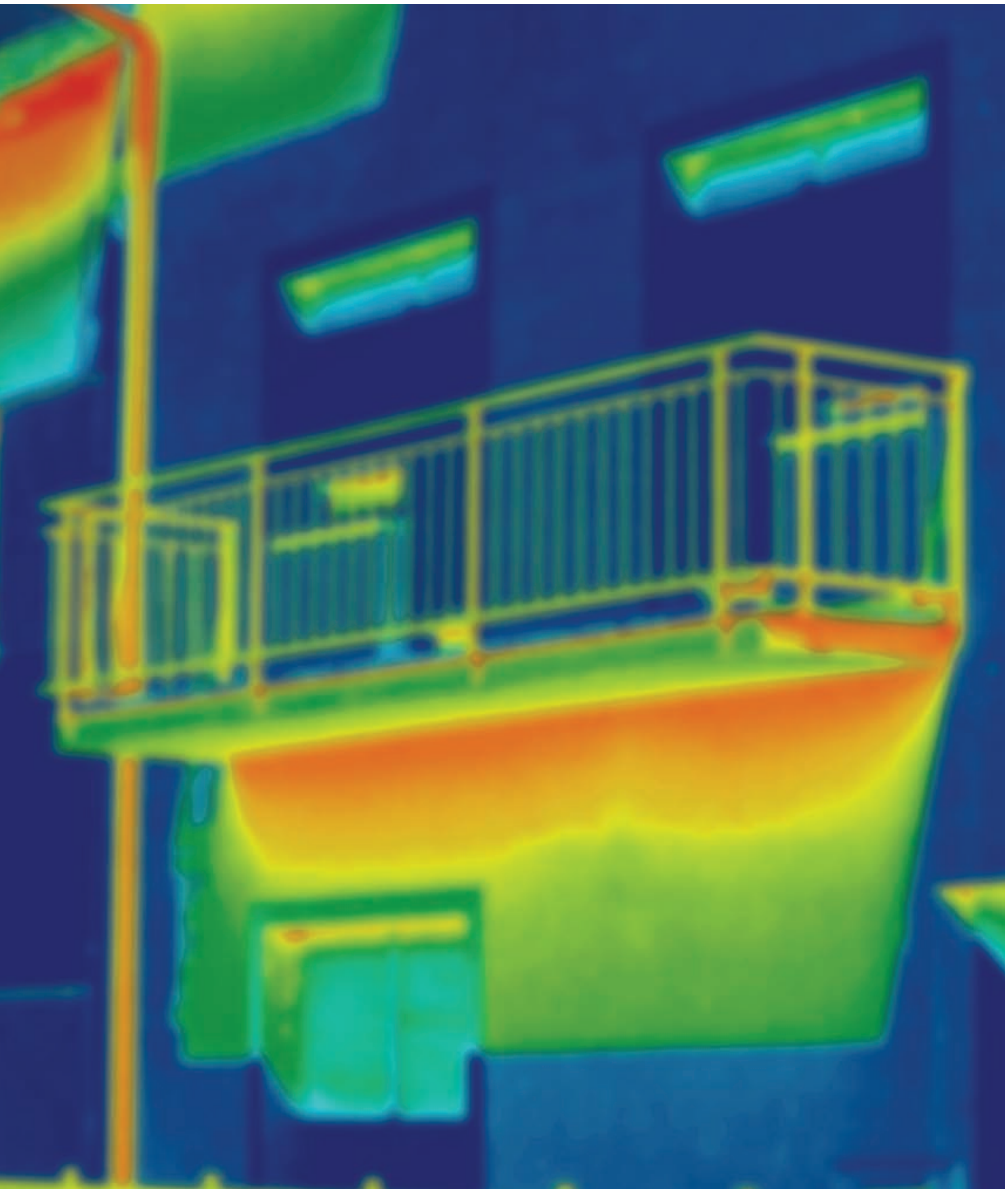

Fabreeka® Thermal Breaks

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003

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Contents





Disclaimer

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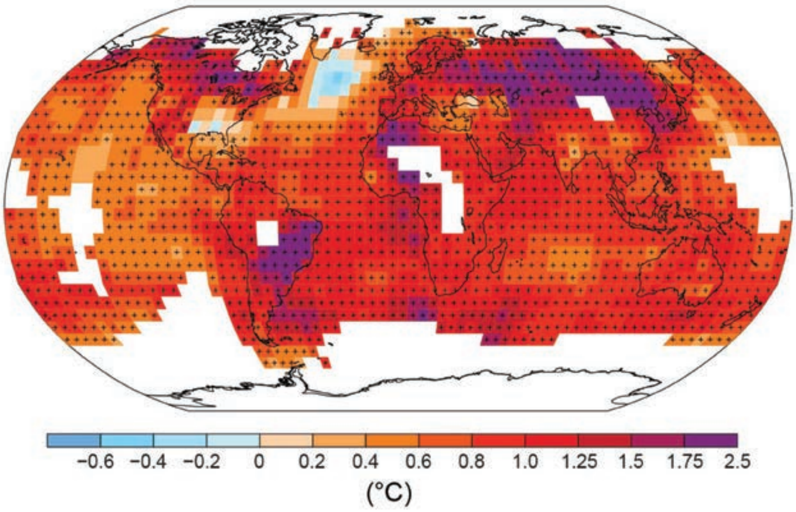
Introduction

ACE Fabreeka UK is a leading developer of products for the control of kinetic and thermal energy transfer. We solve heat-loss, shock, vibration and structure-borne noise problems and our engineered building and construction materials are the number one choice for specifiers and contractors who rely on our top-quality customer service founded on solid technical expertise developed over 80 years.

Solutions To Thermal Efficiency Challenges

We can help you with modern building thermal efficiency challenges whilst still retaining traditional building materials like steel and concrete. The high thermal conductivity of steel makes many connections in a building susceptible to unwanted heat loss through thermal or 'cold' bridging. At these cold bridge interfaces there is the potential for condensation on the surfaces which can cause corrosion and other moisture related defects which could have a negative effect on the structural integrity of the building. To overcome cold bridging in the design of a new building, a material of lower thermal conductivity can be installed at this interface which will act as a thermal break.



Observed change in surface temperature 1901-2012. Courtesy of IPCC.

Thermal Breaks - A Legal Requirement

Thermal breaks are a legal requirement in the UK and Ireland with many other G8 countries and the EU also showing a strong commitment to reduce greenhouse gas emissions and to pursue a low carbon path to limit the increase in global temperature. Architects, structural engineers and building contractors must be able to demonstrate that reasonable provision has been made to conserve fuel and power when designing, specifying and constructing new buildings and achieve this with the integration of a thermal break.

As a leading developer of engineered building and construction materials with a truly global reach for energy conservation in buildings. We can support you with internationally recognised voluntary assessment schemes including the Building Research Establishment Environmental Assessment Method (BREEAM) and Leadership in Energy and Environmental Design (LEED) for the development of environmentally friendly buildings.

A Locally Sourced Solution To A Global Problem

Our Fabreeka-TIM® Structural Thermal Break materials have a low thermal conductivity with test verified structural and resistance to fire performance. With manufacturing facilities in the UK, Germany and the United States, we can profile thermal break materials to shape in the form of pads, spacers, washers and bushing tubes and then deliver direct to site, ready for installation anywhere in the world. We can also provide a full end-to-end engineering service from project initiation through to solution delivery.

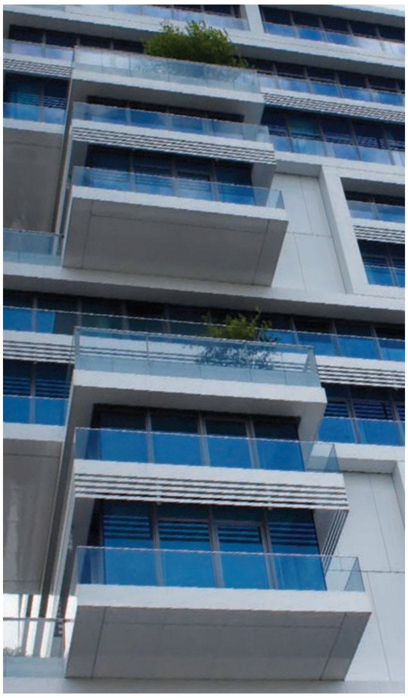
[1] Part L of the UK Building Regulations.

Thermal Bridging In Buildings

Thermal bridging in building envelopes may become apparent under the following conditions:

- Geometry (corners that provide additional heat flow paths)
- Building envelop interfaces (window sills, jambs and headers)
- Structural interfaces (floor to wall junctions and eaves)
- Penetration of the building envelope (balcony supports, fixings and structural elements)
- Structural considerations (lintels and cladding supports)
- Poor construction practice (onsite non-conformance to drawings).

Reasonable provisions must be made to overcome these conditions and conserve fuel and power in the building. This can be achieved by integrating a Fabreeka® Thermal Break but it is critical that the general structural requirements of a building must be the primary control/constraint when designing a building. In general, steelwork connections should be designed in accordance with the latest Steel Construction Institute (SCI) guidance publications to BS 5950-1 and Eurocode 3.



SCI Assessed Product

The SCI has also provided specific design guidance in an assessment report for Fabreeka-TIM® Structural Thermal Break[2]. ACE Fabreeka UK can also offer a simplified yet unified ‘safe-stress’ (un-factored) CASE approach to evaluate the integration of a Fabreeka-TIM® Structural Thermal Break:

Create a joint in the structure to allow a thermal break plate of a specified thickness with known mechanical and thermal performance characteristics to be inserted.

Assign loads to be transferred to the steel support members of the given structure.

Summate the forces that the end plate connection needs to resist with the thermal break plate carrying the bending moment, shear, compression and tension at that location.

Evaluate and check the amount of defection and that the risk of fatigue at the joint is acceptable.

[2] SCI Assessed Report - Fabreeka-TIM® Structural Thermal Break. The Steel Construction Institute (SCI). RT1729v3: July 2017. http://www.sci-assessed.com/product/1704

Thermal Calculation

After the connection design is fixed then a joint detail drawing and fabrication drawing can be submitted for thermal transmittance calculation and certification.

The rate of how quickly heat is transferred through conduction is determined by the thermal conductivity, thickness of the material and the difference in temperature between the two objects which can be simply represented in one-dimensional model developed by Fourier through experimentation (Equation 1).

$$q_X = \frac{\lambda A\,(T_2 - T_1)}{L}$$

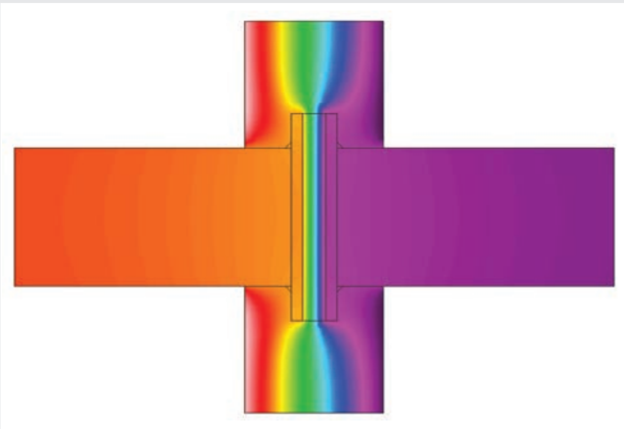
Equation 1

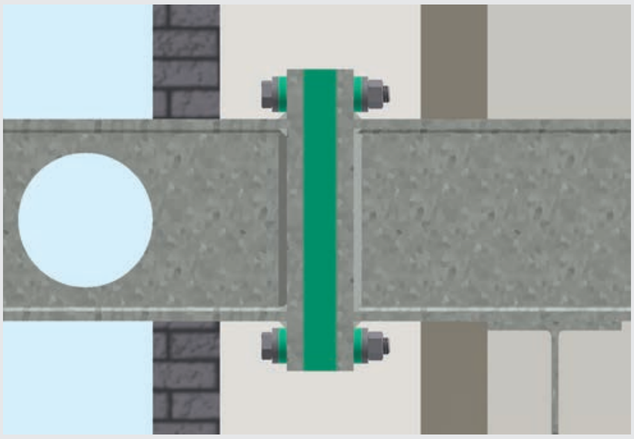
Where: qx = the rate of heat transfer (W); λ = thermal conductivity of the material (W/m·K); A = area of material (m^2); T_1 = temperature of one object (°C or Kelvin); T_2 = temperature of other object (°C or Kelvin) and; L = thickness of material (m).

This simple model in Equation 1 represents the basic principle of heat transfer theory. In the UK, the Standard Assessment Procedure (SAP) and Simplified Building Energy Model (SBEM) are two national methodologies for calculating energy performance of a building taken as a whole, including services for domestic and non-domestic buildings respectively. There are also 2D and 3D software and simulation tools available based on the more complex international standard for calculating heat flows and surface temperatures[3]. These models support a specific rating and associated λ-value for thermal conductivity (linear transmittance between plane, with units W/mK) and U-value (the ability to transfer heat through plane, with units W/m^{2}K). It is important to note that all of the materials in the whole assembly including the grade of bolts and washers influence the thermal performance and associated overall U-value of the connection.

[3] I.S. EN ISO, 10211:2007 (E) Thermal bridges in building construction - Heat flows and surface temperatures - Detailed calculations 2007.

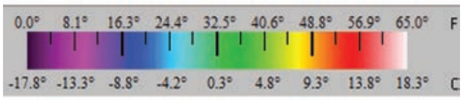
Fabreeka-TIM® Structural Thermal Break can be used as a thermal break solution in both point and linear structural connections. The use of Fabreeka-TIM® material to minimize energy flow in a structural connection requires knowledge of its thermal and material properties. To effectively design a bolted connection using Fabreeka-TIM® components, one needs to consider the tensile and shear forces acting upon the bolts and to also consider any deflection and creep in the material itself.





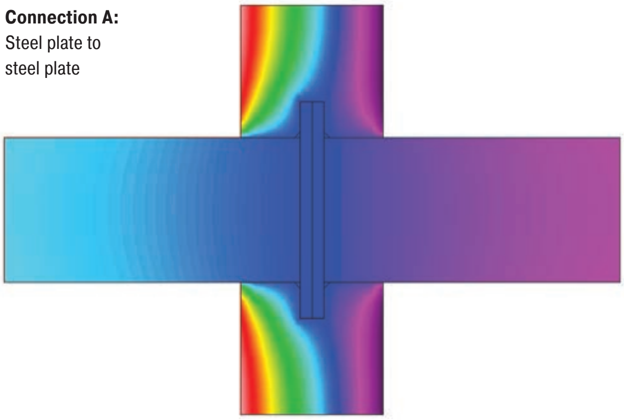
Thermal Models

The following models show energy flow through an end plate connection with and without Fabreeka-TIM® Structural Thermal Break material.



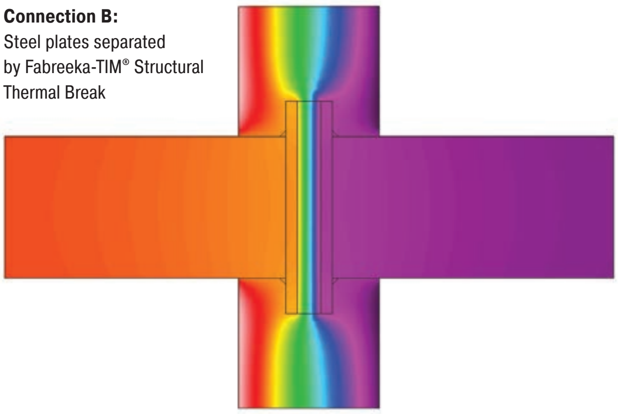
Boundary conditions for all thermal models are 21˚C inside and -18˚C outside, and assume a wall with an effective R-value (resistance to heat flow the inverse of λ through a given thickness of material).

Connection A:
Steel plate to steel plate



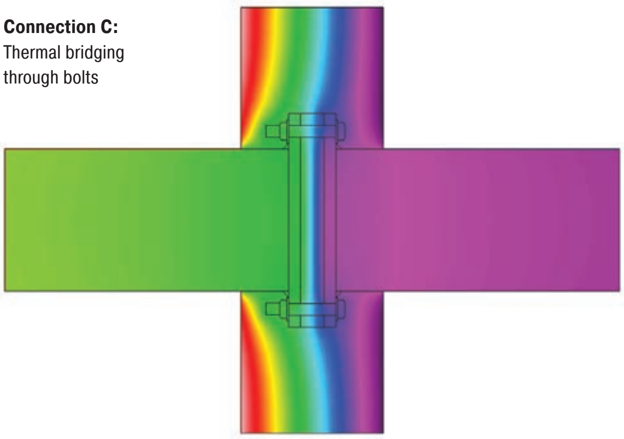
Connection A shows a typical beam-to-beam connection without a thermal break. Note the heat flow gradient through the connection.

Connection B:
Steel plates separated by Fabreeka-TIM® Structural Thermal Break



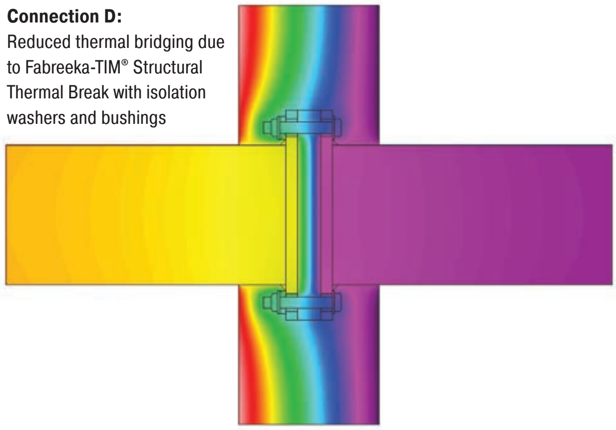
In Connection B, 25.4mm (1 in) thick Fabreeka-TIM® Structural Thermal Break material was added between the steel beams. Note the distinct thermal break of the heat flow on either side of the Fabreeka-TIM® Structural Thermal Break material.

Connection C:
Thermal bridging through bolts



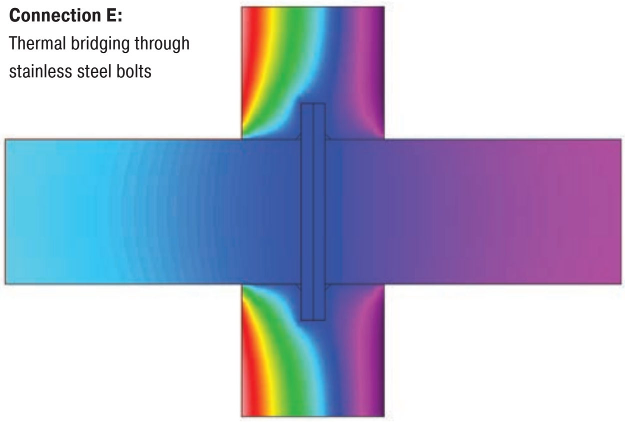
In Connection C, the heat flow profile shows how bolts act as a "thermal bridge" compromising the performance of the thermal break material.

Connection D:
Reduced thermal bridging due to Fabreeka-TIM® Structural Thermal Break with isolation washers and bushings



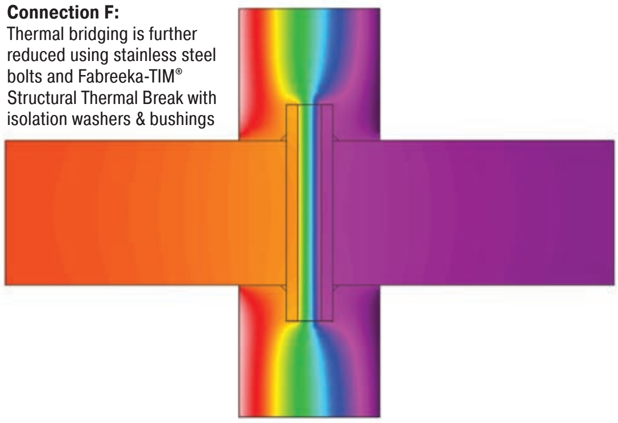
In Connection D, Fabreeka-TIM® Structural Thermal Break washers and Fabreeka Pad bushings were added to the bolted connection to break the heat flow through the bolts. Using Fabreeka-TIM® Structural Thermal Break washers and Fabreeka Pad bushings significantly reduces heat flow.

Connection E:
Thermal bridging through stainless steel bolts



In Connections E & F, stainless steel bolts were used, which further reduce heat flow when compared to steel bolts (Connections C & D).

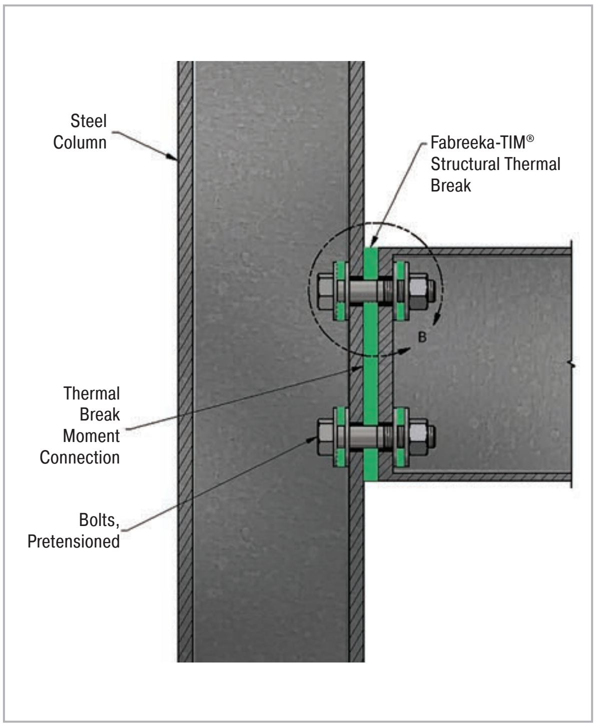
Connection F:
Thermal bridging is further reduced using stainless steel bolts and Fabreeka-TIM® Structural Thermal Break with isolation washers & bushings



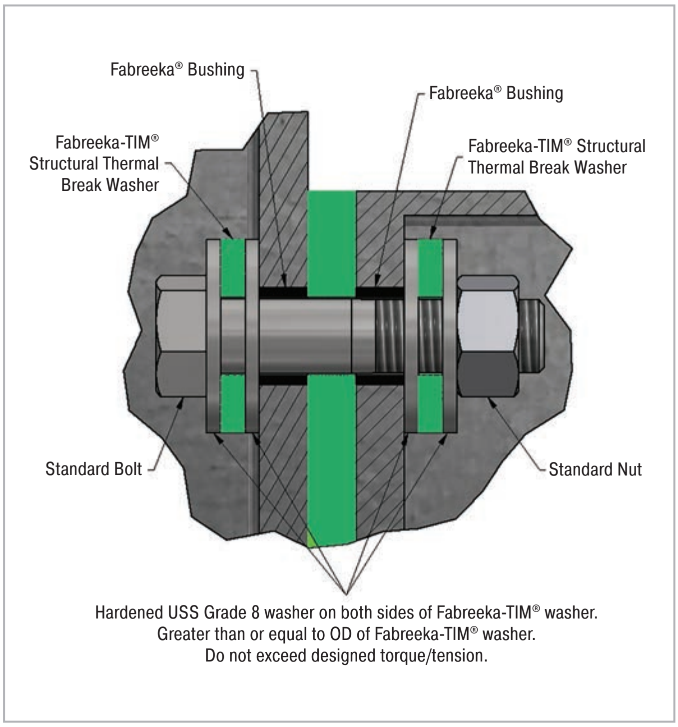
Connection F shows optimal performance. Stainless steel bolts are used in conjunction with Fabreeka-TIM® Structural Thermal Break pad and washers and Fabreeka Pad bushings, significantly reducing heat flow through the connection.

Thermal Washers and Bushings

End Plate Connection



Typical Bushing /Washer Arrangement



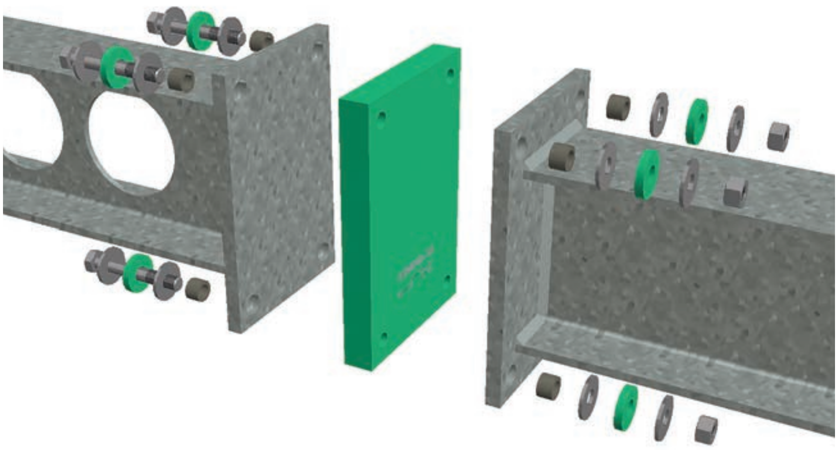
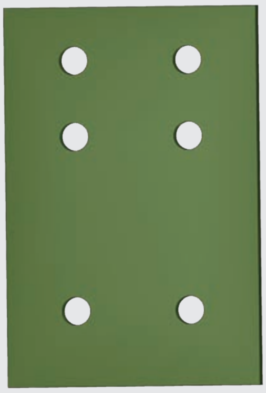


Table 1 - Typical Thermal Washer and Bushing Sizes

Bolt Dia	Washer Outside Diameter (OD)	Washer Inside Diameter (ID)	Bushing Outside Diameter (OD)	Bushing Inside Diameter (ID)
M12 (1/2 in)	34.9 mm (1-3/8 in)	14.3 mm (9/16 in)	20.6 mm (13/16 in)	14.3 mm (13/16 in)
M16 (5/8 in)	44.5 mm (1-3/4 in)	17.5 mm (11/16 in)	23.8 mm (15/16 in)	17.5 mm (11/16 in)
M20 (3/4 in)	50.8 mm (2 in)	20.6 mm (13/16 in)	27 mm (1-1/16 in)	20.6 mm (13/16 in)

Note: Steel washers must be USS grade 8 and cover the entire top and bottom surface of the thermal washer.

Overview of Fabreeka® Thermal Breaks

Name	Fabreeka-TIM® Structural	Fabreeka® Pad	Fabreeka-TIM® LT15	Fabreeka-TIM® LT5
Material	Composite GFRP	Composite NBR/Fabric	Recycled Rubber	Recycled Rubber
				
Key Features	Designed for Moment Connections	Military and Government Grade Anti-Vibration	Recycled Economical	Recycled Economical
Max Compressive Load	Heavy	Medium	Light	Lighter
Typical Applications	Structural Steel	Steel-to-Concrete	Steel-to-Concrete Steel-to-Steel	Light Steel
	Steel grade plate for moment connections. Typical applications: • Balconies • Balustrade • Canopies • End beams • Rooftop dunnage posts • Cold storage • Data centres	For connections with compressive loads, where shock or vibration is of a concern. Deflection and rotation of the pad can be tailored to your application. Typical applications: • Concrete and precast joints • Heavy industry and pipelines • Bridges, rail, tunnels and other infrastructure • Roof mounted structures and exterior HVAC units	Primarily for cost sensitive projects where the load is negligible or uniformly distributed. Typical applications: • Parapets, soffits, roof to wall transitions • Steel stud exterior walls, facades • Masonry ties • Concrete and precast joints • Metal building framing • Cladding attached support clips for Z-girts, C-channels and Hat channels	Primarily for cost sensitive projects where the load is negligible or uniformly distributed. Typical applications: • Parapets, soffits, roof to wall transitions • Steel stud exterior walls, facades • Masonry ties • Metal building framing • Cladding attached support clips for Z-girts, C-channels and Hat channels

Properties of Fabreeka-TIM® Structural Thermal Break

Fabreeka-TIM® Structural Thermal Break is a composite resin glass fibre reinforced plastic (GFRP) with an unrivalled combination of high compressive strength and low thermal conductivity.

Independent laboratory testing has been carried out by various testing establishments including The British Board of Agrément (BBA) and the Building Research Establishment (BRE), this has been verified by the Steel Construction Institute (SCI) with design guidance[4] for the available thicknesses of 6.4 mm (1/4 in), 12.7 mm (1/2 in), 19.1 mm (3/4 in), 25.4 mm (1 in) and 50.8 mm (2 in).

Table 2 - Fabreeka-TIM® Structural Thermal Break Plate Properties

Mechanical Properties (Nominal)			
	Fabreeka-TIM® 12.7mm (1/2 in) Thick Structural Thermal Break	**Fabreeka-TIM® 25.4mm (1 in) Thick Structural Thermal Break**	**Test Standard**
*Characteristic Compressive Strength (at room temperature)	240 MPa (34.8×10^3 PSI)	224 MPa (32.5×10^3 PSI)	ASTM D695
*Characteristic Compressive Strength (at -29°C)	264 MPa (38.3×10^3 PSI)	245 MPa (35.5×10^3 PSI)	ASTM D695
Elastic Modulus	2007 MPa (291.2×10^3 PSI)	3582 MPa (519.5×10^3 PSI)	ASTM D695
Density	1799 kg/m^3 (112.3 lb/ft^3)		NA
Water Absorption	0.289% of dry weight		BS EN ISO 62
Creep (Nominal)			
Long Term Creep	16.8%	35.6%	ASTM D2990
Creep (from 0 to 100hrs)	12.2%	22.3%	
Design Creep Allowance	15.5%	28.3%	
Resistance to Fire (Nominal)			
Flame	Ignition Source B Unmarked		BS 476 Part 12: 1991
Oxygen Index	26.2% O_2		BS EN ISO 4589-2: 1999
Thermal Properties (Nominal)			
Thermal Conductivity	0.252 W/mK (1.747 BTU • in/h • ft² • °F)		ASTM C177
Coefficient of Thermal Expansion	22×10^{-6} mm/mm/°C (22×10^{-6} in/in/°C)		ASTM D696
Operating Temperature Range[5]	-29 to +121°C (-20 to +250 °F)		NA

Where 1 MPa = 1 N/mm^2

*The characteristic values for design to BS EN 1993-1-8 should be converted by using a partial safety factor of 1.25 defined in the UK National Annex. This value is considered appropriate by the SCI for Fabreeka-TIM® Structural Thermal Break due to the mode of failure and the consistency of the test results. Extrapolated results for other thicknesses are available upon request.

Fabreeka® Pad is a military (MIL-C-882 and MIL-E-5272-A) and government (AASHTO 18.4.9.) infrastructure grade Thermal Break and Bearing pad. The resilient laminated fabric pad is impregnated with an elastomeric nitrile rubber compound containing mould and mildew inhibiting agents.

Table 3 - Fabreeka-TIM® Thermal Break Pad Properties

Where 1 MPa = 1 N/mm^2 Note: In addition to these standard range pads, application specific products can be developed to meet individual requirements.

Material Properties (Nominal)			
	Fabreeka® Pad Thermal Break	**Fabreeka-TIM® LT15**	**Fabreeka-TIM® LT5**
Available Thickness	1.6mm (1/16 in), 2.4mm (3/32 in), 3.2mm (1/8 in), 6.4mm (1/4 in), 9.5mm (3/8 in), 12.7mm (1/2 in), 19.1mm (3/4 in), 25.4mm (1 in).	3.2mm (1/8 in), 6.4mm (1/4 in), 9.5mm (3/8 in), 12.7mm (1/2 in), 19.1mm (3/4 in), 25.4mm (1 in).	3.2mm (1/8 in)
Design Value for Compressive Stress*	13.8 MPa (2000 PSI)	10.34 MPa (1500 PSI)	3.45 MPa (500 PSI)
Density	1185 kg/m^3 (74 lb/ft^3)	1153-1384 kg/m^3 (72 - 86.4 lb/ft^3)	1015 kg/m^3 (63.4 lb/ft^3)
Thermal Conductivity	0.274 W/mK (1.9 BTU • in/h • ft² • °F)	0.114 W/mK (0.792 BTU • in/h • ft² • °F)	0.114 W/mK (0.792 BTU • in/h • ft² • °F)
Operating Temperature Range	-55 to +95°C (-65 to +200°F)	-40 to +70°C (-40 to +158°F)	-40 to +70°C (-40 to +158°F)

*Including a conservative factor of safety to allow for dynamic response and energy return. Characteristic compressive strength values as per Eurocode BS EN 1993-1-8:2005 are available upon request.

[4] SCI Assessed Report - Fabreeka-TIM® Structural Thermal Break. *The Steel Construction Institute (SCI)*. RT1729v3: July 2017. http://www.sci-assessed.com/product/1704

[5] Ultimate strength reduction of 30% at 121°C (250°F)

On and Off-Site Support

We are here to discuss your application and assist you in selecting the right thermal break materials to meet your projects specification.

Identification	Specification	Integration	
Thermal Modelling	Structural Analysis	Cost Benefit Analysis	Installation
Architect →	Structural Engineer →	Fabricator →	Contractor
Fabreeka Technical Support			

Fabreeka® has been committed to providing the utmost in quality and service to our customers since our incorporation in 1917. The experience of our technical staff in addressing vibration, shock and thermal concerns will prove invaluable on your building and construction project.

Fabreeka® can support you with thermal modelling, structural analysis, cost benefit analysis and the planning for installation of thermal break solutions from any of our worldwide manufacturing facilities.

We can ensure that the goals of your project are given thorough attention through all phases of the identification, specification and integration of a thermal break. Fabreeka® has a well-developed organisational structure to guide communication amongst all parties, maintain quality and exceed your expectations.

CPD CERTIFIED
The CPD Certification Service
Collective Mark

CPD Approved Online Course Available

FBC1003 Introduction to Thermal Breaks

ACE Fabreeka UK also offers this course to give trainees the basic knowledge required to identify opportunities for the application of thermal breaks and structural thermal breaks.

How To Order

Send us both a detail and a fabrication drawing; we will then guide you through the procurement process.

Please note, the structural engineer responsible for the project must specify the material, thickness and dimensions of the thermal break, taking into consideration the structural characteristics of the connection.

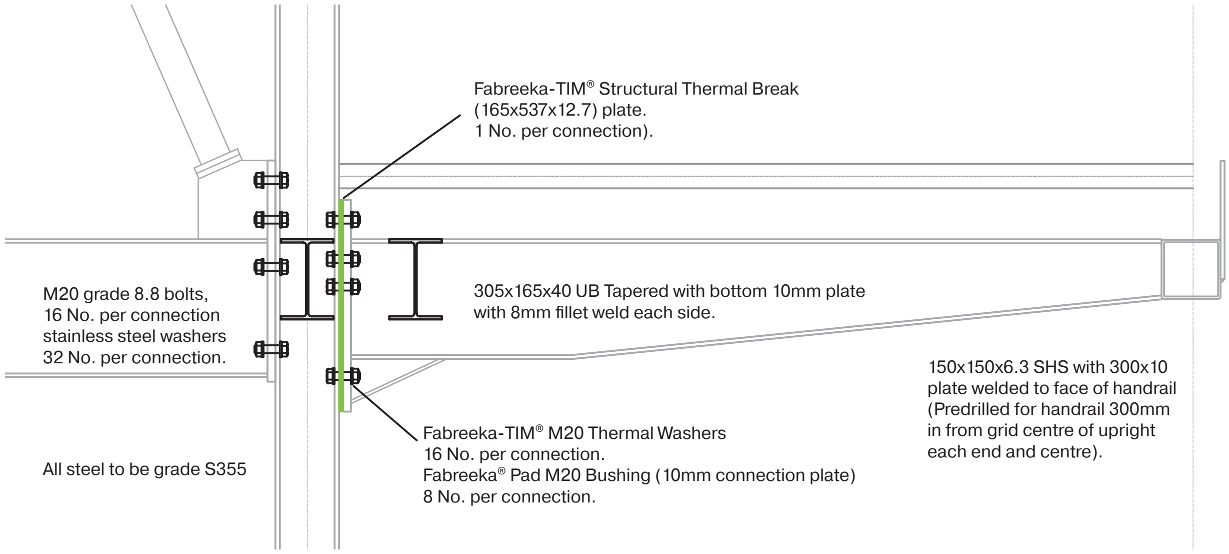


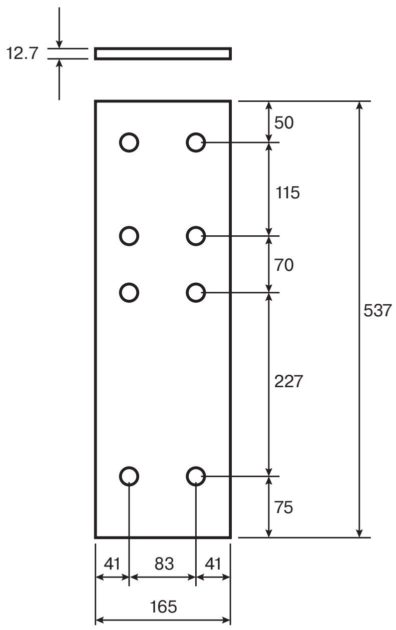
Figure 1 - Example Detail Drawing

Detail Drawing

The detail drawing should show the location of the Fabreeka-TIM® Structural Thermal Break plate (Moment connections) or Fabreeka-TIM® Thermal Break Pad (uniformly distributed load), detailing the other materials specified in the connection, including the connection plate thickness and fastener size (Figure 1). The designer/architect of the building or structure can use this detail to calculate the thermal transmittance (U-value) of this joint taking into consideration all of the components in the assembly. Please let us know if you require washers and bushings to complete the thermal break connection.

Fabrication Drawing

Ideally sent in .dxf file format, the fabrication drawing must specify the material, quantities, dimensions of plate or pad, hole size and location(s) (Figure 2).



Fabreeka-TIM® Structural Thermal Break

4 No. 165x537x12.7

Figure 2 - Example Fabrication Drawing

Other Engineered Building and Construction Products and Services.

In addition to Fabreeka® Thermal Breaks, ACE Fabreeka UK also offers a market leading range of vibration and shock control products and engineered material solutions in two other key product areas to architects and specifiers.

These two areas are:

Foundation Isolation

We offer a bespoke collection of elastomeric or pneumatic systems optimised by our experts to isolate the foundations of laboratories, universities and advanced manufacturing facilities.

Bearing Pads

An extensive choice of military and government infrastructure grade bearing pads, washers and bushings are typically integrated to control expansion, rotation and motion of bridges, buildings and complex structures.

To find out more about our full range of products used in the building and construction sectors, contact us now!

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