Wood-based product platforms
Contact

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Disposition

- Why wood-based product platforms?
- Wood-based product platforms
- Beam-column systems
- Massive wood systems
- Modular systems
Aim

• to show you the industrial application in timber of the theories you have learnt in Roberts lecture regarding industrialized house-building.
Why wood-based product platforms – instead of concrete or steel?
Source: IPCC, Global CO2 Emission
Advantages and disadvantages

• Weight-load bearing capacity ratio
• Material flexibility
• Wintertime construction
• Lead-time on-site
• Fire resistance (pyrolysis)

• Low weight
• Span (> 6m)
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Beam-Column systems

Frame separated from the climate shell
Long spans, open areas, large openings.
Massive wood systems

Floor high elements with load bearing and stabilizing frame
Great adjustability, architectural freedom
Modular systems

Timber frame systems.
High degree of prefabrication
Wood-based building systems

- Load-carrying columns
  - Secondary systems
  - Diagonal bracing
  - Shear walls
- Load-carrying walls
  - Solid wood
  - Timber frame

- Production strategies
  - Simple materials pre-cut at factory and delivered to the building site (stick-build)
  - Prefabricated elements (floors, walls) delivered to the building site and assembled
  - Prefabricated modules (volumes) delivered to the building site and assembled

The choice of where to produce different parts of the building system (on-site or off-site) determines much of the efficiency and flexibility of the system.
Wood-based Building Systems
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Beam-and-post systems

- Large span structures
  - Hockey arenas, sports facilities, horse riding arenas, storage buildings
  - Buildings that are not used as dwellings
  - Requirements on insulation, heating, sound, moisture barriers, window openings etc. are less severe than for dwellings

- Office buildings
  - Taller buildings for offices
  - Smaller spans, but more installations
  - Still less severe requirements on e.g. sound than in dwellings

- No economy today in building dwellings with a beam-and-post system
Assembly efficiency

1. Sub-assembly of rafter

2. Temporary bracing on ground

3. Sub-assembly of roof purlins and roof “packages”

4. Placement on columns

5. Assembly of stabilisation in roof

6. Assembly of wall purlins
Joint reminder

- Avoid tension parallel and perpendicular to grain if you can! Instead try to transform tensile loading into compression in the force transfer
Bracing system in wall

- Commonly made of steel braces that take up tension
- Placement in the structure important for total economy
Shear walls in beam-and-post systems

• For office buildings and dwellings the possibility to use shear walls
• Stabilisation could be realised through special stabilising elements in the structure (strong walls)
• Still separate exterior walls are needed for insulation

Source: Seminar Flervåningsbyggnader i trä och andra avancerade träbyggnader, 27/2/2014
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Load-carrying walls

- No columns or beams exist in the system, only walls and floors
- Very similar to concrete building technique, but with (prefabricated) wood instead
- Walls carry both vertical and lateral loads
- Economical for dwellings (multi-family houses) since the thickness of the insulation layer caters for large enough studs/walls to also carry the vertical load
- Diaphragm action/shear walls are used for stabilisation
Massive wood systems

- 22 mm thick wood, cross laminated and glued into "Mega Plywood"

Source: Seminar Flervåningsbyggnader i trä och andra avancerade träbyggnader, 27/2/2014
Massive wood systems

- Very good load carrying capacity both for vertical and horizontal loads
- Not enough insulation – needs to be completed with insulation material on the outside (and studs to fix the insulation)
- Possibility for interior wood
- Good fire performance

Source: Seminar Flervåningsbyggnader i trä och andra avancerade träbyggnader, 27/2/2014
Massive wood systems

- Not only walls but also floor elements and balconies – 8 stories possible

Source: Seminar Flervåningsbyggnader i trä och andra avancerade träbyggnader, 27/2/2014
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Massive wood systems

Source: Seminar Flervårningsbyggnader i trä och andra avancerade träbyggnader, 27/2/2014
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Massive wood systems

The weather protection was especially developed for this building system since wood needs protection from water. The towers enables the entire tent to travel together with the structure upwards and also functions as the construction crane.

Source: Seminar Flervåningsbyggnader i trä och andra avancerade träbyggnader, 27/2/2014
Cost relations for timber frame houses

Risk/profit 10%

Other costs 35%

Production costs 55%

Process costs on site 25%

Sub-contractors 25%

Own labour costs 25%

Building materials 25%

The total timber frame material cost is less than 2% of the total cost

System costs such as prefabrication, supply chain management, sub-contractor and supplier cooperation can affect around 25% of the production costs

Structural wood share 12%
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Timber frame building system

- Heritage from the single family housing industry
- Conventional solution; a frame with top and bottom rail with evenly spaced studs in between. Sheathing of gypsum boards (typically), insulation, wind and moisture barriers complete the structure.
- Floors have the same structure, only heavier floor joists. Floors often have two parts; floor and ceiling. The separation is needed for good sound and vibration performance.
- Usage; 2-6 stories, both single family and apartment blocks
Stabilisation of timber framed housing

• Double layers of sheathing needed to obtain enough stabilisation capacity (the corner nail/screw is decisive for the capacity)

• Depending on the building system type (element or volume) it might be possible to utilise 3D effects in stabilisation

• Several functional requirements meet; sound, fire resistance and stabilisation
Floor joint

- The floors are hung on the walls – thus no shrinkage and a continuous moisture barrier
- Live loads are transferred as well as stabilising forces in the floors.
- Unwanted vibrations follow the stiffest section, which is the connectors.
- Fire resistance must be guaranteed (R90 if above 4 stories)
Modular systems

- Outer walls load bearing
- Stiff corners
- Double layer ceiling
- None-load bearing inner walls

Source: Seminar Flervåningsbyggnader i trä och andra avancerade träbyggnader, 27/2/2014
Modular systems

- Modules above each other
- Efficient load distribution with "Towers"

Source: Seminar Flervåningsbyggnader i trä och andra avancerade träbyggnader, 27/2/2014
Modular systems

- Working load transferred to walls
- Working load is not transferred to floor elements

Source: Seminar Flervåningsbyggnader i trä och andra avancerade träbyggnader, 27/2/2014
Modular systems

- Stabilization through plane element action
- Sheeting on the inside
- Anchoring from outside

Source: Seminar Flervåningsbyggnader i trä och andra avancerade träbyggnader, 27/2/2014
Modular systems

• Installations in plane elements
  – Electrical inside walls
  – Sewage in floors
  – Water in module separating walls

• Electrical integration into the ceiling -> shaft

Source: Seminar Flervåningsbyggnader i trä och andra avancerade träbyggnader, 27/2/2014
Volume module prefabrication

**Structural design**
- Scheduling
- Interior design and materials

**Electrical drafting**
- HVAC drafting
- General drafting
- Purchase time critical materials
- Drafting coordination

**Detailed electrical drafting**
- Drafting of wall and floor elements
- Purchase materials

**In-house activities**
- Compilation of data for manufacturing
- Wall and floor element manufacturing
- Volume module manufacturing

**Timeline**
- 4 weeks Early client contacts
- 12 weeks Building permit
- 8 weeks Design for tender
- 12 weeks Tender negotiations and acceptance
- 10 weeks Architectural design
- 10 weeks Detailed design
- 4 weeks Manufacturing
Modular systems

Source: Seminar Flervåningsbyggnader i trä och andra avancerade träbyggnader, 27/2/2014
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