Nine storey residential timber construction and the wood building strategy of Växjö municipality

Neun Geschosse in einem Wohngebiet aus Holz und die kommunale Holzbaustrategie der Stadt Växjö

9 étages en bois en zone résidentielle – la stratégie communale de construction bois de la ville de Växjö
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1. Introduction

Due to devastating fires in several Swedish cities between 1838 and 1843, timber was not allowed to be used any more in bearing constructions for buildings with more than two floors. In 1994, the building code was changed towards functional requirements and timber could be used again in multi storey applications. However, this 150 year lasting prohibition let to the fact that building with timber in such applications barely developed. The market and the industry were used to steel and concrete, and mostly still are. Therefore, a strategy for more wood in construction was launched and implemented by the Swedish government in 2004, a.o. aiming at increasing the competition of building materials and techniques. Here, prefabrication in an industrialized way was highlighted. Additionally, more Swedish wood should be processed domestically to save and provide jobs, but also to meet environmental concerns about reducing the CO₂ footprint (Schauerte 2009).

Regarding the implementation of that strategy, the Minister for Communications and Regional Policy in the Ministry of Industry, Employment and Communications, Ulrika Messing, stated that regional innovators and entrepreneurs would be of utmost importance to reach the set up goals. Here, Växjö municipality comes into play.

2. Växjö municipality

2.1. Background

Växjö lies in the heart of Småland, ca 220 km north-east of Malmö, and has about 80 000 inhabitants. In this densely wooded region, ca 1 600 companies are working in the wood-processing industry. At Linnaeus University in Växjö, wood related education and research activities can be found along the whole value chain, from the forest to production and product development and the final products and their markets. Cornerstones for a sustainable development in Växjö municipality were established already in the 70’s, and as the first city in the world, Växjö declared aiming at being completely fossil-free in energy supply by year 2050 (Nilsson 2008). As one part of their environmentally friendly way of working, the city of Växjö decided in 2005 to apply the national strategy for more wood in construction on a municipal level. Due to its several engagements in environmental friendly activities and actions, a.o. leading to a reduced CO₂ footprint by 47% to 2.4 t per inhabitant and year, Växjö was appointed as the Greenest City in Europe by BBC already in 2007.

That local strategy, called Vällebroar – the modern wooden city, was a.o. aiming at exploring an area of 150 000 m² for multi-storey timber buildings. Core competences should be established in a triple helix model, where the industry, the public sector and the university joined forces to advance timber construction(Schauerte 2007). That first strategy is now followed up in a next step. In 2013, the city of Växjö approved and passed the wood building strategy.

2.2. The wood building strategy

Building on the early strategy Vällebroar – the modern wooden city, the city of Växjö set up new goals within the wood building strategy:
- By 2015, 25% of all new buildings should be based on wood.
- By 2020, 50% of all new buildings should be based on wood.

"Based on wood", as mentioned above, means that the major part of the bearing structure of the building is made of wood based materials. Among many challenges in the area of wood building, four areas are highlighted:
- **Life cycle costs**: investment decisions have to be based on the three phases production, usage and dismantling. Better tools to calculate on wooden houses life cycle costs need to be developed.

- **Costs for contractors work**: limited competition leads to higher prices for contractors, especially for multi-storey houses.

- **Maintenance costs**: Today, knowledge about operative and maintenance costs are limited, especially for buildings with wooden facades.

- **Acoustics and vibrations**: issues related to impact sound between two floors need to be solved to make wood more competitive, especially for larger office buildings.

These areas are suggested to best be met by more research, more pilot projects and generally by a higher degree of building in wood.

In order to reach the stated goals, many sub-strategies were stated. There, Växjö municipality underlines its role as being an active part taking initiative, including the determination of responsibilities as driving forces. As an example it can be named, that the cooperation with various partners to start new projects has to be triggered, and that wood has to be examined as building material in cases where it might be appropriate.

Reinforcing the wood building strategy, a yearly follow-up will be done within the city’s score card system, for some areas every third year. Adjustments to the strategy are suggested to happen each third year as well (Växjö kommun 2013).

### 2.3. Examples of timber buildings

One of the first multi-storey timber buildings to be constructed in Sweden after the code change in 1994 was built in Växjö. It was the Wälludden, which is a five-storey timber building, built with a traditional light-weight stud-and-rail system, see Figure 2a. This building was finished in 1995 and was conducted as a joint venture between Södraskogsägarna and Skanska AB, to show on the new possibilities to build with wood in Sweden. After a few pilot buildings in timber had been built in Sweden in the 1990’s, the market for multi-storey timber houses developed slowly until a few years in to the 2000’s. In Växjö, the next big project with four houses was realized between 2006 and 2009. These were the first modern eight-storey residential timber buildings to be built in Sweden, called Limnologen; see Figure 2b. The structural system in these buildings was delivered by Martinsons, from the northern part of Sweden, and is a CLT structure but with some stud-and-rail parts as dividing walls between apartments. Limnologen was also part of several research projects. More information about that research can be found for example in Serrano (2009).

During 2010, another project called Portvakten was concluded in Växjö. These buildings are two eight-storey residential timber buildings, fulfilling the requirement for passive houses. The buildings are as well built with a CLT system from Martinsons, but the walls were made with additional insulation to reach a wall thickness of 53 cm. Extra care also had to be taken during assembly to reach sufficient air tightness in the buildings.

Other examples of buildings within the Vällebroar are the Södra Climate Arena, which is the first wooden Tennis arena built with passive house standards, and the N building at Linnaeus University campus.

The above mentioned wooden buildings are marked in figure 1, showing a part of the city of Växjö with the area called Vällebroar, and figure 2.
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3. **Moelven Trä 8 – Building system**

3.1. **Company**

Moelven Töreboda AB is one of the leading producers of glulam in Sweden. The company was founded in 1919 and their factory is located in Töreboda. Some of the company’s early structures are the glulam structures in the main train stations in Malmö and Stockholm. Since 1982, the company is a part of Moelven Industrier AS.

3.2. **Building system**

The year 2009, Moelven Töreboda AB launched their building system Trä 8 (Timber 8). The system was developed, corresponding to the demand for a timber-based alternative to the traditional beam-column building system. The system is built on glulam beams and columns, with the possibility to be used as an open building system with a span length of 8 meters; see Figure 3. That building system was the result of a research and product development project performed as a joint venture between Moelven Töreboda and Luleå technical university. The system was developed to create larger architectural freedom, compared to many of the existing modularized timber building systems used in Sweden at the time. Another incentive for that development was to create a new system, being adaptable for both residential and office buildings and allowing for larger open spaces.
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The Trä 8 building system includes several elements for the load-bearing system such as continuous columns, beams and stabilizing elements. All the elements are produced off-site and delivered to the assembly site. The floor elements and roof elements are prefabricated as well and delivered to the building site for assembly. The outer walls are made as curtain walls and can be manufactured off-site or built on-site, depending on the buildings shape and site. The inner walls are mainly non-load bearing and are often built on-site (Tlustochowicz et al. 2010).

One of the critical issues with light-weight timber structures is the stabilization to horizontal loads. In multi-storey timber buildings, this issue often is solved by shear walls with sheet materials of gypsum, OSB or plywood. In the Trä 8 system, special stabilizing elements made of timber composite structures, or a concrete elevator shaft, are utilized. The stabilizing timber elements are made up of building high T-, L- or +-shaped elements, with a height of up to four storeys. These elements are made of a composite structure of glulam columns, glued together with Kerto-Q sheets, see Figure 4. The stabilizing elements are provided with steel connectors for attachment to the ground and to the beams in the structures. Theses steel connectors are attached to the glulam within the stabilizing elements through glued-in-rods, see Figure 4b.

This building system has been used in an office building in Växjö in the N building at the Linnaeus University campus, finished 2011. In this example, the house is a three storey building, utilizing the composite stabilizing elements, see Figure 5a. The system also has been used in a five-storey residential building in Askim on the west coast of Sweden, see Figure 5b.
The building system utilizes the Kerto-Ripa floor structure which is made up of LVL. The floor is made up of slab of Kerto-Q with glued on T-shaped ribs of Kerto-S below. The spaces between the ribs are filled with insulation to enhance the sound insulation properties. The floor system has a thickness of 450 mm as a standard can then have a span length of up to 8 meter. The system has shown to have good sound performance for low frequency sound due to its high stiffness.

4. **Vallen – 9-storey building**

4.1. **Introduction**

Facts about Vallen:
- 60 rental apartments, of which 1 x 1 room, 25 x 2 room, 27 x 3 room and 7 x 4 room. All apartments are inclusive bathroom and kitchen.
- Owner: Växjöbostäder, a municipally owned housing company/real estate agency of the city of Växjö.
- Contractor: Väreonds Entreprenad.
- Shell and curtain wall supplier: Moelven.
- Concrete floors and elevator shaft: Abetong.
- Total costs: ca 128 MSEK (ca 13 600 000 €).
- Cost per m² gross floor area: 24 400 SEK (ca 2 600 €).
- Rental charge per m² gross floor area and year: 1 674 SEK (ca 178 €).
- Water and electricity are not included in the rental charge. Individual measurements are applied.
- White goods are included in the apartment standard.
- Moving in: 1st of Maj, 1st of September and 1st of October 2015.
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4.2. Building system – Vallen

Part B of Vallen is in total nine storeys high, with the lower storeys as a podium in concrete. In this case, the building utilizes an elevator/stair shaft in concrete as a stabilizing element. Outside the elevator shaft, a system of glulam columns is erected, see Figure 7a. These columns are continuous through the building height and are as long as 24.5 meters in some cases. Between the columns and the elevator shaft, simply supported beams are attached with steel hangers, see Figure 7c. The beam-column system is the first part to be erected around the whole building. When this system has been erected, the roof elements where attached, and thereafter the floor system installed.

4.3. Vallen – production

The construction of Vallen started in December 2013 with casting of the concrete foundation. During January to April 2014, the concrete wall elements were delivered and mounted into place, with the final parts of the nine-storey stairwell put into place in the second half of April 2014. The mounting of the glulam beams in the nine-storey parts of the building started the last days of April 2014, with the beams and the roof elements mounted during May 2014. For the second part of the building (Part A in Figure 5), the glulam structure was mounted in October 2014. During assembly, the glulam beams were protected against water by the help of plastic wrapping. The total assembly time, from the start of the glulam assembly to the assembly of the roof, was three weeks. During this time, rain protection was applied, as well as temporary support structures to stabilize the glulam beams.
When the roof was set on the structure, the floor elements were assembled by lifting them into place using external cranes. As soon as the floor system was in place, the curtain walls were installed to cover the building, see Figure 8. Thereafter, the internal finishing work could start.

Figure 8: Vallen during construction with wall elements and roof elements on part of the building (Photo: Johan Vessby).

Figure 9 a: Vallenhouses from the seaside. b) View on balconies at Vallen. (Photos: Växjöbostäder 2015)
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5. References


