S16/22 TECHNICAL GUIDANCE

GUIDANCE FOR THE ATTACHMENT OF SINGLE PLY ROOFING SYSTEMS TO CONCRETE DECKS AND ROOF SLABS

Ensuring that clients obtain high quality, polymer-based single ply roofing through a partnership of quality assured manufacturers and contractors.

SPRA
Single Ply Roofing Association

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1. INTRODUCTION

This guidance document relates to the use of a concrete deck or structural, reinforced concrete roof slab to support an air and vapour control layer (AVCL), thermal insulation, waterproof covering and additional finishes where applicable – these include ballast, blue and green roof systems, and paving slabs.

CONCRETE DECK

Concrete deck is used when referring to beam-and-block type constructions, in which inverted, precast concrete 'T' beams are supported by perimeter walls and internal load bearing walls, with lightweight concrete blocks positioned between them. Beam depths and profiles are selected according to span and loading requirements, along with the type of block specified. A sand-and-cement grout is often brushed over the surface, filling any gaps, providing a good load distribution and avoiding movement in the blocks. The grout assists with air tightness also.

CONCRETE ROOF SLAB

Concrete roof slab is used when referring to structural, reinforced concrete roof slabs that are either cast in-situ with permanent or temporary formwork, or pre-cast. With cast in-situ concrete roof slabs, concrete is mixed to the required grade at an external plant, or on site; transported to roof level; and poured into suitably constructed formwork. With pre-cast concrete roof slabs, concrete elements are cast in a factory (usually off site); transported to the site; and hauled, placed and secured into position to form the roof substrate.

Depending upon the design approach, a concrete deck or roof slab is required to not only support the weight of these layers, but also to provide a suitable substrate for either mechanical attachment, or direct adhesion in the case of an AVCL or waterproof covering installed directly to its surface. In some cases (again depending upon the design approach), a concrete deck or roof slab may have to be suitable for both mechanical attachment *and* direct adhesion of subsequent layers, for example in hybrid systems. The mechanical attachment and/or direct adhesion of an AVCL, thermal insulation or a waterproof covering to a concrete substrate requires careful consideration to ensure the integrity and safety of the roofing system.

Structural concrete roof slabs can be classified as reinforced (cast in-situ with permanent or temporary formwork), pre-cast, pre-stressed or lightweight aerated. Each will have a different effect upon contract period, cost and performance.

The following sections of this document provide guidance to building designers, main contractors and specialist single ply roofing contractors, as well as others who are involved in any way with concrete decks or roof slabs as the supporting substrate for a flat roofing system with a single ply membrane waterproof covering.

2. RELEVANT STANDARDS, CODES AND LITERATURE

- **BS 5250:2021** Management of moisture in buildings. Code of practice
- **BS 6229:2018** Flat roofs with continuously supported flexible waterproof coverings. Code of practice
- **BS 8000-0:2014** Workmanship on construction sites. Introduction and general principles
- **BS 8203:2017** Code of practice for installation of resilient floor coverings
- **BS 8204-1:2003+A1:2009** Screeds, bases and in situ floorings. Concrete bases and cementitious levelling screeds to receive floorings. Code of practice
- **BS 8204-2:2003+A2:2011** Screeds, bases and in situ floorings. Concrete wearing surfaces. Code of practice
- **BS 8217:2005** Reinforced bitumen membranes for roofing. Code of practice
- **BS 9999:2017** Fire safety in the design, management and use of buildings. Code of Practice
- **BS EN 1991-1-1:2002** Eurocode 1. Actions on structures. General actions Densities, self-weight, imposed loads for buildings
- **BS EN 1991-1-3:2003+A1:2015** Eurocode 1. Actions on structures. General actions. Snow loads
- **BS EN 1991-1-4:2005+A1:2010** Eurocode 1. Actions on structures. General actions. Wind actions
- **NA+A2:14 to BS EN 1992-1-1:2004+A1:2014** UK National Annex to Eurocode 2. Design of concrete structures. General rules and rules for buildings
- **NA to BS EN 1994-1-1:2004** UK National Annex to Eurocode 4. Design of composite steel and concrete structures. General rules and rules for buildings
- **BS EN 12056-3:2000** Gravity drainage systems inside buildings. Roof drainage, layout and calculation
- **BS EN 12620:2002+A1:2008** Aggregates for concrete
- **BS EN 13670:2009** Execution of concrete structures
- **BS EN 13859-1:2014** Flexible sheets for waterproofing. Definitions and characteristics of underlays. Underlays for discontinuous roofing
- **BS EN 13956:2012** Flexible sheets for waterproofing, Plastics and rubber sheets for roof waterproofing. Definitions and characteristics
- **BS EN 13970:2004** Flexible sheets for waterproofing. Bitumen water vapour control layers. Definitions and characteristics
- **BS EN 13984:2013** Flexible sheets for waterproofing. Plastic and rubber vapour control layers. Definitions and characteristics
- **BS EN 16002:2018** Flexible sheets for waterproofing. Determination of the resistance to wind load of mechanically fastened flexible sheets for roof waterproofing
- **PD 6682-4:2003** Aggregates. Lightweight aggregates for concrete, mortar and grout. Guidance on the use of BS EN 13055-1
- **Department for Education** Reinforced Autoclaved Aerated Concrete: Lightweight Concrete Roofs
- **LABC Warranty** Technical Manual Version 10
- **NHBC Standards (2021)** Chapter 7.1 Flat roofs, terraces and balconies
- **Premier Guarantee** Technical Manual Version 14
- **SCOSS Alert | May 2019** Failure of Reinforced Autoclaved Aerated Concrete Planks
- **SPRA Technical Guidance S15/ 19** Site Pull-Out Protocol for Flat Roofs

3. DESIGN CONSIDERATIONS FOR CONCRETE DECKS AND ROOF SLABS

3.1 GENERAL

Flat concrete decks and roof slabs should meet the design requirements in terms of durability and strength, and also conform to the requirements of NA+A2:14 to BS EN 1992-1-1:2004+A1:2014 *UK National Annex to Eurocode 2. Design of concrete structures. General rules and rules for buildings.*

Information on the span capability and installation requirements of pre-cast panels can be obtained from manufacturers. Pre-cast panels installed to a fall can provide a simple layout, but without cross-falls. Cast in-situ concrete is more difficult to lay to a fall and it is more common to create falls in the insulation (warm roofs only), or by use of an additional screed. Bitumen-bound screeds are not compatible with single ply membranes generally, though the direct installation of a single ply membrane to a screed is uncommon. Information on the required locations of movement joints should be obtained early in the design process, as they have implications for drainage layout and detailing.

3.2 CONCRETE ROOF SLAB TYPES

Concrete slabs for flat roofs are split into two types generally:

- **Cast In-Situ** Concrete mixed to the required grade at an external plant, or on site; transported to roof level; and poured into suitably constructed formwork. Formwork can be permanent or temporary.
- **Pre-Cast** Concrete elements cast in a factory (usually off site); transported to the site; and hauled, placed and secured into position to form the roof substrate.

3.2.1 PERMANENT FORMWORK FOR CAST IN-SITU CONCRETE ROOF SLABS

Permanent formwork – usually profiled steel – significantly prolongs the drying time required to achieve an acceptable moisture content of a concrete roof slab before applying a waterproof covering. Perforated formwork can assist drying out – any perforation should be factory made. A dehumidifier or mechanical extraction can assist the drying process also.

3.2.2 REQUIREMENTS OF CAST IN-SITU CONCRETE ROOF SLABS

Cast in-situ, reinforced concrete roof slabs should:

- Be constructed accurately using adequately supported formwork
- Have a low-shrink concrete mix specification
- Be free of additives, admixtures, or surface treatments that could be detrimental to achieving an adequate adhesive bond for the AVCL or waterproof covering
- Be cured properly to meet the designed durability and strength requirements, and to ensure trapped moisture is avoided
- Adequately dried to enable the direct adhesion of the AVCL or waterproof covering
- Be installed to provide an even surface with no back falls

3.2.3 REQUIREMENTS OF PRE-CAST CONCRETE ROOF SLABS

Pre-cast concrete roof slabs should:

- Be installed on an even and true supporting structure
- Have a minimum 90mm bearing
- Have allowance for continuity or anti-crack reinforcement
- Have allowance for movement approximately every 15m and at abutments
- Be installed to provide an even surface with no back falls
- Be grouted flush

3.3 ADEQUATE STRENGTH

A flat concrete deck or roof slab should be based on a mix specification that has low shrinkage characteristics, giving adequate strength and the capability to span between the supporting substructure points when fully loaded. This includes taking into account all loading in accordance with the relevant codes and standards.

3.3.1 ADDITIONAL LOADING: WARM, INVERTED, BALLASTED, BLUE AND GREEN ROOFS

A concrete deck or roof slab must support the warm roofing system build-up of AVCL, thermal insulation and waterproof covering and – in the case of inverted, ballasted, blue and green roof systems – must be capable of supporting the additional dead loads applied by paving slabs, ballast, blue roof system components, growing media and foliage as necessary. These additional dead loads must be considered along with the wind loads to which a building is subjected, which are determined by its parameters and precise location. The structural design should take into account the additional loading applied by growing media saturation, snow and – in the case of blue roofs – water attenuation.

3.4 FALLS

BS 6229:2018 *Flat roofs with continuously supported flexible waterproof coverings. Code of practice* states that the design fall for a concrete deck or roof slab should be 1:40 to enable a minimum finished fall at any point of 1:80 to be achieved when the roof is completed, loaded and in service. If the concrete deck or roof slab does not achieve the required minimum finished fall once laid or poured, additional measures must be taken to ensure that these requirements are met. There is an exception to this requirement for roofing systems that require zero falls, for example blue roofs, in which a finished fall between 0 and 1:80 should be achieved when the roof is completed, loaded and in service, with no back falls. Please see section *3.4.3 Zero Falls* below for further information.

3.4.1 CONCRETE ROOF FALL DESIGN

BS 6229:2018 states that a minimum finished fall at any point of 1:80 (1.25%) should be achieved, which includes any formed internal gutters. Since adjoining roof planes at 1:80 will meet at a mitre of less than 1:80, the intended finished fall at such intersections should be considered at an early stage.

Design falls should take into account any construction tolerances and potential deflection. In the absence of detailed calculation, this may necessitate design falls of twice the minimum finished falls (1:40 or 2.5%). Tapered insulation systems are often manufactured to a fall of 1:60 (1.7%) or 1:40 (2.5%). Again, it must be noted that adjoining roof planes at 1:60 will meet at a mitre of less than 1:80 (actually 1:85). Where tapered insulation is specified, typically it is assumed that the substrate

is level, so it is necessary to ensure that the 1:80 minimum finished fall as built is achieved by overcoming construction tolerances and/or correcting deflections in the concrete deck or roof slab.

Additional consideration should be given to:

- The available upstand height at the high end of the falls. This may be a limiting factor on the length/size of the roof area to be drained. Additional rainwater outlets may offset the cost of an increased roof zone depth and tapered insulation can be used to create the falls and improve the thermal performance, reducing the maximum roof zone depth.
- Avoidance of ponding behind wide obstructions to the drained slope, such as plant plinths or roof lights.
- Avoidance of gutters by designing with intersecting roof planes.

3.4.2 AVOIDING PONDING ON FLAT ROOFS

Since the primary function of a roof is to exclude water, it is important to consider how best to direct this into the drainage system. Ponding on flat roofs should be avoided because:

- It encourages the deposition of dirt and leaves, which can be unsightly, may obstruct outlets and/or become a slip hazard.
- In the event of damage, the interior will suffer increased water ingress.
- The load may cause progressive deflection of the deck.
- Algae or ice may create a slip or wind hazard, particularly on walkways.

Independent research has shown that roofs with extensive ponding require increased maintenance input.

Maintenance staff working on electrical equipment located at roof level also face an increased safety hazard in the event of any localised ponding of rainwater due to insufficient roof falls.

Membranes are tested for water absorption and watertightness at seams as part of third party certification. However, the construction process – including the laying of components and the forming of seams and temporary seals – is clearly facilitated in dry, well drained conditions.

3.4.3 ZERO FALLS

'Zero falls' are defined in BS 6229:2018 as falls between 0 and 1:80 (1.25%). Zero falls are acceptable in some single ply roofing systems, provided they have third party certification (e.g. BBA, or similar) and are used in a ballasted situation where the membrane is not exposed, to avoid some of the conditions in *3.4.2* (above) arising. **Zero falls roofs must not have any back falls, as this is unacceptable.** If back falls are evident, areas concerned should be highlighted and corrected before commencement of roof waterproofing. Any areas of risk should be identified by a qualified engineer through a detailed structural analysis and the deck installer should then carry out a deck level survey after corrective action has taken place to confirm no back falls exist. Means of correcting back falls include additional recessed outlets in required locations, or screeding to falls locally to eliminate the condition in the affected areas.

3.4.4 WAYS TO CREATE FALLS ON CONCRETE ROOFS

Roof falls may be created either during the construction of the deck, or alternatively by the use of tapered insulation systems. The former has the advantage that the AVCL will be to falls also and will act as a temporary line of defence to water ingress during construction. The default design option is a deck to fall. With concrete deck or roof slab constructions, this can be more difficult to achieve than with other deck types. This can be due to the practical considerations of forming a concrete deck or roof slab. Section 10 and Annex G of BS EN 13670:2009 *Execution of concrete structures* provide information on the geometrical tolerances related to concrete decks and roof slabs and the maximum allowable deviations. The finished deck or roof slab must meet the minimum fall requirements of BS 6229:2018 when fully loaded.

Falls can be created in the concrete deck or roof slab in any of the following ways:

- In-situ concrete roof slab to falls
- Pre-cast concrete panels set on a structure to falls
- Screed to falls on concrete deck or roof slab

3.4.5 INTERNAL ROOF GUTTERS AND FALLS

Internal roof gutters are required to have a minimum finished fall of 1:80 in accordance with BS 6229:2018 also to ensure that rainwater runs to the outlet(s) and is removed from the roof as quickly as possible.

4. CONCRETE ROOF SLABS AND SCREEDS CURING PROCESS

It is important to be aware of the moisture content of a concrete roof slab or screed, as excessive moisture that is trapped within can cause a number of issues that are detrimental to the overall quality of the finished roofing system, which may not be immediately apparent until some time after installation is complete. These include the corrosion of metal products, degradation of materials, loss of adhesion of roofing layers, mould growth, or even total system failure in extreme cases.

Surface dryness of a concrete roof slab or screed can be misleading, as excessive moisture can still be retained within one that is apparently dry at the point of installing the roofing system above. Cast in-situ concrete roof slabs typically require 28 days' curing time before any roofing system can be installed. This is a general rule by which the concrete should have achieved a minimum of 80% of its full structural strength. Guidance may be found in BS EN 13670:2009 *Execution of concrete structures*, or through information provided by the manufacturer or installer of the concrete roof slab or screed.

An indication of how slow the curing process is can be gained from BS 8203:2017 *Code of practice for installation of resilient floor coverings*, which uses the rule of thumb that a screed will cure at a rate of approximately 1mm per day (from one face) in well ventilated conditions, with reduced curing rates as the process continues, such that a 50mm thick screed will take some two months to cure fully. The curing rate for a structural roof slab is expected to be much slower and may be nearer one year for a 150mm thick roof slab to cure fully. Therefore, rapid construction with cast in-situ concrete on permanent formwork should be avoided, the preferred options being the use of perforated formwork or (as recommended in BS 6229:2018 *Flat roofs with continuously supported flexible waterproof coverings. Code of practice*) by temporary cover above the roof to enable full curing of the roof slab or screed.

5. CONCRETE DECK AND ROOF SLAB SURFACE FINISHES

5.1 GENERAL

5.1.1 MEETING THE REQUIRED SURFACE FINISH

In line with BS EN 13670:2009 *Execution of concrete structures*, any finishes formed or unformed should meet the requirements of the execution specification of a concrete deck or roof slab.

The standard also states:

8.6 (1) After form striking, that all surfaces shall be inspected in accordance with the Execution Class for conformity to the requirements,

8.6 (2) The surface shall not be damaged or disfigured during construction.

This places responsibility on the concrete deck or roof slab provider to ensure a standard of finish in accordance with an agreed specification. It is extremely important, therefore, that the surface finish required by the AVCL or waterproof covering manufacturer is communicated well in advance and becomes part of the execution specification for the concrete deck or roof slab.

As the AVCL or waterproof covering may be in direct contact with the concrete deck, roof slab, or any cementitious screed, the finished concrete deck, roof slab, or screed surface is an important consideration. The required surface finish should be achieved using a steel trowel, provided it is free of any ridges or nibs, or a wooden float. The finished surface should be allowed to dry out adequately before applying any subsequent roofing layers.

Equally, it is critical that a concrete roof slab has cured properly to ensure that the correct performance levels in service are achieved and this means that the concrete should be controlled in terms of moisture and temperature during the curing process. Often the concrete is kept wet during the early part of the curing period. This can lead to issues on site, as the specialist roofing contractor requires an adequately dry surface before commencing installation of the AVCL or waterproof covering. It is, therefore, critical that the requirements necessary for an adequately dry, suitable surface before waterproofing works commence are understood by all parties involved in the construction process. Weather conditions can heavily influence the drying out process also and, therefore, need to be allowed for.

5.1.2 TEST TO ENSURE ADEQUATE BONDING

Where the specification calls for either the AVCL or waterproof covering to be directly bonded to the finished concrete deck, roof slab, or cementitious screed, an adhesion test should be performed to confirm the acceptability of the substrate for the adhesion of the AVCL or waterproof covering with regards to dryness and whether the surface has laitance issues. Refer to *Appendix 2: Method for Completing an Adhesion Test on a Concrete Deck, Roof Slab, or Screed.*

5.2 SCREEDS AND STRUCTURAL TOPPING LAYERS

5.2.1 SCREEDS FOR CONCRETE DECKS AND ROOF SLABS

The materials used for screeds should comply with the relevant standards where one exists and to any recommendations made in that standard. Proprietary materials are available for forming dry, insulating and levelling screeds, but are not currently covered by a British Standard.

There are, however, British Standards and Published Documents available covering the following types of screeds. These should be consulted in relation to screeds of related types:

- **BS 8204-1:2003+A1:2009** Sand and cement
- **BS EN 12620:2002+A1:2008** No-fines concrete
- **PD 6682-4:2003** Lightweight aggregates (foamed slag, clinker)

Although direct bonding to an adequately dry cementitious screed (following the AVCL or waterproof covering manufacturer's instructions) is possible, mechanical fixing to the screed layer is not allowed.

If the specification is based on the mechanical fixing of thermal insulation and/or waterproof covering, the appropriate fixings must be embedded into the structural concrete deck or roof slab in accordance with the fastener supplier's recommendations.

Sand/cement screeds used to form falls to concrete roofs should be:

- Free from ridges and indentations
- Finished to provide a smooth, even surface for the AVCL and waterproof covering
- Installed by specialist contractors where a lightweight finish is used and have a topping of 1:6 (cement:sand), 13mm thick
- To a minimum thickness of 25mm where a cement/sand screed 1:4 (cement:sand) is used
- Adequately dry and primed to receive the roofing system

5.2.2 LOCALISED MAKING GOOD OF LOW POINTS

Where a cast in-situ concrete roof slab designed and laid to falls is found to have areas of ponding or back falls, preparation work should be carried out to provide effective drainage prior to the installation of the roofing system. Polymer modified screeds may be used to make up any depressions in the concrete roof slab to avoid any ponding or correct any back falls. The adjusted areas should be resurveyed to ensure no ponding or back falls remain. The compatibility of the levelling screed with the AVCL or waterproof covering should be confirmed by the manufacturer.

Low points in a concrete deck or roof slab designed to receive a tapered insulation scheme should be made level by the same method prior to installation of the tapered insulation.

5.2.3 STRUCTURAL TOPPING FOR PRE-CAST CONCRETE DECKS

For new-build, pre-cast concrete decks where cast in-situ structural topping layers are installed, these should consist of minimum grade C25/30 concrete. Where mechanical fixng into this layer is proposed, the concrete thickness should be confirmed as suitable by the SPRA fastener supplier and pull-out testing undertaken in order to confirm that the required fastener design loads can be achieved.

5.3 TOLERANCES CONCERNING CONCRETE DECK, ROOF SLAB, OR SCREED LEVEL AND SURFACE IRREGULARITIES

The suitability of a concrete deck or roof slab, including any screed, to receive a single ply roofing system above it is dependent upon the quality of finish achieved by the concrete deck or roof slab installer in terms of level (including any fall) and the condition of the deck, roof slab, or screed surface.

Getting the deck, roof slab and/or screed level and minimising surface irregularities within accepted tolerances is vital. It is important for all involved to discuss what is required and possible at an early stage in design and specification considerations. This will ensure main and specialist concrete contractors are aware of the roofing system manufacturer's and specialist single ply roofing contractor's requirements and the need to ensure compliance with BS 6229:2018 *Flat roofs with continuously supported flexible waterproof coverings. Code of practice*, for example, on level and elimination of backfalls.

BS 8204-2:2003+A2:2011 *Screeds, bases and in situ floorings. Concrete wearing surfaces. Code of practice* is primarily for floors, though it details how to specify concrete from a performance standpoint. The maximum permissable departure of the level of the wearing surface from a specified or an agreed datum plane should be specified. Departure from the datum should be measured from the datum plane by using a 2m straight-edge laid in contact with the wearing surface and resting under its own weight. Deviations of the surface should be measured from the underside of the straight-edge using a slip gauge. The maximum permissible departures from a 2m straight edge for surface regularity (SR) classes SR1, SR2 and SR3 are 3mm, 5mm and 10mm, respectively. Unless otherwise specified, SPRA recommends SR2 (5mm) for flat roofs.

The surface of concrete wearing screeds should be brought to a level within the specified tolerances by using rigidly fixed forms, permanently built-in concrete rails or temporary levelling rails. Forms and rails should be fixed so that they are not displaced during the compaction of the concrete. For large area pours, the use of a laser level and staff can avoid the use of temporary levelling rails.

The surface should be finished by means of floating and trowelling or a dry shake finish:

- **Floating and Trowelling** After the concrete has been fully compacted, has stiffened sufficiently, and any bleed water has evaporated, it should be levelled initially and floated smooth by hand or machine. The surface should be trowlled at least twice at intervals, so as to produce a uniform and hard surface.
- **Dry Shake Finish** A dry shake finish should be applied in accordance with the manufacturer's or supplier's recommendations. It is essential to achieve a uniform distribution of the dry shake material, particularly with large area pours, preferably by using an automated spreader machine.

5.4 SURFACE APPLIED CURING COMPOUNDS

In some circumstances, surface applied curing compounds may be used to assist in the important curing process of concrete roof slabs. They are relatively easy to apply and assist the curing process in terms of moisture control, hence their popularity. Most often they are spray applied (sprays made up of a mixture of different, often solvent based, compounds). Once the solvent has evaporated, a thin film is left on the surface of the concrete roof slab. This film restricts water loss from the concrete during the curing process. However, the film left on the concrete by the surface applied curing

compound can inhibit the development of an adequate bond with the AVCL or waterproof covering, preventing sufficient attachment bond strength. This film may be visually difficult to detect also.

- **Acrylic Silicate-based curing compounds** form a permanent film on the surface of the concrete roof slab
- **Resin-based curing compounds** form a residue that can take between 45—60 days to oxidise and flake off when exposed to the elements
- **Sodium Silicate-based curing compounds** do not leave a film or residue on the surface of the concrete roof slab when properly applied, so may not require removal
- **Wax-based curing compounds** cease to be effective after about 28 days, but take 90—100 days to fully dissipate when exposed to the elements. The wax residue is difficult to remove

Methods for removing films and residues include acid etching, grinding, scarification, shot blasting and wire brushing, which are not practical, so it is advisable not to use surface applied curing compounds in the first instance. Where they have been used, however, it is vital that the roofing system manufacturer and the specialist roofing contractor are informed before the AVCL and waterproof covering are installed. BS EN 13670:2009 *Execution of concrete structures* (E), 8.5 (10) provides further guidance on this point, stating, *'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 they are proven to have no detrimental effects on the subsequent operations.'*

5.5 BONDING AGENTS AND PRIMERS

Prior to the installation of a bitumen-based AVCL, concrete decks and roof slabs require a bonding agent or primer. Typically, traditional, cut-back bitumen primers are applied where torch-applied, bitumen-based AVCLs will be installed and synthetic rubber-based bonding agents are applied where self-adhesive, bitumen-based AVCLs will be installed.

Generally, the following items must be considered when using bonding agents or primers on concrete decks and roof slabs:

- **Substrate Preparation** The substrate must be clean and dry.
- **Application Temperature** Generally +5°C and rising.
- **Application Rate** This can vary depending upon the porosity of the substrate.
- **Coverage** Must be even and over the full area to receive an AVCL.
- **Drying Time** Bonding agents and primers must be allowed to dry before applying an AVCL. This is especially important when installing a torch-applied AVCL, as wet primer is likely to ignite due to its solvent content.
- **Allowable Working Time** The time within which an AVCL must be installed once a bonding agent or primer has been applied varies across manufacturers and products. For example, a self-adhesive AVCL may have to be installed within four hours of a bonding agent being applied; beyond four hours, a second application may be required.
- **Contamination** If the primed surface is contaminated with dust and dirt, it must be cleaned and re-primed.
- **Adhesion Tests** Installers should perform adhesion tests to satisfy themselves that the AVCL will adhere sufficiently. It is recommended that these are recorded.

Refer to *Appendix 2: Method for Completing an Adhesion Test on a Concrete Deck, Roof Slab, or Screed.*

6. MECHANICAL FIXING INTO CONCRETE DECKS AND ROOF SLABS

For new build and refurbishment applications where the thermal insulation and/or waterproof covering require mechanical fixing into the concrete deck or roof slab, a pull-out test must be undertaken in order to determine the appropriate fastener design load and the project specific installation requirements. This process is detailed in SPRA Technical Guidance S15/19 *Site Pull-out Protocol for Flat Roofs.*

Where thermal insulation and/or a waterproof covering is mechanically fixed into a concrete deck or roof slab:

- Concrete grade C25/30 or minimum grade C12/15 should be used for cast in-situ and pre-cast roof slabs
- The minimum thickness of the concrete deck or roof slab required for mechanical fixing is product specific and should be confirmed as suitable by the SPRA fastener supplier
- Pull-out testing should only be undertaken once a concrete roof slab has cured sufficiently
- Fixing should not be undertaken into any screed layers (even if these are reinforced), but directly into the concrete deck or roof slab below.

7. REFURBISHMENT

7.1 INTRODUCTION

Because it is lightweight, easy to detail and available in a range of attachment options, single ply technology is well suited to roof refurbishment. If refurbishment is required due to the failure of the existing roofing system, the cause should be investigated fully. For example, cracking of an old bituminous system due to building movement may necessitate revised detailing.

7.2 REMOVAL OR OVERLAY OF EXISTING ROOFING SYSTEM

A major decision concerns whether to remove existing roofing system components or to overlay them. Overlay has the following advantages:

- The interior is at minimal risk of water ingress throughout the works
- Waste removal and disposal cost is minimised
- Contract period can be minimised

Overlay has the following disadvantages also:

- Roof loading may exceed the capacity of the structure
- Any entrapped moisture due to past water ingress must be dissipated effectively
- Details may be compromised by increased finished roof height
- Options for improving drainage may be restricted
- Options for attachment of the new roofing system may be restricted

Removal of the existing roofing system provides maximum scope for the correction of deficiencies in the existing design and for thermal upgrading. It widens the choice of attachment methods also.

7.3 CHANGE OF USE

Refurbishment dictated by a change of use will require special consideration of the following:

- Imposed loads may change, due to roof-mounted plant or access arrangements
- Mandatory resistance to external fire may change
- Internal relative humidity may change, requiring modified thermal design
- Aesthetic considerations may restrict choice, for example with rainwater goods

7.4 EXISTING FALLS

If the existing drainage layout is poor and ponding is widespread, retention of an existing concrete deck or roof slab will restrict the range of design options available. Only a warm roof system with tapered insulation will be suitable.

7.5 THERMAL INSULATION

When upgrading thermal insulation or installing a tapered insulation scheme, consideration should be given to the effect upon finished roof height – especially at points furthest from rainwater outlets. It may be necessary to raise upstand heights to achieve a minimum height of 150mm above finished waterproofing level.

Tapered insulation scheme designs assume that the substrate is level, so where tapered insulation is to be installed on an existing roof, low points should be made level prior to installation.

7.6 MECHANICAL FIXING INTO AN EXISTING CONCRETE DECK OR ROOF SLAB

For refurbishment applications where the thermal insulation and/or waterproof covering require mechanical fixing into the existing concrete deck or roof slab, a pull-out test must be undertaken in order to determine the appropriate fastener design load and the project specific installation requirements. This process is detailed in SPRA Technical Guidance S15/19 *Site Pull-out Protocol for Flat Roofs*.

7.7 REINFORCED AUTOCLAVED AERATED CONCRETE (RAAC)

Autoclaved aerated concrete (AAC) is different from normal dense concrete. It has no coarse aggregate, and is made in factories using fine aggregate, chemicals to create gas bubbles, and heat to cure the compound. It is relatively weak with a low capacity for developing bond with embedded reinforcement. It was used in two main forms of structural elements; lightweight masonry blocks and structural units (such as roof planks, wall and floor units).

When reinforced (Reinforced AAC: RAAC) to form structural units, the protection of the reinforcement against corrosion is provided by a bituminous or a cement latex coating, which is applied to the reinforcement prior to casting the planks. The reinforcement mesh is then introduced into the formwork and the liquid AAC mix added. Although called “concrete”, it is very different from traditional concrete and, because of the way in which it was made, much weaker. The useful life of such planks has been estimated to be around 30 years. Most RAAC constructions date back to between the 1960s and 1980s and are now past their expected service life.

Concerns that have arisen with roof planks include:

- Rusting of embedded reinforcement leading to cracking and spalling of the AAC cover
- Cracking, of varying degrees of severity, thought to be associated with moisture and temperature related movements in the planks
- Excessive deflections due to creep
- Floor and roof planks tending to act independently, rather than as a single structural entity

In some cases, the deflections had become appreciable, with span-to-deflection ratios in the order of 100. This could lead to:

- ponding of rainwater, with the potential increase in the imposed loading
- distress to certain types of waterproof membrane and associated finishes, and
- water penetration sufficient to promote corrosion of the embedded reinforcement

If planks are visible from the underside, then it is important to inspect these for warning signs which include visible cracks (particularly in the vicinity of the end supports), evidence of water ingress, rust staining or spalling. Consideration should be given to conducting a small intrusive drill sample to assist the inspection.

If it is suspected that RAAC planks are present, then an appropriately experienced Chartered Structural Engineer or Chartered Building Surveyor should be appointed when conducting identification and inspection work.

APPENDIX 1: CHECKLIST FOR CONCRETE DECK OR ROOF SLAB AND SINGLE PLY ROOFING SYSTEM

Record the build-up of the proposed roof construction from outside to inside (i.e. surface finish or single ply membrane down to ceiling finish).	
Has a structural engineer provided a specification for the concrete deck or roof slab and confirmed the maximum allowable loading for all areas?	Yes/No
After all loading (dead and imposed, including snow), does the roof achieve a minimum finished fall of 1:80 in all areas, including at internal gutters and intersecting planes?	Yes/No
For third-party certified, ballasted single ply roofing systems with zero falls, have a structural analysis highlighting areas at risk of back falls and a level survey been carried out? If 'No', back falls are not acceptable, and correction is required.	Yes/No
If the above structural analysis and level survey indicated any back falls, has suitable correction been made prior to the application of the single ply roofing system?	Yes/No
Have the number, size and positioning of the rainwater outlets been calculated by a competent person in accordance with BS EN 12056-3:2000 *Gravity drainage systems inside buildings. Roof drainage, layout and calculation*?	Yes/No
Is the concrete roof slab or screed surface sufficiently cured and dry prior to the installation of the single ply roofing system?	Yes/No
How long has the concrete roof slab or screed been allowed to cure and dry prior to installation?	
Has an adhesion test been carried out at regular intervals (50m^2)?	Yes/No
Has a compatibility check been carried out between any additives/admixtures/ surface applied curing compounds used for the control of concrete curing or performance and the single ply roofing system manufacturer?	Yes/No
Prior to priming and or application of the new single ply roofing system, are the concrete roof slab or screed surfaces level and smooth? If 'No', correct by removing through grinding down or other means as necessary.	Yes/No
Is the concrete roof slab or screed surface clean and dry and free from oil, grease or any surface treatment detrimental to the adhesion of the new single ply roofing system? If 'No', correct before proceeding.	Yes/No
Have pull-out tests been carried out on the concrete deck or roof slab by a competent person in accordance with SPRA Technical Guidance S15/19 and used for the determination of the fastener admissible design value (W_{ADM})?	Yes/No
Are mechanical fasteners installed into the concrete deck or roof slab? Mechanical fasteners must not be installed into screed layers.	Yes/No

APPENDIX 2: METHOD FOR COMPLETING AN ADHESION TEST ON A CONCRETE DECK, ROOF SLAB, OR SCREED

Adhesions tests are required to be carried out to determine a concrete deck, roof slab, or screed's suitability to receive an adhered AVCL or waterproof covering. It is imperative that a concrete roof slab or screed is allowed to cure sufficiently, as outlined in section four, *Concrete Roof Slabs and Screeds Curing Process*. The roofing contractor shall carry out a peel bond test to each roof area to be prepared for waterproofing. The testing should be carried out well in advance of the actual application, in case any remedial treatment is required, or further curing is necessary.

METHOD

- Clean a small area of the concrete deck, roof slab, or screed to be tested by using a soft broom or brush to remove any dirt and/or debris from the surface. Dry the surface as required.
- Apply the specified primer (where required) to a 500mm × 500mm area of the concrete deck, roof slab, or screed and allow it to dry as per the manufacturer's recommendations.
- Once the primer has dried, apply a 400mm × 400mm patch of the specified AVCL or waterproof covering as per the manufacturer's recommendations within the primed area. Leave overnight.
- Cut a triangular shaped incision through the AVCL or waterproof covering in the central zone of the test patch. If the AVCL or waterproof covering can be peeled up easily from the substrate, then the substrate is not ready (adhesive failure). This could be due to the deck requiring extra cure time or be an issue of contamination or laitance within the surface. If the AVCL or waterproof covering cannot be pulled away and distorts when pulled, then the bond is considered satisfactory.

It is recommended that a second peel bond test is done 24—48 hours after the first to confirm the security of the first test results. Test results should be submitted to the principal contractor and/or flat roofing system supplier and arranged for inspection. It is recommended that all peel bond tests are dated and recorded by photo or video, referencing the location on the roof where they were completed.

SPRA IS THE VOICE OF THE SINGLE PLY ROOFING INDUSTRY

The trade association was established in 1992 and its mission is to achieve growth and sustainability in all sectors of the single ply roofing industry by raising the awareness of single ply technology, its value and ensuring manufacturing and installation standards remain high.

SPRA is an increasingly influential voice in the roofing sector and is working in close co-operation with its sister trade associations to raise the overall profile of the UK roofing industry.

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