Introduction

Thermal break plates are high performance thermal insulators used between both horizontal and vertical connections of internal and external elements to prevent thermal / cold bridging. They provide a simple, economical and extremely effective solution to meeting Part L of the Building Requirements by way of reducing both heat loss and the risk of internal condensation. Farrat thermal breaks can also be used in hot climate conditions to insulate the cool, air conditioned interior, from the hot outside conditions.

In 2007, responding to a request from a designer who was concerned with cold bridging on a project, Farrat Isolevel began manufacturing thermal breaks for buildings. Changing legislation in response to climate change and energy saving has meant that Farrat now supply tens of thousands of thermal break plates for the UK and overseas market each year. Constantly driven by engineering excellence, Farrat continue to lead the way in the development of the thermal break plate market.

Farrat thermal breaks are accredited by the Steel Construction Institute (SCI) under the Assessed Product Quality Mark Scheme and manufactured under our ISO 9001:2008 Quality Assurance system. Farrat thermal breaks also meet the NHBC’s technical requirements.

We take pride in providing our customers with a high level of service from technical support through to manufacturing accuracy and timely deliveries to site.

Typical Applications

The four primary connections where Farrat thermal breaks are used are as follows:

- Steel to Steel
- Steel to Concrete / Masonary
- Steel to Timber
- Concrete to Concrete

Thermal Breaks are used in new build and refurbishment projects in the following building elements:
Why choose Farrat Structural thermal breaks?

Steel Construction Institute (SCI) – Assessed Product

“SCI Assessed” is an established quality mark that has been awarded to testify that the technical data and structural design methodology for Farrat thermal breaks has been independently verified by SCI.

All material properties were verified by SCI following testing to an appropriate European building product standard and by an approved Nando Accreditation Body.

http://ec.europa.eu/enterprise/newapproach/nando/

NHBC

Farrat thermal breaks meet the NHBC’s Technical requirements. NHBC accepts the use of Farrat TBK and TBL thermal break materials for use in structural applications as set out in the SCI report.

Quality Assurance

Farrat Isolevel Limited operates an ISO 9001:2008 quality assurance system. All thermal breaks are manufactured under this system.

Our in-house testing capabilities include:

- Dynamic Testing
- Static Compression Testing
- Transmissibility Testing
- Isolated Foundation Testing
- Shock Testing
- Creep Testing
- Cantilever Beam Testing
- Thermal Break Heat Transfer Testing

- Façade system connections to the primary frame
- Brise-Soleil and Canopies
- Roof plant room columns
- Balustrading
- Connections of external to internal primary building elements
- Isolation of sub-structure and basement structure elements
- External balconies
- External staircases
- Man-safe/cleaning systems
- Connections to existing structures
Farrat Thermal Breaks - Material Properties

Farrat thermal breaks are manufactured from high performance materials. We offer two grades, Farrat TBK and Farrat TBL. The materials have been independently tested and accredited by the Steel Construction Institute (SCI) under the “Assessed Product” Quality Mark Scheme. In the majority of applications Part L is satisfied by using plates between 5 & 25mm in thickness.

<table>
<thead>
<tr>
<th>PROPERTIES</th>
<th>FARRAT TBK</th>
<th>FARRAT TBL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic Compressive Strength, fck (N/mm², MPa)</td>
<td>312</td>
<td>89</td>
</tr>
<tr>
<td>Design value for compressive strength, fcd (N/mm², MPa)</td>
<td>250</td>
<td>70</td>
</tr>
<tr>
<td>Elastic Modulus (N/mm², MPa)</td>
<td>5178</td>
<td>2586</td>
</tr>
<tr>
<td>Density (Kg/m³)</td>
<td>1465</td>
<td>1137</td>
</tr>
<tr>
<td>Water Absorption (%)</td>
<td>0.14</td>
<td>0.48</td>
</tr>
<tr>
<td>Thermal Conductivity (W/mK)</td>
<td>0.187</td>
<td>0.292</td>
</tr>
<tr>
<td>Colour (may vary)</td>
<td>Amber</td>
<td>Black</td>
</tr>
<tr>
<td>Thicknesses available (mm) ++</td>
<td>5, 10, 15, 20 &amp; 25</td>
<td>5, 10, 15, 20 &amp; 25</td>
</tr>
<tr>
<td>Temperature Resistance (°Celsius)*</td>
<td>+250 short term (Max)</td>
<td>+210 long term (Max)</td>
</tr>
</tbody>
</table>

++ Multiple plates can be provided for applications where thicknesses greater than 25mm are required.
* Fire performance of connections – please refer to page 11.

Specifications

- **Construction drawings** should show a fully detailed connection or one communicating the design intent with a supporting specification (NBS or similar).
- **The Architect** is normally responsible for ensuring that the connection meets the requirements of the Building Regulations Part L (SAP).
  
  Design Output - Thermal performance/ Thickness (Farrat TBK or Farrat TBL)

- **The Structural Engineer** is normally responsible for designing the connection or providing a performance specification for the steelwork fabricator.
  
  Design Output – Strength (Farrat TBK or Farrat TBL)

Sample Specification for a project using Farrat TBK – National Building Specification (NBS)

NBS Clause: G10/350 Thermal Break Connection Plate

- **Manufacturer** Farrat Isolevel Ltd, Balmoral Road, Altrincham, Cheshire, WA15 8HJ, Tel: +44 (0)161 924 1600, Fax: +44 (0)161 924 1616 www.farrat.com
- **Product Reference** Farrat TBK
- **Thickness** 25 mm
- **Plate Size** As Drawing number – or to be determined by the connection designer
- **Hole Size & Positions** As Drawing number – or to be determined by the connection designer
- **Accreditation** SCI Assessed Product/ NHBC
Procurement

Enquiries

Quotations:

The following information is required:

- Material Type – Farrat TBK or Farrat TBL
- Plate dimensions
- Plate thickness
- Size and number of holes
- Quantity
- Delivery location

Orders

A fully dimensioned drawing is normally required for each type of plate with a unique project and plate reference prior to fabrication. Fabrication is undertaken in accordance with our ISO 9001 Accreditation. Prior to delivery all thermal breaks are labelled with the fabricator’s unique reference.

Farrat Thermal Breaks are bespoke products and early procurement is recommended. Where very large orders are envisaged we are happy to work with the customer to plan phased deliveries.

We aim to start manufacturing within 3 days of customers placing an order. The despatch date will be advised at point of order.
Design Consideration - Thermal Performance

Thermal Performance of the Building Envelope

There are very few standard construction details between projects and consequently the detailing of the building envelope and penetrations through the envelope can vary significantly. The calculation of thermal performance and compliance with codified requirements can be complex.

There are two aspects to thermal performance of the building envelope, heat loss and condensation risk. Both of these issues are covered by Building Regulations, and guidance on meeting the Building Regulations is given in various Approved Documents (England and Wales), Technical Handbooks (Scotland) or Technical Booklets (Northern Ireland).

These documents currently all require heat loss and condensation risk to be assessed in accordance with the same British Standards, European Standards and BRE Publications.

Heat Loss

Heat loss is quantified using three parameters, depending upon the nature of the element causing the heat loss.

- For plane elements such as floors, walls and windows, the designer determines a U-value, which is the heat loss per unit projected area per unit temperature difference, expressed in Watts per square metre per Kelvin (W/m²K).
- For linear elements, such as the interface between a window and a wall opening, or a corner where two walls meet, the designer determines a linear thermal transmittance, or Psi-value (ψ-value), which is the additional heat loss per unit length per unit temperature difference, expressed in Watts per metre per Kelvin (W/mK).
- For localised elements, such as a structural member penetration through a wall, the additional heat loss due to the penetration is expressed as a point thermal transmittance or Chi-value (χ-value), which is the additional heat loss due to the element per unit temperature difference, expressed in Watts per Kelvin (W/K).

Connections that penetrate or bridge the insulation layer normally require a χ-value to be determined. The designer must analyse or measure the heat loss through the construction both with and without the penetration. The difference between these values is the χ-value which is the residual heat loss due to the penetration.

It is impractical to measure the heat loss through most real penetrations due to their size and complexity. A more practical and cost-effective approach is for the designer to use computer modelling software based on techniques such as Finite Element Analysis (FEA).

Figures 6.1 and 6.2 show an FEA model of a penetration utilising a 25 mm Farrat TBK thermal break, combined with thermal isolating washers to maximise the effectiveness of the thermal break (only one-half of the detail is modelled – the detail is symmetrical). For the purposes of analysis the FEA model must include the entire wall construction from the inside to outside, including all dry linings, external finishes and the penetration detail, as has been done for the analyses described here.
Condensation Risk

The Specifier will usually identify indoor and outdoor temperatures and relative humidity conditions under which condensation must not occur. Guidance on suitable conditions is given in BS 5250 Code of Practice for the Control of Condensation in Buildings. From these conditions it is possible to determine the allowable minimum temperature on the construction detail below which there would be a risk of condensation. FEA and similar analysis methods allow the temperature distribution to be predicted, as shown in the previous example.

Recommendations

The Specifier must identify temperature and relative humidity conditions under which condensation is not permitted. The Specifier must also state the limiting $\chi$-value for a single penetration.

The size of the connection is then determined by reference to structural requirements and the connection can then be analysed to determine its thermal performance.

The best thermal performance will always be obtained with the least net cross-sectional area of bolt connections through the thermal break, the smallest area of thermal break and the use of the thickest possible thermal break.

Good practice is to locate the Farrat thermal break in the primary insulation layer of the wall or roof, and to fill the space around the connection with insulation.

Dr. Richard Harris
Senior Associate, Consultancy Department
www.sandberg.co.uk
Design Consideration - Structural Performance

Thermal breaks are normally used in protected façades or roof systems. In general, steelwork connections should be designed in accordance with the latest SCI guidance publications as listed below:

**Simple Connections**
SCI-P212: Joints in steel construction. Simple connections (BS 5950-1).
SCI-P358: Joints in steel construction. Simple joints to Eurocode 3.

**Moment Connections**
SCI-P207: Joints in steel construction. Moment connections (BS 5950-1).
SCI-P398: Joints in steel construction. Moment joints to Eurocode 3.

However, additional design checks should be carried out for connections that include Farrat thermal break plates between the steel elements as follows:

1. Check that the thermal break plate can resist the applied compression forces
2. Check that any additional rotation due to the compression of the thermal break plate (including allowance for long term creep) is acceptable
3. Check that the shear resistance of the bolts is acceptable given that there may be a reduction in resistance due to:
   - Packs
   - Large grip lengths

**Nominally pinned connections**

Nominally pinned connections (also referred to as simple connections) are generally designed to only transmit shear forces and tying forces. Therefore, the thermal break plate is not required to resist compression forces. Hence, for nominally pinned connections there is no requirement for the designer to check the compression resistance of the thermal break plate within the connection.

However, there may be situations where beams are also subject to axial load, in these situations the thermal break plate is required to resist compression forces and should be designed accordingly. The design procedure presented later can be adapted to suit thermal break plates subject to compression or alternatively the Farrat thermal break plates can be treated as a column base plate (see Section 7 of SCI Publication P358).

**Moment connections**

In moment resisting connections (fig 8.1) one part of the connection is in tension and the other part of the connection is in compression, as shown below. Therefore, a thermal break plate within the connection is required to resist compression forces. Hence, for moment connections there is a requirement for the designer to check the compression resistance of the thermal break plate within the connection.

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**Fig. 8.1 Moment connection**

- \( F_{r1} \): Bolt row tension forces
- \( F_{r2} \): Bolt row tension forces
- \( F_{r3} \): Bolt row tension forces
- \( F_c \): Compression force
- \( M \): Applied moment
- \( V \): Applied shear
1. **Applied compressive stress to thermal break**

The designer must check that the compressive stress applied to the thermal break plate is less than the design compression strength of the thermal break material. This is achieved by satisfying the expression given below.

\[
F_c \leq B \times L \times f_{cd}
\]

- \(F_c\) is the applied compression force (ULS)
- \(f_{cd}\) is the design value for compressive strength (thermal break)
- \(B\) is the depth of the compression zone on the thermal break
- \(L\) is the width of the compression zone on the thermal break

The compression force \(F_c\) can be obtained from published data for standard moment connections (see SCI-P207 and SCI-P398). Alternatively, \(F_c\) can be calculated as part of the normal connection design process if standard moment connections are not used.

The dimensions \(B\) and \(L\) are calculated based on a dispersal of the compression force from the beam flange as shown in Fig 9.1 and Fig 9.2. However, it should be noted that \(B\) and \(L\) must be reduced if the beam end plate projection is insufficient for full dispersal of the force or if the column flange width is insufficient for full dispersal of the force.

\(B\) and \(L\) are defined in the following expressions:

\[
B = t_{fb} + 2(s + t_p)
\]

Where:
- \(t_{fb}\) is the beam flange thickness
- \(s\) is the weld leg length
- \(t_p\) is the end plate thickness

\[L = b_b + 2 \times t_p\]

Where:
- \(b_b\) is the beam flange width
- \(t_p\) is the end plate thickness
2. Additional rotation due to compression of thermal break

For moment connections, such as those supporting balconies, the rotation of the connection under load is an important design consideration, typically for aesthetic and serviceability requirements.

The amount of compression of the thermal break plate $\Delta T$ is calculated as given in expression:

\[ \Delta T = \frac{t_{tb} \times \sigma_{tb}}{E_{tb}} \]

where:
- $t_{tb}$ is the thickness of the thermal break plate
- $\sigma_{tb}$ is the stress in the compression zone of the thermal break plate (SLS)
- $E_{tb}$ is the elastic modulus of the thermal break plate

The additional rotation of the connection ($\theta$) due to the presence of a thermal break plate within the connection can be calculated using the expression:

\[ \theta = \text{Arcsin} \left( \frac{\Delta T}{h_{b}} \right) \]

where:
- $h_{b}$ is the depth of the beam

Farrat thermal break materials exhibit low levels of creep behaviour. Therefore, in the consideration of additional rotation due to compression of the thermal break plates the designer should include an allowance for long term creep. Based on testing the following allowance should be made:
- For TBK, increase deformation by 20% to allow for long term creep
- For TBL, increase deformation by 30% to allow for long term creep

All connections (with or without a thermal break plate) will rotate when loaded. In most typical cases the additional connection rotation due to the presence of a thermal break plate will be small. A typical example is presented below:

**Example**

**Long term creep**

<table>
<thead>
<tr>
<th>CONNECTION PROPERTY</th>
<th>FARRAT TBK</th>
<th>FARRAT TBL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of beam (mm)</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Thickness of thermal break plate (mm)</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Stress in compression zone of thermal break plate at serviceability limit state (SLS), (N/mm², MPa)</td>
<td>85</td>
<td>35</td>
</tr>
<tr>
<td>Elastic modulus of thermal break plate (N/mm², MPa)</td>
<td>5178</td>
<td>2586</td>
</tr>
<tr>
<td>Compression of thermal break plate (mm)</td>
<td>0.410</td>
<td>0.338</td>
</tr>
<tr>
<td>Additional compression of thermal break plate due to creep [TBK +20% : TBL +30%]</td>
<td>0.492</td>
<td>0.439</td>
</tr>
<tr>
<td>Additional rotation of connection (Degrees)</td>
<td>0.188</td>
<td>0.168</td>
</tr>
</tbody>
</table>
3. Bolt shear resistance

A thermal break plate in a connection must be considered as a pack in terms of the connection design. Where packs are used in connections, there are detailing rules that should be followed and depending on the thickness of packs, it may be necessary to reduce the shear resistance of the bolts within the connection.

- The number of packs should be kept to a minimum (less than 4)
- The total thickness of packs \( t_{pa} \) should not exceed \( 4d/3 \), where \( d \) is the nominal diameter of the bolt
- If \( t_{pa} \) exceeds \( d/3 \), then the shear resistance of the bolts should be reduced by the factor \( \beta_p \) given in the expression

\[
\beta_p = \frac{9d}{8d + 3t_{pa}}
\]

Where:
- \( d \) is nominal bolt diameter
- \( t_{pa} \) is the total thickness of packs

4. Large grip lengths

A thermal break plate in a connection will increase the total grip length \( T_g \) of the bolts. The total grip length is the combined thickness of all the elements that the bolt is connecting together (e.g. end plate, thermal break plate, column flange, additional packs etc.). Depending on the size of the grip length, it may be necessary to reduce the shear resistance of the bolts within the connection.

If \( T_g \) exceeds \( 5d \), then the shear resistance of bolts with large grip lengths should be reduced by the factor \( \beta_g \) given in expression.

\[
\beta_g = \frac{8d}{3d + T_g}
\]

where:
- \( d \) is nominal bolt diameter
- \( T_g \) is the total grip length of the bolt

5. Frictional resistance

a) Non-preloaded bolts

The coefficient of friction of the thermal break plate is not a relevant property for the structural design of connections with non-preloaded bolts.

b) Pre-loaded bolts

For the structural design of connections with preloaded bolts, the coefficient of friction of the thermal break plate will be required. The slip resistance of the bolted connection is calculated in accordance with Section 3.9 of BS EN 1993-1-8. The number of friction surfaces is required for this calculation.

In addition, the local compression force around the bolt holes on the thermal break plate must be checked to ensure the compressive strength of the thermal break plate is not exceeded.

Preloaded bolts are also known as HSFG bolts.

6. Fire

Generally, thermal breaks are used in locations that do not require fire protection. Where the connection requires a fire rating then the following options are available:

- A board fire protection system can be applied
- Sprayed fire protection can be applied. The compatibility of the applied fire protection material should be checked with the thermal break material
- The connection may be designed on the assumption of complete loss of the thermal break material in the accidental condition. For accidental conditions, excessive deformations are acceptable provided that the stability of the structure is maintained

Note: Although all care has been taken to ensure that all the information contained herein is accurate, Farrat Isolevel Limited assumes no responsibility for any errors or misinterpretations or any loss or damage arising therefrom.
Other areas of expertise

Vibration & acoustic control for buildings and structures

We have developed a comprehensive range of solutions to the problem of controlling and isolating noise, vibration, shock and movement in both new and existing buildings. Our diverse range of products includes floating floor systems, isolated foundations, structural bearings, anti vibration washers, resilient seatings and coil spring and damper systems for a variety of different building types.

Anti-vibration and precision levelling products for industrial machinery and equipment

Having manufactured high quality anti vibration and precision levelling mountings for more than 50 years, Farrat has developed a rich expertise in this field. These products include a complete range of anti vibration materials, anti vibration washers and anti vibration and levelling mounts. Our products are used in a wide variety of applications, from power presses to roll grinders and printing presses.

Global experts in Vibration Control, Thermal Isolation & Precision Levelling Solutions for Construction, Industry & Power Generation