No Footprint House

HOGESCHOOL ROTTERDAM

CLIMATE ANALYSIS

Costa Rica: Tropical Marine Climate

Very sunny

A lot of rain during the year

Average temperature:
Between 23 and 27˚C
High temperature during the whole year

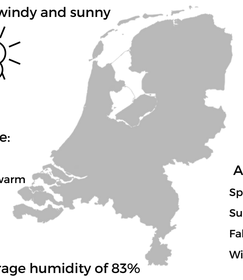
Average rainfall:
Rainy season: 240 mm
Dry season: 17 mm

Average humidity of 77%

The Netherlands: Temperate Maritime Climate

Variety of: Cloudy, windy and sunny

Rainy all year



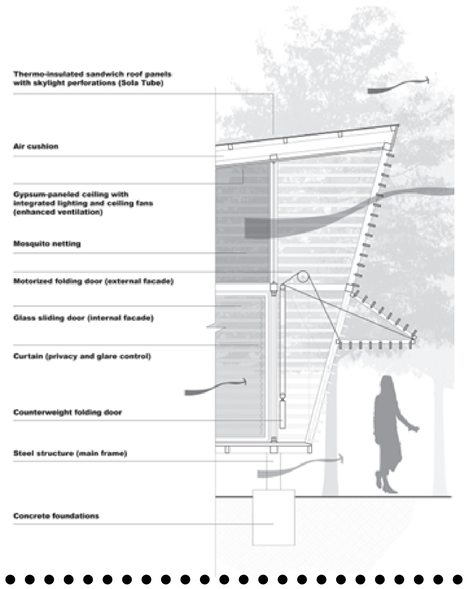
Average temperature:
Between 6,5 and 12˚C
It's never cold, but never warm

Average rainfall:
Spring: 170 mm
Summer: 230 mm
Fall: 240 mm
Winter: 215 mm

Average humidity of 83%

Partial Conclusion:

Both climates have a high average of humidity and a high average of rainfall. The big difference is the annual average temperature. It's on average 18 degrees warmer in Costa Rica than in The Netherlands. The current design of the No Footprint House is very open, but to ensure that it's comfortable inside the building if it's placed in The Netherlands, the design should be more enclosed.



ANALYSIS ARCHITECTURAL ASPECTS

Thermo insulated sandwich roof panels with skylight perforations:
Skylight for daylight in the bathroom, a good solution because otherwise you will not have daylight due to the central location of the bathroom. In the Netherlands we have to insulate the roof, so we probably won't need the cavity in the roof.

Air cushion:
This was chosen because this ensures that the building does not heat up immediately when sunlight comes up.

Gypsum paneled ceiling with integrated lightning and ceiling:
The gypsum paneled ceiling serves as a finish for the interior. This could also be done in the Netherlands.

Mosquito netting:
Not urgently needed in the Netherlands because there is much less burden experienced by musquitos in the Netherlands.

Motorized folding door (external façade):
Since it is necessary to insulate in the Netherlands due to the different climate and requirements, it is difficult to realize a folding door.

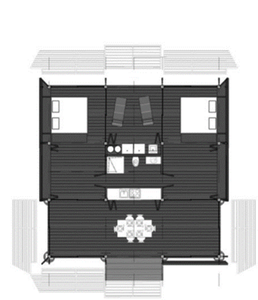
Glass sliding door (internal façade):
Used to organize separation between indoor and outdoor. This is not a hard separation because the walls are made of glass. For example, in the Netherlands it is possible to realize glass sliding doors.

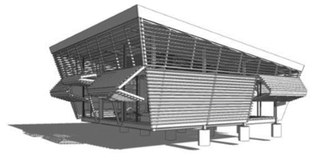
Curtain (privacy and glare control):
In the Netherlands we will have to insulate the facades. That is why we will only place curtains in the places where there are window frames

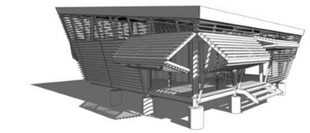
Counterweight folding door:
The chance that we can realize a folding facade in the Netherlands is small.

Steel structure (main frame):
This was the most durable construction material in the designated area in Costa Rica. This is because wood was more difficult to import than steel in the project. For our design we have to look at what is the most sustainable solution in the Netherlands.

Concrete foundations:
In order to build a foundation on footings in the Netherlands, we will have to find a place in the Netherlands where it is possible to build foundations on steel, i.e. places with a sandy soil.







NFH-81

[2 BEDROOMS / 1 BATHROOMS / 1 KITCHEN DINING / 1 TERRACE]

ANALYSIS LAYOUT:

For our proposal, we want to transform variant NFH-81 so that it can be built in a Dutch climate. The bathroom is centrally located, which is convenient because it makes organizing privacy easy. Around this are the western and northern bedrooms. To the south is the kitchen / living area. It is now the case that the washing facility is on the terrace. This can be disturbing. We therefore aim to combine the washing facilities and the bathroom in terms of layout.

DUTCH NATIONAL BUILDING DECREE

Room areas
(based on minimal requirements Dutch national building decree)

Livingroom/kitchen	28,95 m2	Complies
Bedroom (x2)	18,0 m2	Complies
Bathroom	5,1 m2	Complies
Patio	10,95 m2	No avaliable requirement

Sunlight
(minimal requirement national building decree = 10% of room area)

sunlight area per room:

Livingroom/kitchen	33,0 m2	Complies
Bedroom (x2)	6,6 m2	Complies
Bathroom	-	No living space

Soundproofing
(minimal requirement national building decree = 20 dB soundproofing in a living space)

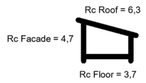
least soundproof material in facade:

Glass, thickness unknown
Soundproofing single layered glass: 29 dB Complies
Soundproofing double layered glas: 40 dB Complies

Fireproofing steelconstruction
(minimal requirement national building decree = 30 min.)

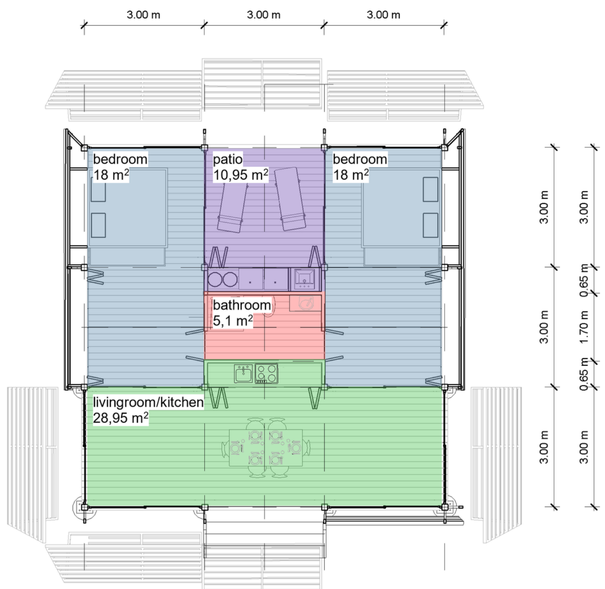
Current fireproofing = 0 min. Does not comply

Thermal insulation
minimal requirements national building decree:

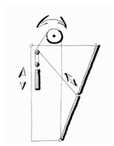


Roof structure =
Thermo-insulated sandwich pannel 20mm
Air 300mm
Wooden lowered ceiling 20mm Does not comply
Facade structure =
double layered glass / mosquito netting Does not comply
Floor strucutre =
wood 50mm Does not comply

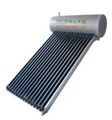
MEASUREMENTS EXISTING BUILDING



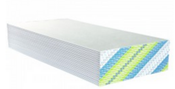
MATERIAL ANALYSYS



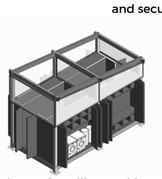
Facade panels can be opened or closed individually to control views and exposure, increase or decrease airflows, create privacy and security



solar panels are used to heat the water on-site in order to save energy

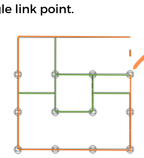


thermally insulated sandwich roof panels with skylight perforations



all the services, like machinery, bathrooms, kitchen and laundry area, in a volume in the center of the floor plan to create a single link point.

The slanted skin decreases the direct impact of sunlight and precipitation, which protects the elevated floorplan from overheating and splashing water.



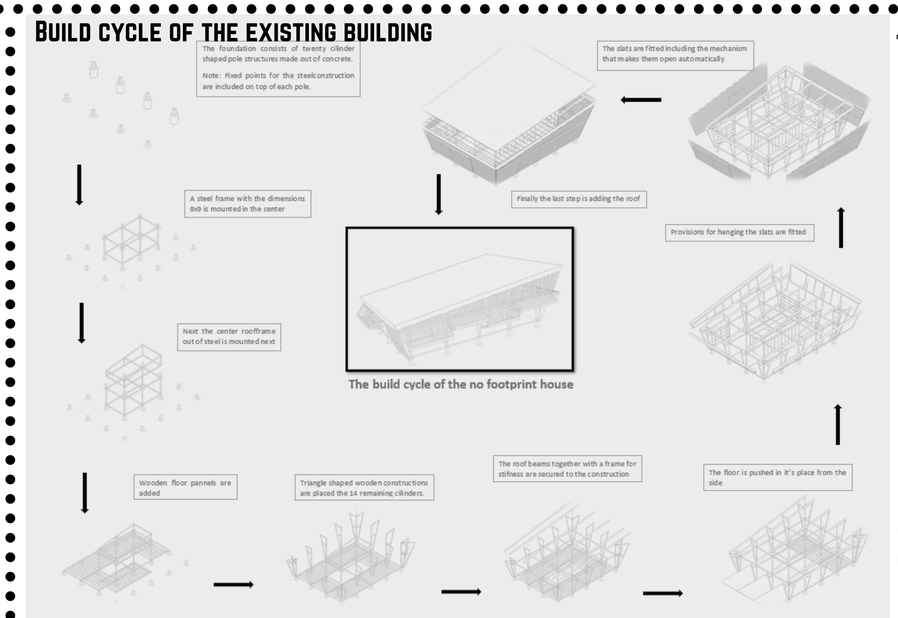
Steel construction PFC & RHS profiles

Concrete foundations

The selection of all elements and materials is based on a thorough investigation regarding the origin, processing, and environmental footprint.

BUILD CYCLE OF THE EXISTING BUILDING

made by: Tom



The build cycle of the no footprint house

Conclusion: It is clear from the sequence and the construction method that prefab elements were used and assembled on site. The advantage of this is that all parts could be delivered with just one truck.

In the Netherlands the elements can also be assembled on site, but partly due to the different climate, the dimensions of the kit become larger this in turn adds more weight. This makes it almost impossible to deliver the package in one go.

In addition, the soil composition in the Netherlands does not allow for the foundation to be constructed in this way.

No Footprint House

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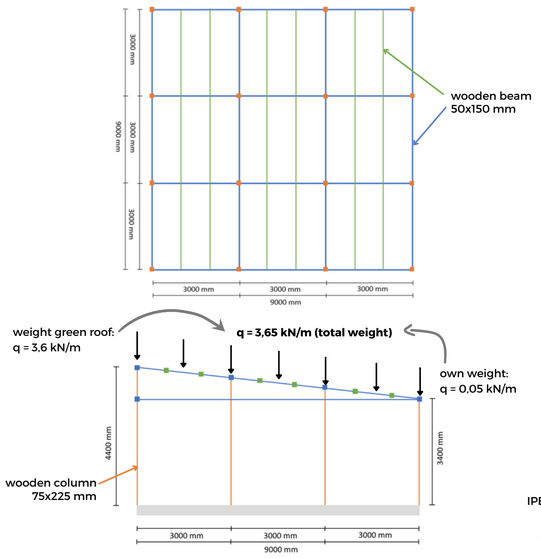
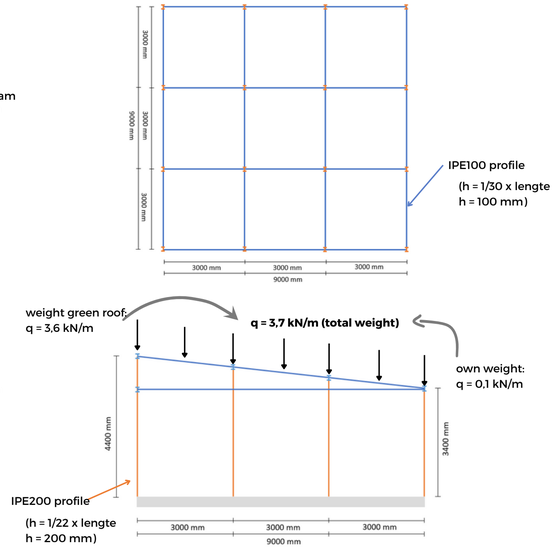
Construction Steel / Wood

Option 1: Wood Construction

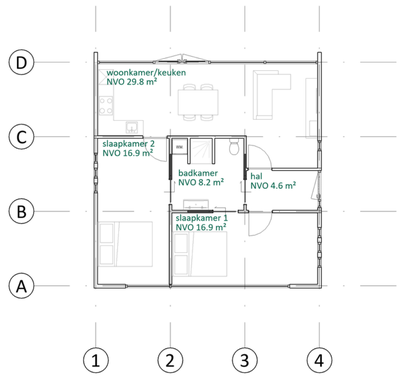


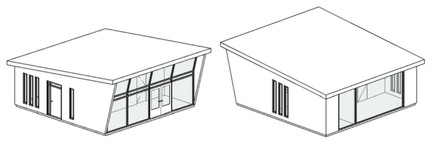
Option 2: Steel Construction



First alternative

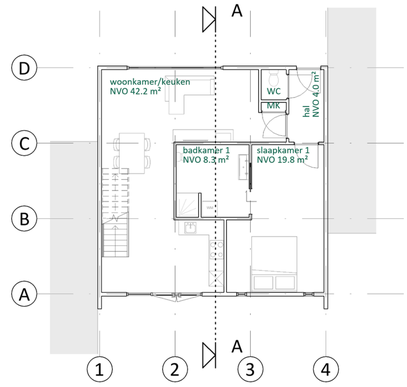
Vacation home

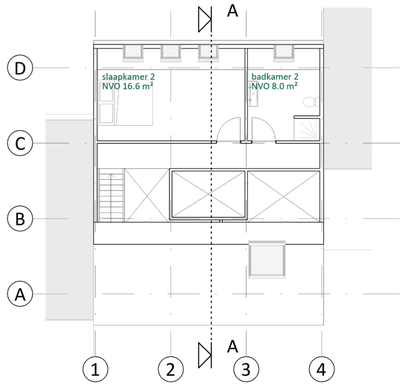


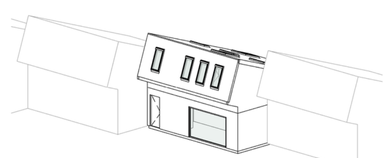


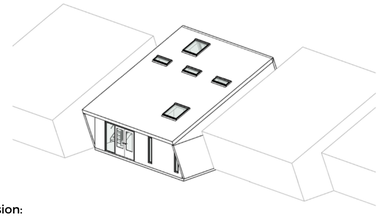
Second alternative

Row house









Conclusion:
We will continue this project with our design for the row house.
This design isn't as similar to the original as the vacation home, acts on the housing problem in The Netherlands and is visually more interesting.

Material comparison

Structural material:

Properties *(Pros & Cons)*	Strong, light, easy and versatile to work with and natural/ timeless character.	Because it is a natural product, there are always imperfections such as knots/ brushes, pith, resin, fungus, rough spots and wood is rarely dimensionally stable.
Types *(Deciduous & Coniferous Trees)*	Oak, mahogany, walnut, birch, beech, cherry, teak, ect.	Larch, spruce and pine
Origin & Route *(Europe & beyond)*	Most wood comes from carefully managed forests in Europe, resulting in a shorter supply line. In addition, these trees are specially planted to be cut down later.	Other types of wood are also possible, but must then bear an FSC quality mark.
Lifespan *(Class 1 to 5 (in years)*	The lifespan of wood is determined on the basis of a durability class that counts 1 to 5. We are talking about wood without preservatives here.	Very durable (25+) Durable (15 to 25) Moderately durable (10 to 15) Not very durable (5 to 10) Not durable (5)
Energy requirement *(processing)*	When building with wood, the easy machinability and the high degree of prefabrication save a lot on transport movements, which leads to less fuel consumption and emissions.	
Recyclable *(3 levels)*	A-wood: Is unprocessed, untreated, unvarnished and unimpregnated waste wood. Often the wood can be reused immediately. C-wood: Is impregnated wood that has been processed with certain substances to extend the useful life of fences, for example.	B-wood: This includes hardboard, chipboard, fibreboard, compressed wood, furniture, painted, varnished and glued wood, doors, frames and non-impregnated wood.

Conclusion: For the construction we compared the materials wood and steel. It turned out that not one is clearly better than the other. That's why we chose to apply them both into our scenarios. steel for the holiday home and a wooden construction for the row home.

Comparison	Steel	Wood
Properties		
Types		
Origin & Route		
Lifespan		
Energy requirement		
Recyclable		

Properties	Pro's	Cons
	- High residual value, low environmental impact - Dismountable with bolt connection. - 100% recyclable - Long lifespan - Good strength and stiffness - No residual waste - Building material arm	- Higher costs - poor sound and heat insulation
Types of steel	IPE100 Profiles 80% of the steel that can be used for the IPE100 van be recycled.	The costs of a IPE100 profile is around 24 euro's per meter
Origin	It depends, a large quantity of our steel is originating from recycled steel. So it is not possible for us to determine where this recycled steel comes from.	The other part of the steel, that is not recycled, can be obtained in the Netherlands.
Lifecycle	The lifespan of steel is relatively long, at least 40 years. After this, it can still be recycled.	
Energy needs	The energy required for steel production depends on the amount of recycled steel. Current energy consumption is between 7 and 21 MJ per kilogram. The required embodied energy decreases as the steel is recycled more often. After four cycles, energy consumption has already decreased by 40%.	
Recycling	Steel is the most recycled material in the world. It is 100% recyclable. It can be easily recovered and reused without loss of quality. The properties of the metal make steel one of the most durable building materials ever. This is reflected in the robustness and stability of existing steel structures and in the reusability of the raw material. Demolished structures can be directly reused if the shape is adapted and the material is cleaned.	a steel building lasts a long time. But when the period of use is over, the construction goes out just as easily as it does put together. After disassembly, after some processing, the original parts are again suitable for reuse as a component in a new construction project.

Insulation materials (150 mm)	Lambda value
PIR or polyisocyanurate rigid foam RC = (7.1 – 5.8)	(0,021 - 0,026)
EPS or expanded polystyrene RC = (4.8 – 3.3)	(0,031 - 0,045)
Glass wool RC = (3.9 – 3.6)	(0,031 - 0,044)
Hemp RC = (3.9 – 3.6)	(0,038 - 0,042)
Cotton RC = (3.9 – 3.6)	(0,038 - 0,042)
sheep wool RC = (3.9 – 3.6)	(0,038 - 0,042)

we compared different insulation materials and made a selection by looking at the Rc values.
We then further investigated the glass wool and hemp insulation to eventually come to the conclusion that we want to use hemp based on the comparison matrix.

Glass wool		Hemp
Non-flammable		Flammable
Acoustics		Acoustics
Glass & sand melted under high temperatures and spun into threads		No pesticides needed 100% natural
Anti-fungal and antibacterial		Anti-fungal and antibacterial
Moisture regulating		Moisture regulating
High heat storage		High heat storage
Flexible, dimensionally stable and robust		Flexible, dimensionally stable and robust
Cannot be processed without irritations		Processable without irritations
Long lifespan		Limited Lifetime
Weight		Weight
Good		Average
Bad		

Criterias after Anlaysis / research

Construction

The building must be designed in such a way that it does not collapse and meet the European standards.
Keep existing grid of 3 x3

Construction execution
The building must be dismantled.
Prefabricated parts on the construction site.
Electric method of transport, trucks.
Use of local products.
Dry building method

Materials:
Use of technological cycle
Materials must comply with the building code

Design
Translate design into the dutch context
Ensure the privacy of the building
Construction not hidden in the building

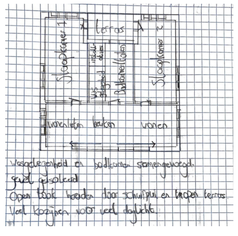
Ventillation System

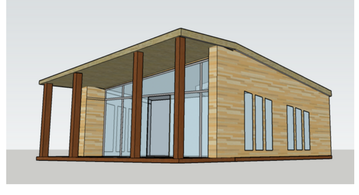
Conclusion:
- In the Netherlands there are 4 possible ventilation systems to use in a home. For our project we briefly looked at all the possibilities and concluded that we are going to look at the possibilities of system D with the provisional choice for system C.

Ventilation systems:

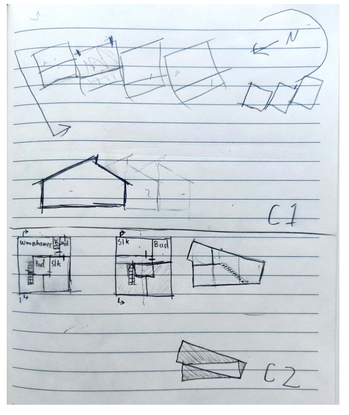
System	A	B	C	D
	Natural air supply and exhaust	Mechanical air supply and natural air extraction	Natural air supply and mechanical air exhaust	Mechanical supply and discharge
				

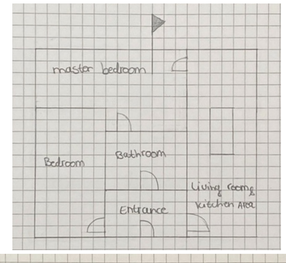
Sub studies design

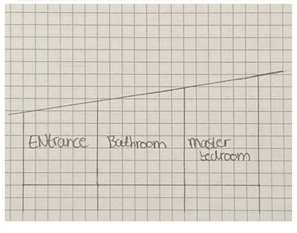




- laundry and bathroom joined together
- insulated façade
- open look kept by sliding doors and open terrace
- many windows for sunlight







Research transport Materials

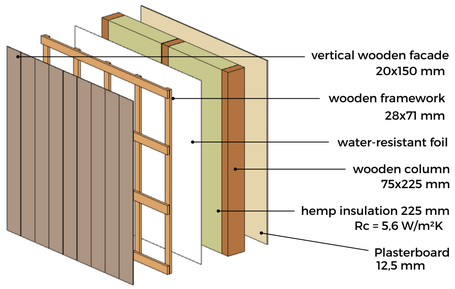
Volvo FL electric	
Driving range	300 KM
Maximum weight capacity	16,7 Tons
Battery capacity	396 kWh

Conclusion:
with our project we try to limit the CO2 emissions as much as possible. We want to stimulate this by using electric trucks and limiting the amount of freight and divide them efficiently.

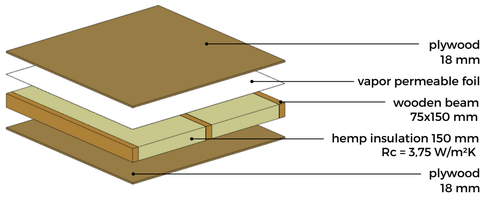
No Footprint House

MATERIAL USAGE

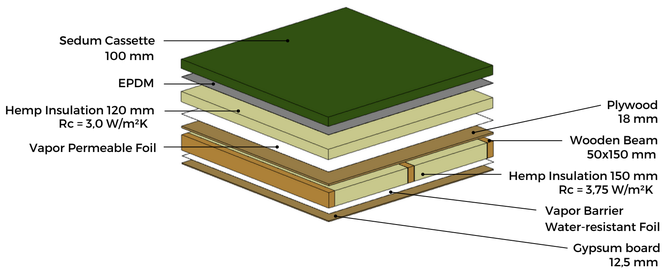
Wall Construction



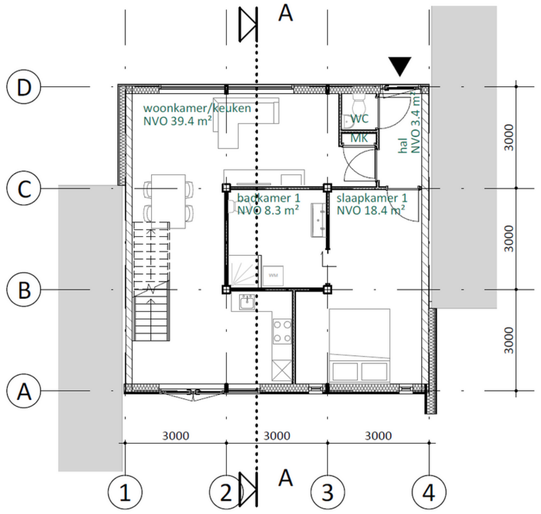
Floor Construction



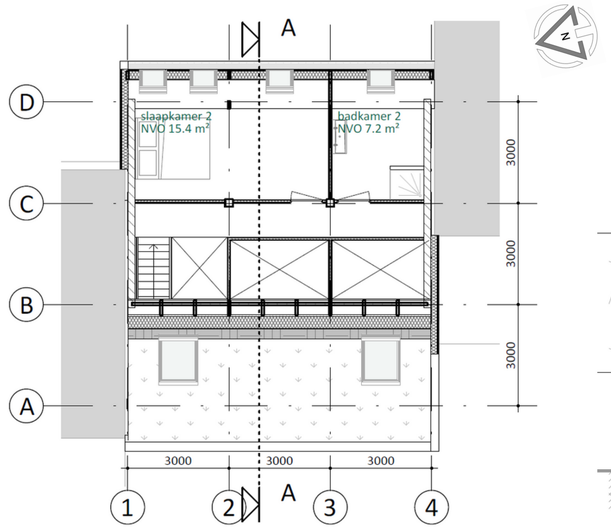
Roof Construction



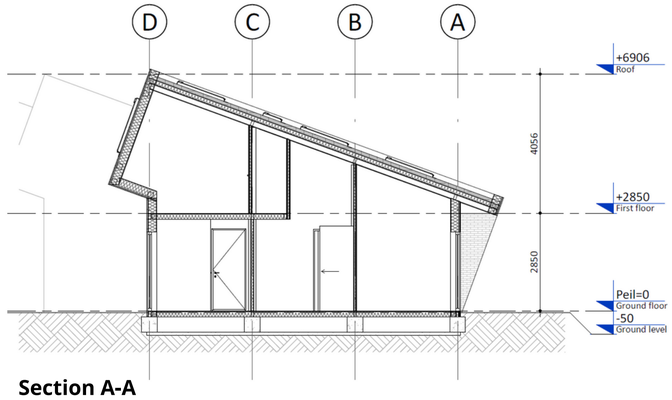
FINAL DESIGN



Ground floor

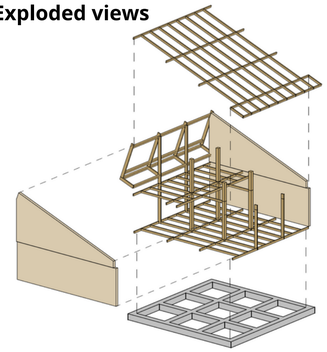


First floor

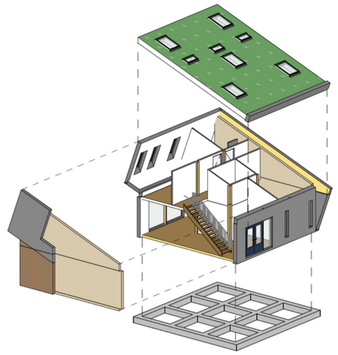


Section A-A

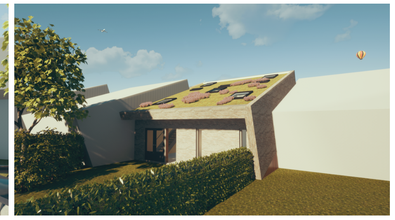
Exploded views



Structure



Complete design



FINAL PROPOSAL & CASE SOLUTION

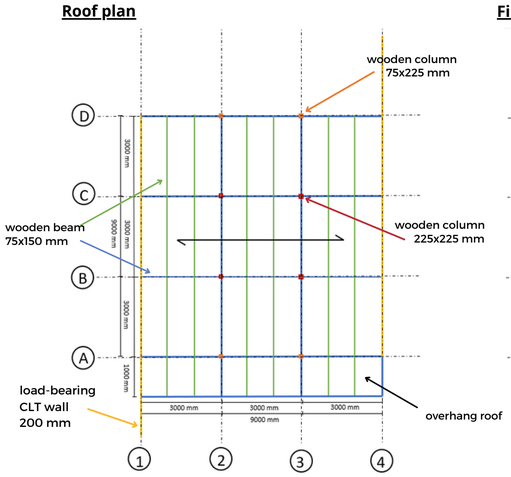
We want to apply a terraced house in the Netherlands. Because its then possible to be produced in larger quantities, a solution has been formed in the field of 'equity'. In our design, the construction will be realized in wood. We have concluded that this is a more sustainable material in terms of origin & routing, energy requirement and recycling than steel for use in the Netherlands.
We've applied as much natural insulation as possible such as hemp insulation as well as many wooden parts such as the façade and floor finish. In this way, we kept a small footprint in terms of material use.
We want to prefabricate the parts as much as possible, because it saves costs and time, which provides a good solution on an economic level. By applying dry connections, our proposal can be realized demountably. This makes it easier to reuse used materials. This is good for the environment in the long run.

WEIGHT & TRANSPORT

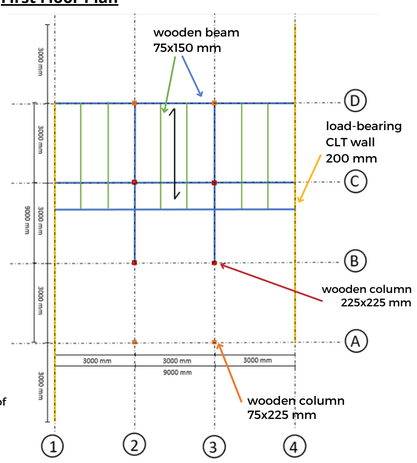
Elements	Total Weight (Kg)	Weight per unit (Kg)	Total elements	Elements per unit
Foundation	286300	47716	192	32
Ground floor	170100	28350	72	12
1st floor	70875	11813	18	3
CLT (load-bearing walls)	54370	9062	24	4
Facades (front & rear)	67050	11175	42	7
Roof	70980	11830	54	9
Wooden construction	165360	27560	378	63
Total in (kg):	885035	147506	780	130

CONSTRUCTION

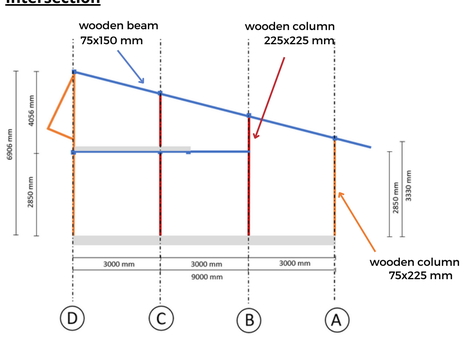
Roof plan



First Floor Plan



Intersection



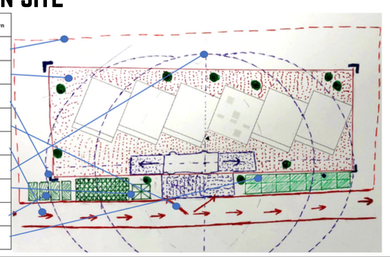
Partial Conclusion:

We have chosen to apply a wooden construction. We used a combination of CLT, as a party wall, and a timber frame construction for the rest of the building. In combination of the load-bearing CLT-walls, the wooden beams and columns have fixed connections to the floor and roof to create stability.

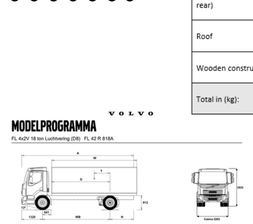
The beams and columns are calculated based on the weight of the roof and the span length.

CONSTRUCTION SITE

Caption	Pattern
terrein fence	1
compacting with sand	2
Construction lighting	3
access to the construction site	4
supply route	5
telescopic crane and reach	6
cabin and toilet unit	7
waste containers	8
storage for prefab elements	9



CONSTRUCTION SCHEDULE



For the transport of the materials we need 70 trucks spread over 7 weeks. Based on the planning, the materials are delivered from the hub to the construction site.

This is all calculated by means of the table with the weights and the numbers of the materials and prefab elements.

the construction site drawing is an indication of the efficiency we want to achieve with the project