WOOD - opportunity and a challenge for municipalities

dr. Bruno Dujić, CBD d.o.o.
bruno.dujic@cbd.si

Content

- Introduction of CBD company
- General about timber construction systems and timber buildings on earthquake areas
- CLT and seismic
- Realized projects in Slovenia
- Multi-story buildings in Europe
- Innovations in CLT
- Conclusions
Company CBD = Contemporary Building Design

- Established in 2006 due to the market's and industry's need of design and construction knowledge of timber structures on seismically active areas.
- The founder of the company dr. Bruno Dujič (2001 PhD in seismic design of timber structures) was employed at the University of Ljubljana, Faculty of Civil and Geodetic engineering, Chair for Materials and Constructions until 2009.
- Led the research projects on the seismic resistance of several types of timber structures / systems.

CBD Contemporary Building Design d.o.o.

Who we are

• R&D performing SME
• Established in 2006
• 2 PhD
• 2 PhD candidates
• 2 Masters of Engineering
• 1 Bachelor of Engineering
• 1 Architect designer
• 1 Carpenter

Igor Gavrič  Taia Huter  Martin Gradišnik
CBD Contemporary Building Design d.o.o.

**What we do**

• Building design (over 500 projects since 2006)
• Building execution of CLT structures (over 50 projects since 2006)
• Research and development (7 R&D projects since 2009)

CBD Contemporary Building Design d.o.o.

**We are specialised in**

• Seismic design of timber structures
• Specific requirements in timber structures
Timber construction elements

Basic timber construction elements

Timber construction elements

Basic timber construction elements
**Timber construction systems**

<table>
<thead>
<tr>
<th>System</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log system</td>
<td><img src="image1" alt="Log system" /></td>
</tr>
<tr>
<td>Timber frame system</td>
<td><img src="image2" alt="Timber frame system" /></td>
</tr>
<tr>
<td>Timber frame system</td>
<td><img src="image3" alt="Timber frame system" /></td>
</tr>
<tr>
<td>Timber masiv system</td>
<td><img src="image4" alt="Timber masiv system" /></td>
</tr>
</tbody>
</table>

**Earthquakes in Europe**

![Earthquakes in Europe](image5)

 Timber structures and earthquakes

- Generally recognized to perform well when subjected to strong earthquakes
- Performance attributed to:
  - Large strength-to-weight ratio of wood
  - Enhanced strength under short term loading
  - High degree of structural redundancy and energy dissipation
- Timber construction itself is not a guarantee for adequate seismic performance

General seismic behaviour of timber structures

Light timber frame structure – 2005
CLT and seismic general behaviour

CLT 1 storey – January 2006

CLT and seismic general behaviour

CLT 3 stories – July 2006
Seismic behaviour of higher CLT structures

CLT 7 stories – nov. 2007

CLT and seismic general behaviour

CLT seismic response
- Rocking
- Slip + Friction

Benefits
- Self-centering (minimal residual deformations)
- Low-cost no damage design
CLT technology for multi-storey timber buildings

- **2006**: 3-storey SOFIE project, Italy
- **2007**: 7-storey SOFIE project, Italy
- **2009**: 8-storey STADHAUS, Waugh Thistleton Arch., GB
- **2013**: 9-storey POLARIS project, MAK Hill, IT

TREND...

CLT technology for multi-storey timber buildings

- **2013**: 9-storey POLARIS project, MAK Hill, IT
- **2009**: 8-storey STADHAUS, Waugh Thistleton Arch., GB
- **2007**: 7-storey SOFIE project, Italy
- **2006**: 3-storey SOFIE project, Italy

Author: Prof. Dr. Gerhard Schichkofer, TU Graz

- **20 storey**: 12-storey
- **30 storey**: 20-storey
- **40 storey**: 30-storey

Trajnostna gradnja in prenova – od strategije do izvedbe 17. oktober 2014, Idrija, Slovenija
Seismic design principles

Performance based design – structure response due to intensity of seismic event

- Very rare event: 2% / 50 years
- Rare event: 10% / 50 years
- Possible event: 20% / 50 years
- Very possible event: 50% / 50 years

Shear force vs. lateral deformation

Wooden frame with both-side particle board sheathing [t = 15mm, b/h/t = 250/268/19 cm; sp-tf connection: glue and threathed nails 2.8/60mm, k=200mm, vertical load 15kN/m²]
Seismic activity in Slovenia

1895 Ljubljana

1976 Breginj
Seismic activity in Slovenia

1998 Posočje

Realized projects in Slovenia
CLT Case studies - Family housing 1

CLT Case studies - Family housing 2
CLT Case studies - Family housing 3

CLT Case studies - Family housing 4
ERROR: stackunderflow
OFFENDING COMMAND: ~

STACK: