Cladding Annex 1 – Cladding Thickness

The following section has been adapted from the BS 8298 part 2. It is important that all calculations are checked by a suitably qualified engineer.

Introduction

The panel thickness should be determined at an early stage of design (stage 3), to influence key decisions relating to the cladding weight, façade setting out and wall construction make up.

There are two modes of failure for the stone panel that relate to the stone thickness;

- breaking due to the lateral load
- breaking at the fixing point

The thickness of Portland stone cladding needs to be determined by calculation as per the methods stated in BS 8298 Part 2 Section 5 to establish the correct Factor of Safety and in Annex C for the actual thickness calculations.

There are various issues to be considered and information that is required to complete the calculation.

1) the lateral load on the building
2) the fixing system
3) the panel size
4) the stone’s technical properties:
   a) the flexural strength
   b) the breaking load at dowel hole
5) the factor of safety to be calculated using the stone technical data

1) The lateral load on the building

This wind load can be calculated using the methods and factors given in BS 6399, which will provide an accurate figure for the lateral load on the stone panels. If for whatever reason the project specific lateral load calculation cannot be completed, then the Table in the Annex from BS 8298-part 2. can be used instead.

This pressure in N/m² (q) is used in the calculation for the thickness of the cladding.

<table>
<thead>
<tr>
<th>CLASS</th>
<th>LOAD</th>
<th>BRIEF DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low wind load environment</td>
<td>1500 N·m²⁻²</td>
<td>Sheltered environment such as the lower floors of a building in a central urban area, e.g. Central Manchester</td>
</tr>
<tr>
<td>Medium wind load environment</td>
<td>2250 N·m²⁻²</td>
<td>A more exposed environment such as the higher floors of a tall building or a more exposed location, e.g. Canary Wharf, London</td>
</tr>
<tr>
<td>High wind load environment</td>
<td>3000 N·m²⁻²</td>
<td>An exposed environment such as a coastal location</td>
</tr>
</tbody>
</table>

2) The Fixing System

The support of the stone will impact on the thickness calculation. Normally it is assumed that it will be four 6mm dowels in the longer lengths, the top and the bottom edges of the stone panel. From the location of the fixings the greatest panel span can be measured / calculated. Typical layouts for restraint fixings are
shown in Figure 9 - Position of Restraint Fixings in BS 8298 part 2. So, for staggered bonding (½ stagger bonded stones) should be position ¼ points in the length and ⅕ for stack bonded stone. The span between the fixings, is the maximum distance between the fixings measured parallel to the side of the panel. The number of fixings forms part of the strength at fixing point calculation.

3) Panel Size
The panel size will affect the calculation as the bigger the panel the greater the lateral load and the more force is applied to the stone and the fixings. The panel height in mm is used in the thickness calculation, b is the width, which represents the vertical distance between the fixings.

4) Stone Technical Properties
It is vital that the stone selected has adequate and current technical data and CE certificate tested to the correct Euro-code testing standards. Albion Stone’s data sheets / certificates provide the figures required to complete these calculations as a mean figure or a lowest expected value (LEV) and these figures are based on over 5,000 test results over 30 years which provides the most reliable results. The stone flexural strength (Dfb) will be used for the thickness calculation and the dowel pull out figures for the strength at fixing calculation.

5) Factor of Safety
The factors of safety for stone tend to be higher than other materials as it is a natural product. The table below is a precis of Table 4 from BS 8298 part 2 that sets out the technical data and information that needs to be considered when calculating the Factor of Safety. This flexural safety factor (FSF) is used as part of the calculation for the thickness.

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>F₀</td>
<td>F₀ is the basic (minimum) factor of safety that is permissible for ultimate limit state design</td>
<td>3.00</td>
</tr>
<tr>
<td>F_LEV</td>
<td>F_LEV is the component which relates to the use of mean or lower expected values of strength;</td>
<td>1.00 - 1.40</td>
</tr>
<tr>
<td>F₃-₄</td>
<td>F₃-₄ is the component which relates to constant moment or concentrated load testing (BSEN 13161 or 12372) Not relevant to strength at fixing calculations</td>
<td>1.00 - 1.40</td>
</tr>
<tr>
<td>F_H₂₀</td>
<td>F_H₂₀ is the component which relates to the use of dry and wet samples for testing;</td>
<td>1.00 - 1.40</td>
</tr>
<tr>
<td>F₅</td>
<td>F₅ is the component which relates to the number of sets of samples that were tested and the sample selection process;</td>
<td>1.00 - 1.50</td>
</tr>
<tr>
<td>F₆</td>
<td>F₆ is the component which relates to the orientation of the stone when tested;</td>
<td>1.00 - 1.40</td>
</tr>
<tr>
<td>F₇</td>
<td>F₇ is the component which relates to the use of freeze-thaw testing.</td>
<td>1.00 - 2.00</td>
</tr>
</tbody>
</table>
A. Calculation for the thickness of the stone slab compared to the lateral loading on the stone.

\[ W = \frac{(qb)}{10^6} \]

\( W \) = load in N/mm
\( q \) = pressure in N/m\(^2\)
\( b \) = width in mm

\[ M_f = \frac{(WL^2)}{8} \]

\( M_f \) = failure moment in N.mm
\( W \) = load in N/mm
\( L \) = span between the fixings in mm

\[ f_b = \frac{D_{fb}}{FSF} \]

\( f_b \) = flexural stress in MPa
\( D_{fb} \) = design flexural stress of the stone in MPa
\( FSF \) = flexural safety factor

\[ S = \frac{M_f}{f_b} \]

\( S \) = section modulus in mm\(^3\)
\( M_f \) = failure moment in N.mm
\( f_b \) = flexural stress in MPa

\[ d = \sqrt{\frac{6SQ}{b}} \]

\( d \) = thickness of the stone in mm
\( S \) = section modulus in mm\(^3\)
\( b \) = width in mm

B. Calculation to check the Strength at fixing point

Wind Load \( \times \) (Panel Area \( m^2 \) / \( 10^6 \)) \( \times \) Factor of Safety = Lateral load on the stone panel

\[ \text{pressure in N/m}^2 \ (q) \times (\text{Panel Area m}^2 / 10^6) \times \text{FSF} = \text{flexural safety factor} \]

Lateral Load on the Stone Panel \( \div \) Number of Fixings = Loading on each Fixing

The loading on each fixing needs to be compared with the result for the BSEN 13664 breaking load at dowel hole for the appropriate thickness.