Lighthouse, Joensuu, Finland: Thread Bars in a Discontinuous Post-Tension System

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Karelia in figures

- Students: 4100
- Completed degrees in 2021: 875
- International degree students: 160
- Staff: 323
- Degree programmes: 22
- Exchange students: 135

Joensuu
- 77,256 residents
- 30% students
Lighthouse Joensuu

- Builder: Student Housing Company Joensuun Elii
- Architectural design: Arcadia Oy Arkkitehtitoimisto
- Structural design: AINS Group Joensuu
- General contractor: Rakennustoimisto Eero Reijonen Oy
- Funding for research: Ministry of the Environment
Located in Joensuu, Finland

Housing for students

117 residences

14-storeys

Total height of 48 meters (157.5 ft)

Completed 2019
Structural facts

- Mass-timber frame
- Shear wall system
- Pile foundations
- Podium slab
- High strength steel rods
- Rothoblaas connectors
Use of tension rods
Tension rods

- Main stability against overturning forces by using post tensioned rods
- Internal and unponded
- SAS 670/800
Alternatives for used system?
Goal to have anchoring of 216 kN

<table>
<thead>
<tr>
<th>Material</th>
<th>Description</th>
<th>Cost (CO₂e kg)</th>
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<tbody>
<tr>
<td>Reinforced concrete</td>
<td>C20/25</td>
<td>~2600</td>
</tr>
<tr>
<td></td>
<td>~9 m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>~2600 CO₂e kg</td>
</tr>
<tr>
<td>Post-tension rod</td>
<td>22 TR+plate+ nut</td>
<td>~200</td>
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<tr>
<td>Steel plate</td>
<td>650×550×10 (mm) +110 screws (d10)</td>
<td>~120</td>
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Cost of labour and assembly?
What is the difference? Stack of two walls...

Reinforced concrete + connectors (top of walls)

Post-tension rod + lock nut + plate (top of walls)

Steel plate + connectors (bottom of walls)

Reinforced concrete + connectors

Post-tension rod + lock nut + plate

Steel plate + connectors

Displacement?

Tension

Compression

Kser?

Equal and opposite forces

Wall designed to be compressed at every situation

Compression

Decreased deflection and displacement

Compression

Deflection?

Tension

Compression

Kser?

Equal and opposite forces

Wall designed to be compressed at every situation

Compression

Decreased deflection and displacement

Kser?
Case studies

- Acoustics
- Building physics
- Deformations
- Vibration
- Resident satisfaction survey
Vibration

- Continuous measurements using 3-axis MEMS accelerometer

- Frequency in the y-direction:
  - Measured 1.3 Hz
  - Calculated 1.129 Hz

- Frequency in the x-direction:
  - Measured 1.8 Hz
  - Calculated 1.583 Hz

- Vibration begins at a wind speed of 12 m/s (39.37 ft/s)
Deformations

- Custom made displacement sensors
- Measurements in two stages
- Deformation during the first four months: 15 mm (0.59 in)
- The largest deformations at the beginning
Deformations

- Deformation in 2020 – 2022, 24 months: 5.5 mm (0.22 in)
- Total deformation: 20.5 mm (0.807 in)
- Deformation per storey: 1.58 mm (0.062 in)