THE IMPORTANCE OF SUSTAINABLE TIMBER CONSTRUCTION IN ACHIEVING LOW CARBON FOOTPRINT BUILDINGS

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ABSTRACT

Building construction, in particular concrete construction, is one of the leading environmental polluters today (1). A possible answer for this problem is utilising timber as the main construction material. More and more contemporary buildings are being raised from timber structures throughout Europe, especially in Scandinavian countries. However, Central Europe is lagging behind especially in large scale timber architecture in cities and large urban areas. Even though there are several built examples of educational, public, residential, and multi-story buildings, many people do not trust timber construction. What are the obstacles restricting timber construction in the 21st century? What type of options are there for different types of timber construction? Modular and preconstructed timber structures have a lot of advantages in building construction in urban centres. Timber construction can positively affect the carbon footprint of buildings, while stored carbon in timber can help achieve carbon neutral and net zero buildings which is important in achieving more sustainable architecture.

KEYWORDS _ *Architecture, Timber construction, Sustainability, Carbon footprint*

INTRODUCTION

Due to the climate crisis and global warming, it is becoming more and more important to not only focus on lowering operational carbon usage of buildings, as heat insulation and energy usage, but to also focus on the carbon footprint of construction and the full lifecycle of a building.

Timber is a sustainable and eco-friendly construction material, if sourced locally from well-managed, sustainable forests. Timber plays an important role as a sustainable material in achieving low carbon footprint buildings, however it must be sourced from sustainable forests and manufactured locally in a sustainable way to reach its desired effect. Modern timber building materials are capable of substituting concrete and steel structural elements in structural strength and most other properties.

CARBON FOOTPRINT AND LIFECYCLE OF BUILDINGS

We are constantly trying to lower a buildings maintenance costs and carbon life cycle use, by building with better, more effective heat insulation, triple glazed windows, better sun shading against summer overheating, reducing electric usage by smart homes and LED lights. However a very large part of carbon usage throughout a buildings lifecycle comes not from maintenance and use, but rather its initial material production, construction and the end of life, and beyond life cycle, when reusing and recycling the building materials (2). An answer for this issue is using locally sourced, low carbon footprint construction materials that in some cases absorb more CO^2, than it takes to produce them, for example timber.

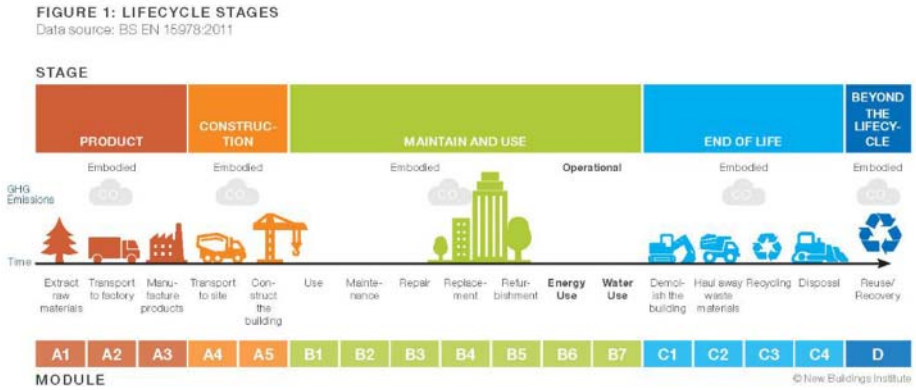


Figure 1: Lifecycle stages with corresponding carbon footprints

According to studies the concrete steel and aluminium used in buildings can be responsible for up to 23% of carbon output of the building industry (3). Therefore the carbon footprint of the building industry could be greatly decreased if these materials were replaced with low embodied carbon alternatives.

TIMBER AS A LOW CARBON CONSTRUCTION MATERIAL

As trees and forests grow, they absorb carbon, and remove it from the atmosphere. Larger a tree is, more carbon it has absorbed. If a forest burns down, the carbon is released back into the atmosphere, where it needs to be recaptured again. The same happens, when trees decompose, the carbon is slowly released back into the atmosphere.

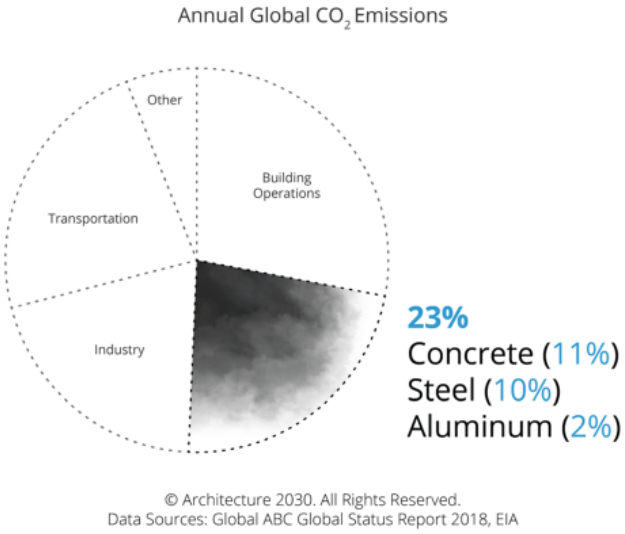


Figure 2: Distribution of CO2 in the building industry

If trees are cut, and produced as a building materials or furniture, then the absorbed carbon stays stored in the timber used. This way it stores carbon within our buildings and homes, until it is demolished, or recycled. This means that a newly built timber building can be carbon negative as it has stored more carbon than it has been used to build or run the building.

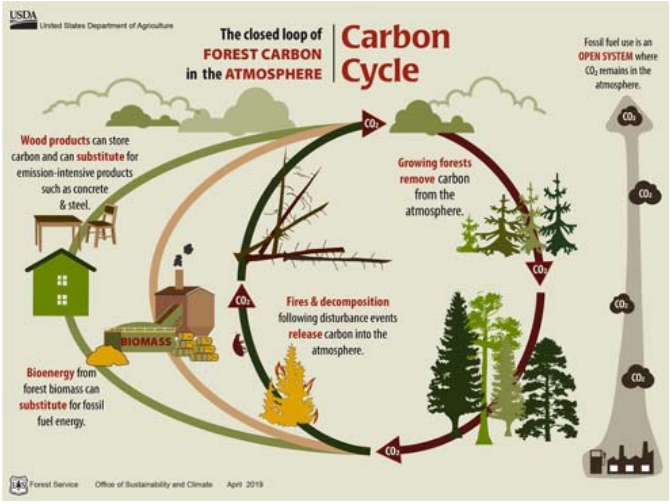


Figure 3: Carbon cycle of trees

EXAMPLES OF CONTEMPORARY TIMBER ARCHITECTURE AROUND EUROPE

Superhub, The Netherlands

The Superhub is a newly built market space, constructed in 2022 in the city of Groningen in The Netherlands, in a newly developing neighbourhood, designed by De Zwarte Hond architecture firm.

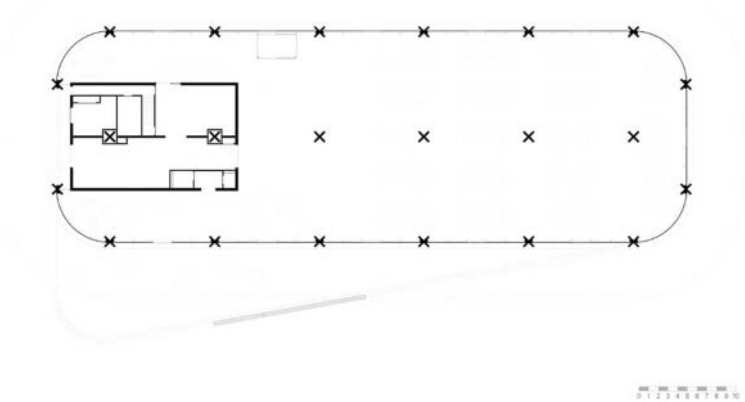
The residential area under development will have 5000 new homes in the following decades, and the designers and planners wanted to build a new market that can develop with the area and can be repurposed in case the building needs a new purpose. This resulted in a market hall with future proof design that has a nine-meter-high ceiling, with a large open space, with a completely flexible layout, large glass façade overlooking greenery and with a large canopy for sunshade.

The structure in entirely made out of cross-shaped laminated wooden columns and beams. The building has been designed to be earthquake protected.

In achieving a low carbon footprint building, it is important that the building can be repurposed, reinvented, after its initial function or purpose is no longer needed. Part of this good design, is that it lets the future owner or tenant a lot of room to redesign and reinvent the building without changing its primary structure.

Picture 1: Exterior of the SuperHub market

The building has been designed to develop and grow with the neighbourhood, and become a local meeting space. With its large spaces it can easily be redesigned in the future as a community centre, theatre, exhibition space, or a museum. This design ideology allows for extending the lifespan of the building, hence decreasing its carbon footprint, compared to a scenario where a new building would be constructed instead, or even having a large renovation.



Floor plan 1. The open floor plan of the SuperHub market

Mjøstårnet, Norway

Constructed in 2019 in Brumunddal, Norway, and designed by the Norwegian architecture firm Voll Arkitekter, the Mjøstårnet is currently the world's tallest timber building standing at 85,4m high. It is a Mixed-use tower, with locally sourced and processed timber, that gives a great example of what a sustainable timber building can be capable of. The building has been constructed from 3 500m3 of timber or about 14 000 threes, which highlights the importance of locally sourced and sustainable forests. The tower is truly wood with timber cladding, timber façade, timber structure, timber stairway and with a timber interiors.

Picture 2: View of the Mjøstårnet tower

The timber used in the tower has been sourced locally from sustainable forests, and processed locally into glulam and CLT elements, that the building has been constructed from. Currently it is very rare, that a building this size has been constructed from timber, and from locally sourced materials.

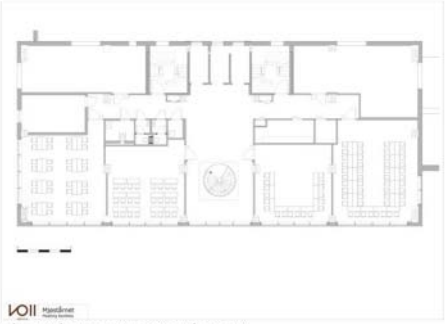
The building is a truly great exhibit of what can be achieved with timber construction. The tower has been designed to allow flexible floor layouts on different levels. The building has 18 stories with different floor plans and programs, which include five office stories, four hotel stories with 72 rooms and 33 residential units, and two floors of public viewing terraces. The building includes a public bath on the ground floor that houses a 25m swimming pool open to the public. The Mjøstårnet tower is an excellent example to show that it is possible to build large complex, sustainable tower buildings whatever the function.

Different floor plan layouts:

Floorplan 2. Office layout

Floorplan 3. Hotel layout

Floorplan 4. Apartment layout



Floorplan 5. Meeting layout

CONCLUSIONS

Wood is a sustainable, carbon negative material, that can be used to decrease the carbon footprint of a building if sourced and produced from local, sustainable forests. The cited examples show, that basically almost any building can be constructed from timber to meet European expectations, requirements and safety regulations. The biggest questions that remain are the willingness, regulations, and the sourcing of the materials. Despite this, the topic requires more research and experimentations, but current trends and examples show that timber construction has an important future in European building construction in achieving low carbon footprint buildings. More and more good examples are being built around Europe. However it is also very important to think of the future use of a building throughout its lifecycle, as buildings can have multiple owners, purposes and uses.

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