

International trends and nuances in the construction of multi-story timber buildings

Vittorio Salvadori









Spöttlgasse Vienna, Austria 2004 Stadthaus Londra, UK 2009 TREET Bergen, Norway 2014 UBC Brock Commons Vancouver, Canada 2017 HoHo Wien Vienna, Austria 2019

24 floor

Ascent Milwaukee, USA 2022



Why building with Timber



New Materials: Engineered Wood **Products**



Source: Pollmeier

Glulam (1906) O. Hetzer (Germany)



Source: Pollmeier

LVL (1950) S. Preston (USA)

DLT (1978) J. Natterer (Germany)

Source: Sohm Holzbauteknik

Source: Maria Laguarda-Mallo





Why building Multi-storey with Timber











Video: Handwerkerhaus Bremen (Germany)

4,000 m² Total – 10 Days Assembly Time (400 m² / per day)

1.1



Research Methodology to create the largest comparative survey ever done



Research Questions

- 1) Where were they built?
- 2) When were they built?
- 3) **How** were they built?
- 4) Why were they built?
- 5) **By whom** were they built?





Previous Comparative Studies

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	Perkins+Will, 2014	Solid Timber Construction Report, 2015	CTBUH Audit, 2017	Salvadori, 2017	Kuzmanovska et al., 2018	Wiegand, 2019
N. Case-studies	10	18	49	40	46	49
Status	Built	Built	Built, Idea	Built, Idea	Built, Idea	Built, Idea
Lowest Limit	5 Floors	None	7 Floors	22 meters	25 meters	7 floors



Methodology

- 1) Literature Analysis/Data Source
 - # Existing Comparative Studies
 - # Academic Papers
 - # "Gray" Literature
 - # Internet and Site Web Databases
- 2) Reserach Criteria
 - # Criterion 1: Definition Multi-story Wood-Hybrid Buildings.
 - # Criterion 2: Height (> 4 Floors)
 - # Criterion 3: Completion Year (2004-2019)
- 3) Definition of Quantitative and Qualitative Data to be searched

197 Case-study

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General Analysis of the Case-studies



Where

- North America
 - # 24 Case-study
- Europe
 - # 161 Case-study
- Other Countries
 - # 12 Case-study



Where - Europe



City/Number of case-studies 1234566>







Panelised all-timber

> Panelised timber-concrete



Number of Projects



Dimensions





Source: b76 Architectura



Sue&til (CH): 53,000m





Source: Implenia AG



Siemens Campus

Siemens AG

Erlangen, Deutschland





Number Buildings Height Total Surface

5 5 Floors

75.500 m²



When





Mid- or High-rise?







Structural Analysis of the Casestudies



- 1) Platform, Post-and-beam, Modular 3D
- Hurmekoski et al., 2017
- 2) Panel Systems, Frame Systems, Hybrid Systems
- Green and Taggart, 2018
- 3) Single Material, Composite, Mixed
- Foster et al, 2017, Wiegand, 2019







Composite Building

timber-steel or

timber-concrete

Single Material Building all timber

Mixee timl

Mixed Building timber-steel or timber-concrete

Structural Categorization

Timber

Concrete

















15)Podium with external bracing











26)Podium, core, and steel bracing



32)Podium and core



Structural Analysis



Timber-concrete (podium)
Timber-concrete
Timber-steel
Timber-concrete-steel



Structural Analysis



Panelised all-timber

Panelised timber-concrete (podium)

Panelised timber-concrete

Panelised timber-steel

Panelised timber-concrete-steel Post-and-beam all-timber Post-and-beam

timber-concrete (podium) Post-and-beam

timber-concrete

Post-and-beam timber-steel

Post-and-beam timber-concrete-steel

Structural Analysis

3D modular element all-timber

3D modular element timber-concrete (podium)

3D modular element timber-concrete

Panelised all-timber

Panelised timber-concrete (podium)

Panelised timber-concrete

Panelised timber-steel

Panelised timber-concrete-steel Post-and-beam all-timber

> Post-and-beam timber-concrete (podium)

Post-and-beam timber-concrete

Post-and-beam timber-steel

Post-and-beam timber-concrete-steel



 $\mathbf{25}$



Total Built Surface (m2) Strucutral system (logo) Structural timber exposure (category) (category) Core (material) Floor Slabs (material) Facade cladding (material) Program (type) Storeys (mumber) Timber Storeys (number) Spain [Junned] (image) Residential 5 CLT 940 Contralaminada 5 Panelised all-timber CLT - Social Plaster Ceiling Housing Panelised Residential Hondarribia 5 timber-concrete 9000 - Social Ceiling CLT CLT Other 4 Visesa VPO (podium) Housing Panelised TT = 5 1200 Residential 5 timber-concrete CLT CLT Metal Ceiling 6 ARV8 (podium) A STREET Panelised Residential La Borda 7 timber-concrete CLT CLT 3000 Wood Ceiling 6 STATE OF THE OWNER (podium) Co-housing Panelised timber-concrete 15 Buenavista 5 4 CLT CLT 409 Residential Wood Walls (podium)



Core







 \mathbf{CLT}

Concrete

 \mathbf{Steel}

Core









CLT

Concrete

Steel



Floor slabs



CLT-Concrete

CLT



CLT-Glulam

Glulam





DLT



Glulam -concrete







NLT




Floor slabs



CLT-Concrete

CLT



CLT-Glulam

Glulam













-concrete





Typology







Timber Exposure







Columns/Beau

Walls



None





Project Clusters



































Slab Edge









TI





Drivers' Analysis

Commission





Motivation





Architects









Engineer (Timber)







UK





Stadthaus

Dalston Lane



Whitmore Road



55 Pitfield



Curtain Palace





106 Lewis Road







Fairmule House

Highpoint Terrace





Birdport House

Hands Building





Cobalt Place Press House





Trafalgar Place Boiler House





Bacton Low Rise

Ellerslie Road

















Norway









Omega Factory



1 I II

Badenerstrasse

Mehr als Wohnen Haus J





Who supplied the timber?



Country or macro-region in which EWPs were produced







F. Floor slabs



n/a

Norway



Conclusions



Europe

Prevalent strucutral system

Both panelised and

post-and-beam

Post-and-beam

3D modular elements

Panelised

Main players

Architect

Engineer

Contractor

Case-study

Client







Other Countries





11/1



Conclusions

- 1) National Differences in the Design of Multi-story Timber Buildings and existence of design Clusters
- 2) Trends: hybrid timber-concrete structures and CLT
- 3) Role of designers, contractors and suppliers is important
- 4) Timber as construction material: Global and Local
- 5) Future: Prefabrication and Made to Measure Assembly





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