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Ballastbrygga Mandal

Objectives

Method

Case studies

Results

Discussion

Conclusions
Ballastbrygga project description

residential & retail

ca 11,000 m², 4-5 floors

Passive house standard (NS 3700)
Ballastbrygga
Structural system
Ballastbrygga
structural module

module 12 x 8 m, 3 alternatives to span

exterior walls: non-loadbearing timber framing

floor slabs: timber construction

primary structural system: steel (preliminary)
Objectives

Evaluation of engineered timber construction systems (ETCS) in floor constructions

• Comparison with respect to embodied emissions

• Assessment of impact on energy efficiency
Method

Review of the Norwegian and Central-European marked

Establishment of performance criteria for preliminary
dimensioning

Emission accounting (spreadsheet-based)

- CO$_2$-equivalents for 1 m$^2$ heated floor area over total lifetime

- embodied emissions:
  - database: “EMPA Økologische Baustoffliste” (cradle-to-gate)
  - only ETCS, flooring assembly, beams and columns

- operational emissions:
  - simplified energy supply system (heat pump covering 80 % of heating demand)
  - emission factor electricity: 260 g CO2-equiv./kWh (scenario zero emission in 2100)
Energy calculations (Simien 5.015)

- simplified model of project
- focus on heating demand and load
- varying heights of floor assemblies represented in varying façade areas, lengths of thermal bridges
- minimum requirements on components according to NS 3700 except of normalised thermal bridge value
- thermal bridges:
  - modelled and calculated in “LBNL Therm 6.3”
  - slab edges (100 mm protrusion into exterior wall), columns, windows (simplified)
Case studies
performance criteria

Structural capacities
• timber structures are dimensioned according to NS-EN 1991 and NS-EN 1995 where serviceability is crucial parameter
• Norwegian “comfort criteria”: deflection less than 1.3 mm due to 1 kN point load and natural frequency not lower than 8 Hz

Fire safety
• fire resistance of floor slabs: R 60 A2-s1,d0
• structure withstands entire course of fire, is restorable afterwards

Acoustic performance
• sound insulation class C according to NS 8175
• airborne sound insulation level $R_w \geq 55$ dB,
  impact sound insulation level $L_{n,W} \leq 53$ dB
Case studies

ETCS

<table>
<thead>
<tr>
<th>Case name</th>
<th>Span</th>
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<tbody>
<tr>
<td>hulldekke HD 320</td>
<td>12 m</td>
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<tr>
<td>hulldekke HD 220</td>
<td>8 m</td>
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<tr>
<td>Cross-laminated timber (CLT)</td>
<td>7+5 m</td>
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<tr>
<td>“Kerto Ripa”</td>
<td>8 m</td>
</tr>
<tr>
<td>“Lignatur LFE”</td>
<td>8 m</td>
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<tr>
<td>“Lignotrend Block Q3”</td>
<td>8 m</td>
</tr>
<tr>
<td>brettstapel &amp; “HBV-System”</td>
<td>8 m</td>
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<td>Case</td>
<td>Material</td>
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<tr>
<td>A</td>
<td>Hulldekke HD 320</td>
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<tr>
<td>C</td>
<td>Cross-laminated timber</td>
</tr>
<tr>
<td>G</td>
<td>Timber-concrete composite</td>
</tr>
</tbody>
</table>
**Case studies**

**ETCS**

**case D**

“Kerto Ripa”

- **assembly:**
  - parquet 14 mm
  - 2 x floorboard (gypsum) 25 mm
  - paviours 40 mm
  - acoustic insulation 20 mm
  - PE-foil 0.2 mm
  - “Ripa” box-element 390 mm
  + rockwool inlay

- **total height:** 489 mm
- **weight:** 193 kg/m²
- **fire safety:** sprinkler

**case E**

“Lignatur LFE”

- **assembly:**
  - parquet 14 mm
  - 2 x floorboard (gypsum) 25 mm
  - paviours 40 mm
  - acoustic insulation 20 mm
  - PE-foil 0.2 mm
  - “LFE”-element 320 mm
  + “silence”-inlay

- **total height:** 419 mm
- **weight:** 271 kg/m²
- **fire safety:** sprinkler

**case F**

“Lignotrend Block Q3”

- **assembly:**
  - parquet 14 mm
  - particleboard 22 mm
  - acoustic insulation 20 mm
  - PE-foil 0.2 mm
  - “Block Q3 335 BV”-element 335 mm
  + blown in grit

- **total height:** 391 mm
- **weight:** 296 kg/m²
- **fire safety:** sprinkler
Results

embodied emissions
Results
embodied emissions

The chart illustrates the embodied emissions of various components in different scenarios (A to G). The emissions are categorized into primary structure, floor slab, flooring, and transport floor element. The data shows a significant variation across different scenarios, with A having the highest emissions at 112.2 kg CO2-equiv/m² BRA, and G having the lowest at 6.3 kg CO2-equiv/m² BRA. Each scenario includes distinct contributions from the different categories, highlighting the importance of specific components in the overall embodied emissions.
Results

energy demand
Results

embodied + operational emissions
**Performance criteria**
- greater dimensions despite shorter spans
- additional measures to improve acoustic performance
- extra steps to fulfil requirements on fireproof surfaces

**Energy performance**
- better thermal bridge values
- little differences with respect to energy demand due to counterbalancing effects
- 25% higher installed heating power (dependent on strategy)

**Emissions**
- no clear advantages for entire assembly (for cradle-to-gate)
- large portion of emission linked to the additional measures to overcome shortcomings
- transport relevant for heavy elements and long distances
Conclusions

Further work

• emission factors for ETCS should be more specific (LCA?!)  
• optimised structural systems with more detail  
• expanded inventories include entire structure and technical systems  
• emissions from transport can be relevant  
• cooling loads and related measures should be included
Thank you!