Preparation of In-situ Concrete Decks

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/m³ - 2600kg/m³ and 800kg/m³ - 2000kg/m³ respectively. Concrete density of 2000kg/m³ - 2600Kg/m³ 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 (50m²) 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

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 1:80 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

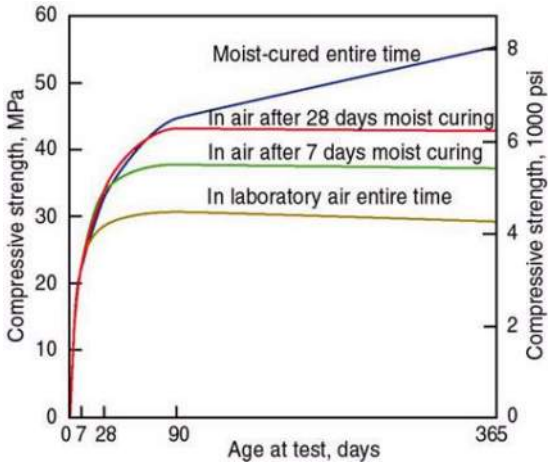
CAST IN SITU CONCRETE

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 is 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.

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.

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.

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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.

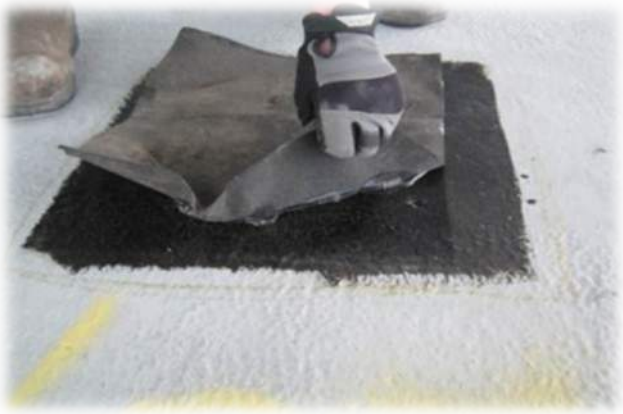
The test area should be a minimum 300mm x 300mm square area. The test area must be allowed to fully cure, prior to the adhesion test being carried out.

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.