Timber construction in the city of Milan

4 residential buildings with 9 storey

All the pictures and renderings: courteously of Arch. Fabrizio Rossi Prodi - Firenze

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Timber buildings for residential area in Milan

The begin of the project: a design competition in 2009

- promoted by Polaris Investments SRI
- with the goal of promoting ongoing experimentation in innovative approaches to social housing management
- calls for the preliminary design of a social housing project supplemented by resident, local and urban services

Winner Arch Fabrizio Rossi Prodi
- innovative technical solution: timber construction - CLT
- CLT construction:
  - high safety of the structure
  - high comfort of the residence
  - high flexibility by the organization of the space
Timber buildings for residential area in Milan

A project under construction - Via Cenni in Milan

**Construction**
- four 9-storeys buildings
- connection buildings as 2-storey buildings

**Final project** - bidding for general contractor
Tekne SpA, Milano
Rossi Prodi e Associati S.r.l., Firenze
Borlini & Zanini SA, Lugano

**Owner - Promoter**
Polaris Investments Italia SGR Spa
- Fondazione Housing Sociale
- Fondo Federale di Lombardia
Investment Fond with a part of public financing
Timber buildings for residential area in Milan

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Residential units
- 124 residences
- 2 to 4 rooms (1 to 3 sleeping rooms - 100/75/50 m$^2$ area)

Others
- some space for urban services
- concierge and administration
- social spaces
- public area and garden

Surfaces
- 9300 m$^2$ gross floor area
- 17000 m$^2$ gross built floor area

Costs*
- 17 Mio. € all inclusive
- rent: 500 to 1000 €/month
- sales: 150'000 to 3000'000 €

* approximately
Timber buildings for residential area in Milan

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Building companies
- Carron Spa
- Servicelegno srl
- lignaconsult
- ETS engineering

Building timetable
- begin excavation: January 2012
- begin timber construction: June 2012
- building time all inclusive: 15 months
- at this time: building program delayed on 3 weeks
- completion expected without delay, according program
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Building site
29.05.2012
Timber buildings for residential area in Milan

The project

9-storey Towers
- 4 similar buildings
- "full" timber construction

2-storey connection buildings
- 4 similar buildings
- timber construction with similar technology to the towers
Multi storey construction on CLT

The load bearing structure on CLT

9 storey, spatial, 3-d CLT-structure
- composed of CLT decks and walls
- full timber construction
- included stairwell and elevator shaft

ca. 27 m

19.1 m

13.6 m
Multi storey construction on CLT

The bearing structure on CLT

9-storey Towers
- 4 similar - not identic - constructions
- "stand alone" constructions
- full CLT timber building

2 storeys connection building
- normal CLT timber construction

Foundation
- one basement store under terrain surface
- concrete
- parking
- technical equipment's
Multi storey construction on CLT

Conditions - Requirements - and Challenges - for project and design

Form and dimensions
- high and slim building - tower
- fascinating und interesting

Earthquake risk
- not very high, but really existing
- important and with high significance by authority and population
- general earthquake engineering rules have to be strictly respected - principle of the structural project
- CLT-timber appropriate for the requirement

High number of storeys - height of the building
- relatively new with timber
- absolutely new on earthquake area

State of the Art
- some experience with similar buildings - but not by earthquake risk and by easier conditions of ratio height/large
- new and innovative, but under applications of actual technology and knowledge
- innovative application of the actual state of the art
Multi storey construction on CLT

Formal requirements

Special authority validation
- examination and approval of the engineering project by a special investigation commission of the national authority
- to assure that timber technology are capable to assure a correct safety level, according the buildings codes and the requirements for building with other material
- the project was evaluated from specialists on building engineers, on earthquake constructions and on high buildings

Timber solutions for engineering constructions
- have "simply" to respect and fulfil the general requirements for similar buildings
- doesn't allow to use the same solutions and details as the "timber houses" with one or two storeys
CLT - solid timber decks and walls

Spatial structural timber construction for high engineer performance

The "revolution" on the timber construction - may be on the construction

CLT: the modern timber material

plane, solid timber surfaces for structural elements
**CLT 9 storey building - via Cenni, Milan**

**Structure composed of CLT-decks and walls**

- **Decks - horizontal structural sheets**
  - intermediate decks
  - horizontal bracing elements
  - main component of the structure

- **Walls - vertical bearing elements**
  - continuous, not interrupted, vertical part of wall needed
  - vertical bracing elements
  - openings are possible, but the wall part above opening are not relevant for the structure
  - other walls - without structural function - are always possible

**Position - axis - of the walls over 9 storeys**

**Dimensions**
- 19.1 m
- 13.6 m
**CLT 9 storey building - via Cenni, Milan**

**CLT-wall elements**

- **Level 1:** Thickness 200 mm
- **Levels 2, 3 and 4:** Thickness 180 mm
- **Levels 5 and 6:** Thickness 160 mm
- **Levels 7 and 8:** Thickness 140 mm
- **Level 9:** Thickness 120 mm

**Characteristics**

- More thickness in the lower storeys
- CLT with not less than 5 layers for better horizontal bracing

**Wall panels interrupted at decks level**

- Because production, transportation and construction
- For better regularity of the structure
- Connections have to be accurately designed
CLT 9 storey building - via Cenni, Milan

Structure composed of CLT-decks and walls

Balcony
- fundamental architecture elements
- variability and flexibility needed

Balcony
- added elements on the spatial structure
- without influence on the regularity of the main structure
- allows to respect and fulfil the requirements of the architecture
- can be open or closed (lateral wall, deck, windows, ...)

Position - axis - of the walls over 9 storeys

Cantilever decks
Cantilever walls
CLT 9 storey building - via Cenni, Milan

CLT-decks elements

- Main direction (outside layers) of the deck
- deck span
- ev. cantilever
- appoggi sulle pareti

Dimensions:
- 13.6 m
- 19.1 m
- 6.70 m

Layers:
- span < 5.80 m: 200 mm - 5 layers
- span < 6.70 m: 230 mm - 7 layers
Connections are the essential structural corposant

Design and construction of "connections lines":
- not just connection points - but a "continuous stitching" to assure high performance in the load transfer
**Example of the connections**

**Special connection for CLT elements with high performance**

Special connection for multi-storey buildings or for important structural requirements

Viti VG f 8; $a = 30^\circ$; $l = \text{ca.} 300 \text{ mm}$

- $s = 100 \text{ mm} = 2 \times 10 / \text{m'}$
- $s = 50 \text{ mm} = 2 \times 20 / \text{m'}$

Viti VG f 8; $a = 45^\circ$; $l = \text{ca.} 450 \text{ mm}$

- $s = 100 \text{ mm} = 2 \times 10 / \text{m'}$
- $s = 50 \text{ mm} = 2 \times 20 / \text{m'}$

**Connection with self-tapping screws**

- high performance on resistance
- high performance on stiffness
- easy in the application
- without steel plates or similar

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Dr. A. Bernasconi  
Milan, 7 June 2012

Promo Legno  
European Wood Network Meeting 2012  
9-storey CLT Building in via Cenni a Milano - page 18
Example of the connections

Special connection for CLT elements with high performance

Connection with self-tapping screws
- high performance on resistance
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CLT 9 storey building - via Cenni, Milan

Example of the connections

Special connection for CLT elements with high performance
Design principle
- generally: timber structure are adequate and interesting
- spatial wall and decks structure are adequate
- CLT-structure are very good qualified

Essential conditions
- right concept for the structure
- application of the basic of earthquake engineering
- correctly designed

In case of higher seismic risk
- the concept (design of structure and connection) can be applied for higher performance or for higher seismic risk - and seismic load conditions
Numerical modelling and calculation

Static structural analysis
- confirmation internal forces
  $M_x, M_y, V_x, V_y, N_x, N_y, N_{xy}$
- forces on connections

Dynamic analysis
- resonance frequencies
- earthquake analysis

Parametric numerical analysis
- stiffness of connections $K_{ser}$
- sensibility of the modelling

Modelling
- high performance software required
- user interfaces not optimized for this kind of systems
CLT 9 storey building - via Cenni, Milan

Principle of the fire protection

Requirement
- Fire compartments: REI60
- Other structural elements: R60

Realisation: full protection of the timber by fire resistant sheeting
- sheeting EI60 of all structural timber elements
- some other singular prescription

Decks:
- upper surface: sheeting EI60
- lower surface:
  floor construction EI60
- fire safety REI 60 given also by branding time of CLT

Internal walls:
- sheeting on both sides EI60

External walls:
- internal sheeting EI60
Remarks about fire protection - possible discussion points

Principle of fire protection: fire resistant sheeting to obtain EI60
- sheeting should be so near as possible to the protected element (CLT wall)
- space between protected element and protection = risks and problems ...

Special solution required
- protection of sheeting perforations
- later interventions by residents not under control

Safer solution
- timber directly protected
- installations not relevant for fire protection

Installations inside of fire-protected space
Installations outside of fire-protected space
Applied solutions for the building via Cenni, Milan

Modern and innovative solutions - but already applied in recent buildings

Bellinzona - CH - 2010 - Arch. D. Caramma

Lugano - CH - 2011 - Arch. M. Marzi
Timber buildings for residential area in Milan

Conclusions

New and ambitious project, but according to
- the actual timber engineering knowledge
- the actual state of the art on timber construction
- multi storey building rules in earthquake area

Full timber construction
- spatial, 9 storey CLT structure
- first time in earthquake area
Timber buildings for residential area in Milan

Conclusions

Interesting example of the State of the art
- CLT for ambitious engineering constructions
- a new way for urban and multi storey buildings
- timber engineering for modern architecture
- CLT engineering for architecture