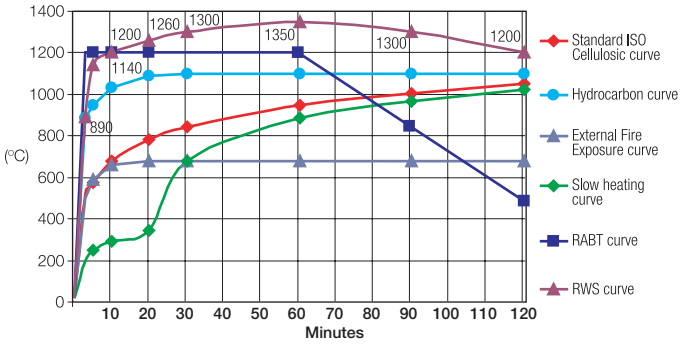
FIRE TESTING METHODS

The fire performance of any system will vary depending on the heating conditions to which it is exposed. National and international fire curves have been developed for differing fire exposures. Examples of fire curves carried out in test furnaces by recognised national organisations are as follows:



1. The Standard Cellulosic Time-Temperature Curve

This ISO-based curve is used in standards throughout the world, including BS 476, AS 1530, DIN 4102, ASTM and the new European Norm (BS EN 1363-1). It is a model of a ventilated controlled natural fire, i.e. fires in a normal building. The temperature increase after 30 minutes is 842°C.

2. The Hydrocarbon Curve

This curve is a simulation of a ventilated oil fire with a temperature increase of 1110°C after 30 minutes. The Hydrocarbon Curve is applicable where petroleum fires might occur, i.e. petrol or oil tanks, certain chemical types etc. In fact, although the Hydrocarbon Curve is based on a standardised type fire, there are numerous types of fire associated with petrochemical fuels, which have wide variations in the duration of the fire, ranging from seconds to days.

3. The RABT Curve

This curve was developed in Germany as a result of a series of test programmes such as the Eureka project. In the RABT Curve, the temperature rise is very rapid up to 1200°C within 5 minutes.

The duration of the 1200°C exposure is shorter than other curves with the temperature drop off starting to occur at 60 minutes.

4. The RWS Curve (Rijkswaterstaat)

This model of a petroleum based fire of 300MW load fire in an enclosed area such as a tunnel, has been developed in the Netherlands and is specified for use in tunnels. It is internationally accepted. The temperature increase after 30 minutes is 1300°C.

5. The External Fire Exposure Curve

This model is for fire exposure external to a building and open to the atmosphere, where there are additional possibilities for heat dissipation. There is a lower level of heat exposure, and the temperature increase is approximately 680°C after 20 minutes and remains constant throughout.

6. The Slow Heating Curve

This curve simulates a slow growing fire. It is basically a combination of two curves, one for the first 21 minutes representing the smouldering effect of materials and one for subsequent periods representing the growth of the fire towards flashover.

As well as controlling the exposure temperature, the test standards require that the air pressure within the test furnace is maintained at a positive level in an attempt to create a worse case scenario and force hot gases and flame though the specimen under test. Thermocouples are fixed to the unexposed face of the specimen to measure the insulation against heat provided by the construction.

FIRE TESTING PERFORMANCE

Fire resistance is not a property of an individual material but is the measure of the performance of a complete system or construction when exposed to standard heating conditions. The failure criteria of elements of building construction when tested in accordance with BS 476: Parts 20-24 are as follows:

Loadbearing Capacity

The ability of a specimen of a loadbearing element to support its test load, where appropriate, without exceeding specified criteria with respect to either the extent of, or rate of deformation, or both.

Integrity

The ability of a specimen of a separating element to contain a fire to specified criteria for collapse, freedom from holes, cracks and fissures and sustained flaming on the unexposed face.

Insulation

The ability of a specimen of a separating element to restrict the temperature rise of the unexposed face to below specified levels (usually 140°C mean rise, 180°C maximum rise).

Stability

The ability of a ductwork system to maintain its intended function.

FIRE TESTING STANDARDS

The fire performance standards most commonly referred to are the British Standards (BS 476: Parts 20 to 24). The new European Norms (EN 1363 - 1366) will replace BS 476 gradually and the current equivalents are as given below:

BS 476: Part 20: 1987 (BS EN 1363-1: 1999)
Methods for determination of the fire resistance of elements of construction (general principles).

This part describes the general procedures and equipment required to determine the fire resistance of elements of construction. It should be read in conjuction with BS 476: Parts 21-24 as appropriate, which describe the detailed procedure for the testing of individual elements of construction.

BS 476: Part 21: 1987 (BS EN 1365: Parts 1 to 4)
Methods for determination of the fire resistance of loadbearing elements of construction

This standard describes methods for determining the fire resistance of loadbearing beams, columns, floors, flat roofs and walls. Beams and columns are assessed in terms of loadbearing capacity, whilst dividing elements such as floors, flat roofs and walls are measured in terms of loadbearing capacity, integrity and insulation.

BS 476: Part 22: 1987 (BS EN 1364: Parts 1: 1999 and 2: 1999) Methods for determination of the fire resistance of non-loadbearing elements of construction

This standard describes methods for determining the fire resistance of non-loadbearing partitions, doorsets, shutter assemblies, ceiling membranes and glazed elements of construction with respect to integrity, and where appropriate, insulation.

BS 476: Part 23: 1987
Methods for determination of the contribution of components to the fire resistance of a structure

This standard describes test methods for:

a) determination of the contribution of suspended ceilings to the fire resistance of steel beams; and
b) determination of the contribution of intumescent seals to the fire resistance of timber door assemblies.

BS 476: Part 24: 1987 (BS EN 1366-1: 1999)
Methods for determination of the fire resistance of ventilation ducts

This standard describes the methods used to test and measure the ability of a duct assembly to prevent the spread of fire from one fire compartment to another. Results are expressed in terms of stability, integrity and insulation.

BS 7346: Part 3: 1990
Specifications for smoke curtains

This standard describes methods for determining the fire resistance of smoke curtains where those items are used as part of a smoke control system.

DURASTEEL®

Applications

- Ductwork, smoke extraction
- Service enclosures
- Walls, partitions, service shafts, lift enclosures, cavity barriers, smoke plenums
- Membrane ceilings, plenum chambers
- Industrial, valve box enclosures, fuel pipe protection
- Fire doors

Typical Mechanical Properties

Flexural strength $F_{rupture}$	6mm	Average, dry	N/mm²	109
	9.5mm	Average, dry	N/mm²	84
Modulus of elasticity E	6mm	Average, dry	N/mm²	55,000
	9.5mm	Average, dry	N/mm²	40,000

General Description

DURASTEEL® is a non-combustible composite panel of fibre reinforced cement mechanically bonded to punched steel sheets on both surfaces.

DURASTEEL® has been developed and supported through rigorous testing for use in partitioning, ducting, door and ceiling applications, with a wide range of specifications available.

DURASTEEL® systems combine lightness, strength, impact resistance and durability with exceptional fire resistance. These systems remain resistant to firefighters' hoses, leaving them capable of performing their original function even in the aftermath of a fire. DURASTEEL® systems have been used successfully for many years, including rail and metro projects, military developments and in commercial, pharmaceutical and petrochemical facilities.

A health and safety data sheet is available from the Promat Technical Services Department and, as with any other materials, should be read before working with the board. The board is not classified as a dangerous substance and so no special provisions are required regarding the carriage and disposal of the product to landfill. They can be placed in an on-site skip with other general building waste which should be disposed of by a registered contractor.

Table 1. General Technical Data

Material class		Non-combustible
Surface spread of flame		Class 1
Building Regulations classification		Class 0
Alkalinity (approximately) pH (core)		10-13
Thermal conductance (approximately) at 20°C W/m²K		60 (9.5mm)
Coefficient of expansion (20-100°C) m/mK		15 x 10^{-6} (9.5mm)
Nominal moisture content (air-dried) %		6
Moisture movement (ambient to saturated) %		–
Thickness tolerance of standard boards	6mm	+1.5 to -0.0
	9.5mm	+1.0 to -1.0
Length x Width tolerance of standard boards mm		±2.0

Table 2. Board Format Data

Thickness (mm)	Length x Width (mm)	Approx.Weight (Kg/m²)	
		Dry	With approx. 6% moisture
6	2500 x 1200	15.9	16.8
9.5	2500 x 1200	19.8	21.0

NOTE: *All physical property values are averages based on standard production. The figures can change dependent on the test methods used. If a particular value is of prime importance for a specification, please contact Promat Technical Services Department.*

PROMALIT®

Applications

- Structural steelwork
- Composite panels
- Door cores
- Ductwork

General Description

PROMALIT® is an inert mineral fibre board. It is light green in colour and is normally used in the fire protection of structural steel, and as a thermal insulation core for composite structures and fire doors.

PROMALIT® is available unfaced or faced with a reinforced scrim or aluminium foil. It is manufactured in accordance with a BS EN ISO 9000 quality management system.

PROMALIT® is resistant to the effects of moisture and is suitable for internal and semi exposed external applications.

PROMALIT® is generally installed using PROMALIT FIXINGS. These are spiral screws made from 16 s.w.g. galvanised wire.

A health and safety data sheet is available from the Promat Technical Services Department and, as with any other materials, should be read before working with the board. The board is not classified as a dangerous substance and so no special provisions are required regarding the carriage and disposal of the product to landfill. They can be placed in an on-site skip with other general building waste which should be disposed of by a registered contractor.

Table 1. General Technical Data

Designation	Mineral fibre
Material class	Non-combustible
Surface spread of flame	Class 1
Building Regulations classification	Class 0
Nominal dry density (average) Kg/m³	160
Thermal conductivity (approximately) at 20°C W/mK	0.034
Nominal moisture content (air-dried) %	1.0
Thickness tolerance of standard boards mm	+4.0 to -2.0
Length x Width tolerance of standard boards mm	±3.0
Surface condition	Reinforced scrim or Aluminium foil

Table 2. Board Format Data

Thickness (mm)	Length x Width (mm)	Approx.Weight (kg/m²) Dry	Thermal Resistance (m² K/W)
20	1800 x 1200	3.2	0.59
25	1800 x 1200	4.0	0.74
30	1800 x 1200	4.8	0.88
35	1800 x 1200	5.6	1.03
40	1800 x 1200	6.4	1.18
45	1800 x 1200	7.2	1.32
50	1800 x 1200	8.0	1.47
55	1800 x 1200	8.8	1.62

NOTE: *All physical property values are averages based on standard production. The figures can change dependent on the test methods used. If a particular value is of prime importance for a specification, please contact Promat Technical Services Department.*

PROMATECT®-L500

Applications

- Ventilation and smoke extract ducts
- Mechanical & electrical service enclosures
- Service enclosures
- Cable protection

Typical Mechanical Properties

Flexural strength $F_{rupture}$	Average, dry	N/mm²	3.0
Tensile strength $T_{rupture}$	Average, dry	N/mm²	1.2
Compressive strength (average, dry perpendicular to board face)		N/mm²	5.5

General Description

PROMATECT®-L500 is a non-combustible low density calcium silicate board, used for the construction of fire resistant ducts. It is a Class 0 product as defined in the Building Regulations.

PROMATECT®-L500 is off-white in colour and has a smooth sanded surface on one face with a lightly honeycombed texture on the reverse face.

PROMATECT®-L500 is resistant to the effects of moisture and will not physically deteriorate when used in damp or humid conditions. Performance characteristics are not degraded by age or moisture. Untreated surfaces will absorb water which can cause some loss of strength, but full strength is regained after drying. It will not encourage mould growth and is resistant to attack by insect or vermin.

PROMATECT®-L500 is chemically inert and is resistant to dilute acids and alkalis. Boards should be protected where high chemical concentrations are likely to occur.

A health and safety data sheet is available from the Promat Technical Services Department and, as with any other materials, should be read before working with the board. The board is not classified as a dangerous substance and so no special provisions are required regarding the carriage and disposal of the product to landfill. They can be placed in an on-site skip with other general building waste which should be disposed of by a registered contractor.

Table 1. General Technical Data

Designation		Calcium silicate
Material class		Non-combustible
Surface spread of flame		Class 1
Building Regulations classification		Class 0
Nominal dry density (average) Kg/m³		500
Alkalinity (approximately) pH		9
Thermal conductivity (approximately) at 20°C W/mK		0.09
Coefficient of expansion (25-105°C) m/mK		7.0 x 10^{-6}
Nominal moisture content (air-dried) %		3-5
Moisture movement (ambient to saturated) %		≤ 0.15
Thickness tolerance of standard boards mm		±0.5
Length x Width tolerance of standard boards mm		±3.0
Surface condition	**Front face:**	Smooth, sanded
	Back face:	Honeycomb pattern

Table 2. Board Format Data

Thickness (mm)	Length x Width (mm)	Approx.Weight (kg/m²)	
		Dry	With approx. 5% moisture
20	2500 x 1200	10.0	10.5
25	2500 x 1200	12.5	13.1
30	2500 x 1200	15.0	15.8
35	2500 x 1200	17.5	18.4
40	2500 x 1200	20.0	21.0
50	2500 x 1200	25.0	26.3
52	2500 x 1200	26.0	27.4
60	2500 x 1200	30.0	31.5

NOTE: *All physical property values are averages based on standard production. The figures can change dependent on the test methods used. If a particular value is of prime importance for a specification, please contact Promat Technical Services Department.*

VICUCLAD®

Applications

- Fire protection of metal ducts
- Construction of smoke extract ducts
- Mechanical & electrical service enclosures

Typical Mechanical Properties

Flexural strength $F_{rupture}$	Average, dry	N/mm²	0.8
Modulus of elasticity E	Average, dry	N/mm²	940
Compressive strength (average, dry perpendicular to board face)		N/mm²	0.95

General Description

A non-combustible board in which the unique cellular structure of vermiculite is maintained and controlled by a pre-treatment process. This gives excellent thermal insulation properties with dimensional stability at high temperatures. It is used to provide up to 240 minutes fire protection to protect sheet metal ducts and for the construction of smoke extract ducts.

This versatile material is also produced in semi-circular sections known as VICUTUBE®, which is used to protect circular steel sections and plastic pipes.

VICUBOND® WR

A ready-to-use, one part non-combustible cement for fixing VICUCLAD® boards to structural steelwork and to adjacent boards. It may also be used for gap filling. Delivered as semi liquid in 10 litre drums. Allow 1 litre for each 1.5m² of 25mm VICUCLAD® board. Other thicknesses require a pro-rata amount.

A health and safety data sheet is available from the Promat Technical Services Department and, as with any other materials, should be read before working with the board. The board is not classified as a dangerous substance and so no special provisions are required regarding the carriage and disposal of the product to landfill. They can be placed in an on-site skip with other general building waste which should be disposed of by a registered contractor.

Table 1. General Technical Data

Designation	Vermiculite
Material class	Non-combustible
Surface spread of flame	Class 1
Building regulations classification	Class 0
Nominal dry density (average) Kg/m³	405
Alkalinity (approximately) pH	8-9
Thermal conductivity (20°C) W/mK	0.09
Coefficient of expansion (20-600°C) m/mk	16 x 10^{-6}
Nominal moisture content (air-dried) %	2-7
Standard thickness VICUCLAD® 900R mm	18-35
VICUCLAD® 1050R mm	45-75
Thickness tolerance (mm)	±1.5
Tolerance for length/width (mm) up to 40 mm	+6.0 to -0
45-80 mm	+10 to -0
Surface condition	Smooth, oatmeal texture and colour

Table 2. VICUCLAD® Board Format Data

Thickness* (mm)	Length x Width (mm)	Approx.Weight (kg/m²)	
		Dry	With approx. 6% moisture
18	1000 X 610	7.3	7.7
25	1000 X 610	10.1	10.7
35	1000 X 610	14.2	15.0
45	1000 X 610	18.2	19.3
55	1000 X 610	22.3	23.6
65	1000 X 610	26.3	27.9
75	1000 X 610	30.4	32.2

* Other thicknesses are available on request.

Table 3. VICUTUBE® Format Data

Internal diameter	Tolerance (mm)	Wall thickness (mm) 30	40	50	Tolerance (mm)
48	+2 to +5			•	+2 to -1
60	+2 to +5	•	•	•	+2 to -1
76	+2 to +5	•	•	•	+2 to -1
89	+2 to +5	•	•	•	+2 to -1
114	+2 to +5	•	•	•	+2 to -1
140	+2 to +5	•	•		+2 to -1
168	+2 to +5	•	•		+2 to -1
194	+2 to +5		•		+2 to -1
219	+2 to +6	•	•		+2 to -1
245	+2 to +6		•		+2 to -1
273	+2 to +6		•		+2 to -1

Standard format: Semi circular x 667mm long

NOTE: *All physical property values are averages based on standard production. The figures can change dependent on the test methods used. If a particular value is of prime importance for a specification requirement, please contact Promat Technical Services Department.*

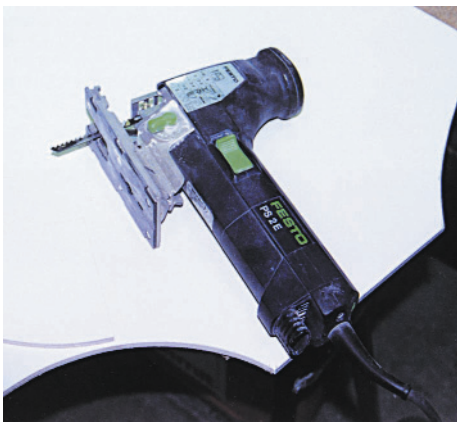
CUTTING

Promat boards can be worked with conventional woodworking equipment although the use of hand saws with hardened teeth is recommended.

Promat boards greater than 6mm in thickness may be more easily cut using a power circular saw in conjunction with tungsten carbide tipped blades, or a jigsaw. For rough cutting, 6mm sheets can be deeply scribed and broken over a straight edge.

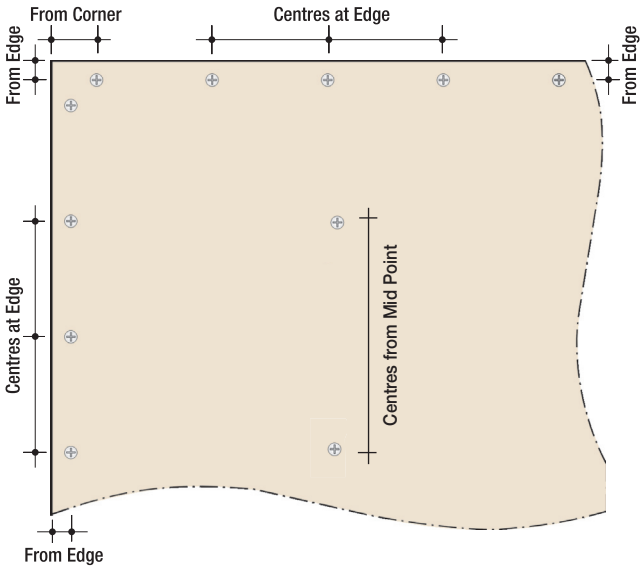
DURASTEEL® can be cut with a jigsaw around services etc. For the cutting of straight edges, a guillotine is recommended for large areas.

Promat recommend that all cutting should be carried out in well ventilated spaces, using dust extractors. Operators should wear protective face masks.



Cutting with a Jigsaw.

Cutting with a circular saw.



FASTENING & FIXING

1. Nailing

The most economical method of fastening is to use pneumatic nailing and stapling equipment.

Nails can be driven directly through boards, without pre-drilling (excluding DURASTEEL®), provided they are at least 12mm from the edge of the board, and the back face of the board is fully supported.

In areas of high humidity, galvanised nails should be used. Panel pins, oval or lost head nails should not be used. Nails should be located 40mm from corners.

Fixing guide as below, used with drawing above:

From Edge	From Corner	Centres at Edge	Centres from Mid Point
Min. 12mm	Min. 40mm	Min. 150mm	Max. 300mm

VICUCLAD® Vermiculite Board

Nails should be used in conjunction with VICUBOND® WR. When edge fixing to another board or VICUCLAD® nogging, the length of the nails should be twice the board thickness. When fixing to the face of another board or batten, nails should be half the board thickness from edge of the board.