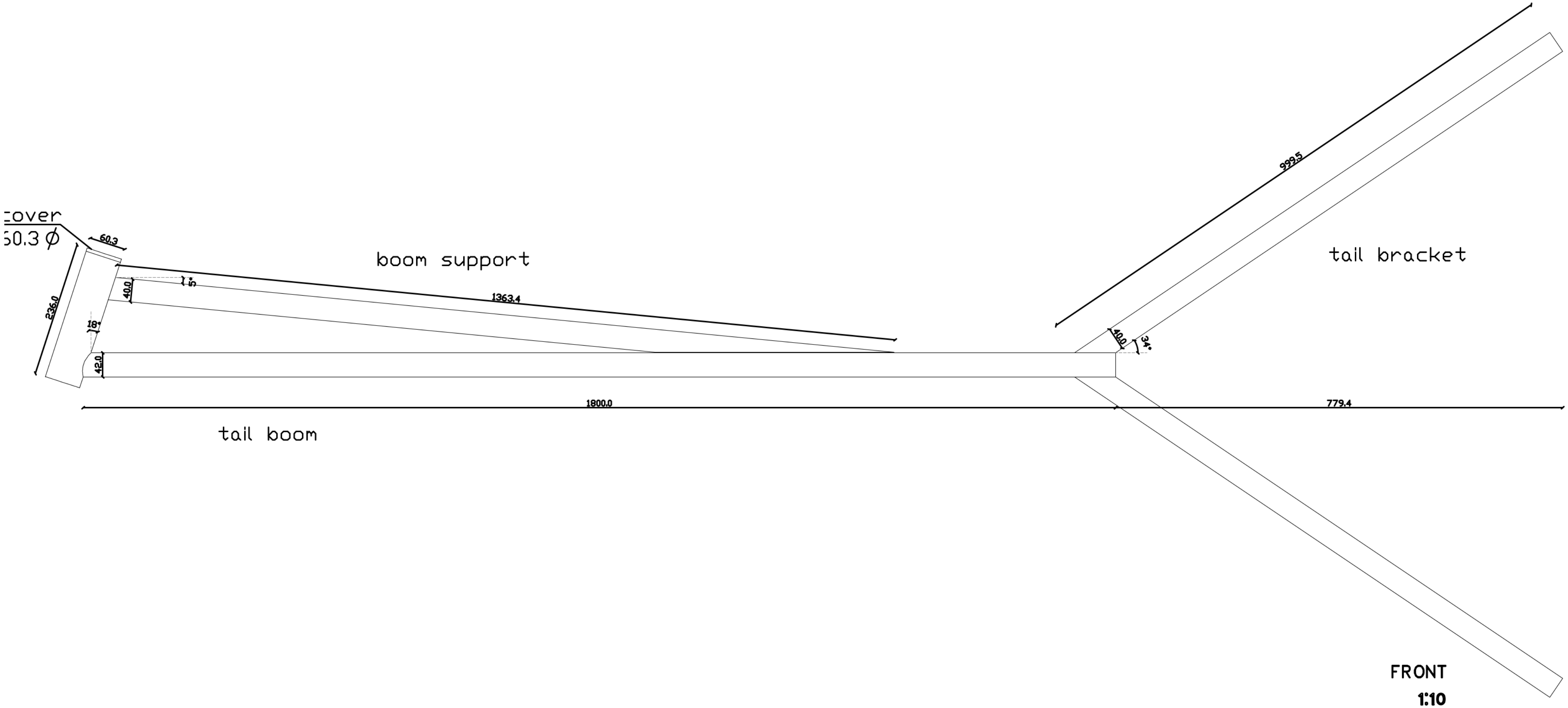
Tail is rotated to furling position. Tail high stop reaches the yaw bearing to stop the tail boom parallel to the plan of blades rotation.



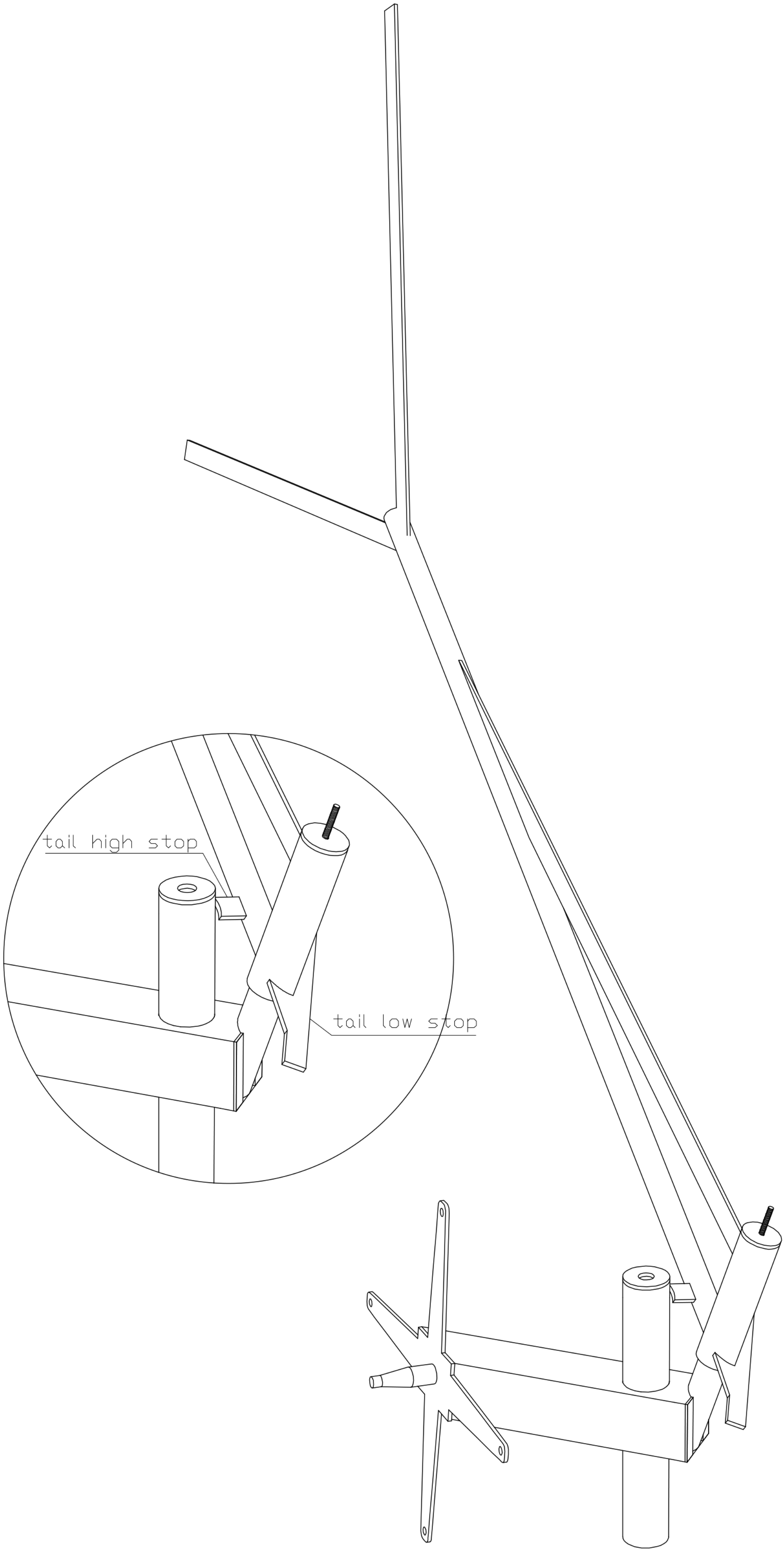
TAIL ASSEMBLY



TAIL



FRONT
1:10



TAIL ASSEMBLY