# Guide to Concrete Floor and Slab Construction

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## Guide to Concrete Floor and Slab Construction



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*The quality of a concrete floor or slab is highly dependent on achieving a hard and durable surface that is flat, relatively free of cracks, and at the proper grade and elevation. Properties of the surface are determined by the mixture proportions and the quality of the concreting and jointing operations. The timing of concreting operations—especially finishing, jointing, and curing—is critical. Failure to address this issue can contribute to undesirable characteristics in the wearing surface such as cracking, low resistance to wear, dusting, scaling, high or low spots, poor drainage, and increasing the potential for curling.*

*Concrete floor slabs employing portland cement, regardless of slump, will start to experience a reduction in volume as soon as they are placed. This phenomenon will continue as long as any water, heat, or both, is being released to the surroundings. Moreover, because the drying and cooling rates at the top and bottom of the slab are not the same, the shrinkage will vary throughout the depth, causing the as-cast shape to be distorted and reduced in volume.*

*This guide contains recommendations for controlling random cracking and edge curling caused by the concrete's normal volume change. Application of present technology permits only a reduction in cracking and curling, not elimination. Even with the best floor designs and proper construction, it is unrealistic to expect completely crack- and curl-free floors. Consequently, every owner should be advised by both the designer and contractor that it is completely normal to expect some amount of cracking and curling on every project, and that such an occurrence does not necessarily reflect adversely on either the adequacy of the floor's design or the quality of its construction (Ytterberg 1987).*

*This guide describes how to produce high-quality concrete slabs-on-ground and suspended floors for various classes of service. It emphasizes such aspects of construction as site preparation, concrete materials, concrete mixture proportions, concrete workmanship, joint construction, load transfer across joints, form stripping procedures, finishing methods, and curing. Flatness/levelness requirements and measurements are outlined. A thorough preconstruction meeting is critical to facilitate communication among key participants and to clearly establish expectations and procedures that will be employed during construction to achieve the floor qualities required by the project specifications. Adequate supervision and inspection are required for job operations, particularly those of finishing.*



**Keywords:** admixture; aggregate; consolidation; contract documents; curing; curling; deflection; durability; form; fracture; joint; mixture proportioning; placing; quality control; slab-on-ground; slabs; slump test.




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# CHAPTER 1—INTRODUCTION

## 1.1—Purpose

This guide presents information relative to the construction of slab-on-ground and suspended-slab floors for industrial, commercial, and institutional buildings. It is applicable to the construction of normalweight and structural lightweight concrete floors and slabs made with conventional portland and blended cements. This guide identifies the various classes of floors based on use, construction design details, necessary site preparation, concrete type, and other related materials. In general, characteristics of the concrete slab surface and joint performance have a powerful impact on the serviceability of floors and other slabs. Because the eventual success of a concrete floor installation depends on the mixture proportions and floor finishing techniques used, considerable attention is given to critical aspects of achieving the desired finishes and the required floor surface tolerances.

## 1.2—Scope

This guide emphasizes choosing and proportioning of materials, design details, proper construction methods, and workmanship. Slabs specifically intended for the containment of liquids are beyond the scope of this guide. Whereas this guide does provide a reasonable overview of concrete floor construction, each project is unique and circumstances can dictate departures from the recommendations given in this guide. Contractors and suppliers should, therefore, thoroughly review contract documents before bid preparation (Chapter 3).

# CHAPTER 2—DEFINITIONS

ACI provides a comprehensive list of definitions through an online resource, "ACI Concrete Terminology," http://www.concrete.org/store/productdetail.aspx?ItemID=CT13. Definitions provided herein complement that resource.

**differential set time**—difference in timing from initial introduction of water to concrete mixture at batch plant to initial power floating.

**dry-shake**—dry mixture of hydraulic cement and fine aggregate (either mineral or metallic) that is distributed evenly over the surface of concrete flatwork and worked into the surface before time of final setting and then floated and troweled to desired finish.

**mixture optimization indicator**—intersection of the coarseness factor value and the workability factor on the coarseness factor chart.

**rutting**—creation of troughs in the soil support system in response to applied wheel loads.

**score**—creation of lines or notches in the surface of a concrete slab.

**soil pumping**—vertical displacement and rebound of the soil support system in response to applied moving loads.

**water slump**—magnitude of slump, measured in accordance with ASTM C143/C143M, which is directly attributed to the amount of water in the concrete mixture.

**window of finishability**—time period available for finishing operations after the concrete has been placed, consolidated, and struck-off, and before final troweling.

**workability factor**—percentage of combined aggregate that passes the No. 8 (2.36 mm) sieve.

# CHAPTER 3—PREBID AND PRECONSTRUCTION MEETINGS

## 3.1—Prebid meeting

The best forum for a thorough review of contract documents before the bid preparation is a prebid meeting. This meeting offers bidders an opportunity to ask questions and to clarify their understanding of contract documents before submitting their bids. A prebid meeting also provides the owner and the owner's slab designer an opportunity to clarify intent where documents are unclear and to respond to last-minute questions in a manner that provides bidders an opportunity to be equally responsive to the contract documents.

## 3.2—Preconstruction meeting

Successful construction of slabs-on-ground or suspended floors or slabs involves the coordinated efforts of many subcontractors and material suppliers. The slab designer should schedule a preconstruction meeting to establish and coordinate procedures that will enable key participants to produce the best possible product under the anticipated field conditions. This meeting should be attended by responsible representatives of organizations and material suppliers directly involved with either the design or construction of floors.

**3.2.1** *Agenda items*—The preconstruction meeting should confirm and document the responsibilities and anticipated interaction of key participants involved in slab-on-ground or suspended floor or slab construction. Following is a list of agenda items appropriate for such a meeting, including ones for which the contract documents should establish a clear responsibility. The following list is not all-inclusive:

a) Site preparation

b) Grades for drainage, if any

c) Work associated with installation of auxiliary materials, such as vapor barriers, vapor retarder/barriers, edge insulation, electrical conduit, mechanical sleeves, drains, and embedded plates

d) Class of floor

e) Floor thickness

f) Reinforcement, when required

g) Construction tolerances: base (rough and fine grading), forms, slab thickness, surface configuration, and floor flatness and levelness requirements (including how and when measured)

h) Joints and load-transfer mechanism

i) Materials: cements, fine aggregate, coarse aggregate, water, and admixtures (usually by reference to applicable ASTM standards)

j) Special aggregates, admixtures, or monolithic surface treatments, where applicable

k) Concrete specifications including:

1) Compressive strength, flexural strength, or both

2) Recommended cementitious material content, if applicable

3) Maximum size, grading, and type of coarse aggregate

4) Grading and type of fine aggregate
5) Combined aggregate grading
6) Air content of concrete, if applicable
7) Slump of concrete
8) Water-cement ratio (*w*/*c*) or water-cementitious material ratio (*w*/*cm*)
9) Preplacement soaking requirement for lightweight aggregates
10) Finishability

l) Measuring, mixing, and placing procedures, which is usually by reference to specifications or recommended practices

m) Strike-off method

n) Recommended finishing methods and tools, where required

o) Coordination of floor finish requirements with those required for floor coverings such as vinyl, ceramic tile, or wood that are to be applied directly to the floor

p) Curing procedures, length of curing, necessary protection, and time before opening slabs for traffic (ACI 308R; 308.1)

q) Testing and inspection requirements;

r) Acceptance criteria and remedial measures to be used, if required

Additional issues specific to suspended slab construction are:

a) Form tolerances and preplacement quality assurance survey procedures for cast-in-place construction

b) Erection tolerances and preplacement quality assurance survey procedures for composite slab construction

c) Form stripping procedures, if applicable

d) Items listed in 5.3 that are appropriate to the structural system(s) used for the project

**3.2.2** *Quality assurance*—Adequate provisions should be made to ensure that the constructed product meets or exceeds the requirements of the project documents. Toward this end, quality control procedures should be established and maintained throughout the entire construction process.

The quality of a completed concrete slab depends on the skill of individuals who place, finish, and test the material. As an aid to ensuring a high-quality finished product, the specifier or owner should consider requiring the use of prequalified concrete contractors, concrete suppliers, accredited testing laboratories, and concrete finishers who have had their proficiency and experience evaluated through an independent third-party certification program. ACI has developed programs to train and certify concrete flatwork finishers and concrete inspectors and testing technicians.

## CHAPTER 4—CLASSES OF FLOORS

### 4.1—Classification of floors

Table 4.1 classifies floors on the basis of intended use, discusses special considerations, and suggests finishing techniques for each class of floor. Intended use requirements should be considered when selecting concrete properties, and the step-by-step placing, consolidating, and finishing procedures in Chapter 10 should be closely followed for different classes and types of floors.

Wear resistance and impact resistance should also be considered. Currently, there are no standard criteria for evaluating the wear resistance of a floor, making it impossible to specify concrete quality in terms of ability to resist wear. Wear resistance is directly related to the concrete mixture proportions, aggregate types, finishing, surface treatments, curing, and other construction techniques used.

### 4.2—Single-course monolithic floors: Classes 1, 2, 4, 5, and 6

Five classes of floors are constructed with monolithic concrete; each involves some variation in joint detailing and final finishing techniques. If abrasion from grit or other materials is anticipated, a higher quality floor surface may be required for satisfactory service (ASTM 1994). Under these conditions, a special mineral or metallic aggregate monolithic surface treatment is recommended. For slabs exposed to vehicular traffic, enhanced detailing, including positive load transfer (typically dowels) and edge protection at all joints, is recommended.

### 4.3—Two-course floors: Classes 3, 7, and 8

**4.3.1** *Unbonded topping over base slab*—The base courses of Class 3 (unbonded topping) floors and Class 8 floors can be either slabs-on-ground or suspended slabs, with the finish coordinated with the type of topping. For Class 3 floors, the concrete topping material is similar to the base slab concrete. The top courses for Class 8 floors require a hard-steel troweling and usually have a higher compressive strength than the base course. Class 8 floors can also make use of an embedded cement-coated hard aggregate, a premixed (dry-shake) mineral aggregate, or metallic hardener for addition to the surface.

Class 3 (unbonded topping) and Class 8 floors are used when it is preferable not to bond the topping to the base course. This allows the two courses to move independently, or so that the top courses can be more easily replaced at a later period. Two-course floors can be used when mechanical or electrical equipment requires special bases and when their use permits more expeditious construction procedures. Two-course unbonded floors can also be used to resurface worn or damaged floors when contamination prevents complete bond, or when it is desirable to avoid scarifying and chipping the base course and the resultant higher floor elevation is compatible with adjoining floors. Class 3 floors are used primarily for commercial or nonindustrial applications, whereas Class 8 floors are used primarily for industrial applications.

Unbonded toppings should have a minimum thickness of 3 in. (75 mm) for foot-traffic, but a minimum thickness of 4 in. (100 mm) is recommended if the surface is to be subjected to vehicular traffic.

The topping slab should have a joint spacing closer than a slab placed on ground of similar thickness to minimize the increased curling or warping stresses when placed over

**Table 4.1—Classes of floors on the basis of intended use and the recommended final finish technique**

| Class | Anticipated traffic type | Use | Special considerations | Final finish |
|---|---|---|---|---|
| 1. Exposed | **Exposed surface**—foot traffic | Offices, churches, multiunit residential, decorative | Uniform finish, nonslip aggregate in specific areas, curing<br><br>Colored mineral aggregate, color pigment or exposed aggregate, stamped or inlaid patterns, artistic joint layout, curing, surface treatment, maintenance | Normal steel-troweled finish, nonslip finish where required<br><br>Burnishing or polishing to enhance sheen as required |
| 2. Covered | **Covered surface**—foot traffic | Offices, churches, commercial, multiunit residential, institutional with floor coverings | Flat and level slabs suitably dry for applied coverings, curing | Light steel-troweled finish |
| 3. Topping | **Exposed or covered surface**—foot traffic | Unbonded or bonded topping over base slab for commercial or nonindustrial buildings where construction type or schedule dictates | *Base slab*—good uniform level surface tolerance, curing<br><br>*Unbonded topping*—bondbreaker on base slab, minimum thickness 3 in. (75 mm), reinforced, curing<br><br>*Bonded topping*—properly sized aggregate, 3/4 in. (19 mm) minimum thickness curing | *Base slab*—troweled finish under unbonded topping; clean, textured surface under bonded topping<br><br>*Topping*—for exposed surface, normal steel-troweled finish; for covered surface, light steel-troweled finish |
| 4. Institutional/ commercial | **Exposed or covered surface**—foot and light vehicular traffic | Institutional or commercial | Level and flat slab suitable for applied coverings, nonslip aggregate for specific areas, curing; coordinate joints with applied coverings | Normal steel-troweled finish |
| 5. Industrial | **Exposed surface**—industrial vehicular traffic such as pneumatic wheels and moderately soft solid wheels | Industrial floors for manufacturing, processing, and warehousing | Good uniform subgrade, joint layout, joint load transfer, abrasion resistance, curing | Hard steel-troweled finish |
| 6. Heavy industrial | **Exposed surface**—heavy-duty industrial vehicular traffic such as hard wheels and heavy wheel loads | Industrial floors subject to heavy traffic; can be subject to impact loads | Good uniform subgrade, joint layout, joint load transfer required, abrasion resistance, curing | Special metallic or mineral aggregate surface hardener; repeated hard steel-troweling |
| 7. Heavy industrial topping | **Exposed surface**—heavy-duty industrial vehicular traffic such as hard wheels and heavy wheel loads | Bonded two-course floors subject to heavy traffic and impact | *Base slab*—good uniform subgrade, reinforcement, joint layout, level surface, curing<br><br>*Topping*—composed of well-graded all-mineral or all-metallic aggregate. Minimum thickness 3/4 in. (19 mm)<br><br>Mineral or metallic aggregate surface hardener applied to high-strength plain topping to toughen, curing | Clean, textured base slab surface suitable for subsequent bonded topping. Special power floats for topping are optional, hard steel-troweled finish |
| 8. Commercial/ industrial Topping | As in Classes 4, 5, or 6 | Unbonded topping—on new or old floors where construction sequence or schedule dictates | Bondbreaker on base slab, minimum thickness 4 in. (100 mm), abrasion resistance, curing | As in Classes 4, 5, or 6 |
| 9. Critical surface profile | **Exposed surface**—superflat or critical surface tolerance required; special materials-handling vehicles or robotics requiring specific tolerances | Narrow-aisle, high-bay warehouses; television studios, ice rinks, or gymnasiums (ACI 360R) | Varying concrete quality requirements. Special application procedures and strict attention to detail are recommended when shake-on hardeners are used. $F_F$ 50 to $F_F$ 125, superflat floor, curing | Strictly following techniques as indicated in 8.9 |

a rigid base slab due to the effects of drying from the top surface only.

Plastic sheeting, roofing felt, or a bond-breaking compound is often used to prevent bond to the base slab. Reinforcement, such as deformed bars, welded wire fabric, bar mats, or fibers is recommended to be placed in the topping in sufficient quantities to reduce the width of shrinkage cracks and to bridge existing cracks in the base slab. Concrete should be proportioned to meet the requirements of Chapter 8.

Curling or warping will also be more probable due to the effects of drying from the top surface only. Reinforcement of unbonded topping slabs is recommended due to increased curling stresses and potential bridging of existing cracks in the base slab.

**4.3.2** *Bonded topping over base slab*—Class 3 (bonded topping) and Class 7 floors use a topping bonded to the base slab. Class 3 (bonded topping) floors are used primarily for commercial or nonindustrial applications; Class 7 floors are

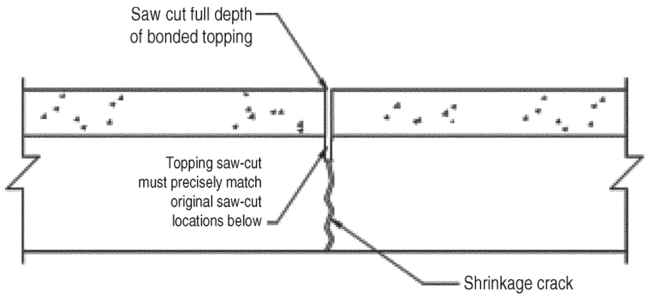


*Fig. 4.3.2—Saw-cut contraction joint.*

used for heavy-duty industrial applications subject to heavy traffic and impact. The base slabs can either be a conventional portland cement concrete mixture or shrinkage-compensating concrete. The surface of the base slab should have a rough, open-pore finish and be free of any substances that would interfere with bonding of the topping to the base slab (Fig. 4.3.2).

The topping installation can occur either the same day before hardening of the base slab or deferred until after the base slab has hardened. The topping for a Class 3 floor is a concrete mixture similar to that used in Class 1 or 2 floors. The topping for a Class 7 floor requires a multiple pass hard-steel-trowel finish and the top course usually has a higher strength than the base course. A bonded topping can also make use of an embedded hard aggregate or a premixed (dry-shake) mineral aggregate or metallic hardener for addition to the surface. Bonded concrete toppings should have a minimum thickness of 3/4 in. (19 mm). Proprietary products should be applied per manufacturers' recommendations. Joint spacing in the topping should be coordinated with construction and contraction joint spacing in the base slab. Saw-cut contraction joints should penetrate into the base slab a minimum of 1 in. (25 mm).

If the topping is placed on a base slab before the joints are cut, joints in the topping should extend into the base slab and depth should be appropriate for the total thickness of the combined slab. If the topping is installed on a previously placed slab where joints have activated, additional joints in the topping are unnecessary as shrinkage relief cannot occur between the slab joints in the bonded topping. When topping slabs are placed on shrinkage-compensating concrete base slabs, the joints in the base slab can only be reflected in the bonded topping slab if the bonded topping slab is installed shortly after the maximum expansion of the base slab occurs. Maximum expansion usually occurs within 7 to 14 days.

## 4.4—Class 9 floors

Certain materials-handling facilities, for example, high-bay, narrow-aisle warehouses, require extraordinarily level and flat floors. The construction of such superflat floors (Class 9) is discussed in Chapter 10. A superflat floor could be constructed as a single-course floor, or as a two-course floor with a topping. A bonded topping would be similar to a Class 7 topping. An unbonded Class 9 topping is similar to a Class 8 topping, typically greater than 4 in. (100 mm), and can be designed with continuous reinforcement, while eliminating joints.

## 4.5—Special finish floors

Floors with decorative finishes and those requiring skid resistance or electrical conductivity are discussed in Chapter 10.

Floors exposed to mild acids, sulfates, or other chemicals require special preparation or protection. Refer to ACI 201.2R for reports on the means of increasing the resistance of concrete to chemical attack. Where attack will be severe, wear-resistant protection suitable for the exposure should be used. Such environments and the methods of protecting floors against them are discussed in ACI 515.2R.

In certain chemical and food processing plants, such as slaughterhouses, exposed concrete floors are subject to slow disintegration due to organic acids. In many instances, it is preferable to protect the floor with other materials such as acid-resistant brick, tile, or resinous mortars (ACI 515.2R).

# CHAPTER 5—DESIGN CONSIDERATIONS

## 5.1—Scope

Chapter 5 addresses the design of concrete floors as it relates to their constructibility. Specific design requirements for concrete floor construction are found in ACI 360R for slabs-on-ground, ACI 223R for shrinkage-compensating concrete floors, and ACI 421.1R and 421.2R for suspended floors.

## 5.2—Slabs-on-ground

**5.2.1** *Required design elements*—Following are the minimum items that should be addressed in the construction documents prepared by the designer (ACI 360R):

a) Slab-on-ground design criteria

b) Base and subbase materials, preparation requirements, and vapor retarder/barrier, when required

c) Concrete thickness

d) Concrete compressive strength, flexural strength, or both

e) Concrete mixture proportion requirements, ultimate drying shrinkage strain, or both

f) Joint locations and details

g) Reinforcement (type, size, and location) when required

h) Surface treatment, when required

i) Surface finish

j) Tolerances (base, subbase, slab thickness, and floor flatness and levelness)

k) Concrete curing

l) Joint filling material and installation

m) Special embeddments

n) Testing requirements

o) Preconstruction meeting, quality assurance, and quality control

If any of this information is not provided, the contractor should request it from the slab-on-ground slab designer.

**5.2.2** *Soil-support system*—Because the performance of a slab-on-ground depends on the integrity of the soil-support system, specific attention should be given to site preparation requirements, including proof-rolling (6.1.1). In most cases, proof-rolling results are much more indicative of the soil-support system's ability to withstand loading than from the results of in-place tests of moisture content or density. A thin layer of graded, granular, compactible material is normally used as fine grading material to better control concrete's thickness and to minimize friction between the base material and slab. For detailed information on soil-support systems, refer to ACI 360R.

**5.2.3** *Moisture protection*—Proper moisture protection is essential for any slab-on-ground where the floor will be covered by moisture-sensitive flooring materials such as vinyl; linoleum; wood; carpet; rubber; rubber-backed carpet tile; impermeable floor coatings; adhesives; or where moisture-sensitive equipment, products, or environments exist, such as humidity-controlled or refrigerated rooms. ACI 302.2R provides recommendations for the design and construction of concrete slabs that will receive moisture-sensitive or pH-sensitive flooring materials or coatings for both slabs-on-ground and suspended slabs.

**5.2.3.1** *Vapor retarder permeance*—A vapor retarder/barrier is a material that is intended to minimize the transmission of water vapor upward through the slab from sources below. The performance requirements for plastic vapor retarder/barrier materials in contact with soil or granular fill under concrete slabs are listed in ASTM E1745. According to ASTM E1745 a vapor retarder/barrier material is to have a permeance level, also known as the water vapor transmission rate, not exceeding 0.1 perms as determined by ASTM E96/E96M or ASTM F1249. However, most flooring installations will benefit by using a material with a permeance level well below 0.1 perms (0.0659 metric perms = 5.72 $ng/s^{-1}m^{-2}Pa^{-1}$).

The selection of a vapor retarder/barrier material and its level of permeance should be made on the basis of the protective requirements of the material being applied to the floor surface or the environment being protected. Although conventional 6, 8, and 10 mil (0.15, 0.20, and 0.25 mm) polyethylene has been used in the past, this class of material does not fully conform to the requirements of ASTM E1745 and should not be considered for use as below-slab moisture protection. Any plastic vapor retarder/barrier material to be used below slabs should be in full compliance with the minimum requirements of ASTM E1745 and the thickness and permeance of the material be selected on the basis of protective needs and durability during and after installation.

However, for a material to be considered a true barrier it would need to have a permeance level of 0.0 perms when tested in accordance with ASTM E96/E96M or ASTM F1249. The industry has not established a permeance level that serves as the dividing point between materials classed as vapor barriers or vapor retarders. It is most likely that when a dividing point between barrier and retarder is established it will be at 0.01 perms or less. The laps or seams for a vapor retarder/barrier should be overlapped 6 in. (150 mm) (ASTM E1643) or as instructed by the manufacturer. Joints and penetrations should be sealed with the manufacturer's recommended adhesive, pressure-sensitive tape, or both.

**5.2.3.2** *Vapor retarder/barrier location*—The decision to locate the vapor retarder/barrier in direct contact with the slab's underside had long been debated. Experience has shown, however, that the greatest level of protection for floor coverings, coatings, or building environments is provided when the vapor retarder/barrier is placed in direct contact with the slab. Placing concrete in direct contact with the vapor retarder/barrier eliminates the potential for water from sources such as rain, saw-cutting, curing, cleaning, or compaction to become trapped within the fill course. Wet or saturated fill above the vapor retarder/barrier can significantly lengthen the time required for a slab to dry to a level acceptable to the manufacturers of floor coverings, adhesives, and coatings. A fill layer sandwiched between the vapor retarder/barrier and the concrete also serves as an avenue for moisture to enter and travel freely beneath the slab, which can lead to an increase in moisture within the slab once it is covered. Moisture can enter the fill layer through voids, tears, or punctures in the vapor retarder/barrier.

Placing concrete in direct contact with the vapor retarder/barrier requires additional design and construction considerations if potential slab-related problems are to be avoided. When compared with identical concrete cast on a draining base, concrete placed in direct contact with a vapor retarder/barrier shows more settlement and exhibits significantly larger length change in the first hour after casting, during drying shrinkage, and when subject to environmental change (Suprenant 1997). Joints that open wider than what is normally anticipated are called dominant joints (Walker and Holland 2007). Dominant joint behavior can be made worse when the slab is placed in direct contact with a vapor retarder/barrier that reduces friction from the base. Where reinforcing steel is present, settlement cracking over the steel is more likely because of increased settlement resulting from a longer bleeding period. There is also increased potential for a greater measure of slab curl.

Concrete that does not lose excess water to the base does not stiffen as rapidly as concrete that does. If rapid surface drying conditions are present, the surface of concrete placed directly on a vapor retarder/barrier has a tendency to dry and crust over whereas the concrete below the top fraction of an inch (millimeter) remains relatively less stiff or unhardened. When this occurs, it may be necessary to begin machine operations on the concrete surface before the concrete below the top surface is sufficiently set. Under such conditions, a reduction in surface flatness and some blistering or delamination can occur as air, water, or both, become trapped below the finish surface.

Each proposed installation should be independently evaluated for moisture sensitivity of anticipated subsequent floor finishes and the level of protection and material strength they might need. When placing concrete in direct contact with the vapor retarder/barrier, the potential effects of slab curling, crusting, and cracking should be considered. Design and construction measures should be implemented to offset or to minimize these effects. The anticipated benefits and risks associated with the specified location of the vapor retarder/barrier should be reviewed (Fig. 5.2.3.2) with all parties before construction (ACI 302.2R).