FeRFA
THE RESIN FLOORING ASSOCIATION

Resin Bound Systems for External Applications

from the voice of the resin flooring industry for over 50 years

Guidance Note N° 14

FeRFA, the Resin Flooring Association, represents the major product manufacturers, specialist contractors, raw material suppliers and specialist service providers within the UK Resin Flooring, Screeding and Surface Preparation industry sectors.
As the association dedicated to seamless resin flooring for over 50 years, FeRFA leads the way in providing advice, guidance and training support.

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1 Introduction

This guide is based on the collective knowledge of FeRFA members having extensive experience in the requirements for successful applications of resin bound surfacing. In separate sections, the guide gives recommendations for the selection, design, substrate preparation, application, maintenance and for the inspection and testing of **resin bound surfacing**. Its scope includes resin bound surfacing applied to concrete, asphalt concrete conforming to EN 13108-1 and hot rolled asphalt conforming to EN 13108-4. Resin **bonded** surfacing is often specified for similar applications. More details on these types of systems can be found in FeRFA Guidance Note No 13 - Resin Bonded Surfacing Systems for External Applications.

② Design

2.1 Who is the Designer?

The designer is that person or organisation who:

- Takes control and responsibility for the design of the surfacing;
- Ensures that they are provided with all the information as set out in Section 2.2;
- Provides all the information set out in Section 3.1 to the Contractor.

A specialist contractor may be deemed the designer if and only if they are provided with the information set out in Section 2.2.

The person or organisation which provides a contractor with a standard form of specification which contains some or all of the information set out in Section 3.1 is ipso facto 'the designer'. The designer is responsible for all aspects of design and should not rely on the contractor to design those aspects which they have failed to include.

2.2 Information Required by the Designer

The following information should be provided to or sought by the designer.

- Description, situation and address of site and means of access;
- Those conditions of contract that might practically affect this particular work;
- Location, intended use and areas to be covered;
- Age and nature of the base and its strength and finish;
- The type and intensity of traffic to be expected;
- Condition of the sub-grade and possible need for a capping layer;
- Composition of the subgrade and possible need for additional drainage (fully permeable resin bound surfacing only).
- Location of manholes, surface drains, etc;
- Drainage requirements;
- Description of junctions with existing edgings/hard landscaping/buildings;
- Location of trees;
- Available depth from finished surfacing level to top of the base;
- Any programming constraints.

2.3 Typical Resin Bound Surfacing Applications

Resin bound surfacing is suitable for foot traffic and light vehicular traffic up to 7.5 tonnes and is not recommended for applications where trafficking by heavier vehicles is expected. Typical applications include private and long stay car parks (excluding decked car parks and shopper's car parks), driveways, podium decks and terraces, public squares, courtyards, footpaths and pool surrounds.

Resin bound surfacing should always be chosen for application to permeable pavements and may be preferred to resin bonded surfacing in areas such as playgrounds where children may suffer more serious abrasive injury by falling on coarser textured resin bonded surfacing. Resin bonded surfacing should always be chosen for roads subject to traffic by heavy vehicles.

2.4 Resin Bound Surfacing Composition and SuDs Compliance

Resin bound surfacing is composed of kiln-dried aggregates bound with a clear resin, typically laid from a minimum thickness of 15 mm to 20 mm. Resin bound surfacing may typically be laid on a solid base of concrete, asphalt concrete or hot rolled asphalt. Some products are available for application at a greater thickness to compacted aggregate bases, but these products should only be used on footways. Manufacturers' specific instructions and recommendations should be followed.

When used with a suitably graded aggregate blend and resin to aggregate ratio, resin bound surfacing is porous. The rate at which water will flow through the surfacing is affected by the choice of aggregate grading as is the ultimate strength of the cured material. It may be applied to existing non-porous bases when an adequate fall is in place and water is free to drain at the interface of surfacing and base. Resin bound surfacing applied to a correctly designed porous base and sub-base will facilitate design of a SuDs compliant permeable pavement construction reducing flood risk and permitting rainwater to flow into natural water courses.

2.4.1. Resin to Aggregate Ratio

The following table is for guidance and reflects the need to consider the resin to aggregate ratio when selecting a resin bound system. The performance of a resin bound surfacing blend can be affected not just by the type and size of aggregate and fine filler selected, but also by the ratio of resin to aggregate. Resin content can seriously affect the performance and service life of the surfacing and although some aggregate blends may require fractionally more or less resin depending on shape and angularity of aggregates and porosity of fine fillers, the specifier or client should consider whether a significant departure from resin content shown in the table will affect the durability of the surfacing. Some manufacturers may publish alternative ratios and it is always advisable to seek their advice directly. The manufacturer's recommendations regarding mix ratios should be strictly followed.

**These figures reflect the majority of the FeRFA members contributing to this guidance table.

Aggregate Size	Resin Pack Size	Aggregate Batch Size	Sand/filler within the Mix	Total Aggregate Weight	Total Batch Size	**Resin Content	**Resin to Aggregate
<1-3 mm	8 kg	100 kg	0	100 kg	108 kg	7.41 %	8.00 %
1-3/2-5 mm	7.5 kg	100 kg	6.25 kg	106.25 kg	113.75 kg	6.59 %	7.06 %
3-6 mm	7.5 kg	100 kg	6.25 kg	106.25 kg	113.75 kg	6.59 %	7.06 %
2-5 mm with 6-10 mm	7.5 kg	100 kg	6.25 kg	106.25 kg	113.75 kg	6.59 %	7.06 %
6-10 mm	6 kg	100 kg	7 kg	107 kg	113 kg	5.31 %	5.61 %

2.4.2. Aggregate Selection

Natural aggregates are most commonly used but coloured glass and artificially colour coated aggregates are also available. The designer should be aware that glass crushes more easily than most natural aggregates and has been known to suffer damage under high heeled shoes. Aggregates with UV stable coloured coatings can be sourced but coating loss can occur under regular medium to heavy foot traffic. The designer should consider restricting the use of coloured glass and colour coated aggregates to areas with light traffic only.

2.4.2.1. Slip and Skid Resistance

Initial pendulum test results and other means of measuring slip and skid resistance values (SRVs) should not be taken in isolation as a guide to long term slip and skid resistance of a surface, particularly when the surface is subject to heavy wear as slip resistance can reduce over time. Steep gradients will also affect SRV and aggregates with high SRVs should be considered. Poor cleaning will lead to reduced slip resistance (see section 4. Care & Maintenance).

2.4.2.2. Wear and Crushing Resistance

The initial SRV will be affected during service by other aggregate properties such as Polished Stone Value (PSV), which measures the resistance of aggregates to polishing. A high PSV will ensure extended slip and skid performance. Aggregate Abrasion Value (AAV) measures resistance to abrasion and a low AAV is desirable when a surface is subject to heavy wear. Aggregate Crushing Value (ACV) is also important to performance in service and some aggregates, such as quartz, may be relatively hard but may not resist crushing as well as granite and basalt. A low ACV is desirable for surfaces subject to regular vehicle traffic.

2.4.2.3. Rust Staining

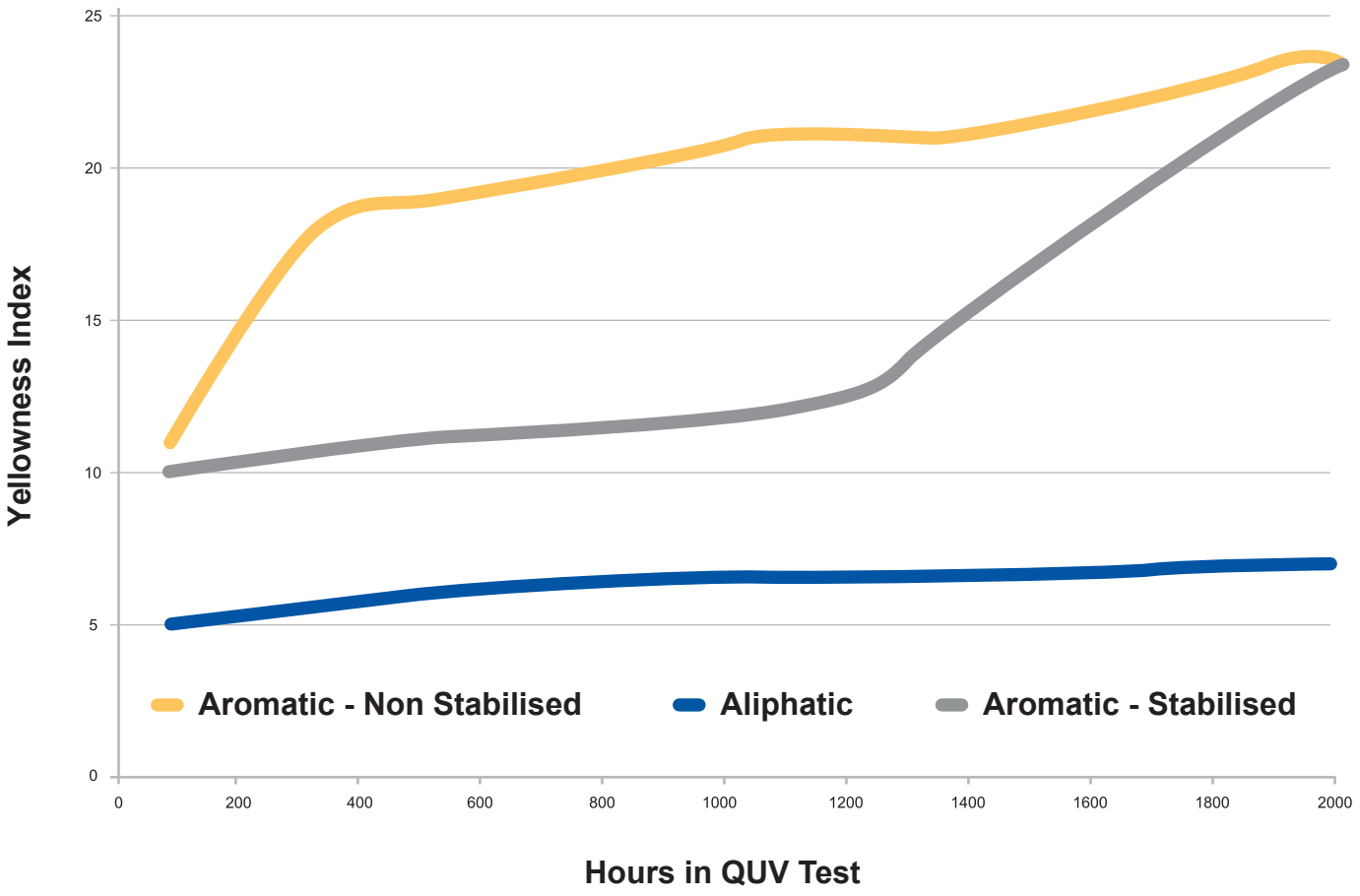
Natural aggregates may contain small amounts of iron which can produce rust staining when exposed to air and water. Standard resin bound surfacing blends contain aggregates selected for infrequency of incidence of staining, but iron may be present in any natural aggregate. The presence of iron cannot be identified before use and any resulting stains should not be regarded as a product defect. The performance of surfacing which exhibits rust staining is not usually affected by the stains.

2.4.3. Resin Binder Selection

Binders for resin bound surfacing are generally polyurethane based. There are two types of polyurethane resin used for resin bound surfacing. One is termed ‘aliphatic’ and tends to be stable on exposure to ultra-violet light (UV stable) and the other termed ‘aromatic’ will yellow and darken on exposure to UV light.

When retention of the original colour is required, UV stable resins should be chosen. Even when yellow/brown aggregates are specified which may mask some yellowing of the binder, on most installations, some areas are exposed to UV light and some are in shade, some areas may be under foliage or covered by movable objects, such as plant pots. In these circumstances, shade variation can occur. UV degradation can also lead to a loss of gloss known as “chalking” where the surface becomes duller over time.

Some aromatic binders (usually based on isocyanates known as MDI) may be marketed as being ‘UV resistant’. This is usually achieved by incorporating chemical additives known as UV “stabilisers”. Evidence suggests that although UV “stabilisers” may delay the effects of UV light, they only delay degradation. The composition and properties of resin binders may differ in terms of the performance characteristics they offer so the designer should always seek specific advice from the manufacturer about the effects of long-term exposure to ultraviolet light in relation to the aesthetic appearance and long-term physical properties of the system.



Aromatic polyurethanes are excellent for numerous uses and are widely used for flooring where their resistance to wear and chemical spillages make them an obvious choice for many industrial applications. However, their lack of resistance to ultraviolet light makes them less suitable for exterior use, except where they are protected from UV exposure, for example as underlayments or as binders for resin bonded surfacing.

2.5 Technical Performance Standards

Binders for resin bound surfacing should be sufficiently elastic to withstand minor substrate movement yet strong enough to cope with trafficking and imposed loads. FeRFA members involved in resin bound surfacing have agreed minimum performance requirements for the compressive & flexural strength of a standard mix design using proprietary resin binders before and after artificial weathering.

2.5.1. Test Methods

Compressive and flexural strength testing should be carried out in accordance with BS EN 13892-2 on samples prepared in accordance with BS EN 13892-1 (synthetic resin). A second 'control' set of specimens should be prepared allowing comparison of physical properties before and after artificial weathering. Cure times of 1 day in the mould followed by 13 days out of the mould shall be used at the storage conditions specified in BS EN 13892-1. Samples shall be prepared using the following standard mix design.

2 - 5 mm European Autumn Quartz	75 kg
1 - 3 mm European Autumn Quartz	25 kg
C52 silica sand	6.25 kg
Resin binder	7.50 kg

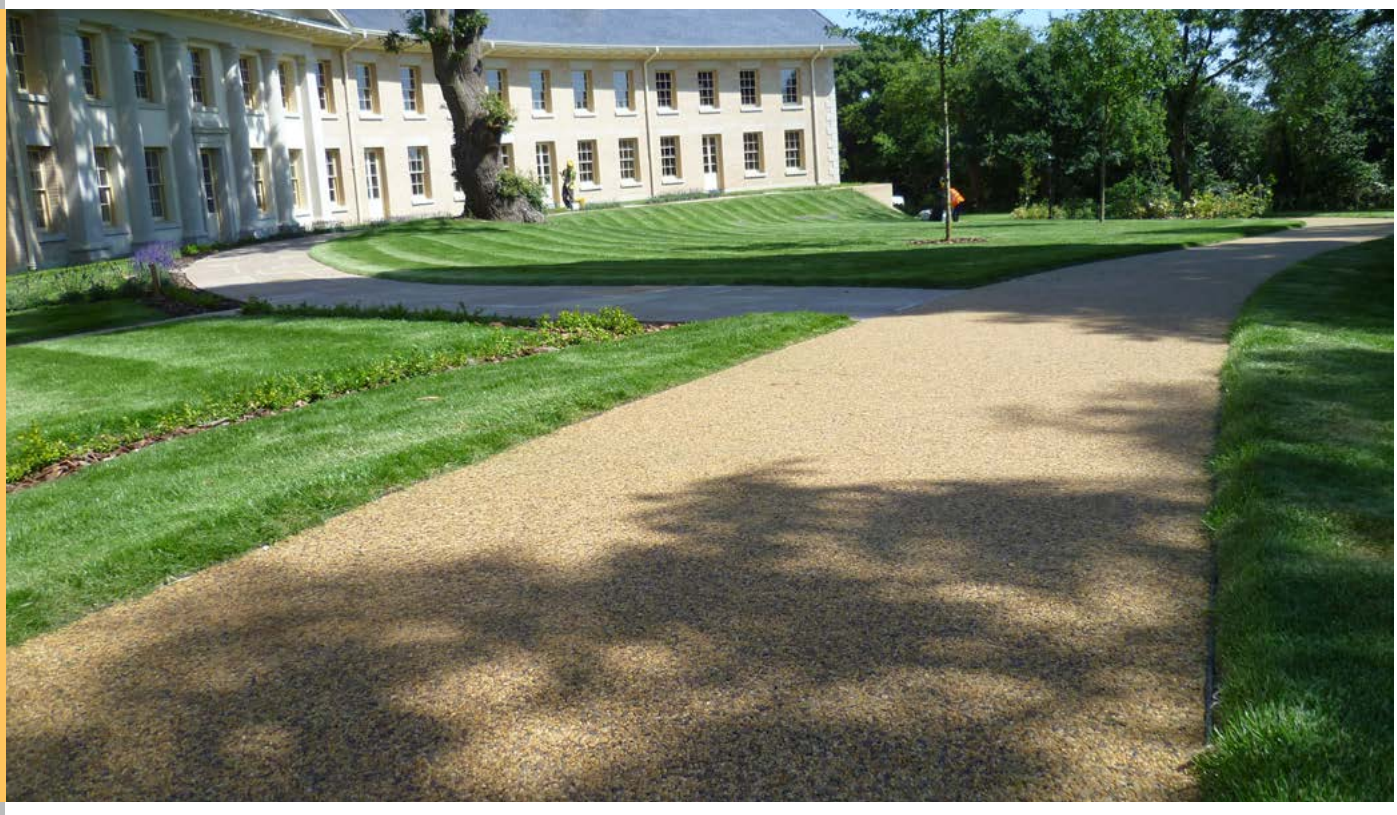
The specified weathering regime shall be as described in BS EN ISO 16474-3 method A, cycle No 1 with an exposure duration of 2000 hours.

Exposure Period	Lamp Type	Irradiance	Black-panel Temperature/˚C	Relative Humidity/%
4 h dry	UVA-340	0.83 W/m^2/nm at 340 nm	60 +/- 3	not controlled
4 h condensation		UV radiation off	50 +/- 3	not controlled

2.5.2. Minimum Performance Requirements

All samples shall achieve a compressive strength of ≥ 5 N/mm^2 and a flexural strength ≥ 2 N/mm^2 before and after artificial weathering when tested as described above. In addition, there should be no reduction of the initial compressive and flexural strength after exposure.

Bespoke aggregate blends should also meet the minimum performance requirements when tested as above before and after artificial weathering.



2.6. Recommended Thickness

- Foot traffic and driveways with no turning vehicles: 2 – 5 mm & 3 – 6 mm aggregate, minimum 15 mm thickness.
- Larger driveways and car parks: 2 – 5 mm & 3 – 6 mm aggregate, minimum 18 mm thickness.

2.7. Cracking

Cracking is principally caused by movement or settlement in the base or sub-base, movement of elements such as edgings or stress relief cracking at manholes etc.

2.7.1. Base Movement

Cracks caused by base movement in concrete slabs are rare but economic considerations and the increased construction thickness often required dictate that resin bound surfacing is frequently applied to asphaltic bases. It is good practice only to apply resin bound surfacing to asphaltic bases with a bitumen binder which has a 'pen' or penetration test value ≤ 100/150 when tested in accordance with BS EN 13108-1 but some flow of asphaltic materials in warm weather will occur irrespective of the hardness of the bitumen. When flow of the bitumen is enough to exceed the tensile strength of the surfacing, cracking will occur. In such cases there may or may not be cracking of the base.

2.7.2. Sub-base Settlement

Settlement of the sub-base caused by inadequate compaction or by movement of the sub-grade, typically in clay belts, may result in cracking of the surfacing.

2.7.3. Edgings

Edgings such as concrete or timber kerbs may be inadequately restrained, there may be settlement of the restraints or vehicles such as mowing machines crossing edgings from hard to soft landscaping may cause movement of the edging. Cracking of the surfacing adjacent to the edging will occur if the edging moves and the adhesion strength between edging and surfacing exceeds the cohesive strength of the surfacing at that point. Positioning of isolation joints at edgings should be considered as a means of crack prevention. Closed cell polyethylene strips applied to edgings before surfacing is laid is suggested. The use of permeable trims should be considered to allow adequate drainage between demarcated sections.

2.7.4. Stress Relief Cracks

Stress within the surfacing which would otherwise not be expressed can occur at re-entrant corners, manholes etc. causing cracking to occur. Positioning of isolation joints at all surfacing perimeters should be considered as a means of crack prevention. Closed cell polyethylene strips applied to perimeters before surfacing is laid is suggested.

2.8. Detailing

Sufficient time should be allowed at the tendering stage for the correct fixing operations of trims and drainage channels. Failure to carry out this operation correctly can lead to premature de-bonding or cracking of the system.

2.8.1. Joints

Movement joints in the base must not be bridged. A mechanical movement joint trim should be securely fixed to the base before application of the surfacing. Open bay joints should be expressed as bay joints in the surfacing or treated in the same way as movement joints. Consideration should be given to the risk of closed bay joints opening up later.

Formed day-work joints are simple butt joints in the surfacing. Care should be taken by the contractor when planning the works to reduce the length of daywork joints where possible and to position joints where they will have the least possible visual impact. Daywork joints should be finished with a 90-degree angle and should be straight unless otherwise agreed e.g. where curved features with different aggregates have been designed. Positioning of closed cell polyethylene strips to produce isolation joints at all surfacing perimeters including ironwork and re-entrant corners should be considered as a means of crack prevention.

2.8.2. Edging Strips

Aluminium edging strips may not be suitable for free edges where crushing could occur due to the malleable nature of the material. Where this may be an issue, stainless steel should be the material of choice. Consideration should also be given to perforated edging strips which allow the passage of water.

In all cases, edging strips and joint details should be securely fixed to the substrate with a suitable adhesive or by mechanical means. In the case of bituminous substrates e.g. asphalt, trims should be mechanically fixed due to the difficulty in adhesives bonding to both surfaces owing to the oily nature of the material and the movement of the substrate over time.

2.8.3. Drainage Channels

Consideration should be given to open-sided/perforated drainage channels to collect and convey rainwater percolating within the resin bound surfacing to drainage points. Standard drainage channels should not be drilled/perforated on site without the express permission and advice of the channel manufacturer as this practice could lead to weakening of the structure.

2.9. Waterproofing

When a waterproof membrane is required which must be positioned directly below the resin bound surfacing, the designer should be satisfied that the membrane is seamless, compatible with the surfacing and fully bonded to an in-situ base. Adequate adhesion to bituminous or EPDM membranes is highly unlikely, and the best results are more likely to be achieved when bonding the surfacing to a resin-based membrane. Most resins are only open to adhesion for a brief period and it is unlikely that adequate adhesion can be achieved without inclusion of a kiln-dried sand scatter into the wet surface of the membrane or mechanical/chemical preparation of the membrane before the surfacing is to be applied. Site trials are strongly recommended. When possible, the membrane should be protected by a polymer modified screed which will provide an ideal substrate for the surfacing.

2.10. Weather Protection and Curing

Adequate weather protection must be provided at the workstation if works are to be carried out when rain is possible and kiln-dried aggregate must be covered. The contractor must not rely on packaging to prevent moisture ingress. Aggregates should not be stored under tarpaulins for long periods unless adequate ventilation can be provided to prevent moisture ingress from atmospheric humidity. Kiln-dried aggregate which has become damp must not be used. Substrates which have become wet must be allowed to thoroughly dry before application proceeds. Application of resin bound surfacing should be avoided if rain, dew or frost are expected before the resin has achieved sufficient cure.

2.11. Inspection & Testing

The designer should specify what, if any, tests are to be carried out during or after application of the surfacing. This should include the type of test, the number of test positions, whether these are on a random or grid basis and the acceptance limits. Tests may include:

2.11.1. Surfacing Thickness

Periodic checks may be carried out during application to ensure that the specified minimum layer thickness is maintained.

2.11.2. Slip Resistance

Slip resistance tests may be carried out using the methods described in BS 8204-6 (pendulum or trolley/ramp test). Tests are normally carried out in both wet and dry conditions. The pendulum test value (PTV) should generally not be less than 40 in both the wet and dry conditions or as specified by the designer. Please note that slip potential is influenced by gradient and steep gradients may require aggregate blends which provide greater slip resistance. Slip resistance can be improved by an even application of fine aggregate to the surface of the freshly applied resin.

3 Application

Application of resin bound surfacing requires specialist skills in substrate preparation, mixing and application. The advice of the manufacturer/system supplier should be sought when choosing a contractor or preparing a tender list.

3.1. Information Required by the Contractor

The following information is required by the Contractor. It is strongly recommended that this information is properly recorded.

- Location of the project;
- Type(s) of surfacing to be laid;
- Programme constraints;
- Relevant details of the base;
- Preparation of the base surface to be carried out;
- Design thickness of the surfacing and minimum thickness to be achieved;
- Joint details and locations.

3.2. Application of Resin Bound Surfacing

- Prepare concrete by mechanical means to provide a sound, clean, dry substrate that is free from laitance and suitable for application of the resin bound surfacing. Asphalt concrete must have cooled and hardened and must be clean, dry and free from loose materials. Resin bound surfacing should not be relied upon to make good an already weak surface.
- The bitumen binder of asphalt concrete must have a pen value no greater than 100/150, when tested in accordance with EN 1426 (Needle Penetration Test). It is advisable to use a harder grade of bitumen when machine application is possible and 70/100 pen (or harder) is preferred. Bituminous materials with a higher pen value will be too soft and may deform in warm weather.
- Adequate compaction of the sub-base and base is essential to prevent cracking. A minimum 1 tonne “sit on” roller should be used when possible and the contractor must ensure that the construction is fully restrained at all edges to ensure dimensional stability.
- Ensure that falls are in place to provide adequate drainage when applying to an impermeable base.
- Protect ironwork and termination points as necessary using duct tape to prevent spillage of mixed resin/aggregate sticking to other surfaces.
- Protect all edges abutting soft landscaping with brick, steel, timber or concrete to prevent damage to the surfacing. Edgings should be securely fixed to prevent movement. A flexible joint filler should be used at edgings where there is potential for movement to separate the surfacing from the edging.
- The minimum application temperature is typically 5 °C on a rising thermometer and maximum is typically 25 °C. Ideal temperature conditions are 15 – 20 °C.
- Resin bound surfacing is designed for foot traffic & light vehicular traffic. The surfacing may be affected by the scrubbing action of tyres when vehicles are turning in confined spaces. Regular inspections should be carried out to ensure early detection of damage should this occur.
- The manufacturer’s technical data must be followed when mixing. Always ensure that all aggregates are fully coated in resin.
- Discharge the mixed material as soon as mixing is complete and spread to the approximate level, minimum 15 mm thick. Use battens and a straight edge for final levelling and smooth with a steel float.
- Always ensure that a wet edge is maintained. Joints between mixes will be visible unless the older mix is still workable.
- Tools and equipment may be cleaned with a suitable solvent based cleaner which will remove uncured resin.
- Allow the surfacing to cure in accordance with the recommendations of the manufacturer.

4 Care and Maintenance

4.1. Use of Cleaning Products

Cleaning products should be pH neutral where possible and biodegradability should be considered when cleaning permeable pavement as chemicals will drain to natural water courses. When using acidic or alkaline cleaners, pH should be as close to neutral as possible and cleaners should be neutralised before flushing with clean water to reduce the risk of staining and degradation of the resin. A discrete test patch should be chosen for a trial before general use.

4.2. Regular Cleaning

Regular appropriate cleaning of surfacing materials will contribute to the durability of the surfacing and help to maintain slip resistance. As with any surfacing material, resin bound surfacing should be cleaned regularly and as frequently as necessary to maintain its appearance. Sweep with a broom to remove leaves, litter etc. Use water as necessary to wash the surface and only use cleaning products when water and a sweeping brush are insufficient for cleaning the surface. The use of abrasive pads and wire brushes should be avoided.

4.3. Removing Moss, Algae and Lichen

After brushing away biological growth, remove remaining moss, algae, lichen or other biological growth from the surface with a proprietary fungicide. Flushing with clean water may not be necessary and may affect the long-term effectiveness of the treatment. Follow the instructions of the manufacturer and abide by local regulations regarding the use of chemicals. Periodic use of a fungicide should be considered as a preventative measure in areas where conditions are likely to promote biological growth.

4.4. Chewing Gum Removal

Chewing gum can be removed by scraping or chipping or using proprietary local “spot” removal solutions or by employing a commercial cleaning company. Take care not to dislodge any aggregate.

4.5. Power Washing

If power washing the surface, use only sufficient water pressure to remove dirt or contamination. Use cold water only (maximum 40 °C) with a fan jet, maintaining at least 300 mm between the lance and the surface holding the lance at an angle of approximately 45°. Avoid concentration of the jet on any one area by using a sweeping action from side to side.

4.6. Removing Oil Stains

Use a proprietary degreasing material, scrubbing into the surface with a broom. Ingrained stains may require the degreaser to be left in place for some time to allow the product to penetrate the deposit before flushing. Several applications of degreaser may be required for full removal.

4.7. Removing Tyre Marks

Use a proprietary tyre mark remover.

4.8. Removing Cement Stains

Use a proprietary acid-based concrete/mortar cleaner and neutralise immediately after removal of the stain using copious amounts of clean water. A discrete test patch should be chosen for a trial before general use. Manufacturer's application instructions and health and safety guidance must be followed.

4.9. Using the Surface

Resin bound surfacing is designed to be used by pedestrians and by light vehicles up to 7.5 tonnes gross weight. Resin bonded surfacing should be considered for heavier vehicle loads and for highways. Protect the surface from damage caused by equipment such as vehicle jacks, skips etc. and from abrasion by the dragging of heavy objects. Protect the surface from liquids and other materials which may stain or affect the surface such as hydraulic fluids, petrol, oil, diesel, paints, chewing gum, cement etc.

4.10. Localised Repairs

Resin bound surfacing can be repaired using the same combination of resin and aggregate as used during installation. Repairs should be carried out as soon as possible after they have been identified to avoid further degradation. Please refer to the manufacturer for specific guidance.

4.11. Chemical Resistance

Resistance to specific fluids should be stated by the manufacturer where relevant i.e. petrol, diesel, hydraulic fluid etc.

4.12. De-icing

The manufacturer's guidance should be sought when choosing de-icing products. In general, the use of brown rock salts is not recommended as they contain sharp sands/crushed aggregates which, when trafficked, can damage a resin bound surface if left in place for extended periods. De-icing products should not be left in place during periods of milder weather. Once the weather has risen to above freezing temperatures the area should be thoroughly washed to remove any traces of salt and grit. Plastic snow shovels should be used to remove snow from resin bound surfaces as metal shovels may cause damage.

5 Health and Safety

Certain resin bound surfacing components may be classified as hazardous under health and safety legislation. Before starting any operations, the manufacturer's Product Safety Data Sheets should be studied for all the flooring products to be applied, including resin components, primers, cleaning solvents and all recommendations therein followed. An appropriate risk assessment should be made for the flooring installers and others likely to be affected in adjacent areas including the correct specification and use of personal protective equipment (PPE).

Used packaging may be classified as hazardous waste and should be disposed of according to local and national regulations.

6 References

This is the fourteenth in a series of useful and informative Technical Guidance Notes produced by FeRFA, all of which can be freely downloaded from the FeRFA website at www.ferfa.org.uk

These include:

- Guide to the Specification and Application of Synthetic Resin Flooring (RIBA CPD Approved)
- Guide to the Selection of Synthetic Resin Flooring
- Resin Bonded Surfacing Systems for External Applications

For a full list go to the publications page on the FeRFA website.

About FeRFA

FeRFA, the Resin Flooring Association, represents the major product manufacturers, specialist contractors, surface preparation companies, raw material suppliers and specialist service providers within the UK resin flooring industry. Established in 1969, FeRFA now represents over 130 UK based companies. The Association has established Codes of Practice for members and takes an active role in promoting resin flooring and in developing both national and international standards.

For further information, contact FeRFA at: PO Box 3716, Stone, Staffordshire, ST15 9EU T: 07484 075254

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