

SINGLE PLY ROOFING MEMBRANES SIKA-TROCAL S, SG, SGK & SGMA

Technical Manual

Sika-Trocal®



Sika-Trocal®



CONTENTS

Introduction	4	Renovation	
Applications	5	Assessments	59
The Sika-Trocal Concept		Overlaying	60
Roof Waterproofing Sheets	6	Surface preparation, Upstands	61
Physical Properties	7	Adhered Roofs	
Ancillary Sheets	8	Product Installation	62
Ancillary Products	10	Typical Details	
Design Considerations		Upstand details	64
-Introduction	11	Drip edge, cappings and terminations	66
-References	11	Rainwater outlets	67
-Roof Build-up	11	Ballasted Roofs	
-Roof Types	11	Surfacing	68
-Decks	13	-Gravel ballast	68
-Methods of attachment	13	-Concrete pavers	68
-Selection of attachment method	13	-Timber decking	69
-Water vapour	14	-Roof gardens	70
-Conservation of Fuel and Power	15	Exposed areas, public access	71
-Insulation	16	Sitework	
-Air leakage	17	Handling, preparation and laying	72
-Incompatible materials and surfaces	18	Jointing Details	74
-Acoustics	20	Care and Maintenance	76
-External fire performance	20	Fixing Methods	
-Roof drainage, falls and upstands	20	Fasteners	77
-Access and walkways	22	Sika-Trocal metal discs	79
-Protection from following trades	23	Pressure plates	80
-Aesthetics	23	Wind Loading	
-Safety equipment	24	-Overview	82
-Mechanical services	24	-Calculations	82
General Principles			
Jointing Waterproofing Sheets	25		
Jointing Ancillary Products	27		
Laminated Metal	28		
Typical Details			
Upstand angles & counter flashing	32		
Downstand angles	34		
Parapets & Raincheck Kerbs	36		
Drip Edge	37		
Rainwater Outlets	37		
Penetrations – Services & Structural	39		
Access Equipment	45		
Cill, Rooflights, Kerbs and Balconies	47		
Lightning Protection	49		
Expansion and Movement Joints	50		
Walkways	52		
Hardstanding	54		
Steps and Angles	55		
Abutments	56		
Vertical Sika-Trocal	58		

INTRODUCTION

Products

Sika manufactures a wide range of single layer roof waterproofing membranes and associated ancillary products.

This manual is intended to provide technical information on the following products:

- Sika-Trocal S mechanically fixed, UV stabilised, exposed waterproofing membrane
- Sika-Trocal SG mechanically fixed, fibre glass restrained, UV stabilised, exposed waterproofing membrane
- Sika-Trocal SGK adhered, fibre glass restrained, fleece backed, UV stabilised, waterproofing membrane
- Sika-Trocal SGmA loose laid, ballasted waterproofing membrane
- Sika-Trocal Laminated Metal for creating upstand and angle profiles
- Sika-Trocal WBP & HD embossed walkway surfacing membranes
- Sika-Trocal T-Felt polyester fleece protection and separation layer
- Sika-Trocal S-Felt polypropylene fleece levelling and protection layer
- Sika-Trocal SBV heavy duty protection and separation layer
- Sika-Trocal S-VAP 500E vapour check
- Sika-Trocal S-VAP 5000E SA (self adhesive) polymer modified bitumen vapour control layer
- Sika-Trocal Metal holding down discs
- Sika-Trocal Tubes & Fasteners for securing Sika-Trocal S membrane and Insulation
- Sika-Trocal Adhesives for Sika-Trocal SGK membrane and suitable insulation
- Sika-Trocal Rainwater outlets – Sika-Trocal rigid PVC outlets, scuppers and overflows
- Sika-Trocal Accessories
- Various installation aids

Applications

Sika-Trocal products are light in weight, quick and easy to install and are suitable for both refurbishment and new build projects.

They can be laid onto flat, pitched or even vertical surfaces along with convex and concave curved surfaces, including wave form and domes.

History

The first Sika-Trocal flexible roofing sheets were produced in Germany in 1962 and since then they have gone on to be used in many different environments around the world. The first major project in the UK was commissioned in 1972 and we have been at the forefront of developing the UK market since then.

Service

Our extensive experience is available to all involved in the construction process to help achieve a properly conceived and detailed roofing project.

Licensed Contractors

Sika-Trocal materials are only available to, and laid by, roofing contractors licensed and trained in Sika-Trocal laying techniques. Additionally, where appropriate our Sika Roofing Field Technicians will visit site.

Specifiers

Specifiers, and others, can choose our products with confidence, derived from our very long successful track record. We have qualified staff available to advise on all relevant details and to find solutions to the challenging situations that inevitably arise.

Main Contractors

Main contractors can benefit from the use of trained and licensed roofing contractors and our site monitoring service.

Owners

Building owners can be reassured by the proven quality of Sika-Trocal materials and the experience of the licensed contractors who lay it.

APPLICATIONS

Sika-Trocal roof waterproofing membranes are suitable for use with virtually all commonly used substrates – including both new and refurbishment applications. They can be part of either warm or cold deck roofs – including mechanically fixed exposed, adhered exposed and ballasted types. The waterproofed surfaces may be flat, sloped, vertical, curved – convex or concave, waveform, domed, etc. Fully British Board of Agrément (BBA) Certified the Sika-Trocal membranes are currently stated to have a minimum life expectancy, in their opinion, of in excess of 30 years.

Sika-Trocal waterproofing sheets are restrained against wind uplift forces either by mechanical fasteners, ballasting or adhering.

Sika-Trocal Type S and Type SG are intended to be mechanically fastened, accommodating movement and transmitting the loads directly to the structural deck, Type SGK is adhered to suitable substrates and Sika-Trocal SGmA is to be loose laid under appropriate forms of ballast.

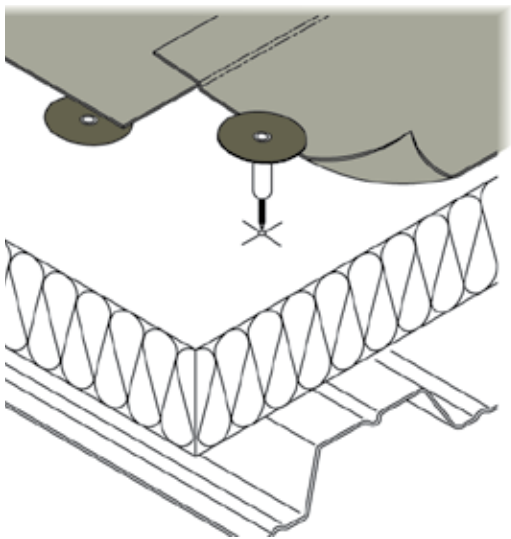
All Sika-Trocal membranes are installed onto the supporting structure and are connected at perimeters, changes of plane and penetrations by welding to continuous membrane faced Sika-Trocal metal or rigid PVC sections as appropriate.

All the individual sheets are welded to each other so as to form one complete waterproof layer over the entire roof surface. Where necessary the membrane can be protected from adverse reactions when in direct contact with either incompatible or abrasive materials, by the use of protective and cushion layers as required.

Finally, there are accessories available such as vapour control layers and such items as preformed corner pieces and the necessary solutions and applicators for welding operations.

Authority

British Board of Agrément (BBA) Certificate number 09/4668 has been awarded for the Sika-Trocal membranes. The products are also covered by BS EN 13956.



Benefits

Sika-Trocal single ply roofing offers quality in construction, convenience in installation and flexibility in use – underscored by excellent weathering characteristics and the reliability demonstrated by a successful track record in mainland Europe since 1962 and in Britain since 1972.

- Quick and easy to install achieving initial waterproofing in unrivalled time so that the concrete ground works can commence very early, followed by rapid progress to completion of the roof. This helps to ensure that today's fast track programmes can be met on site.
- The flexibility and elasticity of the membranes give extremely high fatigue resistance, ensuring that unexpected failure will not be caused by normal building movements.
- Light in weight, producing savings in the tonnage and cost of supporting steelwork required. Less steelwork also equals less time to erect.
- Impermeable to water yet allows water vapour to escape to help minimise the risk of interstitial condensation occurring.
- Minimum disruption on site – no naked flames or hot melt adhesives on the roof, reduces the health and safety risks and, therefore, insurance costs.
- Long working life expectancy, track record of minimum 30 years to first maintenance for the roof, giving clients peace of mind and control of future costs.
- Low maintenance membranes will not require any form of post installation treatments, such as paints or re-saturants to keep them in good condition during their working life, minimising running and maintenance costs for the client.
- (BBA) Agrément certificated, which satisfies Building Control Departments and gives confidence to clients and insurers.
- The long term experience and technical competence of the Sika-Trocal team, along with a commitment to excellence, helps to avoid unwanted surprises or avoidable problems on site.
- Supplied only to fully trained and Licensed Contractors to aid quality of work on site and minimising lost time for remedials.
- Excellent smooth appearance with the ability to make an attractive feature roof when required by the designers.
- A combination of some or many of the features noted above make a Sika-Trocal roof a very cost-effective solution.

THE SIKA-TROCAL CONCEPT

ROOF WATERPROOFING SHEETS

Sika-Trocal fully plasticised PVC membranes are specifically formulated and manufactured on computer controlled calendaring machines, using only ingredients of the best quality. This ensures the highest standards for products of this type. Calendaring ensures the most thorough mixing of the constituent components of the formulation along with the best compaction of the material, producing the densest mix and avoiding entrained air in the completed sheets for instance. We also manufacture the sheets to the stated thickness and do not deliberately exploit the minus 5% tolerance allowance permitted in the manufacturing standards. This ensures that the full performance of the sheet in terms of life expectancy and robustness will be met and give true value for money.

Sika-Trocal S

A homogenous sheet, that is without any polyester fabric carriers, intended to be used solely as an exposed roof waterproofing membrane restrained against wind uplift forces by mechanical fasteners. Containing ultra violet stabilisers and fire retardants, Type S is highly resistant to ageing and industrial pollutants and will require no further surface treatments or coverings or any other maintenance throughout its service life. The absence of any carrier within the membrane means that the natural flexibility and extensibility of the product is left unrestricted so it has the ability to be fully utilised in absorbing all the movements that occur on any roof without failure. Also, the elasticity of the membrane means that when dynamic wind loads are applied to the membrane the full dynamic force of that load is not directly transmitted to the fasteners, reducing the stress they would otherwise receive. The homogenous nature of the membrane also allows the use of 'plastic memory', stretching the membrane during manufacture so that when installed a limited amount of self tensioning will take place, removing the creases that are impossible to avoid during installation.

Type S membranes are not intended to be covered or ballasted, as they are not formulated to resist the effects that arise in that very different environment. We manufacture a specific product for that application, Type SGmA. A need sometimes arises that requires small areas of Type S to be covered; small items of roof mounted plant for instance. In these circumstances and in order to avoid a change of material to Type SGmA it is possible to weld a patch of SBV protective layer to the Type S so as to permit this to happen. Refer to page 54 for further information.

Sika-Trocal SG

An identical sheet to Type S with the addition of a layer of random glass fibres in the middle of its thickness which is designed to virtually eliminate shrinkage. This feature makes Type SG the material of choice on concave roof surfaces where the radius of the curve is 20 metres or less, the fibre glass layer preventing the Type SG sheet from tensioning itself and pulling away from the curved surface between the fasteners and creating facets on the roofscape.

Sika-Trocal SGK

An identical sheet to Type S with the addition of a layer of random glass fibres in the middle of its thickness which is designed to virtually eliminate shrinkage and provide the necessary dimensional stability. Also incorporates a polyester fleece imbedded to the underside of the membrane to provide a key for adhered applications. Often used for exposed membrane applications where the use of mechanical fasteners is inconvenient or not possible, renovation of existing roofs, cold stores, concrete decks or aesthetic reasons.

Sika-Trocal SGmA

A homogenous sheet, with the addition of a layer of random glass fibres in the middle of its thickness which is designed to virtually eliminate shrinkage and provide the necessary dimensional stability. Intended to be used solely as a covered roof membrane restrained against wind uplift forces by the dead weight of ballast. In certain applications, such as with timber decking for instance, it can also require the use of additional restraint in the form of mechanical fasteners as used with the S types, refer to page 69. Containing biocides, Type SGmA is highly resistant to ageing and industrial pollutants and the bacteria that flourish in the moist layer of dirt present at membrane level in all ballasted roofs for long periods of time. Like Type S the Type SGmA will not require any maintenance throughout its service life. Additionally, the membrane and its joints are root proof, which makes the material suitable for incorporation, if required, into a garden roof.

Type SGmA membranes are not intended to be exposed, as they are not formulated to resist the effects that arise in that very different environment. We manufacture specific products for that application, the Type S membranes.

THE SIKA-TROCAL CONCEPT

PHYSICAL PROPERTIES

Sika-Trocal Roofing Sheets				
Membrane Type	S	SG	SGK	SGmA
Duty	Exposed Mechanically Fixed		Exposed - Adhered	Non Exposed - Ballasted
Formulation Characteristics	Homogenous	Random glass fibre matrix Fleece backed Contains UV stabilisers		
Tensile Strength (N / mm ²) (N / 50mm)	12	9.5 / 8.5	600	9.5 / 8.5
Elongation at break (%)	250	200	50	200
Foldability at low temperature (0C)	25%			
Dimensional stability (%)	2.0	0.3	0.3	0.3
Max uniformly distributed load (kg / cm ²)	1.0			

For more detailed information refer to product data sheets.

Dimensions and Colours								
Type	Thickness mm	Width m	Length m	Weight Kg / m ²	Light Grey	Slate Grey	Beige	Traffic White
S	1.5	2.0	15	1.9	✓	✓		
	1.5	1.1	20	1.9	✓	✓		
	2.0	2.0	11.25	2.5	✓	✓		
	2.0	1.1	15	2.5	✓	✓		✓
SG	1.5	2.0	15	1.9		✓		
	1.5	1.1	20	1.9	✓			
SGK	1.2	2.0	20	1.6	✓	✓		
	1.5	2.0	15	2.1	✓	✓		
SGmA	1.5	2.0	20	1.9			✓	
	2.0	2.0	15	2.5			✓	
S Butt Strap	1.5	0.200	50	1.9	✓	✓		
SG Butt Strap	1.5	0.200	50	1.9	✓	✓		✓

Approximate RAL numbers: Light Grey – 7047, Slate Grey – 7015, Traffic White - 9016

THE SIKA-TROCAL CONCEPT

ANCILLARY SHEETS

Sika-Trocal Metal

Galvanised steel that has a top layer of Type S membrane factory laminated to one side and protective enamel the other. Supplied as flat sheet, Sika-Trocal Metal is cut and bent to form perimeter, drip edge, penetration and any other necessary profiles to which the membrane is secured by welding. Profiles are tailor made for each project. A similar material but laminated with a special membrane is used for the manufacture of the Sika-Trocal Metal discs, used to secure the Type S and Type SG type membranes against wind uplift forces.

Sika-Trocal S straps

Strips of Type S and SG materials pre-cut into standard widths and used as butt straps to joints in Sika-Trocal Metal profiles. Butt strap material is manufactured as a reversible product, light grey on one side and either slate grey or traffic white on the other.

Sika-Trocal WBP20

A layer of pyramidically embossed UV stabilised plasticised PVC sheet of 2mm thickness. This is welded to the Type S or SGK membranes as a slip resistant surface for walkways. In some circumstances a steel plate reinforcement may be required under the membrane. WBP20 is provided in slate grey or brick red so that the walkway paths across the membrane roof are clearly defined. Usually installed as original fitment as the roof is constructed.

Sika-Trocal WBP sheets are only intended to be exposed and are not to be covered or ballasted, as they are not formulated to resist the effects that arise in that very different environment.

Sika-Trocal HD Walkway

A heavy duty version of the WBP20 above, this is a layer of pyramidically embossed UV stabilised plasticised PVC sheet of 4mm thickness that is welded to the Type S or SGK membranes as a slip resistant surface for walkways. HD walkway is provided in slate grey so that the walkway paths across the light grey membrane roof are clearly defined. HD Walkway can be used as an alternative way of forming a walkway to that described above, usually when further routes are required after completion of the original installation.

Sika-Trocal HD sheets are only intended to be exposed and are not to be covered or ballasted, as they are not formulated to resist the effects that arise in that very different environment.

Sika-Trocal S-Felt Type T

A white 300 g/m² polyester fleece which is intended to be used as both a levelling and separation layer preventing contact between the waterproofing sheets and any rough/abrasive surfaces or incompatible materials. S-Felt T can also be used between membrane and any protective topping or pavers.

Sika-Trocal S-Felt Type A

A coloured polypropylene fleece 300g/m² for use underneath the waterproof membranes as a levelling layer over rough surfaces. Not bitumen compatible.

Sika-Trocal SBV

PVC skinned polyester fleece for use as a heavy-duty levelling and separation layer. Main usage is as a protective layer on top of Type SGmA, fleece side down, or on mechanically fixed membranes, fleece side up, when small items need to be located there.

Sika-Trocal S-VAP 500E vapour control layer

Polyethylene sheets that offer a reasonable level of resistance to the passage of water vapour into the roof construction for most projects where a vapour control layer is required.

Sika-Trocal S-VAP 5000E SA polymer modified bitumen vapour control layer

S-VAP 5000E is a multi-layer self-adhesive vapour control layer made of polymer modified bitumen with a glass-fibre mat reinforcement and an aluminium foil as the top layer. The aluminium foil provides high vapour resistance and S-VAP 5000E SA may also be used as a temporary waterproofing layer for up to 4 weeks.

Sika-Trocal sheet materials for other duties					
Description	Thickness (mm)	Width (m)	Length (m)	Weight (kgs/m ²)	Colour
Sika-Trocal Metal (plastic face only)	1.4 0.8	1.0	2.0 or 3.0	5.50	Light grey, Slate grey
WBP20	2.0	1.0	10	2.48	Slate grey/Brick red
HD walkway	4.0	1.0	10	4.90	Slate grey
Type T polyester fleece	2.5	2.0	50	0.30	White
Type A polypropylene fleece	1.9	2.0	50	0.30	Coloured
SBV	1.7	2.0	20	1.20	Black one side white the other
S-VAP 500E vapour control layer	0.15	5.0	25	0.145	Translucent
S-VAP 5000E SA vapour control layer	0.60	1.38	30 or 10	0.70	Top - Aluminium matt. Underside - Black with white release liner

Approximate RAL numbers: Light Grey – 7047, Slate Grey – 7015

THE SIKA-TROCAL CONCEPT

Ancillary Products

Sika-Trocal Metal Discs

Manufactured from Sika-Trocal Metal and for use in mechanically fastened roofs. The discs are mechanically secured into the roof deck by appropriate fasteners and cold welded to the underside of the membrane. Three discs types are available -

Type S1 - 4.9mm hole with a shallow dishing primarily intended for 'cold deck' applications, due to the shallow dishing, care is to be taken with the selection of the fixing head shape and size.

Type S2 - 4.9mm hole intended for use over insulation boards in 'warm roof' applications, with standard fixings.

Type S3 - 16mm dia hole for use in 'warm roof' applications where thermally broken fasteners are used.

Sika-Trocal S3 Disc Tube & Cap

Polypropylene tube & cap to be used in combination with the WO-48T x L fastener and Type S3 disc, for the mechanical fastening of Sika-Trocal Type S/SG waterproofing membranes and insulation boards.

WO-48T x L Sika-Trocal Fasteners

These self-tapping, carbon steel screw fasteners have a T25 torx head and are used in combination with the Sika-Trocal S3 disc tube & the S3 disc, or alternatively can also be used for non tube applications with the S1 / S2 disc. These combinations are used for securing Sika-Trocal S/SG waterproofing membranes and insulation to steel decks (0.7mm thick) and timber substrates such as Plywood and OSB (18mm thick).

Sika-Trocal Rainwater Outlets & Leafguards

The Sika-Trocal range of rainwater outlets are made of injection moulded rigid PVC allowing for direct welding of the membranes to the outlet. Vertical Outlets, Scuppers & Overflows are available in varying sizes. The SPL leafguard is designed to fit outlets 56 - 160mm and is easy to install. Made from rigid high quality polypropylene (PP) and acrylnitril butadiene styrol copolymer (ABS), it is robust and has excellent resistance to UV degradation.

Sika-Trocal Corner Pieces

Preformed internal and external corner pieces for additional security at corners. In Type S and Type SGmA formulations and colours to suit, the corner pieces are welded on top of the roofing sheets.

Sika-Trocal SE Profile

An extruded semi-flexible PVC profile to create standing seam or shadow effects by welding to the surface of the waterproofing.

Sika-Trocal THF Welding Agent

To form welded lap joints between individual roofing sheets and for jointing sheets to Sika-Trocal Metal or rigid PVC sections, also for securing membrane to the top side of the Sika-Trocal Metal discs. The Tetrahydrofurane solution is available in 5 litre and 1 litre cans.

Sika-Trocal Liquid PVC

To seal edges of seams and manufactured from a mixture of membrane and THF. The liquid is available in colours and formulations to suit and supplied in 2 litre cans.

Sika-Trocal L100 Cleaning Agent

To clean the surface of heavily soiled membrane prior to welding. The ethylacetate-based solution is supplied in 4kg cans. Generally not required for new work; water or water with mild detergent is generally sufficient for normal cleaning.

Sika-Trocal Polybottle

For the application of THF welding fluid and liquid PVC. The bottle is made from polyethylene and is 500cc capacity and comes with applicator tube for liquid PVC use.

Sika-Trocal Mini-jet and Flat Brushes

The Mini-jet is a cap-mounted brush that screws to the polybottle and allows the THF welding fluid to flow through it and be applied to the membrane surfaces. The flat brushes are for hand held use in applying the THF. The bristles are mechanically restrained, as the THF would loosen them if bonded in place or set into rubber.

Sika-Trocal Jointing Tape

Double sided jointing tape for sealing/jointing side and end laps of S-VAP 500E.

Sika C733 Adhesive

Contact adhesive for bonding PVC membranes to metal as required in certain details.

Sika C300 Adhesive

Polyurethane adhesive for bonding Type SGK membranes to suitable substrates.

Sika C200 Adhesive

Polyurethane adhesive for bonding suitable insulation boards to various substrates. Only boards that are listed on the "Sika-Trocal Adhered Systems Insulation List" should be used. For existing substrates Sika-Trocal Primer 600 may be required.

Sika-Trocal Primer 600

Primer 600 is used, where appropriate, as primer for applying the self-adhesive Sika-Trocal S-VAP 5000E SA vapour control layer to suitable substrates or where necessary, on existing substrates prior to the use of Sika-Trocal C200 insulation adhesive.

Sika-Trocal S-TR LC Clips

Proprietary lightning conductor clips that are hot air & solvent weldable, allowing easy application of both bare & PVC coated lightning conductor tape to Sika-Trocal membranes. Clips are manufactured from high performance polypropylene.

DESIGN CONSIDERATIONS

Introduction

The intention of this manual is to demonstrate best practice in the incorporation of Sika-Trocal roof waterproofing membranes and ancillaries into a roof construction. The information in this manual represents the experience and knowledge gained by us in the installation of our materials since the first roofs were constructed in Germany in 1962. Additionally, we have been involved in the UK since 1972 and have a wealth of experience of what does and does not work in our climate and with our standard forms of construction. Therefore, if the details and guidance provided here are followed, the building owner should be provided with a proven, long term, trouble free, reliable roof. This is the least they should expect and is a worthy goal for all the designers, main contractors, roofing contractors, etc involved in the construction process.

Over time there have arisen many solutions, ways and established practices that are sometimes used during the construction of single ply membrane roofs. Not all of them are successful or will survive the test of time. Many of these practices are rooted in the norms of mainland Europe where the standards of installation are different to those in the UK. If a principle or detail is not described or shown in this manual then it should not be incorporated into the design or construction of a Sika-Trocal membrane roof without our specific written agreement. In many cases the reason that a particular method or practice is not shown here will be because, with our very lengthy experience, we will have discovered that it does not provide a true long-term, maintenance free solution to the building owner.

In order to maintain the trust that specifiers, clients and contractors put in us when choosing to use our products, we may refuse to offer our guarantee for any roofs constructed so that they do not adhere strictly to the details, principles and guidance provided in this manual or any other written agreement entered into by us.

As part of our commitment to the industry to maintain high standards of construction we monitor sites where our materials are installed. Another important element in the achievement of maintaining standards on site is that we only sell our materials to roofing contractors who are trained and licensed by us.

We provide a full technical advice service to specifiers and others involved in the design and construction of Sika-Trocal single ply membrane roofs. We would encourage all to involve us at an early stage in a project - we are only a phone call away.

References

We will make reference to British Standards or Approved Documents, etc in this manual. This is intended to provide guidance and in all cases reference should be made to the original documents so that the full information is available.

The head code for the design of roofs is 'BS 6229 - Flat roofs with continuously supported coverings - Code of practice'. BS 6229 cross-refers to many other specific standards and codes of practice.

Roof Build-up

Sika-Trocal single ply membrane roof build-up's will generally consist of:

- Structural support generally provided by the builder.
- Deck providing continuous support to the roof build-up.
- Sika-Trocal vapour control layer (vcl), if required by calculation.
- Thermal insulation, if required.
- Sika-Trocal waterproofing membrane of appropriate type for the application.
- Sika-Trocal walkway surfacing membrane to permit maintenance foot traffic only on the roof's surface, if required.
- Heavyweight finish, to permit general foot traffic from the public or provide protection from physical damage, including discarded cigarette ends, if required. Sometimes used for aesthetic reasons also.

Roof Types

Warm roof - In a warm deck roof construction, the insulation is placed above the deck, ensuring that the deck remains at around the same ambient temperature as that being experienced within the building. This is the most widely specified form of roof. Warm roofs can be constructed as exposed membrane roofs or ballasted with large rounded gravel or pavers.

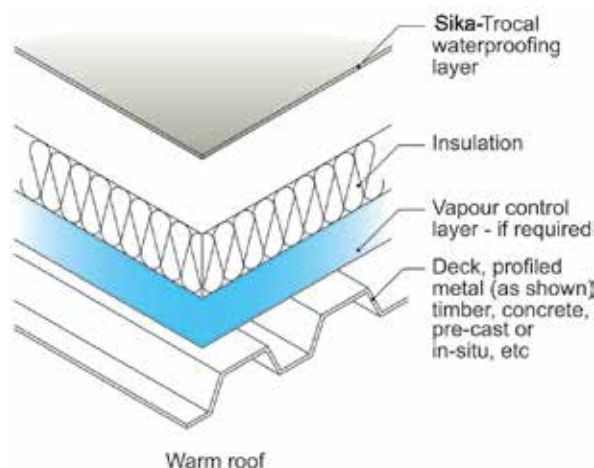
In the case of warm deck ballasted roofs, there is no technical advantage for the Sika-Trocal membrane in installing it under the insulation as an inverted roof. In this situation the membrane acquires an additional function as a vapour control layer and experience has demonstrated that it can, on occasion, create an increased risk of accidental interstitial condensation occurring within the deck.

This risk is created by cold rainwater percolating down between the insulation boards and running across the surface of the waterproofing and cooling it. To reduce this risk there needs to be a Sika-Trocal S-Felt Type T polyester fleece protective layer installed between the membrane and the underside of the insulation.

Note that the insulation board thickness is generally increased by around 20% to offset this cooling effect. The assessment of the level of risk of interstitial condensation occurring as described and any guarantees appertaining to this should be obtained from the insulation manufacturer as part of the design process.

There should also be a proprietary filter layer incorporated between the insulation board and the covering ballast. The filter layer should be as recommended by the insulation board manufacturer, note that when laid under pavers it should be UV resistant. Some manufacturers are able to offer an alternative high performance filter layer made from a non-woven polyethylene geotextile membrane which is claimed to reduce the amount of water percolating through the build up. One claimed benefit of this particular filter layer is a reduction in the cooling effect, which can reduce the extra insulation thickness required to as low as 2%. The continued in service performance of the high performance filter layer can only be sustained so long as it remains undisturbed and undamaged, therefore care and diligence will be required if any work is carried out on the roof.

Note, as a general rule the greater the thickness of insulation specified, the higher the dead weight/thickness of ballast required to prevent flotation of the boards, the insulation manufacturer can advise on precise figures.

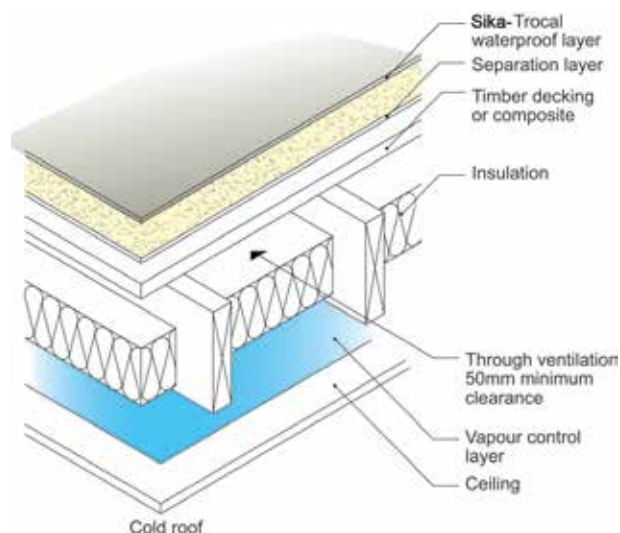


Cold roof - In a cold deck roof construction, where this is permitted by the Building Regulations, the insulation is placed between the rafters and below the deck, which is usually timber based, ensuring that the deck remains at around the same ambient temperature as that being experienced outside the building.

With a cold deck timber roof there is always the risk of condensation occurring within or above the insulation with consequent damage to the timber construction. Because of this risk the current Building Regulations require a minimum air gap of 50 mm between the top of the insulation and the underside of the deck. This air gap must then be ventilated by the use of airways created in the vertical faces at opposite ends of the roof. Note that ventilation airways placed elsewhere, i.e. on the top surface of the roof, that by extracting all the air from within the roof void tends to encourage the entry of moisture laden air from inside the building, failing to keep the roof space clear of condensation.

As insulation levels have risen, and they will probably continue to do so, it increases the risk of interstitial condensation occurring in this form of construction. Therefore, it is not a recommended option.

Uninsulated Roofs - A roof without thermal insulation, permitted only in the case of commercial or industrial buildings with requirement for heating, or external items such as canopies and where permitted by building regulations.



Decks

The deck can commonly be; profiled metal sheet, plywood, oriented strand board (OSB), timber, in situ, pre-cast and lightweight aerated concrete.

Pre-stressed concrete, whether in-situ or pre-cast, can pose a health and safety risk if mechanical fastenings are used and any of the tensioned wires within are damaged or cut during installation.

Unless the exact location of the wires in the concrete can be ascertained before installation commences, and therefore avoided, it could be advisable to utilise a structural concrete topping to provide a suitable fixing base.

Note also the difficulties of forming openings and penetration details through pre-stressed concrete.

Where pre-cast reinforced concrete units and composite constructions incorporating hollow tiles, pre-cast beams and planks etc are installed, a levelling screed will be essential due to the tolerances and curvature of these items.

Timber based particleboards (chipboard) and boards of compressed straw are no longer considered suitable decks for any purpose. If these types of deck are found in a roof refurbishment situation, the only recommendation can be total removal.

When constructing warm roofs it is important to avoid incorporating any timber-based products into the build-up above any vcl and the insulation in order to prevent them from being destroyed by any condensation. Ply topped insulation boards and timber based reinforcement to walkways should not be used, for example.

Methods of attachment

Sika-Trocal roof waterproofing sheets are restrained against wind uplift forces either by mechanical fasteners, the dead weight of ballast (gravel/pavers) or adhesives.

In the case of mechanical fasteners, the number of fixings required will be determined by calculation of the size and location of the various zones of influence of wind loading upon each individual roof. Guidance on this can be found in the Wind Loading section at the back of this book.

In the case of ballasted roofs, ballast will consist of rounded gravel 20–40 mm diameter at a minimum rate of 80kgs per square metre and 50mm thickness, or pre-cast hydraulically pressed concrete pavers of 50mm minimum thickness and approximately 120kgs per square metre. Gravel ballast of 20–40 mm diameter is required in order to provide resistance to the effects of wind scour, BRE Digest 311 refers, which can easily remove smaller units from the roof.

The use of timber decking can also be considered as a ballasted application but due to its general lack of sufficient dead weight to resist the wind forces, special measures need to be considered, refer to page 69.

In the case of adhered roofs, special fleece backed membranes are required to provide a key for bonding to the substrate. The maximum wind load that an adhered system can ultimately resist can be limited by the delamination resistance of the selected insulation board.

Selection of attachment method

Mechanically fixed - A mechanically fixed roof is generally quick and economical to install and because of its lightness in weight, will often enable savings to be made on the supporting structure. Additionally, as the membrane is exposed, any alterations are easily executed, as access is easy. Similarly, any damage is easy to spot and repair. The wide range of fasteners now available means that it is possible to mechanically fix an exposed Sika-Trocal membrane to virtually any type of deck.

The exposed, mechanically fixed membrane roof is the most widely specified option.

This type of roof is not suitable or intended to be heavily trafficked or subjected to public or leisure usage. Nor is it a suitable surface for an 'over-roof' fire escape route. If the roof under consideration is overlooked by windows in higher buildings, access paths, roads, patio areas etc, the risk of items such as discarded cigarette ends, bottles, rubbish etc, which can all cause damage, being thrown onto the roof surface needs to be taken into account. With overlooked roof surfaces the aesthetics should always be considered. In all these cases the alternative choice is likely to be a ballasted roof.

Factory Mutual Insurance specifications have very specific fastening and other requirements and all such applications should be discussed with Sika-Trocal Roofing before any irrevocable decisions are taken.

Ballasted - A ballasted (gravel/paved) roof will generally require a stronger supporting structure than that for the exposed membrane one, but will allow the roof to be used as a trafficked or leisure / utility area. Additionally, a ballasted roof will provide a higher degree of sound reduction and, if covered with a minimum 50mm depth of gravel ballast is deemed to achieve an FAA fire rating. Access to the membrane for the purpose of alterations or repair is obviously more difficult than with an exposed membrane roof. Ballast provides a good level of protection to the membrane from damage caused by discarded cigarette ends and other items that may get thrown onto the roof surface.

Roof gardens are also possible with the appropriate Sika-Trocal membranes and are essentially another form of ballasted construction.

Adhered - An adhered membrane could be considered for many refurbishment applications where the existing surface is sound and remains firmly attached to the substrate or for concrete decks where the use of mechanical fasteners may be slow and tedious. Additionally, as the membrane is exposed, any alterations are easily executed, as access is easy. Similarly, any damage is easy to spot and repair.

This type of roof is not suitable or intended to be heavily trafficked or subjected to public or leisure usage. Nor is it a suitable surface for an 'over-roof' fire escape route. If the roof under consideration is overlooked by windows in higher buildings, access paths, roads, patio areas etc, the risk of items such as discarded cigarette ends, bottles, rubbish etc, which can all cause damage, being thrown onto the roof surface needs to be taken into account. With overlooked roof surfaces the aesthetics should always be considered. In all these cases the alternative choice is likely to be a ballasted roof.

The ultimate wind uplift resistance of an adhered roof is dictated by the inter-laminar strength of the system.

The maximum permissible wind uplift will be dictated by the weakest bond within the system and therefore where an adhered system is proposed, consideration must be given to the bond strength between each individual layer.

Advice must be sought from the individual component manufacturers on the wind uplift limitations of their products.

Water vapour

Introduction - Water vapour and heat constantly flow into and out of any construction and its materials, including the roof. This movement is driven by the differences between the internal and external environments. In the majority of buildings warm moisture-laden air will rise where it is generally cooled, which makes it denser and less able to carry water vapour. As a result of the cooling of the air, any water vapour present is likely to be squeezed out as liquid water, or more precisely condensation, at some point. This is usually referred to as the 'dew point'. This dew point can occur within the roof construction itself or within the thickness of a material layer. This is referred to as interstitial condensation.

Condensation - Most roof constructions and materials will be able to tolerate a certain amount of condensate build-up in the 'winter period', however, it should be noted that different materials have different tolerance levels. The build-up of condensate in the 'winter' must not reach a level that it will not be cleared away by the conditions pertaining to the 'summer period'. It is these two factors that dictate the need for a vapour control layer. A vapour control layer is used as a means of reducing, or considerably reducing, depending on the level of risk, the flow of moisture into the roof construction.

Calculations in accordance with the provisions of BS 5250 will prove the required amount of vapour transmission reduction to limit damaging interstitial condensation. The Services Engineers or the manufacturers of the insulation material usually provide these calculations.

The greater the difference between the internal environmental factors of relative humidity and temperature and the external ones, the greater possibility there is of creating condensation.

Ideally, the vapour control layer (vcl) should always be installed on the 'warm' side of any insulation to ensure it is kept at as high a temperature as possible. However, some forms of construction utilising aerated concrete or any other 'insulating' materials mean that the vapour control layer has to be placed higher in the insulation sandwich. In these cases the calculation is of even greater importance as condensation occurring on the underside of the vcl becomes more likely because it is 'colder'.

The varying permeability of the different layers in the roof build-up can have an impact on how the roof will perform. It is of great importance that the outer layer of the roof offers as little resistance to the passage of water vapour as possible; this allows the roof to breathe.

Sika-Trocal plasticised PVC waterproofing sheets, in building terms, offer a comparatively low resistance to the passage of water vapour and this combined with the 'open topped' detailing to the upstands provides a roof that breathes easily. Conversely materials, such as many 'rubbers' and other different plastics that offer a much higher resistance tend to suffocate a roof by preventing it from breathing, leading to a more rapid build-up of condensate.

'Breather vents' have in the past been associated with the construction of certain types of flat roofing, they are, however, neither intended, nor suitable for use with Sika-Trocal membranes and should never be installed.

Notes - For ballasted roof applications, it should be noted that the frequent presence of a film of water across the surface of the membrane acts as a very effective vapour control layer and will inhibit the permeability of the membrane.

Where Sika-Trocal membranes are to be laid over a roof deck containing construction water, that is, insitu concrete and/or screeds, it is recommended in BS 6229 that a minimum vapour control layer, such as the S-VAP 500E, be laid to prevent too much of this entrapped water drying out upwards into the roof build up. This requirement is still necessary even if the calculation demonstrates that a vapour control layer is not necessary in 'service', because the calculation process takes no account of the entrapped water.

As highlighted in BS 6229, the excess construction water present in insitu concrete slabs and/or screeds must dry out downwards. In order to aid that process, there are recommendations about forming temporary drainage holes at the points of lowest sag of the slab. Refer to the standard for the full recommendations.

Where metal decking is used as permanent shuttering, BS 6229 states that even with the drainage holes formed as the previous paragraph, the concrete will not be able to fully dry out downwards. Therefore this should be taken into account at design stage.

If an un-bonded wet screed is to be used to create falls, then it should be a minimum of 65mm thickness and no greater than 200mm in accordance with BS 6229. Screeds of all types must only be laid below the vapour control layer.

When a vapour control layer is installed beneath insulation it is considered good practice to 'wrap' it around the ends of the boards and 'trap' it under the Sika-Trocal Metal edge profiles.

Material	Thermal/Vapour Values		
	Vapour resistance MNs/g (23°C, 85% RH)	Thermal conductivity W/m°C	Specific Heat J/kg°C
S 1.5mm	138	0.16	900
S 2.0mm	183	0.16	900
SG 1.5mm	147	0.17	900
SGK 1.2mm	110	0.16	1000
SGK 1.5mm	147	0.16	1000
SGmA 1.5mm	147	0.17	900
SGmA 2.0mm	196	0.17	900
SBV	15	0.15	900
S-Felt Type T	NIL	0.10	1100
S-Felt Type A	NIL	0.10	1100
S-VAP 500E	576	0.50	1200
S-VAP 5000E	>9000	0.15	-

Conservation of Fuel and Power

At the time of writing Approved Document L of the Building Regulations for England came into force in 6th April 2014. Further revisions are planned for 2016 and 2019 implementing increasing percentage reductions in energy use through improved insulation values, renewable energy sources and more efficient heating, lighting and ventilation services, culminating in all new buildings being "Zero Carbon" by 2019. The Government's aim is to similarly reduce energy use in existing buildings through the Building Regulations (Consequential Improvements) and initiatives such as "The Green Deal" for residential buildings.

For Wales and Scotland, similar requirements are contained in the local Regulations & Approved Guidance for the individual country. Building Regulations (Wales) and Section 6 (Energy) of the Scottish Building Standards Agency's Technical Handbooks.

The latest edition of the relevant local Building Regulations should always be referred to.

Approved Document L (England & Wales) is divided into four separate parts dealing with the following:

- Part L1A – New Dwellings, Part L2A – New Buildings other than Dwellings. Parts 1A and 2A require CO2 emission targets to be met and there are also limiting 'U' value standards for various thermal elements of a building such as roofs, rooflights, ventilators, etc.
- Part L1B – Existing Dwellings. Part L2B – Existing Buildings other than Dwellings. Parts 1B and 2B require specific 'U' values and minimum services performance to be achieved.

New Buildings - The regulations require that all aspects of the construction are to be taken into account in the design process in assessing the potential overall carbon emissions of the building. Apart from the construction materials themselves it includes the design of the details, choice of heating system and its controls, type of lighting, etc. When constructing the building envelope, the major factors in meeting the requirements to limit energy losses will be the incorporation of insulation and the achievement of a level of air tightness.

Existing Buildings - For existing buildings, the regulations require that if any refurbishment works are being instigated the need to upgrade the thermal performance of the existing construction must be considered. Generally, if renovating a 'thermal element', a roof or wall for instance, there are certain specific 'U' values that need to be met, usually by the provision of extra insulation. The requirements are limited by a cost effectiveness factor, which would normally expect 'pay back' from the works within 15 years. They can also be limited by factors of technical feasibility. There are exemptions, for example some specific types of building uses are exempt, listed buildings may not need to meet the full requirements under certain circumstances. However ultimately this should be confirmed with the local building control body. These are a complex set of regulations and reference to the actual documents is recommended for each individual project as is the advice of a 'competent person' as outlined within the regulations themselves.

Insulation

In all roofs heat will flow from the warm side to the cold side. In most cases the Building Regulations will require a certain level of resistance to this flow in order to conserve energy, limit heat loss and reduce carbon emissions. This resistance is known as the 'U value' of a particular thermal element and is established by the calculation methodology contained within the regulations and is expressed as W/m^2K .

There are certain factors in the regulations that need to be considered in the design process of any roof build up. The use of all metal fasteners in a mechanically fixed membrane roof is deemed to cause thermal bridging and requires a correction factor to be used, this is governed by the number of fasteners per square metre, the material they are made from and their cross sectional area. Normally this can entail an increase in insulation thickness of around 10%, this extra cost can be avoided by utilising 'thermally broken' fasteners and are therefore recommended. Correction factors also need to be applied to cold deck timber roofs where the insulation is laid between the rafters. Finally, inverted roofs have a factor that compensates for the cooling effect of rain water percolating down through the insulation boards and impinging on the membrane.

Most structures, unless constructed of naturally insulating materials, will need the addition of manufactured insulation products to achieve the required 'U' values.

There are many different types of insulation available with widely varying characteristics and properties. Selection of the appropriate type for a particular roof will depend on many different criteria, some points that should be considered follow:

- Compatibility with other components in the roof build-up - this is to avoid the risk of reaction with the membrane and other components or corrosion of any metal items.
- Compressive strength - especially related to the amount of traffic the roof will receive both during construction and in use.
- The long term thermal conductivity performance, W/mK , which takes into account the effects of ageing of the board, can vary according to type or even the facings used, a better aged performance can mean a thinner board being selected at the time of specification.
- Fire resistance related to the application.
- Thermal conductivity can vary between different types of board; this can affect the thickness required to meet the required U value for the roof.
- Cost of purchase.
- Cost of installation - some products involve more effort than others to lay and this is reflected in the overall costs.
- Moisture resistance - products should be capable of accepting a degree of wetting during the laying process without deterioration.

Physical properties - The main physical property required from any insulation that may be used under Sika-Trocal is sufficient compressive strength to provide adequate support for the Sika-Trocal membrane and its fasteners. The minimum compressive resistance for plastic foam insulation boards is 150 kPa at 10% compression. It should be noted that some extruded polystyrene boards can typically provide a resistance of 220 kPa and upward. This can make them the preferred choice for paved roofs with support pads. The minimum overall compressive resistance for 'dual density' mineral wool (MW) insulation boards is 60 kPa at 10% compression. It should be noted that these products are also available with a higher resistance of 75 kPa. Single density mineral fibre insulation boards are not recommended.

Compatibility - Generally, the insulation materials commonly used in flat roof construction are not compatible with the Sika-Trocal if the two are in direct contact, that is un-faced, as there will be a reaction that adversely affects both products. A suitable separation layer will therefore be required. Fortunately, in virtually all cases, insulation manufacturers can supply their products with suitable factory applied facings so that compatibility is assured. All rigid plastic foam boards must be supplied either with aluminium foil or glass tissue facings to the upper surface applied either during or post production. The commonly used products are rigid polyisocyanurate foam (PIR); extruded polystyrene (XPS); expanded polystyrene (EPS); and mineral wool (MW).

For mechanically fixed and ballasted applications, utilising the Type S, Type SG and Type SGmA membranes, where they would be in direct contact with the rigid plastic foam insulation boards, the aluminium foil faced types should be used. For adhered membrane systems using Sika-Trocal Type SGK, mineral filled glass tissue faced insulation boards must be used. Note that the insulation boards utilised for the specialised adhered application must be agreed with Sika-Trocal prior to installation.

Note that the use of glass tissue faced boards will generally require a greater thickness to achieve the required 'U' value and the installation of a vapour control layer is mandatory. Mineral fibre resin bound insulation boards must be supplied with a glass fibre tissue facing, factory applied to the upper surface of the board, note there is a specific facing for use with adhered applications. In the event of wanting to specify an insulation type or product for use with Sika-Trocal membrane that is not listed here please contact us.

Membrane/application	Insulation selection guide				
	Insulation Type				
	Foil faced - PIR, XPS, EPS	Glass tissue faced - PIR	Glass tissue faced - MW (dual density)	SPA glass tissue faced - MW (dual density)	Unfaced - XPS
Type S & SG mechanically attached	✓		✓		
Type SGmA ballasted	✓		✓*		
Type SGmA ballasted inverted					✓
Type SGK adhered		✓**		✓**	

* Subject to manufacturers recommendations

** Selected boards only – contact Sika-Trocal

Air leakage

The Building Regulations Approved Documents Conservation of Fuel and Power in Buildings, as part of the drive for more efficient use of energy, also contain requirements relating to the need to restrict the amount of air moving through buildings.

Requirements - The Approved Document requires that the measured air leakage rate for any completed building should be no worse than the **limiting air permeability** value of 10m³/h.m² at 50 Pa. The actual **design air permeability** is the target value for a building which will be set at design stage and can vary depending on varying factors, including building type and size.

The performance levels of leakage quoted in the approved document are reasonably easy to achieve if buildings are constructed with care and planning. It is our experience over several years with many clients that much lower levels are regularly achieved and in fact many clients will specify these lower levels as a matter of course.

Methods - There are two ways commonly utilised in the roofing industry to meet the air sealing requirements.

Firstly a suitable vapour control layer, when installed, is utilised as the air sealing layer that in turn needs to be sealed to the building perimeter and around all penetrations.

Experience has shown that the mechanical fasteners used to secure the roofing membrane will not effect air permeability significantly because the ends of the screws are tapered creating a 'force fit' and the insulation is compressed tightly to the deck at each fixing point.

Alternatively, the deck itself, if not naturally airtight, is sealed at all overlaps and joints, etc with appropriate sealing at perimeters and penetrations by incorporating sealants into the construction.

Incompatible materials and surfaces

In order to ensure the maximum working life for the Sika-Trocal materials it is necessary to separate them from contact with incompatible materials and protect them from rough surfaces.

Incompatible materials - Most materials that are manufactured from hydrocarbons are likely to create an adverse reaction if placed in direct contact with either the upper or underside of the Sika-Trocal membranes.

Typically, this is going to include such products as: bitumen felt; asphalt; liquid bitumen; bitumen based roof treatments; liquid applied roofing materials – fibre glass – polyurethane and other foams; insulation boards; paints of any type; solvents; cooking oils and fats; other single ply membranes; rubber based materials; most mastic sealants; occasionally discharges from roof mounted or adjacent extract fans or chimneys, etc. None of the listed products should ever be applied directly to the membranes themselves, however, it is possible in the case of roof refurbishment projects to overlay bituminous based products by first installing a separating layer, usually either S-Felt Type T fleece, SBV or a suitable insulation board. This list above is not exhaustive so if there are any doubts about anything that may come into contact with the Sika-Trocal materials, whether in solid, liquid or airborne form, please consult Sika Limited.

Rough surfaces - Direct contact with rough or abrasive surfaces either above or below the membranes should be avoided. To prevent this a protective layer of the 300g/m² S-Felt Type T polyester fleece or S-Felt Type A polypropylene fleece can usually be installed, or in some circumstances the more robust type SBV sheet, which is a polyester fleece layer with a PVC facing. Note that the S-Felt type Type A fleece cannot be exposed to UV nor is it bitumen compatible, it is therefore only suitable for use under membranes.

Typically, the surfaces that would require the use of the S-Felt Type T polyester or S-Felt Type A polypropylene fleece are: in-situ concrete: cementitious screeds: aerated concrete panels: brickwork: masonry: plywood and oriented strand boards: timber boarding: wood wool slabs: metal sheets: for existing mineralised bitumen felts and asphalt only the S-Felt Type T is suitable.

However, the use of a protective layer does not negate the need for other parties to provide as smooth a working surface as possible. Where in-situ concrete and cementitious screeds are concerned, the finish should generally be the equivalent of a power or wood float. Particular attention also needs to be paid to achieving a level surface at the correct falls; any deficiencies here will only be mirrored in the final surface of the roof. Additionally, where pre-cast reinforced concrete units and composite constructions incorporating hollow tiles, pre-cast beams and planks, etc are installed, a levelling screed will be essential due to the tolerances and curvature of these items. Ballasted roofs of all types must always have a protective layer installed on top of the SGmA membrane prior to laying the ballast, refer to table below.

Sometimes there is a requirement to position various items directly onto the surface of an exposed mechanically fixed membrane. These items can be free standing handrail systems with rubberised pads, cable and trunking supports or lightweight items of mechanical plant etc, occasionally even with anti-vibration pads placed under them. In the cases of small items of plant these are usually fixed to a paving slab prior to being positioned. In placing items onto the UV stabilised membrane that area is permanently converted into a covered or ballasted situation, which will lead to degradation over time. Therefore, these situations will always require the use of a patch of the SBV type separation layer or 1.5mm SGK (PVC face down), welded to the waterproofing membranes surface, by the roofing contractor, refer to page 54 for details.

Common separation/protective requirements	
Type	Separation/Protective layer
Asphalt/mineralised felt over laid with Sika-Trocal membranes	Insulation board, S-Felt Type T polyester fleece (if part L permits)
Bituminous felt with chippings over laid with Sika-Trocal membranes	Insulation board
Pitch over laid with Sika-Trocal membranes	Insulation board, type SBV (if Part L permits)
Butyl/EPDM materials, curtain walling membrane sometimes adhered to Sika-Trocal upstands	Self adhesive aluminium tape, minimum 75 mm width applied to face of upstands prior to adhering materials
Non-solvented silicone sealant	None
All other mastic/sealants	Not acceptable
Concrete, screed, aerated concrete, brick/block work, plywood, OSB, timber products other abrasive surfaces, over laid with Sika-Trocal membranes	S-Felt Type T polyester or Type A polypropylene fleece
Bases free standing handrail systems onto Sika-Trocal S, SG and SGK membranes, including those with rubber pads to the underside	SBV, PVC face down, welded to membrane / Alternatively 1.5mm SGK PVC face down, welded to membrane
Pavers/in-situ concrete onto Sika-Trocal S, SG and SGK membranes	SBV, PVC face down, welded to membrane / Alternatively 1.5mm SGK PVC face down, welded to membrane
Bases for small/lightweight roof mounted plant onto Sika-Trocal S, SG and SGK membranes	SBV, PVC face down, welded to membrane / Alternatively 1.5mm SGK PVC face down, welded to membrane
Any item onto Sika-Trocal S, SG and SGK membranes	SBV, PVC face down, welded to membrane / Alternatively 1.5mm SGK PVC face down, welded to membrane
Pavers onto Sika-Trocal SGmA membranes, public or leisure use	SBV fleece side down
Pavers onto Sika-Trocal SGmA membranes, no public or leisure use	SBV fleece side down or S-Felt Type T polyester fleece
Gravel ballast onto Sika-Trocal SGmA membranes	SBV fleece side down or S-Felt Type T polyester fleece
Timber decking onto Sika-Trocal SGmA membrane	S-Felt Type T polyester fleece or SBV
Extruded polystyrene insulation boards, (inverted roof) onto Sika-Trocal SGmA membranes	S-Felt Type T polyester fleece

Acoustics

Consideration should be given as to whether the roof needs to have any acoustic properties.

The typical lightweight roofs widely utilised only offer a limited resistance to the effects of rain drumming for instance and general transmission of sound in both directions. Whilst this is not at a level to normally cause concern in typical commercial/industrial/retail buildings, in residential/domestic applications it might. With other buildings, such as cinemas, theatres, dance halls, sports halls, buildings near airports, etc one might consider the need to exclude unwanted outside noise or prevent noise pollution travelling outwards.

The department for children, schools and families in their 2008 publication 'Roof coverings in schools' requires designers to consider noise transmission through any roof over sensitive areas from external sources. Also to take account of the potential for rain impact noise on the roof and any rooflights. BS EN 12354-3 refers.

There is a choice of methods for reducing noise transmission:

- The addition of heavily filled sound deadening polymeric layers of membrane at deck level - the insulation manufacturers usually supply these as an ancillary item.
- The use of mineral fibre roof insulation.
- The use of metal deck trough fillers.
- The provision of acoustically attenuated suspended ceilings below the deck.
- The use of ballasted roof finishes and/or use of heavyweight concrete decks.

Or indeed a combination of more than one of the above.

Acoustics is an extremely complicated and specialist subject that is also evolving rapidly, therefore expert advice should be sought for all applications. It is also advisable to liaise with all parties concerned with the construction process to ascertain that any proposed 'acoustic solution' is actually buildable and that suitable materials have been selected.

External fire performance

The 'fire performance' of a roof construction is determined using the methods laid down in BS 476: Part 3: External Fire Exposure Roof Tests. Note that this test method has now been incorporated into the BS EN standard.

The fire tests are carried out on samples of completed roof build ups in accordance with the above test method and are designed to establish the abilities of a construction to resist penetration by fire and to limit the spread of flame across its surface. The actual performance achieved is shown as a letter code, i.e. F: AB and will be included in the report given by the test house. With all the changes that are happening in terms of increased thicknesses of insulation and construction methods to meet current regulations it is important to check that any fire test certificates relied upon are up to date.

When tested the most commonly specified combinations of deck, insulation and mechanically fixed or adhered Sika-Trocal membranes will achieve a rating that allows unrestricted use under the Building Regulations. The Building Regulations define the acceptable areas of use for roofs with various fire ratings by means of type of building, size and distance from the site boundary. Ratings AA, AB and AC have unrestricted use.

Ballasted gravel membranes are generally deemed to achieve an FAA rating. The ratings for a number of specific roof build-ups can be obtained from Sika Limited.

Note that while exposed Sika-Trocal membranes will not ignite easily, it can be damaged by discarded cigarette ends, in the event that this is likely to occur on the roof under consideration, precautionary measures should be taken. Refer also to previous section, 'Selection of attachment method', for further information.

Roof drainage, falls and upstands

Normal good practice is to try and remove rainwater from the main roof surface as rapidly as possible and to avoid ponding. Ponding is often considered unacceptable by many building owners and is undesirable from a number of aspects, it encourages silt build-up, which can become dangerously slippery and also the growth of mosses, etc. Water sitting on the membrane prevents it breathing, as it is an extremely effective vapour control layer. Water can freeze in winter and present a safety hazard. Standing water forms a reservoir that can allow a greater amount of water to enter the roof than would have been the case in the event of any accidental damage. Standing water in sufficient quantities can also provide suitable breeding areas for insects such as midges. Too much retained water on a roof could lead to deflection of the roof structure and, even in some cases, collapse of the roof itself.

Drainage - BS EN 12056 and the Building Regulations Approved document Part H will provide guidance on calculating the amount of precipitation to allow for and the number of outlets and down pipes required to remove the water from the roof. The Services Engineers or the Manufacturers of the rainwater outlets usually provide these calculations.

Rainwater outlet capacities should be clarified with each manufacturer and supported by the necessary certificated information.

It is not generally necessary to create box gutters where two roof planes meet, nor when a single plane meets an abutment. Box gutters are slow to construct and difficult to incorporate into current building construction without accidentally creating a cold bridge.

Roofs that are drained internally, that is when there is a parapet all the way around the roof perimeter, should incorporate some sort of over flow provision to at least give warning and relief in the event of the normal outlets becoming blocked.

Falls - To encourage the removal of water from the roof surface falls need to be formed to direct it towards the gutters or rainwater outlets. BS 6229 recommends that no part of the finished roof should have a fall of less than 1:80. The guidance given is that to ensure the finished fall requirements are met then design falls need to be greater in order to allow for deflections caused by dead and live loads and for tolerances in construction. In the absence of any accurate information or calculations about the level of those deflections and tolerances, etc the design fall should be double that of the minimum required, that is 1:40.

Where two planes of a roof meet in a mitre, the fall along the junction is less than that of the two planes; this should be taken into account when deciding the design falls.

Tilting the supporting structure, laying screed to falls or the use of tapered insulation can create the necessary falls. With long runs of roof care should be taken to ensure that the build-up of thickness does not compromise details at abutments with walls or make the actual construction of the various layers difficult. There have been instances, for example, of the insulation becoming so thick that it was impossible to get fasteners long enough to penetrate it. In these cases it could be worth considering breaking the roof up into smaller areas in order to contain the total depth of the build up to a reasonable figure.

Occasionally areas of standing water can occur on the roof surface due to design limitations, however Sika-Trocal membranes are not adversely affected by ponding water and this will not affect the waterproofing integrity of the membrane.

Ponding water on a roof when associated with fallen leaves can sometimes lead to the development of certain bacteria that can cause some staining of the membrane. On exposed membranes this stain is purple and ballasted ones, brown. Whilst unsightly, this staining will not affect the waterproofing integrity of the Sika-Trocal membranes.

It should be noted that some insurance based design guides and some clients will actually require falls to be constructed at greater angles than the minimum's specified in BS 6229.

Conversion table for falls		
Fall ratio	Slope angle	% slope
1:80	0° 42' 58"	1.25
1:70	0° 49' 06"	1.40
1:60	0° 57' 17"	1.70
1:50	1° 09' 44"	2.00
1:40	1° 25' 55"	2.50
1:30	1° 54' 33"	3.30
1:20	2° 51' 45"	5.00
1:11	5° 11' 40"	8.75

Upstands - All weatherproofing upstands occurring around the roof area including doorways, openings, rooflights, smoke vents, plinths, etc must have a minimum height of 150mm measured from the finished surface of the roof, if unwanted water entry into the building is to be avoided. This requirement is stated in BS 6229 and 8217 and generally there are no exceptions. The finished surface in the case of covered/ballasted roofs is defined as the upper surface of that covering. Only with exposed membrane roofs is the upstand height measured directly from the membrane.

The implications of the requirements of minimum 150mm upstands should be considered at design stage. If designing balconies for instance, it might be necessary to allow for a cranked floor slab at the external walls so when the insulation, membrane and surfacing of the balcony are installed it does not compromise the upstand height.

Where 'gutters' are located alongside an upstand, the finished roof level is measured from the adjacent main area of roof, not the sole of the gutter.

There are instances on balconies and terraces where disabled or wheelchair access is required and the relevant Building Regulations should be followed. Where the specifier requests the upstand at these locations, is less than the 150mm required under BS 6229, alternative detailing methods should be followed and is the responsibility of the specifier.

Access and walkways

Access - Access to all areas of the roof should be incorporated into the Building Design from inception. It is a vital element in the proper and necessary routine maintenance of the roofscape.

The preference should always be for access to be internally from within the building itself, this being usually safer and less weather dependent than external access. Due consideration needs to be given to security aspects so as to prevent unauthorised access to the roof or to the building from the roof area itself.

Whether the access point is via a doorway or a hatch, due note should be taken of the necessity on occasions for equipment, tools and materials to be taken onto the roof, so access points should be generously sized.

Access hatches should be located well away from the edges of any roof area or any other local hazards.

External access would either have to be via permanently fixed ladders or by mechanical devices such as scissor lifts or cherry pickers. The selection of the mechanical device option is always going to cause delays and costs to the building owner when he wants to gain access. There can also be other associated problems such as finding road space where the devices can be legally and safely parked. The overall difficulties of this approach are always likely to discourage the building owner from carrying out the necessary regular maintenance inspections.

Walkways - Infrequent maintenance access on to an exposed Sika-Trocal membrane surface roof, such as for the regular biannual inspection of rainwater outlets, checking security of flashings etc can be carried out without any special precautions. It should be noted however, that when wet, the membrane can be slippery underfoot and that appropriate footwear with a good depth of tread should be worn to avoid accidents.

In situations when there is plant on the roof that will need frequent inspections and/or maintenance or any other reasons why personnel will be trafficking the roof on a regular basis, then precautionary measures are required to contain the effects of that traffic. The vulnerable part of the roof build-up in most need of protection is the insulation. Various insulations have different compressive strengths and recovery characteristics, and may require additional protection, such as steel spreader plates, if they are expected to last as long as the membrane itself.

In order to provide protection for mechanically attached Sika-Trocal membranes, Type S and Type SG, it is possible to create walkways using the Sika-Trocal WBP20 or HD walkway materials.

Sika-Trocal WBP20 walkway, welded to the waterproofing membrane, provides protection for light foot traffic and has a pyramidically embossed surface to provide a greater degree of slip resistance than the waterproofing membrane itself. Where required, this may be used with a galvanised steel spreader plate installed over the insulation to protect the insulation board. If additional reinforced walkways are required after the roof is complete, it is possible to create them by assembling the build-up on top of the existing waterproofing. That is - steel plate, protective layer, fasteners, waterproofing membrane & walkway membrane.

An alternative option is to use the heavier duty HD walkway, which is 4mm thick, also welded directly to the surface of the waterproofing.

The walkway membranes are a different colour to the standard light grey roof membrane so as to define the route to be followed.

Where an extra heavy-duty walkway is required, then the use of the HD 4mm thick walkway can also be combined with a steel plate under the Sika-Trocal waterproofing.

The steel plate generally used on roofs as the reinforcement to the walkway is not vapour permeable and therefore prevents the roof from breathing properly. The plate is also likely to collect a quantity of condensate to its underside therefore its use should be limited. If large areas of the roof need protecting with walkway it is probably best to consider the alternative specification of a paved roof in conjunction with Sika-Trocal Type SGmA ballasted membrane.

The walkway protection for installations utilising adhered Sika-Trocal membrane, Type SGK, are either the 2mm WBP20 or the thicker 4mm HD walkway, which are welded directly to the surface of the waterproofing.

The need for walkways should be considered at an early stage of the design process and the likely routes across the roofscape delineated on the drawings. The chosen routes should follow the most logical path that an average person could be expected to take, which is usually the shortest. There is little virtue in locating walkways along unseen grid lines or to suit some idea of aesthetics or neatness, if not in the right place, they will not be used.

Even on roofs without any obvious need for regular accessing and therefore not generally requiring reinforced walkways, it is probably worth considering the construction of a 'patch' of reinforced walkway at all points of entry and exit from the roof, as the footfall in these areas will always be in the same place. In some cases the use of a few pavers on a Sika-Trocal SBV protection layer or 1.5mm SGK (PVC face down) welded to membrane may be preferred.

On most ballasted roofs, walkways would normally be created with rows of pavers, as gravel ballast is unsuitable for foot traffic.

Note that even with the provision of walkways, exposed membrane roofs are not intended or suitable either as fire escape routes or for public/leisure use.

Protection from following trades

When an area of roof is completed, it should be signed off and access to it denied to all except the roofing contractor himself in order to prevent damage from following trades. If this is not possible, then the roof should be protected from damage and over trafficking. Protection often takes the form of sheets of plywood or oriented strand boards, sometimes with the addition of heavy-duty polyethylene underneath. Care needs to be taken placing the boards so that the corners do not damage the membrane or underlying insulation. Old formwork materials should never be used for this purpose.

Precautions need to be taken to retain the boards in place against wind load uplift forces.

Protection of finished work should be included in the specifications and Bills of Quantities at inception and be placed in the main contractor's area of responsibility.

As a general note care also needs to be taken about using the roof area as a storage area. It is common to witness pallets of roof tiles or even bricks stacked several units high and with some lightweight decks, commonly used, it is very easy to exceed the design or actual dead and live load capability of the roof with possible fatal consequences.

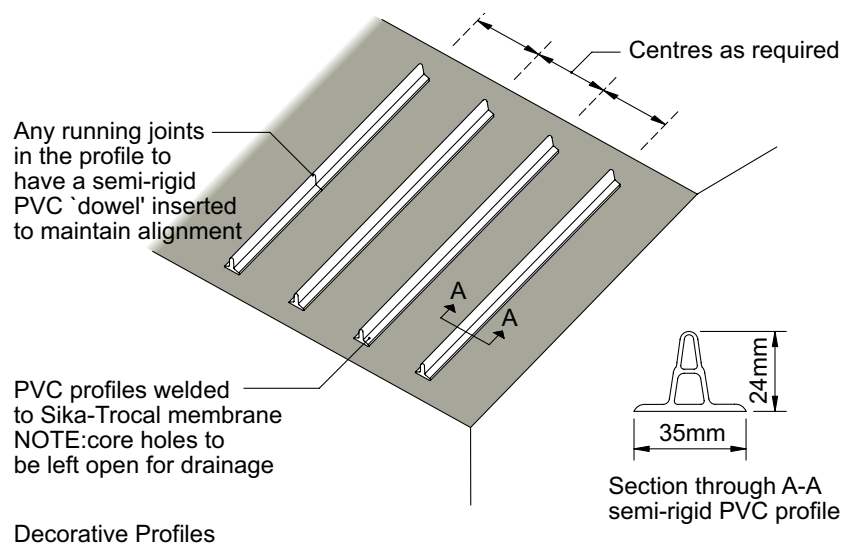
Aesthetics

Particular designs such as barrel vaulted, curved, double curved and domed roofs that are meant to be clearly visible need greater care in construction than normal, if the end result is not to be marred.

When designing these types of roofs where aesthetics will be an important part of the finished article please involve our personnel at an early stage. Based on our experience there are certain parts of the normal construction process that can be done in different ways to make them visually more acceptable. For instance, there is the availability of the SE decorative profiles that can be welded onto the membrane after installation to create the appearance of a raised seam. There are different ways and types of mechanical fastening that can be more appropriate for these situations. There are alternative ways of detailing and positioning the butt joints in the external Sika-Trocal Metal profiles. Finally, the actual layout and positioning of the sheets can also have a dramatic effect. All these points need to be discussed, agreed and finally incorporated into the specification that goes to all parties and the Licensed Roofing Contractor. Unless all parties are made aware of the special requirements, they will get missed.

Internally, it should be noted that with 'thin' decks, such as metal decking, timber and timber based sheet materials, the restraint fasteners securing the roof build-up of insulation and membrane will penetrate the deck and protrude from the underside by at least 15mm. This is necessary for the correct functioning and performance of the fasteners. Under no circumstances can these fasteners be shortened or cropped after installation, as it will lead to failure of the fixing system. In the case of metal decking all of the membrane restraint fasteners will be located in the crown of the profile which is recessed when viewed from below and helps to make them less obvious. With metal decking, account should also be taken of the 'lap stitching', which is a row of screws installed along each side lap and is at the lowest point and hence most visible, of the deck. On most projects these protruding fasteners do not cause any concern, but in the event of a painted finish to the soffit or heights being low, consideration should be given to the level of visual intrusion of the fasteners. It might be worth considering a false ceiling or some other route to making them less visible. In some cases and in suitable locations, it might be worth considering a build-up of adhered insulation and membrane in order to omit the fasteners, although it should be noted that the lap stitching to the deck would still be present.





Safety equipment

Many projects will require the installation of 'fall arrest' safety systems, which will generally mean the fitting of some specially developed shock absorbing posts to which are attached cables that operatives hook onto whilst working on the roof. These items should be discussed with the relevant manufacturers at an early stage so that all the special requirements can be designed in from the beginning. The best types of these systems incorporate a heavy duty base plate which is coated with a special PVC so that the Sika-Trocal waterproofing can be securely connected to it by welding, ensuring it is weathertight.

Mechanical services

In order to avoid problems arising on site, the location of plant on the roof needs to be agreed early in the overall programme. This should include the location and means of all the service runs and subsequent roof penetrations, that is everything from a small cable up to the largest duct. Without the necessary pre-planning, details could be missed on site, or inappropriate details being constructed that could become major and sometimes insoluble water penetration problems for the building owner.

Penetrations - There are a number of simple principles that need to be observed to help prevent the service installation becoming a problem. All penetrations rising vertically through the roof surface need to be cased in an upstand sleeve of rigid PVC or Sika-Trocal Metal with a permanent cravat fixed to the penetrating item itself to weatherproof the gap between the two. All services running horizontally along the roof surface that need to then pass through the roof itself must swan neck upwards first and then pass under a cowl before being turned down through a sleeve. All services running horizontally across the roof that need to enter the building through a wall must rise up before entering the wall and also be shielded with a cowl. These requirements are to provide weathertight entry points and to prevent water running along the underside of the services and entering the building and are all detailed in this manual.

Another factor in achieving a satisfactory installation of services is to leave enough room around each item so that the roofing contractors can actually gain physical access to install the waterproofing. For example things to avoid are ventilation ducting placed too close to walls, multiple runs of ducting placed so close together that it is not possible to work between them; pipes and cables grouped together so that it is not possible to work the waterproofing around each of them individually. The answer is to provide enough working space around each item and to ensure penetrations are not clustered together.

Plant location - The most practical and trouble free way to locate items of plant onto a roof is to put some stub columns through the waterproofing with a grillage of steelwork fixed to the top so as to provide a fixing base for the plant. The grillage also leaves the membrane visible and accessible, avoiding the need to de-commission and lift plant should access ever be required.

This avoids all the pitfalls of trying to locate items of plant onto plinths that are notoriously difficult to waterproof successfully. Note that Sika-Trocal membranes are not suitable for the task of waterproofing the upper surface of plinths.

Lightning protection - Lightning protection systems on a structure are designed to collect a strike and dissipate it safely to earth. BS EN 62305 contains the required information to design a system appropriate for the building under consideration and its location. If a protection system is required; early involvement of all parties is advisable as there is a degree of collaboration required between the Sika-Trocal Licensed Contractor and the specialist that will install the system, mainly to ensure that fixing bases are in the correct locations.

Sika-Trocal S-TR LC Clips are hot air & solvent weldable lightning conductor clips that allow easy application of both bare & PVC coated lightning conductor tape to Sika-Trocal membranes.

GENERAL PRINCIPLES

JOINTING WATERPROOFING SHEETS

Sika-Trocal roof waterproofing sheets are secured at all edges of the roof, internal corners and changes of plane by welding them to Sika-Trocal Metal profiles fixed to the substrate. In addition, the sheets are secured to Sika-Trocal Metal or rigid PVC sections at all penetrations. Sika-Trocal Type S & SG membranes are used where the main expanse of the roof covering is to be exposed and restrained by mechanical fasteners, Sika-Trocal Type SGmA in cases where ballast is to be used.

Type SGK is used when an adhered solution is required, as the main detailing is different due to the fleece backing to the membrane, it is shown separately later in this manual.

Joints in Sika-Trocal Type S, SG and SGmA

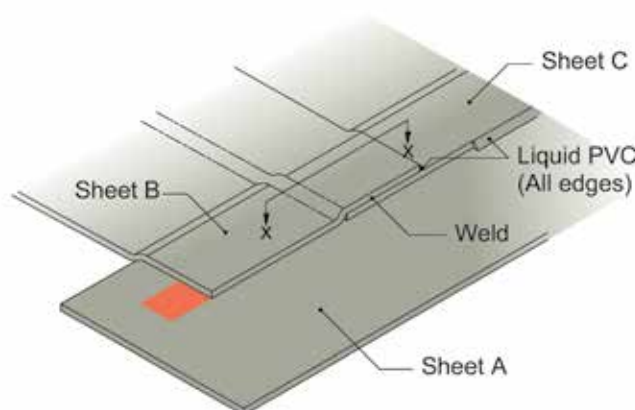
In covering the main expanse of the roof area, both sides and ends of the Sika-Trocal sheets must overlap adjacent sheets or Sika-Trocal Metal or rigid PVC profiles and sections by a minimum of 50mm.

All these laps must be welded together so as to create, from the individual sheets, one homogeneous, single layer of waterproofing sheet across the whole roof.

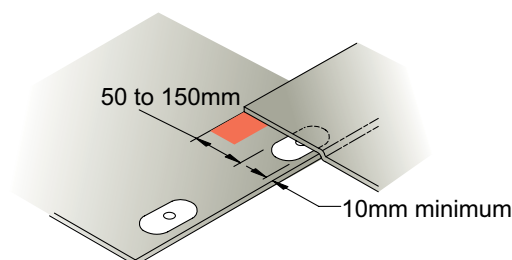
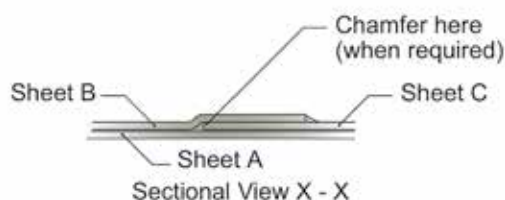
Within the laps the welds must have a minimum width of 30mm.

In the case of sidelaps incorporating pressure plates, the overlap must be a minimum of 50mm beyond the edge of the plates themselves, this usually means a minimum lap of around 100mm.

'T' joint - three sheets of Sika-Trocal membrane

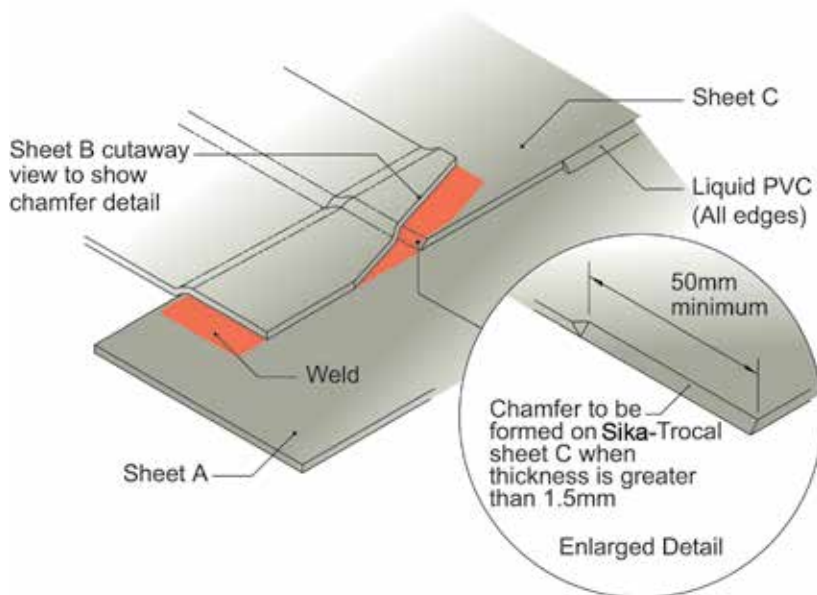


Sika-Trocal 'T' joint for membranes up to and including 1.5mm thickness

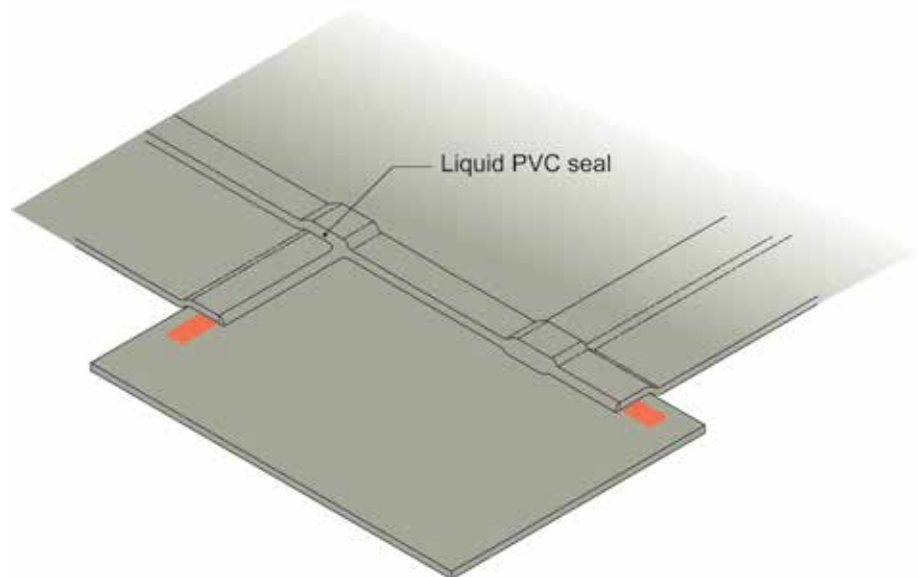


Multiple sheet overlaps - Where one sheet rides over another, a small hollow or capillary is created between the two. This is commonly known as a 'T' joint and must be sealed using a hot air gun to a minimum depth of 30mm. The 'T' joint weld must be carried out prior to the solvent weld of the main lap. Where utilising Sika-Trocal sheets in excess of 1.5mm thickness, the edge of the 'middle' sheet must be chamfered in order to enable the capillary to be fully sealed. This can be achieved by using the edge of the nozzle of a hot air welding gun.

Sealing welded joints - When welded joints have been checked and any discontinuities made good, they must be completed by the application of liquid PVC. The liquid PVC is applied as a full bead to all exposed edges of the Sika-Trocal sheets. As the bead of liquid PVC cures it will bond itself tightly to the edges of the sheets. The liquid PVC ensures the absolute waterproof integrity of the joints. This operation should be carried out shortly after the completion of the welding process.



Sika-Trocal 'T' joint for membranes greater than 1.5mm thickness



Note - For practical installation reasons many joints made between individual Sika-Trocal waterproofing sheets will be against rather than with the general flow of rainwater across the roof.

The truly homogenous nature of the welded joints ensures that water cannot enter and prevents the occurrence of the damaging freeze/thaw cycle.

GENERAL PRINCIPLES

JOINTING ANCILLARY PRODUCTS

Sika-Trocal S-VAP 500E vapour control layer - 80mm overlaps to joints and penetrations sealed with double sided adhesive tape supplied by Sika Limited for the purpose. The surfaces must be fully secured to the tape by hand roller whilst the joint is fully supported.

Sika-Trocal S-VAP 5000E SA polymer modified bitumen vapour control layer - The side and end lap seams of S-VAP 5000E SA are formed with a minimum overlap of 75mm by self-adhesion. To achieve tightly sealed seams the laps must be fully supported and rolled down firmly with a pressure roller (silicone roller) or by applying pressure. Where the rolls end, an additional 200mm wide strip should be adhered firmly on the deck sheets, running perpendicular to the deck direction (and laid rolls).

For concrete, plywood, timber boards and/or OSB decks Sika-Trocal Primer 600 is required if the insulation is going to be bonded and not mechanically fastened or ballasted. Before priming all substrates must be clean without any surface contaminations, free of foreign objects and loose or surface toppings, oil and grease free and dry.

For new metal decks no primer is required, but the surface must be clean & degreased (use Sika-Trocal L100 cleaner if required).

For adhered systems over metal decks a minimum contact surface area of $\geq 49\%$ is required.

Sika-Trocal S-Felt Type T polyester fleece - When used as a protective layer beneath the Sika-Trocal waterproofing sheets the fleece is loose laid with simple, loose end and side laps of minimum 100mm. Generally, trapped at the perimeters by having the Sika-Trocal Metal profiles fixed over it.

When used as a protective layer over the Sika-Trocal Type SGmA waterproofing sheets prior to the application of a ballasted finish, the minimum 100mm laps should be sealed to prevent foreign matter being washed under the fleece and to also hold it in place whilst the ballast is placed. The joints should be sealed with a generous application of liquid PVC introduced into the lap and the joints consolidated by pressure applied to the top layer using either a hand roller or sandbag.

The fleece must also be turned up the upstand at perimeters so as to terminate at or just below the level of the ballast, to be secured to the vertical surface by two strips of liquid PVC.

Sika-Trocal S-Felt Type A polypropylene fleece - Used as a protective layer beneath the waterproofing sheets the fleece is loose laid with simple, loose end and side laps of minimum 100mm. Generally, trapped at the perimeters by having the Sika-Trocal Metal profiles fixed over it. Note not compatible with bitumen.

Sika-Trocal SBV - These sheets are faced one side with a PVC skin and on the other with a polyester fleece.

When utilised under ballast the SBV should be laid PVC face uppermost to provide the maximum level of protection and ease the spreading operation. The side and end joints are to be overlapped a minimum of 50mm and sealed with liquid PVC as noted for S-Felt Type T above. Likewise, the edges are to be turned up and secured at the perimeter as noted above.

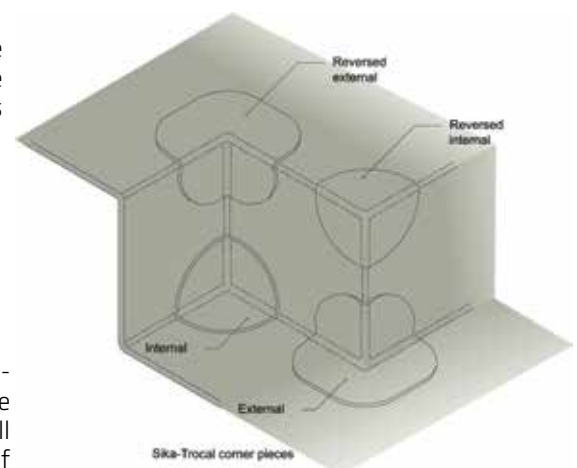
When SBV is utilised as a protective layer over Type S membrane, it must be laid PVC face down and all edges fully welded to the membrane, minimum width of 30mm. All edges must be sealed with liquid PVC after welding.

Sika-Trocal WBP/HD Walkway - These materials are not overlapped and jointed at all, but will be installed with the sheets with a gap between, as indicated in this manual.

Note - Adhered joints between Sika-Trocal membranes and metal items are sometimes required. In all circumstances adhesives are only used where the membrane is additionally clamped between two surfaces as indicated in this manual.

Sika-Trocal SE Profile - Welded to the surface of the waterproofing membrane to create a standing seam effect. **When welding over Type S membrane a 20mm long x 5mm high cutback is required to the end of each profile as per the Sika-Trocal Technical update.** When installed over SGK, SG or Topdek panels incorporating Type SGK, the SE Profiles can be butt jointed without this cutback.

Sika-Trocal corner pieces - Pre-formed corner pieces are available in both Sika-Trocal Type S and Sika-Trocal Type SGmA formulations to suit the membrane type being used. These must be fully welded to all corners as a final operation. All edges to be sealed with liquid PVC. These corner pieces ensure the waterproof integrity of these areas. Corner pieces are available in external and internal 90° form.



GENERAL PRINCIPLES

LAMINATED METAL

Sika-Trocal laminated metal is required at all perimeters and changes of direction or plane; it is also required at all penetrations unless these are detailed with rigid PVC.

Sika-Trocal Metal is supplied as flat sheet to be cut and bent to form the profiles and sections as required.

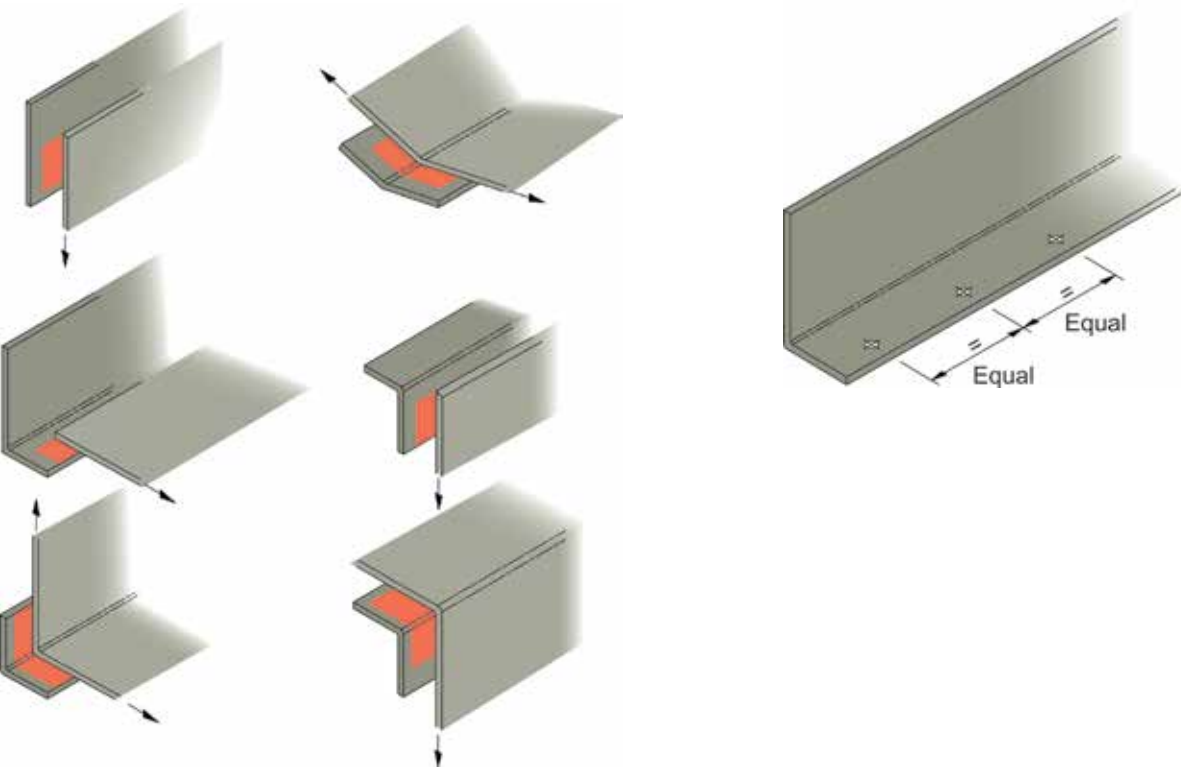
Pre-drilling of Sika-Trocal Metal sections will make installation of the fasteners quicker and easier, avoid damage to the anticorrosion coating, assist in seating the head of the fastener and avoid deformation of the section. The head of the fastener must be such as to offer minimum impediment to achieving a full weld of the membrane to the metal. To avoid building movements stressing the metal, fasteners are to be in one shank of the profile only.

All membrane welds to Sika-Trocal Metal to be in shear only, as illustrated.

Fixing centres - Fasteners that achieve a minimum of 1.2kN resistance each for pull out and shear from the deck may be used to secure the metal profiles up to the maximum centres indicated and illustrated opposite. For aerated concrete this minimum figure must be 1.8kN to give the increased safety margin this material requires. When the fasteners cannot achieve the minimum performance figures noted above, the fixing centres must be reduced to compensate. For further details, refer to the fixing methods chapter of this manual.

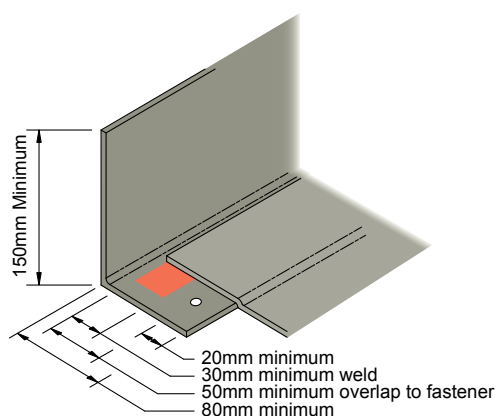
Transfer loads - It should be noted that there are potential loads onto each Sika-Trocal Metal profile of maximum 2kN per linear metre for Sika-Trocal sheets up to and including 1.5mm thickness.

For sheets greater than 1.5mm up to and including 2.0mm the load is a maximum of 2.5kN per linear metre. Therefore, the substrate to which the profile is fixed must be adequately secured itself and be capable of receiving and transmitting these loads to the main structure.

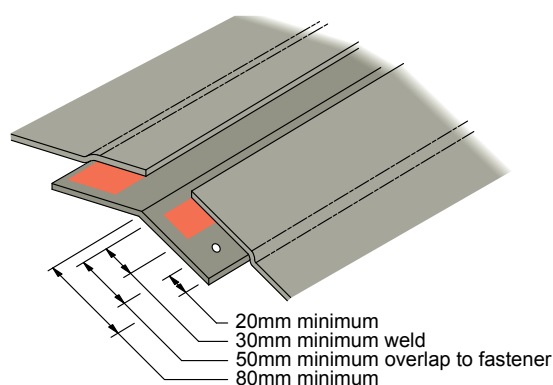


Maximum fixings centres for Sika-Trocal metal	
Membrane thickness	Max fixing centres
Up to 1.5 mm	225 mm
Greater than 1.5 mm up to 2.0 mm	180 mm

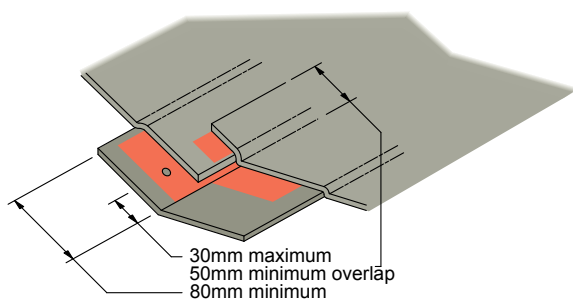
Upstands - Illustrated here is a simple Sika-Trocal Metal upstand. The fasteners are taken through the horizontal shank and waterproofed by welding the membrane over them.



Ridges - Due to the self-tensioning of the Sika-Trocal membrane it is not essential to provide Sika-Trocal Metal profiles for ridge details, especially those at very low angles of pitch. However, their use can make installation of the membrane more convenient, protect the underlying insulation and improve the aesthetics.

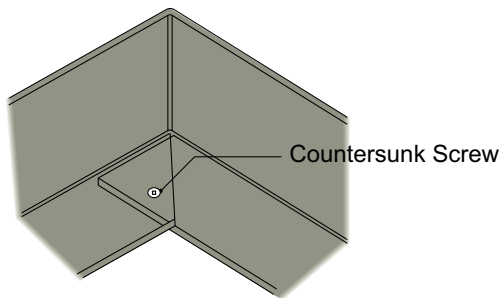
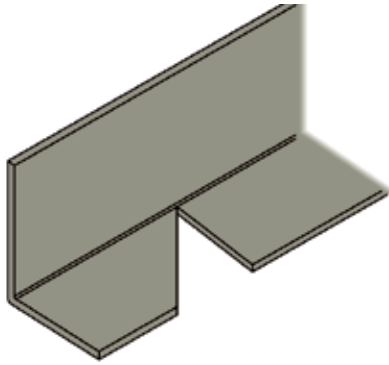


Valleys - When the enclosing angle on valleys becomes 177° or less it is necessary to provide a Sika-Trocal Metal profile to secure the membrane into the corner.



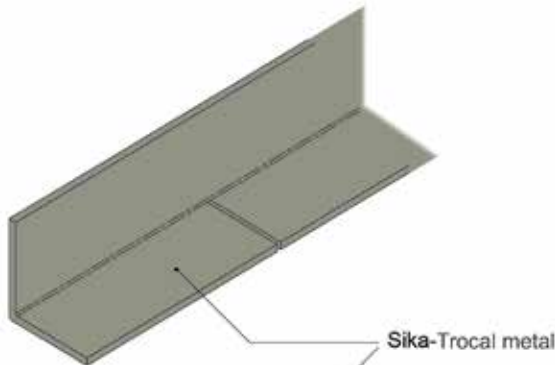
GENERAL PRINCIPLES

LAMINATED METAL

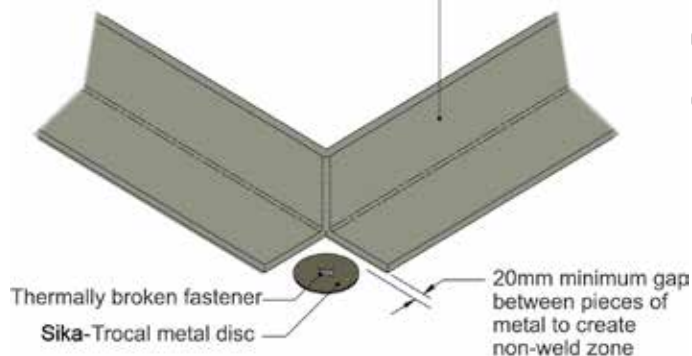


Internal and external returns - Wherever possible, Sika-Trocal Metal profiles should be joined away from corner locations. Internal and external returns should be formed as follows:

Internal - The horizontal shank should be cut, as illustrated, to allow the vertical shank to be bent. A fastener is then required through the two overlapping parts of the horizontal shank and driven into the substrate. It is important that the cut edge that is uppermost on the horizontal shank approximately bisects the enclosing angle of the bend.



External - All that is required is one simple 90° cut of the horizontal shank. A Sika-Trocal Metal disc (or minimum 80 x 80mm plate) must be placed in the birds mouth formed when the profile is bent to the required angle and fixed to the substrate. The membrane sheet must then be welded to the disc prior to its attachment to the profile itself.



Completion - The membrane is then welded to the Sika-Trocal Metal profiles in the standard method and the whole finished off by welding in a preformed corner piece and finishing with the liquid PVC.

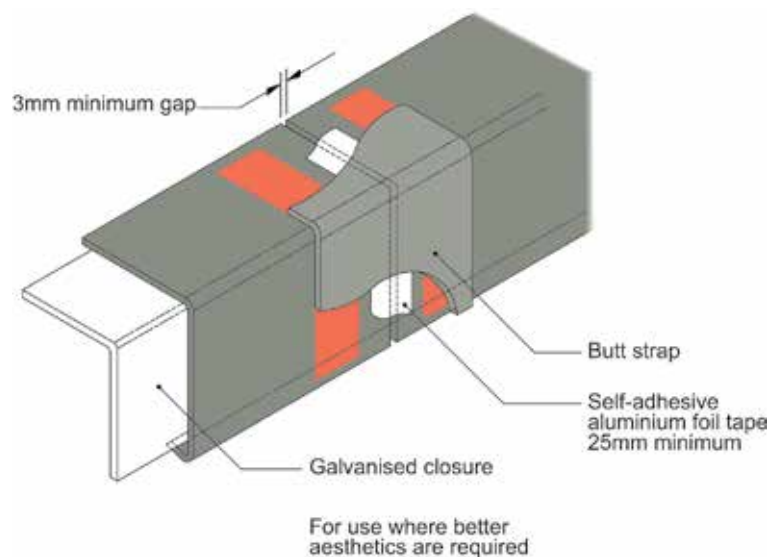
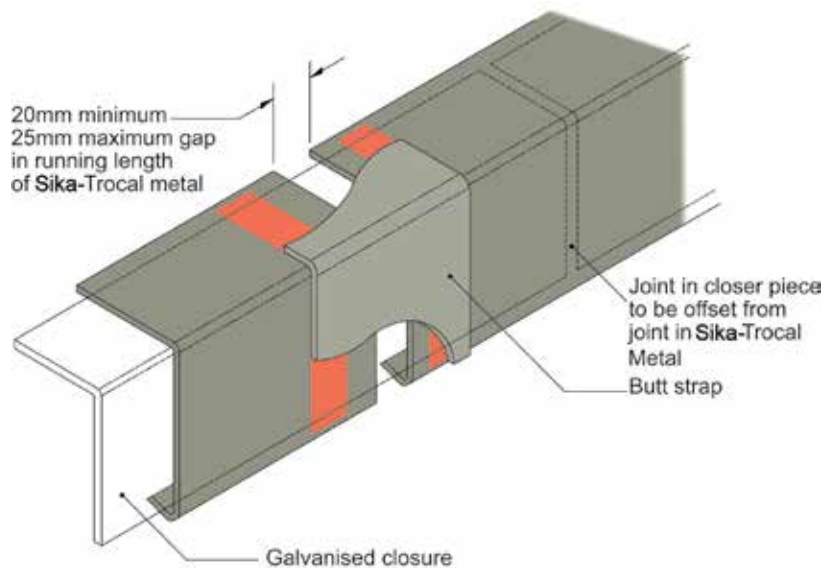
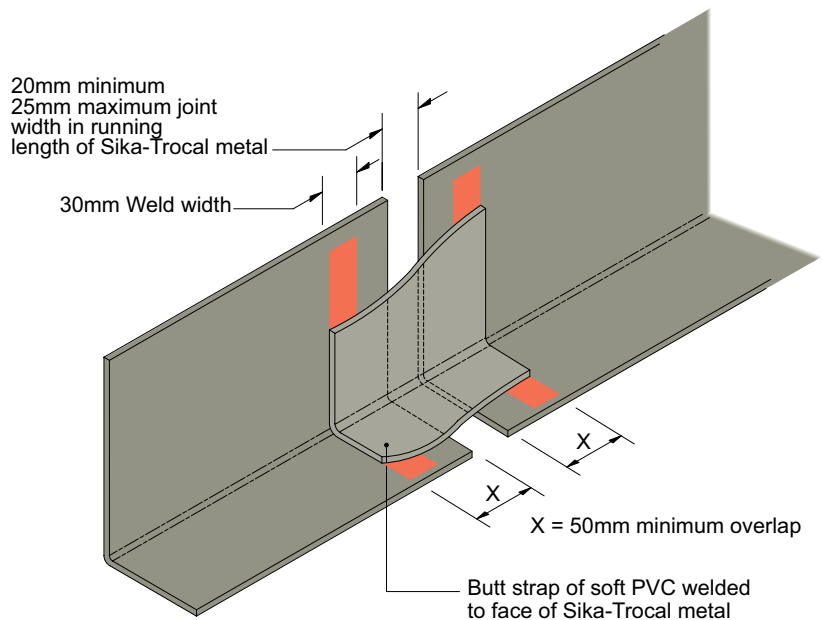
Running joints in laminated Sika-Trocal Metal profiles

- Where there are runs of Sika-Trocal Metal profiles there will obviously be joints between the individual lengths, maximum 3.0 metres. Due to expansion and contraction there will be differential movements occurring between these lengths. It is necessary, therefore, to not only seal this joint against water penetration but also make it into a mini expansion joint able to cope with these movements in the long term.

The Metal profiles should be fixed so as to form a gap of minimum 20mm and maximum 25mm between the ends. A minimum 200mm wide strap of Sika-Trocal Type S material is then welded to the face of the Sika-Trocal Metal each side of the gap, this being flexible enough to absorb the movements for the life of the roof. (There is an exception to this rule with external profiles when a high aesthetic standard is required, refer to detail below.)

Technically this is known as a butt strap and 200mm wide strips of Sika-Trocal Type S membrane are manufactured specifically for this purpose. The butt strap is made in various shades to suit the commonly used membrane and metal colours and are often double-sided and reversible. It is also possible to cut these butt straps from the normal roof waterproofing membrane sheets when they can be different dimensions to the standard ones, this is also a good way of using up the waste material generated during the laying process.

Where roofing sheets are laid continuously over Sika-Trocal Metal profiles, then the requirements relating to the dimensions for the gap and welding of the membrane both sides must be observed. However, in these circumstances there is no need for an individual butt strap as the membrane sheet itself serves that purpose.



TYPICAL DETAILS

UPSTAND ANGLES AND COUNTER FLASHINGS

The following section provides information and typical detailing for the design and installation of roofs using Sika-Trocal roof waterproofing membranes. The drawings generally illustrate the Sika-Trocal Type S exposed and mechanically fastened membranes. However, the basic principles apply equally to ballasted, Sika-Trocal Type SGmA and adhered, Sika-Trocal Type SGK, roofs.

For details relating to the use of ballast and adhesives and details specific to their applications refer to the appropriate sections of the manual.

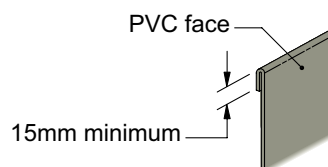
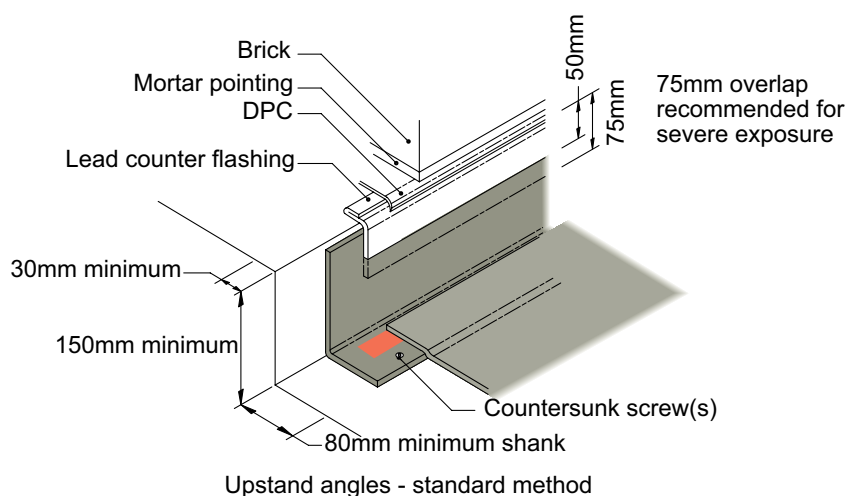
Sika-Trocal Metal profiles will be required at all locations where the membrane terminates, such as roof perimeters and penetrations, they are also required at changes of plane in the roofscape. Additionally, many penetration details can also be formed utilising specialised rigid PVC fabrications.

Upstand Angles - Upstand angles are to be formed from Sika-Trocal Metal. In its simplest form this will consist of a piece of Sika-Trocal Metal cut and bent to form an angle profile. The top edge of the upstand profile must be a minimum of 150mm above the finished surface of the roof in accordance with BS 6229. In the case of ballasted or covered membrane roofs, the measurement must be taken from the upper surface of any covering.

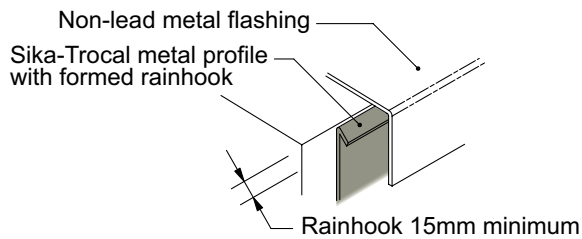
The open edge at the top of the upstand needs to be protected from the weather, normally by the installation of a counter flashing built into the wall and linked to a damp-proof course or cavity tray as appropriate. Lead is considered the normal material for counter flashings, although other materials are sometimes used due to circumstances.

Sika-Trocal materials are never 'built-in' to any construction nor are they suitable for use as damp-proof courses.

When using lead, it may be desirable to impart greater stiffness to the laminated Sika-Trocal Metal profile, at heights greater than 150mm for example. This can be achieved by forming a welt along the top edge.



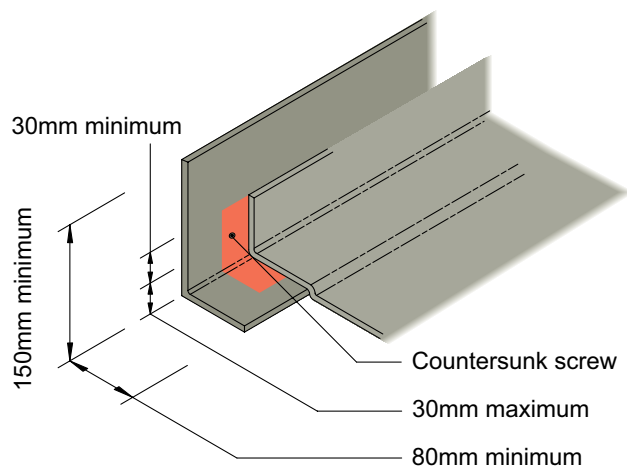
When the counter flashing material used is not malleable like lead, such as zinc or aluminium, then a 'rainhook' must be formed at the top of the Sika-Trocal Metal upstand to avoid the possibility of wind driven rain being blown over the top of the section.



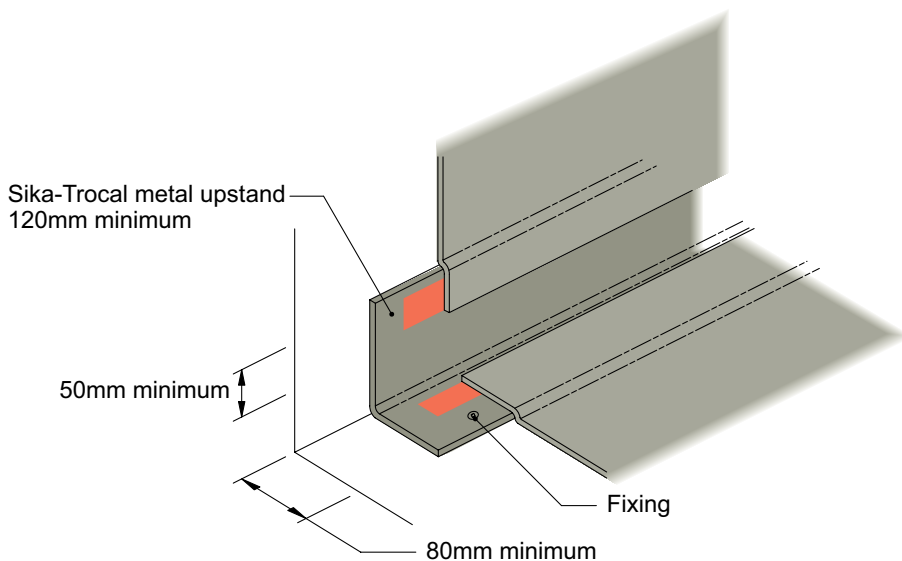
On some occasions the counter flashing may be other parts of the building construction, such as wall cladding panels or rain screening; these should always incorporate their own drip flashing.

When forming Sika-Trocal Metal profiles for use in internal or external angles, it is advisable to over or under bend it by about 5° - 7° so as to ensure a good fit when it is installed.

When fasteners are located in the vertical leg of the profile, then the membrane must be turned up the vertical face of, and welded to the Sika-Trocal Metal to achieve a weatherproof seal.



In cases where membrane is installed onto two planes, the Sika-Trocal Metal profile provides the means of transition.

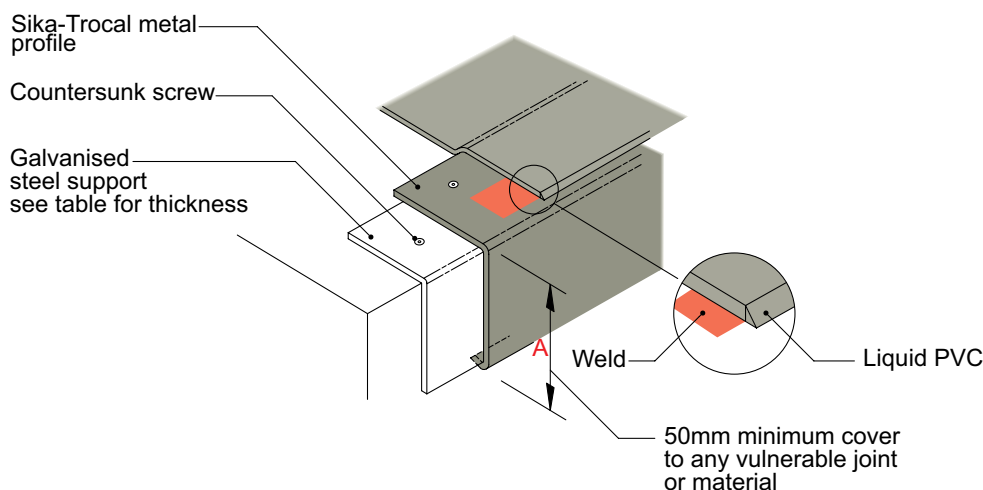


TYPICAL DETAILS

DOWNSTAND ANGLES

Downstand angles are to be formed from Sika-Trocal Metal. In its simplest form this will consist of a piece of Sika-Trocal Metal cut and bent to form an angle profile. Additionally, where these angles are forming the external termination of the roofing membrane it will require a 'rainhook' at its lower end.

These angles may also need to incorporate an internal continuous galvanised steel support profile as shown in the drawing below. The 'rainhook' engages onto the lower edge of the internal galvanised steel support and also prevents rainwater from impinging on the cut edge of the laminated Sika-Trocal Metal.



Required thickness of galvanised steel support profile, determined by downstand dimension A:

Dimension A	Thickness required
Up to 100mm	1.2mm
101-200mm	2.0mm
201-300mm	3.0mm

Continuous galvanised steel support option:

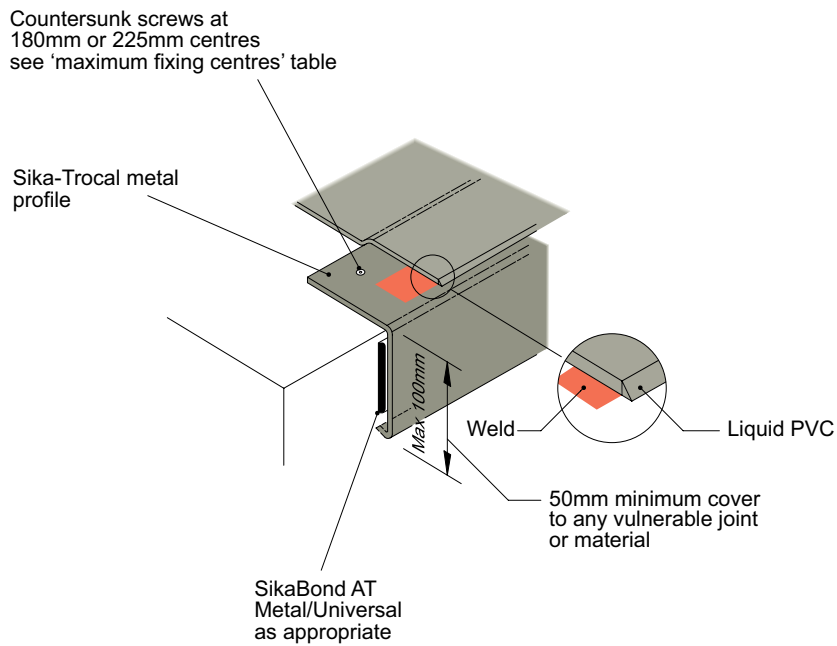
All Sika-Trocal Metal profiles forming the external termination of the roofing membrane will be exposed to high wind load forces. The internal continuous galvanised steel support profiles will help provide the necessary resistance to these forces. The galvanised steel supports also help to locate the Sika-Trocal Metal and support it during the construction period, ensuring a much better appearance upon completion.

The minimum thickness required for the continuous galvanised steel support profile will be dictated by the face dimension of the down stand, see table above.

The galvanised steel support profile should be securely fixed to the substrate first. Then the lower end of the Sika-Trocal Metal is 'hooked onto' the support turned into position and then fixed through the steel into the substrate. It is advisable to stagger the two rows of fasteners so as to create extra turning resistance to the wind forces. Additionally, one row of the fasteners should be located as close as feasible to the outer edge of the front face of the building so as to aid wind resistance.

SikaBond AT adhesive option:

As an alternative to the 'rainhook', a flat welt can be used and the vertical leg bonded to the substrate using the suitable SikaBond AT adhesive (Sikabond AT Metal or Universal). When using Sikabond AT the vertical leg of the Sika-Trocal Metal should be no greater than 100mm. The horizontal leg of the Sika-Trocal metal should be fixed as instructed on page 28 of this manual.



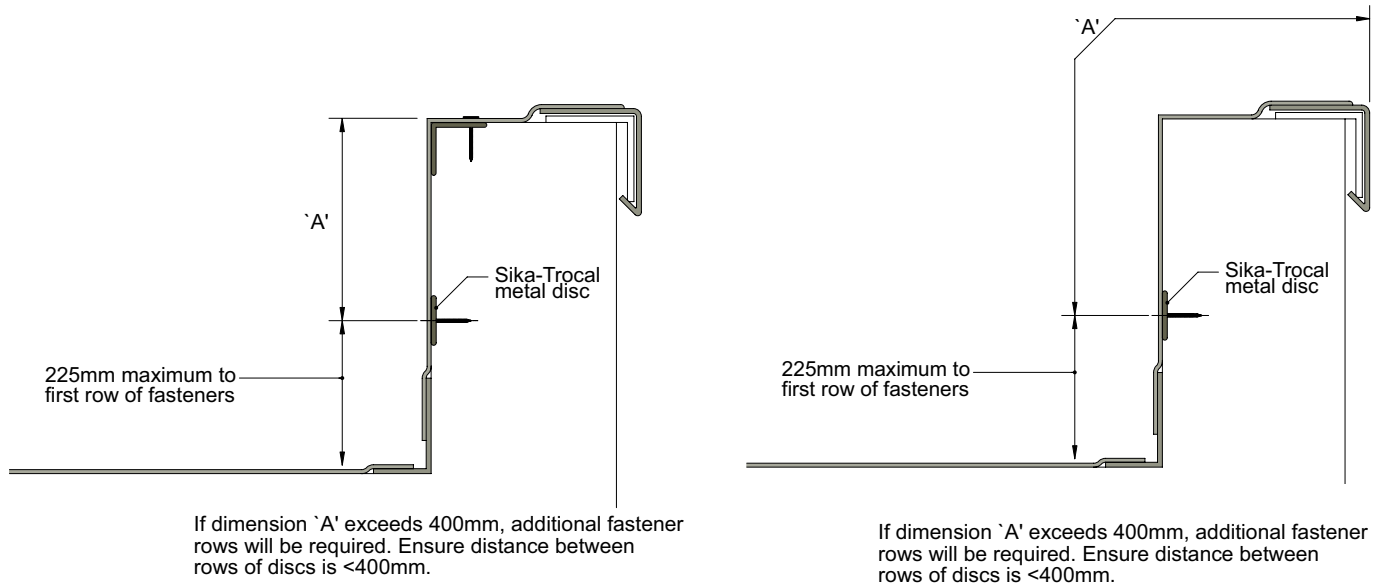
TYPICAL DETAILS

PARAPETS & RAINCHECK KERBS

Parapets - Parapets may be fully clad with the waterproofing by welding the membrane to the vertical leg of the laminated Sika-Trocal Metal angle profile and taking the sheet up the inside face of the parapet and terminating on the external face with a Sika-Trocal Metal downstand profile.

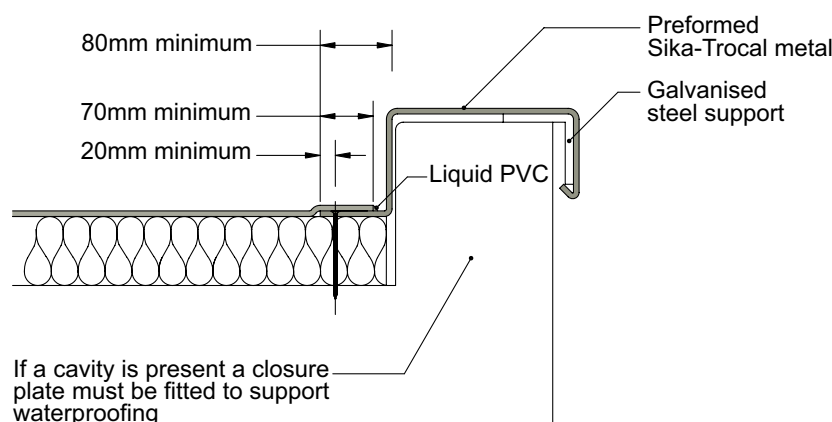
The advantage with this type of detail is that the waterproofing runs from one outside edge of the building to the other and effectively encapsulates the roof itself. This also avoids a change of material, which is always a potential weak spot for water penetration.

Additional restraints will be required to the vertical membrane at parapets if the distance between the first row of fasteners and the top of the corner Sika-Trocal metal profile, exceeds 400mm. Refer also to the section on vertical work for further information.



Raincheck kerb - The raincheck kerb is utilised when drainage of the roof is required internally and water is not intended to run off the edge of the roof area.

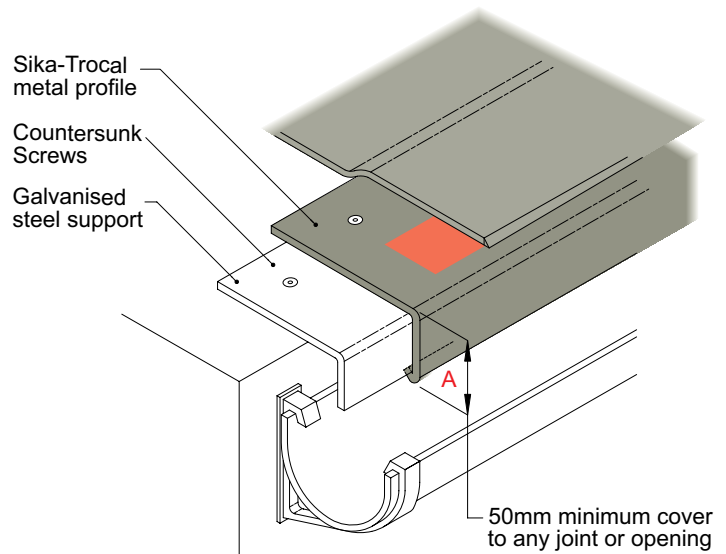
There are no official recommendations concerning a minimum height for these kerbs. However, general experience from the industry suggests that a minimum height of 75mm from the finished roof surface to the top of the kerb should be sufficient to prevent wind driven water from overtopping it in all but the most severe conditions.



TYPICAL DETAILS

DRIP EDGE & RAINWATER OUTLETS

Drip edge - A drip edge detail is formed by fixing a Sika-Trocal Metal profile over a continuous galvanised steel support section and where required, locating it so as to direct any water off the roof into a gutter.

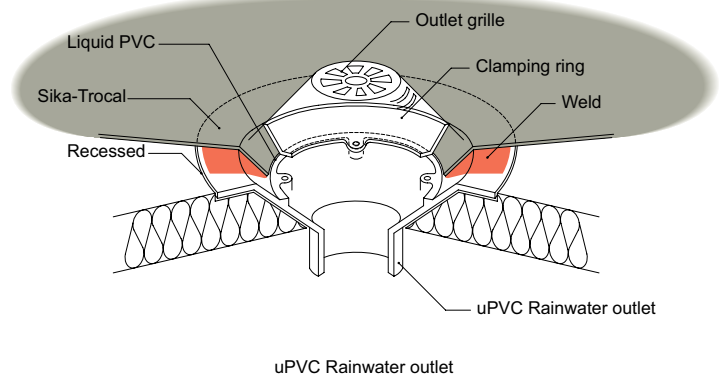


Rainwater Outlets

uPVC rainwater outlets - Sika-Trocal membranes can be welded directly to uPVC rainwater outlets, such as the Sika-Trocal rigid PVC rainwater outlet. This ensures a permanent, watertight joint at one of the most vulnerable points on the roof.

The flange of the outlet must have a smooth, flat surface to which to weld the membrane, with a minimum 30mm wide weld, clear of all outlet fasteners. In some applications the membrane may need to be welded down the 'throat' of the outlet in order to obtain this. Some outlets also come with small ribs, etc moulded onto them, these will need to be removed prior to installation to ensure a full and complete welding operation.

Outlets must be securely fixed to the deck to prevent the possibility of subsequent building operations or structural movement dislodging them and raising them above their intended level. When setting outlets in the roof it is advisable to recess the substrate so that the thickness of the fitting itself does not form an obstruction to the free flow of rainwater.



Proprietary outlets are also available, which have an apron of appropriate Sika-Trocal membrane factory fitted to them to permit easy installation on site.

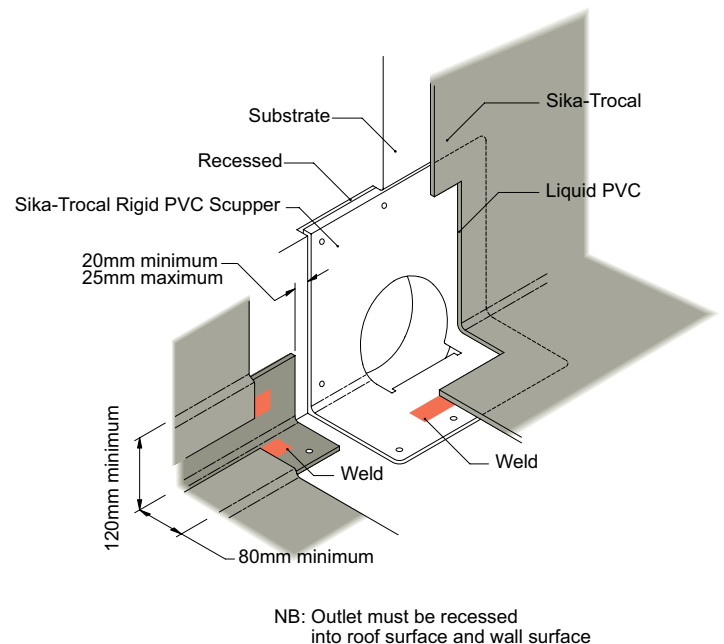
Where outlets are to be placed adjacent to a vertical surface, i.e. close to a parapet, it will be necessary to allow at least 100mm from that face to the outside diameter of the outlet to permit satisfactory installation. If being installed between two such surfaces, i.e. in a gutter, then at least 100mm should be allowed each side of the outlet.

Parapet outlets/Scuppers - These are normally manufactured from uPVC, as per the Sika-Trocal rigid PVC scupper shown below.

Again, it is recommended that the substrate is recessed to accept the outlet and that it is securely fixed to the deck.

Warning pipe/overflow outlets - It is good practice to consider the use of an overflow pipe, especially on roofs which are drained internally, in order to provide an emergency warning pipe.

Sika-Trocal membranes can be welded directly to uPVC rainwater outlets, such as the Sika-Trocal Overflow/Warning Pipe (75mm diameter). This ensures a permanent, watertight joint at one of the most vulnerable points on the roof.



TYPICAL DETAILS

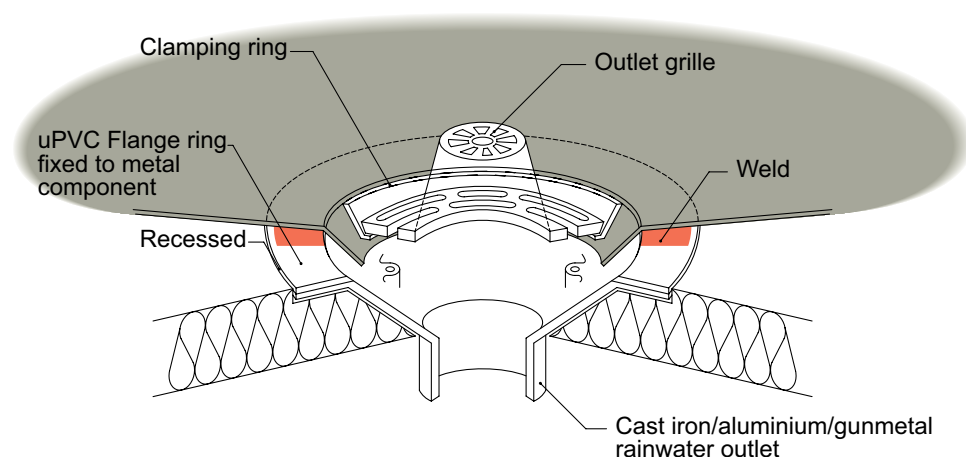
RAINWATER OUTLETS

Metal outlets - Cast iron, aluminium or gunmetal rainwater outlets may be selected for use with Sika-Trocal membranes. They are generally considered essential for heavy duty applications such as ballasted or heavily trafficked roofs.

In order to ease the installation process, some manufacturers have developed their outlets so that they either incorporate an uPVC flange or are coated in liquid PVC. This is to make the installation process as simple as that used with an uPVC outlet. It is strongly recommended that if selecting metal outlets only these types be used.

If traditional metal outlets are selected they will require the use of adhesives to make the connection between membrane and the fitting. They will also require the installation of a stress interceptor flange to the substrate. Details for this particular type of installation are available from Sika Limited upon application.

Again, it is recommended that the substrate is recessed to accept the outlet and that it is securely fixed to the deck.



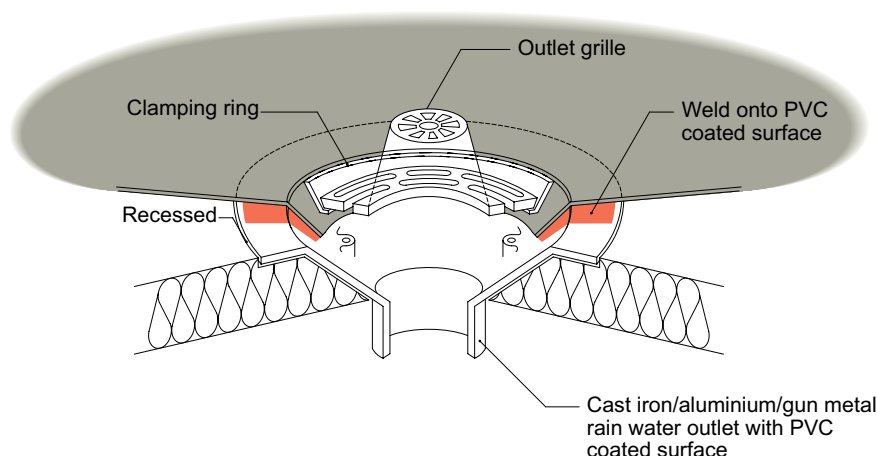
Siphonic Rainwater outlets - Proprietary siphonic drainage systems, with outlets manufactured in metal are also available. Some of these are also available factory coated in liquid PVC to permit easy installation. Others are designed to have a clamping action to connect to the membrane; these too will require the installation of a stress interceptor flange to the substrate prior to fitment. Details for this particular type of installation are available from Sika Limited upon application.

With clamping type siphonic outlets it is advisable to have the actual manufacturer/supplier fit the membrane at their factory due to the complexity and fine tolerances associated with these types of fittings.

Where outlets are to be placed adjacent to a vertical surface, i.e. close to a parapet, it will be necessary to allow at least 100mm from that face to the outside diameter of the outlet to permit satisfactory installation. If being installed between two such surfaces, i.e. in a gutter, then at least 100mm should be allowed each side of the outlet.

Notes - When outlets are installed into a ballasted roof, it is recommended that an apron of Sika-Trocal Type S membrane be welded onto the flange and turned down the throat of the outlet first.

The Sika-Trocal Type SGmA membrane can then be welded over the apron of Sika-Trocal Type S and terminated at the inside edge of the flange. This is easier than trying to get the fibreglass restrained Sika-Trocal Type SGmA to follow the tight radii of most outlets.



TYPICAL DETAILS

PENETRATIONS

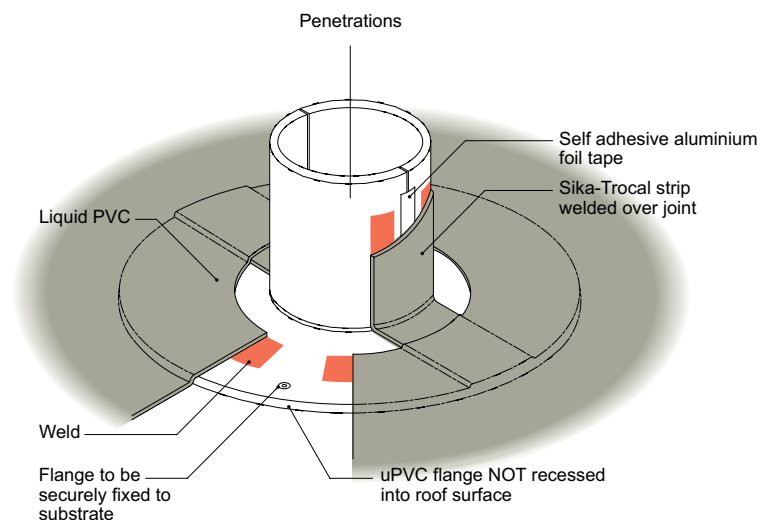
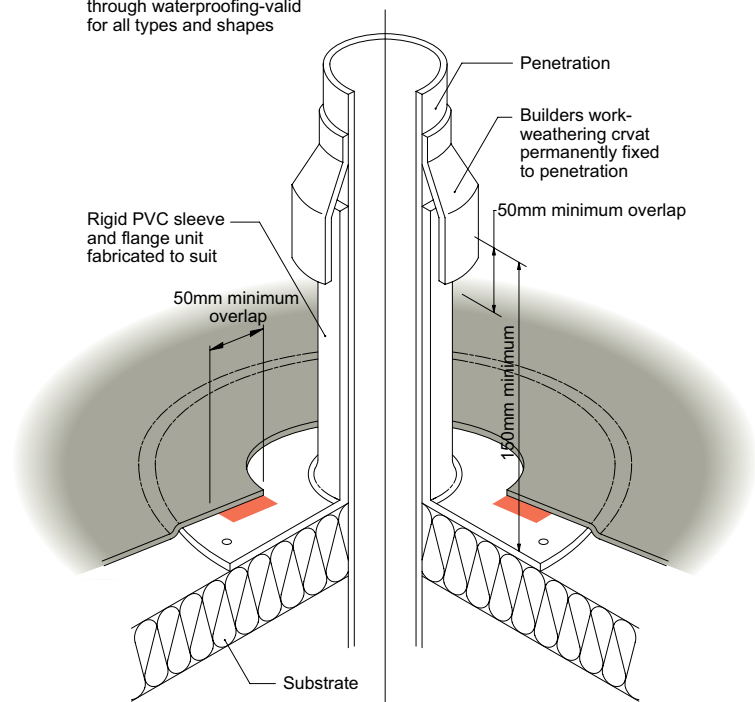
Penetrations of many types, sizes, shapes and materials are required to come through the Sika-Trocal waterproofing. Examples are structural steel work, handrails, safety posts, mechanical services items such as trunking, pipes, cables, etc. Unless these are detailed and constructed in a proper fashion, they are likely to become an easy source of water penetration into the building.

The basic principle is that a sleeve of waterproof material is formed around the penetration itself and carried up till it is at least 150mm above the finished roof surface. This sleeve is then weatherproofed with a cravat fixed to the penetration itself. The cravat itself is best provided and fitted by the supplier of the penetrating item or alternatively the main contractor. This principle relies only on mechanical overlaps to maintain its weathertightness and should last at least as long as the service life of the membrane itself. This method of detailing, whilst traditional, is well established as about the only way of achieving reliable details on site and is in accordance with BS 8217.

The sleeve and its base flange are often best fabricated from uPVC, ensuring easy installation of the membrane. The flange of these items must be adequately fixed to the deck. The detail can also be executed utilising Sika-Trocal Metal but is best restricted to those shapes with straight sides.

When the nature of the penetration prevents the unit being slid on from the top then a two piece unit can be assembled around the item and jointed as indicated. Examples are drop rods from external beams and existing penetrations in a refurbishment situation, etc.

Basic principles of weatherproofing penetrations through waterproofing-valid for all types and shapes



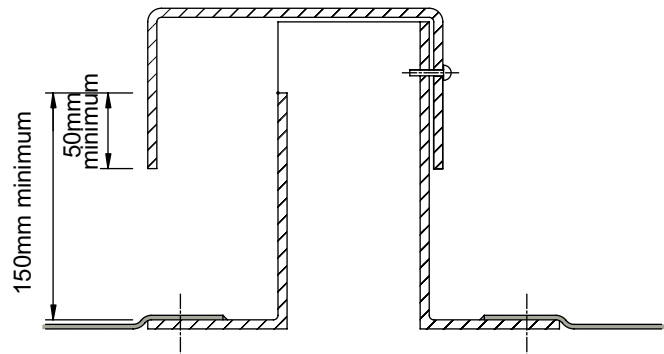
Services

Flues - Flues are sometimes required to penetrate the roof. When these convey hot gases the double skinned, insulated type of flue should be used to ensure that the surface temperature never exceeds 38°C. If this cannot be achieved within the flue construction itself, then it is necessary to provide a sleeve with sufficient space to permit packing with non-combustible insulation to reduce the external temperature to the required level.

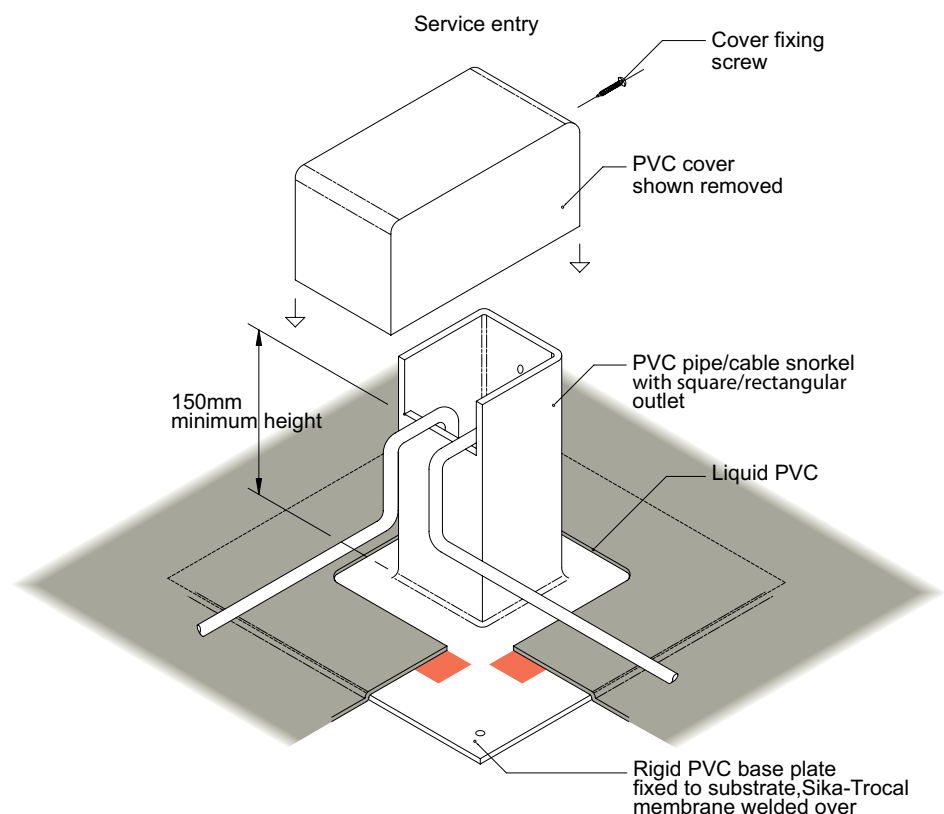
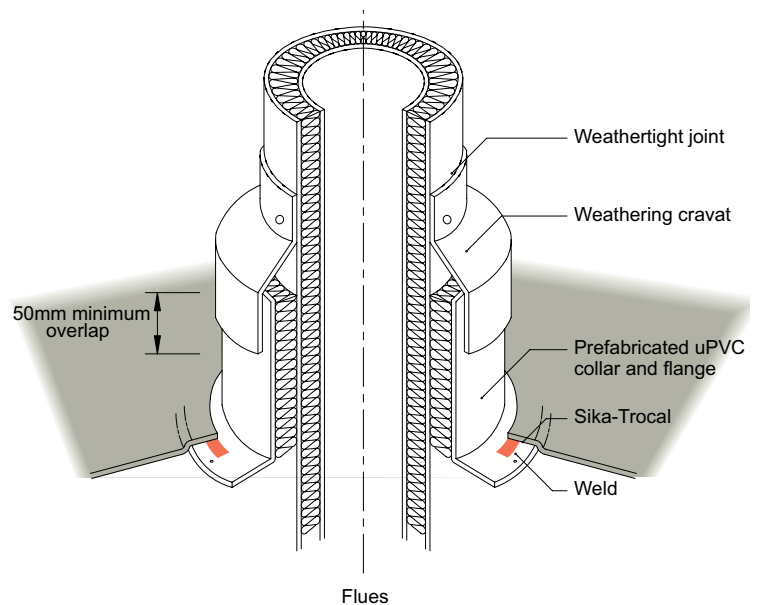
Pipes and cabling - Pipes and cables may be required to penetrate the waterproofing and many of them can be simply detailed as indicated previously. However, when there are a number of smaller items bundled together or the nature of their materials are such as to exclude the fitting of cravats then there is a need to provide a suitable weatherproof housing and cowl as indicated here. The underlying principles being that any opening must be at least 150mm above the finished roof surface and the services themselves must be angled up towards that opening so as to prevent water running along their undersides and entering the building.

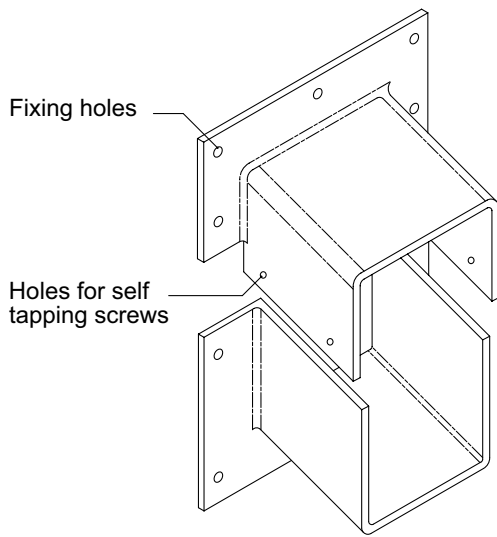
Consideration should be given to the necessity of providing insulation and/or anti-bird and insect screens as required.

Details for penetrations through vertical surfaces are on the following page.

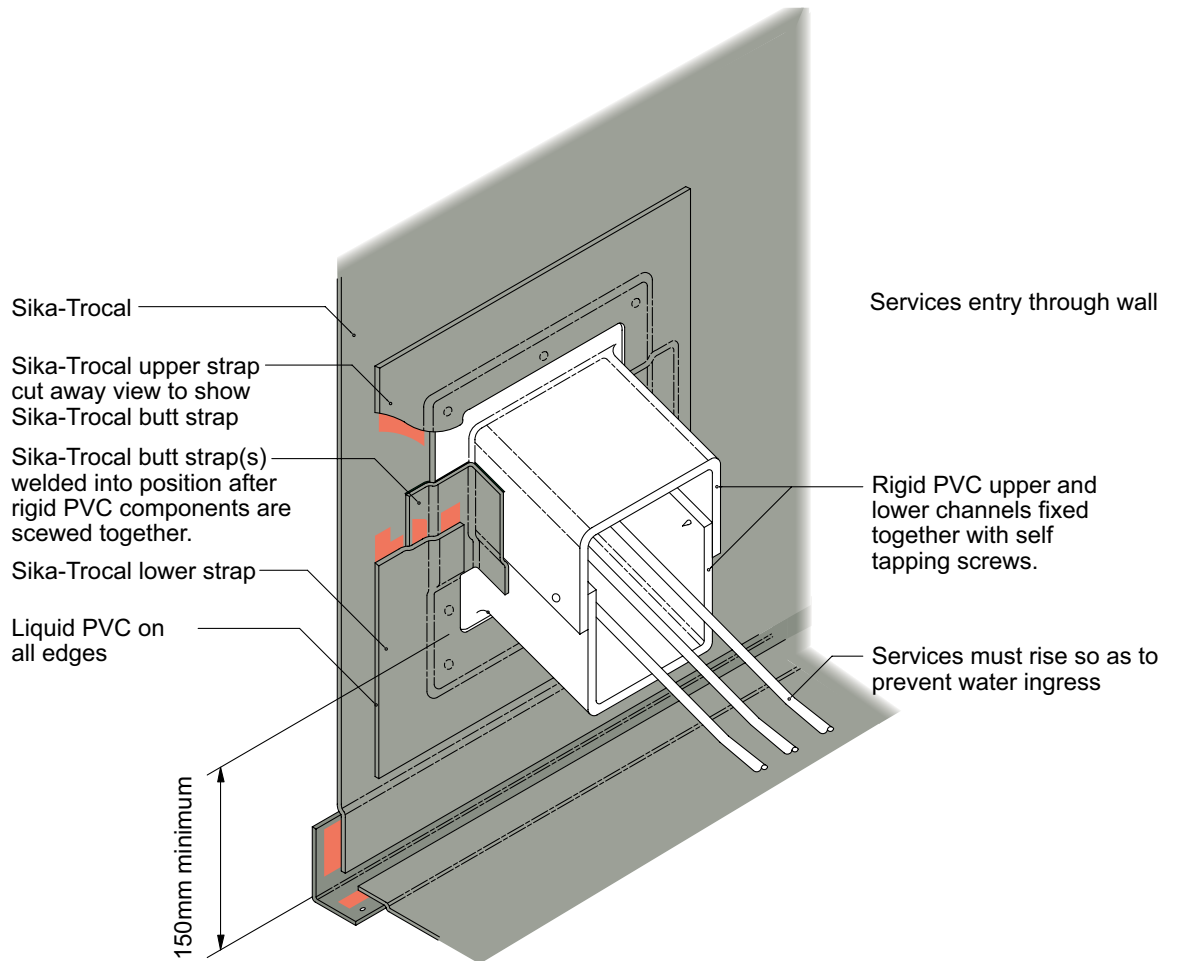
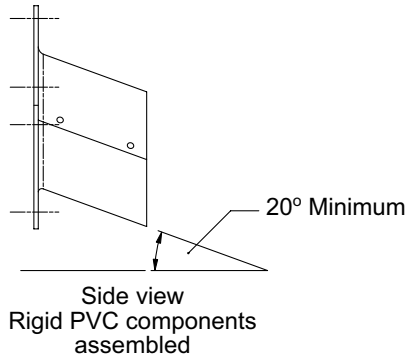


Section through PVC pipe/cable snorkel





Service entry through wall
rigid PVC components

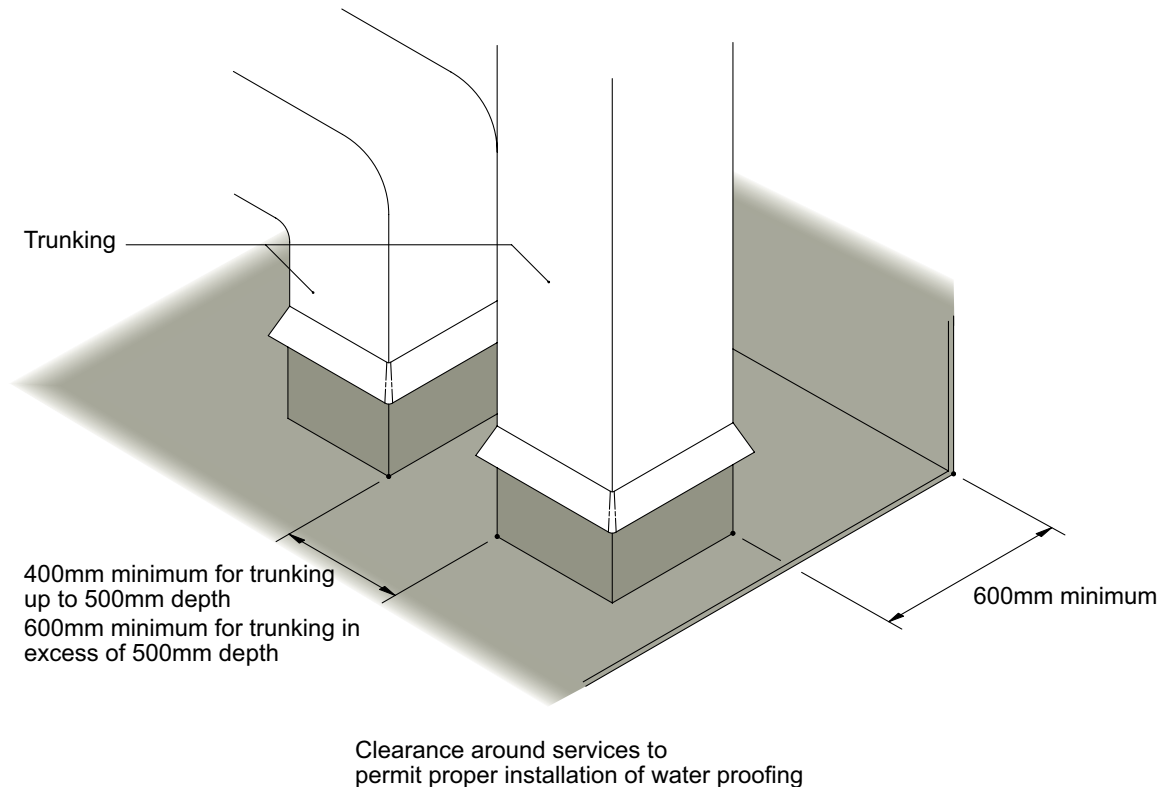


Notes - It is of vital importance to allow sufficient space around any penetration so that it is possible to actually gain access and successfully install the waterproofing in an acceptable manner.

In particular this means not locating penetrations too close to walls or other penetrations or any other obstructions. It is suggested that an absolute minimum space of 180 - 200mm be allowed between a wall and any small penetration and also between individual penetrations themselves. In the case of multiple small penetrations occurring in one area they may best be bundled together and brought through a housing and cowl as indicated previously.

Liaison with the appointed Sika-Trocal contractor before service runs and penetration locations are finalised seems essential if the problem of having service/roof interfaces that are impossible to weatherproof are to be avoided.

Due to their size, the location of ventilation trunking can be particularly critical. Indications of suitable clearance dimensions are indicated here although these should be checked and agreed with the roofing contractor before commencing work.



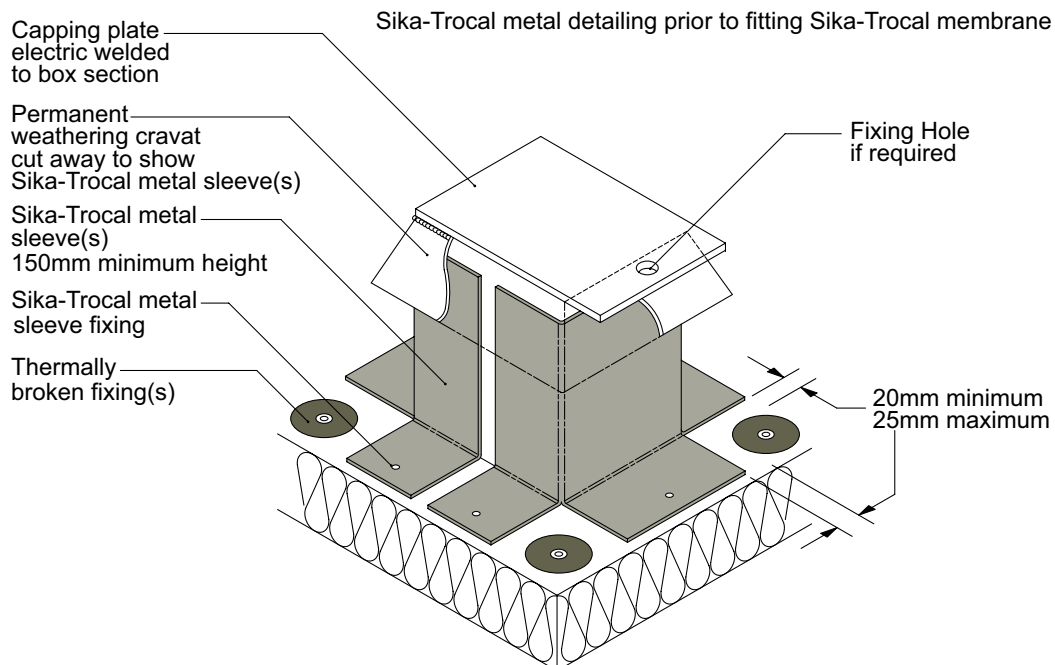
Structural

Where steel sections penetrate the roof construction a sleeve should be formed around the section with a weathering cravat welded to the steel. The sleeve must have a minimum height of 150mm above the finished roof level.

In these circumstances the sleeve is frequently formed from Sika-Trocal Metal although uPVC is an equally acceptable material. If the cravat is welded in place after the steel has been installed precautions should be taken to prevent damage to the roof surface from sparks and spelter.

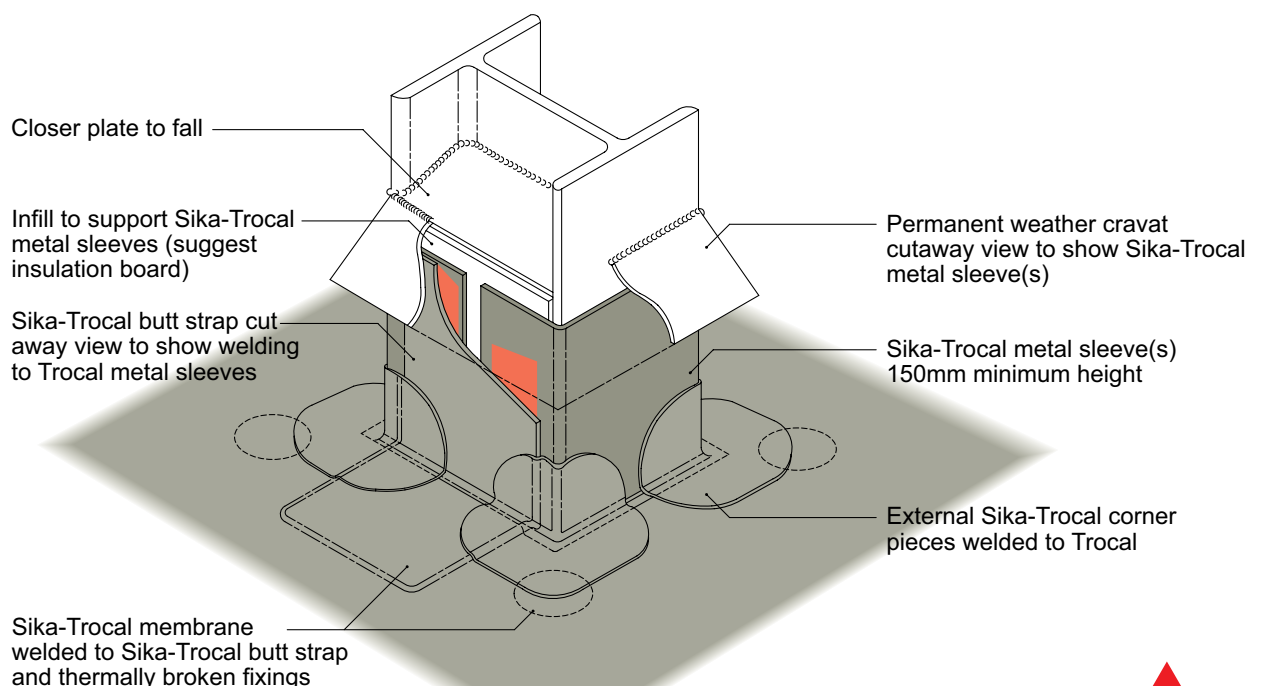
Steel Hollow Section - Shown here is a rolled hollow section, which with a plate welded to the top, is suitable as a base to form a grillage for roof mounted mechanical plant. Note that the fixing hole in the plate is shown offset to avoid penetrating the hollow space in the steel, which would provide a water penetration point.

Structural penetrations

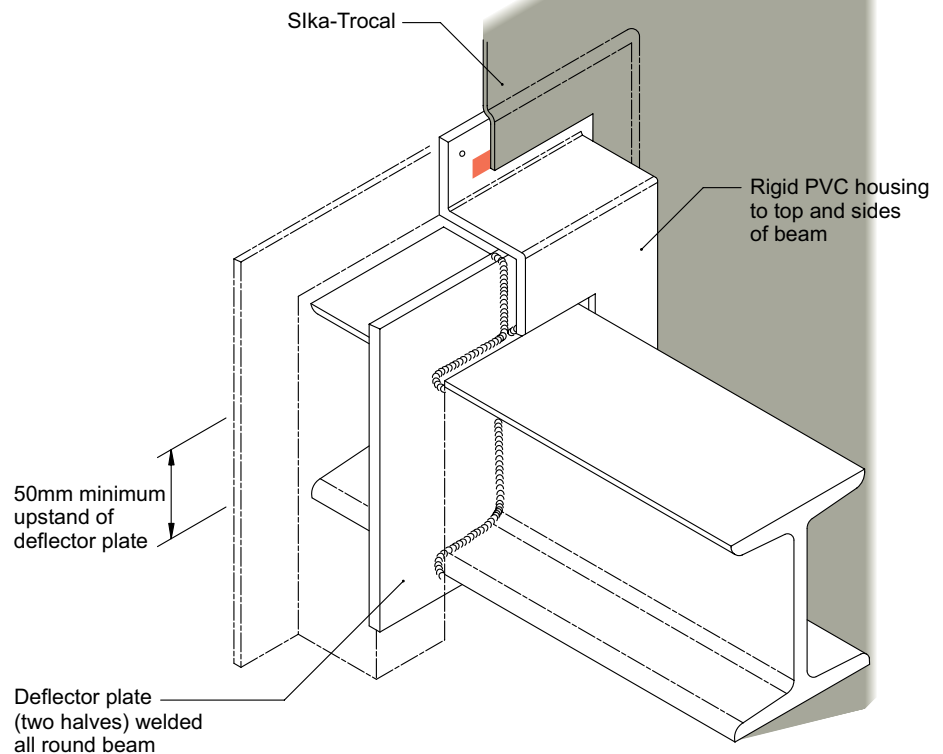


Steel I-Beam - With an 'I' shaped beam it is necessary to infill the gap between the flanges and the cravats as shown. Also, note the need to infill the space below the cravat to support the upstand of waterproofing against distortion from impacts

Roof penetration by I-section beam Sika-Trocal metal detailing prior to fitting Sika-Trocal membrane



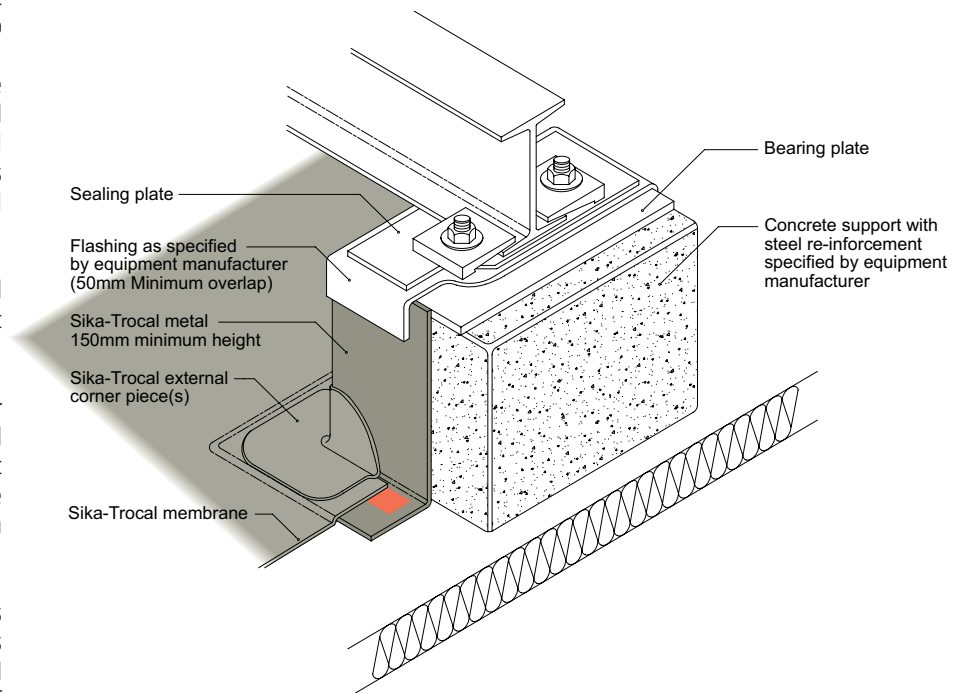
Vertical Surfaces - Where a structural member is carried through vertical waterproofing it is necessary to provide a 'cowl' that will provide weathering to the opening in the wall. In addition, a deflector plate welded to the beam is required to prevent water tracking along the horizontal surfaces.



Mechanical equipment - Some buildings require some form of mechanical equipment to enable window cleaning and maintenance to be carried out via a suspended cradle system. Some of these require a rail or rails around the roof from which to operate. The rail based system is the only method of locating and operating this type of equipment that seems to provide a relative trouble free operational life for the roof itself.

Provision does, however, need to be provided in the form of a 'hard standing' at the point where the cradles are going to be 'parked'.

This detail indicates how to weather this junction. Details of the concrete and reinforcement required needs to be sought from the equipment manufacturers. For ease of installation it is best if the sides of the plinth are vertical rather than sloped.



Due to the loads imposed Sika-Trocal materials are not suitable for incorporation into this detail as the counter flashing material and should therefore be terminated at the top of the upstand.

Note that special attention needs to be paid to sealing the point where the threaded rods pass through the sealing plate as water can easily track down the threads and enter the building.

TYPICAL DETAILS

ACCESS EQUIPMENT

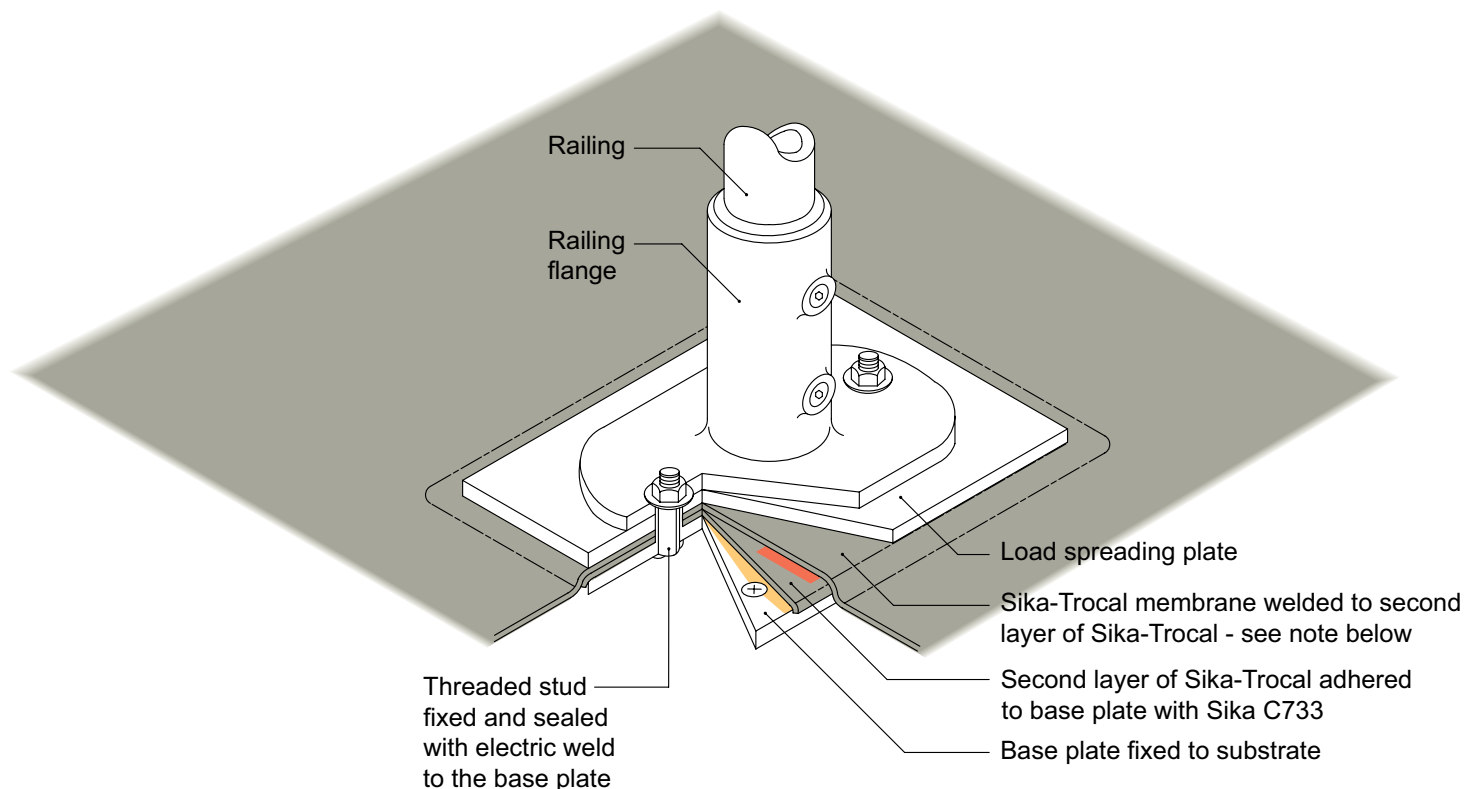
Handrails - Handrail systems are sometimes required to the roof area and these tend to come in three forms.

Some are manufactured from solid metal components and are fixed to the structural deck itself. These require waterproof sleeves and permanent cravats as generally detailed for penetrations previously.

Others are 'free standing' and are retained in place by self-weight combined with occasional extended horizontal legs for stability. The bases of the vertical posts and the ends of the extended horizontal legs usually come with a large load spreading metal plate commonly with a foam rubber pad to the underside which sits directly on the roof's surface. Wherever these systems are installed onto a roof in direct contact with the Sika-Trocal membrane it will be necessary to provide a permanently welded patch of Sika-Trocal SBV to the membrane before placing the hand railing in position.

In certain applications the use of the appropriate walkway material may be acceptable.

Finally, some systems are fabricated from hollow tubular rails which are interconnected via a series of cast sockets. As the tubes are hollow and the junctions at the sockets are not sealed, water can enter the tubing and gravitate to the lowest point. Therefore, it is essential that the lowest fitting, that is the base flange socket, be fixed above the waterproofing membrane. If the base is fixed under the membrane it simply allows the water to bypass the membrane and enter the building. The detail below demonstrates the means of achieving an anchoring point without compromising the waterproofing.



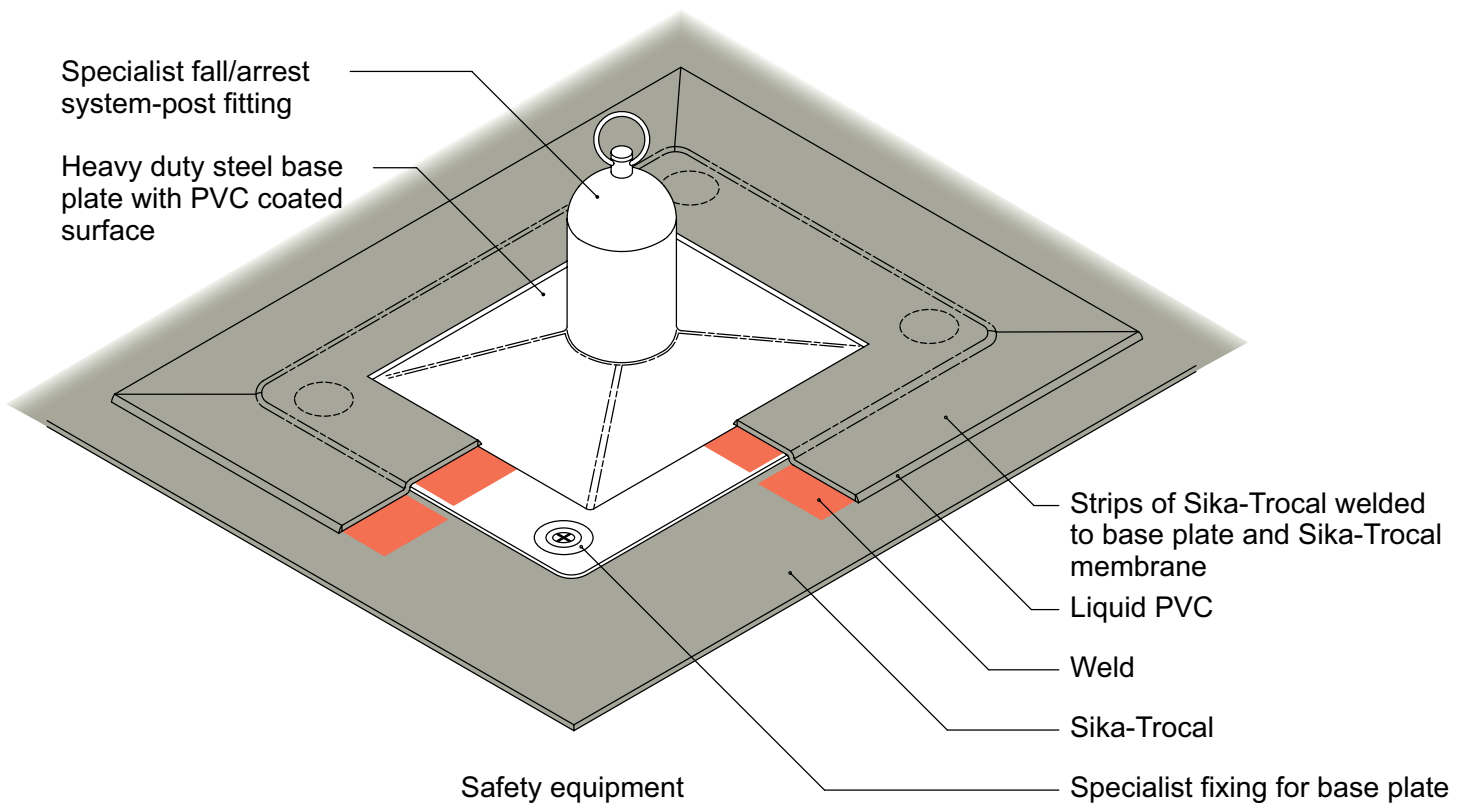
Fall arrest systems - Some roofs will be required to be fitted with cable based safety systems for those accessing the roof area.

Some devices are based on steel posts rigidly fixed to the structure, which then penetrate the roof membrane to provide an anchoring point or a cable holder. These require waterproof sleeves and permanent cravats as generally detailed for penetrations previously.

More recent developments have sought to build-in a fair degree of shock absorbency to reduce the severity of injuries sometimes suffered by those personnel who actually fall off a roof. At the same time a method was developed for surface mounting these devices onto lightweight roofs. This not only makes the installation itself easier but also means they can be installed after most work on site has been completed, avoiding the damage that can sometimes occur from subsequent building operations.

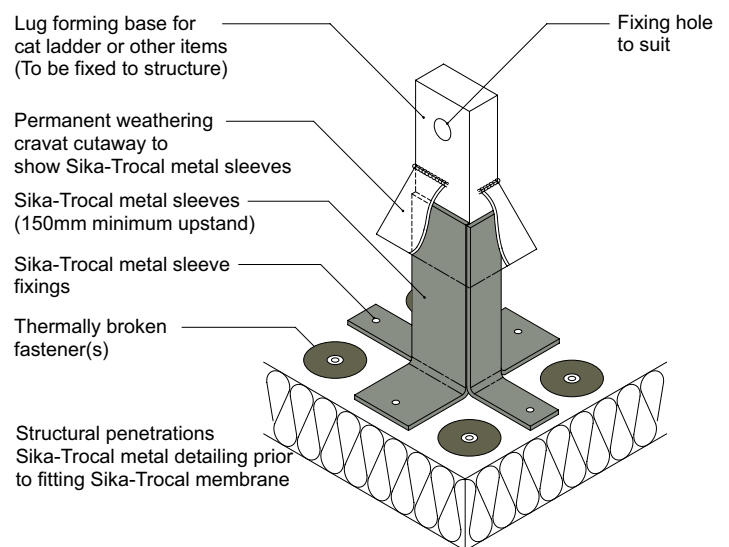
Basically, these units consist of a large baseplate which is secured to the deck by specially developed fasteners. As the baseplate is factory coated with PVC it is then possible to waterproof the joint between plate and roof and the fasteners by simply welding on strips of Sika-Trocal membrane as shown.

Because of the safety related nature of these fall arrest systems they must only be installed by those certified by the manufacturers to be competent to do so.



Access ladders - Access and cat ladders should, for preference, be fixed to walls so as not to penetrate the waterproofing. If this is not possible then they should be attached to a lug attached to a structural member of the roof construction and brought through the Sika-Trocal waterproofing membrane. These require waterproof sleeves and permanent cravats as generally detailed for penetrations previously.

Under no circumstances should the base of a ladder be located directly onto the exposed roof surface, the loads imposed will crush the underlying insulation and lead to rupture of the membrane.



TYPICAL DETAILS

CILLS, ROOFLIGHTS, KERBS AND BALCONIES

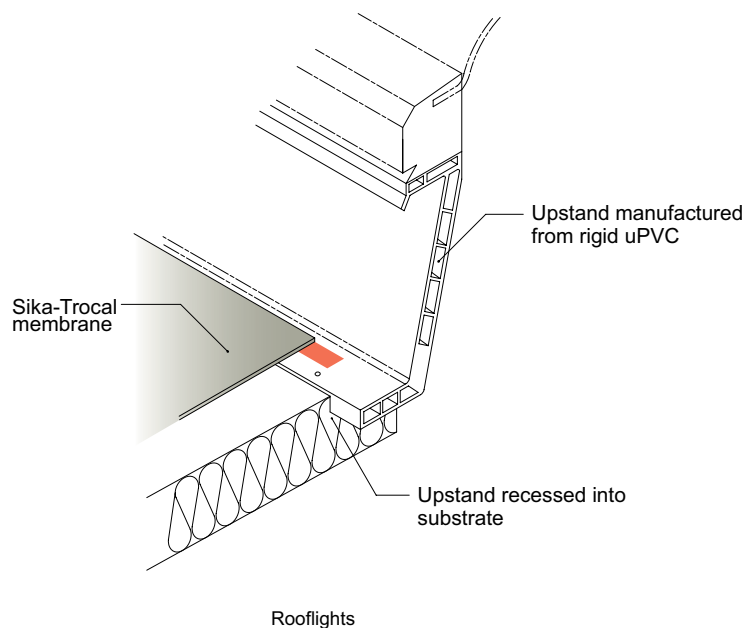
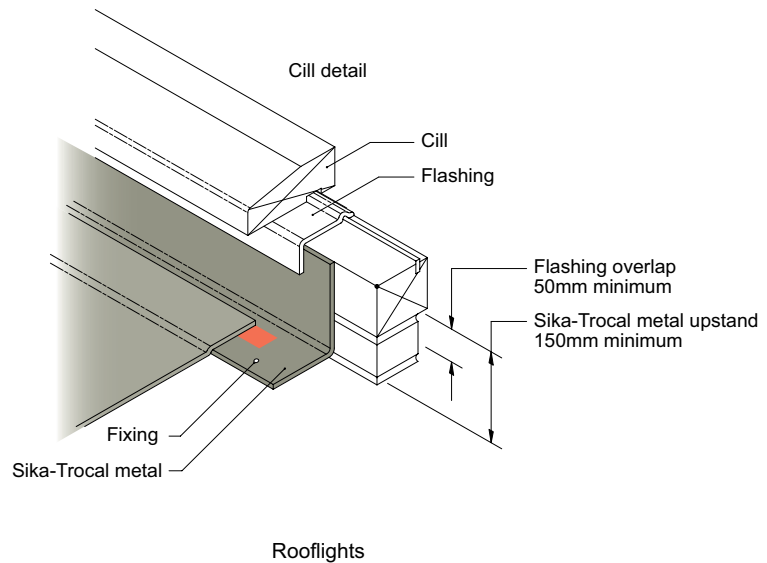
Cills, rooflights, kerbs and balconies

Openings may be required in walls to accommodate service access doors, doors onto patios and balcony areas, windows and glazed panels, louvre grilles, etc.

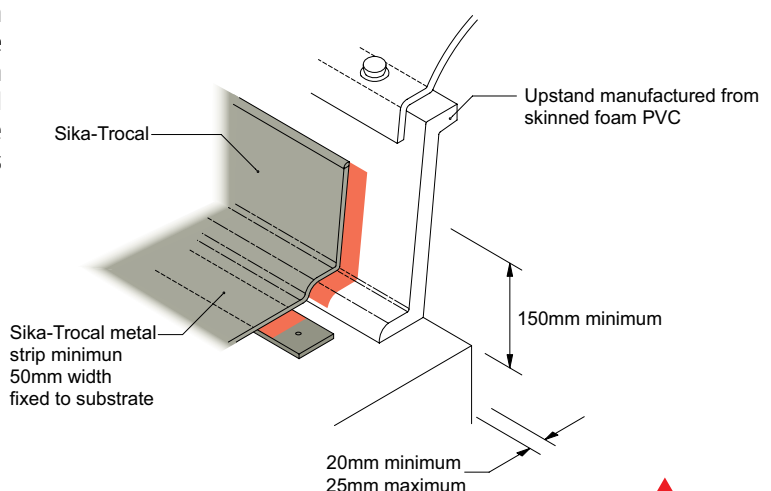
Most of these will incorporate some form of cill section that has to form a junction with the Sika-Trocal Metal upstand. To avoid water penetration and comply with the requirements of BS 6229 the 150mm minimum upstand height, measured from the finished surface of the roof, must be complied with here as elsewhere.

Balconies and other public access areas are likely to be covered with hard surfacing and probably incorporating insulation as well; the extra thickness of these items will need to be taken into account when setting floor slab levels, etc. In many cases it may be necessary to crank the floor slab down at the wall line in order to accommodate the extra thickness and still maintain the minimum 150mm upstand.

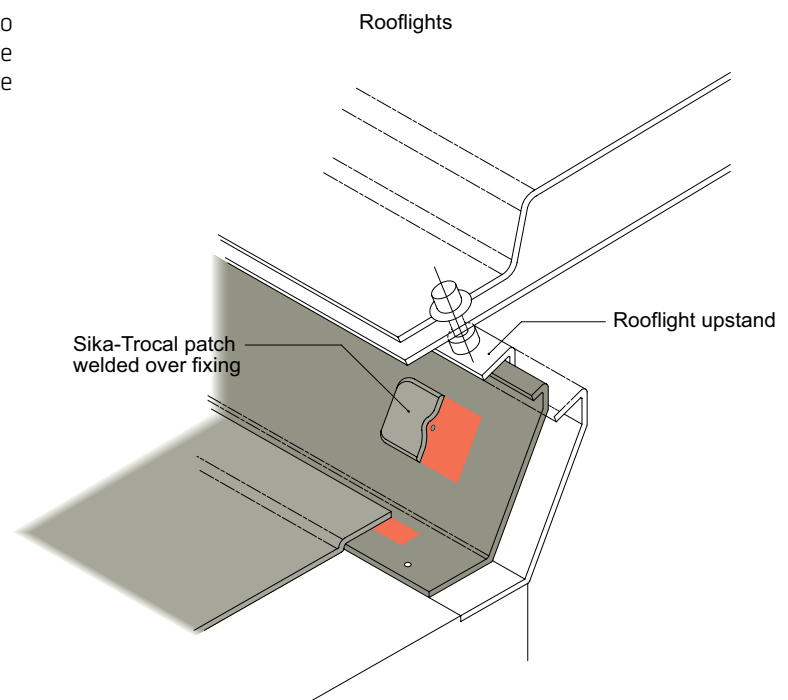
Rooflights - Some rooflight kerbs are manufactured from multi-chambered uPVC sections of a similar nature to those used in uPVC windows. The Sika-Trocal membrane should be welded to the horizontal leg of the base of these units and then continued up the sides of the upstand to the top.



Also available are rooflight kerbs that are manufactured from a foamed skinned PVC material. It is possible to weld the membrane to these also, as indicated here. However, there is an additional requirement to fix an interceptor flange of Sika-Trocal Metal around the unit. The membrane must be welded to the interceptor flange prior to it being welded to the kerb itself. As above the membrane should be taken up the sides of the unit.

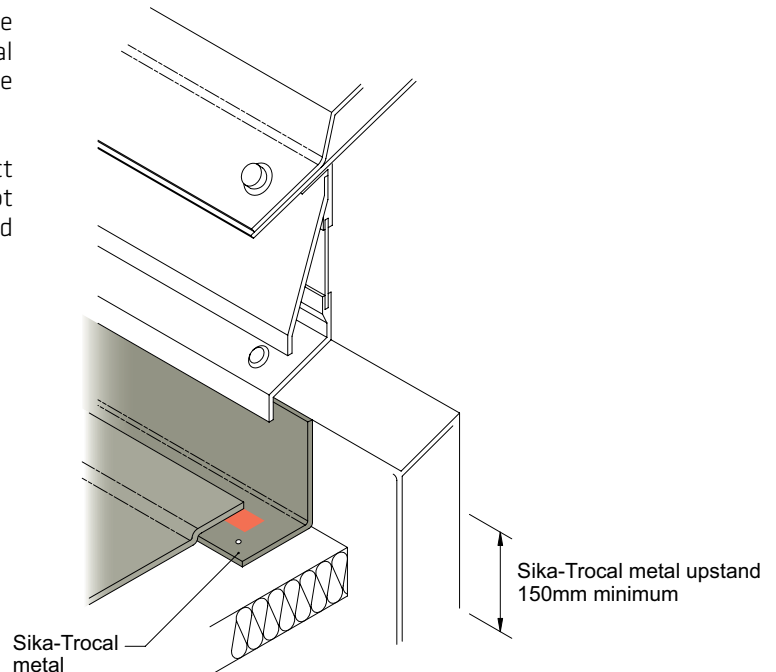


Shown here is a single skin proprietary item that is more likely to be found on a refurbishment project. This solution could only be used if permitted under the Building Regulations relating to the conservation of fuel and power.



Kerbs - Traditional builders work kerbs for rooflights, smoke vents, ventilators, fans, etc will require Sika-Trocal Metal upstands around them with a minimum height of 150mm above the finished roof level.

The unit mounted on the kerb needs to be designed so as to act as a counter flashing to the Sika-Trocal upstand. If this is not possible then a separate lead counter flashing needs to be fitted to the top of the kerb.



TYPICAL DETAILS

LIGHTNING PROTECTION

Reference should be made to BS EN 62305 Protection against Lightning, Parts 1 – 4 for full guidance.

Protection would generally be provided by a system of conductor tapes augmented by air terminals when required.

Usually the conductor tapes are laid on the roof in a grid pattern known as a Faraday's cage. This cage needs to be attached to the roof and restrained against wind load forces and the forces generated by a lightning strike, both of which are sufficient to dislodge the system.

The normal method of attachment consists of a semi-rigid PVC stool, the base of which is welded to a cleaned dry area of the membrane surface. Sika-Trocal S-TR LC Clips are hot air & solvent weldable lightning conductor clips that allow quick, easy application of both bare & PVC coated lightning conductor tape to Sika-Trocal membranes.

In the case of a disc fastened roof, the Lightning Conductor Clips must be welded to an area of membrane that is directly over a fastened Sika-Trocal Metal disc or profile.

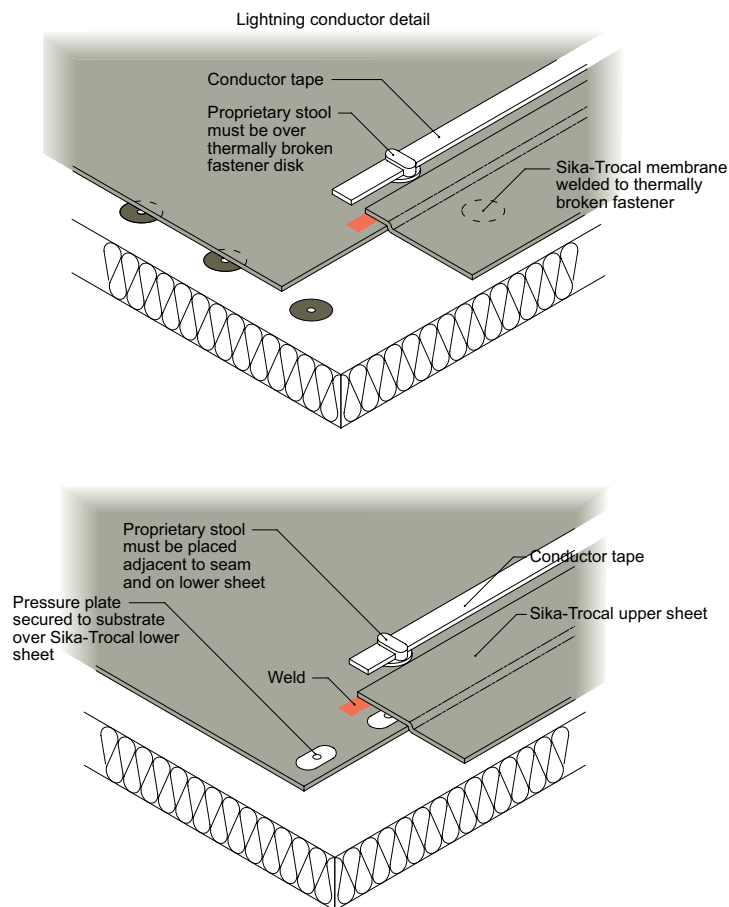
For a pressure plate or in-seam fastened roof, the clips must be welded to the lower membrane sheet and immediately adjacent to the seam itself.

There needs to be some liaison between the roofing contractor and conductor installer at an early stage in the contract. This is to ensure that any rows of discs that are going to be used as a base for a conductor-fixing run are in the correct location and in a straight line. There is usually up to a half a metre tolerance either way in the location of conductor runs, therefore it is usually easy to locate a suitable run of fasteners.

Similar clips bases are available with self-adhesive foam backing, which are designed for use on glass and plastisol coated metal panels etc, these units are completely unsuitable for use on Sika-Trocal membranes.

Any air terminals are likely to be secured to metal frames weighed down with some form of ballast. Where these are placed onto the membrane, there will need to be a layer of SBV welded to its surface first.

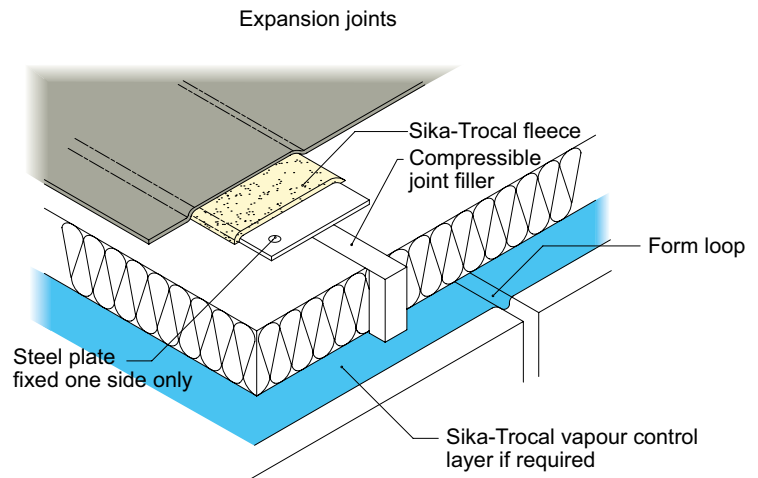
Full details of the fixing centres and layout, along with other equipment, should be obtained from the Specialist Lightning Protection Installer of the Lightning Protection System Manufacturer: **Thomas & Betts Ltd (Furse), Wilford Road, Nottingham, NG2 1EB, Tel: 0115 964 3700.**



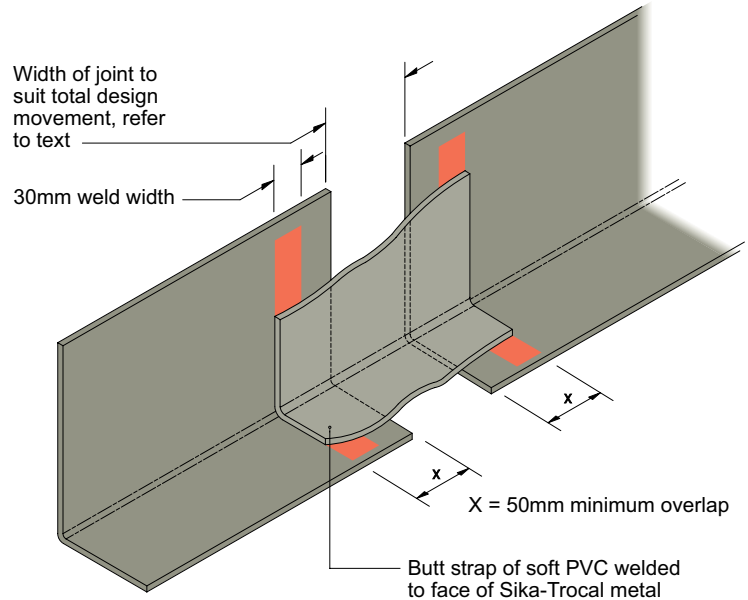
TYPICAL DETAILS

EXPANSION AND MOVEMENT JOINTS

The waterproofing may be carried straight over many simple expansion joints where movement is expected only in the same plane as the membrane itself. That is a simple horizontal movement at right angles to the joint faces themselves. The elasticity of the membrane allows it to 'ignore' the expansion joint and cope with such movement.



It should be noted, however, that other components in the roof build-up would not be able to cope with this movement. Therefore, it is likely that it will be necessary to provide a compressible infill between the ends of the insulation boards for instance and to form a loop in any vapour control layer. Also required is a galvanised steel plate, fixed one side only and protected with a Sika-Trocal protective fleece to prevent the membrane from dropping into the joint itself.

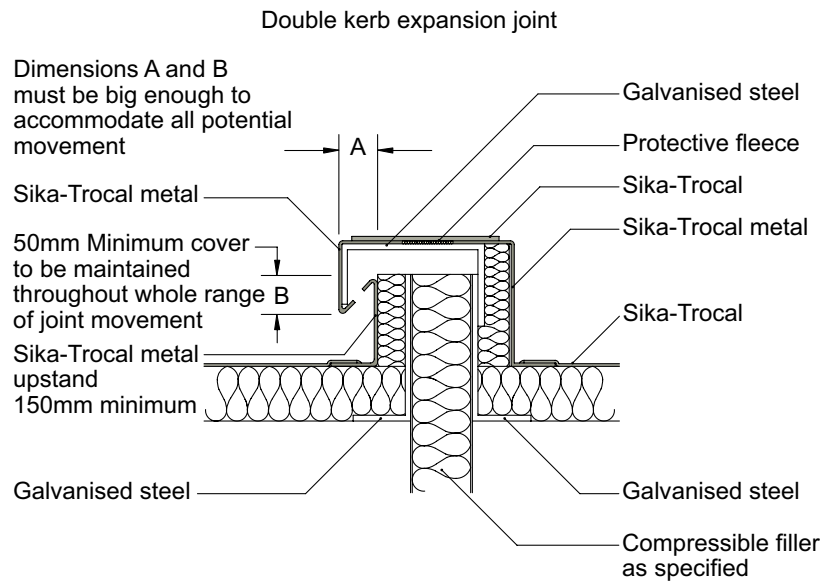


When the simple expansion joint reaches a vertical surface, that is the upstand, then the Sika-Trocal Metal sections have to be detailed so as to take into account the designed movement of the joint. This is achieved by creating a wider than standard butt joint.

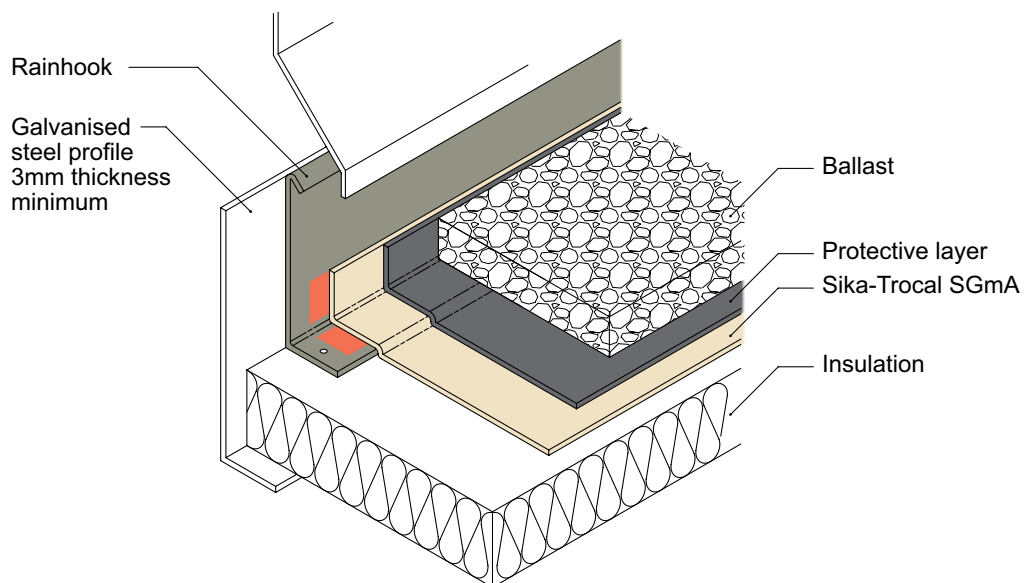
The width of the gap between the metals should be at least twice the sum of the expansion joint width and the total range of movement expected plus 25mm. The strap of membrane itself needs an additional minimum 50mm overlap each side onto the metal where it is welded into position. Depending on the substrate, it may be necessary to provide some backing and possibly a layer of Sika-Trocral protective fleece to support the strap material itself against damage.

Where expansion joints are designed to move in two or even three planes it is necessary to utilise a traditional 'twin kerb' type of expansion joint in order to cope with this degree of movement. A typical approach is shown here.

When detailing such a joint, it is necessary to leave sufficient clearance between the components to accommodate the total anticipated movement. It might be advisable to also consider the incorporation of anti-bird or insect screens.



Movement joints - Expansion or movement joints can occur parallel to a wall; therefore the Sika-Trocal Metal upstand profile which terminates the roof will abut that joint. In these situations the Sika-Trocal Metal will be without its customary support. Therefore, it is necessary to provide this support in the form of a galvanised steel profile of minimum 3mm thickness, securely fixed to the substrate.



TYPICAL DETAILS

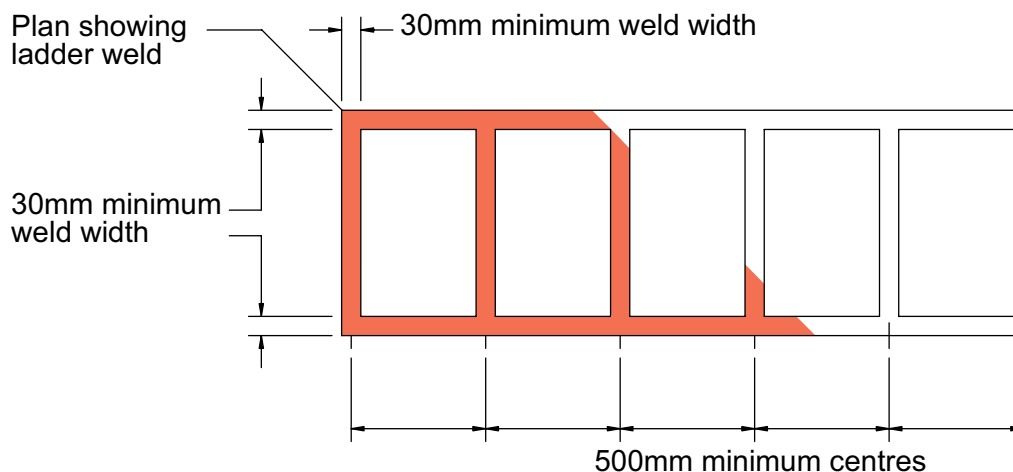
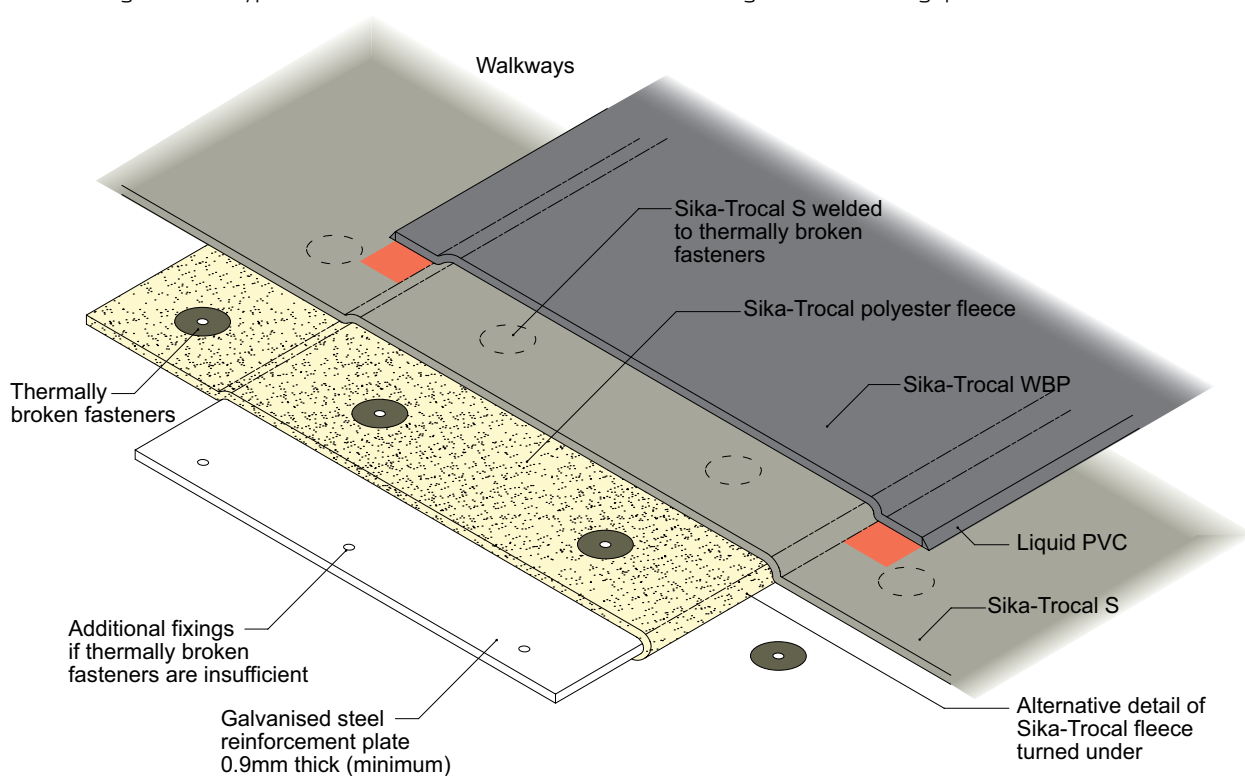
WALKWAYS

Infrequent maintenance access onto a Sika-Trocal membrane roof, such as the biannual inspection of rainwater outlets, gutters, upstands, security of flashings, etc can be carried out without any special precautions. It should be noted, however, that wet membrane can be slippery underfoot and it is recommended that footwear with heavy duty tread patterns be worn at all times. When more than occasional very light access is required to the roof it will be necessary to provide walkways to protect the insulation and provide a degree of slip resistance. For full details relating to the different ways of providing walkways, refer to the design guidance section on page 22 of this manual.

Even on roofs with infrequent access requirements it is recommended that at least the area of roof adjacent to the access point should be reinforced. Either with a small section of walkway as indicated here, or a few pavers placed onto Sika-Trocal SBV welded to the membrane.

Sika-Trocal WBP20 - Sika-Trocal WBP pyramidically embossed walkway can be laid over Sika-Trocal membranes to provide protection for light foot traffic. The Sika-Trocal WBP20 should extend a minimum of 50mm beyond the edges of the underlying reinforcement. The sheets of Sika-Trocal WBP are to be welded 'ladder fashion'. That is with a full minimum 30mm weld all around the perimeter of the sheet with cross welds at maximum 500mm centres.

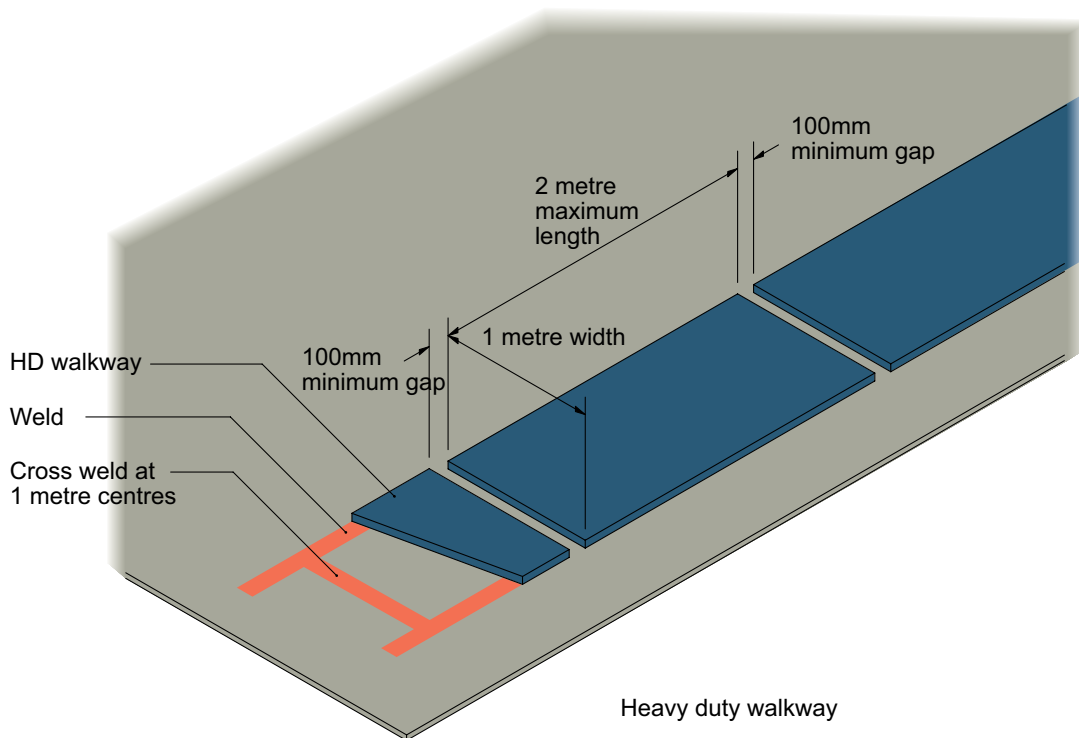
It is supplied in rolls 10m long by 1m wide. For installation over Type S membrane, the WBP20 should be cut into lengths no greater than 2m long before being welded to the surface of the waterproofing. These lengths will be installed with gaps of minimum 100mm between each length. Over Type SGK WBP20 can be installed in one roll length with 20mm gaps.



Sika-Trocal HD Walkway

This is a heavy duty version of the Sika-Trocal WBP20 walkway surfacing material previously described, but has an overall thickness of 4.0mm instead of 2.0mm. It is supplied in rolls 10m long by 1m wide. It is cut into lengths no greater than 2m long before being welded to the surface of the waterproofing. These lengths will be installed with gaps of minimum 100mm between each length.

Alternatively, the roll can be cut across its width into 800mm wide strips and laid in 1m lengths with 50mm minimum gaps between each length.



For extra heavy-duty applications, the Sika-Trocal HD Walkway can also be combined with the steel plate reinforcement as described below.

Reinforced Walkways - Where a reinforced walkway is required, the build up is as follows, the insulation is laid onto the deck and then the reinforcement of minimum 0.9 mm galvanised steel plate which in turn is overlaid with a Sika-Trocal fleece protective layer. The fleece is either turned under the edge of the plate for a minimum of 150mm or extended across the substrate and trapped under the nearest row of fasteners and their discs. The Sika-Trocal Metal discs are then placed following the normal pattern for that part of the roof and fixed to the substrate through pre-drilled holes in the steel reinforcing plate.

Alternatively, if the pressure plate or in seam fastening system is being utilised the membrane is first laid over the fleece and then the fasteners are then placed following the normal pattern for that part of the roof and fixed to the substrate through pre-drilled holes in the steel reinforcing plate.

Additional fasteners should be used to secure the plate in position against movement caused by subsequent foot traffic if the normal pattern of discs is not sufficiently close to the edges.

The Sika-Trocal membrane is laid over the steel plate and fleece and mechanically fixed and welded in the normal fashion.

Finally, sheets of the appropriate Sika-Trocal pyramidically embossed walkway surfacing are laid in position and welded to the membrane as described above.

TYPICAL DETAILS

HARDSTANDING

Occasionally there is a requirement to provide an area of robust protection to the roof where a small item of plant is to be positioned or the creation of a small area of paving.

Where this occurs on top of an exposed Sika-Trocal Type S/SG/SGK membrane it is converting the covered area from an exposed to a ballasted application, which will prove detrimental to that area over time.

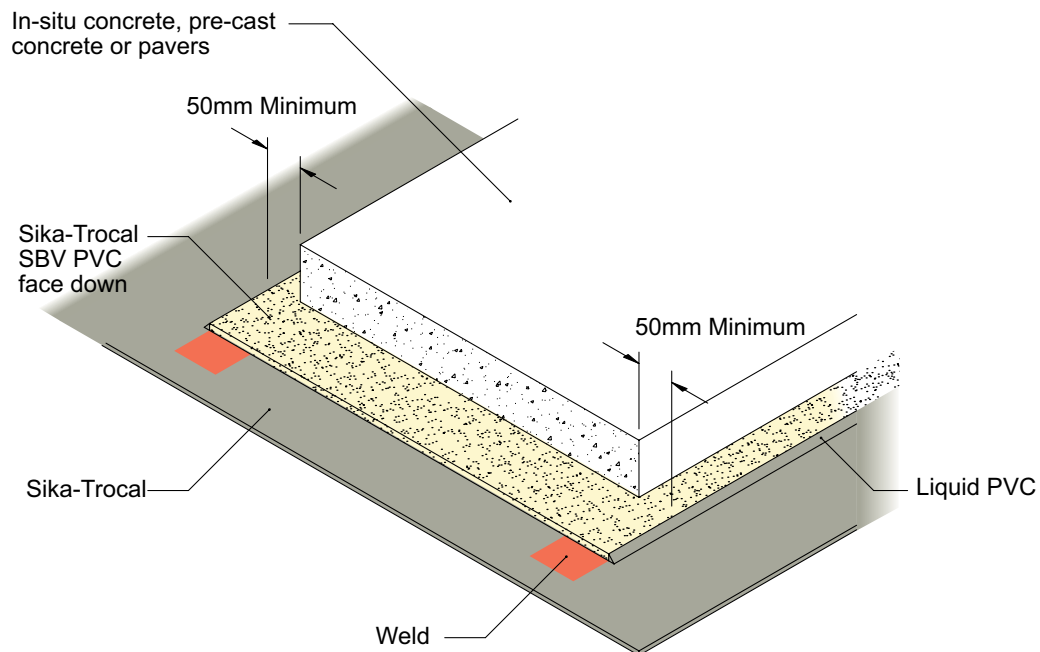
In order to protect that area, whether it is covered with an insitu concrete plinth, pavers or heavy timber bearers, it is essential to weld a patch of Sika-Trocal SBV, PVC face down or as an alternative, 1.5mm SGK PVC face down, to the surface of the membrane. A loose laid patch of Sika-Trocal SBV / SGK will not provide the necessary level of protection to the membrane. The weld is to be a minimum width of 30mm and to be sealed with liquid PVC. The patch of SBV / SGK must extend beyond the item placed on it by at least 50mm on all sides. Only a Sika-Trocal Licensed Contractor is qualified to install this patch.

This type of detail can also be utilised for the creation of small areas of paving onto an exposed membrane roof if necessary. Where pavers are to be used in this sort of application they must be placed directly onto the roofs surface and not onto paving support pads. When pavers are not constrained by parapet walls, etc they are likely to work their way off the support pads and tip over and dig into the roof itself.

The practical limitation to the area that can be treated in this way is the width of the SBV material, which is 1.7m; therefore the greatest width of plinth or pavers that can be accommodated is 1.6m. If any greater coverage than that is required, the specification of the waterproofing membrane should be changed to Sika-Trocal Type SGmA and that area of roof to become a ballasted application.

As the concrete plinths or pavers will sit directly on the roof's surface, consideration must be given to the effect this will have on the movement of rainwater across the roof.

Consideration also needs to be given to what effect the combined weight of concrete/pavers and plant will have on the underlying insulation and structural deck.



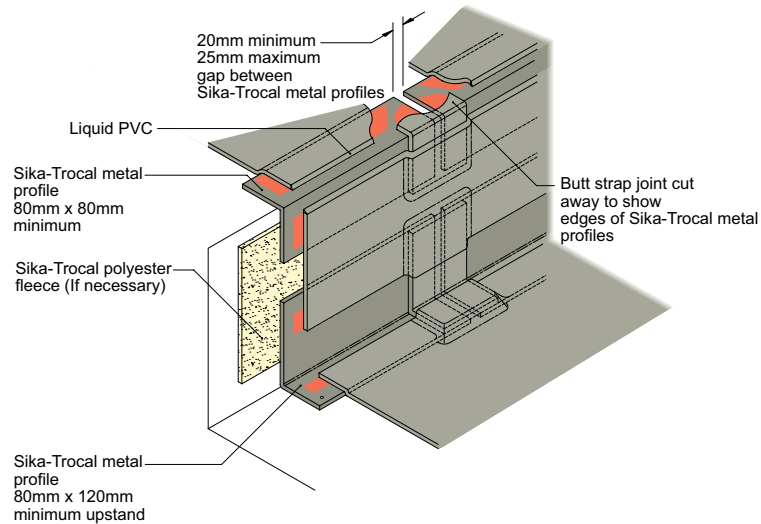
TYPICAL DETAILS

STEPS AND ANGLES

Change of level

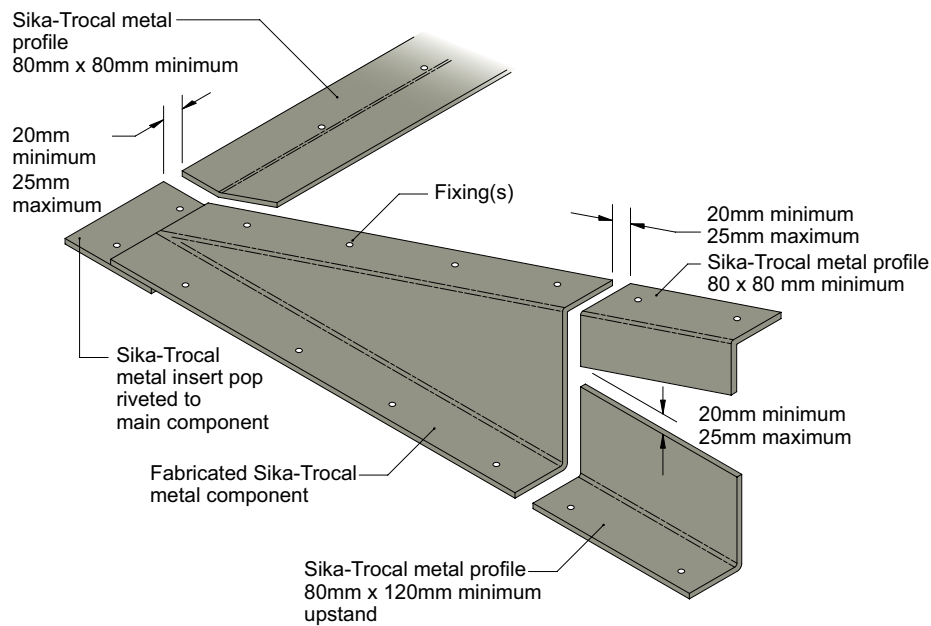
At changes of level Sika-Trocal Metal profiles must be fixed at the angles and the membrane welded to them to hold the membrane to the shape of the roof.

If the change of level is small it is probably easier to utilise a one piece 'Zed' shaped profile rather than two separate ones.



Raking angles

Shown here is a suitable arrangement of the Sika-Trocal Metal profiles at raking angles, for example, where a pitched roof runs into a flat one, or the end of a clear storey window. The detail also indicates the point at which it is possible to change from the one-piece unit of Sika-Trocal Metal to two pieces.



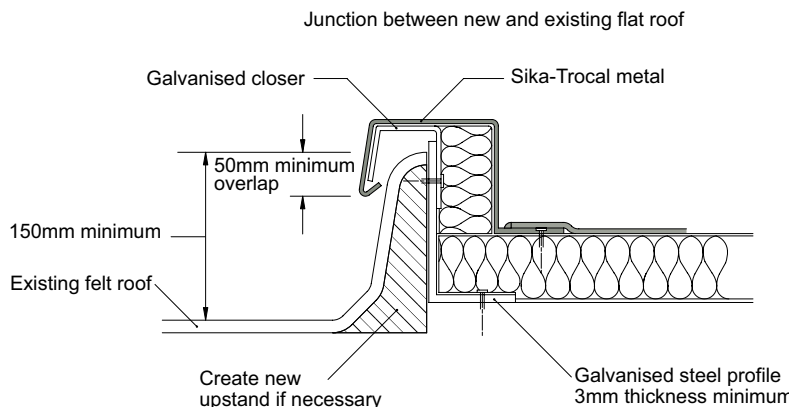
TYPICAL DETAILS

ABUTMENTS

Junction between new and existing flat roof It is not possible to actually connect Sika-Trocal membranes to existing bitumen finishes therefore this detail provides the means of achieving a weatherproof junction whilst avoiding direct contact between the two materials.

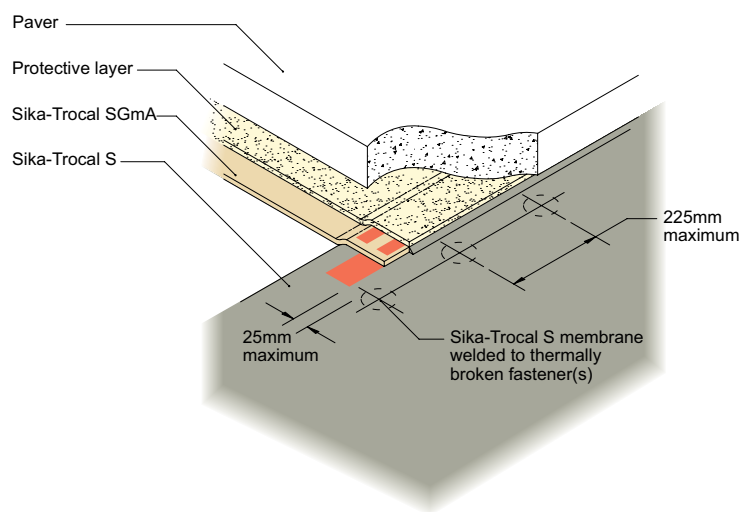
The galvanised steel angle forms the basis for the new upstand. A shaped timber former can be fixed to the steel to allow the creation of a new upstand for the existing bituminous finish.

The galvanised steel closer can then be fitted to the top to permit installation of the Sika-Trocal elements. For guidance on the thickness of the closer, refer to the section on downstands.



Junction between exposed and ballasted roof At an abutment between exposed Sika-Trocal Type S membrane and ballasted Sika-Trocal Type SGmA it is necessary to firmly secure the materials to the roof at the point of the junction. This is to prevent thermally induced movements from pulling the membranes out of their respective correct locations. The membrane is to be welded to a row of Sika-Trocal Metal discs fixed at 225mm centres for material up to 1.5mm thickness, or 180mm up to 2.0mm.

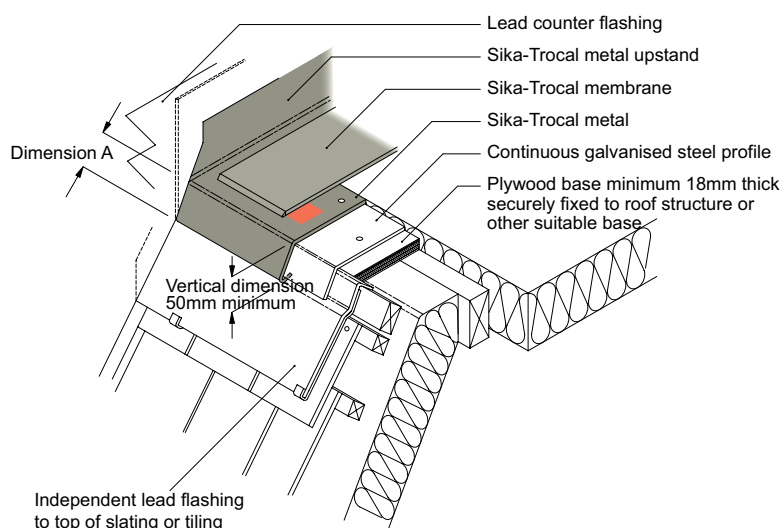
It is envisaged that the occurrence of an area of exposed membrane roof adjacent to a ballasted one will be a rare one and never in an area accessible to anyone other than building maintenance staff.



Junction with mansard - The constructions of the flat and pitched parts at the mansard roof junction should be kept apart and only linked by the lead counter flashing. The Sika-Trocal Metal profile should terminate at or just above the top edge of the last row of tiles or slates.

A continuous galvanised steel profile must be fixed at the junction to provide support for the Sika-Trocal Metal, for required thickness and further relevant information refer to the section on downstands.

Keeping the two constructions independent avoids conflict in programming and simplifies access to the pitched roof in the event replacement or adjustments are required to the tiles or slates.

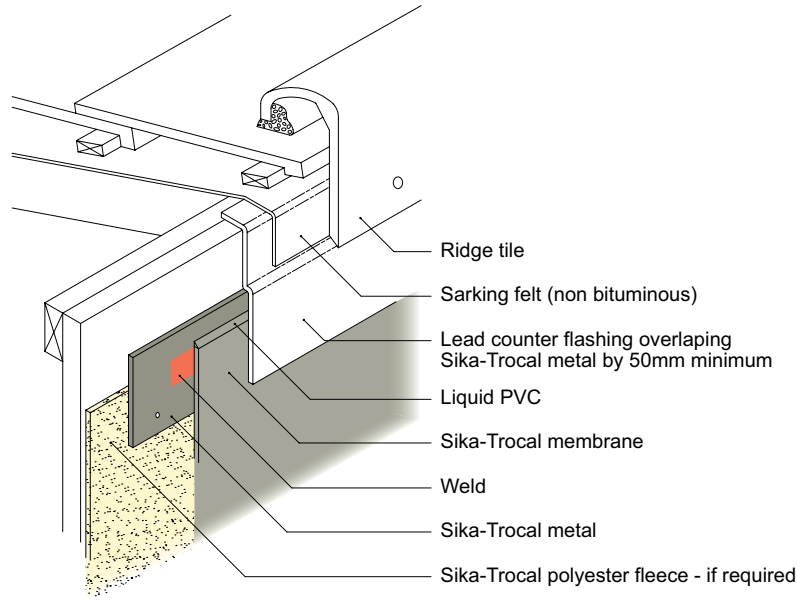


Junction with monopitch - The constructions of the vertical and pitched parts at the apex of the monopitch roof junction should be kept apart and only linked by the lead counter flashing. The Sika-Trocal Metal profile should terminate at or just below the lower edge of the ridge tile.

The sarking felt underlayer to the pitched roof area should be of the non-bituminous type so there is no possibility of the bitumen melting in hot weather and dripping onto the Sika-Trocal membrane.

Continuous support and suitable fixing bases must be provided for the Sika-Trocal materials here as elsewhere.

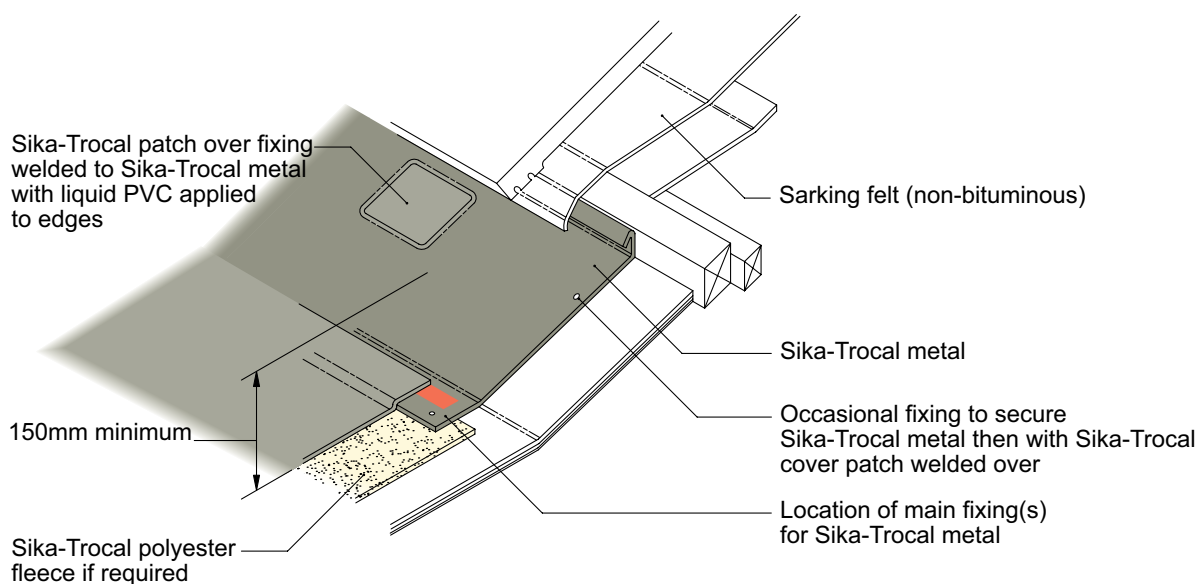
Keeping the two constructions independent avoids conflict in programming and simplifies access to the pitched roof in the event replacement or adjustments are required to the tiles or slates.



Junction with eaves - The top edge of the Sika-Trocal Metal profile must terminate at the first tiling batten and must not be laid under the tiles or slates. Additionally, the top edge of the Sika-Trocal Metal must be a minimum of 150mm above the finished level of the flat roof; this dimension is to only be measured vertically.

The sarking felt underlayer to the pitched roof area should be of the non-bituminous type so there is no possibility of the bitumen melting in hot weather and dripping onto the Sika-Trocal membrane.

Keeping the two constructions independent avoids conflict in programming and simplifies access to the pitched roof in the event replacement or adjustments are required to the tiles or slates.



TYPICAL DETAILS

VERTICAL SIKA-TROCAL

Vertical Sika-Trocal Type S membrane is often used to 'clad' the inside faces of parapets and dummy mansards, plant rooms, changes of levels between roofs, etc.

Any roof pitches in excess of 30° from the horizontal should be classified and detailed as vertical. Note that the membrane is not suitable for use in those few areas where the Building Regulations require cladding materials to have a class 'O' fire rating.

Where the height of such vertical membrane does not exceed 400mm, when measured from the horizontal leg of the lower Sika-Trocal, up to the lower edge of the uppermost Sika-Trocal metal profile, dimension 'A', then no additional fasteners are required.

However where the above dimension does exceed 400mm, then additional fasteners will be required, in the form of Sika-Trocal discs or pressure plates fixed to the substrate in the same way as for the general roof area. The first row of fasteners is to be installed at a maximum distance of 225mm up from the flat roof level, subsequent rows (where required) are then installed at 400mm centres, until the final dimension between the last row and the top of the uppermost Sika-Trocal metal profile, is less than 400mm.

Where only the first row is required, at 225mm up from the flat roof level, the distance between fasteners in that row should not exceed 400mm. Where additional rows are required the number of fasteners required per square metre must be calculated in the same manner as for the remainder of the roof and the distance between fasteners adjusted accordingly.

The absolute minimum number of fasteners per square metre for 'vertical' work is 6no/m².

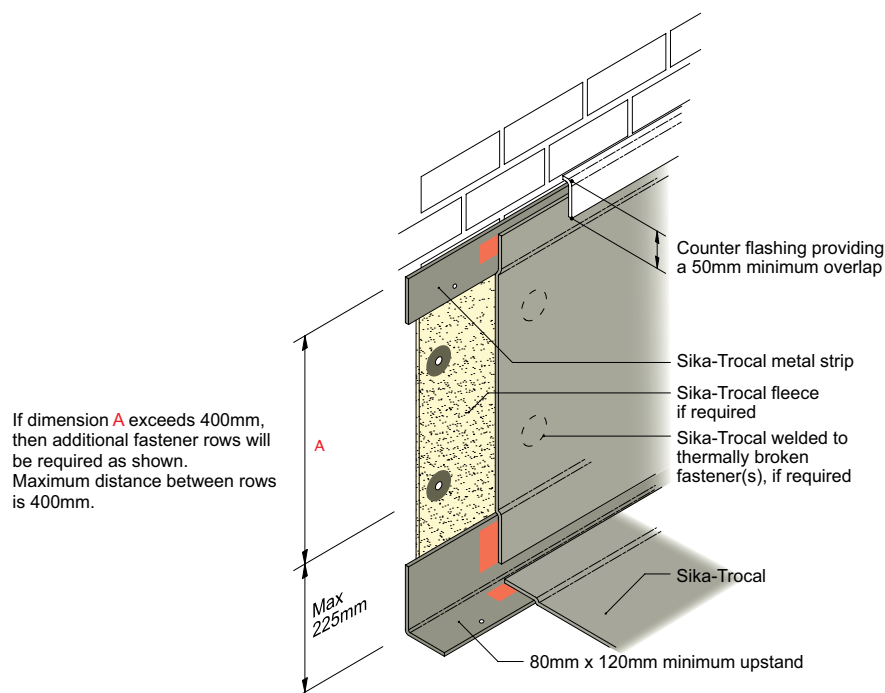
For practical reasons and to achieve the best appearance, on vertical and steeply sloped surfaces only the 1.1 metre width of Sika-Trocal Type S should be used. The sheets should be laid vertically, not horizontally.

Care needs to be taken when setting out the sheets to ensure that the joints are 'truly vertical' in order to achieve a good aesthetic result.

Where desired, vertical work can also be executed using Sika-Trocal Metal sheet, although it should be noted there is a tendency to form a slightly quilted appearance due to the fasteners.

There are no technical restrictions on the height of upstand that can be clad in the membrane and they have been installed several metres high.

When required the membrane 'cladding' may be terminated on the vertical surface. A simple flat strip of laminated Metal is fixed to the substrate and the membrane welded to it. A counter flashing then completes the weatherproofing.



Vertical Sika-Trocal

RENOVATION ASSESSMENTS

Overview - The Sika-Trocal concept can also be used for the renovation of virtually all forms of existing roofs, either with mechanically fixed, ballasted or adhered membranes.

On many occasions it is possible to overlay the existing roof with the new membrane without stripping off the old waterproofing, minimising disruption to the occupants and reducing the risk of accidental water penetration during the works.

However, it must be appreciated that failed roofs will vary widely in their form of construction and current condition. Therefore, consultation between the building owner, specifier, Sika-Trocal Licensed Contractor, fastener manufacturers and Sika Limited should be sought in each individual case.

Considerations - A thorough survey of the existing roof should be carried out to ascertain the form of construction, the real cause and location of any leaks that have occurred, the level of damage, if any, sustained by the roof construction, the location and type of any services.

If the roof build-up between the existing waterproofing and the structural deck has or is likely to have suffered degradation due to water penetration then it must be stripped back to the deck. If stripping back to the deck is required then the renovation will proceed as for a new roof.

Decks that have suffered degradation due to water penetration must be stripped back to a sound structure.

If the existing structural deck is found to be of chipboard or boards of compressed straw, materials that are seriously weakened by any contact with water, the only sensible recommendation can be complete removal and replacement with more suitable materials.

Should the proposed renovation specification involve the use of ballast, then it must be established that the structure is capable of taking the extra load.

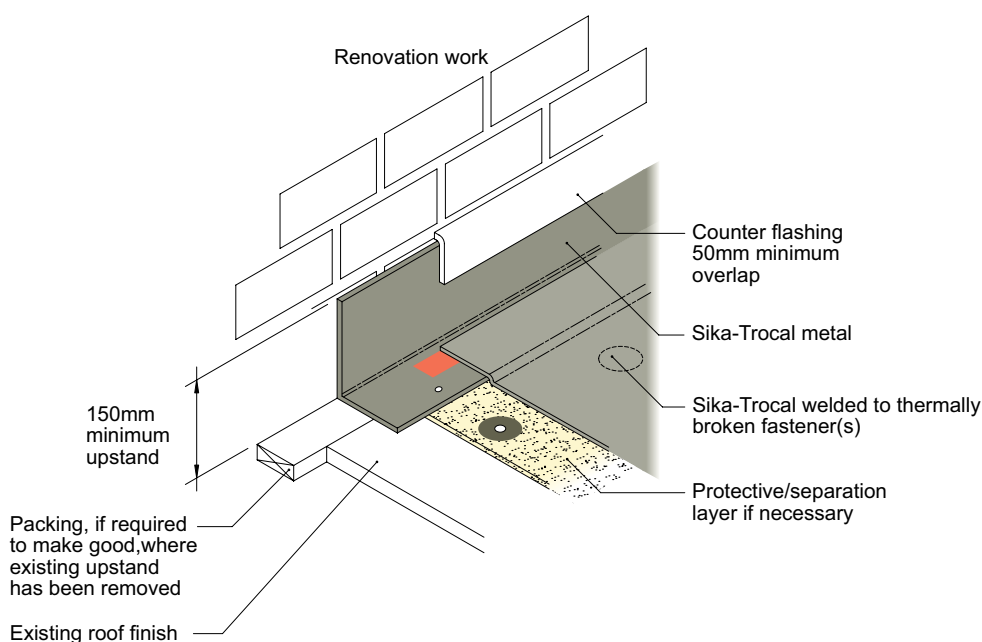
Some older roofs have already been overlaid more than once in their lifetime, often with additional bitumen systems. As these systems are heavy it must be established that the existing structure is capable of taking the extra load. If not, some of the extra roofing layers may need to be removed before commencing renovation.

Any renovation programme that involves either adding or subtracting more than the minimum dead load to the existing roof will require a Building Regulation application. An application is also required if adding a walkway across a roof that did not exist before.

Many older buildings with concrete roof slabs have electrical conduits buried in the screed, this makes a mechanically fixed solution problematic, adhered or ballasted may offer a better solution.

On many roofs with timber decks that have bituminous felt finishes, it will be found that the bond between deck and bitumen has failed, this renders an adhered solution unsuitable, unless a suitable insulation board is fixed to the deck first.

It is recommended that existing roof surfaces containing pitch or tar, or treated with bitumen re-saturants, should be removed.



RENOVATION

OVERLAYING

Overlaying - For existing buildings, the Building Regulations concerning the Conservation of fuel and Power, require that if any refurbishment works are being instigated the need to upgrade the thermal performance of the existing construction must be considered. Refer to Design Guidance section.

Whenever an existing roof surface is considered sound enough to overlay with Sika-Trocal, a separation layer will be required. The separation layer is to protect the Sika-Trocal from contact with rough abrasive surfaces or contact with incompatible substances such as bitumen or asphalt.

The most commonly used separation layer is an insulation board which also improves the thermal performance of the existing roof. In the case of an existing roof finished with mineralised bituminous felt or asphalt and if thermal upgrading is not required by the Regulations, then the separation layer could be the S-Felt Type T 300 g/m² polyester fleece. Roofs finished with chippings will generally require an insulation board as a separation layer.

Many existing roofs have deficient falls and suffer from ponding, in some cases the ponding can be very extensive. Simply overlaying the surface with membrane, even if an insulation layer is included, will not eliminate the ponding. The only way to eradicate the ponding is to utilise tapered insulation to correct the deficiencies of the original roof construction. The advice of the insulation manufacturer will need to be sought so that they can carry out a survey and design a suitable scheme. When utilising tapered insulation, consideration needs to be given to the thickness and height of the finished renovation and whether it will compromise existing upstands and damp proof courses.

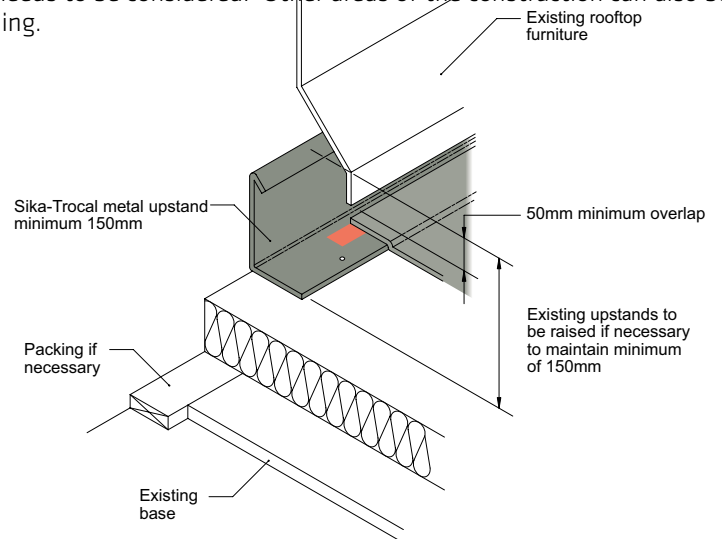
It should be noted that the addition of an insulation board in the renovation process would convert the existing waterproofing into a vapour control layer that did not exist before. It is advisable to have the insulation manufacturer carry out a condensation risk analysis on the proposed new build-up.

On many existing roofs it will be found that part of the problem of water penetration is caused by upstands not meeting the requirement of a minimum height of 150mm above the finished roof surface. In some cases details have been found where there are no upstands at all. Unless these defective upstands are to be corrected at the time of the roof renovation works, the problem will still exist when the work is completed and water will continue to enter the building.

In many cases of failed roofs it is not just the waterproofing that needs to be considered. Other areas of the construction can also be defective and contribute to the amount of water entering the building.

Commonly seen items that cause problems are, metal cappings to parapets, parapets generally, disturbed or missing flashings, hollow tube handrail systems, failed sealants, service penetrations, botched alterations and additions to the roofscape, defective repairs, etc. These items need to be corrected at the same time as the rest of the roof works.

Some existing roofs suffer from insufficient rainwater drainage capacity with the result that in heavy rain the roof becomes flooded which can result in water entering the building. Whilst it's never easy to incorporate additional drainage outlets into an existing building, it is worth considering it in order to obtain a complete solution.



RENOVATION

SURFACE PREPARATIONS, UPSTANDS

Surface preparation - In some cases a degree of surface preparation can be necessary before commencing the overlaying of the existing roof.

It is important to recognise that the new waterproofing can only reflect the condition of the existing surface. For instance if the surface is uneven, unless measures are taken to combat this, then the 'new' surface will also be uneven.

Blisters in asphalt and bituminous felt must be opened and flattened or removed altogether. Any hollows should be filled and levelled off.

When chippings are present on the roof they can either be scarified off, which is extremely noisy and dirty, or left in place. Often it will be found that many of the chippings have become loose and formed into drifts in various parts of the roof, if the remaining chippings are not being scarified, the loose ones can be evenly redistributed across the roof or swept up and removed.

In the case of an adhered membrane being used, the surface of the roof will have to be thoroughly cleaned before operations commence. Note that the use of adhered membranes requires special consideration and Sika Limited should be consulted before taking any irrevocable decisions to use this particular solution.

Upstands - On occasions it will be found that existing upstands will not be the required 150mm minimum above the finished roof level, or that the additional thickness of the new build-up will make them so. In these cases the height of the upstands will need to be corrected, including upstands to rooflights, vents, patent glazing, doorways, windows etc. Failure to raise the upstands to the 150mm minimum height seriously increases the risk of water penetration and must remain the building owners responsibility. Where upstands and their associated counter flashings are linked to damp proof courses these must also be modified or adapted to suit.

ADHERED ROOFS

PRODUCT INSTALLATION

Product

Sika-Trocal SGK is a modified version of the long established and proven Sika-Trocal Type S membrane. Sika-Trocal Type SGK is produced by taking the standard Sika-Trocal Type S and incorporating a centrally placed restraint layer of plastisol saturated random glass fibres for thermal stability and a polyester fleece bonded to the underside to create a separation layer and key for the adhesive. It is intended for use as an exposed and adhered membrane. It is suitable for both new build and refurbishment projects.

The Sika-Trocal Type SGK is bonded to the substrate using a non-solvent based polyurethane adhesive to secure it against wind uplift forces. The long edges of the waterproofing sheets are joined by welding in the 60mm overlap joint. The short edges are butted together and sealed by welding a strap of un-backed material over them. It is essential and established good practice in the industry, that in order to ensure full security of the membrane against wind forces, that peel stops are fixed at all changes of plane and around perimeters.

Application

The adhesive is first applied to the surface of the substrate in strips or beads and then spread with a squeegee and finally lightly dampened with a fine water spray to speed the reaction time. The membrane is then simply placed onto the prepared adhesive. After a short time the adhesive starts foaming which drives it into the polyester fleece backing material, forming the bond.

During the setting out of the membrane the sheets should be positioned so that the backing fleece of the upper sheet overlaps the edge of the lower one by a minimum of 10mm. By using the laser line, positioned approx 60mm in from the edge of the sheet, to line up the rolls, this will ensure that the minimum 10mm overlap is achieved.

Trafficking of the freshly laid membrane should be avoided until the adhesive has cured. Subsequently, the side laps can be either solvent welded or hot air welded using a self-propelled hot air welding machine. The end laps of the sheets, which are butted together, are then sealed by welding straps over them.

Substrates

There are potentially many types of surfaces that the Sika-Trocal Type SGK could be adhered to such as new and old bitumen, existing asphalt and various types of insulation boards, or direct to steel, timber or even concrete. Compatibility of the adhesive with the selected surface should be checked before work on site commences.

When adhering over existing roofing materials it is important that the appointed roofing contractor should establish the condition and suitability of the substrate. In particular it must be established that all the various layers are still attached to each other and the substrate.

Existing roof surfaces are likely to require some level of preparation before commencing the installation, such as filling and levelling of any hollows, removal of blisters, etc and cleaning of the surface. Cleaning may require careful use of a jet washer and brushes. Some surfaces may require the application of a primer prior to applying any adhesive.

If defective roof falls are present on the existing roof, then measures to correct them should be taken prior to any renovation work being carried out, otherwise the problem will remain afterwards. The use of tapered insulation is a popular answer to the problem of defective falls. Care needs to be taken that any such modifications do not compromise any existing upstands or other weatherproofing details.

Insulation

For adhered roof finishes the quality of the substrate is of vital importance, as it is receiving all the wind loads from the membrane and transmitting then down to the deck. This is particularly relevant when that substrate is an insulation material. Important considerations are the relatively low delamination resistance of insulations and the ease with which the upper surface can be damaged by subsequent foot traffic. If the insulation boards are stressed to the point of delamination or the upper surface damaged, then it can no longer restrain the waterproofing against the wind forces.

For the reasons quoted above, one important consideration is the maximum level of wind uplift pressure the insulation manufacturer would accept to be applied to their product.

Another important consideration is the likely volume of foot traffic that is to be expected across the finished roof surface. Ideally, once the roof is completed, access should be restricted to the Roofing Contractor only. If this is not possible, anything above a bare minimum of traffic increases the risk of damage to the upper surface of the insulation leading to eventual delamination of the board and possibly subsequent removal of the waterproofing by wind forces. If any significant level of trafficking across the finished roof is unavoidably expected, then it would be wiser to select an alternative method of attachment.

There are generally only two types of insulation board that are currently used in adhered applications. These are either rigid polyisocyanurate plastic foam boards with a perforated mineral filled glass tissue facing or a dual density mineral fibre insulation board also finished with a glass fibre facing. Note that these are dedicated products intended specifically for use with adhered membranes. Further details of suitable insulation boards can be found in the design guidance section of this manual or on the latest Technical Update - "Sika-Trocal Adhered Systems Insulation List."

The Sika-Trocal C200 polyurethane cold applied adhesive can be used for bonding suitable insulation boards to common substrates, both new and existing. For existing substrates Sika-Trocal Primer 600 may be required. Refer to the product data sheet for full application details.

Vapour control layers

When insulation boards are to be incorporated into the build-up, especially on new build work, they will generally need to be bonded directly to the vapour control layer. Therefore, the vapour control layer will need to be either a suitable self adhesive vapour control layer, such as Sika-Trocal S-VAP 5000E SA, or a traditional bituminous felt product.

When installing insulation boards that are to be mechanically fixed then the vapour control layer could be the Sika-Trocal S-VAP 500E polyethylene, S-VAP 5000E SA self adhesive, or an alternative proprietary vapour control layer.

Wind Uplift

The ultimate wind uplift resistance of an adhered roof is dictated by the inter-laminar strength of the system.

The maximum permissible wind uplift will be dictated by the weakest bond within the system and therefore where an adhered system is proposed, consideration must be given to the bond strength between each individual layer.

Advice must be sought from the individual component manufacturers on the wind uplift limitations of their products.

TYPICAL DETAILS

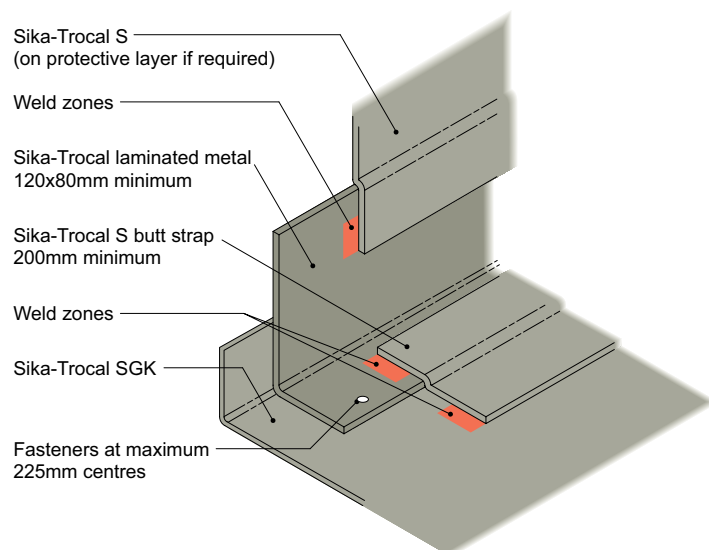
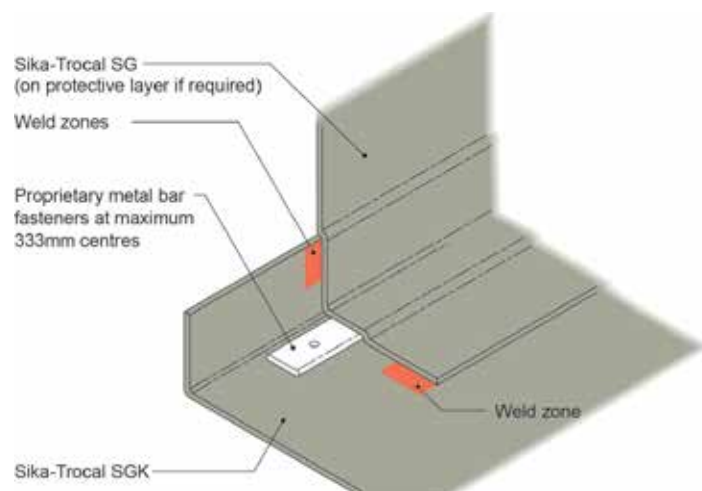
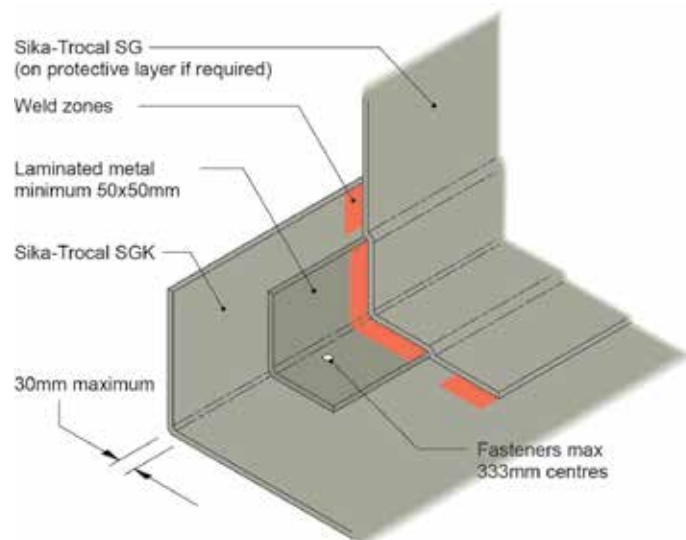
UPSTAND DETAILS

Restraints against wind uplift forces are required at all changes of plane and at perimeters. These are generally referred to as peel stops and are formed with Sika-Trocal metal or proprietary bars.

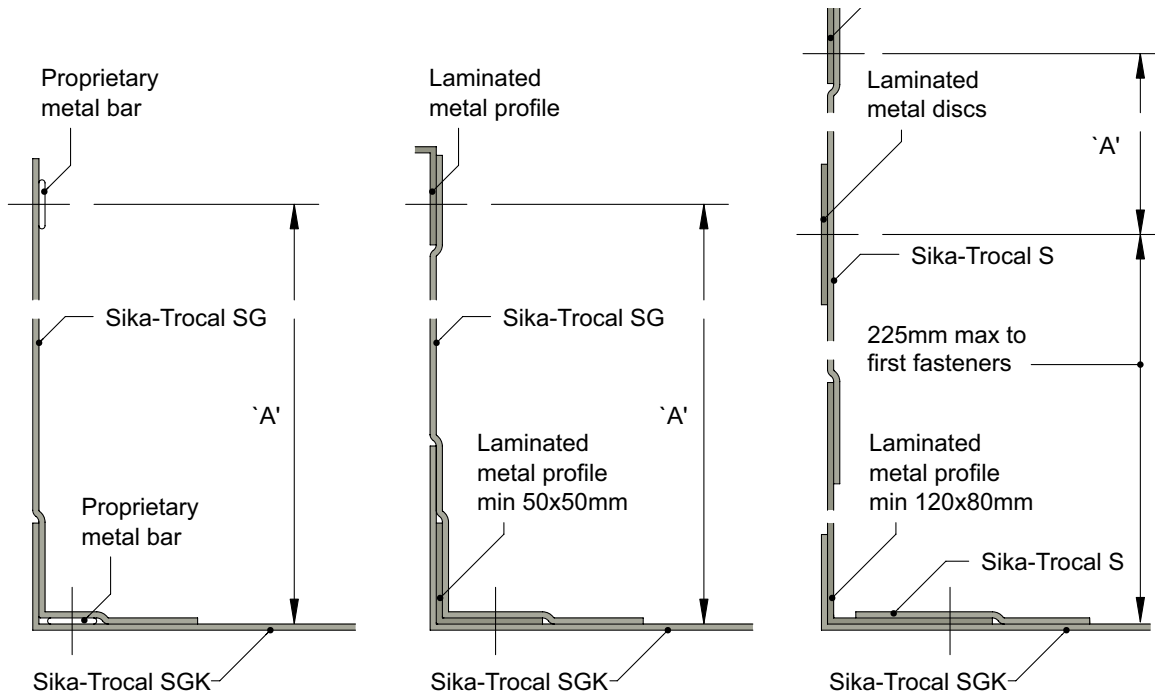
Where the waterproofing membrane is required to be carried up in the vertical plane, then a minimum 50 x 50mm Sika-Trocal metal profile can form the means of transition and peel stop. Note that as the peel stop is encapsulated the membrane utilised is Type SG as this has similar thermal characteristics to Type SGK.

Where the waterproofing membrane is required to be carried up in the vertical plane, then a proprietary bar can form the means of transition and peel stop. Note that as the peel stop is encapsulated the membrane utilised is Type SG as this has similar thermal characteristics to Type SGK.

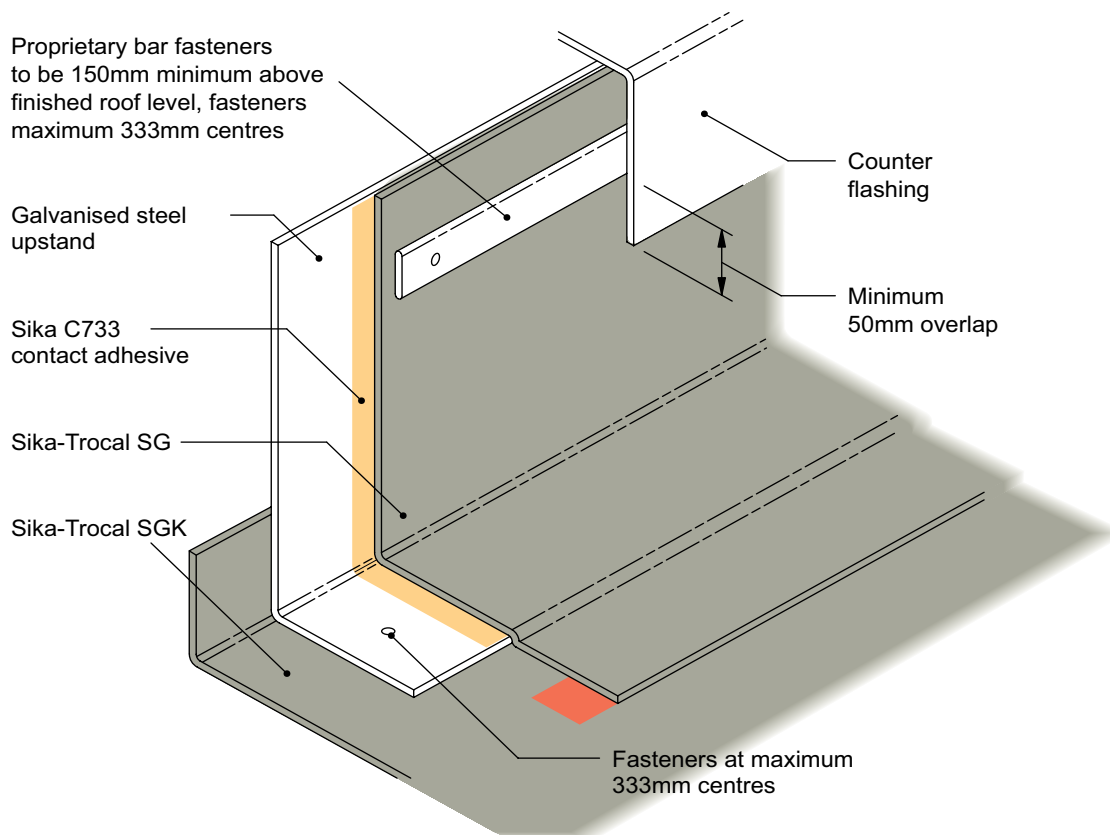
Where the waterproofing membrane is required to be carried up in the vertical plane, then a minimum 120 x 80mm Sika-Trocal metal profile can form the means of transition and peel stop. Note that as the peel stop is not encapsulated this permits Sika-Trocal Type S to be utilised.



Additional mechanical restraints will be required to the vertical membrane where dimension 'A' exceeds 400mm.



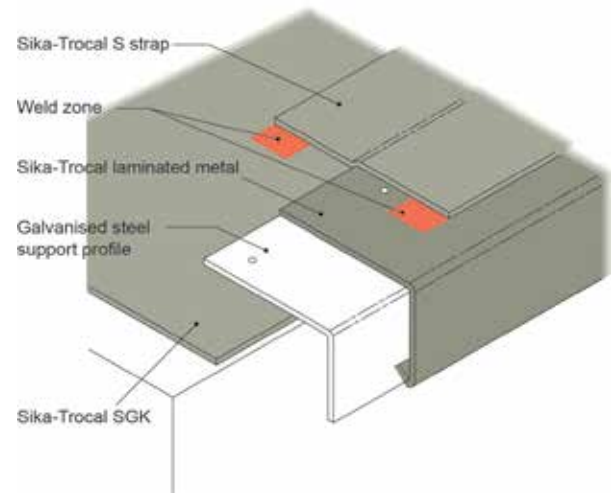
Where it is necessary to create a substantial steel support upstand, such as at expansion or movement joints, then the vertical SG membrane can be adhered and secured at the top



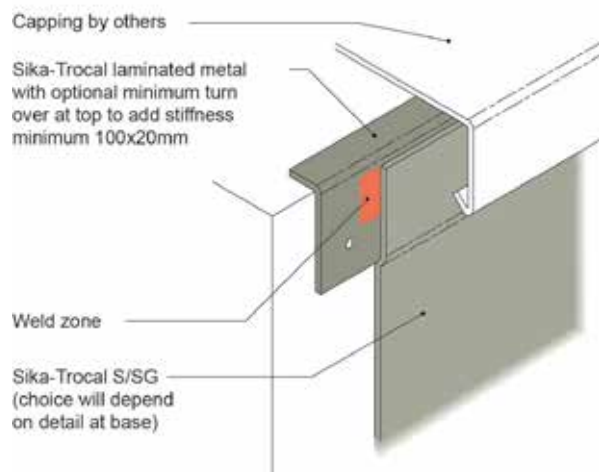
TYPICAL DETAILS

DRIP EDGE, CAPPINGS AND TERMINATIONS

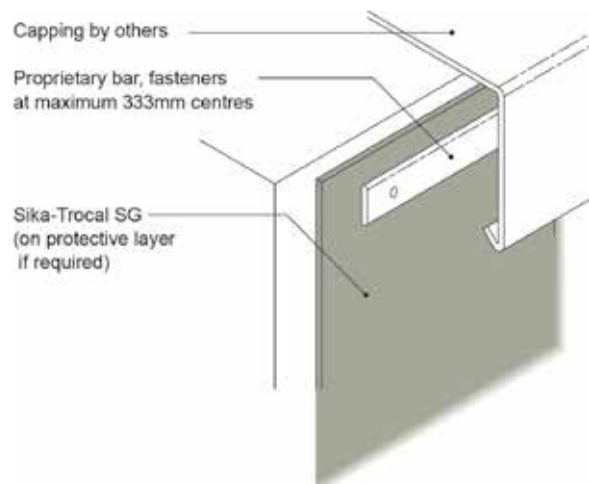
A drip detail is formed by fixing a Sika-Trocal metal profile over a continuous galvanised steel support section and where required, locating it so as to direct any water off the roof into a gutter.



Where the vertical Type S or SG membrane terminates it must be secured, below it is shown welded to a profile of Sika-Trocal metal. This termination needs to be weathered by a capping or counter flashing.



Where the vertical Type SG membrane terminates it must be secured, below it is shown restrained with a proprietary metal bar. This termination needs to be weathered by a capping or counter flashing.



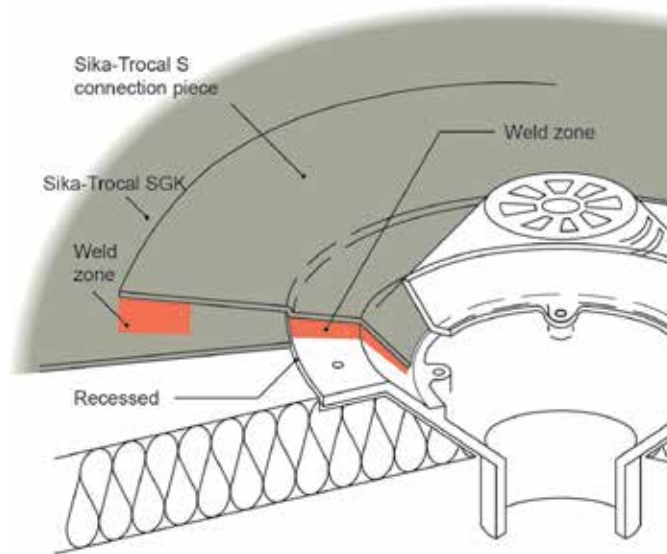
TYPICAL DETAILS

RAINWATER OUTLETS

To ensure a secure permanent welded joint at the junction between the waterproofing membrane and outlet, it is strongly recommended that only uPVC outlets or metal units which incorporate either an uPVC flange, or are coated with liquid PVC, be specified.

Due to the fleece backing on Type SGK membrane, it is not possible to actually weld it to the outlet. Therefore the connection has to be made with a separate 'disc' of Type S.

The outlet should be recessed into the substrate so that the upper surface of the flange is flush with the topside of the Sika-Trocal SGK membrane, as to minimise any lip formed.



BALLASTED ROOFS

SURFACING

General

Sika-Trocal roof waterproofing sheets that are intended for use under ballast have to operate in a completely different environment to those that are exposed. Therefore, a different formulation, Sika-Trocal Type SGmA, was developed for this purpose.

Ballast laid at a minimum rate of 80kg/m² is the minimum satisfactory level to resist wind uplift forces.

Ballast commonly takes the form of large well rounded gravel or concrete pavers. The potential load of the ballast needs to be taken into account when designing the structural supports for the roof construction. Gravel imposes a dead load of approximately 80kg/m² and concrete pavers 110-125kg/m².

In the case of green or garden roofs, the growing medium and its associated drainage layers, etc form the ballast, the likely dead load, including retained water, will need to be ascertained specifically for each application. Equally important is the dead load in 'dry' conditions and whether it will be enough to restrain the waterproofing membrane against the expected wind uplift forces.

Timber decking is another form of ballast, which is generally not heavy enough to meet the minimum dead weight requirements, so special measures are necessary during installation, see later in this section.

Gravel ballast

Ballast should consist of washed, well rounded gravel graded between 20mm to 40mm size. Fines and sharps must be excluded, fines particularly can cause blockage of drains. Gravel of this size is required to mitigate the onset of 'wind scour'; BRE Digest 311 refers.

Note that we do not recommend the use of gravel adhesive as experience has shown it only remains effective for a few short years.

Gravel must be laid to meet the twin minimum requirements of 80kg/m² and 50mm thickness.

Gravel ballast is only suitable for very low pitches of roof slope.

Gravel ballast is not suitable for foot traffic, therefore pavers would normally be used to create walkways if required.

Where the degree of roof exposure is high the gravel ballast can be lifted out by wind uplift forces in the worst conditions, especially when adjacent to parapets, in these cases it is advisable to have pavers rather than gravel around the margins of the roof area.

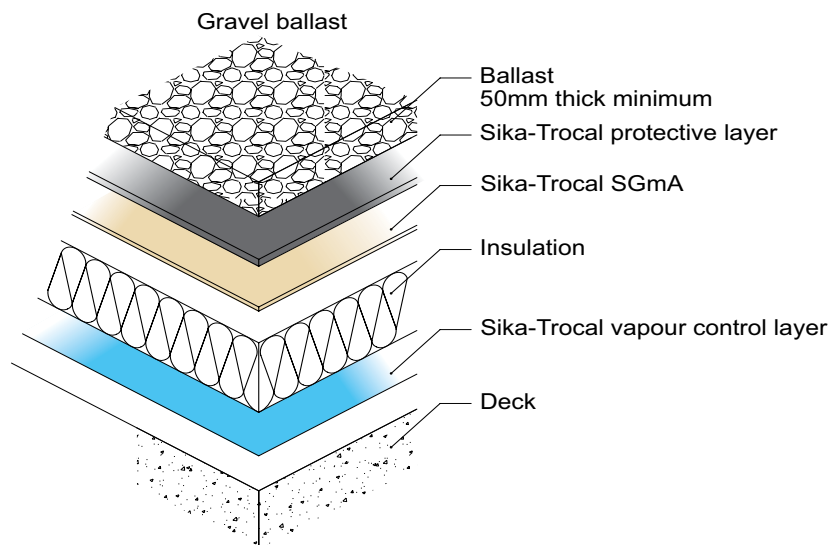
Concrete pavers

Hydraulically pressed dense concrete pavers on paving support pads must not be less than 50mm thickness.

As the pavers are heavy and the support pads concentrate the load it should be established with the insulation manufacturer that their product is suitable for the duty of supporting the load.

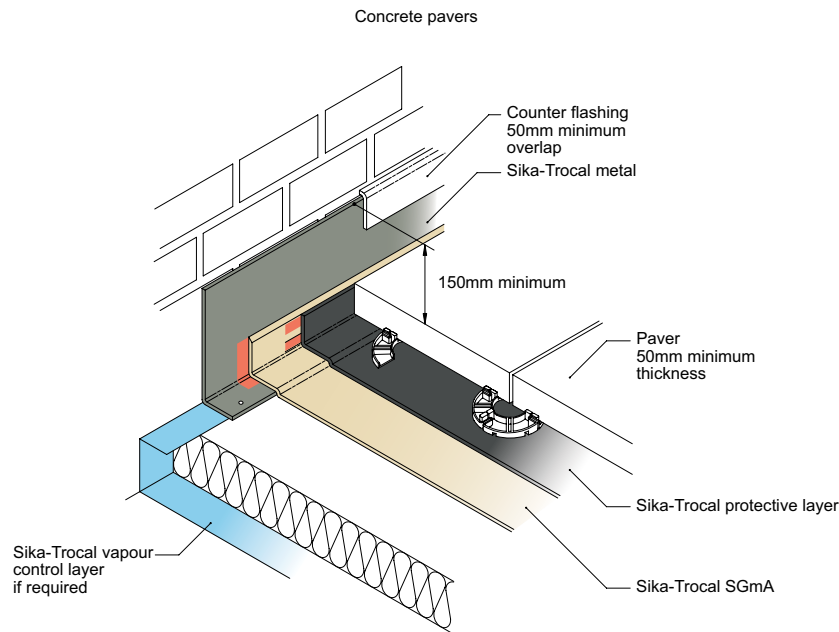
Walkways across gravel ballasted areas of roof should be formed from concrete pavers.

Where pavers are specified for use in 'public' areas greater measures will need to be taken to ensure they are levelled up correctly to avoid creating trip hazards.



When required, pavers can be bedded onto a dry mix, in order to obtain greater vandal resistance for example. Precautions will need to be taken to prevent the dry mix causing blockage of any roof outlets. This will take the form of providing stainless steel grilles around the outlets and wrapping them in a suitable filter layer. It should be noted that when solidly bedded any rainwater would wash across the top of the pavers rather than finding it's way through the gaps as when using support pads. Access to the membrane will obviously be more difficult.

Other forms of hard surfacing can be used over Sika-Trocal if required, examples are interlocking pavers, stone flags etc.



Timber decking

Recent years have seen an increasing use of timber decking, especially in residential applications, as an alternative surface to the use of pavers.

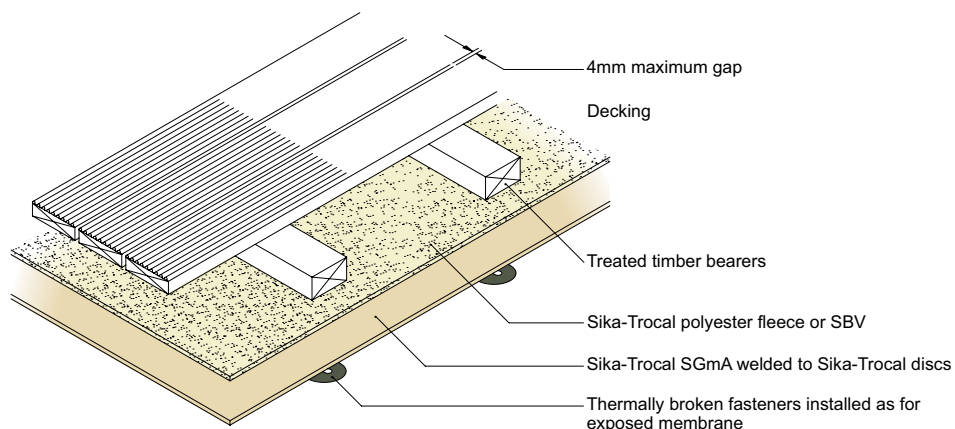
The timber used for decking in these applications needs to be substantial, especially as they have to be heavy enough to provide protection to the underlying Sika-Trocal waterproofing and also a degree of resistance to wind uplift forces. It is important that the gaps between the individual planks are no greater than 4mm, this helps to prevent lighted cigarette ends from finding their way through and also to exclude UV radiation from reaching the membrane.

Generally, ballasted membranes are loose laid and only restrained against wind uplift forces by the dead weight of that ballast. Substantial timber decking as described above will probably be dense enough, relative to its surface area, to stay in place in all but the more extreme wind conditions. However, the negative wind loads acting on the surface of the decking will be transferred through the gaps and start acting on the greater surface area of the underlying membrane. If the wind forces are high enough they can start to lift the membrane that will then act like a sail under the decking and possibly cause it to be lifted out exposing the roof structure.

Suitable separation layers for use between the SGmA and the decking are the Sika-Trocal S-Felt Type T 300g/m² polyester fleece or the SBV protective layer.

The only separation layer suitable for use between the SGmA and the decking is the Sika-Trocal S-Felt Type T 300g/m² polyester fleece as it is air permeable. Any layer that was not permeable, such as the SBV, would act as a sail behind the decking.

Any preservative treatment process used on the timber should be of the waterborne salts type rather solvent based one, which are detrimental to the membranes.



Roof Gardens

Roof gardens are also possible with Sika-Trocal materials. Both the membrane sheets and the welded joints are resistant to root penetration (FLL test method). The detail below indicates a general build-up for this type of roof, the essential point being to protect all the membrane surfaces against physical damage.

Sika-Trocal Type SGmA will form an appropriate roof waterproofing membrane as a base for a roof garden build-up. The actual specification of the build-up of the roof garden itself above the waterproofing requires specialist knowledge and advice should be sort from appropriate suppliers and companies.

The use and popularity of roof gardens, or living roofs, has increased in the UK, as they not only provide visual enhancements to the building, but can also bring environmental and performance benefits also.

- Improved acoustic and thermal performance
- Protection for the waterproofing membrane
- Rainwater retention reducing impact of local flooding
- Traps airborne pollution and dust
- Reduces urban heat island effect
- Reduces carbon dioxide in the atmosphere
- Provides higher humidity locally
- Provides a habitat suitable for local birds and insects
- Encourages biodiversity
- Improved visual impact
- Added value

The main types of living roof are listed below -

Extensive - lightweight, low cost, generally self-sustaining with low maintenance, naturalistic finish including sedum blankets, sedum plug plants.

Intensive - thicker substrates, load-bearing applications, requiring higher levels of maintenance, often amenity areas, can be complex, effectively roof top gardens including lawns, shrubs, trees etc.

Bio-Diverse/Brown - Encourage local biodiversity by using the roof space to create or replicate natural habitat for local flora and fauna.

Dead weight of the living roof systems, especially when wet is critical, suppliers can advise on this factor.

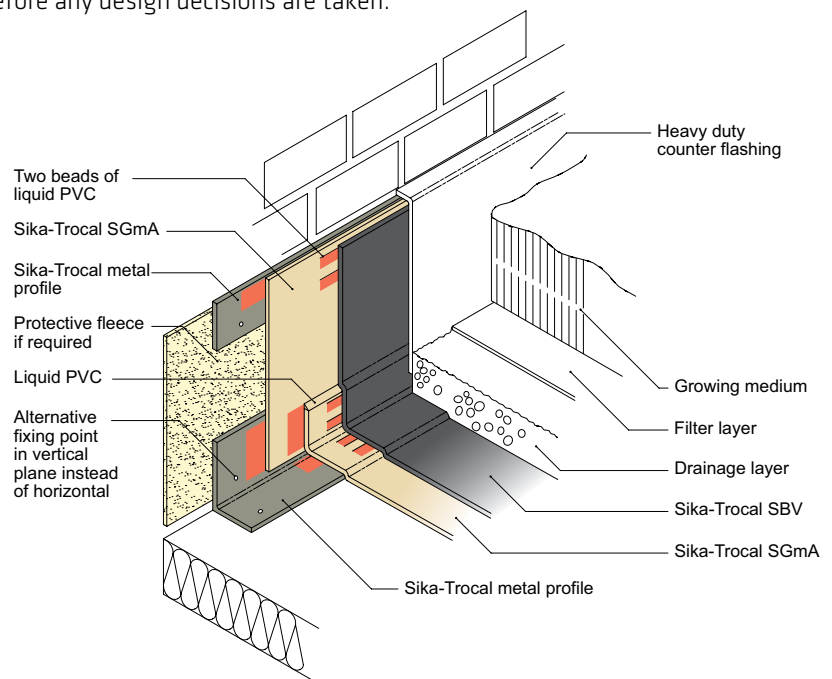
Intensive roofs, in some cases, can be expected to create some very heavy dead loads indeed.

There is a minimum weight requirement of 80kg/m² to hold the Sika-Trocal SGmA membrane and its protective layer in place against wind uplift forces. Therefore it is the dry weight of the garden build-up that would be critical and use of 'lightweight' systems less than this should be carefully considered. Whilst it is possible to mechanically fix the SGmA waterproofing membrane to mitigate the effects of a below minimum weight covering, each case where this is considered necessary must be referred to the Sika-Trocal Technical Department and the Green Roof Specialist for appraisal, before any design decisions are taken.

The height of the build-ups, especially for intensive roofs, needs to be considered when designing the details, penetrations and abutments. The requirements from BS 6229 that upstands should be a minimum of 150mm above the finished roof level, is critical to the success of the roof.

Suitable access for maintenance requirements should be incorporated in the design as appropriate.

Essentially a garden/living roof is, from our perspective, just another form of ballasted roof. Therefore, all the relevant requirements outlined in this Technical Manual will apply.



BALLASTED ROOFS

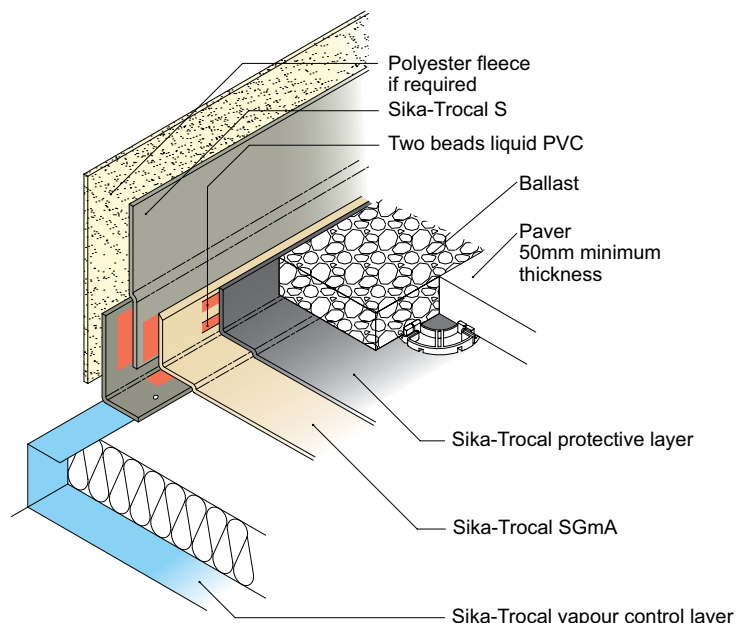
EXPOSED AREAS, PUBLIC ACCESS

Exposed areas on ballasted roofs

Sika-Trocal Type SGmA is formulated to be covered and Type S to be exposed and it is necessary that these materials only operate in their correct environments. The layering sequence of materials indicated here is intended to achieve that aim and must be followed.

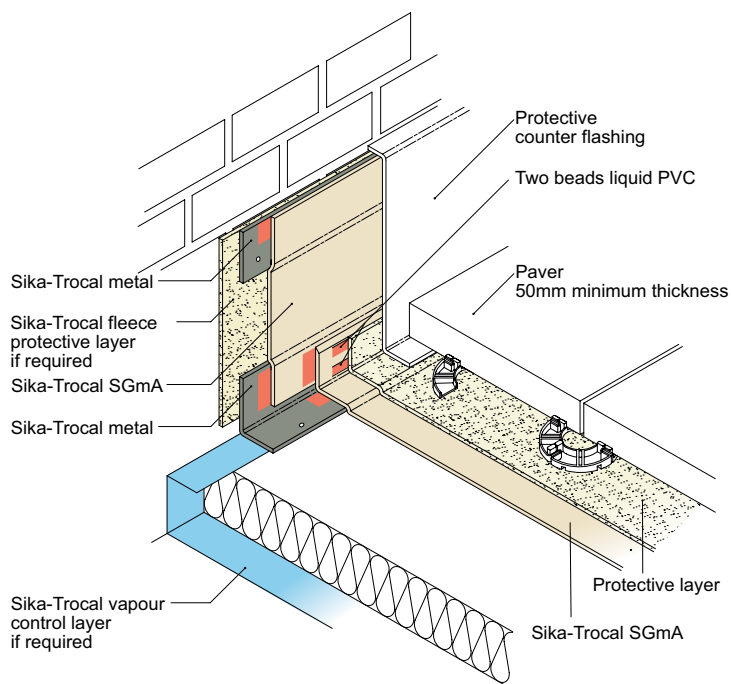
The laminated Sika-Trocal Metal is faced with Sika-Trocal Type S; therefore any part of the profiles located under ballast must be fully covered by having the Sika-Trocal Type SGmA welded to them. In turning the Sika-Trocal Type SGmA up the vertical face of any upstand it should be terminated at or just below the top surface of the ballast. The protective layer, polyester fleece or Sika-Trocal SBV, must terminate at the same point, held in position by a couple of beads of liquid PVC.

Where the Sika-Trocal Type S membrane is used vertically adjacent to a ballasted area of roof it must be welded to the vertical leg of the laminated Sika-Trocal Metal profile first and the Sika-Trocal Type SGmA second so as to ensure the correct layering sequence.



Public access

Where ballasted Sika-Trocal roofs are accessible to the general public, precautions must be taken to prevent abuse and vandalism to the exposed upstands. Whether those upstands consist of laminated Sika-Trocal Metal or membrane. This is best achieved by having a robust counter flashing and extending it down so that it can be turned under the ballast to secure it.



SITework

HANDLING, PREPARATION AND LAYING

Preliminaries

Installation is by Sika-Trocal Licensed Contractors only, whose employees receive continuous training in material selection, production application and laying techniques.

The Sika-Trocal Technical Advisory Service is available to answer any queries, whether of a general nature or site specific.

Handling and Storage

Sika-Trocal sheet membrane materials are supplied in rolls, larger quantities are usually on a pallet.

Laminated Sika-Trocal Metal sheets are supplied on pallets, but are cut and formed into shape off-site. Pre-formed Laminated Sika-Trocal Metal sections should be stored and handled carefully so as to avoid damage and distortion.

Sika-Trocal materials should be stored & used in accordance with the relevant regulatory requirements.

Health and Safety Data sheets as applicable are available on request.

Contamination with diesel oil, petrol and other solvents, with paint and with hot and cold bituminous products, such as asphalt, bitumen adhesive, pitch, tar etc will mar the appearance and reduce the life expectancy of Sika-Trocal PVC sheets and must be avoided.

Hazardous Chemicals

The THF welding agent, liquid PVC and L100 cleaning agent are hazardous chemicals and are highly flammable, having a low flash point. They should be stored in a locked container suitably marked.

Smoking, naked flames, sparks, etc must be forbidden. Keep out of strong sunlight.

Protection of Works

Care is required during installation to avoid damage to Sika-Trocal waterproofing sheets by following trades. If it is impossible to restrict access to the roofing contractors alone, then temporary protection must be employed, adequate to protect the membrane from the level of traffic that will occur.

Incomplete areas of Sika-Trocal roofing can be vulnerable to wind action. Additional temporary ballast must be provided to counteract this effect.

Works that can only be carried out after the laying of the waterproofing sheet, such as installation of rooflights, roof mounted plant, etc should be carried out with care and adequately supervised to avoid damage to the membrane and/or insulation boards.

Suitable protection must be utilised where necessary or desirable. Where ladders are required, these should be placed on a timber plank to spread the load.

Preparation

Laying of Sika-Trocal materials should commence only when all necessary works to prepare the supporting structure of roof deck and upstands have been completed.

Surfaces must be firm, fully supported, smooth and free from sharp edges and protuberances. The use of protective and cushion layers does not avoid this requirement, for they are not designed to counteract these inadequacies of construction.

Damp surfaces can be overlaid with Sika-Trocal sheets, but standing water should be removed from the deck surface and from the build-up before recommencing laying operations.

Laying Procedure

The starting point should be the laying of any necessary underlayers and insulation onto the deck, closely followed by the Sika-Trocal laminated metal profile sections.

Where possible the Sika-Trocal Metal sections should be fixed in place at roof perimeters, internal corners and penetrations before commencing the laying of the membrane.

The total build-up should be created and progressed across the total roof area by stages, NOT by completely covering the roof with one layer before starting on the next layer.

Work can be started from many different areas of the roof concurrently, however, no more insulation than can be fully covered with the waterproofing by the end of the day, or the onset of inclement weather, should be laid.

Consideration should be given to making the roof secure at the end of each day's work or when work is interrupted in order to prevent water or wind penetrating the roof construction and causing damage.

Temporary seals can be achieved by taking the tail of the Sika-Trocal membrane and bonding it to the deck with cold bituminous adhesive. When work recommences, this tail must be cut away from the sheet area and removed from the roof.

Alternatively, the vapour control layer may be turned back over the Sika-Trocal membrane and weighted down. Due consideration should be given to the direction of existing falls and prevailing wind directions.

Note that in the case of ballasted roofs, the specified ballast should be placed as soon as possible once the protective layer is in position for, until the ballast is distributed, the waterproofing will be vulnerable to wind uplift forces. If it is necessary to delay ballasting then temporary ballast, such as sleepers or gravel in plastic bags, should be strategically placed across the completed areas of roofing.

SITework

JOINTING DETAILS

Care must be exercised during the distribution and laying of the ballast to avoid puncturing the waterproofing sheets. The use of tools without sharp edges and wheelbarrows with pneumatic tyres is therefore recommended.

Care is needed when loading the bulk ballast onto the roof surface to avoid localised overloading.

Jointing Details

The THF Welding Agent is the preferred method of creating watertight joints between adjacent Sika-Trocal PVC waterproofing sheets and between those sheets and the PVC faced laminated Sika-Trocal Metal sections.

Hot air welding will be used to ensure a complete seal at multiple sheet overlaps and at points of intricate detailing, at corners and 'T' joints, for example. Hot air is also used to rectify any areas where the THF weld is found to be discontinuous or incomplete.

THF Welding Agent - The THF must be used undiluted and as it is easily absorbs water vapour, care must be taken to ensure that water contamination does not occur, e.g.

- Open containers of THF must not be left out in the rain.
- Closed containers exposed to rain must be dried before decanting.
- Partly used containers should be topped up before returning to store.

THF vaporises rapidly and has a low flash point. Welding operations in a closed area should only take place when ventilated adequately. No smoking, naked flames or sparks are allowed. It must be noted that Sika-Trocal liquid PVC contains THF and can therefore only weld itself to PVC and uPVC surfaces. It is not suitable for use as a general-purpose sealant.

Creating a welded joint

General - The seam overlap to be welded must be at least 50mm wide and both surfaces must be dry and free from dust or dirt. Dirt or contamination must be removed, usually with water and a cloth. The addition of a little washing up liquid can often assist in the cleaning process. If stubborn, then Sika-Trocal L100 Cleaner (ethylacetate) may be sparingly used. The minimum width of the welded area of the overlap must be 30mm.

A mini-jet brush head or a welding brush charged with THF is introduced between the two surfaces of the overlap and drawn along the seam for about 400mm, being followed by light pressure from the operative's other hand. The objective is to wet both surfaces simultaneously.

To continue welding the seam, reintroduce the mini-jet or recharged brush into the seam, where it should first be backed slightly into the previously welded areas and then drawn along the seam as above.

The joint is 'fully cured' only when all the THF has evaporated.

It should be noted that it is normal and permissible to overlap the waterproofing sheets against the direction of the water flow.

When welding seams on the vertical or on slopes it will be necessary to maintain hand pressure on the fresh weld for a period. This will obviously cause a slight reduction in the rate of welding.

For these vertical applications it is best to start the weld at the bottom and work up.

Checking

After concluding the THF welding, the edge of the joint is probed to check the security of weld and locate any discontinuities, which will need to be rectified.

Rectification - A hot air welder blowing into the edge of the joint softens the PVC sheet and, by application of the hand roller, the sheets are welded together eliminating the discontinuities.

'T' joints - Multiple sheet overlaps, which create 'T' joints, must have the void that is formed along the edge of the middle sheet sealed against capillary action.

The fine nozzle of the hot air welder is fully inserted into the void and, by applying pressure with the edge of the hand roller as the nozzle is slowly withdrawn, the void is sealed completely, leaving a characteristic step in the surface of the membrane.

Cold and Humid Weather - In cold and humid weather, typically at or below 5°C, THF welding can continue provided the hot air blowers are used to pre-warm the sheet.

Sealing the joint - After completion of this checking and rectifying sequence, the edge of the joint must be sealed. Ensure that the edge of the joint is clean and dry.

Draw the clipped nozzle of the polyethylene bottle along the edge of the joint, depositing an even bead of Sika-Trocal liquid PVC. This will obscure the edge of the top sheet while lapping onto the bottom sheet.

General notes - The full welding sequence outlined above must be completed before moving on to other work. It is recommended that the procedure of clean, weld, check, rectify and seal with liquid PVC be treated as a continuous process with one operation following closely behind the other. This way contamination of the working area, which will interfere with successful completion of the joint, should be avoided.

When welding, too little solvent or too little heat can result in a weak or ineffective weld. Too much solvent, particularly in cold weather, delays the sequence due to the length of time required for curing. Too much heat in hot air welding can embrittle or char the waterproofing sheet.



CARE AND MAINTENANCE

Access

Sika-Trocal waterproofing sheets are not intended to be trafficked surfaces, but will accommodate reasonable and considerate access, i.e. for occasional maintenance, footwear should be soft soled with a good robust tread pattern for grip.

Where walkways are provided, these should be used whenever possible.

To avoid personal accidents, care should be taken when walking over exposed Sika-Trocal waterproofing sheets, particularly on slopes and in wet conditions with certain footwear. Access should not be attempted when ice or snow is lying on the roof.

When the occasional use of ladders is required from Sika-Trocal waterproofed surfaces, a 'load spreader' or a suitable sized plank of wood should be used to avoid damage to the insulation boards and/or waterproofing.

Inspections

Sharp or rough edged foreign matter such as screws, metal off cuts, broken glass etc, should be removed from the roof during the biannual inspections, which should check on the state of all edge details, noting particularly disruptions to flashings and pointing.

Vegetation

Sodium Chlorate solution can be used as a weed killer on ballasted roofs, but the solution must be rinsed off exposed surfaces of Sika-Trocal Type S, SG or SGK as the combined influence of UV light and the solution may create a detrimental effect.

Vegetation is readily removed from exposed un-ballasted Sika-Trocal Type S or SGK, without any need for weed killer, because the roots cannot penetrate the membrane.

Rainwater Outlets

Rainwater outlets, gullies, spouts and gutters can become blocked, and as with any type of roof waterproofing, the blockage needs to be removed to ensure the roof drainage system is able to perform as designed.

Solar Gain

Exposed surfaces of Sika-Trocal roof waterproofing are generally light grey (Sika-Trocal Type S, SG and SGK) and therefore do not require painting to reduce solar gain. It should be noted that if colours darker than light grey have been specified they will naturally be subjected to higher solar gain.

Painting

The use of paint on the membrane surfaces is not recommended. Spots, drips and spillage of paint onto Sika-Trocal materials are to be avoided as the solvents in paints may adversely affect the life expectancy of the sheets, as can oil, pitch, tar, bitumen, solvents and other hydrocarbon based materials.

Repairs

If, in spite of all precautions, damage does occur to the waterproofing, the sheet can be restored to its original watertight conditions simply by welding on a patch of the appropriate fresh material of the same type.

The patch must have rounded corners and be larger than the damaged area by at least 50mm in each direction. Water that has entered through the damaged area should be removed; residual dampness will in most instances be able to be 'breathed out' from under the waterproofing.

Note that bituminous materials are not compatible with the Sika-Trocal membrane and are not therefore suitable for effecting repairs. All repairs must be carried out by Sika-Trocal Licensed Contractors.

The surfaces to be welded must be clean and dry. Contamination can generally be removed with warm soapy water. Very stubborn soiling can require the sparing use of Sika-Trocal L100 cleaner.

Alterations

The addition of new or replacement items of roof furniture, roof lights, services equipment, extractor fans, cables to cameras and satellite dishes, etc that will necessitate connection to, penetration of, or alterations to, the existing Sika-Trocal waterproofing must be executed by a Sika-Trocal Licensed Contractor in accordance with this Handbook.

Cleaning

It is possible to clean the surface of the roof membrane if required by using water mixed with a little washing up liquid and the use of a large headed soft broom. The roof can be rinsed afterwards with a hose running at normal domestic pressure. High-pressure washers and fire hoses are not to be used.

Note that the use of soapy water will make the membrane more slippery.

FIXING METHODS

FASTENERS

Introduction

With loose laid exposed Sika-Trocal Type S/SG membranes it is necessary to provide mechanical restraints against wind uplift forces. Utilising either Sika-Trocal Metal discs or proprietary pressure plates provides those restraints. In both cases, fasteners will be required to secure the discs or plates to the structural deck while passing through the overall roofing build-up. Similar fasteners are also required to secure the Sika-Trocal Metal profiles.

Sika-Trocal S3 Disc Tube & Cap -

Polypropylene thermally broken tube & cap to be used in combination with the WO-48T x L fastener and Type S3 disc, for the mechanical fastening of Sika-Trocal Type S/SG waterproofing membranes and insulation boards.

WO-48T x L Sika-Trocal Fasteners -

These self-tapping, carbon steel screw fasteners have a T25 torx head and are used in combination with the Sika-Trocal S3 disc tube & the S3 disc, or alternatively can also be used for non tube applications with the S1 / S2 disc. These combinations are used for securing Sika-Trocal S/SG waterproofing membranes and insulation to steel decks (0.7mm thick) and timber substrates such as Plywood and OSB (18mm thick).

Fasteners

Due to our geographical location on the eastern side of the Atlantic, here in the UK we have a particularly demanding environment for fasteners to operate in, especially when compared with the majority of mainland Europe. We have the strongest winds, both in terms of actual wind speeds and frequency of high velocity events, combined with the thinnest galvanised steel decks and design standards that permit our buildings to be very dynamic. In addition, nowhere in the UK is further than 75 – 80 miles from the sea, which means we have a generally humid climate with high levels of airborne salt, which makes most of the country a higher corrosion risk.

The aspects noted above place high demands on two areas of any fastener's performance, which is mechanical resistance to unwinding and pullout, along with the need for a good level of corrosion protection. Fasteners must, therefore, only be obtained from Sika-Trocal or from approved manufacturers who have authorised the use of their products for the particular duty required and the fixing base. These are generally listed in our relevant Agrément certificates or can be obtained directly from Sika Limited.

Generally, fasteners will have heads without corners or sharp edges with a minimum protrusion above the surface. All fasteners will be covered and weatherproofed by the Sika-Trocal membrane.

Thermally broken fasteners sets automatically incorporate a 'telescoping' function that permits the restraint disc or plate to be deflected downwards to a degree when subjected to overloading and helps to minimise the risk of the screw part damaging the membrane from below. When non-thermally broken fasteners are utilised these should, wherever possible, incorporate a 'tread fast' type device, so that the disc or plate is locked up under the head.

Compatibility

There are a wide variety of possible substrates for both new and old roof constructions and suitable types of mechanical fasteners are available for virtually all of them. However, it is vital that the fastener is matched correctly with the substrate and that the manufacturer agrees to any particular situation, especially if it is not a recognised standard one.

Due consideration also needs to be taken of the other materials that the fastener will be passing through, especially if they are abrasive or chemically aggressive, which could damage protective anti-corrosion coatings. These considerations are particularly vital on those projects where an existing roof is being overlaid and the fastener will be penetrating and residing in the existing build-up, these situations will require the active involvement of the fastener manufacturers in ensuring the correct solution.

Correct matching of materials is important, for instance the avoidance of an electrolytic corrosion situation arising by combining dissimilar metals together, in particular the selection of stainless steel fasteners in combination with galvanised steel decking, which is not recommended.

Requirements

When fixed in accordance with manufacturer's recommendations into the proposed fixing base fasteners should have a minimum resistance of 1.2kN to pull out and shear forces. Fasteners attaining this minimum level of performance, when used to restrain the membrane, can use a design load not exceeding 0.4kN when calculating wind load forces.

In certain substrates it may not be possible to attain a minimum of 1.2kN resistance to pullout and shear forces. In these cases the maximum design load figure can only be one third of the actual minimum pull out value attained. For instance, if the minimum value achieved was 0.9kN, then the design value can be no greater than 0.3kN. This does mean that a greater number of fasteners will be required to restrain the roof membrane. In all cases where the pull out values fall below the 1.2kN minimum, the specific project must be discussed with both the fastener manufacturer and Sika Limited before proceeding.

In some other substrates, such as concrete for instance, it is possible to achieve extremely high pullout values. However, no matter how high these results are, the 'design value' cannot exceed 0.4kN, as this would simply unbalance the system and over stress the membrane.

When fixing into aerated concrete, only one quarter of the minimum pullout values may be used as the 'design value', up to a maximum of 0.4kN.

Pullout tests are frequently carried out before work commences on site, however, certain commonly specified substrates are generally found to provide sufficient resistance. These are:

- Min 0.7mm profiled galvanised steel sheet
- Min 0.9mm profiled aluminium sheet
- Min 38mm timber
- Min 18mm plywood
- Min 18mm OSB board (roofing grade)
- Structural concrete, (note that screeds, unless structural, do not provide a suitable stable fixing base)

In most common applications fasteners are likely to be of the screw type. Certain substrates, such as profiled aluminium, aerated concrete and woodwool slabs usually require specialised rivet types or other dedicated fasteners.

With most thin substrates, such as metal decking, timber, plywood and OSB boards, it is necessary for the correct functioning of the fasteners that they pass through the deck and protrude from the underside. Manufacturers can advise on minimum protrusions required and it should be noted that under no circumstances must these protrusions be removed or cropped after installation, as this will lead to subsequent failure of the fastening system itself.

All fasteners securing the build-up to any form of profiled metal decking must be located so that they only engage in the uppermost surface of that profile, otherwise known as the deck crown.

Corrosion

The fastener is an important element in creating the completed roof and in ensuring its continued performance for the working life of the membrane. UEAtc provide two test methods for measuring the corrosion resistance of fasteners, in view of the climatic conditions prevailing in the UK we have selected the most onerous one. That is the manufacturers are required to supply fasteners that are corrosion protected to UEAtc standard class 2.

The test involves placing the fasteners into a Kesternicht cabinet with 2 litres of sulphur dioxide, SO₂ solution. The solution is heated and the vapour travels around the cabinet for a time and then the samples are given a rest period, this takes place over a 24-hour cycle. Under class 2 requirements the fasteners are exposed for 15 24-hour cycles and must not display more than 15% surface corrosion, this is sometimes colloquially referred to as the 15/15 test. This is an extremely severe test and demonstrates that the fasteners generally have a higher resistance to corrosion than the decks they are going into. Note that class 1 fasteners are permitted no more than 15% surface corrosion after 2 cycles in the Kesternicht cabinet.

FIXING METHODS

SIKA-TROCAL METAL DISCS

The discs are manufactured from Sika-Trocal Metal, similar to that used for profile work and consists of galvanised steel with a surface of specially formulated Sika-Trocal Type S membrane. They are generally of an 80mm diameter with a countersink and hole formed in the centre. Thermally broken applications combine a laminated Sika-Trocal Metal disc with a plastic tube with a fastener located in it. The plastic tubes and fasteners come in a variety of sizes and shapes; consequently discs are manufactured to precisely match the various manufacturers products to ensure they work together. Therefore, only the dedicated discs are to be used with each specific fastener.

Fixing requirements

Wind load calculations will decide the size of the various zones of influence occurring on a roof and the number of fixings required per square metre for each zone.

Within each zone the spacing between the discs along each axis must be equal.

Working within the constraints imposed by the selected deck or substrate and insulation board sizes, the aim should be to make the grid for the discs as near square as possible.

The absolute minimum number of fixings per square metre for any part of the roof is $2n_0/m^2$.

Application

The discs are positioned at the required centres over the top surface of the roof substrate. The fastener is then driven through the disc and insulation (if present) until it is secured into the substrate. The discs should be so secured by the fastener that by just biting into the top surface of the insulation board without distortion they are unable to be rotated by finger pressure.

The Sika-Trocal sheets are then laid onto the roof in the desired position. During the rolling out operation, the THF welding agent will be applied, so as to simultaneously wet the underside of the sheet and the topside of the disc. The two surfaces are then brought together under light pressure so that they are permanently fused.

This is a 'spot fixed' system and provides the means of restraint against wind uplift forces. As additional sheets are laid across the roof they are joined together at the side and end laps by welding so as to form one continuous waterproof membrane.

Where Sika-Trocal Metal discs are used any width of Sika-Trocal weatherproof sheet can be utilised. However, the maximum width of 2.0 metres is generally used in order to minimise the number of seams to be welded together.

The positioning and direction of the Sika-Trocal sheets is totally independent of the pattern of the fixings and the direction of the metal decking, if used.

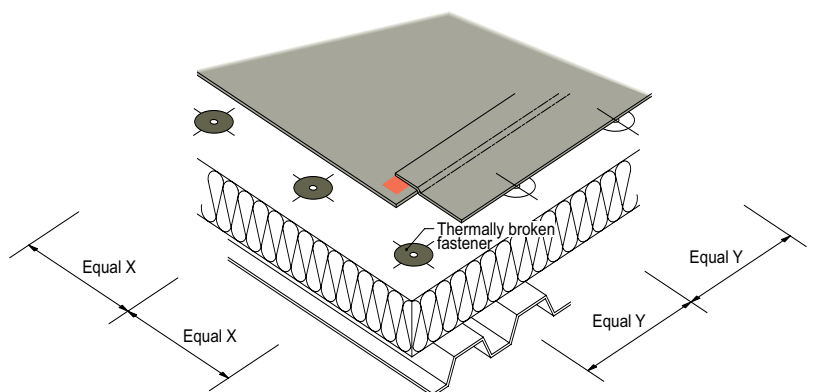
The disc fixed solution when used with 2.0m wide sheets will save 7% wastage compared with seam fixed 1.1m wide sheets.

Sika-Trocal Metal discs under the membrane also provide the anchoring points for the 'weld down' lightning protection conductor system.

Insulation

It should be noted that insulation products will have their own separate fixing requirements, information on which will be provided by the respective manufacturers. The discs and fasteners that are used to secure the membrane can also act for the insulation, but only where the fixing locations coincide with the recommended layout for the insulation boards.

In some cases there will be a need to provide additional fasteners for the insulation. These 'insulation fasteners' may be the types specifically manufactured for this application or alternatively the Sika-Trocal Metal discs can be used.



Whilst metal deck is indicated, the substrate could also be concrete or timber based or an existing roof being refurbished

FIXING METHODS

PRESSURE PLATES

The pressure plate system employs proprietary manufactured plates of approximately 80 x 40 mm with rounded ends and straight sides. Circular plates are not generally recommended as they create localised high stress points onto the membrane when placed under windload. Thermally broken applications consist of a moulded plastic plate combined with an integral tube to accept a fastener. It is of vital importance to ensure that pressure plates are only installed with the specific dedicated fasteners recommended by their manufacturers in order to ensure they function correctly.

Fixing requirements

Wind load calculations will decide the size of the various zones of influence occurring on a roof and the number of fixings required per square metre for each zone. Within each zone the spacing between each row of plates must be equal and the spacing between each of the individual fasteners must be equal.

The fasteners are set out in rows and in each row there must no more than 5 fasteners per linear metre, that is minimum 200mm centres. Therefore, as the number of fasteners required per square metre rises, then the distance between the rows of fasteners must be reduced to compensate. The table below sets out the requirements where A = the distance between the rows of fasteners. The absolute minimum number of fixings per square metre for any part of the roof is 2no/m².

Application

A Sika-Trocal sheet is positioned and laid onto the substrate. Pressure plates are then placed onto the sheet at the required centres along one long edge, minimum of 10mm inboard from that edge. The fastener is then inserted and driven into the deck and clamps the membrane, and insulation if present, in place. The plates should be so secured by the fastener that they are without distortion but are actually clamping the membrane.

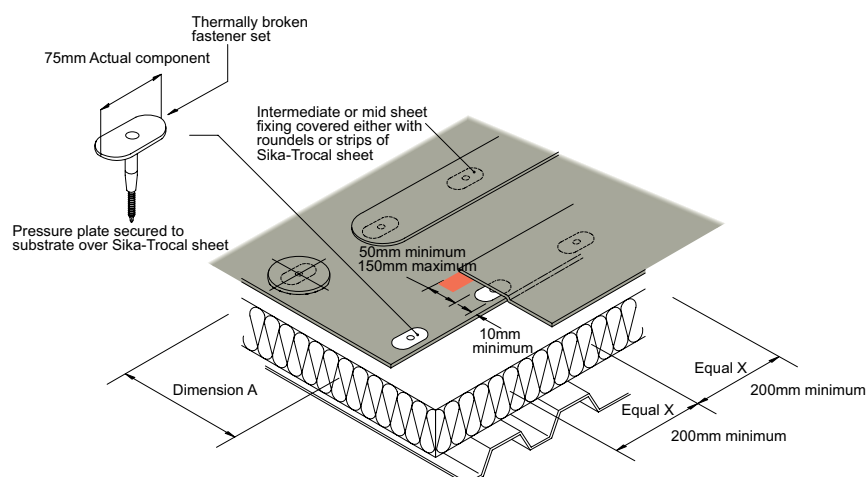
The adjacent sheet is then positioned so that its edge is set 50mm minimum, 150mm maximum, beyond the pressure plates and their fasteners, thereby covering and weatherproofing them. The upper sheet is then welded to the lower one in the standard way.

This is a 'linear fixed' system and provides the means of restraint against wind uplift forces. As additional sheets are laid across the roof they are joined together at the side and end laps by welding so as to form one continuous waterproof membrane.

Where the rows of pressure plates are to be spaced at 1.0 metre centres they will be placed along one edge of the 1100mm width sheet. Where the rows need to be spaced at 500 or 333mm centres some will be placed on the upper surface in the middle area of the Sika-Trocal membrane sheets. In these cases the plates that are placed mid-sheet will need to have patches or strips of membrane welded over them to make them weathertight. The aesthetics of this method should be considered and clarified with the building designer.

When pressure plate systems are installed over profiled metal decks the rows of plates and their fasteners must run at right angles to the direction of the troughs. This obviously dictates the direction in which the membrane sheets will be laid.

No. of fasteners m ²	Dimension A
From 2 up to & including 5	1000 mm
From 5 up to & including 10	500 mm
From 10 up to & including 15	333 mm



Insulation

It should be noted that insulation products will have their own separate fixing requirements, information on which will naturally be furnished by the respective manufacturers. The pressure plates and fasteners that are used to secure the membrane can also act for the insulation, where the fixing patterns coincide. In some cases there will be a need to provide additional fasteners to and for the insulation. These 'insulation fasteners' are generally specifically manufactured for this application.

WIND LOADING

Overview

This section is intended to provide a brief overview on how wind loads affect roofs. BS 6399-2: 1997 Code of Practice for Wind Loads has been superseded by the European standards. At the time of writing the current code of practice is Eurocode 1: BS EN 1991-1-4, and the accompanying UK National Annex; NA to BS EN 1991-1-4.

Introduction

Wind moves across the earth's surface driven by the gravitational pull of the sun and the moon plus the heating and cooling of the globe's surface as it rotates. Anything that obstructs and deflects the wind, such as a building, has to be capable of resisting the forces that this action imposes on it.

The turbulence and acceleration of the wind meeting and passing over the roof surfaces of a building create both positive and negative pressures. Wind uplift or negative pressure can exist at some time on every part of the roof surface. It is these forces that have to be resisted by the Sika-Trocal membrane and its attachment system.

It should be noted that all roof finishes, whether flat or pitched, continuous or discontinuous and irrespective of material and attachment method, including adhered or bonded, have to be designed by calculation to resist these forces.

There is a general level of uplift across a roof but these forces are increased in local areas, such as in corner, perimeter and ridge zones, along with wind shadow areas created by higher parts of the roofscape and changes of level.

Considerations

Each individual site, building and roof area will have its own micro wind climate. This is affected by the expected maximum wind speed for a particular area, which in turn is locally modified, that is slowed down or speeded up by a number of factors. The greater the speed at which the wind passes over the surface of an object, i.e. the roof, the greater the uplift force applied to it.

One factor is the general roughness of the local surrounding terrain. Lots of obstructions such as buildings and trees slow the wind down, conversely large open areas such as fens or airfields allow the wind to accelerate.

The height of the individual roof under consideration is also a factor, the further it is above the lowest ground level, the greater the wind speed across it. It should be noted that on a building with roofs at varying levels, all would experience different wind speeds, therefore a separate calculation is required for each one.

The wind pressure generated on a particular roof surface is not constant over the whole area. In the case of a simple rectangular or square building, there is an area of generally higher uplift at the corners, lesser uplift all around the remaining perimeter of the roof and the remainder of the roof has the lowest level of uplift.

More complex roofscapes create further different areas of uplift. Changes of level, such as between one roof and another, or roof top obstructions such as lift motor, plant or water tank rooms create a wind shadow across the adjacent roof area. Roof pitches greater than 5° will have 'ridge' zones as well as 'perimeter' ones.

All these different zones will have their own level of wind uplift force acting on them.

Calculations

Sika-Trocal have developed an internet based calculation service for its Licensed Contractors who are able to login and enter all of the relevant data required for the building under consideration. Once complete an electronic PDF copy of the calculations will be sent to them. Visit <http://www.sika-trocal-calcs.co.uk>

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WHO WE ARE

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In the UK, we provide market-leading solutions for concrete, waterproofing, roofing, flooring, refurbishment, sealing & bonding, and industry, and have manufacturing sites in Welwyn Garden City, Preston, and Leeds with 700 employees and a turnover of £190 million.

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