Design of external timber cladding
to the BS 8605 series

Dr Ivor Davies

Wood Knowledge Wales, 28/11/17
External timber cladding
Part 1: Method of specifying

BS 8605-1: 2014

Moisture content
Durability
Species
Grade
Geometrical characteristics
Warp
Fixing resistance
Dimensional stability
Reaction to fire

Etc.
External timber cladding
Part 2: Code of practice for design and installation

BS 8605-2: 201X

BSI Standards Publication

Appearance
Environment
Durability
Robustness
Fire
Safety
Noise
Energy
Sustainability
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Moisture content of external timber cladding

Mean: 16 to 18%

Range: 10% up to the fibre saturation point for the species

MC specification in BS 8605-1: (16 ±4)%

[6]
Types of external wall

- Massive wall
- Face sealed wall
- Screened & drained wall
- Siding
- Rainscreen
Timber rainscreen cladding

Open jointed

Closed jointed
Timber rainscreen cladding

Framed substrate

Masonry substrate
Timber rainscreen cladding

Rigid insulation

Flexible insulation within a frame
Timber rainscreen cladding

**Interior functional layers**
- Room lining
- Services void (optional)
- Air & vapour control layer

**Core**

**Exterior functional layers**
- Timber cladding
- Cavity (drained & ventilated)
- Breather layer

**Wet zone**
Timber rainscreen cladding

Minimum gap?
Splashzone: ≥ 200 mm

Drainage gap at cavity base: ≥ 10 mm

Ventilation gap within cavity & at cavity head: ≥ 5 mm
Avoid water traps
Seal between breather layer and window
Appearance
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Durability
If wetting is persistent, ensure timber is decay resistant, taking account of cost of failure & ease of replacement

Deflection
Minimize wetting

Drainage
Allow rainwater to escape

Drying
Ventilation for drying
<table>
<thead>
<tr>
<th>Natural durability classes (fungi)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Very durable</td>
</tr>
<tr>
<td><strong>Jarrah</strong></td>
</tr>
</tbody>
</table>

[9]
## Use classes

<table>
<thead>
<tr>
<th>Use class</th>
<th>Moisture condition</th>
<th>Wood destroying organisms in UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dry interior</td>
<td>Minor beetle risk</td>
</tr>
<tr>
<td>2</td>
<td>Damp interior</td>
<td>Dry rot + beetles</td>
</tr>
<tr>
<td>3</td>
<td>Exterior out of ground contact</td>
<td>Wet rot + beetles</td>
</tr>
<tr>
<td>4</td>
<td>In ground contact or fresh water</td>
<td>Soft rot + beetles</td>
</tr>
<tr>
<td>5</td>
<td>In sea water</td>
<td>Marine borers</td>
</tr>
</tbody>
</table>

[16]
Use class 3

3.1 Occasionally wet
3.2 Frequently wet

Use class 5
<table>
<thead>
<tr>
<th>Use class</th>
<th>Natural durability class (fungi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

- **Blue**: Natural durability always sufficient
- **Green**: Natural durability usually sufficient
- **Yellow**: Natural durability probably insufficient, but...
- **Orange**: Preservative treatment usually needed
- **Red**: Preservative treatment essential

**Matching natural durability to use class**  BS EN 460

[17]
## Matching natural durability to use class

<table>
<thead>
<tr>
<th>Use class</th>
<th>Natural durability class (fungi)</th>
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<tbody>
<tr>
<td>1</td>
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</tr>
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<td>2</td>
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</tr>
<tr>
<td>3</td>
<td>3</td>
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<tr>
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</table>

- **Blue**: Natural durability always sufficient
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- **Yellow**: Natural durability probably insufficient, but…

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**BS EN 460**
Options for increasing biodeterioration resistance

**Wood preservation**

Specify to BS 8417

**Chemical modification**

Modified wood is specified in a similar way to naturally durable timber

**Thermal modification**
Appearance
Environment
Durability
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Structural design of cladding should address:

1. Imposed loads from the cladding onto the wall
2. Self-weight of the cladding
3. Attachment of cladding to the wall
4. Movements and tolerances
Structural design of cladding should address:

1. Imposed loads from the cladding onto the wall
2. Self-weight of the cladding
3. Attachment of cladding to the wall
4. Movements and tolerances

With lightweight cladding, these are usually the responsibility of the cladding designer.
1. Imposed loads from the cladding onto the wall

2. Self-weight of the cladding

3. Attachment of cladding to the wall

4. Movements and tolerances
External timber cladding is a semi-structural application and is therefore within the scope of the Eurocodes:

- **Basis of design:** Eurocode 0
- **Wind loads:** Eurocode 1
- **Timber connections:** Eurocode 5
Rule of thumb guidance: ‘a smooth nail should penetrate the support by 2½ times the board thickness & an improved nail should penetrate by twice the board thickness’

This is not in accordance with Eurocode 5
Boundary conditions

Aim:

Peak wind loads < 2.5 kN/m²

Minimize lateral loads
Boundary conditions

Aim:

Peak wind loads < 2.5 kN/m²

Minimize lateral loads

Low risk: < 1.5 kN/m²
Medium risk: 1.5 to < 2.5 kN/m²
Boundary conditions

Aim:
Peak wind loads < 2.5 kN/m²
Minimize lateral loads
Design for robustness

- Full design to Eurocode 5

- Redesign or get advice
  - Yes: Conceptual design
  - No: Conditions met?
    - Yes: Determine wind load
    - No: Wind load <2.5 kN/m²?
      - Yes: Design 1st batten layer
      - No: Design 2nd batten layer?
        - Yes: Design 2nd batten layer
        - No: Design cladding

- Design for robustness
Connections: vertical batten to stud
Use ring shank nails or screws

Pointside penetration

Ring shank nails:
Diameter $d = 2.1$ to $6$ mm
Pointside penetration of threaded part $\geq 8d$
Fastener centres determined by diameter and wind load

Plan section
Connections: horizontal batten to counter batten

- **Batten spacing** 600 mm
- **Board width** 150 mm
- **Design wind load** 1.2 kN/m²

**Counter battens**
- 3 nails/m length (6/m²)
- Axial load/nail: 0.2 kN
  \( (1.2 \div 6) \)

**Battens**
- 2 nails/m length (4/m²)
- Axial load/nail: 0.3 kN
  \( (1.2 \div 4) \)

**Cladding**
- 4 nails/m length (26/m²)
- Axial load/nail: 0.05 kN
  \( (1.2 \div 26) \)
Connections: horizontal batten to batten

**Pointside penetration (incl tip)**

**Headside thread length**

**Only screws are suitable**

Headside thread length and batten spacing determined by screw diameter and wind load.

Plan section
Nail connections: vertical batten to stud

\[ d = \geq 3.5 \text{ mm} \quad d_{\text{head}} = d \times \geq 1.78 \]

Pointside penetration of threaded part \( \geq 6d \)
Examples of minimum spacings and unloaded edge/end distances for fasteners

<table>
<thead>
<tr>
<th>Spacing or end/edge distance</th>
<th>Fastener spacing as multiple of $d$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean wood density (kg/m$^3$)</td>
</tr>
<tr>
<td></td>
<td>$\leq 500$</td>
</tr>
<tr>
<td>Spacing $a_1$</td>
<td>$12d$</td>
</tr>
<tr>
<td>Spacing $a_2$</td>
<td>$5d$</td>
</tr>
<tr>
<td>Distance $a_{3c}$</td>
<td>$10d$</td>
</tr>
<tr>
<td>Distance $a_{4c}$</td>
<td>$5d$</td>
</tr>
</tbody>
</table>
Minimum batten thickness 38 mm to maintain edge distances. This determines cavity depth.
Structural design of cladding should address:

1. Imposed loads from the cladding onto the wall
2. Self-weight of the cladding
3. Attachment of cladding to the wall
4. Movements and tolerances
Differential movement

Lightweight cladding is fixed to and should move with the wall structure

Heavyweight cladding is separately supported and moves independently of the wall structure
### Movement classes for wood species

<table>
<thead>
<tr>
<th>Movement class</th>
<th>Across grain dimensional change due to moisture content fluctuation below the fibre saturation point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>1% for every 5% change in MC</td>
</tr>
<tr>
<td>Medium</td>
<td>1% for every 4% change in MC</td>
</tr>
<tr>
<td>Large</td>
<td>1% for every 3% change in MC</td>
</tr>
</tbody>
</table>
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Three fire scenarios affecting timber-clad facades

- Compartment fire
- Fire in a nearby but non-adjoining building
- Small fire near the wall
Peak heat release rate above window can be 70 kW/m²

Total energy release in front of the facade: 1 to 1.5 MW

Duration of thermal exposure on facade: 15 to 20 minutes
The flame plume from a fully developed fire can spread 2 to 4 m up the facade irrespective of the combustibility of cladding materials.

The plume might reach 6 m high in some conditions.
Performance criterion for timber-clad facades

Maximum allowable fire propagation up the facade before fire brigade intervenes

Possible flame height up to 6 m

Typical flame height 2 to 4 m

[22]
Irvine fire, Scotland 1999

Fire spread from a 5th floor flat onto the facade and externally to the eight floors above. The upper floors were engulfed in minutes. One person died.
Grenfell Tower fire, London, 2017. 71 people died after a compartment fire spread to the cladding.
Time

Heat release rate

Reaction to fire

Flashover

Sprinkler controlled

Fully developed

Fire resistance

Growth

Decay

Time
Reaction to fire
A classification of how fire starts and spreads up to and including flashover
BS EN 13501-1

Fire resistance
A classification of how long construction elements can resist the power of a fully developed fire
BS EN 13501-2
Floor >18 m?

Combustible cladding or insulation might be prohibited

Spanning a compartment wall or floor?

Junction should maintain fire resistance of the compartmentation

Facade near boundary?

External surfaces to be Euroclass B or A2

Use?

Assembly buildings etc need Euroclass B or C surfaces

Cavity barriers?

Almost always needed
Options for limiting flame spread on facades

- Fire resistant room lining
- Internal sprinklers
- Separating buildings
- Cavity barriers
- Flame retardants
- Projecting baffles
- Fire resistant glazing
Options for limiting flame spread on facades

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Options for limiting flame spread on facades

- Fire resistant room lining
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- Fire resistant glazing
Generally there are no restrictions on the reaction to fire class of timber cladding. Flame retardants can improve the reaction to fire class of timber if needed.

Options for limiting flame spread on facades:
- Fire resistant room lining
- Internal sprinklers
- Separating buildings
- Cavity barriers
- Flame retardants
- Projecting baffles
- Fire resistant glazing
<table>
<thead>
<tr>
<th>BS EN 13501-1</th>
<th>BS 476 series</th>
<th>Examples*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A1</strong></td>
<td>Non combustible</td>
<td>Inorganic materials</td>
</tr>
<tr>
<td><strong>A2</strong></td>
<td>Limited combustibility</td>
<td>Products with small % of organic materials</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>O</td>
<td>Flame retardant treated timber</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>1, 2 or 3</td>
<td></td>
</tr>
<tr>
<td><strong>D or E</strong></td>
<td>4 or 5</td>
<td>Timber with no flame retardant treatment</td>
</tr>
<tr>
<td><strong>F</strong></td>
<td>Unclassified</td>
<td>Untested products</td>
</tr>
</tbody>
</table>

* Classification is affected by assembly conditions
Insurance criteria for school & academy buildings

Typical criteria (facades):

- Exterior walls non-combustible < 3 m
- Internal sprinklers
- Euroclass B timber
- Parapets not eaves
Options for limiting flame spread on facades

- Fire resistant room lining
- Internal sprinklers
- Separating buildings
- Cavity barriers
- Flame retardants
- Projecting baffles
- Fire resistant glazing
Summerland fire, Isle of Man, 1973. At least 50 people died after a small external fire spread to the wall cavity.

Flames entering a cavity can extend 5 to 10 times their original height irrespective of the combustibility of cavity linings.
Cavity barrier to block fire spread

Ventilated cavity to promote drying
Cavity barriers for timber rainscreens

Horizontal cavity barriers: use intumescent strips with specified fire resistance

Vertical cavity barriers do not need through-ventilation: use timber battens ≥ 38 mm thick
(Non-combustible barriers needed above 18m)
Cavity barriers for timber rainscreens

Fire resistance of separating wall and floor junctions must be maintained.

- Interior
  - e.g. mineral wool batt
- Interior
- Exterior
  - e.g. 2 solid timber cavity barriers ≥ 38 mm wide
References

Dr Ivor Davies

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