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SPECIFICATION & GUIDELINES FOR SYNTHETIC RESIN FLOORING

FOREWORD

EFNARC was founded in March 1989 as the European federation of national trade associations representing producers and applicators of specialist building products. Membership has since widened and now includes many of the major European companies who have no national trade association to represent their interests either at national or European level. **EFNARC** members are active throughout all the countries of Europe, more particularly in Belgium, France, Italy, Germany, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

EFNARC main activities at European level and at CEN Technical committees are in flooring, the protection and repair of concrete, in soft ground tunnelling and in sprayed concrete. It provides a common voice for the industry to make known its position and view to the European Commission departments dealing with the CPD, CEN Technical Committees and other Groups dealing with European harmonisation of Specifications, Standards, Certification and CE marking relevant to our industry.

In each product area it operates through specialist Technical Committees that have been responsible for producing Specifications and Guidelines which have become recognised as essential reference documents by specifiers, contractors and material suppliers throughout Europe and beyond.

The **EFNARC 'Specification for Synthetic Resin and Polymer-modified Cementitious Floorings for Industrial Use'** was published in November 1997 as a draft for public comment. Since that time many copies of the draft version have been issued and it has also been registered as a formal document by the CEN committee (TC 303) responsible for European standards for flooring. As requested, many users have submitted comments and these have been taken into account in the production of this definitive specification. A major change from the draft stage is that separate specifications have now been produced for Synthetic Resin and Polymer-modified Cementitious Floorings respectively. This recognises that the two types of specialist floorings have different end uses and in the case of the Polymer-modified Cementitious Floorings will allow subsequent extension to cover their use as levelling screeds.

Another significant change is the removal of requirements for Identification tests. The requirement that manufacturers should operate a formal independently-certified quality control scheme will give the customer assurance of continuity of formulation. Also it is believed that the performance requirements are a better check that the product will give satisfactory service than a series of analytical tests which may not in themselves be conclusive.

Acknowledgements

EFNARC wishes to acknowledge gratefully all the contributions and comments made by users of the draft Flooring Specification published in 1997 and to the subsequent extensive work undertaken by members of its Flooring Technical Committee.

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1 INTRODUCTION

This specification provides minimum standards of performance and methods of installation for synthetic resin (PC) floorings to be applied in situ to a direct finished concrete slab or fine concrete screed. These floorings are based on liquid Synthetic resin systems in which curing takes place by polymerisation of the resin components.

Concrete wearing surfaces can give satisfactory service under many industrial conditions but become less effective where there are specific requirements of chemical resistance, hygiene, cleanliness, resistance to high impact or abrasion. The main advantages of synthetic resin floorings include the following:

- a) strong permanent bond to the substrate
- b) improved resistance to a wide spectrum of aggressive chemicals
- c) impermeable to liquids
- d) increased toughness, durability, resilience, and resistance to impact or abrasion
- e) non dusting
- f) hygienic and easily cleaned surfaces
- g) greater resistance to cracking
- h) lower applied thickness
- j) rapid installation and curing with minimum disruption to normal operations
- k) more aesthetic appearance with the opportunity to produce decorative finishes

2 SCOPE

This Specification covers the performance, design and installation of flow-applied or trowel-finished synthetic resin (PC) floorings directly bonded to the substrate, for industrial, commercial or domestic use. Synthetic resin floorings can be divided into different types varying in thickness and surface finish, as described in Table 1.

Table 1: Types of Synthetic resin flooring

Type	Name	Typical thickness	Description
1	Floor seal	dry film thickness up to 150 μm	applied in 2 or more coats: generally solvent or water borne.
2	Floor coating	final thickness of 150-300 μm	applied in 2 or more coats: generally solvent-free but may be solvent- or water-borne.
3	High build floor coating	final thickness of 300-2000 μm	applied in 2 or more coats: generally solvent-free.
4	Multi-layer flooring	1 mm +	multiple layers of floor coatings or flow-applied floorings with aggregate dressing: often described as 'sandwich' systems.
5	Flow applied flooring	2 to 3 mm	Often referred to as 'self-smoothing' or 'self-levelling' flooring, and having a smooth surface: or may be given a surface dressing.
6	Screed flooring	4 mm +	heavily filled, trowel-finished systems, generally incorporating a surface seal coat to minimise porosity.
7	Heavy duty flowable flooring	4 to 6 mm	aggregate-filled system, having a smooth surface: or may be given a surface dressing.
8	Heavy duty screed flooring	6 mm +	trowel-finished, aggregate-filled, system which is effectively impervious throughout its thickness.

Some of these categories of flooring may be produced with special decorative effects by the incorporation of coloured particles or flakes in the surface. Terrazzo-like finishes (ground exposed aggregate) may be produced from certain trowel-applied floorings of Types 6 and 8. Slip resistant or anti-static/conductive versions of all these categories may also be available.

3 REFERENCED STANDARDS

The following standards are relevant to synthetic resin flooring. However, any subsequently published or revised European Standard (EN) should always take preference over standards referred to in this document. The hierarchy of authority is EN standard, ISO standard, National standard.

EN 1081	Resilient floor coverings – Determination of the electrical resistance
EN 1504	Products and systems for the protection and repair of concrete structures
EN 1542	Products and systems for the protection and repair of concrete structures - Test methods- Measurement of bond strength by pull-off
EN 1766	Reference concretes for testing
EN 12086	Thermal insulating products for building applications – Determination of water vapour transmission properties
EN 13318	Screed material and floor screeds - Definitions
EN 13529	Products and systems for the protection and repair of concrete structures: Test methods - Determination of chemical resistance
EN 13687-2	Products and systems for the protection and repair of concrete structures: Test methods - Determination of thermal compatibility; resistance to temperature shock
EN 13892-4	Methods of test for screed materials; Part 4: Determination of wear resistance BCA
EN 13892-5	Methods of test for screed materials; Part 4: Determination of wear resistance to rolling wheel
EN ISO 6272	Paints and varnishes – falling weight test
ISO 178	Determination of elastic modulus in flexure
IEC 61340-4-1	Electrostatic behaviour of floor coverings and installed floors
BS 1881-202	Testing concrete: Recommendations for surface hardness testing by rebound hammer
BS 8204-1:	In situ floorings: Code of practice for concrete bases and screeds
BS 8204-2:	In situ floorings: Code of practice for concrete wearing surfaces
DIN 53 754	Testing of plastics; determination of abrasion; abrasive disk method

Note: Some of these standards are still in preparation and available only at the prEN stage.

4 DEFINITIONS

4.1 Mix components

4.1.1 Admixture

Material added in small quantity during a mixing process to modify the properties of the cementitious screed material in the fresh and/or hardened state, and complying to EN-934

4.1.2 Pigment

Finely dispersed insoluble solid material that provides colour and opacity to the flooring products and systems.

4.1.3 Primer or Bonding agent

A liquid product applied to a substrate, either subfloor or base, prior to the application of the final flooring, to seal and consolidate the surface of a porous substrate and aid adhesion of the final flooring.

4.1.4 Synthetic resin

A reactive organic polymer binder for a flooring system comprising one or more components that react at ambient temperature.

4.2 Construction components

4.2.1 Curing compound

Product applied to a newly laid concrete surface to reduce loss of moisture by evaporation.

4.2.2 Insulation material

Material placed within a floor structure to provide either acoustic and/or thermal insulation.

4.2.3 Reinforcement

Bars, wires, meshes or fibres added to screeds.

4.3 Construction

4.3.1 Base

Building element which provides the support for a screed and any other flooring system.

4.3.2 Screed

Layer of material or materials laid in situ, directly onto a base, bonded or unbonded, or onto an intermediate layer or insulation layer, to achieve one or more of the following purposes.

- to obtain a defined level.
- to carry the final flooring.
- to provide a wearing surface.

4.3.3 Flooring

Uppermost layer of a floor that is designed to provide a wearing surface: this layer may consist of a product or system of products.

4.3.4 Bay

Area of screed or flooring bounded by joints or free edges.

4.3.5 Channel

Longitudinal recess in the floor surface designed to collect liquid flowing over the surface and direct it to the drains.

4.3.6 Day-work joint/ Construction joint

Joint incorporated where work is interrupted either by design or accident so that subsequent work will provide discontinuity in the surface.

4.3.7 Joint

Formed discontinuity in either the whole or a part of the thickness of a screed or other building element.

4.3.8 Movement joint

Joint between building elements or screed bays which can absorb dimensional changes or movements.

4.3.9 Perimeter isolating joint

Isolating strip placed between a screed and vertical elements of the building.

4.3.10 Skirting

Continuation of the floor surface up the lower part of a vertical wall, kerb or plinth, generally coved.

4.3.11 Wearing surface

Upper surface of a screed designed to be used as a final floor.

4.3.12 Core

Cylindrical specimen cut from a hardened screed.

4.4 Product

4.4.1 Bonded screed

Screed which is bonded to the base.

4.4.2 Cementitious screed

Screed where the binder is a hydraulic cement.

4.4.3 Damp-proof membrane

Layer or layers in a floor to resist the passage of moisture.

4.4.5 Flowing screed

Highly fluid screed composition with self-smoothing (or self-levelling) properties.

4.4.6 Levelling screed

Screed applied to compensate for unevenness in the base or to accommodate pipes or provide a defined slope.

4.4.7 Monolithic screed

Cementitious screed laid onto the still plastic surface of a fresh concrete base.

4.4.8 Polymer-modified cementitious (levelling) screed (PCC - Polymer-modified cement concrete/mortar)

Screed where the binder is a hydraulic cement that is modified by the addition of polymer dispersion or re-dispersible powder polymer with a minimum content of dry polymer of 1% by mass of the total composition, excluding aggregate particles larger than 5 mm.

4.4.9 Reinforced screed

Screed containing reinforcement.

4.4.10 Sealer

A liquid product applied to the surface of a flooring product to seal any porosity and generally to enhance the chemical resistance, aesthetic appearance and/or reduce dusting of the flooring.

4.4.11 Synthetic resin flooring (PC - Polymer concrete)

Mixture of synthetic resin, aggregates and pigments that hardens on curing by means of chemical reaction but excluding oxidative drying.

4.4.12 Synthetic resin screed

Screed where the binder consists of synthetic resins.

4.4.13 Synthetic resin coating

Fluid synthetic resin based composition that can be applied as a thin layer to a concrete or other substrate which then sets to provide a coherent wearing surface.

4.5 Properties

4.5.1 Working life

The time following mixing during which the flooring material can be applied and finished without detrimental effect on its properties such as adhesion, compaction and surface finish.

4.5.2 Abrasion resistance

Resistance to wear by mechanical action of a flooring surface.

4.5.3 Chemical resistance

The capacity of the flooring surface to withstand exposure to chemicals without significant change to its service characteristics.

4.5.4 Consistency

A measure of fluidity of fresh screed or flooring material which characterises its ease of use.

4.5.5 Crazeing

Network of irregularly shaped micro-cracks formed on the surface of a flooring.

4.5.6 Electrical resistivity

A measure of the ability of the flooring system to conduct electricity.

4.5.7 Identification test

Procedure to characterise a product in order to check its compliance with a reference sample batch used for initial type testing or customer acceptance test.

4.5.8 Levelness

Conformity of the surface of a flooring layer to a fixed datum plane within allowable tolerance.

4.5.9 Osmosis

A physical process whereby water contained in a concrete base is induced, by the presence of soluble salts or other water soluble material in the surface of the base, to cause liquid-filled blisters to occur between the concrete base and the flooring layer.

4.5.10 Performance

Ability of a flooring product or system to provide a durable floor and exhibit effective service characteristics.

4.5.11 Performance requirements

Required mechanical, physical and chemical properties of a flooring product and systems

4.5.12 Porosity

Ratio between the volume of pores within a material to the total volume.

4.5.13 Pull-off strength

The tensile force per unit area which has to be applied perpendicularly and centrally to the surface of a bonded screed or flooring in order to cause failure.

4.5.14 Self-levelling

Capacity of fresh screed or flooring material to spread out unaided to form a flat horizontal surface.

4.5.15 Self-smoothing

Capacity of fresh screed or flooring material to form a smooth surface unaided.

4.5.16 Surface hardness

Resistance of the surface of a screed or flooring to indentation by a loaded steel device.

4.5.17 Surface regularity

A measure of the flatness of the floor surface.

4.5.18 Time before service

The period required to attain sufficient mechanical strength to withstand the intended exposure.

4.6 Process**4.6.1 Bonding/Priming layer**

Layer which improves the adhesion of a screed or flooring to the base.

4.6.2 Compaction

Manual or mechanical treatment of freshly spread screed material that increases its density.

4.6.3 Datum level

Reference level for fixing the height of building elements.

4.6.4 Direct finish base slab

Base slab that is suitably finished to receive the flooring to be applied directly without the need for a levelling screed.

4.6.5 Grinding

Mechanical treatment of a surface using rotary abrasive action to provide a texture or to eliminate irregularities.

4.6.6 Screed laid to fall

Screed laid to provide a defined slope to promote drainage.

4.6.7 Surface dressing

A scatter of fine aggregate or other particulate material spread evenly into the surface of a synthetic resin flooring while it is still mobile.

4.6.8 Trowelling

Finishing and smoothing the surface of the fresh screed, using a trowelling tool operated manually or mechanically.

4.6.9 Underfloor heating

Heating system incorporated in a floor.

5 PRODUCT REQUIREMENTS**5.1 Performance requirements**

General and Special requirements are summarised in Table 2. The requirements shall be based on tests undertaken at laboratory conditions of $21\pm 2^{\circ}\text{C}$ and $60\pm 10\%$ R_H. Unless otherwise stated, all results are for 7 days cure.

Table 2: Performance requirements

Classification for intended use*	Performance characteristic	Specified test method	Requirement
A	Abrasion resistance	For systems exceeding 2 mm in thickness - BCA Abrasion Tester to EN 13892-4 or - Rolling Wheel tester to EN 13892-5 For systems less than 2 mm in thickness - Taber Abrasion Tester to DIN 53 754	Depth of wear shall not exceed 0.1 mm - (Class AR1) Loss of volume shall not exceed 1.0 cm ³ - (Class RWA1) Loss in weight shall not exceed 100 mg (1000 cycles/CS10 wheels/1000g load)
A	Pull off strength to the substrate	EN 1542, using reference concrete to EN 1766 (type MC 0.40) as substrate	> 1.5 MPa: nature of failure to be reported.
A	Impact resistance	EN ISO 6272, when bonded to a reference concrete of EN 1766, (type MC)	impact resistance > 4Nm with no cracking or debonding.
B	Thermal compatibility to concrete	EN 13687-3 but with test conditions as +20°C dry to +80°C wet, for interior floorings. EN 13687-2, for exterior floorings	In either case, the bond of the flooring to a reference concrete substrate of EN 1766 shall not fail by cracking or detachment.
B	Permeability to water vapour	EN 12086	The permeability shall be expressed as g/m ² /24 hours.
B	Chemical resistance	EN 13529	Class I (3 days) or Class II (28 days): the nature of the chemicals to be tested to be agreed between the manufacturer and the potential user.
B	Electrical resistivity	IEC 61340-5-1 or EN 1081	To meet customer's specification
B	Modulus of elasticity (flexural)	ISO 178	The flexural modulus class shall be declared by the manufacturer and shall be indicated by E, followed by the modulus of elasticity in kN/mm ² , eg E15.
B	Resistance to slipping (wet)	Pendulum Slip resistance tester to BS 8204-2	> 40, when tested wet (see section 8.2 for detailed requirement)

* Classification for intended use:

A Mandatory requirement for all intended uses - standard test method and performance limits are specified.

B Special requirement for particular situations - standard test method is specified and performance limits are to be met or the result declared on request.

5.2 Declaration of Conformity

5.2.1 Testing

Testing shall be carried out by the manufacturer to prove the conformity of each product, covered by this specification, with the requirements of Table 2.

5.2.2 Quality control

The manufacturer shall operate a quality control system in accordance with the principles of EN ISO 9000 at each facility where products covered by this specification are produced.

Compliance with this requirement should preferably be verified by an approved certification body which shall issue a certificate to each production facility where procedures have been verified.

After initial certification, an audit of each production facility shall be carried out by the approved certification body not less than once per year. If any non-compliance with the requirements of EN ISO 9000 is found, the certification body shall either:

- (i) require correction of non-compliance within a stated time which, if not carried out, shall result in withdrawal of the certificate, or
- (ii) immediately withdraw the certificate, if correction is not possible.

5.2.3 Declaration of Conformity by the Manufacturer

Provided the requirements of 5.2.1 and 5.2.2 have been fulfilled, a declaration of conformity with this specification shall be made available by the manufacturer for each product or system which satisfies the appropriate requirements in this specification.

A new declaration of conformity shall be provided following any change in formulation or in constituent materials which results in a change of the characteristics of the product.

The time between repeat conformity tests shall be not more than 3 years.

5.2.4 Declaration of Conformity by the Contractor

The Contractor shall make available a declaration of conformity that all work will be undertaken to a quality plan and the flooring will be installed by trained operatives in accordance with this specification.

6 EXCHANGE OF INFORMATION AND TIME SCHEDULE**6.1 General**

Consultations and exchange of information between all parties concerned with the building operations should be arranged so that each has full knowledge of the particulars of the flooring work and be able to co-operate in producing the conditions required to complete a satisfactory installation.

Some of the items listed in 6.3, 6.4 and 6.5 may need additional precautions or procedures: responsibility for these should be determined in advance of the work.

6.2 Selection of flooring to be applied

It is essential that, in the design and construction stages, there should be full consultation with all interested parties to ensure that the product to be selected is entirely suited for the conditions both during application and in subsequent service. Consideration should therefore be given to whichever of the following are applicable:

- a) intended use of the synthetic resin flooring including the type, extent and frequency of trafficking;
- b) type of loading, static or dynamic, and severity of impact;
- c) details of all chemicals, including those used for cleaning or sterilising, which could come into contact with the floor, and extent, frequency and temperature of spillage;
- d) temperatures that the flooring is required to withstand in normal service or as part of the cleaning operations and whether exposure is by radiant or conductive heat or by direct contact;
- e) colour, uniformity and retention, aesthetics and decorative effects
- f) extent to which the flooring will be exposed to direct sunlight or ultra-violet light;
- g) compliance with hygiene or food industry requirements;
- h) special requirements, such as slip resistance or anti-static characteristics;
- i) expected life of the flooring;
- j) thickness of flooring to be installed;
- k) time available for the application and curing of the flooring;
- l) age, specification where known and nature of the base, including information about any previous use of the floor which could affect adhesion, and any preparatory treatment required;
- m) health & safety and environmental issues during application and in service.

6.3 Information to be provided to the flooring contractor

All relevant information should be provided in good time to those responsible for installing the flooring and to others whose work could be affected, including whichever of the following are applicable:

- a) description, situation and address of site and means of access;
- b) those conditions of contract which could practically affect this particular work;
- c) location and area of flooring to be installed;
- d) finished floor level, falls and maximum permissible departure from datum in each location;
- e) class of surface regularity of the finished flooring;
- f) type of damp-proofing and insulation if present;
- g) type and thickness of any levelling screed proposed, and whether any curing compound is to be applied;
- h) type of finish of concrete base or screed;
- i) any work consequent upon services passing through the floor;
- j) treatment of joints;
- k) treatment of channels;
- l) treatment of skirtings and kerbs;
- m) treatment of junctions with adjacent floorings and doorway thresholds;
- n) any special requirements related to underfloor heating;
- o) the timing of the introduction of heating in the building;
- p) date for the completion of the concrete base or screed to receive the flooring;
- q) dates for the start and completion of various sections of the floor;
- r) details of any compliance testing required;
- s) any potential restrictions on working hours;
- t) any limitations on installation due to production or other activities.

6.4 Information to be provided by the flooring contractor

The flooring contractor should provide in good time to those responsible for the building, details of the conditions needed for the installation of the flooring, including whichever of the following are applicable:

- a) the extent of weatherproof areas to be provided for storage of raw materials and mixing of the flooring product and whether any temperature control is necessary;
- b) ambient temperature requirements in the area where the flooring is to be installed;
- c) power and lighting requirements to facilitate the laying operation;
- d) protective screening to isolate the working area from adjacent facilities;
- e) minimum time intervals after the flooring is installed before allowing foot traffic, vehicular traffic and water or chemical exposure respectively;
- f) extent and type of surface preparation necessary.
- g) protection necessary for the flooring between installation and final handover.

6.5 Time schedule

Allowances should be made for the following:

- a) curing and drying of the concrete base or screed, and/or polymer-modified cementitious levelling screed, when applicable;
- b) time between commencement and completion of work;
- c) period necessary for curing and protection of the completed flooring from damage by other trades, including restriction of access.

7 MATERIALS

All the different classes of synthetic resin flooring comprise three basic ingredients: the base resin, a reactive hardener and a filler powder or particulate filler. Generally the flooring product will be supplied as these three separate components although in some cases, particularly resin coatings, the filler component may be pre-blended with one of the liquid components. Some products may also include additional components such as pigments, accelerators, surface dressings, coarse aggregate.

In most cases a separate primer will be supplied. Depending on the product type a surface seal, to be applied subsequently to the main flooring product, may also be provided. The primer and the surface seal will generally be two component products comprising a liquid resin component and a reactive hardener, although in some cases they may comprise only a single component.

For all synthetic resin flooring products the setting reaction, by which the initially liquid components are converted into a strong tough polymer, begins only when the base resin and the reactive hardener are intimately mixed. To obtain the optimum results these components must be blended in the prescribed proportions needed for the chemical reaction to occur and mixing must be thorough to ensure the final product is homogeneous and uniform.

The base resin and the reactive hardener will generally both be liquids, although for some product types the reactive hardener may be in powder or paste form. The individual components may comprise blends of different resins, hardeners, catalysts, and other modifiers. However the make up of such components under site conditions is not permitted because the necessary levels of precision and quality control are unlikely to be achieved consistently. These base resins and reactive hardeners are therefore normally supplied pre-formulated to facilitate site operation.

For most applications the flooring product will be supplied in matched pre-weighed packs of the components so that no measuring out on site is necessary. No attempt should be made to sub-divide such packs because of the difficulties involved in ensuring correct proportioning. In some situations it may be feasible for any of the components to be supplied in bulk and then batched on site provided a level of quality control in accordance with 5.2.2 can be assured. Particular care will be needed if the liquid resin components contain dispersed filler or pigment to ensure that the quantities dispensed are uniform in composition as any separation would lead to variations in colour or mechanical properties.

A variety of different types of synthetic resin systems are available which can form the binder of a flooring system. These typically include epoxy, epoxy novolac, polyester, vinyl ester, furane, methacrylate and polyurethane resins. The considerations which might affect the selection of a particular type of resin flooring are given in section 8.

8 DESIGN

8.1 Selection Parameters

Factors influencing the selection of a flooring system should include amongst others:

- type and degree of traffic
- temperatures to which flooring will be exposed
- nature and duration of any chemical contact with the floor
- texture of surface expected
- wet or dry conditions
- slip resistance requirements
- nature of light exposure
- aesthetic appearance
- crack bridging capability
- ease of cleaning (including hygiene requirements)
- site conditions at time of installation
- cost

The most appropriate flooring for any situation will depend upon the particular conditions to which it will be subjected, and the choice should be made in discussions between all the interested parties, including client, designer, contractor and supplier. It is not possible to provide a simple guide as to where to use different flooring types, since so many parameters can affect the decision for a particular situation.

8.2 Surface smoothness and slip resistance

The flooring shall be finished in a manner that produces reasonable slip resistance appropriate for the circumstances of use.

As a general rule, the smoother and less porous a floor surface, the easier it is to keep clean. However, whilst these specialist floorings can be formulated to produce smooth, non-porous surfaces with excellent slip resistance under dry conditions, the surface has to be textured if it is to have adequate slip resistance under wet conditions. Such texturing can be achieved by selective grading of the larger aggregate particles in the flooring composition, or by a surface scatter of special polish-resistant aggregate into the surface of the flooring composition whilst it is still mobile.

The heavier the likely build up of contaminants, the coarser the surface texture has to be to retain the required level of slip resistance. However coarse textured surfaces are more difficult to clean, so where both slip resistance and ease of cleaning are important, a compromise must be made. Flooring should be

selected with sufficient texture to suit specific working conditions and hygiene standards, and the frequency and type of cleaning must be organised to retain these properties.

In areas where the floor will be frequently wet during service, the slip resistance value (SRV) of the flooring should preferably be not less than 40 in the wet state, except for situations where ease of cleaning is more critical than slip resistance and/or where all who use or are likely to use the floor will wear specially provided slip resistant boots or shoes. In these circumstances, a slip resistance value in the wet of not less than 33 may be acceptable.

8.3 Chemical resistance

Well formulated and correctly applied synthetic resin floorings have proved an effective method of protecting concrete substrates sensitive to attack from aggressive spillages. Whilst no floor finish is completely resistant to prolonged contact with high concentrations of all possible chemical types and combinations, selected synthetic resin floorings are resistant to many of the chemicals and products found in normal industrial service situations. In practice prolonged contact with large quantities of the most aggressive chemicals is unlikely because of the health hazard likely to be involved.

By attention to floor design, eg provision of adequate drainage and maintenance of good housekeeping standards, excellent service life can be achieved under conditions of aggressive chemical spillage. Because of the wide variety of chemical products used in industry and the diversity of floorings it is not practicable to provide a simple guide to chemical resistance and the advice should be sought of the manufacturer based on his experience in similar locations and on laboratory testing of the product.

Resistance to particular chemicals does not exclude the possibility of surface staining. Some chemicals may cause discoloration of the flooring surface without affecting the service integrity and durability of the flooring material. It is therefore essential that the user should establish whether the proposed flooring product will be resistant to staining as well as chemical attack in the particular environment, especially when aesthetic appearance is a major requirement.

The manufacturer or contractor in deciding which product to recommend for a particular situation will require information on:

- chemical constituents and concentration of likely spillage
- temperature of the spillage
- quantity and frequency of the spillage
- presence of water and procedures for emergency wash-down
- regular cleaning procedures
- chemical composition of cleaning or sterilising agents
- falls, drainage and sumps (waste collection tanks) to be provided

8.4 Temperature resistance

Most synthetic resin floorings have relatively low Heat Distortion Temperatures (HDT), generally between 50 and 80°C, much lower than ceramic tiles or concrete screeds. In practice certain synthetic resin floorings have proved capable of withstanding higher temperatures than their HDT through attention to formulation, application and floor design. Those systems which have been found satisfactory against steam cleaning, for example, combine a higher HDT with a lower elastic modulus and a higher design thickness in order to give improved thermal shock resistance.

The resistance of a synthetic resin floor to heat will depend on a number of factors:

a) nature and type of heat source. Due to the low heat capacity of air and the relatively slow changes in temperature caused by convected and radiant heat, dry heat is normally only a problem in extreme conditions, eg close to oven doors. Liquids in contact with floors give a much higher heat transfer and therefore pose more of a risk.

Particular care should be taken in the design of the flooring where extreme temperature variations are likely, such as in cold stores and areas around ovens or furnaces. The movement of these areas in relation to the surrounding floor must be carefully considered and appropriate joints installed.

Where direct radiant heat is anticipated such as the surrounds to oven doors it may be necessary to install a more heat resistant flooring such as ceramic tiling in the immediate vicinity but again the need for a movement joint between such an area and the main flooring needs to be assessed.

b) duration of contact with the floor. This will depend on the overall design of the installation. Thus with a minimum fall to drains of 1.5% a considerable volume of hot liquid spillage would be needed to raise the floor temperature above the HDT of the product. Wherever possible, known bulk discharge should be

piped direct to the drains. Where this is not possible, floors regularly subjected to discharge of large volumes of hot liquids can be protected by the installation of cooling sprays. Such a cold water curtain not only cools the floor but dilutes any aggressive spillage to safer levels.

c) rate of change of temperature. With slow changes in temperature, the stresses transmitted to the bond line due to differential expansion between the synthetic resin flooring and the substrate may usually be accommodated. However as lower flooring thickness allows rapid heat transfer through to the bond line rapid changes of temperature may cause failure if the substrate has not been adequately prepared to ensure maximum adhesion.

Although the synthetic resin flooring may soften if exposed to high temperature, its mechanical strength will generally return and no damage occur, provided the area is kept free from traffic during the 'tender' stage. On the other hand prolonged exposure to high temperatures may lead to a degree of post cure manifest in the product becoming more brittle or less flexible and, in the most severe cases, inducing shrinkage stresses within the product leading to cracking or detachment.

d) steam cleaning. A combination of softening and subsequent damage may be caused by misuse of high temperature pressure cleaning equipment, particularly with thinner self-levelling floorings. On more heavily filled screeds, steam cleaning can be satisfactory carried out provided care is taken to ensure that the steam is not allowed to discharge on one place at one time for too long. However for thin layer flow applied flooring, modern cleaning and sterilising agents and machines are generally more cost effective than steam cleaning.

8.5 Taint

Correctly formulated and fully cured synthetic resin floorings should be entirely satisfactory for use in the proximity of all food stuffs. The critical period for tainting is during the application of the floorings and in general all food stuffs should be removed from the area where the flooring is to be laid and care taken that air from such areas is not vented towards storage or working areas where food may be present. Some flooring systems have been designed to be applied in a working food factory without causing taint problems. In all cases the situation needs to be positively discussed before the installation of the flooring begins so that all parties are aware of the potential risks.

8.6 Curing time

The final floor system shall be allowed to cure according to the manufacturer's instructions. These generally require 1-3 days at 15 - 20°C before allowing significant use by traffic and 3 to 7 days at 15 - 20°C before allowing contact with chemicals or sterilising agents. Adequate curing should always be allowed before wet testing the flooring for drainage or ponding.

At site temperatures below 10°C cure times will be substantially increased unless some form of external heating is used. In assessing curing conditions it should be recognised that the concrete slab temperature will generally be lower than the air temperature and this will govern the rate of cure.

As a general rule, synthetic resin floorings should not be applied unless both air and slab temperatures are greater than 5°C and rising. The ambient relative humidity may also be a critical factor. Floor seals or coatings of Types 1 or 2 will require a relative humidity less than 85% if they are to through-cure satisfactorily. Condensation onto the surface of the resin flooring as it cures may cause 'blooming', a clouding of the surface, and this could be exacerbated if the slab is colder than the air temperature.

Certain types of synthetic resin flooring can be formulated to cure even at sub-zero temperatures and are then used to repair cold store areas or for similar applications. Such products should be used with care because of the risks associated with ice formation on the substrate.

8.7 Damp proof membranes

8.7.1 New construction

In new buildings a damp proof membrane should have been incorporated into the design of the concrete base, when ground supported. The membrane is then preferably installed directly below the base. In some fast-track construction an additional membrane may be bonded to the top of the concrete base, to prevent subsequent operations from being affected by water remaining in the concrete.

8.7.2 Existing buildings

In existing buildings without a functioning damp proof membrane or where there is suspicion of rising dampness, the following should be considered:

- a) installation of a membrane under a new concrete or polymer-modified cementitious screed. In this case the flooring manufacturer's recommendations for minimum screed thickness should be carefully followed.
- b) surface-applied membrane: the compatibility of membrane and flooring material must be established. Systems vary in their resistance to osmotic blistering, and this aspect must be discussed in each situation with the flooring manufacturer.
- c) certain purpose-designed resin floorings are able to tolerate high levels of moisture in the substrate.
- d) hydrostatic pressure may, under certain circumstances, cause adhesion failure between the flooring and the substrate. Where this is likely to occur, such as in areas where the ground water table is higher than the substrate, and where external tanking has not been applied, pressure relief must be provided, eg by directed drainage.

8.8 Tolerances

8.8.1 General

Synthetic resin floorings will generally follow the profile of the underlying substrate, due to the method of application. The agreed standards for flatness and regularity should therefore be produced in the base concrete or levelling screed as far as possible. When upgrading existing floors, the means of obtaining the required levels and flatness need to be agreed in advance.

8.8.2 Tolerance to datum plane

The designer should specify the maximum permissible departure of the level of the wearing surface from an agreed or specified datum plane, taking into account the area of the floor and its end use. For most normal purposes a departure of ± 15 mm from datum will be found to be satisfactory. Greater accuracy to datum could be required in small rooms, along the line of partition walls, in the vicinity of door openings and, where specialised equipment is to be installed directly on the floor.

The datum plane for the majority of floors will be horizontal but, on occasions, sloping. In the latter case, departure from datum should be measured from the sloping plane.

8.8.3 Surface regularity

The class or category of surface regularity required for a floor surface will depend upon the use of the floor. Insistence on a higher tolerance than needed for the operating conditions will result in unnecessary higher costs and this should be borne in mind in selecting a surface regularity standard.

The 3 metre straightedge method given in BS 8204-1 is generally satisfactory for the majority of floor uses and, where appropriate, the designer should specify one of the classes of surface regularity given in Table 3. Alternatively the method of DIN 18 202 may be used.

Table 3:
Classification of surface regularity for wearing surfaces of normal and high standard flooring

Class	Maximum permissible departure from a 3 m straightedge in contact with the floor	Application
SR1	3 mm	High standard: special floors
SR2	5 mm	Normal standard: normal use in commercial and industrial buildings
SR3	10 mm	Utility standard: other floors, where surface regularity is less critical

Where the floor will be subject to wet service conditions, a high class of Surface Regularity may be necessary to minimise ponding.

Where the straightedge method of specification is used it will be necessary for the various interested parties in a contract to agree the sampling rate for testing the floor to check conformity, before the floor is constructed.

The simple straightedge method of specifying floor surface regularity is only suitable for floors finished by conventional finishing techniques that will produce a smoothly undulating surface rather than an irregular 'washboard' finish.

Where a very high degree of accuracy is required, e.g. for high level racking or television studios, specialist test equipment should be used to govern the level of the floor as it is laid and to check its conformity.

The difference in height across any joints in the flooring should be less than 1 mm with no abrupt changes in level. Because of the relatively low thicknesses of some classes of synthetic resin flooring, it is essential that any significant differences in height across the joints in the concrete base or screed are ground flat before the flooring is to be applied.

Testing to check surface regularity and level conformity should be made within 24 h of the first area of flooring being laid to establish at an early stage that the method of laying can meet the specification requirement. Surface regularity and level testing should not be left to be checked until all the flooring is completed.

8.9 Falls

A floor, particularly one with a coarse surface texture, will not drain water satisfactorily unless sufficient falls are introduced. A minimum slope of 1.5% should be specified to produce a free draining floor. However, slopes greater than this may lead to problems of slumping if the eventual finish is to be flow-applied.

8.10 Joints

The number of joints designed into the floor should be kept to a minimum consistent with stability in order to maintain the seamless nature of the surface that will then be easy to maintain.

The spacing of movement joints must be determined by the design of the subfloor. All movement joints in the subfloor must be carried through the flooring. In areas where regular trucking occurs it is desirable to reinforce the screed edges at the movement joints: stainless steel or other suitable metal angles may be used or prefabricated joints suitable for this purpose. Alternative methods for forming such joints are shown in **Figure 1**.

In all instances the necessity for movement joints and their type and positioning should be agreed at the design stage between all parties concerned.

8.11 Edge design

Where the new flooring has to finish level with an existing floor or around the outside perimeter of the area, feather edges must be avoided. This reduces the risk of early mechanical wear at the edge or of seepage of liquids under the flooring. This can be achieved by forming or cutting a groove in the surface of the concrete floor into which the flooring is then applied, as shown in **Figure 1**.

For heavy traffic this groove should be to a minimum specification in depth equal to the thickness of the resin screed and twice the thickness of the screed in width, e.g. for a screed of thickness 5 mm, the joint cross-section should be at least 5 mm deep and 10 mm wide. With the flow applied floorings of Types 4, 5 and 7 it is normally sufficient to provide a concrete saw cut approximately 5 mm wide into which the flooring should flow, to terminate at the edge.

Resin coatings of Types 1 to 3 do not usually require a special edge detail.

8.12 Channels

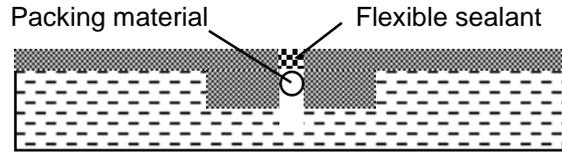
Channels are normally incorporated in floor systems to carry liquids such as spillages and washing water to suitable drains. By the very nature of their purpose and design they may be subject to more stringent and diverse chemical duty than the individual floor areas from which they receive their contents. The channels must be formed with sufficient slope to ensure complete and rapid flow of any discharge to the drains.

Channel design detail can take a variety of forms and in new installations should be designed in conjunction with the specialist contractor. Frequently a preformed stainless steel channel is inset into the underlying concrete. These are inherently flexible, but should have a formed joint between the flooring and the channel to accommodate vehicular traffic or thermal shock.

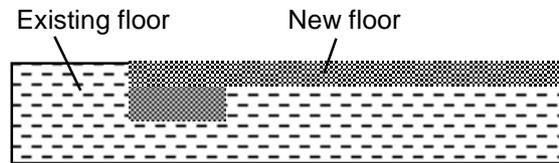
In chemically aggressive environments it is advisable to form the channels in the concrete base and then line the channels with the flooring product thereby maintaining a continuous surface and so avoiding joints in a vulnerable area.

Figure 1: Example of joint details (schematic)

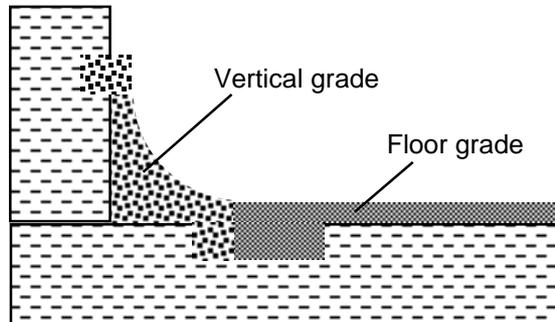
MOVEMENT JOINTS



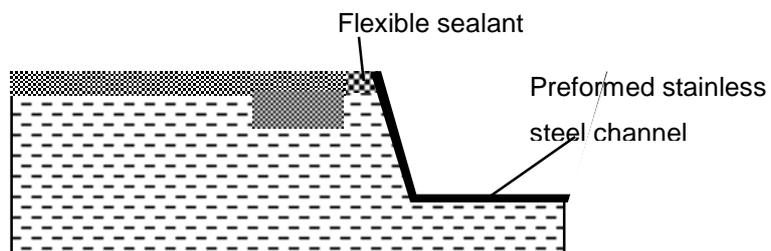
PERIMETER DETAIL / DOOR THRESHOLD



SKIRTINGS



CHANNEL DESIGN



8.13 Skirtings

Where the floor is to be washed regularly or where chemical attack is possible it is essential that the flooring is correctly terminated at perimeters, upstands, columns, etc, to prevent ingress of liquid. Frequently a cove is formed using the flooring material. With such a detail a movement joint needs to be installed at the foot of the wall or cove. The free edge of the flooring should then be terminated into a groove formed adjacent to the movement joint rebate. The width and depth of the chase should be nominally equal to the thickness of the flooring. Anchoring the resin flooring into the groove distributes any stresses created by thermal and mechanical action on the floor.

Where no movement joint is necessary, a simple vertical extension of the synthetic resin flooring may be applied.

Simple skirting details may be extended to related situations such as kerbs or plinths.

8.14 Service penetrations

Although not desirable, in some circumstances services may be required to pass through the flooring surface. A suitable method of achieving this is to have a protective sleeve cast into the base concrete, which permits the services to pass through without direct contact with the floor screed. This is particularly important if the services include pipes carrying liquid at temperatures other than ambient. The sleeve also acts as an upstand to prevent liquids flowing down through the floor.

8.15 Stairs

Flooring to the treads can be formed from each of the different classes of flooring. For the risers special thixotropic grades or renders derived from the flooring products may be necessary. The structural concrete should have been formed to the precise profile of the stairs less the thickness of the flooring. Before commencing application of the flooring the surfaces of the treads and risers should be prepared as described in 9.2 for new bases or in 9.3 for old bases.

9 PREPARATION OF CONCRETE BASES AND SCREEDS

9.1 General

Because of the wide variety of types of product available commercially, this specification can only provide the basic principles that should govern the necessary preparatory work. It is imperative therefore that the flooring manufacturer's instructions are followed precisely.

From the point of view of structural design of the substrate, whether it is slab or screed, the main function of the flooring is to provide a protective finish. The substrate should therefore be designed independently of the flooring to withstand all structural, thermal and mechanical stresses and loads that will occur during service. It should remain stable whilst protected by the flooring and be provided with all necessary expansion, contraction and crack inducement joints to enable it to do so. Failure of the substrate to remain stable will invariably affect stability of the finish. In particular, cracking of the substrate, however caused, is likely to reflect in the finish.

The surface strength of the concrete base or screed needs to be sufficient to restrain any stresses that occur during the setting and hardening of the synthetic resin flooring.

The surface tensile strength of the concrete base or screed, after preparation to remove the surface laitance, should be determined by the method given in EN1542 and should normally exceed 1.5 MPa. Where the mean surface tensile strength is less than 1.5 MPa the designer should specify suitable systems, for example reinforcement of the surface with penetrating resin sealers or more extensive preparation and making good.

Alternatively the surface strength of the base or screed may be assessed using a rebound hammer (Schmidt) in accordance with BS 1881-202. This method has the benefit of allowing a more rapid evaluation of large areas with a greater number of point tests than the pull-off method. For all classes of flooring the rebound hammer readings should generally be above 25, but a lower reading may be acceptable if the surface tensile strength of the base concrete or fine concrete screed exceeds 1.5 MPa. Assessment of the hardness or strength of a concrete base surface with a rebound hammer should only be made at locations having a smooth and clean surface.

The substrate needs to be finished with a strong even surface and laid to such falls as necessary. Synthetic resin floorings are relatively thin and cannot in most instances economically alter levels or

correct badly-laid substrates. Where the levels have first to be finely adjusted a polymer-modified cementitious levelling screed may be appropriate.

In coatings or flow-applied systems, there is an inevitable tendency for the finish to mirror imperfections in the substrate. Permissible tolerances for surface regularity of the substrate must therefore be closer than with alternative floorings.

9.2 New concrete bases and screeds

A direct finished concrete base slab or screed, should be designed and constructed as described in BS 8204-1 and laid to falls as necessary. The concrete should not contain a water repellent admixture where water-based synthetic resin floorings are to be applied. All services should be confined within the base concrete or screed and not allowed to penetrate into the flooring.

In order to achieve sufficient tensile strength in the surface of the base concrete, it should preferably be designed to have a minimum characteristic compressive strength of 35 MPa and adequate workability to allow full compaction.

Unmodified sand/cement screeds are unsuitable to receive synthetic resin floorings because of their low tensile strength, but a polymer-modified cementitious screed or concrete may be acceptable subject to the approval of the flooring supplier.

Care should be taken that during the hardening and curing of the base slab or screed it does not suffer mechanical damage or become contaminated with grease, oil etc. If such problems do arise the slab or screed should be treated as for old bases (see **9.3**).

The concrete and laying technique used should achieve the surface strengths given in **9.1** before the flooring is laid. The surface regularity of the base should be SR1, SR2 or SR3 to match the requirement of the final flooring.

Many synthetic resin flooring systems are tolerant of significant moisture levels in the concrete base. Unless otherwise specified by the flooring manufacturer, the base should be at least 28 days old, with the relative humidity at the surface no more than 75%.

For those synthetic resin floorings that are moisture sensitive during application, it is necessary to ensure that sufficient of the water used in the construction of the base is eliminated. The use of curing membranes will effectively prevent drying out until removed. After the curing of the concrete it is essential that the excess water be allowed to evaporate. The time for this to happen should be taken into account at the planning stage.

Surface preparation is a most vital aspect of all flooring application. The quality and condition of the interface between the substrate and the flooring determine its ability to withstand static and dynamic loads imposed in use. Failure to transfer loads adequately results in loss of adhesion and hollowness.

The laitance on in-situ bases and any surface sealer or non-bonded curing compound should be entirely removed by suitable mechanised equipment, e.g. shot-blasting, planing, grinding, to expose the coarse aggregate cleanly. Care should be taken to ensure that high intensity mechanical treatment does not cause micro-cracking to weaken the underlying substrate. For the thinner floorings, light contained shot-blasting or diamond grinding is preferred so that the profile does not reflect in the finish.

The surfaces of precast units should be left as cast and should be thoroughly prepared to remove all adhering dirt and laitance. The use of contained abrasive blasting equipment is more suitable than mechanical scabbling which could damage the precast units.

After surface preparation all loose debris and dirt should be removed by vacuum equipment. Very fine dust may need to be removed by detergent washing. The preparation operations should be delayed until shortly before the flooring is to be laid to avoid the risk of fresh contamination or further accumulation of dirt.

9.3 Old concrete bases

All surface contamination, e.g. oil, rubber and flaking paint, should be removed and adequate mechanical preparation carried out to achieve a sound and stable surface with exposed coarse aggregate.

When dealing with heavily compacted oil or grease deposits, the bulk of the contamination should first be removed mechanically. A liberal application of a purpose-designed cleaning preparation should then be thoroughly scrubbed into the surface by the use of a mechanical scrubber. Sufficient time should be allowed for penetration followed by thorough washing with clean water before wet vacuum cleaning the entire surface. If necessary these procedures will need to be repeated until the substrate is clean.

Alternatively a more rapid method which may be used in some situations is high temperature burning, often known as HCA - Hot Compressed Air, followed by shot blasting and then a repeat burning followed by application of a penetrating primer.

Where oil or grease contamination has been severe or of long duration none of these methods may prove satisfactory in preparing the base to allow full bonding of the flooring. In such cases removal of the affected base would be necessary followed by reinstatement with new concrete or polymer-modified cementitious screed.

Alternatively, mechanically fixing a metal mesh over the oil-contaminated concrete would provide a mechanical key for the flooring system but would need an oil resistant membrane installed directly over the concrete.

Existing floor paints should preferably be removed by mechanical abrasion or contained shot blasting. If this is not feasible because of other restrictions on noise, vibration, etc, chemical etching may be used. When all existing coatings have been removed chemically, the entire surface must be thoroughly rinsed with clean water. All use of chemical agents should comply with local environmental regulations.

When clear of all surface contamination, the concrete should be mechanically prepared to remove all laitance and expose a fresh surface. This can be achieved with suitable mechanised equipment, e.g. shot-blasting, planing, grinding, to expose the coarse aggregate cleanly. Care should be taken to ensure that high intensity mechanical treatment does not cause micro-cracking to weaken the underlying substrate. For the thinner floorings, light contained shot-blasting or diamond grinding is preferred so that the profile does not reflect in the finish.

After surface preparation all loose debris and dirt should be removed by vacuum equipment. Very fine dust may need to be removed by detergent washing. The preparation work should be delayed until shortly before the flooring is to be laid to avoid the risk of fresh contamination or further accumulation of dirt.

Prior to applying the flooring a close visual examination should be made to verify cleanliness, soundness of the surface and freedom from soft deleterious materials such as lignite and iron pyrites. Any weak or suspect earlier patching should be removed.

When the base is dust free and reasonably dry, a water droplet test is useful to check that any water repellence has been removed and to assess porosity. The procedure is as follows: a droplet of water from a laboratory wash bottle or syringe is applied to the floor from a height of about 10 mm. If the droplet remains intact and does not spread laterally or soak into the concrete within a few minutes, this indicates that materials might be present that could reduce the bond of the flooring. In this case, further floor preparation would be necessary to remove the residual contamination. Very densely trowelled high quality concrete bases can be highly impermeable to water penetration and give a similar effect to the presence of water repellents, etc. Where difficulties in bonding the flooring are anticipated special advice on bonding methods could be necessary. Alternatively a trial area should be applied, allowed to cure and the degree of bond assessed by the method of EN 1542.

Acid etching is no longer a recommended method of surface preparation because of the health and safety risks associated with its use and the fact that the surface is left thoroughly saturated with water and calcareous salts which may cause osmotic blistering at a later stage.

9.4 Other substrates

Special procedures are available for other substrates, eg metal, timber, ceramics, etc, and the flooring manufacturer's instructions should be strictly followed.

10 WORK ON SITE

10.1 General

Because of the wide variety of types of product available commercially, this specification can only provide the basic principles which should govern the site application procedures. It is imperative therefore that the manufacturer's instructions are studied in advance of the work starting, since particular recommendations or restrictions may influence the overall programme. These instructions should be incorporated in the flooring contractor's method statement.

10.2 Materials storage

Storage should be arranged so that consignments can be used in the order of their batch numbers. It is therefore important that labels do not become damaged or detached from their containers.

10.2.1 Powder components and aggregates (including any pigments)

Bags of fillers, aggregates or other powdered components should be kept dry and stored in a weatherproof building. If the floor is concrete, the bags should be stacked on a timber pallet away from walls. Fillers and aggregates should be kept preferably at 15° - 20°C to ensure that the resultant flooring mix does not set too quickly or too slowly.

10.2.2 Liquid components

The containers of resins and hardeners should be stored in a weatherproof building maintained preferably at 15°-20°C, unless the product manufacturer has stipulated other storage conditions for the stated shelf life.

10.3 Batching

All materials should be accurately proportioned and mixed in the correct sequence in accordance with the manufacturer's recommendations. It is usual to mix the liquid components together thoroughly before blending in the fillers and aggregates.

The usable life of the mixed materials depends upon the temperature of the mixed materials. Manufacturers' literature should give an indication of the working life of the properly mixed product at one or more temperatures. As a rough guide, a 10°C rise in temperature may halve the working life and a 10°C fall may double the working life. However it is not advisable to mix and lay these products outside of the range 10-25°C unless the system has been specially designed to be used for a different temperature range.

Resin systems are generally exothermic and so an important factor governing the temperature of the mixed materials, is the volume being mixed. Larger volumes will heat up more so shortening the available working life.

If the mixing area is not adjacent to the laying area an appropriate allowance for the time to transfer the mixed material should be made to ensure sufficient time for the product to be installed within the working life.

10.4 Mixing

10.4.1 Primers

The primer is usually a two pack formulation supplied in pre-weighed quantities ready for site mixing. The two components should be thoroughly mixed together mechanically to form a homogenous mix. The two components should be mixed preferably using a slow speed (200-500 rpm) drill fitted with a mixing paddle, taking care not to entrain excessive air in the mix.

It is important to ensure that any material adhering to the sides and bottom of the mixing vessel is always thoroughly mixed in. It is good practice to transfer the mixed material into a clean container and stir well before application. This procedure prevents the use of partially mixed material.

10.4.2 Flooring mix (including trowel-applied mixes, self-smoothing mixes and coatings)

All mixes should be mixed mechanically. Resin coatings shall be mixed using a heavy duty slow speed drill (200-500 rpm) drill fitted with a mixing paddle. Forced action mixers of the rotating pan, paddle or trough type shall be used for all flow applied and trowel applied screeds. Free fall mixers are not recommended because there is insufficient shear action to disperse all the dry materials.

The reactive components are first thoroughly mixed together and then the fillers and/or aggregates are added gradually whilst continually stirring. After all the fillers and/or aggregates have been added, sufficient mixing time (typically 3-4 minutes) must be given to ensure thorough 'wetting' out of the fillers and/or aggregates by the binder. Excessively vigorous mixing shall be avoided as this can lead to undesirable air entrainment. Care should be taken to ensure that any material adhering to the sides, bottom and corners of the mixer is thoroughly blended in.

10.5 Laying Synthetic Resin Flooring

10.5.1 Priming the substrate

The primer should be chosen to be compatible with the conditions of the substrate. Ideally the primer should be a solvent-free, low viscosity composition in order to reduce the risk of solvent entrapment in the concrete and to maximise penetration of the primer into the surface.

After mixing the components of the primer together, it should be applied as soon as possible after mixing (and well within its working life) to the prepared substrate. The primer should be applied evenly to the substrate with a stiff brush or roller or by tight trowelling. The substrate should be completely wetted by the primer to achieve maximum penetration into the substrate and ensure good adhesion and to prevent pin-holing. Full saturation of the surface is desirable but pooling of the primer should be avoided by using a roller to remove any excess.

When applying the screeded synthetic flooring of Types 6 and 8, a useful technique is to apply a scatter of fine dry aggregate over the liquid primer, but avoiding localised saturation, in order to provide a key for adhesion of the flooring and to reduce slippage under the trowel. As a guide an aggregate addition rate of 0.5 to 1.0 kg per m² should be suitable. This also helps to reduce the risk of limited bond if the primer has cured too far.

With flow applied systems, two coats of primer, or an excess of primer in one coat, may be necessary to prevent pin hole defects in the finish, and it is a wise precaution to provide for this in terms of material consumption and timing.

The area of substrate which can be coated with the primer prior to the laying of the flooring will depend on the working life of the primer, as specified by the manufacturer. Unless otherwise specified, the primer should be partially cured to a tacky stage before the resin flooring is applied, to ensure a good bond between the primer and the applied resin finish. However for certain systems, particularly flow applied resin systems, it is essential that the primer should have become tack free. The manufacturer's instructions must therefore always be followed.

10.5.2 Resin Coatings (Types 1-3)

These coatings are usually applied by spray, brush or roller in 2 or more coats, applied at right angles to each other. Typically the first coat is allowed to cure before the second coat is applied. The manufacturer's instructions on timing must be followed to ensure full bond between the coats.

10.5.3 Multi-layer flooring (Type 4)

These products are normally made using combinations of floor coatings (Types 2-3) or flow-applied flooring (Type 5) with intermediate aggregate scatter. They should be applied strictly in accordance with the manufacturer's instructions.

10.5.4 Flow applied systems (Types 5 & 7)

These compositions are designed to flow out readily in order to provide a smooth substantially level surface. They are applied by spreading evenly over the surface, using a serrated trowel, pin rake or squeegee. This should be followed by rolling with a spiked roller to release any entrapped air and assist in smoothing out. The use of the spiked roller on areas which are starting to thicken or are partially set should be avoided.

The quality of surface finish achieved with flow applied systems is particularly temperature sensitive and the manufacturer's recommendations in terms of minimum air and slab temperatures should be strictly adhered to. Forced heating of the atmosphere over a cold slab is undesirable since it can promote blistering of the surface.

10.5.5 Trowel-Applied Resin Flooring (Types 6 & 8)

The material should be spread out over the primed substrate between screeding laths or bars or using a screed box (sledge) to ensure a uniform thickness and level surface throughout. The screed should be well consolidated in order to obtain the optimum properties from the end product. A final smooth finish should be obtained using a suitable steel trowel. Carbon steel trowels can lead to unsightly marking of the flooring surface. The trowel should be kept clean at all times by using a minimum amount of cleaning solvent or water as advised by the manufacturer. Over-trowelling should be avoided as this can cause patchiness and blistering in the finished floor.

Trowel-applied resin flooring provides a durable slip resistant floor surface for most applications. However if a more hygienic surface is required, it may be necessary to seal the surface using a one or two coat application of a compatible resin sealer, much of which is absorbed into the trowel applied flooring. This may be either a solvent-free or solvent-containing system applied by brush, squeegee or

roller. It is usually applied after the screed has cured, but taking care to ensure that the surface has not been contaminated during the curing period.

10.5.5 Reinforcement

Reinforcement, such as fibre glass cloth, may be included in the flooring system to minimise problems from cracks or bay joints in the substrate. After applying the primer, a thin layer of the resin flooring is applied and the fibreglass is rolled into it, overlapping the fabric at joins by at least 50 mm. Entrapped air should be avoided. The final layer of resin flooring is then applied. If necessary, any outstanding reinforcement should first be ground off.

10.5.6 Curing

The final floor system should be allowed to cure according to the manufacturers' instructions. These generally require 1-3 days at 15°-20°C before trafficking and 3-7 days before washing, before contact with chemicals, or before any ponding tests. At site temperatures below 10°C these times will be substantially increased.

The climate above the uncured resin floor should be maintained at least 3°C above the dew point or below 75 % relative humidity to reduce the risk of condensation or 'blooming' on the floor finish. Condensation occurs when the substrate temperature is lower than the dew point temperature, which is a function of the relative humidity and the ambient air temperature. Table 4 shows the approximate relationship between these variables.

Table 4: Dew point temperatures

Ambient dry temperature °C	Dew point temperatures (°C) for ambient relative humidity between 40 and 100% RH						
	40%	50%	60%	70%	80%	90%	100%
35	19	23	26	29	31	33	35
30	15	19	22	24	26	28	30
25	11	14	17	19	21	23	25
20	6	9	12	15	17	18	20
15	2	4	7	10	12	13	15
10	-3	0	3	5	7	9	10
5	-7	-5	-2	0	2	4	5

11 OSMOTIC BLISTERING

11.1 Occurrence

In a few cases severe blistering of synthetic resin floorings occurs some while after laying, typically between 3 months and two years later. These blisters commonly vary in size from a few mm in diameter up to 100 mm with heights up to 15 mm. When drilled into or otherwise broken the blisters are found to contain an aqueous liquid under considerable pressure. The mechanism of their formation is not fully understood but it is assumed because of their physical state that they are caused by a process of osmosis. Blistering which occurs soon after laying is generally caused by vapour pressure from moisture in the substrate.

Osmotic blisters are generally confined to synthetic resin floorings, resin coatings and flow applied systems, up to about 6 mm in thickness. The problem has not been observed with trowel applied resin floorings probably because of their higher resistance to deformation and greater lateral permeability.

Osmotic blistering can occur on suspended floors, as well as on ground supported slabs, if sufficient moisture is retained in the concrete.

11.2 Prevention

Because the mechanism is not fully understood it is not possible to be specific about the steps which should be taken to avoid osmotic blistering. However it is considered good practice to take the following steps in order to minimise the risk.

- a) in new construction ensure the base concrete has low soluble salts by avoiding poorly washed aggregates and by curing the concrete well immediately after laying to prevent premature

- surface drying out;
- b) allow the concrete to dry out thoroughly after curing, preferably for a minimum of 21 days;
- c) by the use of mechanical rather than chemical means of preparing the concrete surface. In particular by avoiding the use of acid etching;
- d) by avoiding washing the concrete surface with detergent solutions as part of the preparation procedure;
- e) by the complete removal of all contamination from existing floors: this may prove very difficult where the concrete has been saturated for long periods with water soluble materials;
- f) any levelling screeds should preferably be polymer-modified to minimise permeability and salt migration;
- g) by avoiding the use of water-dispersed primers;
- h) by the use of primers which are free of water soluble constituents which might promote osmosis, for example, benzyl alcohol;
- j) by avoiding the use of solvents, especially in the primer;
- k) by ensuring that the synthetic resin flooring is precisely proportioned, either by weight or volume as specified by the product manufacturer;
- l) by applying a scratch coat underneath.

11.3 Repair

Where osmosis has occurred, techniques which have proved successful in preventing the problem re-appearing, after cutting out the affected area and mechanically cleaning the exposed concrete, include:

- a) double application of a penetrating primer to the base to ensure complete coverage and maximum adhesion of the replaced flooring;
- b) replacing with a trowel applied flooring;
- c) hot compressed air blasting of the exposed concrete coupled with the application of a penetrating primer whilst the concrete is still warm.

12 HEALTH AND SAFETY PRECAUTIONS

12.1 General

- a) Care shall be taken to ensure that all procedures comply fully with national and local Health and Safety and Environmental regulations.
- b) Before starting any operations the manufacturer's Materials Safety Data Sheets for all the flooring products to be applied shall be studied and all recommendations followed in addition to those listed here.

12.2 Synthetic resin flooring

When mixing and/or laying synthetic resin floorings, precautions taken should include the following:

- a) Full protective clothing should be worn to prevent all contact of the products with the skin. Gloves resistant to the synthetic resins should be worn at all times. Goggles or full face shields should be worn during mixing and at any time when splashing is a risk.
- b) It is good practice to apply an appropriate barrier cream on the hands at the beginning of each session.
- c) Any splashes of product on the skin should be washed off immediately using soap and water or preferably a proprietary resin-removing cream. Cleaning solvent should never be used on the skin since it defats the surface and aids deeper penetration of the contamination.
- d) Any splashes of the product in the eye should be treated immediately by washing with copious amounts of water. Medical treatment should then be sought taking full product details so that correct medication can be supplied.
- e) None of the flooring materials should be swallowed. If any is accidentally ingested a doctor should be consulted immediately. The consumption of food and drink shall be prohibited in the vicinity of the mixing and laying operations.
- f) Effective exhaust ventilation to atmosphere should be provided in all areas where the flooring products are being mixed or applied, to prevent build up of fumes or contamination of adjacent areas.
- g) Smoking should not be allowed in the vicinity of the mixing or laying operations.
- h) Some synthetic resin flooring products contain flammable components, which are not necessarily solvents. No sources of ignition should therefore be allowed in areas where the components are stored, blended or applied.

13 INSPECTION AND TESTING OF FLOORING

13.1 Inspection

The works should be inspected during progress and after completion, special attention being paid to the following:

- a) quality and preparation of the base;
- b) levels and surface regularity of the base;
- c) climatic conditions, throughout the application stages;
- d) priming of the base;
- e) mixing/batching of the flooring;
- f) laying the flooring, including the applied thickness;
- g) levels and surface regularity;
- h) sealing, if any;
- i) curing;

13.2 Testing

At the appropriate time after laying the flooring, tests may be carried out for the following:

- a) levels and surface regularity;
- b) adhesion of the flooring to the base;

The following tests are normally made only when there are specified performance requirements and the quality of the flooring is in dispute:

- c) slip resistance;
- d) abrasion resistance.

13.3 Levels and surface regularity

When the flooring is tested by the methods described in BS 8204-1, the departure from datum should be within the limit specified and the surface regularity should be within the limit given in Table 3 for the appropriate class specified.

The number of measurements required to check levels and surface regularity should be agreed between the parties concerned bearing in mind the standard required and the likely time and costs involved.

13.4 Adhesion of the flooring to the base

13.4.1 General

The adhesion between the flooring and the base may be examined by tapping the surface, e.g. with a rod or a hammer, a hollow sound indicating lack of adhesion or possibly, hollowness in the substrate. Tests to check the adhesion of a flooring to its base should be made as late as possible in a construction programme when the flooring will be fully cured. Those areas of flooring that are considered to be unsatisfactory should be treated by isolating the area concerned by sawing, removing and re-laying the affected flooring. When removing an area of flooring, care should be taken to minimise any loss of adhesion of the adjacent part of the flooring.

13.4.2 Quantitative test method

The preferred method of testing the adhesion of the flooring to the base is that of EN 1542. When tested by this method, a mean bond strength of at least 1.5 MPa with an absolute minimum of 1.0MPa should be obtained, provided the substrate itself was of this quality initially. Slightly lower values may be acceptable provided the failure occurs within the concrete substrate.

13.5 Slip resistance

The floor should be tested in accordance with the method described in BS 8204-2. The slip resistance value should be in accordance with the design value, see **8.2**.

13.6 Abrasion resistance

The floor should be tested for abrasion resistance in accordance with the BCA method described in BS 8204-2 or the Swedish Rolling Wheel tester of SS 923508. The value obtained should be in accordance with the design value. These test methods are not appropriate for on-site testing of thin coatings of Types 1-3.

14 MAINTENANCE

The designer shall provide full specification for the maintenance procedures to be adopted in order to optimise the life cycle of the flooring.

Under normal circumstances, frequent washing of the surface with a compatible detergent solution should be sufficient to maintain the floor surface in a clean condition. In areas where hygiene is of prime importance regular sterilisation with bactericide solutions should be adopted. Food preparation areas, where there is the risk of accumulation of fats or food residues, may need frequent hot water jetting at temperatures of 60 to 80°C. Steam cleaning may be appropriate in some cases but the type of flooring used must have been chosen to suit.

All potentially corrosive spillages should be immediately mopped up with appropriate absorbents or washed away with copious amounts of water.

Localised damage to the floor surface should be repaired at the earliest opportunity to prevent liquids penetrating to the bond line and causing lateral failure.

A detailed record, including location, extent and date(s), should be maintained of all damage and subsequent repairs.

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