Flat Roof Decks - Guidance

STRUCTURAL DECK

The structural deck provides the primary support for the roofing system including all of its components and any additional finishes such as green roof, paving, ballast or solar panels etc. It must resist dead, live and wind loads, including storms. It must also be suitable for the proposed roofing system, and subsequent use.

Relevant structural and loading codes for each material must be followed for, and the requirements of the current building regulations must be checked and observed. Resultantly, a structural engineer should be consulted to confirm compliance.

Dead and imposed loads upon a roof should be assessed in accordance with BS EN 1991-1-1 +UK National Annex taking due consideration of any added surface; green roof, paving, gravel, blue roof water retention, etc.

Snow loads should be assessed in accordance with BS EN 1991 -1 - 3 + UK National annex.
Wind loads should be assessed in accordance with BS EN 1991 -1 - 4 + A1: 2010 + UK National annex.

Note: for relevant structural material on roof structure strength and stiffness, see BS EN 1992-1-1, BS EN 1993 -1 -1, BS EN 1994 1-1, BS EN 1995 1-1, BS EN 1999 1-1 and their UK National annex.

Note: If the use of the roof is to be changed, the suitability of the deck and the structure must be re-confirmed.

The deck may also be laid or fixed so as to provide a suitable fall for drainage of the roof surface, as required in the current BS6229 Code of Practice for flat roofs with continuously supported coverings.

Falls

BS6229: 2018 - Flat roofs with continuously supported roof coverings code of Practice, states that "**all flat roof waterproofing surfaces including any formed internal gutters** should be designed with a fall of 1:40 (2.5%) to ensure finished drainage falls of 1:80 (1.25%) are achieved.

Design falls should take account of any potential defection, construction tolerances, permitted deviations, deflections under load and settlement. In the absence of detailed calculation, this may necessitate design falls of twice the minimum finished falls (1:40 or 2.5%).

The falls may be formed within many ways, the most typical are:

a) Within the structural deck
b) Within a screed
c) Within a tapered insulation scheme

Where a deck is constructed to be flat such as with Insitu concrete where it is difficult to form to provide drainage falls and as such may also need to have a suitable cementitious screed as necessary to achieve a minimum finished fall of 1:80. Or where a built up warm roofing system is being applied, the use of tapered insulation can be utilised to provide drainage falls in accordance with BS6229.

Tapered insulation systems are often produced to a fall of 1:60 (1.7%) or 1:40 (2.5%). If tapered insulation is specified, it will be necessary to ensure that it can achieve the 1:80 minimum, as built, by overcoming defection of the deck and/or construction tolerances.

In other words, design should allow for all factors that could reduce or hinder the drainage eliminating the risk of ponding on roofs.

Ponding water adds a dead load to the roof structure and in exposed warm roofs increased stresses in the waterproofing layer.

Typical effects of standing on flat roofs

- Increase stress on the waterproofing
  - *Most waterproofing membrane will deteriorate under standing water; therefore ponding water may well invalidate any guarantee or warranty*
- Increased weight loading,
  - *25mm standing water over 20m² would equate to 500kg loading.*
  - *15mm standing water over 500m² would equate to 7.5 tonnes*
- Progressive deflection of the deck.
- Slip hazard
  - *(During cold spells or during any maintenance)*
- Build-up of dirt, leaves, algae and plant growth
  - *Increasing risk of drainage point becoming blocked.*
- Stagnant water
- Require increase maintenance regime
- Thermal stress.
- Increase risk of birds drinking and nesting
  - *Make the roof less attractive to birds is a small investment that will limit their damage*
- Compromise of any guarantee terms and conditions

Zero falls

Certain third-party certified waterproofing and insulating systems are approved for use with zero falls.

Zero falls are defined in BS 6229:2018 as falls between 0 and 1:80 (1.25%). Zero falls are acceptable with some waterproofing system, provided they have third party certification (e.g., BBA, ETA, or similar) and are used – for example – in a ballasted situation where the membrane is not exposed and does not act as the primary drainage layer. Any back falls of zero fall roofs must be highlighted by the undertaking of a level survey and corrected before commencement of the waterproofing.

This means that back falls and ponding are not acceptable, and in order to ensure a finished surface with a zero fall, a design of 1:40 should be used and a detailed structural analysis should account for construction tolerances, settlement and deflection under load. If there are negative falls, then remedial action should be taken e.g. localised screed or additional of rainwater outlets at the lowest point.

To prevent ponding caused by waterproofing system lap, build ups around rainwater outlets, rainwater outlets should be recessed into the slab/deck or fitted in sumps when it is practicable to do so.

As a result, the roofing contractor should expect a flat, properly drained surface on which to lay the specified system and the finished roof should not suffer from ponding or inadequate drainage.

It is a requirement and as stated within NHBC 7.1.5 that a deck survey is undertaken by the deck erector and any back falls should be addressed. Dependent upon the substrate, a localised screed may be used or an additional rainwater outlet in worse areas of deflection. A formal handover of the deck should be undertaken between the deck erector and the installing waterproofing contractor.

It is no longer acceptable for a main contractor to provide roof decks with large depressions, back falls and non-draining areas.

Since the primary function of a roof is to exclude water, the designer must consider the most effective means of drainage, so to prevent ponding water upon the roof finish. For further details please refer to IKO Technical Bulletin on falls and drainage of flat roofs.

Working on any roof is a hazardous activity, irrespective of whether it is fragile or non-fragile.

Work on roofs with such decks need a careful risk assessment agreed before commencement.

Timber based structural decks

Structural support of timber sheet materials.

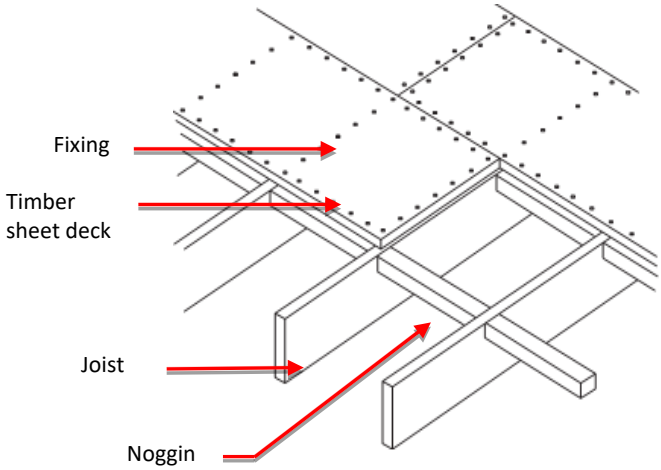
The structural support system used to support timber structural decks are typically by timber joist being supported on a wall or framed structure.

The size of joists can be defined by the current version of the Approved Document Part A: Structure or by guidance within TRADA (Timber Research and Development Association) span tables.

Consideration should be made for the use of the roof:

- Flat Roofs for access and maintenance only
- Flat roofs with full access

Note: Allowances should also be made should if the roof construction is a cold roof whereby insulation is applied between the joist, then allowance must be made for a 50mm continuous air gap above the insulation.



Fixing and support – Timber Sheet materials
Timber panel sheets are fixed to suitable joists or rafters typically spaced at 450mm or 600mm centres.

Install each board in a staggered pattern

Square edge deck laid across the joists and supported on noggins. Noggins are required to the long edges of square edge panels.

Fixed and secured using corrosion resistant nails such as **50mm x 10g ring shank nails** or **conventional countersunk woodscrews 50mm x 10.**

Fixing should be at **100mm centres.**

OSB/3 or OSB/4 DECK

OSB/3 or OSB/4 used for roof decks should be **18mm** thick.

OSB/3 or OSB/4 panels for roof decks must be CE marked in accordance with BS EN13986:2004. This standard is a technical specification for wood-based panels which implements the provisions of the Construction Products Regulation (CPR) In addition to the CE mark, OSB/3 that is certified by the British Board of Agrément (BBA) is permitted for structural use by NHBC (UK)

OSB/3 or OSB/4 conforming to BS EN 300: 1997 is deemed suitable for flat roofing would be identified on each board facing.

Design of the roof structure and installation of the panels should be carried out in accordance with BS EN 1995-1-1:2004, DD CEN/TS 12872:2007 or BS 8103-3:2009, as appropriate according to the type of construction.

The panels should be supported at not more than 600mm centres with noggins or bearers to support edges. Long edges should be at right angles to the joists. 15mm OSB/3 could be used where the deck is supported on joists at 450mm centres

A 3mm expansion gap should be provided between the panels, which should be fixed to the joists at 100mm centres using 50mm x 10g ring shank nails which should be knocked home to provide a flush finish.

All decks should provide finished falls as required by BS6229 to achieve a minimum fall of 1:80. This may be undertaken by the use of timber firring pieces fixed to each joint support beneath the OSB deck, or by the use of tapered insulation.

PLYWOOD DECK

Plywood used for roof decks should be **18mm** thick.

Plywood panels for roof decks must be CE marked in accordance with BS EN13986:2004. Plywood suitable for flat roofing would be marked BS EN 636-2 or BS EN 636-3 and must be suitable for exterior use.

Design of the roof structure and installation of the panels should be carried out in accordance with BS EN 1995-1-

1:2004, DD CEN/TS 12872:2007 or BS 8103-3:2009, as appropriate according to the type of construction.

The panels should be supported at not more than 600mm centres with noggins or bearers to support edges. Long edges should be at right angles to the joists. 15mm OSB/3 could be used where the deck is supported on joists at 450mm centres

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All decks should provide finished falls as required by BS6229 to achieve a minimum fall of 1:80. This may be undertaken by the use of timber firring pieces fixed to each joint support beneath the plywood deck, or by the use of tapered insulation.

TIMBER BOARDED DECK

Timber boarding suitable for roof decks should be **19mm** nominal thickness, planed and closely clamped together, tongued and grooved or closely butted.

Where using this type of deck then it will be necessary to first install a random nailed isolating layer prior to the installation of the main roofing system to cover the joints between adjacent boards. This decking is not suitable for hot melt or cold liquid applied systems.

The panels should be supported at not more than 600mm centres with noggins or bearers to support edges. Long edges should be at right angles to the joists.

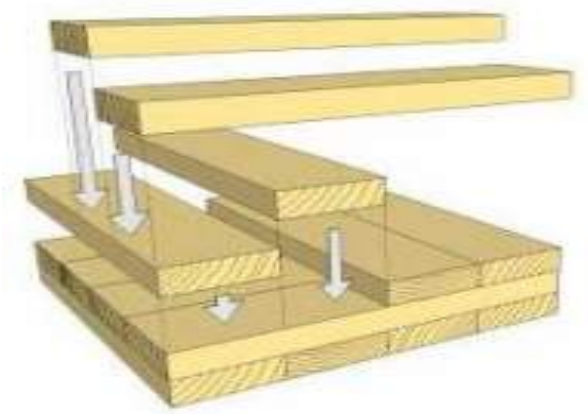
The boards should be securely clamped and fixed to the joists at 100mm centres using suitable exterior wood screws or shank nails which should be knocked home to provide a flush finish.

CROSS LAMINATED TIMBER

CLT (Cross Laminated Timber) is an engineered timber product with good structural properties and low environmental impact (where sustainably sourced timber is used).

CLT (Cross Laminated Timber) typically 3 or more layers of laminated timbers

These are usually preformed off site in factory conditions making them more robust.



They are specifically designed for rapid installation of a structural deck and capable of spanning large openings.

Typically used to provide an internal ceiling finish

CLT (Cross Laminated Timber) is an engineered timber product with good structural properties and low environmental impact (where sustainably sourced timber is used).

CLT commonly available in the UK are manufactured from quality-controlled softwood materials which have no natural defence against decay caused by sustained high levels of moisture, typically above the design threshold of 20% moisture content, unless treated with water repellents in their manufacture.

CLT should be manufactured and CE or UKCA marked to BS EN 16351.

Cross laminated timber (CLT)

- Preformed off site.
- Designed for quick installation of timber structural decks.
- Capable of spanning large open spaces
- Suitable for internal ceiling finishes
- Protection from the elements must be allowed for to prevent the panels becoming saturated prior to the application of any waterproofing.
- **Usually contain high levels of moisture content and must be protected from the elements upon installation until such time they can be made waterproof.**
- **Due to the high levels of moisture content this may inhibit the application of any first layer of waterproofing.**

CLT structures should not be subjected to high moisture either during installation or in-service, as incorrect installation may create conditions for moisture to become trapped. Every effort should be made to ensure no moisture is trapped within CLT structure including detailed plan for protection against both short- and long-term exposure to excessive moisture or precipitation. A satisfactory Moisture Control Plan will be required for the management and control of moisture on all projects.

The Structural Timber Association publication: STA Advice Note 14 titled 'Robustness of CLT Structures - Part 1: Key principles for moisture durability' provides guidance for the design, concept detailing and installation of panelised CLT building structures.

CLT should always be protected from exposure to rain, snow and wet ground during transport, storage and erection. CLT panels are vulnerable to damage from excessive wetting due to the nature of their laminated construction and because they absorb large quantities of water, especially through any exposed end grain and gaps between the panel laminates.

Storage principles of CLT protection

- Where possible CLT should be delivered to site in a 'just in time' approach to avoid site storage.
- If storage is required, panels should be stacked on suitable bearers, lying flat and off the ground.
- Covered with waterproof sheeting to protect from inclement weather, but to allow for free flow air circulation to prevent condensation.

Temporary weather protection

- Where CLT is to be left exposed for a long period of time additional weather protection may be required to exposed grain members.
- CLT used for roofs, balconies and parapets should be protected as soon as possible with a vapour permeable or waterproof membrane, however these membranes should not be applied when the CLT surface is wet (above 20% moisture content). If the roof panels are wet before the protective membrane is applied, it may be necessary to provide temporary protection above the roof to allow for the panels to dry.
- An adhesion test for the bonding of the waterproofing must be undertaken at regular intervals across the roof prior to the installation of any waterproofing membrane. IKOs recommendation is the use of the IKO Ultra S-A Air and Vapour Control layer to be applied using either the IKOpro Bonding agent or IKOpro Sprayfast MPP, and should a satisfactory bond be achieved, this would enable the CLT to be made watertight, and no further preparation layer should be required.

The NHBC state that they do not recommend the use of CLT within flat roof, balconies and parapet constructions and defines it as being a high risk, due to the detailing of these elements to exclude moisture in the long term is difficult to achieve in practice and their adequate construction cannot be guaranteed.

In consideration of this guidance note, we should also be aware and brief our clients accordingly wherever CLT is being specified.

Where the use of CLT timber is being used, and due to the potential high moisture content of CLT, we should be highlighting to any user specifying the use of CLT that CLT structural decks should be protected from water, moisture, and inclement weather conditions prior to the application of the waterproofing and the first layer of waterproofing should be applied as soon as practicable as defined previously.

This can be achieved by:

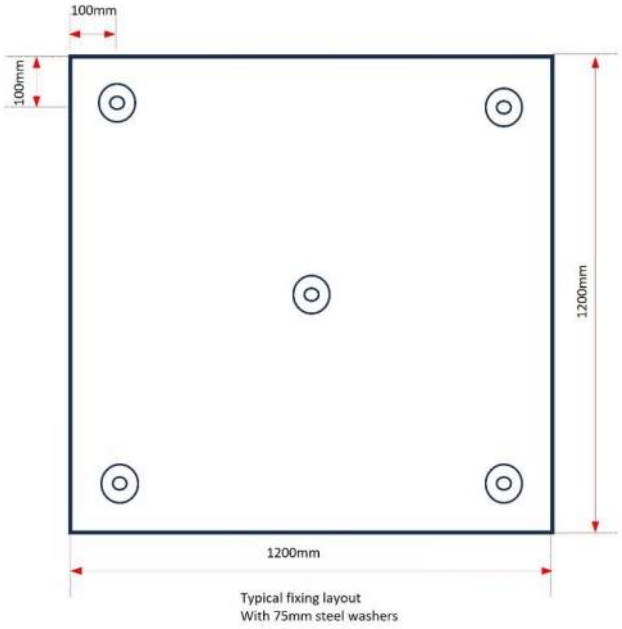
- In line with the NFRC safe2torch guidelines the use of torch applied waterproofing must be prohibited, IKO would recommend the use of the e-torch as a means of drying any timber structure without naked flames and the use of the IKO Ultra S-A Air and Vapour Control Layer being fully bonded to the CLT deck.

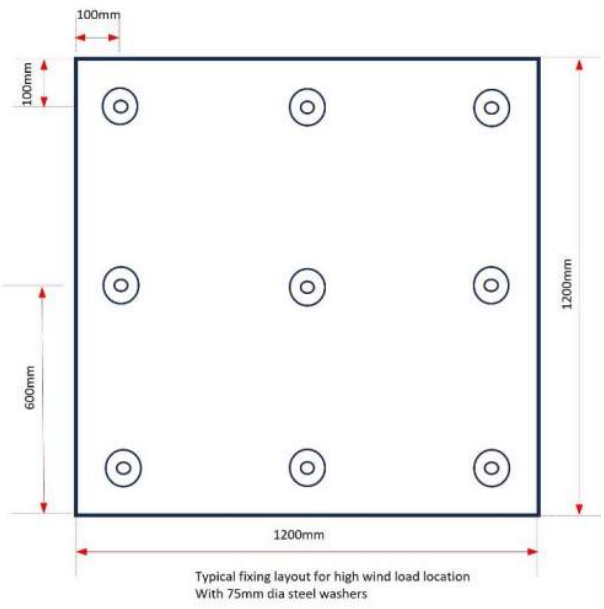
Where the moisture content of the CLT is high and inhibits the bond of the first waterproofing layer, the use of IKO Protectoboard being mechanically fastened with a minimum 5 - 9 No fixings with 50mm washers per board must be used. For small projects less than 100m then a nailing preparation membrane (minimum 175gsm polyester reinforced bitumen membrane) could be used.

This can be achieved by:
The inclusion with all specifications with CLT timber constructions the use of IKO Protectoboard should be used, unless an affective moisture plan has confirmed a suitable bond can be achieved directly to the CLT.

IKO Recovery board:

- IKO Protectoboard – for Reinforced Bitumen membrane systems
- IKO Permaguard-PB – for Permatec hot melt systems





The IKO specified waterproofing can be fully bonded directly to the IKO Protectoboard.

Where practical on smaller projects the use of a nailed first layer could be used, this can be either:

- IKO Ultra T-F underlay (Nailed) for where the IKO Ultra S-A Air and Vapour Control Layer has been specified, or
- IKO Ultra H-A underlay (Nailed) for where the IKO Ultra T-O Air and Vapour Control Layer has been specified.

The nailing patterns is to be undertaken in accordance with BS8217, whereby 20mm large headed clout nails are to be used at 150mm centre and 75mm to all perimeters throughout the membrane.

Note:
IKO will not be held liable for the degradation of CLT.

COMPOSITE ROOF DECKS

Composite boards consist of two or more different materials laminated together, and most include an insulation material.

Where used as a structural deck, the insulation is bonded to plywood or OSB3 panels. The composite boards are fixed with the plywood or OSB3 side uppermost. Noggins are essential for such products.

The underface has an integral foil /paper facing, which is normally intended to form and perform as a vapour control layer. To be effective in such cases, the foils must not be damaged, and foils on adjacent panels should be connected, by laying a sealant along all joists, noggins and other bearing timbers just before the panel is placed into position and fixed.

As the foam cores have relatively low compressive strength, the joists and noggins must all have adequate bearing surfaces, to ensure that the foam is not subjected to excessive loadings. For this reason, such constructions are not suitable for terrace roof areas.

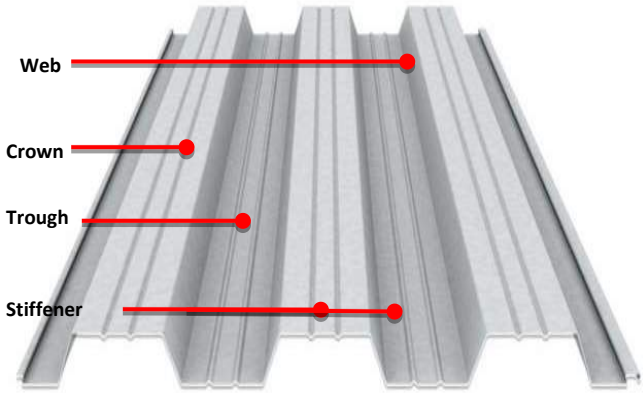
Corrosion-resistant round headed ring shanked nails or suitable screws should be used at
150mm centres around perimeters and 300mm on intermediate supports. The fixings should be long enough to penetrate at least 35mm into the supporting joists and noggins.

In all cases, the specific manufacturer's instructions on installation should be followed.

Note: composite boards do not form a conventional warm-decked construction, nor do they offer full protection against condensation risks. Hence, they are not suitable for use in high humidity roofs, e.g. above kitchens or bathrooms.

PROFILED METAL DECK

Profiled metal decks that are to support Built Up Roofing systems and their components, should be of a suitable profile where the crowns that are wider than the troughs. The trough span should not exceed 150mm, otherwise the vapour barrier may sag at the laps and adequate support will not be provided or the insulation.



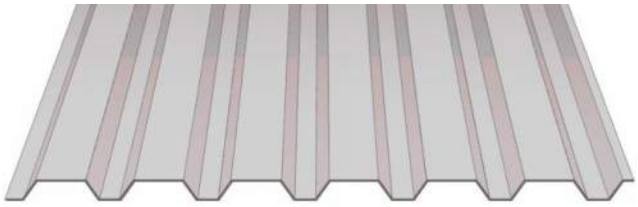
Metal roof decking minimum thickness **0.7mm for galvanised steel (BS EN 10147)** or **1.2mm for aluminium (BS EN 485-2) and in accordance with BS EN 1993-1-3** being installed in strict accordance with the manufacturers' instructions. The decking should be designed in strict accordance with the Metal Roof Deck Association "Code of Design and Technical Requirement for Light Gauge Metal Roof Decks." as well as being capable of supporting any dead and live loads acting upon it.

The lightweight construction has the advantage of being able to cope with very long spans, enabling large room spaces to be created and reducing the load on the building's structure.

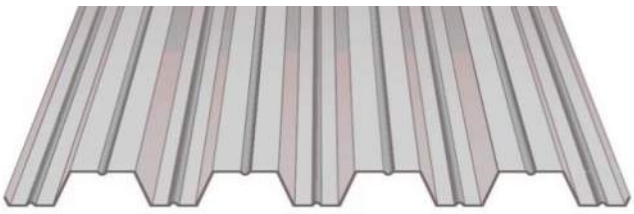
Metal deck profiles

There are wide varieties of profiled metal decks suitable for flat roofing and there selection could define how they are addressed.

Typical profiles:



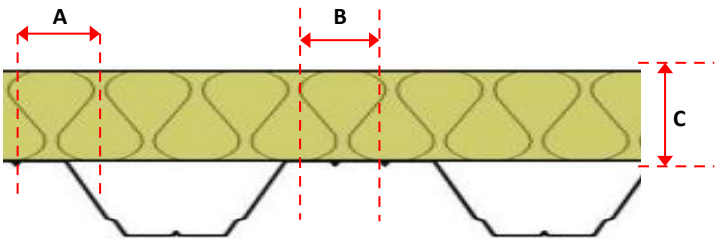
Without stiffeners



With stiffeners

The decking should be designed in strict accordance with the Metal Roof Deck Association "Code of Design and Technical Requirement for Light Gauge Metal Roof Decks." as well as being capable of supporting any dead and live loads acting upon it.

Profiled metal decking does not provide a continuous supported surface and therefore can only be used when supporting a timber deck or rigid insulation which can then be covered with a waterproofing membrane.



Maxiumum permissible spans between crowns for PIR insulation types are given in BS4841-1: 2006 as below:

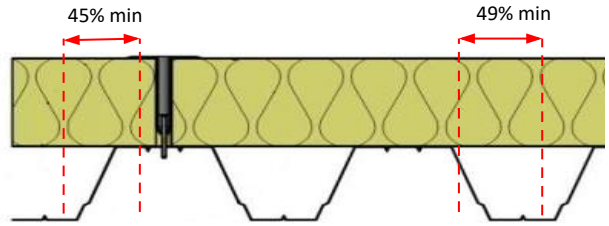
Maximum clear span (mm)		Maximum roofboard thickness (mm)
A	B	C
<75		25mm
>75	≤100	30mm
>100	≤125	35mm
>125	≤150	40mm
>150	≤175	45mm
>175	≤200	50mm
>200	≤225	55mm
>225	≤250	60mm

For mineral wool type insualtions for flat roofing, these should be a minumum 60mm thick

Whereby the miniumum board thickness is maxiumum trough width divided by 3, with a maximum of 300mm. where spans exceed these maximums, then the profiled metal deck should be overboarded with plywood or OSB/3 to fully support the insulation.

Type of metal deck profile must be considered.

Provide 49% crown support to the waterproofing, or a plywood/OSB3 over boarding should be specified for bonded systems, and 45% crown support for mechanically fastened systems.

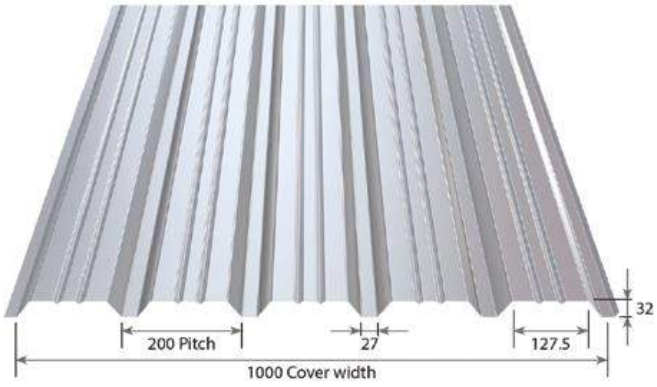


Mechanically fastened Adhered/bonded

Profiled metal deck types

Trapezoidal profiles

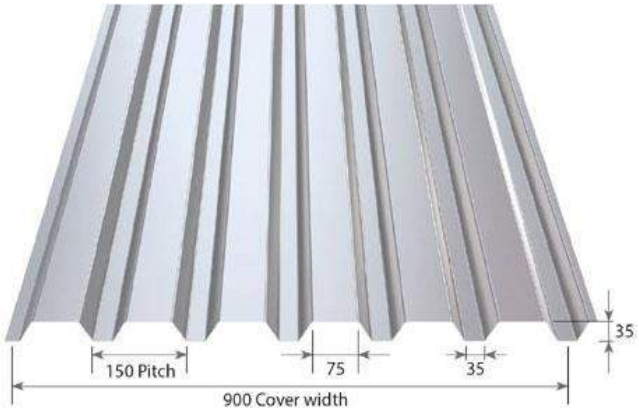
Roofdeck D32S



Roofdek D32S

- Economy profile for use on purlins
- Span range 1.2m to 2m
- Steel 0.9mm, aluminium 1.2mm
- Bonded surface area: 52% (without stiffeners) 64% (with stiffeners)
- Max load KN/m² : 2.55

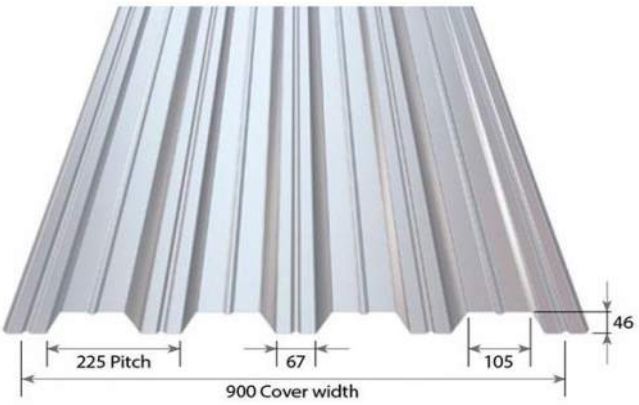
Roofdeck D35



Roofdeck D35

- Economy profile for use on purlins
- Span range 1.5m to 2.5m
- Steel 0.9mm, aluminium 1.2mm
- Bonded surface area: 5% (without stiffeners) 50% (with stiffeners)
- Max load KN/m² : 2.41

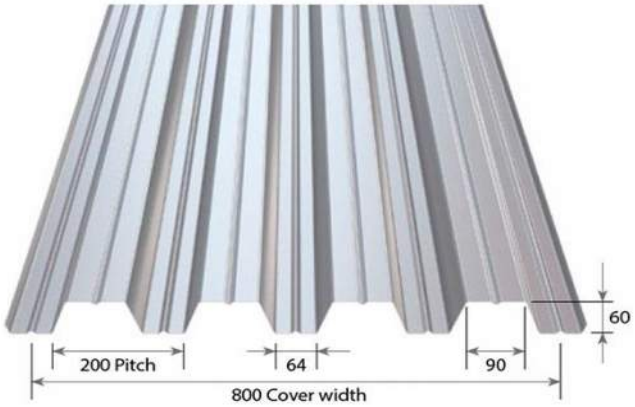
Roofdeck D46



Roofdeck D46

- Efficient deck for use on purlins or main steel
- Span range 2m to 3.5m
- Steel 0.9mm, aluminium 1.2mm
- Perforated version available
- Bonded surface area: 38% (without stiffeners) 47% (with stiffeners)
- Max load KN/m² : 2.30

Roofdeck D60

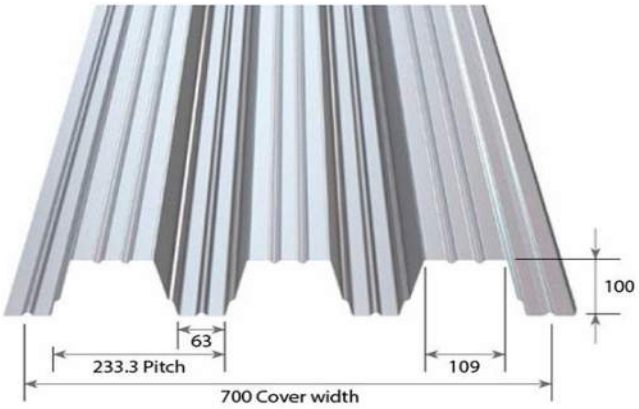


Roofdeck D60

- Strong mid span for use on purlins or main steel
- Span range 2.5m to 4m
- Steel 0.9mm, aluminium 1.2mm
- Perforated version available
- Bonded surface area: 37% (without stiffeners) 45% (with stiffeners)
- Max load KN/m² : 2.20

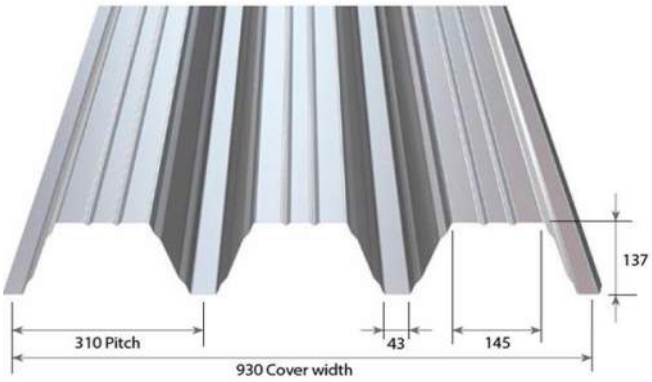
Decks between main frames

Roofdeck D100



Roofdeck D100

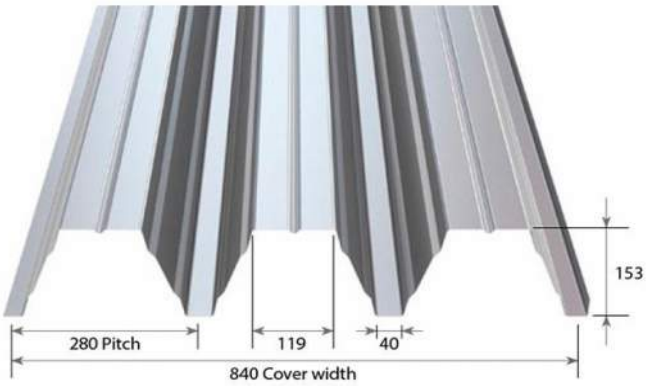
- Robust long span deck
- Span range 4m to 6m
- Steel 0.9mm, aluminium 1.2mm
- Perforated version available
- Bonded surface area: 34% (without stiffeners) 47% (with stiffeners)
- Max load KN/m² : 2.30



Roofdeck D137

- Optimised low deflection design
- Span range 4.5m to 7m
- Steel 0.9mm, aluminium 1.2mm
- Perforated version available
- Bonded surface area: 36% (without stiffeners) 47% (with stiffeners)
- Max load KN/m² : 2.30

Roofdeck D153

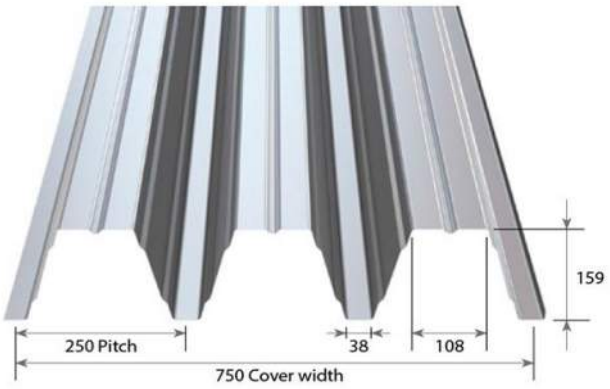


Roofdeck D153

- Big brother to D137 extended span range
- Span range 5m to 8m
- Steel 0.88mm, aluminium 1.25mm
- Perforated version available
- Bonded surface area: 35% (without stiffeners) 43% (with stiffeners)
- Max load KN/m² : 2.30

Roofdeck D137

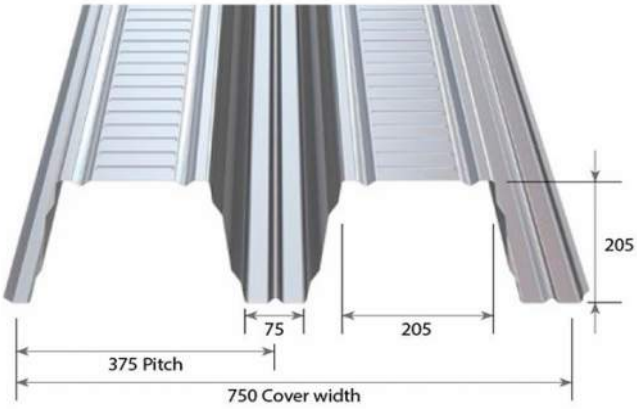
Roofdeck D159



Roofdeck D159

- Economy profile for use on purlins
- Span range 6m to 9m
- Steel 1.25mm, 1.5mm aluminium
- Perforated version available
- Bonded surface area: 34% (without stiffeners) 44% (with stiffeners)
- Max load KN/m² : 2.11

Roofdeck D200



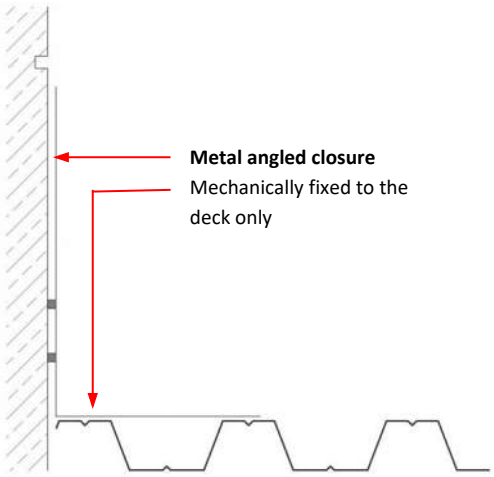
Roofdeck D200

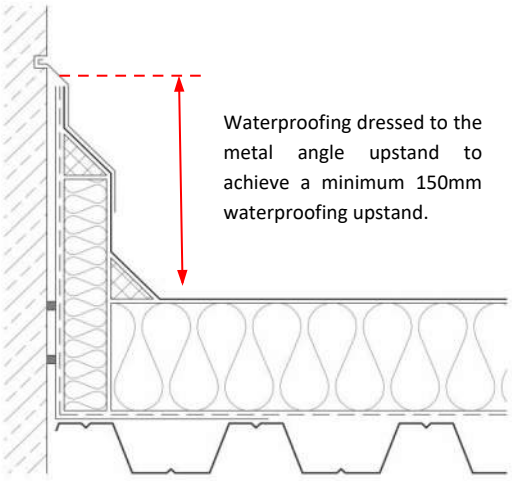
- Ultimate profile for use on purlins
- Span range 9m to 11m
- Steel 0.88mm, 1.25mm, 1.5mm
- Perforated version available
- Bonded surface area: 39% (without stiffeners) 55% (with stiffeners)

Closures

Metal decks are defined with roofing applications as lively decks. As such allowances must be made to allow for movement where metal decks abut wall constructions.

To achieve this, a metal angled closure is used where it abuts a wall. The angle is mechanically fastened to the deck only, and free standing against the wall junction. This is to allow for the dressing of any waterproofing membrane whilst maintaining allowance for movement between the two types of constructions.





Laying the Air and Vapour Control layer

When installing the Air and Vapour Control Layer, this must be laid in the direction of the crown of the profiled metal deck and laps fully supported on the crowns.

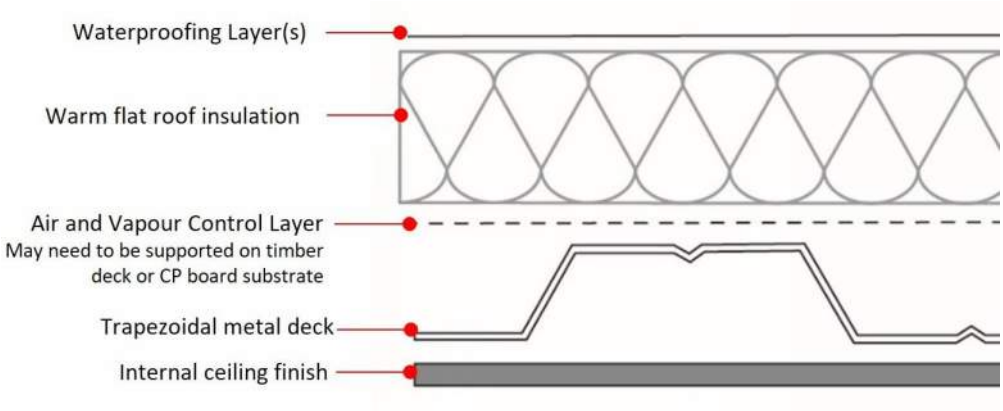
Key Points:

- **Type of deck**
  - **1.2mm minimum Aluminium or**
  - **0.7mm minimum Galvanised steel**
- **Profile of deck to provide 49% bonded surface (crown) area minimum or over ply required. 45% For mechanically fastened systems**
- **Method of waterproofing application (mechanically fastened or bonded)**
- **Closures in place**

Profiled metal deck warm roof constructions

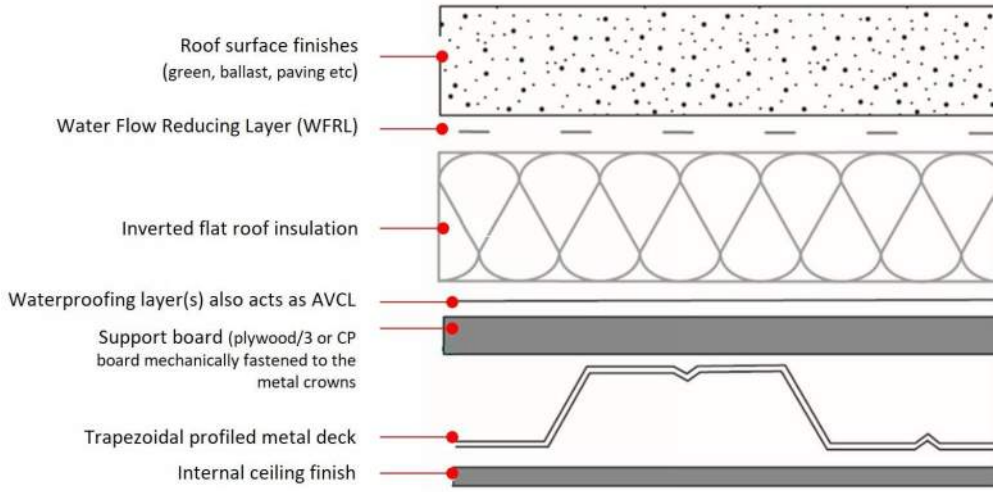
An Air and Vapour Control Layer is bonded to the crowns of the profiled metal deck to which must achieve a minimum bonded area of 45%.

The insulation may be bonded/adhered or mechanically fastened to the crowns of the profiled metal deck.



Profiled metal decks for inverted roof construction

Where the waterproofing system build up is for an inverted flat roof construction over a profiled metal deck. The profiled metal deck must have a support board layer mechanically fastened to the crowns of the profiled metal deck to provide a fully supported waterproofing installation.



CONCRETE DECKS

There are several types of concrete slab/decks and all should be treated separately when it comes to the application of the waterproofing layers.

The concrete slab/deck should be based upon a specification that has low shrinkage and has adequate strength and capability to span between its structural supports when fully loaded.

Types:

- Insitu cast concrete *(typically 150mm thick)*
- Precast concrete panels
- Beam and block

Concrete specification

Normal Weight and Lightweight concretes are suitable substrates for most IKO Waterproofing system applications. As defined in BS EN 206:2013, Normal Weight and Lightweight concrete shall have a density of 2000kg/m^3 - 2600kg/m^3 and 800kg/m^3 - 2000kg/m^3 respectively. Concrete density of 2000kg/m^3 - 2600Kg/m^3 will retain 3-5% moisture by volume when cured. Low density lightweight concrete will be likely to encounter adhesion difficulties due to the friable dusty nature of the surface.

The concrete should comply with the National Structural Concrete Specification for Building Construction guidance and that the finish should be 'Ordinary' with a cumulative global variation from the intended flatness of the surface of <9mm and that the overall defection will be <10mm.

The concrete surfaces shall be of sound structural grade, 3500 psi minimum and shall have a wood float or very fine broom finish, free of fins, ridges, voids or entrained air holes. A steel towelled finish or polished surface is not acceptable. All knots and dust must be removed and any ridge over 4.5mm will require further surface treatment.
The minimum grade of concrete should be M30 (C25/30)

The loading of the roof must be taken into account when designing the concrete mix, and any such loads taken into account of any potential deflection.

As with all types of concrete slabs/decks and their associated finishes, they all use water within their process and it is imperative this water is of a level that will not inhibit the bonding of the waterproofing, or result in entrapped moisture within the building fabric. Excessive moisture can cause major building fabric defects and potential premature failure of the building. Water should not be added to concrete on site, and if added on site should be deemed non-conforming until strength testing shows the concrete is acceptable.

As with all concrete and screed finishes it is critical that the substrate is allowed to fully cure and dry, prior to the application of any waterproofing.

Cast in situ concrete generally requires 28 days curing time before any waterproofing can be applied, and by this time the concrete would typically achieve 80% of its structural strength.

Once the substrate has cured and prior to the application of any waterproofing layer an adhesion test must be undertaken at regular intervals (50m^2) to ensure a suitable bond and adhesion can be achieved with the new proposed waterproofing system.

Tolerances concerning concrete slabs/decks

It is paramount for the waterproofing to be bonded to the concrete finish has been design and finished so no back falls are present. The handover of the concrete slab/deck to the roofing contractor should ensure the concrete has cured sufficiently and that the surface finish has no back falls or irregular surfaces.

Voids, cracks, holes, honeycombs and other damaged horizontal or vertical surfaces must be repaired before application of the waterproofing.

The suitability of a concrete slab/deck including any screed to receive a waterproofing system is also dependent upon the quality of the concrete/screed finish.

Providing a concrete slab/deck or screed with minimal surface irregularities to an acceptable tolerance and standard is highly important.

Table 2 of BS 8204-2 provides different classifications on finished wearing surfaces:

Class	max permissible departure
SR1	3mm
SR2	5mm
SR3	10mm

A flat roof concrete finish should be to SR2 (5mm) for most waterproofing applications and SR1 (3mm) for blue roofs.

Falls

It is difficult to form to provide drainage falls and as such may also need to have a suitable cementitious screed as necessary to achieve a minimum finished fall of 1:80. Or where a built up warm roofing system is being applied, the use of tapered insulation can be utilised to provide drainage falls in accordance with BS6229

BS6229: 2018 states that "**all flat roof surfaces including any formed internal gutters** should be designed with a fall of 1:40 (2.5%) to ensure finished drainage falls of 1:80 (1.25%) are achieved.

"This should take account of construction tolerances, permitted deviations and deflection under load, and account for deflections/settlement."

In other words, design should allow for all factors that could reduce or hinder the drainage eliminating the risk of ponding on roofs.

Ponding water adds a dead load to the roof structure and in exposed warm roofs increased stresses in the waterproofing layer.

Zero falls

Certain third-party certified waterproofing and insulating systems are approved for use with zero falls.

The standard, for the first time, defines a 'zero fall roof' as a roof with a slope, which lies between 0° and 1:80. This means that back falls and ponding are not acceptable, and in order to ensure a finished surface with a zero fall, a design of 1:40 should be used and a detailed structural analysis should account for construction tolerances, settlement and deflection under load. If there are negative falls, then remedial action should be taken e.g. localised screed or additional of rainwater outlets at the lowest point.

To prevent ponding caused by waterproofing system lap, build ups around rainwater outlets, rainwater outlets should be recessed into the slab/deck or fitted in sumps when it is practicable to do so.

As a result, the roofing contractor should expect a flat, properly drained surface on which to lay the specified system and the finished roof should not suffer from ponding or inadequate drainage.

It is no longer acceptable for a main contractor to provide roof decks with large depressions, back falls and non-draining areas.

Concrete Drying process

An indication of how slow the drying out process is can be gained from BS8203, which uses the rule of thumb that a screed will dry at approximately 1mm per day from one face. In well vented conditions with reduced drying rates as the process continues, such that a 50mm screed will take 2 months. The equivalent time for a slab 150mm thick is much slower and may take near 1 year to dry.

Curing

The rate at which concrete dries will depend on a number of factors but is mainly affected by climatic conditions and the water/cement ratio of the mix.

Normal weight concrete typically retains 5% moisture when fully cured and because lightweight concrete aggregates are pre-wetted prior to manufacture, their retained moisture content will tend to be higher, but may result in an extended drying time.

It is recommended an in-situ concrete deck is allowed to cure to ensure the concrete has achieved its structural design strength, usually 28 days, and prior to installing the waterproofing system.

Hardness: The surface compressive strength of cementitious substrates after preparation must be excess of 25N/mm² when tested with a rebound hammer.

Cohesive strength: The cohesive strength of the concrete when subject to adhesion tests must be excess of 1.5N/mm²

However, with the agreement of the Principle Contractor, the installation of the waterproofing system can commence earlier subject to a visual inspection and successful adhesion tests witnessed by IKO.

Concrete surface finishes

All concrete decks should meet the requirements of BS EN 1992 -1-1, BS 8204 -2 and BS EN 13670 and the National Structural Concrete Specification

In line with BS EN 13670, the execution of concrete structures, and finishes formed or unformed should meet

the requirements of the specification of the concrete roof slab/deck. The standard states:

1. After striking, that all surfaces shall be inspected in accordance with the execution class for conformity to the requirements.
2. The surface shall not be damaged or disfigured during construction.

This places the responsibility of the concrete slab/deck provider to ensure a standard finish in accordance to an agreed specification. It is therefore important that the surface finish to the specification required for the application of the waterproofing to which is **typically to a wood float finish**.

Decks suitable to receive the waterproofing system should be free from raised float marks or protruding aggregate which will cause potential thinning of any liquid coating/primer or lack of adhesion of the waterproofing system. Such blemishes will need to be ground flat prior to installing the waterproofing system.

Typical raised float ridge

A phenomenon termed 'reinforcement ripple' can occur where the skip-float action over the surface moves the mortar and coarse aggregate away from above the reinforcing bar. This can fail to return fully causing a slight depression to form over the reinforcing bar position and a slightly raised profile between the bars. Reinforcement ripple will not normally have a detrimental effect on the installation of waterproofing system but additional thickness of material will be required to fill the depressions.

Example of 'reinforcement ripple'

SURFACE DEFECTS

Laitance

The main causes of a failed Peel test is the presence of surface laitance (a thin layer of residue left after water evaporation) or dusting of the concrete surface

Laitance is always present on new concrete and must be mechanically removed. However, surface laitance is not to be confused with a poor quality concrete or screed that needs addressing in another way.

Laitance comes in varying degrees of thickness, from a fine dust to several millimetres or more, depending on contributing factors. Laitance may also be caused by over-trowelling, rain damage, or poor curing.

To determine the thickness of the laitance, contractors should score the surface of the substrate with a steel edge until reaching the main aggregate.

Proprietary scratch testing equipment is available which can be used as a guide to determining the depth of laitance.

If laitance is left untreated, the application of subsequent materials will have a high risk of failing.

Example of surface laitance

Surface dusting

There are a number of potential causes:-

- Premature surface moisture loss - this can occur particularly in summer months if the surface is allowed to dry out before sufficient hydration of the cement has taken place.
- Excessive Bleed Water affecting the Water/Cement ratio at the surface
- Frost shortly following placement which will affect the surface paste integrity
- Rain shortly after placement – similar affect to excessive bleed water affecting the water/cement ratio at the surface. Usually noticeable within the finished surface as dimples.

Curing techniques can also affect the bond of the waterproofing system and procedures involving spray- on waxes should be avoided or if used will need to be removed prior to application.

Laitance, dusting and curing materials are usually restricted to the surface only, but will need to be removed in order for the waterproofing system to achieve a suitable bond. Light mechanical brushing will normally be sufficient to prepare the surface. However, in more severe cases, shot blasting or scabbling will be required.

How do I test for laitance?

Here's the highly technical answer: scrape the surface of your concrete floor with a knife. "If a powdery material can be scraped from the surface, excessive laitance is present,"

To get a sense of how thick the laitance is, "Score the surface of the substrate with a steel edge until the main aggregate is reached,"

Then, how do I remove it?

There are several ways to remove laitance. The method depends on how much area the laitance is covering, how thick the layer is, and how detailed your work needs to be.

If laitance is thicker, mechanical planing may be preferred. Surface planers, also called scarifies or milling machines, remove the layer faster and more aggressively because "they use the pummelling action of multi-tipped cutting wheels that rotate at high speeds to chip away at the surface

Shot blasting is the fastest and most efficient form of laitance removal, especially in large areas. Shot blasting machines are available in varying sizes making them ideal for use on most surfaces, no matter the size. Using a shot blaster will allow up to 1000sq m of flooring to be prepared in just one day.

Mechanical planing is a method often used to remove greater thicknesses of laitance. Also referred to as concrete planing, the machines used carry rows of rotating cutters tipped with tungsten to provide an excellent removal of laitance.

Scrabbling, grinding and abrading are also recommended for removing laitance. Handheld grinding machines, designed for precision, control and safe operation are recommended for use in smaller areas and edge detail.

Successful preparation: Unless it has been removed by previous surface preparation techniques, laitance may still be present on old concrete and screeds.

Removal of surface laitance

Adequate adhesion of screeds, renders, concrete repairs and floor coatings/ membranes can only be achieved when correct substrate preparation has been carried out. Finishing of concrete and screeds by troweling, power floating or tamping will leave a layer of laitance on the surface which must be removed;

Some degree of surface texture is also required for adequate adhesion and mechanical preparation of the surface of the substrate will remove laitance and provide the required texture for good adhesion of screeds, renders, concrete repairs and floor coatings/ membranes. When floor coatings/ membranes are to be applied, surfaces should be lightly textured to ensure that a smooth finish to coatings can be achieved or to ensure that adequate coverage of high points in the substrate can be achieved by waterproof membranes.

Concrete out gassing

Concrete during its curing process may result in the phenomenon of out gassing (air bubbles in the primer), this may be caused by:

Where concrete is highly aggregate rich, subject to heavy preparation or re-profiling, plastic reinforcement fibres have been burnt back, or there are voids or capillaries near the surface, there is an increased risk of concrete outgassing which may result in pin holes or micro blisters in subsequent coatings.

Concrete releases air and water vapour as it cures when the temperature rises, and it is likely to absorb air and water vapour when the temperature falls. It is these changes in heat flow from hot to cold that may result in the concrete out gassing.

In these cases an alternative primer may be required and the concrete primed when the concrete and air temperature is cooling and when the concrete temperature is lower than the air temperature. Consult ourselves for specific recommendations.

To reduce and assist with preventing out gassing of the concrete it is important to monitor the air temperature and that of the concrete. Ensure that the air temperature is falling, and that the temperature of the concrete is lower than that of the air, thus resulting in the primer being drawn into the concrete as it cools.
Care should be undertaken during cold spells and cold weather applications that the temperatures of the air, the material and the substrate are within the specified materials application guidance. In such applications it should be allowed for undertaking the area being uninterrupted until the substrate is completely covered.

In location where air temperatures is restricted or sheltered such as basements or stairwells, it may be possible to apply the specified primer, and whilst still wet broadcast with IKO quarts sand (2kg/m²) and allowed to dry. Then sweep all loose quarts sand, prior to applying a second coat of primer and allow to dry thoroughly.

As such as direct sunlight will raise the temperature of the concrete as the day progresses, it would be recommend that any such application of the primer is undertaken as the sun starts to set and the temperatures start to drop.

It is therefore important that application temperatures are measured of the substrate, the material and the air temperature. Ambient temperatures should be between 5°C and 30°C.

Pyrite Contamination

Pyrite contamination in the aggregate can manifest on the surface of cementitious substrates and coated cementitious substrates in the form of rust staining and rust trails. All instances of corrosion at the surface should be investigated and where these do not relate to the steel reinforcement consult IKO for specific recommendations.

Concrete Repairs

The specification or use of generic sand and cement screeds is not recommended under any circumstance. As new non-polymer modified cementitious materials may also take significant time to hydrate and harden sufficiently, programme benefits can be achieved using either specialist resin based concrete replacement materials, polymer modified concrete or natural cement based products

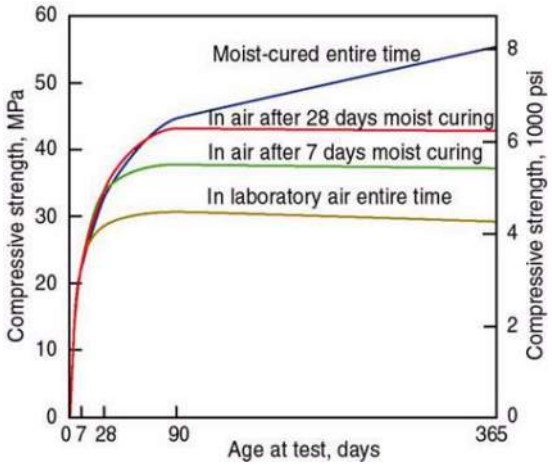
CAST IN SITU CONCRETE

Cast in situ concrete is where the concrete is delivered to site that is poured into a supporting formwork to create the mould to form the concrete structure.

As insitu concrete is a wet poured material that is typically in excess of 100mm thick will require typically 28days to provide a satisfactory cure for the application of a waterproofing covering to be applied to.

Concrete Drying process

An indication of how slow the drying out process is can be gained from BS8203, which uses the rule of thumb that a screed will dry at approximately 1mm per day from one face. In well vented conditions with reduced drying rates as the process continues, such that a 50mm screed will take 2 months. The equivalent time for a slab 150mm thick is much slower and may take near 1 year to dry.



As Insitu concrete involves the use of water within its mixture, this construction water must be drained by forming temporary drainage holes through the slab as specified in BS 6229.Excess water in concrete slabs and concrete decks cast in situ should be drained downwards through temporary drain holes formed in the area of maximum sag of the roof deck. Subject to checking their effect on structural strength, the holes should be not be less than 25mm diameter, positioned to avoid reinforcement bars in the concrete and at approximately 3m spacing.

The holes should not be re-filled before seepage and damp have ceased, but they should be filled with cement-sand mortar before finishing work on the ceiling is commenced. Precast concrete roof decking units with open joints are self-draining and holes are not required, but if the joints are to be subsequently sealed, they should be left open for as long as possible.

Roofs with permanent steel shuttering will take longer to dry out properly, and therefore mechanical extraction processes should be used, ideally before the waterproofing is installed. Reliance should not be placed on drying out trapped water by roof ventilators.

The cure of the Insitu concrete will result in irregular surface finish creating hollows and depressions, voids, cracks, holes, honeycombs that will need rectifying prior to the installation of any waterproofing.

Falls

It is difficult to form to provide drainage falls and as such may also need to have a suitable cementitious screed as necessary to achieve a minimum finished fall of 1:80. Or where a built up warm roofing system is being applied, the use of tapered insulation can be utilised to provide drainage falls in accordance with BS6229

Insitu concrete is more typically used for podium areas where the waterproofing system has been approved for use at zero falls (falls between 0° and 1:80°). Whereby there are no back falls. A design fall of 1:40 should be used and a detailed structural analysis undertaken should account for construction tolerances, settlement and for deflection under load. Where areas are found by a site level survey to have negative falls i.e. will hold water, remedial action should be undertaken e.g. localised screed or additional rainwater outlet.

To prevent ponding around rainwater outlets in inverted roof or uninsulated applications, these should be recessed or fitted with sumps, where practical.

Surface finish

The surface finish of insitu concrete needs to be acceptable for the application of the waterproofing layer. The surface finish must have a smooth wood float/easy float uniform finish and free from projections. Where this cannot be achieved a suitable screed may be required to provide a

suitable surface finish for the application of the waterproofing.

The surface of the deck/screed should be sufficiently cured and dried before the commencement of any waterproofing works, and free from any ridges or hollows.

Before priming and application of the new waterproofing system, the concrete substrate shall be clean and dry, free from surface water, ice, snow or frost, dust, dirt, oil, grease, curing compounds or any foreign matter detrimental to the adhesion of the new waterproofing.

Any scaling or laitance concrete must be sandblasted and scarified off.

PRECAST CONCRETE PANELS AND BEAM AND BLOCK

There are a wide range of precast beams and blocks for a range of applications, and these must be installed in accordance with the manufacturer's guidelines.

These units are usually manufactured off site in factory conditions and as such less prone to defects.

Precast concrete products should conform to BS EN 13369: common rules for precast concrete products.

Typically used for smaller span constructions to those for precast concrete panels with easier site handling, making them quick and easy to install on site. They require no formwork for their installation.

A suitable cementitious screed is then applied to fill the joint and as necessary to achieve a minimum finished fall of 1:80, or where the surface is not sufficiently smooth/level.

The screed finished surface must be adequately clean, dry and free from surface water, ice, snow or frost, dust, dirt, oil, grease, curing compounds or any foreign matter detrimental to the adhesion of the waterproofing.

BEAM AND BLOCK

There are a wide range of precast beams and blocks for a range of applications, and these must be installed in accordance with the manufacturer's guidelines.

Typically used for smaller span constructions to those for precast concrete panels with easier site handling, making them quick and easy to install on site. They require no formwork for their installation.

Beam and block deck construction are where a preformed concrete beam support structure is infilled with cement/brick blocks to create a suspended slab/deck.

A suitable cementitious screed is then applied to fill the joint and as necessary to achieve a minimum finished fall of 1:80, or where the surface is not sufficiently smooth/level.

The screed finished surface must be adequately clean, dry and free from surface water, ice, snow or frost, dust, dirt, oil, grease, curing compounds or any foreign matter detrimental to the adhesion of the waterproofing.

CONCRETE CURING COMPOUNDS

Where concrete may cure to quickly, the concrete may not have reached its specific strength requirements. This can have serious consequences on the quality of the concrete. To reduce or prevent the concrete from curing to quickly from the loss of moisture content, a concrete surface compounds are sometimes used to slow this process down.

There are many curing compounds that can be added to the concrete when it is mixed for various performance requirements; there are also others that are applied to the surface of the concrete to assist with its cure, it is these that must be suitable for the application of the waterproofing system.

Concrete curing compounds for a membrane when applied to fresh concrete. This does not allow the moisture to come out of the concrete; hence the curing of the concrete occurs.

So why are these compounds necessary?

Weather conditions, particularly hot dry weather during the works may be required to prevent the concrete drying out to quickly. British standard BS EN 13670 – execution of concrete structures, whereby section 8.5 Curing and Protection provides guidance on these requirements.

- Curing compounds are not permitted on construction joints, on surfaces to be treated or surfaces where bonding of other materials is required, unless they are fully removed prior to the subsequent operation, or are proven to have no detrimental effects on the subsequent operations.
- Curing compounds shall not be used on surfaces with special requirements for the surface finish unless they are proven to have no adverse effect.

It is therefore assumed that surface curing compounds are likely to have detrimental and adverse effects, so it is highly important that the type used is suitable for the application of the waterproofing.

Surface compounds can come as transparent or pigmented (typically white or grey), to which are better for identifying the areas covered and heat reflectance.

Types of surface curing compounds

1. Synthetic resin based
2. Acrylic based
3. Wax based
4. Chlorinated Rubber based

Whichever waterproofing system is being proposed, it is critical that any concrete curing compound is suitable for the application of the waterproofing, for this you should check with the relevant manufacturer's guidelines.

ADHESION AND MOISTURE READING TEST.

It is highly important that all substrates and surfaces where a waterproofing system component is being applied must be suitable to allow the waterproofing application to provide a satisfactory level of adhesion

The whole roof area, where the waterproofing is to be applied is to be prepared in accordance with the specification. Substrates will vary in terms of the specific requirements to test the area for:

- Adhesion test.
- Moisture content

All substrates must be clean, dry and free from grease, curing compounds, laitance, dirt, silt and other contaminants. Any irregularities and loose material or other condition that may be detrimental to the adhesion to the substrate must be removed prior to undertaking any test area.

ADHESION TESTS

An adhesion test is done to determine substrate compatibility. A key attribute for waterproofing overlays is the bond achieved between the substrate and first waterproofing layer.

IKO recommends test procedures outlined below be performed on roofs prior to the application of any IKO waterproofing system. Running these tests will help ensure that the waterproofing will adhere properly once installed

Substrates need to be free of moisture, debris and contamination before the adhesion tests. To test for cleanliness, press a 100mm long piece of 50mm tape to the cleaned and dried roof using hand pressure. Then, peel the tape off the roof. If it comes off easily, and or is laden with dirt, degraded roofing material and other particulates, the roof is not cleaned satisfactorily. Re-clean and dry the roof and repeat this test. This test should be conducted in several areas around the roof, especially in ponded or other dirty areas

Undertake a number of adhesion tests to satisfy and determine if adhesion can be obtained to the prepared substrate.

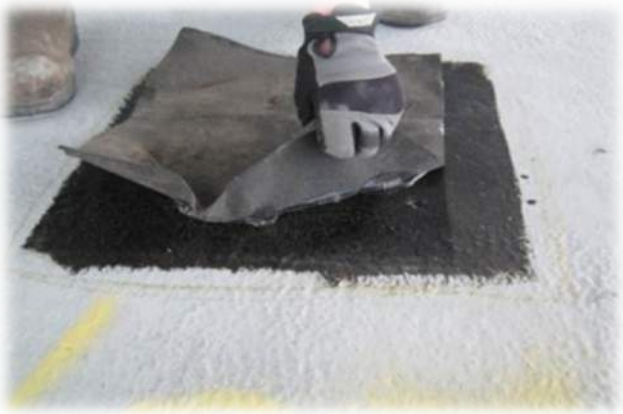
The test area should be a minimum 300mm x 300mm square area. The test area must be allowed to fully cure, prior to the adhesion test being carried out.

The adhesion tests must be undertaken at locations over the whole roof area at max 50m² centres and must be undertake at all locations where the substrate is different or has undertaken any form of mechanical abrasion and preparation, this is to ensure all areas are suitable for the application.

Each are must be suitably prepared and clean and dry before any adhesion test is undertaken. The findings must be recorded by the installing contractor.

Where adhesion is not achieved, IKO must be contacted immediately.

The type of test we recommend is to apply the specified primer, if required, and when sufficiently cured to apply a 300mm x 300mm test area utilising either (a 100mm strip of the waterproofing membrane or liquid coating with a 100mm strip of woven reinforcement embedded), dependent upon the waterproofing specified.



Where undertaking an adhesion test, the pull off should confirm where the mode of failure occurs. I.e. has the primer pulled away from the substrate suggesting an issue with the surface or primer used?

Adhesion tests on new concrete are critical, removal of surface laitance is highly critical to ensure suitable adhesion can be achieved.

Scarifying the concrete surface to remove the laitance is required before a test area can be undertaken.

Area should be primed with the specified primer, allowed to dry thoroughly prior to the application of the specified first waterproofing layer. Allow to cool and cure before undertaking the pull off test.

Embed a strip of polyester fabric into the roof coating and allow to cure completely

Pull free end. Should the coating be freely removed from the substrate then a primer should be considered and re tested.

A good adhesion will require some amount of force to remove the test sample.

After curing (up to 7 days for liquids), the strip is connected to a simple luggage weighing scale.

The carrier strip should then be pulled at 90° to the substrate, noting the force reading on the scale. It is important to note where the strip becomes detached known as the "mode of failure". This might be at the substrate which may delaminate. Providing the force is greater than 3.5Kg then this is adequate for the minimum recommended adhesion required.

Another method more frequently used is by using a sharp knife, cut through to the substrate making two cuts in the shape of a "V". The point of the V should then be peeled back. If no coating is removed or split cohesively, leaving a layer of coating on the surface, then the adhesion could be considered suitable.

Adhesion test

MOISTURE READING OF SUBSTRATES:

Concrete, screeds, masonry and brickwork surfaces should be smooth and flat. Any raised areas or protrusions must be mechanically removed and areas filled to a flush finish as required. New concrete surfaces must be cured for a minimum of 28 days prior to application of the waterproofing first layer.

The substrate shall have a maximummoisture content of 6% or 75% relative humidity, and be prepared as required to provide adhesion of the system to the substrate with a minimum bond strength of 116 psi (0.8 N/mm^2). Determinations of adhesion, bond strength and moisture content shall be performed periodically by the contractor throughout the course of work at locations over the whole area to be waterproofed.

Moisture readings can be undertaken by using a **Tramex CME4** concrete moisture meter

Moisture content reading should be within 6%

Pull out tests

Where installing a mechanically fastened insulation board or waterproofing membrane, pull out tests must be carried out by an approved fixing supplier. A minimum of 6 pull out tests should be carried out for each 1000m² areas, thereafter in accordance with ETAG006. The result must be confirmed the fixing supplier to ensure they can provide the correct type of fixing for the substrate.

Disclaimer

Whilst every precaution is taken to ensure that the information given in this literature is correct and up to date it is not intended to form part of any contract or give rise to any collateral liability, which is hereby specifically excluded.

IKO reserve the right to amend and/or withdraw this document without notice.

Users of published guidance for the installation of IKO materials should therefore verify with the company whether any changes in our specification, application details, withdrawals or otherwise have taken place since this literature was issued.