

SSPC: The Society for Protective Coatings

TECHNOLOGY GUIDE 26

CONCRETE FLOOR COATING SYSTEM SELECTION GUIDE

1. Scope

This guide provides specifiers, owners, and installers with descriptions of generic floor coating systems for specific service environments, including the basic benefits and limitations of the most widely used polymer chemistries incorporated into these systems. Flooring system selection is dictated by several factors, including existing substrate conditions, performance requirements, installation restrictions, and aesthetics, as well as budget. Criteria to assist in evaluating the various systems are included. This guide does not provide tank lining or vertical coating recommendations.

2. Background and Use

There are several publications that provide guidance for system selection outlining system design and/or general considerations.¹⁻⁸ This document consolidates systems selection criteria. Flooring system selection is dictated by several factors including:

- existing substrate conditions
- performance requirements
- installation restrictions
- regulatory compliance
- aesthetics, as well as
- budget

These criteria are identified here to assist in evaluating the appropriate floor coating system selection. Every application will vary by condition of existing concrete, installation environment and schedule, use conditions, exposures, expected life and budget. System selection for a specific application should involve the recommendation of material manufacturers to ensure proper performance and compliance with expectations. In most cases, more than one system will provide satisfactory service, but aesthetics or performance qualities may vary.

3. Units of Measure

This standard guide is based upon US Customary units and provides approximate conversions to IEEE/ASTM/SI10⁽¹⁾

⁽¹⁾ ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19380-2959, phone int+1-610-832-9500 or referenced ASTM standards, visit the ASTM website <<http://www.astm.org>>

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International Standards (SI) units, which are presented for information only.

4. Terms and Definitions

Floor Coating: Liquid-applied or cast-in-place polymer material applied to concrete substrates for improving resistance to chemicals, enhancing resistance to impact and wear, imparting enhanced performance properties, and/or for aesthetic appearance purposes. *Discussion: Resinous flooring, broadcast flooring, seamless flooring, and slurry flooring are all types of floor coatings. Section 6 contains descriptions of the various floor coating types listed below:*

Broadcast Flooring: (Section 6.4)

Self-Leveling Flooring Systems (Section 6.3)

Slurry Flooring: (Section 6.4)

Thin-mil Coatings: (Section 6.2)

Polymer Concrete: Concrete in which a polymer is added or used instead of portland cement to bond the aggregate together. *Discussion: Polymer concrete may also be a combination of Portland cement and polymer resins.*

Sealers and underlayments (Section 6.1): Sealers and underlayments are components or options for concrete treatment but generally not considered “coating” systems.

w/cm (Water to Cementitious Material): The ratio of water to cementitious material used to form concrete. Generally calculated to optimize the amount of water used to mix and place concrete.

5. Factors Affecting Systems Selection

5.1 Substrate: The concrete substrate to which the flooring system is to be applied is critical to the long-term performance of the flooring system. Seamless systems require a substrate that has little or controlled movement in order to maintain the integrity of the system. Concrete joints are installed to minimize cracking and to control the location of shrinkage cracks. Limits to the water to cementitious material (w/cm) ratio,¹⁶ paste-to-aggregate ratio,¹⁷ and other factors should be considered during installation.

Inspection and testing of the concrete floors should be performed to determine the surface preparation requirements

for a floor coating system. This is especially important when resurfacing or repurposing an existing concrete floor versus new construction.⁹ The condition of the prepared surface must meet the requirements of the flooring system selected and specified.¹⁰⁻¹¹ The methods used to achieve these conditions vary and are discussed in detail in other publications.¹² Existing coatings or curing compounds are usually removed prior to the application of a new coating system. Flooring system manufacturers will dictate the minimum surface preparation profile and cleanliness required for the system to be installed.

Moisture testing should be performed on concrete according to manufacturer's requirements. Concrete is a porous substrate. The movement of moisture within and through concrete can be problematic for low permeance coating systems. New construction designed to receive a low-permeance coating utilizes a vapor retarder¹³ below the slab on grade.¹⁴⁻¹⁵

Existing slabs to be coated may not have a vapor retarder below the slab and should be tested for the presence and movement of moisture vapor using standardized tests when installing a moisture sensitive system.¹⁸⁻²¹

5.2 Performance Considerations: The first step in selecting the flooring system to be used in a specific application is to define the performance requirements. These typically include, but are not limited to, protection of the concrete substrate for chemical and/or mechanical damage, enhancing the flooring performance, protecting the flooring system from use conditions, and providing added aesthetic value.

5.2.1 Aesthetics and Ease of Cleaning: Concrete may be coated simply to improve aesthetics, light reflectance, and/or ease of cleaning. Concrete coatings will prevent the absorption of water, chemicals, and other liquids. Untreated concrete also tends to dust with use. Coatings and sealers provide a finish that minimizes dusting while providing a surface that is easier to clean.

5.2.2 Chemical Exposure: Seamless flooring systems are frequently required to protect concrete from chemical exposure. Concrete is an alkali substrate and is easily eroded in acidic conditions. Most foods and juices are acidic in nature. When evaluating chemical exposure, it is important to identify the chemicals, the duration of exposure, the concentration, and the temperature of exposure. ACI 515.2 provides a detailed list of chemicals and the resistance properties of various resin systems.²²

Concrete can also deteriorate from contaminants other than acid. Due to the porous nature of concrete, oils, grease, and other substances can penetrate the slab causing staining, degradation, or both. Coatings are used to protect the concrete from these contaminants.

Flooring systems are designed with several base chemistries to provide protection. A more detailed discussion

of the benefits and limitations of each of these chemistries can be found in Section 6 of this document.

5.2.3 Abrasion: Concrete is a strong building material when measured for compressive strength. The concrete paste, however, has a relatively low tensile strength (about 10% of compressive strength). This means that concrete can crack, chip or spall relatively easily if not treated or protected. When evaluating the area of service, consider the traffic and potential abrasive exposure.

5.2.4 Impact: Like the risk presented by abrasion, impact incidences can cause chips and cracks in concrete. Heavy impact areas will dictate the flooring systems selection. Thin coatings, especially highly crosslinked rigid chemistries, will chip and transfer the impact force to the concrete. The concrete under the coating has the potential to powder, causing delamination even if the coating does not chip. High build systems are generally recommended for high impact areas. These systems are specifically designed with aggregates that minimize the risk of system damage while protecting the concrete.

5.2.5 Thermal Buffering: Floor coating systems tend to exhibit different physical properties than the concrete substrate. In the case of rapid temperature change, differential thermal expansion and contraction properties can cause bond line stress or stress within the coating. To address this issue, systems are designed with high aggregate content and application thickness to minimize the risk of disbondment, blistering and cracking. Cementitious resinous systems are frequently used in these situations, although other resinous mortar systems can also be successfully used.

5.2.6 Slip Resistance: Slip resistance is a critical performance consideration, especially for areas expected to be wet or have contaminants on the floor between cleaning. Most resinous floor coating systems are not porous. This changes the coefficient of friction (COF) of the floor surface. Flooring systems incorporate a surface texture to reduce make the surface less slippery. SSPC published a guide for evaluation of slip resistance²³ and is developing a standard to quantify this texture during the specification, installation and maintenance stages of the flooring system.²⁴

5.2.7 Specialty: Specialty system design and supplementary treatments in combination with standard flooring systems can address specific performance requirements.

5.2.7.1 Electrostatic: Flooring systems can minimize the risk of explosion, fire or electronic equipment damage caused by electrostatic discharge. These systems are formulated to ground or dissipate the static electric potential. Conductive flooring (25,000 to 1,000,000 ohms resistance) is most commonly used in munition facilities and other high explosion risk or highly flammable storage areas to dissipate

electrical charges to avoid static sparks. Electronics manufacturing facilities most often specify flooring in the dissipative range $10^6 - 10^9$ ohms.²⁵⁻²⁷

5.2.7.2 Fire and Spark Resistance: A number of building codes require flooring systems to meet Class 1 flame and smoke development ratings per ASTM E648.⁷ In most cases, resinous flooring systems will be self-extinguishing when applied to concrete. During installation, however, some products contain volatile solvents and specific manufacturers' safety and installation instructions must be followed.

5.2.7.3 Waterproofing: Elevated slabs over occupied space that are either constantly wet or have the potential for excess moisture, such as showers, mechanical equipment rooms, and parking garages require a waterproofing membrane to protect the reinforced concrete and the space below. Fluid-applied, flexible membranes are applied under the flooring system to provide crack bridging capability and serve as a waterproofing membrane.²⁸

5.2.7.4 Antimicrobial Certification: Resinous flooring systems can be formulated with antimicrobial agents incorporated within the resin matrix to offer complete surface protection against harmful bacteria, mold and yeasts. The flooring system must be tested and certified to claim antimicrobial activity.²⁹ An effective cleaning and maintenance routine must be in place to preserve the aesthetic and performance characteristics of the resin finish.

5.2.7.5 Levelness: High build resinous systems are used to provide slope (ramps or drainage) and to resurface uneven concrete. Coatings and self-leveling/broadcast systems will follow the contour of the existing surface. Hand-troweled slabs-on-ground and suspended slab surfaces are specified for flatness and levelness based upon ASTM E 1155 "Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers" and the ACI 302.1R "Guide for Concrete Floor and Slab Construction" recommendations.^{14, 30}

5.2.7.6 Permeability: Concrete breathes based upon the environmental conditions that drive moisture vapor movement within the slab. Seamless flooring systems frequently have very low permeance and may not tolerate high vapor emissions. Depending upon the flooring system design, some systems, such as epoxy and urethane cement systems, have a high degree of permeability that will accommodate vapor transmissions through the concrete.

5.2.7.7 Moisture Mitigation:³¹ Many resinous flooring systems have very low permeability relative to the concrete substrate. Moisture mitigation systems have been developed to address high concrete moisture vapor emissions. These treatments include polymer modified cementitious underlayments, fibrous or permeable underlayments, and moisture suppression coatings.³²⁻³³

5.2.8 Summary of Performance Considerations: The physical properties of the floor coating are influenced by the resin chemistry, the fillers and additives within the formulation and any aggregates that are added to complete the system during installation. The values presented in Table 1 provide an industry accepted approximation for the individual resins and systems. Manufacturers will select the most appropriate test methods for the respective resins and flooring systems to help evaluate the anticipated performance of the system for the intended application.

Comparing different flooring systems physical properties should not be the sole selection criteria. Variation in these values may not necessarily reflect better system performance. Specifiers should identify those properties relevant to the specific application. Individual test values may not necessarily reflect the system performance for a desired application. Some tests are specific to the resin only (mostly ASTM "D") while others will apply to systems containing aggregates.

5.3 Regulatory Considerations: Flooring system selection requires compliance with all local and federal mandates and guidelines. Volatile organic content (VOC) of the flooring materials is regulated by the Environmental Protection Agency (EPA) and several more restrictive geographic locations throughout the country, most notably the Southern California Air Quality Management District (SCAQMD). The Food and Drug Administration (FDA) and the United States Department of Agriculture (USDA) provide guidance for flooring installed in inspected facilities. Simply stated, the floors must be easily cleanable and provide a safe walking surface.³⁴

The EPA and Registration, Evaluation, Authorization and Restriction of Chemicals (REACH – European Union) maintain a list of "Chemicals of Concern" for potential toxic, carcinogenic and/or mutagenic correlation.⁷ The Safety Data Sheets (SDS) for these materials will list any potentially hazardous chemicals in the formulation. Polymer formulations are composed of active chemicals which may present health hazards in the uncured state. Once polymerized these macromolecules are non-reactive and not classified as hazardous.

5.4 Aesthetic Designs: Only after satisfying all performance and functional parameters of a flooring system can the selection of design and appearance be addressed. Most flooring resins are available in multiple colors and aggregates can be used to enhance the appearance. Ultraviolet light stability will vary among different resins. In general, the higher degree of aromaticity within the polymer chemistry the lower the UV stability.

5.5 Installation Restrictions: The time schedule and the environmental conditions during installation may also play a role in determining system selection. Polyurea, polyaspartic and methylmethacrylate systems offer rapid cure and cure at low temperatures. These chemistries can be selected to

TABLE 1
TYPICAL TEST METHODS FOR MATERIALS UTILIZED FOR CONCRETE FLOOR COATING

Physical Properties	Test Method	Explanation	Applicability	Typical Values
Abrasion Resistance	ASTM D4060 CS17 Wheel (1000 GM Load 1000 Cycles)	Determines the resistance of coatings to abrasion.	Lower values imply the coating will wear longer. Results from this test method may not accurately reflect the wear of flexible coatings.	20-100 mg loss
Adhesion	ACI 503R (Withdrawn)	Measures the pull strength of an epoxy coating to concrete.	Successful adhesion test results indicate adhesion with the concrete (100% concrete failure). Adhesion of the coating to concrete reflects material properties, concrete strength and surface preparation.	Concrete Failure
Adhesion (Pull-Off)	ASTM D7234	Measures the pull strength of a coating to concrete.	Successful adhesion test results indicate adhesion with the concrete (100% concrete failure) for coating types other than gypsum underlayment. Adhesion of the coating to concrete reflects material properties, concrete strength and surface preparation.	Concrete Failure
Adhesion (Pull-Off)	ASTM C1583	Measures the near-surface tensile strength of the concrete substrate after surface preparation or the bond strength of a repair or overlay material.	Results indicate the controlling failure mode and corresponding strength of the surface of the substrate or the bond of the overlay material.	Concrete Failure
Chemical Resistance	ASTM D1308	Determines the effect of household chemicals on clear and pigmented organic finishes, resulting in any objectionable alteration on the surface, such as discoloration, change in gloss, blistering, softening, swelling, loss of adhesion, or special phenomena.	Three test methods, each of which is particularly applicable to individual reagents under study, Spot Test, Covered, Spot Test, Open, and Immersion Test.	Observations of visual or weight changes.
Chemical Resistance	ASTM C267	Provides for the determination of changes in the following properties of the test specimens and test medium after exposure of the specimens to the medium: Weight of specimens, Appearance of specimens, and Compressive Strength of specimens.	Test Method A outlines the testing procedure generally used for systems containing aggregates less than 0.0625 in. (1.6 mm) in size. Test Method B covers the testing procedure generally used for systems containing aggregate from 0.0625 to 0.4 in. (1.6 to 10 mm) in size. Test Method C is used for systems containing aggregate larger than 0.4 in.	Observations of visual, weight or compressive strength changes.
Chemical Resistance	ASTM D543	Evaluation of plastic materials for resistance to chemical reagents.	Provisions are made for various exposure times, stress conditions, and exposure to reagents at elevated temperatures. The type of conditioning (immersion or wet patch) depends upon the end-use of the material.	Observations of weight and dimensional changes.
Coefficient of Friction	ASTM F1679 (Withdrawn 2006)	Measures the slipperiness of a surface using a variable indentation tribometer (VIT).	Higher values reflect increases in traction. In practice surface cleanliness most frequently dictates slipperiness.	≥0.5 Wet and Dry
Coefficient of Friction	ASTM D2047	Laboratory test method covers the use of the James Machine for the measurement of the static coefficient of friction of polished floor surfaces.	Originally designed for tile. Cannot be used for wet surfaces. Higher values reflect increases in traction. In practice surface cleanliness most frequently dictates slipperiness.	≥0.5 Dry

Physical Properties	Test Method	Explanation	Applicability	Typical Values
Coefficient of Friction	ASTM F609	Method for quantifying surface resistance using a Horizontal Push/Pullmeter (HPS) in dry conditions.	Higher values reflect increases in traction. Cannot be used for wet surfaces. In practice surface cleanliness most frequently dictates slipperiness.	≥0.5 Dry
Coefficient of Friction	ANSI/NFSI B101.3	Defines procedures and devices used for both laboratory and field testing to measure the wet dynamic coefficient of friction (DCOF) of common hard-surface flooring.	Higher values reflect increases in traction. In practice, surface cleanliness most frequently dictates slipperiness.	≥0.5 Dry >0.42 Wet
Coefficient of Friction	UL 410	Laboratory test using the James Machine (ASTM D2047). Measurements of 0.5 and higher are considered slip-resistant.	This test measures static coefficient of friction only. The measuring foot is leather and does not measure wet conditions.	≥0.5 Dry
Coefficient of Expansion	ASTM C531	This test method covers the measurement of the linear shrinkage during setting and curing and the coefficient of thermal expansion of chemical-resistant mortars, grouts, monolithic surfaces, and polymer concretes.	The CTE of concrete is about $5.5 \times 10^{-6}/^{\circ}\text{F}$ ($10 \times 10^{-6}/^{\circ}\text{C}$). Unfilled resins can be five times this value. Regardless of material bonding to concrete should minimize the CTE differential to avoid stress (and separation) at the bond interface during curing and thermal changes.	1×10^{-5} to 2×10^{-5} mm/mm/°C
Compressive Strength	ASTM D695	Determines the compressive strength of rigid plastics when loaded in compression at relative low uniform rates of strain or load.	Higher values reflect the coating's ability to withstand heavier traffic and point loads. See ASTM C579 for systems containing aggregates.	8,000 – 10,000 psi (55 - 70 MPa)
Compressive Strength	ASTM C579	Determines the compressive strength of chemical-resistant mortars, grouts, monolithic surfaces, and polymer concretes.	Higher values reflect the system's ability to withstand heavier traffic and point loads.	5,000 – 12,000 psi (35 - 80 MPa)
Crack Bridging	ASTM C1305	A laboratory procedure for determining the ability of a waterproofing membrane to bridge a crack in the substrate.	Used for elastomeric materials used for waterproofing and/or crack bridging membranes.	Pass: 10 cycles at 1/8 inch (3.2mm) opening and closing
Elongation	ASTM D2370	This test method covers the determination of the elongation, tensile strength, and stiffness (modulus of elasticity) of organic coatings when tested as free films.	Higher values (as a percentage) for elongation reflect resistance to impact and reduced brittleness. Used for unfilled resins and coatings.	Variable, depends upon polymer chemistry
Flammability	ASTM D635	This fire-test-response test method covers a small-scale laboratory screening procedure for comparing the relative linear rate of burning or extent and time of burning, or both, of plastics in the form of bars, molded or cut from sheets, plates, or panels, and tested in the horizontal position.	Originally developed to test flammability of equipment parts. Most coatings will self-extinguish when bonded to concrete.	Self-extinguishing on concrete
Flammability	ASTM E648	This fire-test-response standard covers a procedure for measuring the critical radiant flux of horizontally mounted floor-covering systems exposed to a flaming ignition source in a graded radiant heat energy environment in a test chamber. A specimen is mounted over underlayment, a simulated concrete structural floor, bonded to a simulated structural floor, or otherwise mounted in a typical and representative way.	Class I inter or floor surfaces must have a critical radiant flux of 0.45 W/cm ² or greater. Class II inter or floor surfaces must have a critical radiant flux of 0.22 W/cm ² or greater.	Class I

Physical Properties	Test Method	Explanation	Applicability	Typical Values
Flexibility (Mandre Bend)	ASTM D522	Determination of the resistance to cracking (flexibility) of attached organic coatings on substrates of sheet metal or rubber-type materials.	Used primarily for elastomeric coatings to measure flexibility. Method A: Conical bend test - a painted test panel is clamped into the conical test apparatus and is bent over the conical cone using the rotating bending arm. Method B: Cylindrical mandrel test - a painted test panel is bent 180° around a specified diameter steel rod.	Pass (must be associated with method and sample size)
Flexure Modulus of Elasticity/Flexure Strength	ASTM C580	Determines the flexure strength and modulus of elasticity in flexure of cured chemical-resistant materials in the form of molded rectangular beams.	This test method is generally applicable to rigid and semi-rigid materials. Higher values indicate better impact/load capacity. Method A outlines the testing procedure generally used for systems containing aggregate less than 0.2 in. (5 mm) in size. Method B covers the testing procedure generally used for systems containing aggregate from 0.2 to 0.4 in. (10 mm) in size.	Flexure Modulus: 1.0×10^6 - 3.0×10^6 psi (7,000 – 20,000 MPa) Flexure Strength: 2,000 – 4,000 psi (15 – 30 MPa)
Flexure Modulus of Elasticity/ Flexure Strength	ASTM D790	These test methods are used to determine the flexure properties of plastic utilizing a three-point loading system to apply a load to a simply supported beam (specimen). The methods are generally applicable to both rigid and semi-rigid materials.	This test measures the ability to resist deformation under load. Results are reported for flexure modulus and flexure strength. Higher values reflect higher load capacity. Flexible systems may have much lower modulus.	Flexure Modulus: 1×10^5 - 5×10^6 psi (700 – 35,000 MPa) Flexure Strength: 2,000 – 5,000 psi (15 – 35 MPa)
Hardness	ASTM D2240	Durometer Hardness is used to determine the relative hardness of soft materials, usually plastic or rubber. The test measures the penetration of a specified indenter into the material under specified conditions of force and time.	Shore hardness is a measure of the resistance of a material to the penetration of a needle under a defined spring force. It is determined as a number from 0 to 100 on the scales A or D. The higher the number, the higher the hardness. Shore A scales are used for softer and the Shore D scale being used for harder materials.	Shore A 70-90 Shore D 10-85
Impact Resistance	MIL D-3134J (reinstated)	This specification establishes the requirements for poured or pre-cast composite deck covering materials consisting of portland cement, or a synthetic polymer binder that may include rock or glass chips. These deck coverings are intended for use on shipboard interior decks.	MIL D 3134J provides testing to measure Impact Resistance, Indentation Resistance, Water Absorption and Resistance to Elevated Temperature. NOTE: Test results may not reflect coating performance on a concrete substrate.	16 ft-lb (22 Nm) with no chipping, cracking, loss of adhesion
Impact Resistance	ASTM D2794	This test method covers a procedure for rapidly deforming by impact a coating film.	Used primarily for thin film coatings, this test provides a Pass/Fail result for a known weight impacting a coated steel plate. NOTE: Test results may not reflect coating performance on a concrete substrate.	Pass 160 in-lbs (18 Nm) ()

Physical Properties	Test Method	Explanation	Applicability	Typical Values
Indentation	MIL D-3134J (reinstated)	This specification establishes the requirements for poured or pre-cast composite deck covering materials consisting of portland cement, or a synthetic polymer binder that may include rock or glass chips. These deck coverings are intended for use on sheetrock or decks.	MIL D 3134J provides testing to measure Impact Resistance, Indentation Resistance, Water Absorption and Resistance to Elevated Temperature. NOTE: Test results may not reflect coating performance on a concrete substrate.	Pass 160 lbs (18 Nm)
Permeance	ASTM D1653	Determines the rate at which water vapor passes through films of paint, varnish, lacquer, and other organic coatings.	Due to the porosity of concrete and the movement of moisture within and out of the concrete substrate, this test quantifies the ability of the coating to accommodate the vapor movement. Test can be performed using a Dry cup or Wet cup method. The two methods are not correlated.	Very low permeability: < 1 perm Semi-permeable: between 1 and 10 perms Permeable: greater than 10 perms
Permeance & Permeability	ASTM E96	Determines water vapor transmission (WVT) of materials through which the passage of water vapor may be of importance, such as paper, plastic films, other sheet materials, fiberboards, gypsum and plaster products, wood products, and plastics.	Generally used to measure the effectiveness of moisture vapor migration systems, therefore the values should be <0.10 perms at a defined thickness. Test can be performed using a Dry cup or Wet cup method, whichever is most representative of the product in service. The two methods are not correlated.	<0.10 perms @ a defined thickness
Resistance to Elevated Temperatures	MIL D-3134J (reinstated)	This specification establishes the requirements for poured or pre-cast composite deck covering materials consisting of portland cement, or a synthetic polymer binder that may include rock or glass chips. These deck coverings are intended for use on sheetrock or decks.	MIL D 3134J provides testing to measure Impact Resistance, Indentation Resistance, Water Absorption and Resistance to Elevated Temperature.	No spalling @ 158°F (70 °C)
Smoke Density	ASTM E662	Determines the specific optical density of the smoke generated by specimens of materials and assemblies under the specified exposure conditions.	ASTM E662 is not currently used for regulation or fire rating purposes.	<450 ODU for Class 1
Tear Strength	ASTM D624	This test method measures the resistance to tearing action primarily for elastomeric materials.	Higher values reflect better tear resistance. Test values are based upon laboratory conditions and may not have any direct relation to service performance.	200 - 400 psi (35 – 70 N/mm)
Tensile Elongation/ Tensile Strength	ASTM D638	This test method is designed to produce tensile property data for the control and specification of plastic materials.	This test is conducted primarily for unfilled polymeric materials. High tensile strength corresponds to rigid material. High percentage elongation prior to break measures degree of elasticity.	Varies significantly by resin.
Tensile Strength	ASTM C307	This test method covers the determination of tensile strength of cured chemical-resistant materials such as polymeric mortars and composite systems.	This test is conducted primarily for aggregate filled materials. Higher values represent higher strength.	500 – 2,000 psi (3.4 – 14 MPa)

Physical Properties	Test Method	Explanation	Applicability	Typical Values
Tensile Strength	ASTM D412	These test methods cover procedures used to evaluate the tensile (tension) properties of vulcanized thermoset rubbers and thermoplastic elastomers.	These tests are used to measure the strength of elastomeric membranes. Test Method A—Dumbbell and Straight Section Specimens Test Method B—Cut Ring Specimens	400 – 3,000 psi (2.8 – 20 MPa)
Tensile Strength	ASTM D2370	These test methods cover the determination of the elongation, tensile strength, and stiffness (modulus of elasticity) of organic coatings when tested as free films.	These tests are used to measure the strength of elastomeric membranes. These tests do not define a specimen thickness.	200 – 3,000 psi (1.4 – 20 MPa)
Thermal Compatibility	ASTM C884	These test methods cover the determination of which epoxy-resin formulations are subject to debonding when used as overlays for concrete when the combination of the two is subjected to temperature changes that may be met in the field.	These Pass/Fail test methods evaluate the ability of an overlay to remain bonded to a concrete substrate during repeated thermal cycling in a range of significant temperature range and is not intended to duplicate temperature fluctuations in the field.	PASS
Water Absorption	ASTM D570	These test methods cover the determination of the relative rate of absorption of water by plastics when immersed.	Test method for unfilled resin. Lower water absorption is desired in constant wet environments.	<0.02%
Water Absorption	ASTM C413	These test methods cover the determination of the absorption of chemical-resistant mortars, grouts, monolithic surfacings, and polymer concretes.	Test method for filled polymer concrete systems. Method A is used for systems containing aggregates less than 1/16 inch (1.6 mm) in size. Method B is used for systems containing aggregates from 1/16	<0.5%

accommodate the installation conditions within the system design that meets the physical performance criteria.

5.6 Performance Life: The expected life of the flooring system is one of the final decision options in the selection of the coating system. In most cases, this consideration is driven by budget concerns. Providing minimum protection and functionality is better than none but may require resurfacing or resurfacing more frequently. In the long-term strategy is more expensive but initial costs will be lower. A large percentage of the installation costs is associated with labor, therefore multiple applications and operational disruption significantly impact life cycle costs. If the function benefits of the system are related to safety, major liability risks outweigh cost savings. See Section 7 for additional information regarding life cycle cost by system design.

5.7 Economics: Aesthetic options will also impact the costs of the flooring system. Many times, the same functionality is available with solid color finishes or multicolor or designer finishes. Color and design frequently require additional time and labor during installation.

6. System Types

Systems are grouped into thickness and application methods. Sealers and underlayments are included in this discussion as components or options for concrete treatment but generally not considered “coating” systems.

6.1 Sealers: All concrete coating systems technically seal the concrete. From the purpose of this discussion “sealers” are considered to be concrete penetrating applications to measure Impact Resistance, Indentation Resistance, Water Absorption and Resistance to elevated temperature. Sealers are used to densify the surface and reduce the porosity of the concrete. However, they provide limited protection for chemical exposures and highly abrasive environments. Penetrating sealers will also allow the concrete to breathe. The majority of products available for this application are based upon silane, silicate, silicate, siloxane, and silicone chemistry. Sealers can be used over concrete stains to enhance the aesthetics.

6.2 Thin-film Coatings: Thin-film concrete coating systems can be protective, decorative, or both. Some systems contain aggregate for texture or design. Concrete surface profile is reflected through the coating; therefore slope, repairs and existing concrete profile must be considered prior to coating. Coatings are generally used in areas to ease maintenance, reduce concrete dusting, improve light reflectivity, and provide direction. Coatings have a shorter useful life in abrasive or high traffic areas than higher build systems.

6.3 Self-Leveling: Self-leveling flooring systems are generally solvent free or low VOC systems incorporating chemically cured resins with inert fillers and powders applied in single layers that have a cured thickness greater than 30 mils (750 µm) (but usually not more than 1/8 inch (3 mm)).

Surface imperfections tend to be reflected through the self-leveling system.

6.4 Broadcast: Broadcast flooring systems can be installed by first applying unfilled or filled resins (self-leveling) then broadcasting selected aggregates into the receiving matrix while the matrix is still wet and uncured. Broadcast systems generally range in thickness from 20 mils to 1/4 inch (500 μm to 6 mm). The finished texture is determined by the size and shape of the aggregate used and the thickness of subsequently applied topcoats.

6.5 Slurries: Slurry flooring systems are generally resin rich systems filled with aggregates larger than self-leveling systems, troweled or squeegeed to the thickness of the largest aggregates. While resin-rich, these systems do not tend to flow out as readily after application as do self-leveling flooring systems. Slurry systems are generally applied in thicknesses from 1/8 inch (3 mm) to 3/8 inch (9 mm).

6.6 Mortars: Mortar flooring systems are less resin-rich than other flooring systems and are filled with larger proportions of blended aggregates and in some cases cement. Mortar flooring systems are generally applied in thicknesses of 3/16 to 1/2 inch (5 to 13 mm). These systems are typically required for high abrasion areas, areas expected to experience rapid temperature change and when the concrete substrate requires resurfacing. Trowel-applied integral coved base is designed as a mortar system to allow for vertical application.

6.7 Underlayments: Underlayments are not considered a flooring system themselves but can be used to resurface an existing concrete slab prior to applying a floor coating system. These products are generally self-leveling when applied up to 1 inch (25 mm) thick. Thicker applications can be achieved with the use of larger aggregate fillers. Cement based products are preferred over gypsum based products due to the need for high compressive strength. Polymer modified underlayments require relatively short cure time for foot traffic (2-4 hours) and overcoating (24-48 hours). The integrity of the entire flooring system is dependent upon a sound bond throughout the application, therefore surface preparation of the concrete is equally important for underlayments. Primers are used to minimize slab outgassing and improve adhesion.

7. Expected Lifetime

The expected life of the floor treatment is entirely dependent upon the conditions of use, traffic, cleaning schedule and exposure to chemicals and environmental elements. The values offered in the following table are arbitrary estimates based upon a variety of applications. When selecting a flooring system, the durability and expected life must be considered with respect to the anticipated traffic and exposures balanced with the project's

initial and maintenance budgets. A coating life can be loosely associated with the application thickness of the protective layer under the same traffic and exposure conditions. Table 2 provides a range of expected service life under "typical" conditions. In low wear or minimum exposure conditions the service life will be greater, while in aggressive environments the service life can be much shorter. Note: Many coating systems can be renewed by simply recoating, minimizing the replacement costs when calculating life cycle costs.

8. Systems Chemistries^{7, 22}

Except for the penetrating sealers, each of the system types described above can potentially be built with different resin chemistries to meet the required performance. Table 3 briefly compares the merits and limitations of each of the chemistries.

8.1 Acrylics: Acrylic floor coatings are typically used as light duty coatings or sealers. Acrylic coatings can provide protection to stained concrete, as well as color and/or texture to concrete. These products are generally single-component waterborne emulsions. These are not to be confused with methyl-methacrylate chemistry discussed below.

8.2 Epoxies: Epoxies are the most commonly used chemistry for concrete floor coatings and high build systems due to their bond strength, abrasion- and chemical-resistance, and (in most cases) low solvent content.

Fillers such as aggregates, fibers, flakes, and mats are incorporated into the systems design to enhance physical performance properties.

Epoxy coatings are formulated with various flexibilizers, extenders, diluents, and fillers to facilitate application as well as modify performance properties. The properties of the cured coating are dependent on the epoxy resin and curing agent used. Bisphenol A, bisphenol F, and novolac epoxy resins offer increasing crosslinking densities, chemical resistance and cost. Curing agents include cycloaliphatic amines, polyamines, amides, amidoamines amine adducts, polyamides, polysulfides, tertiary amines, and mannich bases. Manufacturers select the appropriate epoxy in combination with the curing agents to fine-tune the system installation and performance properties.³⁵

Epoxy formulations are available in high-solids, solvent-based, or water-borne coatings. Most epoxies require temperatures of at least 50°F (7°C) to cure, but there are epoxy systems that cure at temperatures as low as 40°F (4°C). There are epoxy systems that are tolerant to damp application conditions, and some that can cure under water. Most epoxies, however, must be applied to a dry surface to avoid curing issues. Epoxies will chalk and yellow with exposure to ultraviolet light, depending on the resin and curing agent type.

8.3 Methyl methacrylates: Methyl methacrylates are base chemistries most frequently selected for their speed

of cure and ability to cure at low temperatures (as low as -20°F [-29°C]). Low molecular weight formulations provide low temperature and rapid cure, as well as good concrete penetration. These low-viscosity formulations are typically used for priming to improve the bond when considering a fast-cure chemistry. Higher molecular weight methacrylates will cure more slowly at higher temperatures and will not penetrate the concrete as well.

Methacrylate flooring systems are designed like epoxy systems with multiple application steps, various fillers and aggregates, and aesthetic design options. Varying the formulation allows for either flexible or hard materials. These systems are resistant to weak acids, alkalis, and solvents, and can withstand temperatures up to 140°F (60°C).

During the curing process, proper ventilation is required because of the vapors emitted by the polymer as it hardens. The strong odor associated with the substance also becomes intensified with heat. Low molecular weight MMA can be highly flammable. Safety precautions must be considered when applying the polymer onto surfaces.

8.4 Polyester and Vinyl Ester:³⁶ Polyesters and vinyl esters are used in applications that require resistance to

aggressive chemicals and elevated temperatures. They are known for their solvent and chemical resistance, especially acid resistance. Alkaline solutions attack the ester linkage, reforming the polyol and a salt of the carboxylic acid. Styrene or a similar vinyl-type monomer is used to cross-link the resin and form the film. The polymerization is initiated by a catalyst, with the reaction by free radical addition. This reaction is inhibited by oxygen and moisture during cure. Topcoats are frequently formulated with a wax to reduce air inhibition.

These resins undergo high shrinkage and give off heat during cure. The shrinkage can lead to cracking or disbondment. Systems are designed with fillers and reinforcing fibers to increase physical properties. These fillers or reinforcements usually reduce resistance to chemicals and decreases thermal stability. The styrene component of these formulations is a volatile organic substance and has a strong odor. Proper ventilation and safety precautions must be considered when applying.

8.5 Polymer concretes: Polymer concretes have grown in popularity as workhorse slurry and mortar systems, especially in the food and beverage industries. These

TABLE 2
SYSTEMS DESCRIPTION AND EXPECTED LIFE

Treatment	Thickness	Description/Protection	Aggregate Options	Expected Life in Service Condition		
				Light Duty	Medium Duty	Heavy Duty
Sealers	Penetrants	Reduce the surface porosity to minimize dusting, ease cleaning and enhance aesthetics. Sealers may include stained concrete for decorative applications.	none	2-4 yrs	<2 yrs	NR
Thin-Film Coatings	≤ 20 mils (≤ 500 microns)	Protect the concrete from contamination, ease cleaning, provide surface texture, improve light reflectivity, improve aesthetics and wayfinding.	Powders Flakes Slip Resistant Broadcast	5-6 yrs	<5 yrs	NR
Self-leveling	1/16 to 3/32 inches (1.5 to 2.4 mm)	All of the above plus improved impact resistance and longer life.	May contain aggregates and fillers within the liquid applied resin.	8-12 yrs	6-8 yrs	<6 yrs*
Broadcast	1/16 to 3/32 inches (1.5 to 2.4 mm)	Similar to Self-Leveling Systems	Silica Sand Quartz Rubber (Broadcast into the applied resin)	8-12 yrs	6-8 yrs	<6 yrs*
Slurry	1/8 to 3/8 inches (3 to 9 mm)	All of the above.	Formulated Aggregates	8-12 yrs	6-8 yrs	<6 yrs*
Mortar	≥ 3/16 inches (≥ 5 mm)	All of the above plus thermal shock resistance, resurfacing, leveling and sloping.	Silica Sand Rubber Proprietary Blends	>15 yrs	10-15 yrs	10 yrs*

* In many cases a flooring system can be “renewed” with an additional coating rather than complete replacement.

TABLE 3
FLOOR COATING CHEMISTRY COMPARISON

	Bond Strength	Cure	Performance Properties	Chemical Resistance
Acrylic Emulsions	Good	Evaporation	Light duty only	Poor
Epoxies	Excellent	Relatively slow, available in low temperature cure (~40°F/~4.4°C)	Varies with hardener	Moderate
Epoxy Novolac	Excellent	Slightly faster cure than Bis A/Bis F epoxies	High strength, high modulus	Excellent
Methyl Methacrylates/ High Molecular Weight Methyl Methacrylates	Moisture sensitive, low viscosity materials penetrate concrete	Low molecular weight MMA cures fast and at low temperatures. HMWM cure more slowly. Moisture and oxygen inhibit cure. May shrink during cure.	Fast cure, low-temperature cure	Moderate
Polyester / Vinyl Esters	Poor bond to damp substrates; use an epoxy primer	Free radical polymerization can be catalyzed to increase cure, moisture and oxygen inhibit cure. May shrink during cure.	Chemical and heat resistant	Excellent acid resistance
Polyurea / Polyaspartic	Varies with cure speed	Polyurea cures in seconds, hybrids and polyaspartics cure more slowly, but faster than epoxy or urethane coatings. Cures at low temperatures.	Fast cure, low-temperature cure, UV-resistant	Moderate
Aliphatic Polyurethane	Require epoxy primer, poor intercoat adhesion to other polyurethanes	Slow cure, affected by humidity and temperature	UV-resistant and gloss-retentive	Good
Silicates	Penetrates concrete	Applied in thin coats to allow for penetration and avoid puddling. Reacts with concrete.	Densify concrete	Poor
Urethane Cements	Excellent	Fast cure relative to epoxy, will cure at above freezing temperatures.	High-strength, breathable	Excellent

systems utilize a complex multi-reaction chemistry involving cement and various resin formulations. The coefficient of thermal expansion of these materials and the system thickness insulating the bond line allows them to tolerate rapid temperature changes, such as steam cleaning in food processing areas, without delamination, blistering, or cracking.

The most commonly used systems are based upon urethane cement formulations. These systems usually contain water to facilitate hydration and chemical reaction. Therefore, installation temperature is limited to above

freezing. They exhibit good chemical resistance and abrasion resistance. The bond to dry concrete is excellent. Some cementitious underlayments are polymer modified and are used when resurfacing is required for an existing concrete substrate prior to applying a polymer coating system.

8.6 Polyureas: Polyurea systems are plural component (two-part) systems derived from the reaction of a modified isocyanate component and an amine resin-blend. They can be aromatic-based, or aliphatic-based, for UV-stability. Both aromatic and aliphatic polyureas are available in a variety

of colors. Polyurea systems are VOC-compliant and have excellent resistance to most common hydrocarbons as well as a wide range of corrosive attack between pH 4 and 12.

Polyureas provide extremely fast cure (faster return to service), high thermal resistance, cold temperature cure, and are more hydrolytically stable than polyurethanes. Application to concrete generally requires a primer to maximize bond due to the extremely fast cure rate of the polyurea. Due to their rapid set time polyurea coatings can be applied in conditions of high ambient humidity. An uneven finish texture is often achieved using a spray technique for slip resistant textures.

Mixtures of polyols and amines may be reacted with isocyanates to produce polyurethane/polyurea hybrids. This hybrid formulation slows the chemical cure relative to pure polyurea while maintaining many of the properties of polyurea.

8.7 Polyaspartic: A polyaspartic is a type of polyurea (actually a polyaspartic aliphatic polyurea). Polyaspartic polyureas are based on the reaction of an aliphatic polyisocyanate and a polyaspartic ester, which is an aliphatic diamine.

Polyaspartic flooring systems have been developed to take advantage of the rapid cure. In addition, polyaspartic systems can be applied at low temperatures, they bond well to the concrete surface, and they have good stain and UV resistance.

Polyaspartic systems provide unique benefits during installation and provide performance properties like epoxy systems. They can be applied at a wide range of surface temperatures and humidity; the high solids formulations allow for thick film applications; and the pot life can be adjusted to meet the application methods. The finished system can handle high temperatures; is UV-stable; provides good stain resistance; and has good abrasion resistance. As with polyurea systems, polyaspartic systems are best used in areas not expecting extreme chemical exposure.

8.8 Polyurethanes: Polyurethanes coatings and topcoats can be formulated as high-build or thin-film protective coating on the concrete surface that provides excellent resistance to abrasion and chemicals. They are formed through the reaction of a polyol with an isocyanate. They are available in water- and solvent-based versions, one component (moisture cure) or two component (chemical cure) formulations, and a range of colors and sheen levels. In general, two-component aliphatic polyurethanes are used as topcoats for UV-stable, high gloss, abrasion and chemical resistant finishes.

Polyurethanes can be formulated with elastomeric properties for waterproofing and traffic bearing applications or more rigid, highly durable, chemical-resistant coatings. Both humidity and temperature will affect the cure of polyurethanes. Most polyurethanes are moisture intolerant

until they cure, so they should not be applied to surfaces if any water is present. Polyurethanes are frequently applied with an epoxy primer or as a higher durability topcoat over an epoxy basecoat. Another consideration is that many polyurethanes are solvent based, requiring thin application and safety considerations during application

8.9 Silica-based Chemistries: Silicone and siloxane concrete sealers are inorganic-organic polymers that provide hydrophobic (water repellent) and oilphobic (oil repellent) properties. They generally have very low penetration and their performance is based upon the surface layer. They deteriorate when exposed to ultraviolet light and do not wear well with abrasive traffic.

Silane concrete sealers penetrate the concrete and can seal the concrete providing multi-year service. The silane chemical structure remains active and may react when exposed to other hydrocarbons such as oil or gasoline causing a permanent stain in the concrete that can never be cleaned except through removal of the concrete. This makes silanes less attractive for stain resistance. Over time silane sealers will usually significantly darken or discolor the concrete.

Silicate concrete sealers penetrate the concrete and significantly reduce porosity. They react with the excess CaOH in the concrete that bonds the silicates within the concrete producing calcium silicate hydrate (C-S-H) which is deposited in the concrete pores providing a long-term wearable and water repellent surface.

Silicates are formulated as sodium, potassium, or lithium silicates. The function of the sodium, potassium, or lithium part of the silicate's function only is to stabilize and solubilize the silicate so it can remain in solution until it penetrates the concrete and then can react with the calcium hydroxide found in the concrete. Lithium silicates generally have a lower viscosity than sodium or potassium silicates of equal solids, so the lithium silicate can penetrate the concrete more effectively.

The reaction of soluble silicate with calcium hydroxide in concrete produces alkali metal hydroxide, which could be detrimental to concrete if reactive aggregates and moisture are present. Lithium silicate is considered to reduce the risk of alkali silica reaction (ASR).³⁷ The hydroxides from sodium, potassium, and magnesium in combination with laitance from the scrubbing process must be removed before they crystallize on the surface. The Environmental Protection Agency (EPA) rates silicate residues as hazardous materials because pH levels are high (10+ pH).

Siliconate concrete sealer, like the silicates, seal by forming a permanent chemical change in the concrete reacting with calcium hydroxide and other alkalis. Siliconates are usually a larger molecule, offering more surface protection and hydrophobicity. They are also used as a concrete cure and seal to retard the hydration process leaving little or no membrane.

The silica-based class of concrete sealers will inhibit subsequent polymer coatings from bonding to the concrete and must be completely removed prior to other coating system application.

8.10 UV-cure: UV-cure is more of a cross linking technology than a description of base chemistry. These systems can be built with polyurethane, polyester, or epoxy molecular backbones, yielding cured coatings that reflect the performance properties of the selected resin. UV-cure technology utilizes radiation in the form of ultraviolet light to initiate the crosslinking reaction providing instant cure.

The main application of this technology is in conditions requiring rapid turnover and minimum down-time. Most applications can be performed overnight. The bulk of the installation time is devoted to cleaning and preparing the surface to ensure a good bond.

The limitation of this technology is the degree of light penetration of the coating and “wet edge” cure between UV-light passes. This requires resins to be relatively thin and/or transparent. Formulators have resolved early issues of “zippering” where incomplete cure caused coating surface irregularities at the “wet edge.”

9. System Selection

Table 4 provides a recommendation of system type by selected areas of use. A Light Duty and Heavy Duty recommendation is listed for each area. These are intended to be minimum performance selections. A higher build system than those listed will also meet or exceed the performance requirements. In many cases, special considerations are noted when additional functionality or chemical resistance is required. Although any system can effectively be used for most applications listed, these recommendations are typical of the systems used throughout the industry.

10. Floor Coating System Selection Considerations

The process of selecting the best flooring system options begins with identifying the performance requirements during installation and throughout the life of the floor system. Prioritize which performance property or properties are most important for the application under consideration. Addressing each performance consideration will limit the available system options.

The following considerations address each of the performance criteria. The components of the flooring system that influence performance capability include:

- Base resin (Chemistry)
- Formulation package (fillers and additives contained in the supplied resin)
- Aggregates used during the installation process (composition, size, shape, relative volume to resin)
- System design (thickness and application steps: primer, membrane, matrix, grout, topcoat, etc.)

The installation schedule and environmental conditions may also dictate which systems are most appropriate. It is important to understand that several flooring options are acceptable for specific conditions of use. Expected life and aesthetics may vary.

10.1 Consideration 1. Selecting the Flooring System

Chemistry: The polymer backbone of the flooring system plays a significant role in the overall performance of the flooring system. Several chemistries will provide acceptable performance for most flooring applications. Harsh or extreme conditions of exposure (pH, Molarity, Duration, Temperature, combinations, etc.) will necessitate specialty resins. Consult flooring system manufacturers for appropriate recommendations.

10.1.1 Chemical Resistance Requirements:

Determine which chemicals (acids, alkali, solvents, detergents, oils, etc.) will be exposed to the finished floor. Note the concentrations, combinations, duration of exposure, frequency of exposure, and temperature. Some chemical exposures may stain the flooring system without a significant deterioration in system performance.

High Chemical Resistance Options:

- Novolac Epoxy
- Vinyl Ester
- Polyester

Specific Test Methods to consider:

- ASTM C267 Chemical resistance test
- ASTM C413 Water absorption test
- ASTM D1308 Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
- ASTM D543 Chemical resistance test

10.1.2 Ultra Violet Light Stability Requirements:

Many polymers discolor over time with exposure to UV light or high intensity lighting. Most polymer flooring applications are indoor and have limited UV exposure, therefore standard epoxy may be acceptable, and pigments will help mask “yellowing.”

High UV Resistance Options:

- Acrylic
- Polyaspartic
- Polyurethane
- Methyl Methacrylate

Specific Test Methods to consider:

- ASTM D4587 Ultraviolet Light Stability

10.1.3 Cold Temperature or Rapid Cure Requirement:

Speed of installation or cold temperatures during installation require special chemistries. Although a resin may cure at a lower temperature, the temperature during installation may affect the viscosity and workability.

Fast/Cold Cure Options:

- Low Temperature Epoxy
- Polyaspartic
- Polyurea
- Methyl Methacrylate
- Urethane Cements

and aggregates, reinforcements, crack bridging membranes, and/or vapor control steps.. Systems may incorporate different chemistries to enhance functional properties. Various system designs can provide acceptable performance with a range of expected life, aesthetics, and cost.

10.2 Consideration 2. Selecting the Flooring System
Design: Flooring System design refers to the thickness, application steps, application methods, incorporated fillers

10.2.1 Does the existing concrete substrate require resurfacing or sloping? Thin coatings and self-leveling systems may reflect the underlying concrete profile. Thicker systems are used to resurface. Slope, pitch and coving can

TABLE 4
TYPICAL SYSTEM TYPES BY SPECIFIC USAGE AREAS

Application	Light Duty	Heavy Duty	Special Considerations						
			Decorative	Slip Resistant	Chemical Resistant	UV Resistant	Impact Resistant	Thermal Shock Resistant	Other Considerations
Aircraft Hangars	Thin-Film Coating	Self-Leveling/Broadcast			X				Reflectivity
Animal Holding Areas	Self-Leveling/Broadcast	Mortar		X					
Armory	Self-Leveling/Broadcast	Mortar							Conductive/ESD
Assembly areas/lines	Sealer	Thin-Film Coating							Line Stripping (OSHA ³⁸)
Atriums	Thin-Film Coating	Self-Leveling/Broadcast				X			
Automotive Service Areas	Self-Leveling/Broadcast	Mortar					X		
Autopsy Rooms	Self-Leveling/Broadcast	Mortar		X	X				
Baggage Handling Area	Self-Leveling/Broadcast	Mortar					X		
Bakeries	Sealer	Mortar						X	
Barracks	Thin-Film Coating	Self-Leveling/Broadcast							
Bars/Lounges/Pubs	Thin-Film Coating	Self-Leveling/Broadcast	X						
Battery Charging	Self-Leveling/Broadcast	Mortar			X				
Bio/animal research	Self-Leveling/Broadcast	Mortar	X						
Biosafety Laboratories (Levels 1, 2, 3, 4)	Self-Leveling/Broadcast	Mortar	X						
Best Practices	Self-Leveling/Broadcast	Mortar							Conductive/ESD
Bottling area	Self-Leveling/Broadcast	Mortar		X					
Break Rooms	Thin-Film Coating	Self-Leveling/Broadcast							
Bulk Storage	Sealer	Self-Leveling/Broadcast							
Bus Terminal	Sealer	Thin-Film Coating							
Cafeterias	Sealer	Self-Leveling/Broadcast	X						
Changing/Locker rooms	Thin-Film Coating	Self-Leveling/Broadcast							

Application	Light Duty	Heavy Duty	Special Considerations						
			Decorative	Slip Resistant	Chemical Resistant	UV Resistant	Impact Resistant	Thermal Shock Resistant	Other Considerations
Chemical Containment/Storage	Seal-Leveling/Broadcast	Mortar			X				
Classrooms	Seal-Leveling/Broadcast	Mortar							
Clean Rooms	Seal-Leveling/Broadcast	Seal-Leveling/Broadcast Mortar	X						Low Texture
Communications	Thin-Film Coating	Seal-Leveling/Broadcast							
Concession areas	Seal-Leveling/Broadcast	Mortar							
Concourse area	Sealer/Thin-Film Coating	Seal-Leveling/Broadcast							
Coolers	Seal-Leveling/Broadcast	Mortar						X	
Corridors/hallways	Thin-Film Coating	Seal-Leveling/Broadcast							
Dances	Seal-Leveling/Broadcast	Mortar			X				
Decks	Seal-Leveling/Broadcast	Mortar	X						
Dining areas	Sealer	Seal-Leveling/Broadcast	X						
Dish wash Areas	Seal-Leveling/Broadcast	Mortar		X					
Dry Storage Areas	Sealer	Thin-Film Coating							
Emergency Rooms	Seal-Leveling/Broadcast	Mortar	X						
Freezers	Seal-Leveling/Broadcast	Mortar		X					Hot Temperature Resistant
Food Prep and Storage	Seal-Leveling/Broadcast	Mortar							
Freezers/refrigeration	Sealer	Mortar						X	
Gowning Areas	Thin-Film Coating	Seal-Leveling/Broadcast							
Greenhouses	Thin-Film Coating	Seal-Leveling/Broadcast		X		X			
Grooming area	Sealer	Thin-Film Coating							
Heavy Manufacturing	Sealer	Mortar							Lead Stripping (OSHA)
Helicopter Pads	Mortar	Mortar		X		X	X		
ICU/NICU/PACU	Thin-Film Coating	Seal-Leveling/Broadcast	X		X				
Kitchens - inside	Seal-Leveling/Broadcast	Mortar		X					
Kitchens - outside	Sealer	Mortar		X		X			
Kitchens	Seal-Leveling/Broadcast	Mortar		X					
Laboratories	Seal-Leveling/Broadcast	Mortar	X		X				
Laundry	Thin-Film Coating	Seal-Leveling/Broadcast							
Lobbies	Thin-Film Coating	Seal-Leveling/Broadcast	X						
Light Industrial	Sealer	Thin-Film Coating							
Loading Docks	Seal-Leveling/Broadcast	Mortar		X			X		
Lobbies	Sealer	Seal-Leveling/Broadcast	X						
Locker Rooms	Thin-Film Coating	Seal-Leveling/Broadcast	X	X					

Application	Light Duty	Heavy Duty	Special Considerations					
			Decorative	Slip Resistant	Chemical Resistant	UV Resistant	Impact Resistant	Thermal Shock Resistant
								Other Considerations
Mach ne Shops	Se f-Leve ng/Broadcast	Mortar					X	
Manufactur ng Traffic A s es	Se f- eve ng/Broadcast	Mortar					X	L ne Str p ng (OSHA)
Meat cutt ng/seafood	S urry	Mortar		X				X
Mechan ca Equ pment Room	Th n-F m Coat ng	Se f- eve ng/Broadcast		X				Waterproof
Med um Industr a	Se f- eve ng/Broadcast	S urry/Mortar						L ne Str p ng (OSHA)
Morgues	Se f- eve ng/Broadcast	S urry/Mortar	X					
Mun t on Areas	Se f- eve ng/Broadcast	Mortar						Conduct ve/ ESD
Nurses Stat ons	Se f- eve ng/Broadcast	Mortar	X					
Offices	Th n-F m Coat ng	Se f- eve ng/Broadcast	X					
Operat ng Su tes	Se f- eve ng/Broadcast	Mortar	X		X			
Packag ng Areas	Th n-F m Coat ng	Se f- eve ng/Broadcast						L ne Str p ng (OSHA)
Pat ent Rooms	Se f- eve ng/Broadcast	Mortar	X					
Pat os and Decks	Sea er	Th n-F m Coat ng						Waterproofing
Pedestr an Wa kways	Sea er	Se f- eve ng/Broadcast		X				Waterproofing
Pharmacy	Th n-F m Coat ng	Se f- eve ng/Broadcast	X					
P at ng L nes	Se f- eve ng/Broadcast	Mortar			X			
Poo Decks (nter or)	Se f- eve ng/Broadcast	Mortar		X				S ope
Poo Decks (exter or)	Sea er	Se f- eve ng/Broadcast		X		X		S ope
Res dent a Garage	Sea er	Th n-fi m coat ng, Broadcast		X				
Restaurants/D n ng Areas	Sea er	Se f- eve ng/Broadcast	X					
Restrooms	Th n-F m Coat ng	Se f- eve ng/Broadcast	X		X			
Resurfac ng App cat ons	S urry	Mortar						
Reta Areas/Shops	Sea er	Th n-fi m coat ng/Se f- eve - ng/Broadcast	X					
Show rooms	Sea er	Se f- eve ng/Broadcast	X					
Showers	Se f- eve ng/Broadcast	Mortar	X	X				Waterproofing, S ope, Cove Base
So vent Extract on/E ectrow n- n ng	Se f- eve ng/Broadcast	Mortar			X			
Stad um Concourses	Sea er, Th n-F m Coat ng	Se f- eve ng/Broadcast		X				
Steam C ean Areas	S urry	Mortar		X				X
Transit platforms	Sealer	Self-leveling/Broadcast	X	X				
V var ums	Se f- eve ng/Broadcast	Mortar	X	X				
Wa t ng Rooms	Th n-F m Coat ng	Se f- eve ng/Broadcast	X					

Application	Light Duty	Heavy Duty	Special Considerations					
			Decorative	Slip Resistant	Chemical Resistant	UV Resistant	Impact Resistant	Thermal Shock Resistant
Warehouse	Sealer	Thin-Film Coating						Line Stripping (OSHA)
Wash Down Areas	Slurry	Mortar		X			X	Scope

be incorporated with a high build mortar system.

Resurfacing Options:

- Mortar Systems
- Slurry Systems
- Underlayments

10.2.2 Is Thermal Shock Resistance Required? Rapid changes in temperature while the flooring system is in service can stress the bond between a polymer flooring system and concrete. Highly filled (aggregates/cement) systems applied at thickness greater than 4.5 mm (3/16" – 180 mils) and urethane cement systems minimize the risk of disbondment due to bond line stress.

Thermal Shock Resistant Options:

- Mortars Systems
- Slurry Systems
- Urethane Cement Systems
- Elastomeric Systems

Specific Test Methods to consider:

- ASTM C531 Shrinkage and Thermal Expansion
- ASTM C884 Thermal Expansion
- ASTM E1356 Maximum Temperature

10.2.3 Is Abrasion Resistance Required? The aggregates used in the flooring systems provide durability and wear resistance in high traffic abrasive environments. The resin chemistry itself also affects abrasion resistance and resistance to surface scratching.

Abrasion Resistant Options:

- Mortar Systems
- Slurry Systems

Specific Test Methods to consider:

- ASTM D4060 Abrasion Resistance
- ASTM C307 Tensile Strength
- ASTM D412 Tensile Strength
- ASTM D638 Tensile Elongation/Tensile Strength
- ASTM D2370 Tensile Strength

- ASTM C580 Flexural Modulus of Elasticity/Flexural Strength
- ASTM D790 Flexural Modulus of Elasticity/ Flexural Strength
- ASTM C579 Compressive Strength
- ASTM D5045 Fracture Toughness

10.2.4 Is Impact Resistance Required? Heavy impacts on thin coatings can damage the underlying concrete resulting in a loss of bond. Aggregate filled systems improve impact resistance, while flexible resins can minimize impact deformation and cracking.

Impact Resistant Options:

- Mortars Systems
- Slurry Systems
- Elastomeric Systems

Specific Test Methods to consider:

- ASTM D2794 Impact Resistance
- MIL-D-3134J Impact Resistance
- ASTM D2370 Elongation

10.3 Consideration 3. Selecting the Flooring System for Specialty Performance Requirements: Specialized performance properties can be added to a system design depending upon the conditions of the application or the functional requirements. These systems are well defined by the manufacturers and the manufacturer should be consulted to ensure appropriate selection.

10.3.1 Is excessive moisture vapor being emitted from the concrete?

Excess Moisture Vapor Options:

- Moisture Vapor Remediation Systems
- Breathable Systems

Specific Test Methods to consider:

- ASTM E96 Water Vapor Transmission (Permeance and Permeability)

- ASTM D1653 Water Vapor Transmission (Permeance)

10.3.2 Is Positive-side Waterproofing Required?

Most systems can incorporate a waterproofing membrane between the coating and the substrate. These elastomeric membranes must be flexible to bridge movement of the substrate.

Waterproofing Options:

- Underlying Elastomeric Membranes
- Elastomeric Systems

Specific Test Methods to consider:

- ASTM D570 Water Absorption
- ASTM C1305 Crack Bridging
- ASTM D522 Flexibility (Mandrel Bend)
- ASTM D2240 Hardness

Relevant Specifications

- ASTM C957 Standard Specification for High-Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane with Integral Wearing Surface
- ASTM C898 Standard Guide for Use of High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane with Separate Wearing Course

10.3.3 Are Conductive or Static Dissipative Properties Required?

Conductive and ESD Options:

- Specialty Resins applied as a Coatings, Broadcast, Self-Leveling or Mortar Systems.

Specific Test Methods to consider:

- ANSI/ESD S20.20 ESD and Conductive Standards

10.4 Consideration 4. Selecting the Texture Required for the Application: Texture is primarily incorporated into a flooring system for safety and traction. This is most frequently a surface incorporated feature. Texture is not directly correlated to slip resistance because there are numerous factors contributing to slipperiness. Highly textured surfaces are more difficult to maintain and thus surface contamination may reduce traction. Selection of texture within the flooring system requires the understanding of the potential use, maintenance procedures, and degree of wear (abrasion) anticipated.

10.4.1 Is Texture Required for Safety? Most flooring systems can incorporate texture in the topcoat or through application methods. Not all applications require texture but wet environments expecting foot or vehicle traffic should utilize the appropriate texture to maintain a slip resistant surface.

Slip Resistant Options:

- Broadcast Systems
- Textured Topcoats

Specific Standards to consider:

- ANSI/NFSI B101.3 Coefficient of Friction
- ASTM F2508

10.5 Consideration 5. Selecting the Aesthetics of the Flooring System: After addressing all the above performance requirements, aesthetic considerations can be addressed. This may include color(s), patterns, and gloss. Most highly chemical resistant resins and urethane cements are offered in limited colors, other chemistries are available in a variety of colors. Various aggregates (quartz, paint chips, etc.) are available to provide color and design options. Finally, application techniques can be used to offer unique designs and texture variations.

The cost of the flooring system will be dependent upon the materials and the installation labor. Multi-step installation systems will increase the installation cost. High performance or specialized resins will typically increase the material costs. In most cases, there are several systems that will meet the performance requirements for a specific application. Extended system service life, enhanced design aesthetics and installation restrictions will typically increase the initial cost. Life cycle cost should be considered to avoid operations interruptions and lost business costs that may be significantly higher than the higher initial system costs.

11. Disclaimer

This guide is an SSPC consensus document developed by SSPC: The Society for Protective Coatings. This guide is for information purposes only. It is not a standard. While every precaution is taken to ensure that all information furnished in SSPC guides is as accurate, complete, and useful as possible, SSPC cannot assume responsibility nor incur any obligation resulting from the use of any materials, coatings, or methods specified herein, or of the guide itself.

This guide does not attempt to address problems concerning safety associated with its use. The user of this guide, as well as the user of all products or practices described herein, is responsible for instituting appropriate health and safety practices and for ensuring compliance with all governmental regulations.

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