



Berner Fachhochschule
Architektur, Holz und Bau
Burgdorf, Biel

Structural Design for Energy Efficient Multi-Storey Timber Houses

- State of the Art in Europe

Andreas Müller

Professor in Timber Construction

Head R+D Timber and Composite Construction





Multi-storey log construction, CH-Valley



Multi-storey timber frame construction, De-Hildesheim



4-storey-building

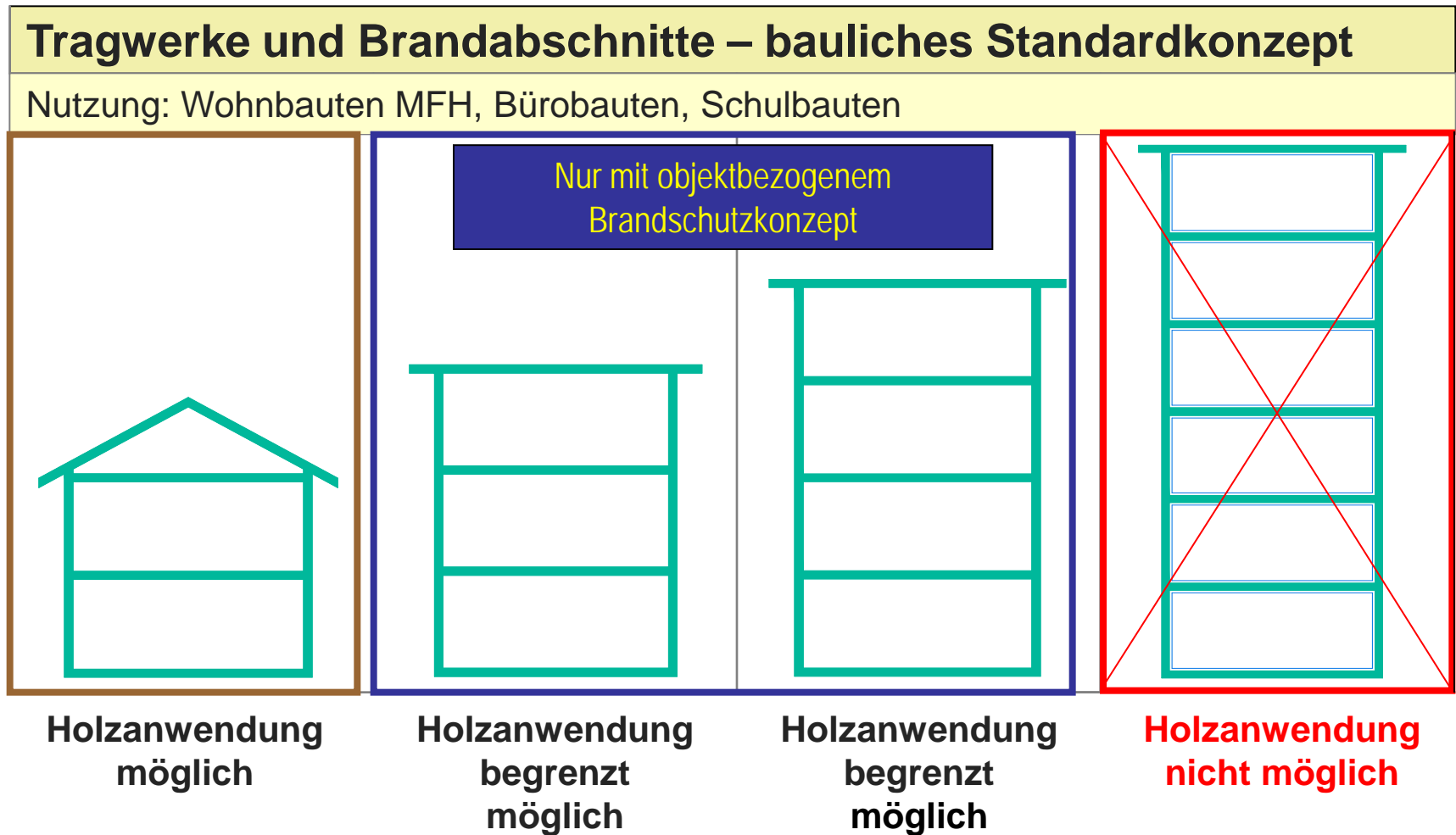
Bern University of Applied Sciences, Biel



Marcel Meili, Markus Peter, Architekten Zürich, constructed between 1996 and 1998



Fire protection regulations (before 2005)



Built up as a prototype

**1990-1991 competition of architecture
with the requirement of interdisciplinarity**

Team architects and civil engineers

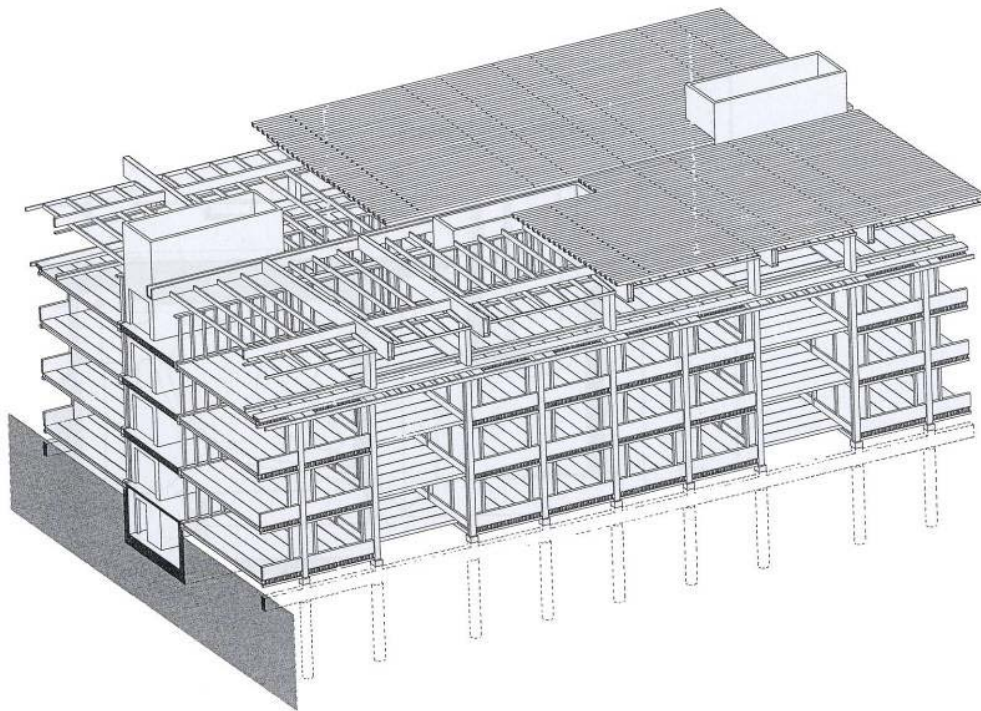
**Meili + Peter Architekten, Zürich +
Branger, Conzett & Partner AG, Chur**

**1991-1992 Special Competition
for the ceiling system
Civil engineer + producer**

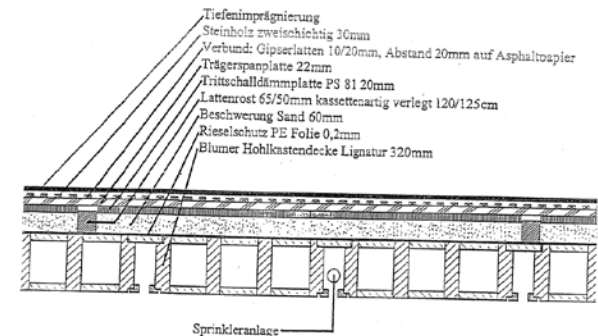
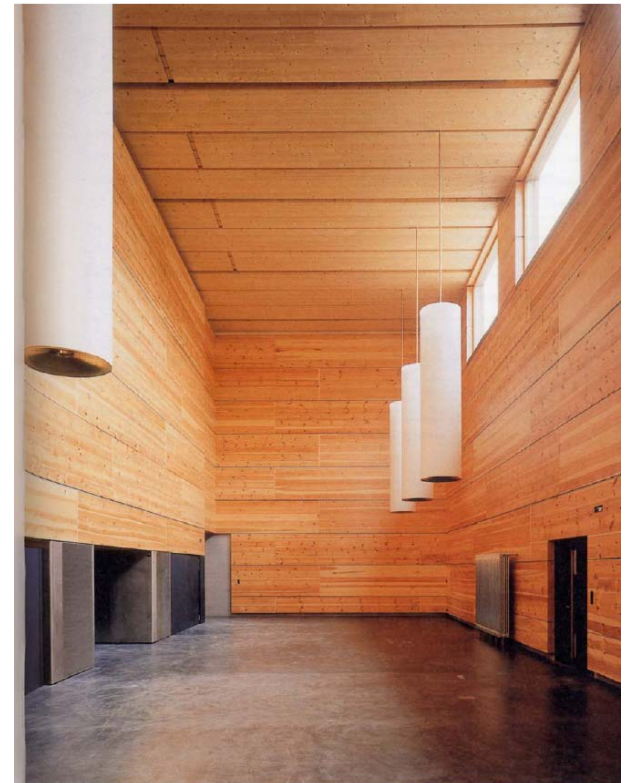
**Decision for the hollow box system
lignatur**



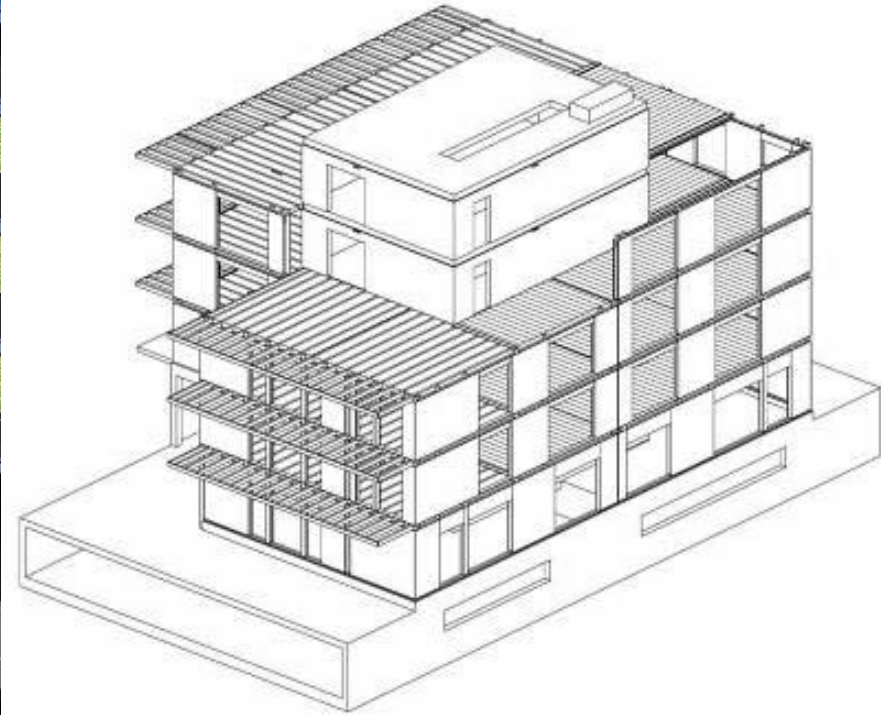
Individual fire protection concept



- Sprinkler, stairways and corridors in reinforced concrete
- Load bearing timber-structure REI 30



5-storey-building in Zürich



Fünfgeschossiger Holzbau am Hegianwandweg, Zürich 2002-2003

Architekten: EM2N Architekten, Zürich

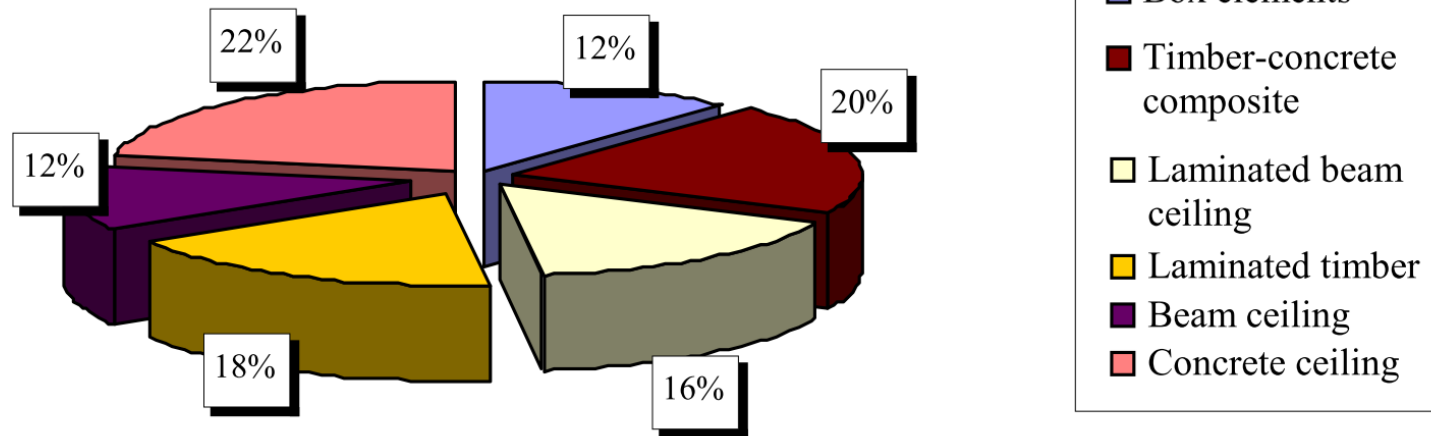
**Holzingenieure: Pirmin Jung, Rain
Makiol + Wiederkehr, Beinwil am See**



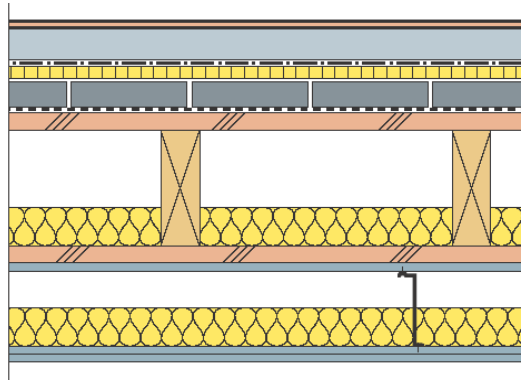
Constructive requirements for multi-storey-buildings

Ceiling systems in multi-story timber buildings

Usage in Switzerland for residential buildings with three or more stories

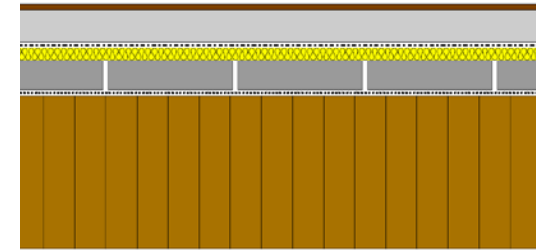


Constructive requirements for multi-storey-buildings



Beam /Box construction

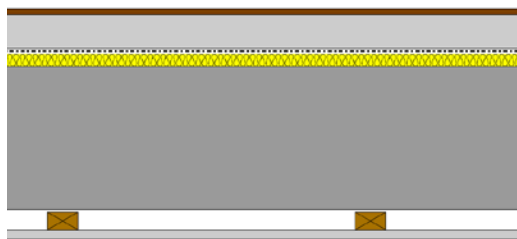
Ceiling systems



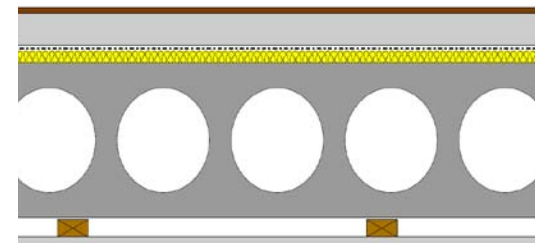
Solid wood



Timber-concrete deck



Concrete deck

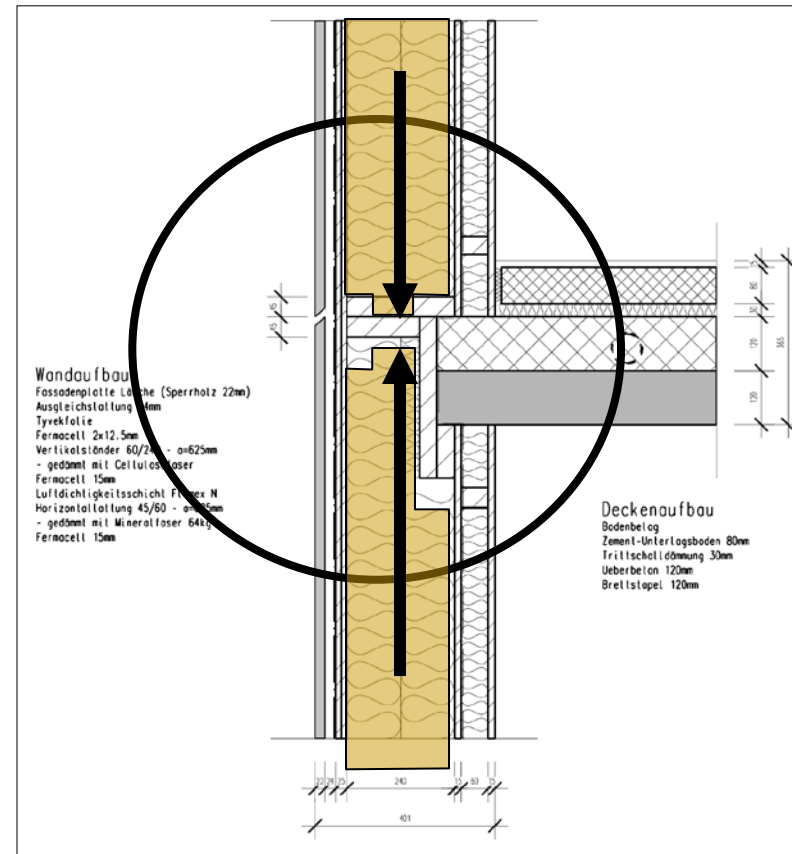
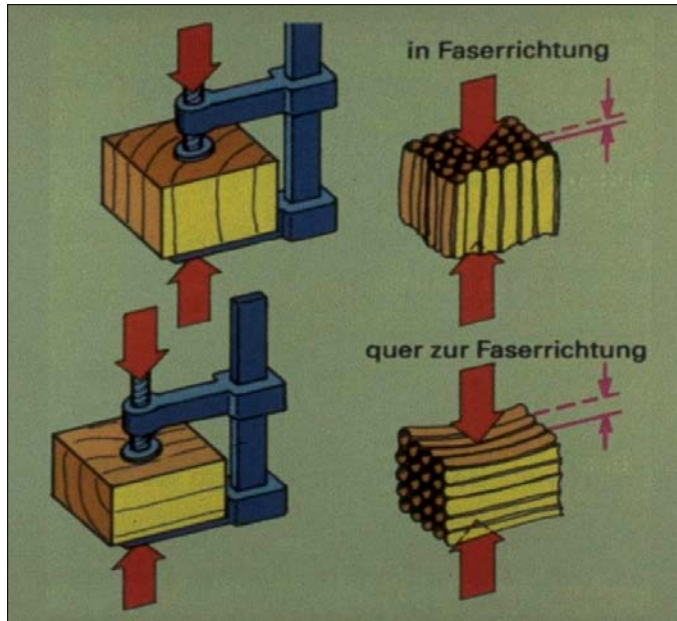


Prestressed concrete deck



Constructive requirements for multi-storey-buildings

- ! No pressure perpendicular to the grain !



Constructive requirements for multi-storey-buildings

!! Horizontal loads (Wind / Earthquake)

Concepts:

Bracing walls and staircase in combination with bracing ceilings

- stiffness of the construction (floors, walls)
- center of stiffness
- Anchoring forces

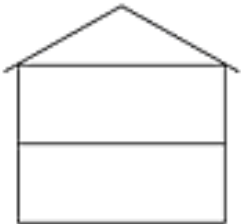
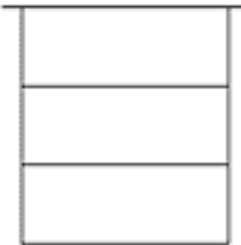
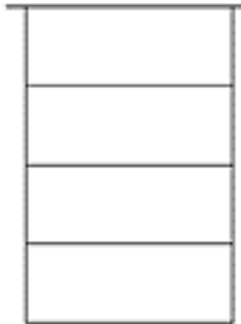
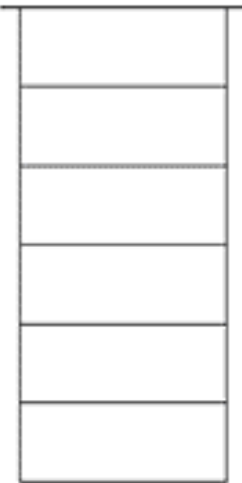
Design of joints:

- transfer of compressive and tensile force
- exact assembly
- easy and fast use on-site



Constructive requirements for multi-storey-buildings

Fire safety, a relevant issue

Nutzung: Wohnbauten MFH, Bürobauten, Schulbauten			
			
Bis 2004	Ab 2005		
F 30 bb	REI 30	REI 60	REI 60/EI 30 (nbb)
Holzanzwendung	Holzanzwendung	Holzanzwendung Dämmung nbb	Holzanzwendung, nbb verkleidet
VKF Norm 1993	Schweizerische Brandschutzvorschriften VKF 2003		



6-storey-building in CH-Steinhausen



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*Architekturbüro Scheitlin_Syfrig + Partner
Architekten AG, Luzern*

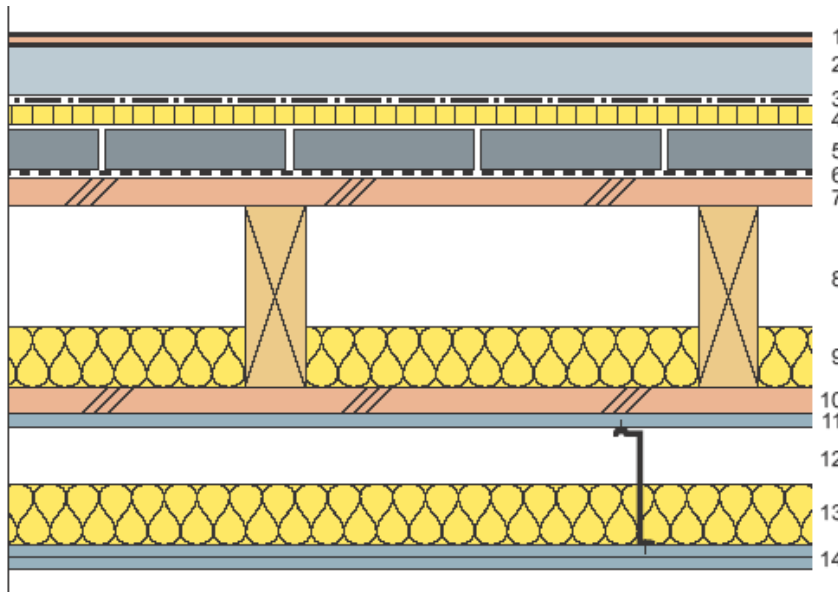
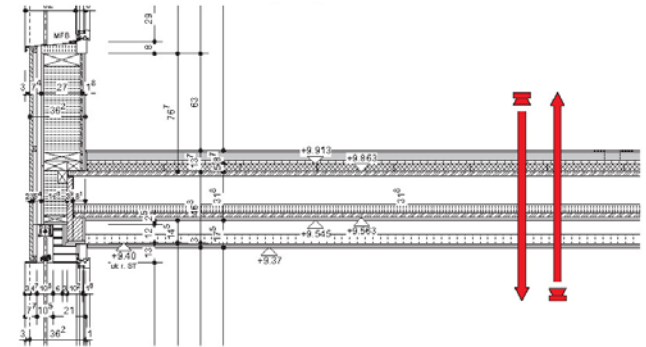


Constructive requirements for multi-storey-buildings

Sound insulation

Requirements of SIA standard 181
(sound insulation) are achieved or exceeded

- impact sound
- airborne sound

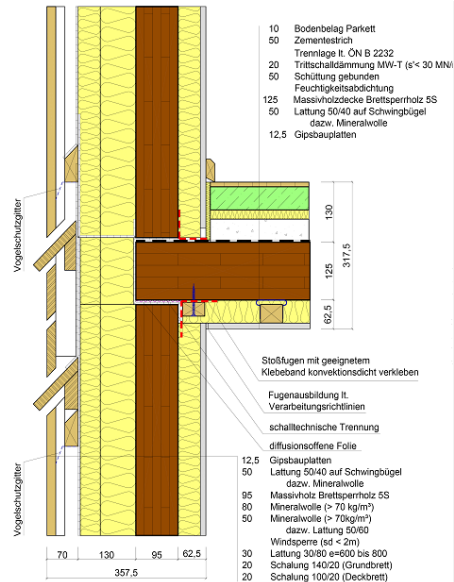
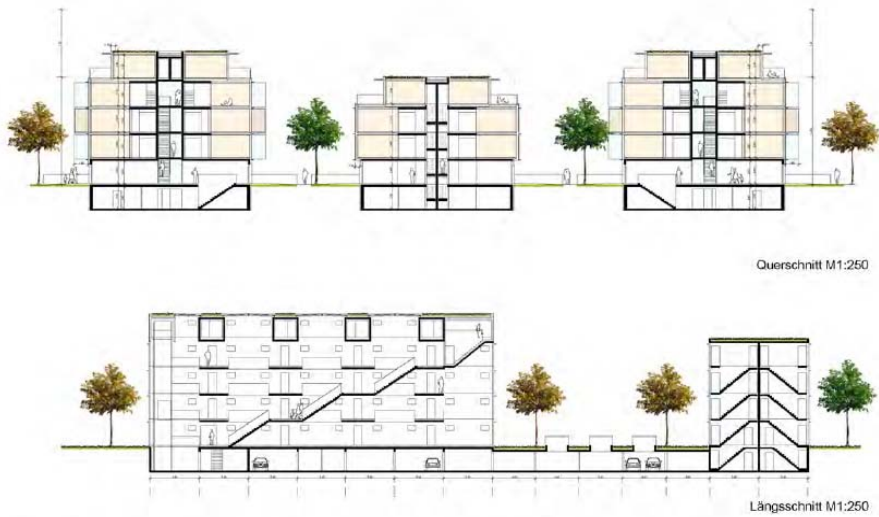


Example of a ceiling

- 1 variable decking
- 2 Anhydrite screed 55 mm
- 3 Dividing layer
- 4 Impact sound insulation board 20 mm
- 5 Concrete plates 50 mm
- 6 Fleece
- 7 OSB 30 mm
- 8 Timber beam 80 mm x 240 mm (e = 600 mm)
- 9 Mineral wool bat 60 mm
- 10 OSB 30 mm
- 11 Plasterboard 18 mm
- 12 Suspended ceiling, Installation space 90 mm
- 13 Mineral wool bat 60 mm
- 14 Plasterboard 25 mm



5-storey-building in Wien, Mühlweg



8-storey-building in London

Standort [Murray Grove](#),
London N1/UK

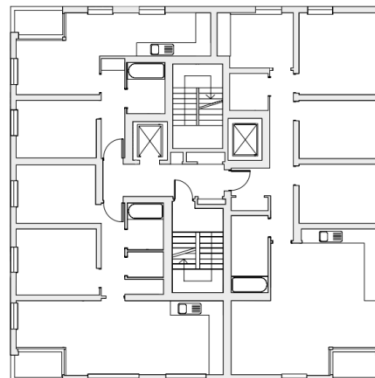
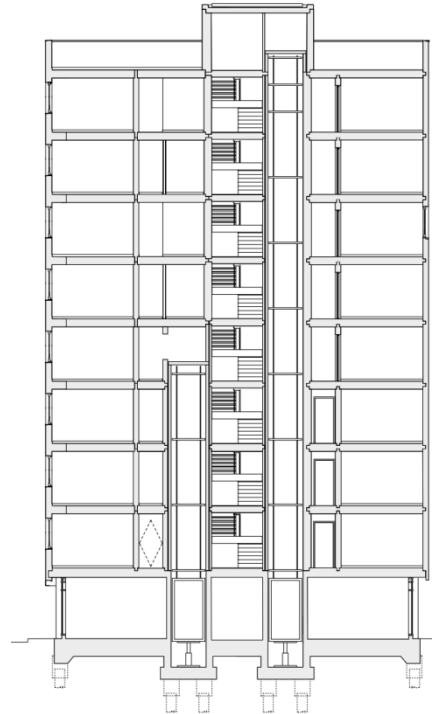
Planung
Waugh Thistleton
Architects, London/UK

Auftraggeber
Telford Homes Plc,
London/UK

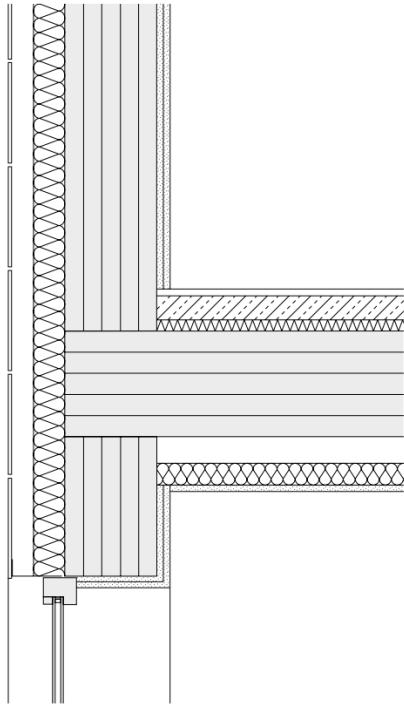
Statik
Techniker Ltd., London/UK

Holzbau
klh UK Ltd.

Fertigstellung Oktober 2008



8-storey-building in London



Wandaufbau

Faserzementplatten
Hinterlüftung 50 mm
Wärmedämmung 70 mm
Brettsper Holz 128 mm
Gipskartonplatten 2 Lagen

Bodenaufbau

Bodenbelag 15 mm
Estrich 55 mm
Trittschalldämmung 25 mm
Gummimatte
Brettsper Holz 146 mm
Abhängekonstruktion:
Lufthohlraum 75 mm
Mineralwolle 50 mm
Gipskartonplatte

Load bearing structure:

Cross laminated timber elements
within the staircases



Fotos:
© Sissi Slotover-Smutny, Kurt Zweifel



7-storey-building in Berlin, Esmarchstrasse 3



Completion Date May 2008

Client: Baugruppe e3 Gbr

Architects: Kaden Klingbeil Berlin



7-storey-building in Berlin, Esmarchstrasse 3

- **Characteristics:**
 - 7 storeys (Berlin's regulation allowed for 5...)
 - High degree of prefabrication
 - Great freedom in the floor plan
- **Specific solutions had to be developed regarding actual codes**

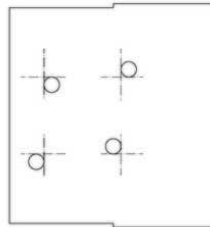


7-storey-building in Berlin, Esmarchstrasse 3

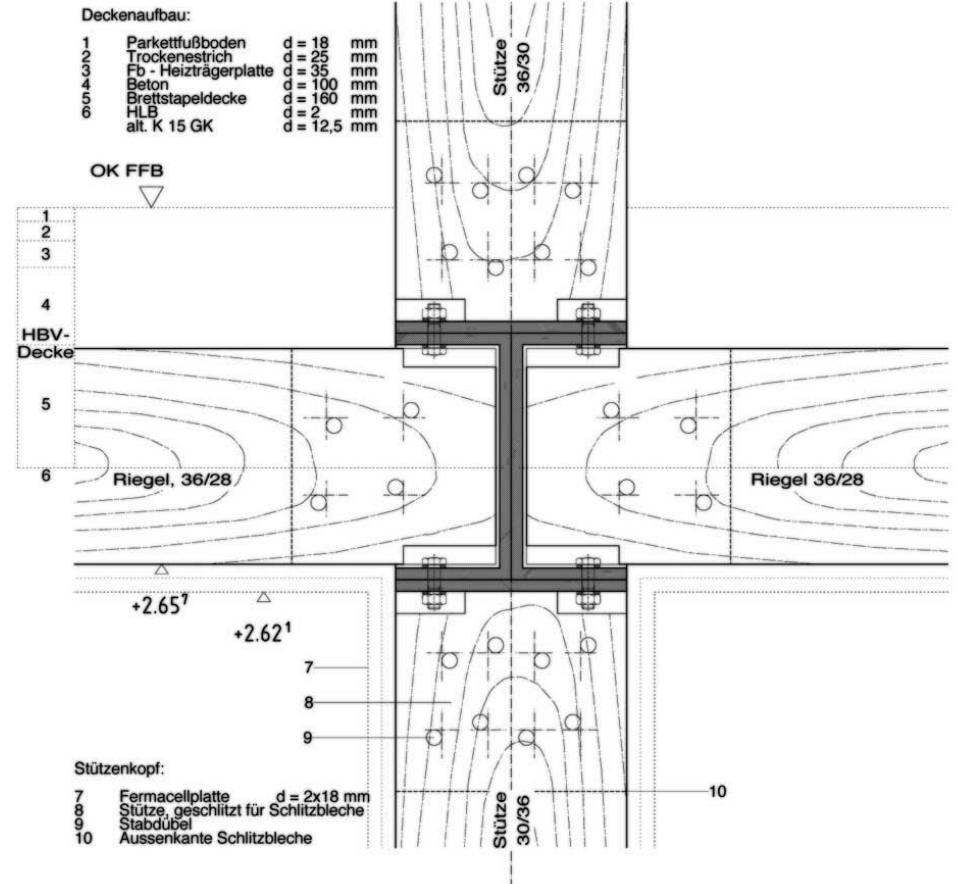
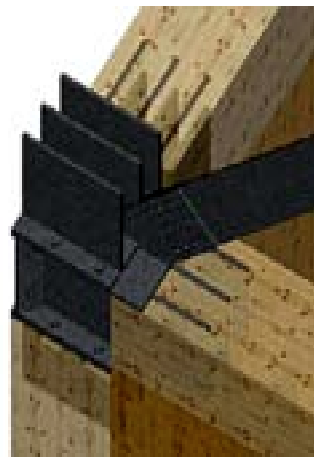
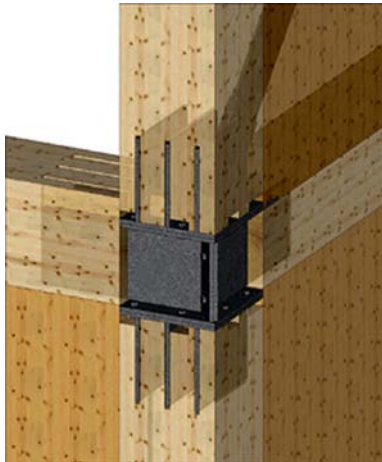


Systemskizze
Riegelschlitzbleche

Ausrüstung für die
Betonplatte der
HBV-Decke



Ausrüstung für die
Brandschutzbekleidung



7-storey-building in Basel



Place:

Jacob-Burckhardt-Haus 2-12, 4052 Basel

Source: Lignum CH

Architects:

**Brigitte Kowanz, Wien; Gun Gordillo, Kopenhagen;
Claude Lévêque, Montreuil; Anna Amadio, Basel**

Timber engineer:

Erne AG, Laufenburg

Façade engineer:

**Walther Mory Maler Bauingenieure AG, Basel and
Schlaich, Bergemann & Partner, Stuttgart**

Façade construction:

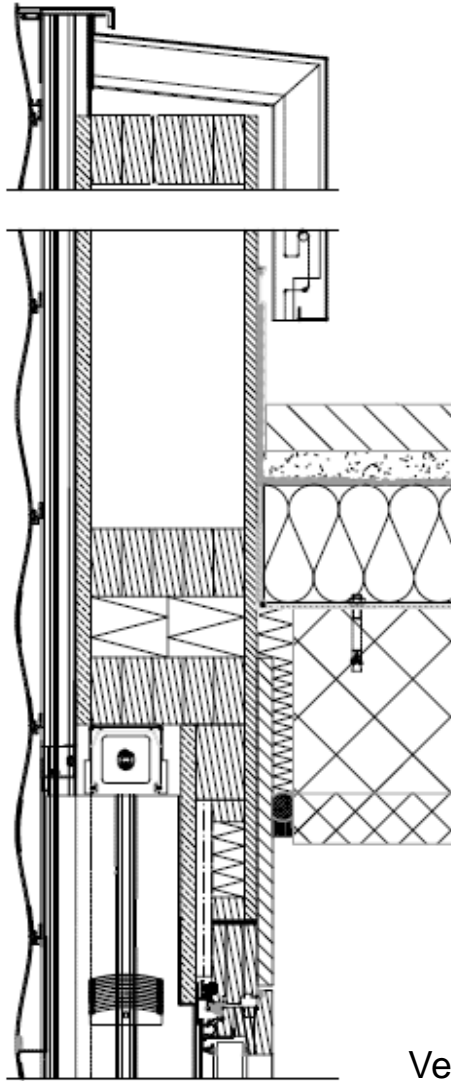
**ARGE Erne AG, Laufenburg and Gerber-Vogt AG,
Allschwil**

Construction time:

2003-2007



7-storey-building in Basel



Construction outer wall (inside to outside) :

- medium-hard wood fibre slab 19mm, with finish coat
- OSB 15mm
- beam construction 60x180mm
- insulation cellulose fibre
- fibrous plaster panel 18mm
- aluminium façade construction, façade venting 40mm

Vertical section: façade



Conclusion

- Modern multi-storey timber buildings fulfill the requirements of the future with high quality and low energy consumption
- To improve the economic competitiveness of timber buildings is necessary



Monte Rosa Hütte, 2883 müM,

