‘NEARLY’ HIGH-RISE TIMBER BUILDINGS IN GERMANY - PROJECT, EXPERIENCES AND FURTHER DEVELOPMENT

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ABSTRACT: Since 2008 a number of ‘nearly’ high-rise multi-storey timber projects in Germany were realised up to eight storeys. As they are ‘outside’ of building regulations, exceptions in the area of fire regulations were necessary. To enable approvals and to avoid non-controllable cavity fires, massive timber (CLT, Glulam) or massive-timber/concrete hybrid constructions were chosen. Staircases are built in concrete, which requires special investigations to limit the vertical deformation of the timber structure. Facades are made out of a mineral-wool based ETIC, in other cases timber claddings are applied. New projects will use also massive-timber staircase and elevator shaft. Experience demonstrates that the structural and fire design is a minor problem, but moisture safety requires more alertness. For wider application further development of regulations and improvement of economic solutions are necessary.

KEYWORDS: high timber buildings, construction, fire safety, moisture rise, building regulations, further development

1 INTRODUCTION

Typically high-rise buildings start with a height of 22 – 23 m of uppermost ceiling above mean ground level, adequate to more than eight storeys. According to most of the building regulations only non-combustible materials and structures are allowed above this limit. As timber structures recapture urban environment, also in Germany a number of ‘nearly’ high-rise, multi-storey timber buildings were built up to eight storeys and a number of projects are under development. Even these buildings are not covered by the actual building regulations, as mainly due to fire safety, regulations cover only five storey timber buildings (since year 2000). Therefore there was only a very reduced experience with more than three storey timber buildings in practice and up to now exceptions from regulations must be obtained. The article describes the actual chosen structural solutions, e.g. to minimize vertical and horizontal displacements, the special fire safety concepts and experiences with planning teams, prefabrication and site work. In addition the increasing necessity for special investigations in moisture safety are discussed, as with the increasing altitude e.g. the driving rain intensity is drastically increasing. In the examples discussed the author was involved with his office as design or check engineer.

2 PROJECTS

2.1 STRUCTURES

For vertical load distribution skeleton structures and massive timber structures are used. Timber frame structures are mainly used as non-load bearing exterior walls. Where skeleton structures require additional structures to resist horizontal loads (often out of steel), massive timber like CLT is able to carry loads in both directions. Special investigations are necessary to anchor the resulting vertical lifting loads. Solutions are presented in full paper. A typical, load bearing exterior structure is given in figure 1.

As up to now reinforced concrete staircases are used as escape routes they are used as additional horizontal load bearing structures.

Figure 1: Cross section of encased and highly insulated massive timber structure, used e.g. at H8, see figure 2
2.2 BUILDING PHYSICS

Most of the ‘nearly high-rise’ building projects are build at the same time as ‘nearly passive-house’ buildings. All of them are very energy-efficient, the heat energy consumption is around 25 kWh/m²a. The very good floor area/building envelope ratio in combination with insulation layers of 250-350 mm thicknesses help to meet high requirements. Excellent airtightness values are self evident, as well as noise insulation on highest level. Details will be presented in the full paper. Up to now no problems occurred in the realised buildings. But especially moisture safety is crucial, as impact of driving rain increases exponential with height of the buildings.

3.2 ESCAPE ROUTES

Up to now staircases are built in reinforced concrete, to meet REI 90–A requirement. But mix of construction causes problems, e.g. differences of structural settlement. Solutions are presented in full paper.

3.3 FACADES

Most of the projects used mineral wool based ETIC’s, but e.g. H8 (fig. 2) used from floor 2 timber claddings. Special constructions are used, to enable combustible façade material.

4 FURTHER DEVELOPMENT

4.1 MOISTURE SAFETY

As wood is a natural material we have to be extremely careful to avoid any decay by moisture and following fungi. Therefore ‘safety concepts’ are necessary to avoid any destruction of construction by moisture, see fig. 3.

4.2 FIRE SAFETY

Fire safety is a minor problem! REI 90 structures in timber are ‘state of the art’ and in future we will be able to proof, that timber buildings also survive a full fire without fire fighting, if we use adapted structures, like slightly upgraded CLT. Examples are given in full paper. A first project with CLT based staircases is under development and is presented in full paper.

4.3 BUILDING REGULATIONS

Building regulations should follow the ‘built reality’. In Germany new parts of regulations are under discussion, some remarks to this difficult process are included in full paper.

5 CONCLUSIONS

Timber buildings at the borderline to high-rise buildings are good training subjects before crossing to real high-rise buildings. Fire safety and structural design will be not the main restrictions but adequate moisture safety from outside (driving rain) and sometimes from inside (sprinklers) has to be observed more consequently in future! In addition based on prefabrication timber buildings offers an industrial quality, which should be further developed as a unique selling point. And this needs further education on all levels! As in many of the actual projects hybrid structures (concrete, steel, timber) are used, it figured out that mainly the harmonization of the building cultures of the different materials needs further development!