CONCRETE CONSTRUCTION SERIES — TECHNICAL BRIEF

What Makes Concrete Slabs, Driveways, and Basements Last?

Concrete does not dry, it cures, and nearly every common concrete failure traces back to one of three water decisions. Water added at the truck raises the water-cement ratio and permanently lowers strength. Water lost too quickly in the first hours causes plastic shrinkage cracking and a weak, dusting surface. Water arriving later as vapor drive, groundwater, or deicing chemicals drives long-term deterioration. Subgrade preparation, joint layout, and curing decide durability more than mix design alone.

Reinforcement does not prevent cracks in concrete. Steel and fiber hold cracks tight so they stay small and stable. Every slab on grade will crack. The only real question is whether the cracks appear where the joint layout put them or somewhere the owner has to look at every day.

Key Takeaways

1. Concrete cures through a chemical reaction with water rather than drying, so protecting water in the first days matters as much as the mix design.
2. Water added at the truck to make concrete easier to place raises the water-cement ratio, permanently lowering strength and increasing shrinkage cracking.
3. ASTM C94/C94M-21, published April 2021, removed the automatic 90-minute discharge limit that had stood since 1933; the purchaser now states the time limit at order, or the producer sets it, and it must appear on the delivery ticket.
4. Control joints in unreinforced slabs on grade should be spaced 24 to 36 times the slab thickness, which is roughly 8 to 12 feet in a 4-inch slab.
5. Exterior concrete must never receive a hard steel-troweled finish, because a densified surface traps bleed water and entrained air beneath it and leads to delamination and scaling.
6. Deicers containing ammonium sulfate or ammonium nitrate chemically disintegrate concrete and must never be used on any slab at any age.
7. The International Residential Code requires dampproofing on foundation walls enclosing below-grade space, and full waterproofing only where a high water table or other severe soil-water condition is known to exist.
8. Color variation and efflorescence in integrally colored concrete are inherent material behavior rather than defects, which is why approved mockups and a written maintenance expectation belong in the contract.

What Actually Decides Whether Concrete Lasts?

Concrete construction gets discussed as though the mix design is the whole story. Compressive strength is what appears on the submittal, so strength is what gets argued about. In the field, the mix is rarely the thing that fails.

Nearly every common concrete failure traces back to one of three decisions about water. Water added at the truck to make placement easier raises the water-cement ratio and permanently lowers strength. Water lost too quickly during the first hours after placement causes plastic shrinkage cracking and a weak, dusting surface. Water arriving later as vapor drive through a slab, groundwater against a foundation wall, or deicing chemicals on a driveway drives long-term deterioration.

> **Concrete does not dry. Concrete cures. Hydration is a chemical reaction that needs water to continue, which is why protecting water is a construction operation and not a waiting period.**

Reading concrete work through water rather than through strength reorganizes the whole scope. Subgrade preparation, vapor retarder selection, joint layout, finishing method, and curing all become strength decisions, because each one governs where water goes.

Why Is Water Added on Site the Most Expensive Shortcut on a Pour?

Adding water at the truck is the most common and least visible way to damage a concrete placement. Stiff concrete is hard to move and hard to finish, so the request to add water usually comes from the crew that has to place it, and it usually sounds reasonable.

Compressive strength is inversely related to the water-cement ratio. Extra water occupies space in the fresh concrete, and as that water leaves it leaves capillary pore structure behind. The result is lower compressive strength, higher permeability, and more drying shrinkage, which means more cracking in the same slab that just got easier to finish.

The record already exists

ASTM C94 requires water added after batching to be recorded on the delivery ticket. The batch ticket is therefore the single most useful document on a concrete pour, and the one least often collected. A ticket showing water added on site, alongside a slump test result, explains a low cylinder break weeks before anyone starts assigning blame.

1. Order the right slump for the placement method rather than correcting slump in the field.
2. Use a mid-range or high-range water reducer when workability is genuinely inadequate.
3. Collect and file every delivery ticket, including tickets for loads that were rejected.
4. Record who authorized any water addition and how much.

Did the 90-Minute Concrete Delivery Rule Change?

The 90-minute discharge limit is one of the most widely quoted rules in concrete construction, and it is no longer automatic. ASTM C94/C94M-21, published in April 2021, removed the default time limit that the standard had carried since 1933.

Under the current standard the purchaser states the time limit from the start of mixing to completion of discharge when the concrete is ordered. If the purchaser states nothing, the manufacturer establishes the limit and communicates it before delivery. Either way, the established limit must appear on the delivery ticket.

> **A general contractor who assumes 90 minutes still applies automatically has quietly transferred a specification decision to the ready-mix producer.**

Practical effect on a jobsite is straightforward. State the discharge time limit at the time of order, confirm the stated limit is printed on the ticket, and reject loads that exceed it. Technology has genuinely extended how long some mixes stay workable, but that judgment belongs in the specification rather than in a conversation at the chute.

What Has to Be Under a Slab Before Anyone Pours?

Subgrade quality decides more about a slab on grade than the concrete does, and the governing property is uniformity rather than raw strength. A slab bridging between a hard spot and a soft spot develops bending stress the slab was never designed to carry. Uniform support beats high support.

Compaction and proof rolling

Fill must be placed in controlled lifts and compacted to a specified density with testing, not compacted by the weight of whatever equipment happened to drive over it. Loose or inconsistently compacted fill under a slab produces settlement cracking that no amount of reinforcement will prevent, and the repair happens after the slab is in place and the finish floor is down.

Vapor retarders

Moisture-sensitive floor coverings fail when water vapor moves up through a slab. ACI 302.1R recommends a vapor retarder complying with ASTM E1745 and at least 10 mils thick, and ACI 302.2R associates a vapor barrier with a permeance at or below 0.01 perms. Class A material is the common specification for slabs receiving moisture-sensitive flooring.

Placement of the vapor retarder matters as much as the material. Current guidance places the vapor retarder directly beneath the slab. The older practice of covering the vapor retarder with a sand blotter layer creates a reservoir that holds water directly under the concrete, which is the opposite of the intent.

> **A vapor retarder installed correctly and then punctured by rebar chairs, stakes, and foot traffic is a vapor retarder in name only. Repair penetrations before placement.**

Does Reinforcement Stop Concrete From Cracking?

Reinforcement does not prevent concrete from cracking. Welded wire fabric, reinforcing bar, and fiber all serve to hold cracks tight once cracks form, keeping them narrow, stable, and able to transfer load across the crack face. Concrete shrinks as it cures, and restrained shrinkage cracks.

Setting that expectation in writing before construction is a contractual act as much as a technical one. An owner who was told the slab would not crack has a complaint on the day the first shrinkage crack appears, no matter how well the work was executed.

Position is the whole value

Steel only works where the steel actually sits. Welded wire fabric lying on the subgrade contributes nothing to crack control at the slab surface, and the field practice of hooking mesh upward during placement produces steel at an unknown and inconsistent depth. Chairs and supports are what convert reinforcement from a line item into a functioning element.

Concrete cover governs durability in the same way. ACI 318 requires 3 inches of cover for concrete cast against and permanently exposed to earth, and 1.5 inches for formed surfaces exposed to earth or weather. Cover is corrosion protection, and reduced cover is a durability defect even where strength is adequate.

How Far Apart Should Control Joints Be in a Slab?

Control joints exist to decide in advance where a slab will crack. Shrinkage stress will find a release somewhere, and a sawcut or tooled joint gives that stress a straight, planned, maintainable path instead of a random one across the middle of a finished floor.

ACI 302.1R and ACI 360 recommend a maximum joint spacing of 24 to 36 times the slab thickness for unreinforced slabs on grade. NRMCA states the same rule in CIP 6.

4 inches	roughly 8 to 12 feet
5 inches	roughly 10 to 15 feet
6 inches	roughly 12 to 18 feet

Timing matters as much as spacing

A joint cut after shrinkage cracking has already started is decoration. Conventional sawing generally happens within the first day, and early-entry sawing considerably sooner, with the exact window depending on mix, temperature, wind, and humidity. Panels should also be kept close to square, because long narrow panels crack across the narrow dimension regardless of spacing.

1. Keep panel length-to-width ratio near 1 to 1, and no more than about 1.5 to 1.
2. Avoid interior corners and re-entrant shapes that concentrate stress, or reinforce them deliberately.
3. Continue joints through the full slab depth requirement for the joint type specified.
4. Isolate columns, footings, and walls so the slab can move independently.

What Makes a Concrete Driveway Different From an Interior Slab?

Exterior flatwork faces exposure conditions an interior slab never sees, and the differences change the mix, the finish, and the curing. Freeze-thaw cycling, deicing chemicals, ultraviolet exposure, and direct vehicle loading all apply to a driveway.

Air entrainment is not optional

ACI 318 assigns exterior concrete exposed to moisture and freeze-thaw cycling to Exposure Category F, and concrete in Classes F1, F2, and F3 must be air entrained. Required air content is set by exposure class together with nominal maximum aggregate size, so the value belongs in a project specification rather than a rule of thumb. Entrained air gives freezing water somewhere to expand without spalling the surface.

The finish that ruins driveways

Hard steel troweling and air-entrained exterior concrete are incompatible. A densified troweled surface traps bleed water and entrained air immediately below the surface, and the result is delamination and scaling that appears in the first winters. Exterior flatwork gets a broom finish, which also supplies the slip resistance a wet driveway needs.

> **A smooth troweled driveway is not a premium finish. A smooth troweled driveway is a warranty claim on a delay.**

1. Slope the surface for positive drainage so water leaves rather than ponding.
2. Thicken and reinforce edges and any area taking wheel loads.
3. Cure the surface deliberately; exterior flatwork loses water fast to sun and wind.
4. Match sealer chemistry to the exposure and plan on periodic reapplication.

Which Deicing Chemicals Destroy New Concrete?

Deicer selection causes more avoidable driveway damage than almost any other owner decision, and the worst products are widely sold. Deicers containing ammonium sulfate or ammonium nitrate chemically attack and rapidly disintegrate concrete, and belong on no slab at any age. Many fertilizers contain exactly those compounds.

Sodium chloride does not attack the cement paste in the same chemical way, but chloride ion accelerates corrosion of embedded steel, and corroding steel expands and cracks the concrete from within. On new concrete the standard guidance is to avoid deicing chemicals entirely through the first winter, while the surface is still maturing.

1. Never use any product containing ammonium sulfate or ammonium nitrate on concrete.
2. Avoid all deicers during the first winter after placement.

3. Use sand for traction instead of chemical deicers where possible.
4. Keep fertilizer off concrete surfaces and rinse accidental spills promptly.
5. Give an owner this instruction in writing at closeout, because verbal guidance does not survive the first ice storm.

What Actually Keeps a Basement Dry?

Basement moisture control is a drainage problem before it is a coating problem. Water standing against a foundation wall develops hydrostatic pressure, and no surface treatment reliably resists sustained hydrostatic pressure. Relieving the water is the primary control, and coating the wall is secondary.

What the code requires

International Residential Code Section R406 requires dampproofing on exterior foundation walls that retain earth and enclose below-grade habitable or usable space. Full waterproofing is required in areas where a high water table or other severe soil-water condition is known to exist. Section R405 governs the footing drain that makes either approach work.

> **Dampproofing resists moisture. Waterproofing resists water under pressure. Specifying dampproofing on a site with a known high water table meets the letter of a sentence and fails the building.**

Consolidation and grouting

Concrete placed in a foundation wall has to be consolidated so the mix completely fills the forms around reinforcement and embedded items. Internal vibration in controlled lifts, with the vibrator penetrating down into the previous lift, is what produces the dense, watertight concrete a below-grade wall depends on. Limiting free-fall drop height, ordering a mix suited to the placement method, and sealing form joints against paste loss all support the same result.

Grouted concrete masonry foundation walls follow the same principle. Grout must be consolidated so cells fill solid around vertical reinforcement, and grout lifts require consolidation and reconsolidation as the grout settles. A wall that is dense and solid is the first line of moisture control, well before any coating is applied to the outside face.

1. Install and protect the footing drain, drainage aggregate, and filter fabric before backfill.
2. Treat the footing-to-wall cold joint deliberately with a keyway or waterstop.
3. Grade finished soil away from the building and get roof water discharged away from the foundation.
4. Document wall condition photographically before damproofing covers it.

Why Do Colored Concrete Jobs Get Rejected?

Decorative colored concrete generates a disproportionate share of disputes, and the cause is usually an expectation problem rather than an execution problem. Colored concrete is a cast, cured, site-mixed material, and uniform color is not one of its properties.

Integral color	Pigment batched throughout the concrete	Shade shifts with water content, cement source, and curing uniformity
Dry-shake color hardener	Pigment and hardener floated into the surface	Color is surface depth only; wear exposes gray beneath
Acid stain	Reacts chemically with the cement paste	Result varies with the specific slab; limited palette
Dye	Penetrates without reacting	Generally interior; many dyes are not ultraviolet stable

Two things clients read as defects

Mottling and shade variation in integrally colored concrete follow water content and curing uniformity. Inconsistent water between truckloads, uneven curing, and differing evaporation across a slab all show up as visible color difference, because pigment concentration relative to paste changed. Consistency in the field is what produces consistency in color.

Efflorescence is the whitish bloom that appears as soluble salts are carried to the surface by migrating moisture. Efflorescence is a normal consequence of moisture movement through cementitious material, is worse in cool damp conditions, and generally diminishes over time. Efflorescence is not a workmanship failure.

> **The contract protection for decorative concrete is an approved mockup. ACI 303 treats sample panels as the standard of acceptance for architectural concrete, and a mockup converts a matter of opinion into a documented reference.**

1. Build and get written approval on a mockup using the actual mix, pigment lot, finish, and sealer.
2. Order pigment for the whole placement from a single lot where possible.
3. Hold water content consistent load to load, since water is also a color control.
4. Confirm the curing compound and sealer are compatible with the color system.
5. State in writing that shade variation and efflorescence are inherent, and give the owner a sealer maintenance interval.

What Does Ducere Test and Document on Every Concrete Pour?

Ducere Construction Services treats a concrete placement as a documented event, because concrete is the one trade where the evidence disappears as the work is completed. Once concrete is placed and

backfilled, the only remaining proof of what was installed is the record made at the time.

Compressive strength cylinders	ASTM C31 and ASTM C39	Concrete met specified strength at 28 days
Slump	ASTM C143	Concrete was delivered at the ordered consistency
Air content	ASTM C231 or ASTM C173	Freeze-thaw durability requirement was satisfied
Concrete temperature	ASTM C1064	Hot or cold weather limits were respected
Delivery ticket	ASTM C94	Mix, batch time, discharge limit, and any water added on site

Pre-placement documentation carries equal weight. Photographs of subgrade, compaction testing, vapor retarder condition, reinforcement position and support, and embedded items are taken before concrete covers them. Ducere uses OpenSpace for field capture so that field conditions are recorded with location and date rather than reconstructed from memory.

Ducere holds Georgia General Contractor license GCCO006711 and Georgia Residential Light Commercial license RLQQA005251, NASCLA license 404696491, and Florida Certified Building Contractor license CBC1263793. Ducere warrants work for two years across all divisions.

> **A pour with no cylinders, no tickets, and no pre-placement photographs is not a cheaper pour. A pour with no record is an undefendable pour.**

What Are the Honest Limits of Concrete Work?

Concrete carries real constraints that no contractor can specify away, and stating them before construction is more useful than explaining them afterward.

1. Every slab on grade will crack. Joint layout and reinforcement control where cracks go and how wide they get, and eliminate neither.
2. Colored concrete varies in shade and will show efflorescence. An approved mockup sets the reference; matching a photograph from another project is not achievable.
3. Sealers are consumable. Exterior sealers require periodic reapplication, and a driveway that looked rich on handover will look flat without maintenance.
4. Concrete strength is confirmed at 28 days, so a pour is not verified on the day it is placed, and early loading is a risk decision rather than a schedule decision.
5. Repairs to concrete are visible. A structurally sound repair rarely disappears cosmetically, which is why getting the placement right the first time is far cheaper than correcting it afterward.

6. Weather governs the calendar. Hot, cold, dry, and windy conditions each require specific protective measures, and a placement made outside those measures cannot be corrected later.

Setting these limits in the contract and in the closeout package is what separates a concrete scope that ends in acceptance from a concrete scope that ends in an argument.

Frequently Asked Questions

Does concrete dry or cure?

Concrete cures. Hydration is a chemical reaction between portland cement and water that continues for weeks, and concrete gains strength as long as moisture and temperature allow that reaction to proceed. Concrete that loses water too early stops gaining strength permanently, which is why curing is a specified operation governed by ACI 308.1 and not simply the passage of time.

Why does adding water to concrete on the job site reduce strength?

Adding water at the truck raises the water-cement ratio of the concrete, and strength is inversely related to that ratio. The extra water creates additional capillary pore space as it leaves, which lowers compressive strength, increases permeability, and increases drying shrinkage. Water added after batching must be recorded on the delivery ticket under ASTM C94, so the record exists whether or not anyone reads it.

How far apart should control joints be in a concrete slab?

Control joints in unreinforced concrete slabs on grade should be spaced no farther apart than 24 to 36 times the slab thickness, per ACI 302.1R and ACI 360. In a 4-inch slab that is roughly 8 to 12 feet, and in a 6-inch slab roughly 12 to 18 feet. Joints must also be cut early, before shrinkage stress finds its own crack path.

Should a concrete driveway get a smooth troweled finish?

No. Exterior concrete in a freeze-thaw climate should receive a broom finish, not a hard steel trowel finish. Hard troweling densifies the surface and traps bleed water and entrained air just beneath it, which produces delamination and surface scaling. A broom finish also provides the slip resistance a driveway or walkway needs when wet.

Does the International Residential Code require basement waterproofing or dampproofing?

The International Residential Code requires dampproofing on exterior foundation walls that retain earth and enclose below-grade habitable or usable space, under Section R406. Full waterproofing is required only in areas where a high water table or other severe soil-water condition is known to exist. Both approaches depend on a working footing drain under Section R405 to relieve hydrostatic pressure.

Why does colored concrete look blotchy or develop a white haze?

Integrally colored concrete shows color as a function of water content, cement source, and curing uniformity, so inconsistent water or uneven curing between truckloads produces mottling. The white haze is efflorescence, which is soluble salt carried to the surface as moisture migrates out of the concrete. Both are inherent behavior of a cast material rather than workmanship defects, which is why approved mockups matter.

How long before you can drive on a new concrete driveway?

Common industry guidance is to keep foot traffic off new concrete for 24 to 48 hours and passenger vehicles off for about 7 days, and to hold heavy vehicles and equipment until 28 days, when specified compressive strength is verified under ASTM C39. Concrete continues gaining strength well past the point it feels hard underfoot, so surface firmness is not an indicator that a driveway is ready for load.

Sources & Further Reading

1. NRMCA CIP 6 - Joints in Concrete Slabs on Grade — https://www.concreteanswers.org/CIPs/CIP6.htm
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3. Change to ASTM C94-21 Time Limit - American Concrete Pumping Association — https://www.concretepumpers.com/acpa-news/2022/06/21/change-astm-c94-21-time-limit
4. 2021 IRC Section R406 Foundation Waterproofing and Dampproofing — https://codes.iccsafe.org/s/IRC2021P2/chapter-4-foundations/IRC2021P2-Pt03-Ch04-SecR406.2
5. Concrete Exposure Classes and Code Compliance Criteria — https://www.fandr.com/concrete-exposure-classes-code-compliance-criteria/
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7. Deicer Warning - Concrete State — https://www.concretestate.org/deicer-warning.html
8. American Concrete Institute — https://www.concrete.org/

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