WORLD’S TALLEST TIMBER BUILDING, BERGEN

Trondheim, Norway. 2014-09-26

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Bergen- og omegn boligbyggelag (BOB) is a Norwegian housing association. They are a major player in the residential building market in Bergen.

Ole Kleppe
Project Chief at BOB and pioneer
Project group

In 2010 BOB proclaims that they want to build the world’s tallest timber building.

The following project group was established:

- **Sweco** – engineering
- **Artec** – architecture
- **Moelven** – glulam and CLT structures
- **Kodumaja** – building modules

Supported by:

Forum Holzbau Nordic 14. Trondheim
Sweco is one of Europe’s leading companies in consulting engineering, environmental technology and architecture

9 000 employees in 12 countries

1 billion € net sales

37 000 assignments per year

15 000 customers

Sweco has about 100 offices in the Nordic region
Where is Bergen?
Location
The plot in Bergen
“Treet” (The tree) is under construction now.

Ground works started in April, and the first timber elements will be installed in October.

Residents can move in autumn of 2015.

Net area of 5830 m².
A webcam service will be in operation soon

We can email you the link to the camera. Please leave your name card or register at our stand after this session 😊
Facts

- 45 m high
- 550 m³ glulam
- 385 m³ CLT produced by the German company Merk
- The building stands on top of a concrete garage.
- Foundations piled to the bedrock
- Drawn in Revit 3D. BIM
More facts

- Calculated using the software Robot
- Concrete decks serve as extra weight as well as platform for modules
- 71 mm max horizontal deflection (Level 14)
- Prefabricated timber frame based building modules are inserted in the “cabinet rack”
Even more facts

- Large glulam sections are block glued
- Typical column: 405x650 and 495x495 mm
- Typical diagonal 405x405 mm
- Glulam carries all vertical load
... and then some facts

- Wind load from 8 directions was applied for design

- The building is not designed for seismic loads. It’s so tall that the wind load prevails, which means that seismic design can be omitted according to Norwegian code

- Highest compression force in a column is 4287 kN = 437 tons
Sweco used glulam trusses for this 5 storey complex in Trondheim in 2005. This was used as a basis for high-rise engineering choices.
Engineering choices

- To limit the need for maintenance a permanent weather protection system was chosen.
- The north and south facades have glass to protect the timber structure
- The east and south facades have metal cladding
- In this way the timber can be regarded as protected
Engineering choices

- The main load bearing is handled by glulam alone. CLT is used in the staircases, elevator shaft (15 storeys), some inner walls and balconies, but is not structurally connected to the glulam.

- Concrete decks are used on three levels in the building mainly to improve dynamic behavior, but also to serve as platforms for stacking building modules.
To reduce the work on site and reduce building time, we wanted to prefabricate as much as possible.

Timber frame modules

Each module / apartment complies with the passive house standard
Building modules

- Modules are stacked up to four levels high
- Single level in the power storey
- The stacked modules are only connected in the bottom to the slabs.
Typical plan

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Timber is not a pre-accepted material for highrises in Norway. However, Norwegian regulations open up for alternate materials as long as required documentation is produced.

Fire design is done according to the Eurocode.

Timber can burn. In this project the glulam is so thick that we allow it to burn for 90 minutes without failing. No extra gypsum is used on the glulam.

All steel connections are hidden inside the timber. In this way it will not fail within the required fire resistance time.

In addition there are sprinklers, pressurized escape stairs and painted surfaces to improve fire safety.
Lack of information of dynamic values. Testing was needed!

Norwegian University of Science and Technology, NTNU, performed the tests.

The Estonian company Kodumaja provided modules.

Non destructive testing of similar modules.

Impact hammer and accelerometers.
Results, serviceability

Results plotted into evaluation curves given in ISO 10137:

Key:
- $A$: peak acceleration, m/s²
- $f_0$: first natural frequency in a structural direction of a building and in torsion, Hz

1. offices
2. residences

Figure D.1 — Evaluation curves for wind-induced vibrations in buildings in a horizontal (x, y) direction for a one-year return period

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**Conclusion, serviceability**

- Residents in the top floors might in rare cases feel vibrations, but it is very unlikely that they will become uncomfortable.

- The chosen structural solution for "The tree" using glulam truss works and stacked prefabricated building modules gives a robust design and most probably insignificant effects from vibrations caused by wind exposure.
Conclusive remarks

Timber high-rise buildings are for real!

Timber high-rise is a good answer to sustainable building in urban areas

The chosen concept is robust and feasible

It’s possible to build even higher with this building system
Picture taken 2 days ago
Picture taken 2 days ago
Make a visit to Bergen next year!

Thank you for your attention!