Multi-storey timber construction in the UK

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Scope - Inhalt

- Timber construction UK: Some figures
- UK market and its drivers: Applications
- Multi-storey and UK regulation
- Importance of validation
- Case study: Murray Grove
Timber Frame shares
Main drivers for timber construction

- Environmental as well as technical considerations
- Sustainable construction “carbon neutral”
- Shortage of residential living space
- Speed of erection: Offsite construction
- Construction sector specifics
  - Ownership models
  - Skills
Timber uses and its credentials

Rated construction materials for
- External walls
- Windows
- Roof
- Floors
- Linings
### Brief history of timber frame in UK

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1920</td>
<td>Introduction to UK from Sweden</td>
</tr>
<tr>
<td>Late 1930s</td>
<td>UK trials in Scotland</td>
</tr>
<tr>
<td>By 1940</td>
<td>Over 3000 houses built</td>
</tr>
<tr>
<td>WW 2</td>
<td>Delayed its wider use</td>
</tr>
<tr>
<td>1963</td>
<td>Canadian housing practice was adopted by UK</td>
</tr>
<tr>
<td>1963-1973</td>
<td>Further developments to suit UK practice and conditions</td>
</tr>
<tr>
<td>1973-1984</td>
<td>Market saw a boom in public &amp; private sector</td>
</tr>
<tr>
<td>1984</td>
<td>World in Action TV Programme</td>
</tr>
<tr>
<td>1996</td>
<td>TF2000</td>
</tr>
<tr>
<td>Since 1998</td>
<td>Gradual increase in the market: 2, 3, 4, 5 storeys for houses / flats / hotels</td>
</tr>
<tr>
<td>2000 onwards</td>
<td>6 storeys, large span structures, alternative timber structures (up to 8 storeys)</td>
</tr>
</tbody>
</table>
Multi-storey timber construction
UK regulatory requirements: Example

- Distance to neighbouring property
- Number of windows
- Roof coverings
- Materials on external surface
  - Cladding
  - Insulation
  - Cavity barriers

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<table>
<thead>
<tr>
<th>Requirement</th>
<th>Limits on application</th>
</tr>
</thead>
<tbody>
<tr>
<td>External fire spread</td>
<td></td>
</tr>
<tr>
<td>B4. (1) The external walls of the building shall</td>
<td></td>
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<tr>
<td>adequately resist the spread of fire over the</td>
<td></td>
</tr>
<tr>
<td>walls and from one building to another, having</td>
<td></td>
</tr>
<tr>
<td>regard to the height, use and position of the</td>
<td></td>
</tr>
<tr>
<td>building.</td>
<td></td>
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<tr>
<td>(2) The roof of the building shall adequately</td>
<td></td>
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<tr>
<td>resist the spread of fire over the roof and</td>
<td></td>
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<tr>
<td>from one building to another, having regard to</td>
<td></td>
</tr>
<tr>
<td>the use and position of the building.</td>
<td></td>
</tr>
</tbody>
</table>

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**KEY TO EXTERNAL WALL SURFACE CLASSIFICATION**

- Relevant boundary
- No provision in respect of the boundaries indicated
- Class 0 (national class) or class B+c3, d2 or better (European class)
- Profiled or flat steel sheet at least 0.5mm thick with an organic coating of no more than 0.2mm thickness is also acceptable
- Index (I) not more than 20 (national class) or class C=s3, d2 or better (European class).
- Timber cladding at least 9mm thick is also acceptable.
- (The index relates to tests specified in B3 470-0)
# UK Timber construction: Requirements

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of storeys</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1920</td>
<td>1-3</td>
<td>General, no special consideration</td>
</tr>
<tr>
<td>1988</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>5</td>
<td>A- Disproportionate collapse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B- Fire</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C- Differential movement</td>
</tr>
<tr>
<td>To date</td>
<td>6, 7 and 8*</td>
<td></td>
</tr>
</tbody>
</table>

* Cross laminated timber, solid construction rather than timber frame
Requirements and concepts

• **Structure**
  – Vertical load capacity
  – Disproportionate collapse
  – Differential movement: Moisture, creep
  – Racking

• **Fire performance**

• **Durability=moisture control**

• **Acoustics**

• **Thermal/ Airtightness**

• **Quality: Manufacture, erection**

• **PERCEPTION:** Fires during construction have been damaging
Building in timber: Interaction of Regulation, Insurance and Certification

- Building Regulations: Approved Documents, Parts A-P
- Performance function-based Structure, Fire, Acoustic, Durability, Thermal, Environmental
- Insurance can override Building Regulations: Main insurers- NHBC and Zurich- technical manuals
- Certification of innovative products
The importance of validation - TF 2000
Key research areas- Forschungsfelder

• Covering the main difference between 1-5 storeys construction
  – Construction process
  – Stability and overturning
  – Differential movement
  – Progressive collapse
  – Lift and stair shafts
  – Acoustics
  – Fire performance
  – Brickwork shielding effect
  – Types of materials and composition
  – Earthquake performance
An example for functional regulatory guidance: Escape stairs

If fire is in the stair, the staircase

- **must retain** its load bearing capacity
- **must not contribute** significantly to the fire development
Safety goals

• Provide life safety in buildings
• Safe escape for occupants
• Escape routes must remain unaffected by fire and smoke, egress to place of safety
• Access for fire fighters: Rescue and fire control, fight in place

Timber is combustible, ignites, spreads flames, generates smoke. In many countries this excludes timber from applications in escape routes.
Proven performance- effective communication
Impact of TF 2000 on UK regulations

- Harmonisation of UK regulations
- Changes to Scottish technical standards-
- Removal of non-combustibility requirement for separating floors between 11m and 18m
- Possible use of timber in escape areas
- Best practice guidance for industry, designers, insurers and users
STADTHAUS, MURRAY GROVE

17m height, 29 apartments, CLT, UK engineer and developer, Austrian supplier, completed 2009
Main validation points

1- Structural Design
   Detailing for disproportionate collapse
   Racking: In-plane stability
   Differential movement (moisture/creep),

2- Durability: Through life performance and user guidance

3- Fire performance
Structure- ADA

- **Disproportionate collapse:** The building shall be constructed so that in the event of an accident the building will not suffer collapse to an extent disproportionate to the cause.

<table>
<thead>
<tr>
<th>Table 11</th>
<th>Building Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Class</strong></td>
<td><strong>Building Type and Occupancy</strong></td>
</tr>
</tbody>
</table>
| 1 | Houses not exceeding 4 storeys.  
Agricultural buildings  
Buildings into which people rarely go, provided no part of the building is closer to another building, or area where people do go, than a distance of 1.5 times the building height |
| 2A | 5 storey single occupancy houses  
Hotels not exceeding 4 storeys  
Flats, apartments and other residential buildings not exceeding 4 storeys  
Offices not exceeding 4 storeys  
Industrial buildings not exceeding 3 storeys  
Retailing premises not exceeding 3 storeys of less than 2000m² floor area in each storey  
Single storey educational buildings  
All buildings not exceeding 2 storeys to which members of the public are admitted and which contain floor areas not exceeding 2000m² at each storey |
| 2B | Hotels, flats, apartments and other residential buildings greater than 4 storeys but not exceeding 15 storeys  
Educational buildings greater than 1 storey but not exceeding 15 storeys  
Retailing premises greater than 3 storeys but not exceeding 15 storeys  
Hospitals not exceeding 3 storeys  
Offices greater than 4 storeys but not exceeding 15 storeys  
All buildings to which members of the public are admitted which contain floor areas exceeding 2000m² but less than 5000m² at each storey  
Car parking not exceeding 6 storeys |
Murray Grove: Structural detailing
Murray Grove: Differential movement

- Total differential movement of building* 3.3mm

* Quote KLH
Durability - Dauerhaftigkeit

- Big difference in UK
- Brief section in EN1995
  - Hazard classes in EN335
  - Preservative treatment in accordance with EN351 and EN 460
  - Fixings (higher level of protective coating required)
- More guidance in BS: Need, options, reducing risk - more conservative
- Generally 60 years
Murray Grove - Durability

- Production control
- Transportation
- Installation and erection
- Training
- Durability guidelines
- Technical quality of the product
- Condensation risk

- Moisture ingress inside and outside, during manufacture
- Need for preservative treatment
- Cavity construction
- Climate differences
Design for durability

• Transport to and on-site exposure controlled
• Detailing: Quality controlled products - through life maintenance
• Interaction during build process
• Liability
Murray Grove- Fire concept- Brandschutz Nachweis

- Residual cross section method
  - EN 1995-1-2
  - BS 5268- 4

- Charring rates for material determined by testing

- Charring rates provided by third party notified body and independently certified

- No sprinkler required- only when building >30m
Murray Grove - Feuerwiderstandszeiten
Sustained growth through innovation

supported by careful monitoring, analysis of failures and regular adjustment of best practice
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