"Animate form"

"Animate form through lowtech wood construction"
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Introduction

Contemporary architecture has for the last decades been searching for a more dynamic and organic design and architectural expression. Curves and irregular shapes is more and more common as computer technology has developed and made complex shapes possible to dissect structures and brake down into building components.

Architects such as Frank Gehry and Zaha Hadid have explored and pushed the limit forward and made large scale sculptural architecture a part of our architectural history.

All though this is a very exclusive and expensive architecture used mostly in large institutional and public buildings far away from our everyday small scale housing.

At the same time we have for thousands of years mastered the technique of shaping wood into curves with both small boats and large ships.

Wood - a material that has dominated the small scale building scene in Sweden for more than a thousand years is still very much the most accessible and easiest small scale building material. With environmental supremacy in terms of binding carbon dioxide and natural origin it is still one of the most beneficial building components today.

New techniques in glulam beams and boards has made this material a rediscovered building material for todays architects, and is now a sustainable competitor to steel and concrete. However this technique is still quite excluding in its demand for large scale building to have economical sustainability and is not used in the small scale housing market today.

How can we build small scale dynamic shapes with what we have?

Process

I started our with categorizing the different methods I could use and tested through models how they could function and their aesthetics.

Stacking

I tried different types of stacking, from bricks to longer timber pieces. The aesthetics were not what I was searching for and there was a clear problem with the structural qualities. If they were sanded down the aesthetics was excellent but the structural issues and workload made me discard the technique.

Context

In Sweden the self built house is a culture in it self. Traditional building techniques has been used for hundreds of years with little change. Very much because of the access to a uniformed building material, wood. During the last decades the homogeneity has increased due to standardized components, such as wall panel standards, steel plate roofing and water diversion. Together with higher requirements of energy consumption and safety the diversity has almost vanished into a monotonous typical Swedish house with little peculiarity and individual personality, which I think need to be challenged.

As an aspiring architect I want to learn if and how this is made, and how it can be done by the self-building person who wants to express more through architecture.

Carving

Carving out your space from a solid or semi solid wood piece was discarded because of the inefficiency of economics both in terms of time and material.

Stud network

This is basically how we build our houses today but with shaped studs. This was the technique I decided was the most appropriate but I needed a way to shape my studs.

With the condition that it is supposed to be a low tech project and the material must be available on shelf at the hardware-store, I figured the cheapest and most manageable way would be to get loads of plywood and glue the overlapping to create bigger sheets of wood.

Having solved the studs I moved on to the cladding. There is no problem to deal with a single curved wall, but the double curved needs a different approach. There needs to be a flexibility in both directions so I decided on a square shingle made from plywood as well.

From there I developed a design that was a bit too complex and not very animate in its appearance.

After the mid crit I redefined it to a structure with a main roof beam, like an upside down wood boat. To have a defined measurement from the roof beam to the floor beam makes it more manageable to shape your walls within those limits.

With those limits set, the structure will have a set footprint and a maximum height. Not enough for a building permit, but sufficient to build your own Friggebod.

A friggebod comes only with limits of building footprint at 15 m² and a maximum height of 3m, no permit required. This gives you an arena to shape your building as it is built and a good way to explore my building method.
Outcome

As comparison to the build kits available on the market I made an estimate on how much it would cost to build a 15m² Friggebod.

The total for my method is a bit higher than a prefab kit but my house has interior cladding, insulation, steam-brake, paint and foundation included which makes it cheaper. I believe the result of my method is more fun and personal, however the amount of working hours is higher on my method.

One important aspect is also that using one dimension of plywood as the key ingredient, the amount of waste can be kept to a minimum. I realized that using left over scrap pieces where they fit gives you a very small pile of waste at the end of the build, sustainable and economical.

As an inspiration I designed two small structures to show how and what they can be used as.

Testing 1:1

Moving on from model to full scale I wanted to test my method, how much the walls could bend and how the plywood would perform.

I glued and screwed the plywood as planned and cut out wall studs, one positive curve and two negative to test the difference. My first idea was to use regular 22x40 laths but soon learned they don’t bend very good, but plywood does. So I cut out laths from leftover pieces and mounted them before moving on to the cladding. As the cladding developed into a shingle cladding, it came natural to use the same type of plywood as for the beams. During the build I tried different sizes, I had overestimated the flexibility of 12mm plywood so I went from 600x600 down to using 300x300mm shingles as a good size to handle the curves and a reasonable amount of screws and work to put it up.

The overlapping was also tested in different lengths and finally set to 50mm as a aesthetic and functional best way.

Put up on laths cut out from single layer plywood in a 30 degree angle to deal with the curves of the house and get rid of rain water.

I learned that the minimum radius should the 3.5m vertical, and the offset between each stud should not exceed 100mm to avoid a smaller lateral radius.

As for the inner cladding I tested different dimensions of plywood. Shown in the mock-up is 50-100-200mm. They each have different bend-ability and where the curve is sharper as the dimension decrease. Just as for the exterior cladding the positive curve on the mock-up is too sharp, but the negative has a manageable curve.

For the floor beams the idea was to use regular 195x45 studs but as the rest of the house was made from plywood, and the load bearing is higher with cross-glued wood the idea is to use plywood as floor beams as well.

To keep the amount of waste and cost to a minimum I took the leftover pieces from making the wall studs and used them as an inner floor. This is not only economical in both money and material but gives the floor a irregular pattern from the shape of the exterior which brings life into the otherwise flat surface.

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First of the negative curved house. A sleeping hut where the beds protrudes on different heights, creating privacy and space within the hut. With windows put in between the wall studs to give access to the outside and a nights sleep on the boarder between inside and outside.

The positive curved sauna continue with its curves inside shaping the seats. Surrounding you with only the skylight and fireplace as only light source.

Conclusion

From the full scale testing I defined a minimum radius of 3.5m for walls, an maximum offset between studs of 100mm and a overlapping of 50mm of the shingle cladding.

Every material has its qualities, wood is rather cheap, sustainable, easy to cut glue and screw together. Making your own large plywood/sheets gives you an affordable and manageable opportunity to shape your building in a more expressive way within those set parameters. This method has its limits with difficulty to fulfill building-permits, but that might be an opening for a
Contemporary build-kits
Model photos

Testing different building techniques
Model photos structural concept model and structural models 1:20
Learning by building

- Gluing and screwing plywood
- Drawing and cut out studs
- Testing first stud
- Testing first wall/roof
- Erecting second wall/roof
- Mounting laths
Mounting cladding

Testing overlap and amount of screws

Testing different size of cladding

Testing different overlap

Final cladding
Overlap vs curve

Final cladding cut

Inner floor from left over pieces turns into pattern
What you need
This is what you need to build. Depending on how big your house is, you will have to calculate the amount of plywood. Each estimate is per m² of building footprint.

Time and Budget
Every page has a time estimate, as an example I have made a time-estimate and budget for a 15 m² Friggebod:

<table>
<thead>
<tr>
<th>Material</th>
<th>168,3 m² plywood = 57 pieces</th>
<th>8935 sek</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60 m² Weatherproofing</td>
<td>2585 sek</td>
</tr>
<tr>
<td></td>
<td>75 m² Steam break</td>
<td>6840 sek</td>
</tr>
<tr>
<td></td>
<td>45 m² Insulation</td>
<td>11745 sek</td>
</tr>
<tr>
<td></td>
<td>420 kg Concrete</td>
<td>637 sek</td>
</tr>
<tr>
<td></td>
<td>34 L Wood glue</td>
<td>3394 sek</td>
</tr>
<tr>
<td></td>
<td>3360 Screws</td>
<td>996 sek</td>
</tr>
<tr>
<td></td>
<td>15 L Paint</td>
<td>1950 sek</td>
</tr>
<tr>
<td></td>
<td>3x window 1 door</td>
<td>10936 sek</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>48738 sek</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Glueing</td>
<td>20 h</td>
<td></td>
</tr>
<tr>
<td>Plinths and floor beams</td>
<td>15 h</td>
<td></td>
</tr>
<tr>
<td>Wall study</td>
<td>10 h</td>
<td></td>
</tr>
<tr>
<td>Openings</td>
<td>2 h</td>
<td></td>
</tr>
<tr>
<td>Weather proofing</td>
<td>15 h</td>
<td></td>
</tr>
<tr>
<td>Mount cladding</td>
<td>5 h</td>
<td></td>
</tr>
<tr>
<td>Sealing the envelope</td>
<td>5 h</td>
<td></td>
</tr>
<tr>
<td>Inside Insulation/inner Floor</td>
<td>15 h</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>162,5 h</strong></td>
<td></td>
</tr>
</tbody>
</table>

Floor beams (200mm) - 1,92 m² plywood/m²
Floor - 3 m² plywood/m²
Walls/roof (200mm) - 6,3 m² plywood/m²
Weatherproofing - 4 m²/m²
Steam break - 5 m²/m²
Insulation (200mm) - 5 m²/m²
Concrete - 35 kg/plinth
Glue - 0,2 L/m² plywood
Board screw - 20/m² plywood
Paint - 1 L/m²

Tools for this task
- Circular handsaw
- Wood glue for outdoor use
- Tiger saw or jigsaw
- Roller or spreader
- Concrete mixer
- Screw 35 mm board screw

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Plinths and floor beams
Cast plinths.
Cut out beams from your plywood sheets.
In doubt of dimensions consult with a carpenter or engineer.
A 150mm beam will reach about 2,5 m.
Place floor beams with a centre distance of 600 mm.
Place a piece of roof tarpaper or other non-waterconducting material between the plinths and beams to prevent moisture transferring from the ground.

Plinths and floor beams
- Cut plinths.
- Cut out beams from your plywood sheets.
- In doubt of dimensions consult with a carpenter or engineer.
- A 150mm beam will reach about 2.5 m.
- Place floor beams with a centre distance of 600 mm.
- Place a piece of roof tarpaper or other non-waterconducting material between the plinths and beams to prevent moisture transferring from the ground.

Building manual

Glueing plywood
Start with placing plywood boards in 3 layers overlapping half over half.
Apply glue on boards and screws with 35 mm board screws every 300 mm.
Cut off protruding parts and fill gaps so the plywood is 3 layers everywhere.

Estimated time: 10 min/m² plywood

Plinths and floor beams
- Cut plinths.
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- Place floor beams with a centre distance of 600 mm.
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Estimated time: 30 min/plinth

Estimated time: 30 min/m²

Board screw goes every joist
Plywood goes
Cut off boards that stick out
Fill gaps to get 3 layers of plywood everywhere
Apply glue with roller or spreader
Main roof beam
Cut out your main roof beam and pillars.
If in doubt of dimensions consult with a carpenter or engineer.
A 60x360mm beam will reach about 6m.

Estimated time: 10min/m

Tools for this task

Wall studs
Cut out your wall studs in the shape you desire.
A 200mm thickness will give you sufficient insulation and load bearing but consult with a carpenter or engineer if in doubt.
Restrictions are a minimum radius of 3.5m on curves.
If your stud protrudes more than 500mm from the foundation it will add to the building square meters.

Estimated time: 1h/m wall

Tools for this task

Openings
Make boxes of plywood for your desired windows, doors and other openings.
Mount them in the frame as desired.

Estimated time: 30min/ opening

Tools for this task

Weather proofing
Mount your wall studs together and raise them to the roof beam.
Ensure they are supported efficiently.
Mount weatherproofing (open on the outside) of the wall studs.
Cut out laths from single plywood sheets at a 30 degree angle across the wall studs.
Cut out shingles from single plywood 300x300mm.
Paint shingles, leave one side unpainted.

Estimated time: 3h/m wall

Tools for this task

Weather proofing layers

Wall studs

Cladding

Laths

Weather proofing layers

Weather proofing layers

Weather proofing layers

Weather proofing layers
Insulation and interior cladding

Put insulation between all wall studs.

Call the electrician if you want to have any electricity installed in your walls.

Mount steam brake on inside of wall studs.

Cut strips of single layer plywood in appropriate with. Here you have to test your curves to see how wide your cladding can be. Wider strips bend less and vice versa. I used three different widths, 200mm, 100mm and 50mm.

Tools for this task

| Insulation | Woodfiber diffusion open |
| Steam brake | Vario Extra diffusion open |
| plywood 12mm |  |
| 3 layers x200mm |  |
| Underfloor plywood |  |
| Insulation woodfiber diffusion open |  |

Tools for this task

Estimated time: 1h /opening
10min /m wall

Cladding

Mount shingles with the painted side outwards. Start from the bottom and overlap every shingle at least 50mm.

Use 35mm board-screws to mount bottom and top corners of the shingles.

Tools for this task

Floor beams plywood 3 layers

Floor beams plywood 2 layers

Floor beams plywood players sawn

Wall studs 12mm plywood players sawn

Laths plywood 12x40mm

Tools for this task

Estimated time: 3h /m wall

30min /m2 cladding

Sealing the envelope

Mount windows and doors in your boxes. Cut the protruding pieces of cladding.

Make sure to cover the seam of cladding on top of your roof.

If needed mount window-sills and make sure no water gets on the inside of your cladding.

Estimated time: 1h /opening

Tools for this task

Floor beam Plywood

Floor beam Plywood sawn

Insulation Plywood

Steam brake Vario Extra diffusion open

Insulation woodfiber diffusion open

Sheet plywood

Board-screws

Tools for this task

Estimated time: 1h /opening
10min /m wall

Sealing the envelope

Mount windows and doors in your boxes. Cut the protruding pieces of cladding.

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Estimated time: 1h /opening

Tools for this task

Floor beam Plywood

Floor beam Plywood sawn

Insulation Plywood

Steam brake Vario Extra diffusion open

Insulation woodfiber diffusion open

Sheet plywood

Board-screws

Tools for this task

Estimated time: 1h /opening
10min /m wall

Building manual
Inspirational house - Sleeping hut

Facades
Cladding K-plywood 300x300x12mm
Lath K-plywood 200x12mm
Weatherproofing Isover Vempro
Stud K-plywood 3 layers 12x200mm
Insulation wood fibre 200mm diffusion open
Steambreak Isover Vario extra
Silicon sealer

Windowsill steelplate
Furniture structure K-plywood 12mm
Boardscrew 35mm

Cladding K-plywood 12mm
Insulation wood fibre
Skirting
Mounting frame K-plywood 12mm

Cladding K-plywood 300x300x12mm
Lath K-plywood 40x12mm
Weatherproofing Isover Vempro
Stud K-plywood 3 layers 12x200mm
Insulation wood fibre 200mm diffusion open
Steambreak Isover Vario extra

Window

Cladding K-plywood 300x300x12mm
Lath K-plywood 12x200mm
Weatherproofing Isover Vempro
Stud K-plywood 3 layers 12x200mm
Insulation wood fibre 200mm diffusion open
Steambreak Isover Vario extra

Rooftop

Cladding K-plywood 12mm
Insulation wood fibre

Floor K-plywood 2 layers 12mm
Insulation wood fibre 150mm diffusion open
Under floor K-plywood 12mm
Lath K-plywood 2 layers 40x12mm

Ground

Concrete plinth

Moisture barrier tarpaper

Filebeam K-plywood 3 layers 12x150mm
Steel bracket
Inspirational house - Sauna

Section perspective
Inspirational house - Sauna

Facades
Cladding - 12mm Kplywood 300x300 mm
Laths - 12mm Kplywood with 40-50mm
Windscreen - Isover Vempro water and air tight, diffusion open
Insulation - 200m Woodfiber, diffusion open
Steam break - Isover Vario Extra, diffusion open
Roof beam - 12mm Kplywood 360mm x 6 layers glued and screwed
Roof pillar - 12mm Kplywood 100mm x 6 layers

Wall stud - 12mm Kplywood 200mm x 3 layers
Steam break - Isover Vario Extra, diffusion open
Cladding - 12mm Kplywood cut in boards of 150mm x 2500mm

Floor - 12mm Kplywood 1200x2500 mm 2 layers screwed
Steam break - Isover Vario Extra, diffusion open

Floor beams - 12mm Kplywood 150mm 3 layers glued and screwed
Insulation - 150m Woodfiber, diffusion open
Board - 12mm Kplywood 564 x 2000mm
Pliths - 150mm Concrete
Cladding - 12mm K-plywood 300x300 mm
Laths - 12mm K-plywood with 40-50mm
Windscreen - Isover Vempro water and air tight, diffusion open
Insulation - 200mm Wood fibre, diffusion open
Steam break - Isover Vario Extra, diffusion open
Roof beam - 12mm K-plywood 360mm x 6 layers glued and screwed
Roof pillar - 12mm K-plywood 100mm x 6 layers
Insulation - 200mm Wood fibre, diffusion open
Windscreen - Isover Vempro water and air tight, diffusion open
Laths - 12mm K-plywood with 40-50mm
Cladding - 12mm K-plywood cut in boards of 150mm x 2500mm
Wall stud - 12mm K-plywood 200mm x 3 layers
Steam break - Isover Vario Extra, diffusion open
Cladding - 12mm K-plywood 300x300x12mm
Lath - K-plywood 40x12mm
Weatherproofing - Isover Vempro
Stud K-plywood 3 layers 12x200mm
Insulation - wood fibre 200mm diffusion open
Steam break - Isover Vario extra
Boardscrew 35mm
Cladding - 12mm K-plywood 12mm
Plexiwindow Scanlight
Board - 12mm K-plywood 564 x 2000mm
Plinth - 150mm Concrete
Floor beam - K-plywood 150mm 3 layers glued and screwed
Insulation - 150mm Wood fibre, diffusion open
Board screw 35mm
Cladding - 12mm K-plywood 12mm
Plexiwindow Scanlight
Mounting frame K-plywood 12mm
Door seal
Moisture barrier tarpaper
Doorsill steel plate
Weatherproofing - Isover Vempro
Floorbeam K-plywood 3 layers 12x150mm
Moisture barrier tarpaper
Concrete plinth
Door - 12mm K-plywood 12mm
Stud base plate K-plywood 12mm
Floor K-plywood 2 layers 12mm
Steam break - Isover Vario extra
Insulation wood fibre 150mm
Steel bracket
Under floor K-plywood 12mm
Lath K-plywood 2 layers 40x12mm