



# Concrete Pavement Construction Basics

## Tech Note

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### General principles

- Everyone at the construction site, particularly foremen and supervisors, is responsible for recognizing and troubleshooting potential problems as they arise.
- Batches of concrete should be consistent and uniformly mixed.
- A major cause of pavement failure is unstable subgrade. The subgrade should consist of uniform material, and the subgrade system must drain well.
- Dowel bars are important for load transfer at transverse joints on pavements with high truck volumes. Dowels must be carefully aligned, horizontally and vertically, to prevent pavement damage at the joints.
- Stringlines control the slipform paver's horizontal and vertical movement and ensure a smooth pavement profile. Once stringlines are set, they should be checked often and not disturbed.
- Overfinishing the new pavement and/or adding water to the surface can lead to pavement surface problems. If the concrete isn't sufficiently workable, crews should contact the project manager. Changes to the mixture or to paver equipment may reduce the problem.
- Proper curing is critical to preventing pavement damage from rapid moisture loss at the pavement surface.
- A well spaced and constructed system of joints is critical to prevent random cracking.
- Joints are simply controlled cracks. They must be sawed during the brief time after the pavement has gained enough strength to prevent raveling but before it begins to crack randomly (the "sawing window").
- Seasonal and daily weather variations affect setting time and other variables in new concrete. Construction operations should be adjusted appropriately.

# Site preparation

Before construction begins, the construction site must be carefully prepared. This includes preparing the grade, establishing control mechanisms (the stringline), and placing dowel baskets.

## Preparing the grade, or roadbed

The majority of concrete pavement failures are not caused by failure of the concrete slab but by problems with the materials beneath the slab. These problems can include poor drainage, unstable or nonuniform materials, or poor compaction.

Adequate preparation of the roadbed—the subgrade, subbase, and base—is essential for a strong, durable concrete pavement system.

- **Subgrade:** earth that has been graded to the desired elevation. (In county and municipal paving projects with low traffic volumes, concrete is often placed directly on the prepared earth subgrade.)
- **Subbase:** a course of material that is placed on the subgrade to provide drainage and stability. Three kinds of subbases may be used, based on the need to balance drainability and stability:

Granular subbase is the most drainable subbase. It is a mixture of granular material that is uniformly shaped and minimally compacted. It does not provide significant structural support; no construction traffic is allowed on a granular subbase.

Modified subbase is moderately drainable. It contains a greater percentage of crushed particles and a denser gradation than granular subbase, providing more stability.

Special backfill provides more stability and support but is the least drainable. It is generally a uniform mixture of crushed concrete or crushed limestone, or a mixture of gravel, sand, and soil, with or without crushed stone. Special backfill or modified subbase is often used under pavement in urban areas to support construction traffic.

- **Base:** a course of fairly rigid material, sometimes cement- or asphalt-treated, that is placed on the subbase to provide a stable platform for the concrete pavement slab.

## Grading

First the site is graded to cut high points and fill low areas to the desired roadway profile elevations. Generally, cut material can be used as embankment fill. However, peat, organic silt, or soil with high organic content should not be used; borrow material should be used instead.

## Stabilization

Stable soils are generally defined as those that can support loads. Loam or clay loam of glacial till origin or clean sand is typically desirable.

Just as important as the soil's quality, however, is its uniformity. During excavation, localized pockets of various kinds of soil may be encountered where water absorption rates, densities, and expansion and contraction rates may vary. These pockets lead to different levels of support.

To stabilize the subgrade so that it will provide uniform support to the rest of the pavement structure, localized pockets of undesirable material should be removed and replaced with the dominant soil type or with select backfill, or the soil should be treated with additives.

Typical stabilizing materials are select soils or backfill—loam or clay loam, clean sand, or other stable soil material—excavated from road cuts or borrow sites.

Typical stabilizing additives include the following:

- **Lime:** either quicklime or hydrated lime, either high calcium or dolomitic. Through chemical reactions with soil, lime reduces soil plasticity and increases compressive strength. It is sometimes used to stabilize wet soils.
- **Portland cement:** hydrates with moisture in the soil and hardens. Portland cement performs best with well graded, sandy, and gravelly materials with 10 to 35 percent fines. More cement is usually needed for soils with little or no fines and with clay soils.
- **Fly ash:** a byproduct of coal furnaces. When mixed with soil and water, it acts as a binder. Self-cementing Class C fly ash can be used for treating subgrades.

A layer of polymer geosynthetic, called geogrid, may be used as a foundation under special backfill to provide underlying tension reinforcement. The grid interlocks with aggregates in special backfill and spreads wheel loads over a large area.



**Fly ash can be used as a soil-stabilizing additive.**

## Compaction and trimming

Before compacting, subgrade material may have to be brought to the optimum moisture content. The subgrade must be thoroughly compacted, generally with a sheep's foot roller, to provide a strong platform for construction activities.

After compaction, a proof-roller (a heavy, loaded, pneumatic-tired vehicle) is driven over the subgrade to locate soft areas or other problems that may require additional stabilization.

Finally, an electronically controlled trimmer machine is used to trim the subgrade surface to the profile grade. The trimmer runs off the stringline for both elevation and alignment control. Trimming should occur within a week of proof-rolling.

The subgrade cannot be used for a haul road. Trucks are only allowed to drive on the grade for dumping.



**Trimming a granular subbase**

## Establishing the stringline

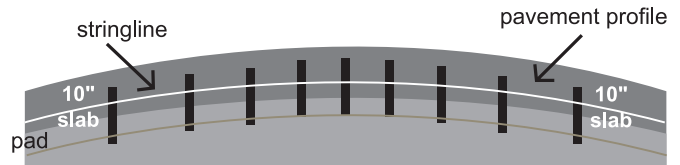
A stringline, supported by stakes alongside the paving lane, guides the paving equipment horizontally and vertically. The pad line, or track line, is the space between the stringline and new pavement; it must provide adequate room for paver tracks and have a stable, smooth surface.

The stringline must be set outside the pad line, parallel to the proposed pavement, to guide the trimmer, slip-form paver, and other paving equipment. The paver's elevation-sensing wands ride beneath the string, and the alignment-sensing wands ride against the inside of the string.

An accurately set, taut stringline is critical to constructing a pavement of uniform thickness and with the desired profile.

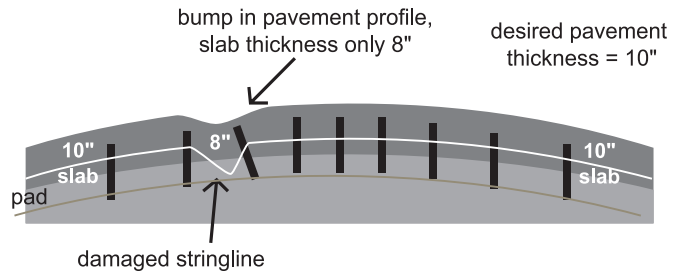
Meticulous setting of the stringline cannot be overemphasized. Before paving begins, the stringline must be carefully inspected for accuracy and continuously checked ahead of the paver.

(Side profile view)



**The stringline controls the pavement profile.**

(Side profile view)



**A damaged stringline can cause a dip in the profile, making the slab thinner at the dip.**

Once the stringline is set, be careful not to bump it out of alignment or knock the wands loose. Do not operate trucks or other equipment close to the pad line; this could pump the ground around the stakes and disturb the stringline alignment. Any of these situations could cause the paver to deflect from the correct elevation, creating a dip or a bump in the concrete slab.

During paving operations, the stringline must be eyeballed often for correct alignment. If you notice a disturbance in the stringline, notify your supervisor.



**Eyeball the stringline for alignment.**

### Setting the stringline

Before the grade is prepared for paving operations, surveyors install the stringline. The stringline may be wire, cable, woven nylon, polyethylene rope, or similar material.

1. Paving hubs, or construction stakes, are installed at certain intervals outside the pad line, along with pie stakes (flats) showing the difference in elevation between the top of the slab and the hub. A stringline support stake is securely placed just outside each hub so that the stringline will be directly over the hub.
2. The appropriate stringline height is calculated relative to the hub elevations, the offset distance (either level or projected) between hub and pavement reference point, and the desired grade.
3. Finally, the line is installed between stakes, adjusted to the desired height, and made taut.
4. Hand winches are generally installed at about 1,000-foot intervals. The winches allow the line to be tightened to prevent sagging between stakes. (Apply stringline tension carefully; a line break may cause injuries.)
5. For maximum control, contractors normally set stringlines on both sides of the proposed pavement.

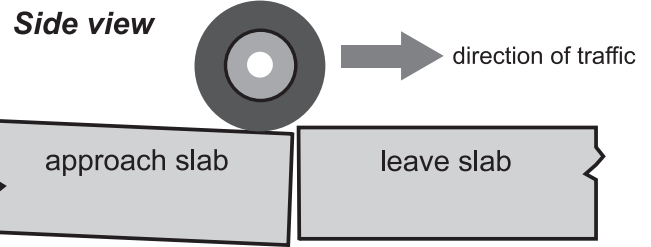
### Placing dowel baskets

Dowel bars transfer heavy loads across joints in the pavement, preventing faulting at the joint that can lead to pavement damage.

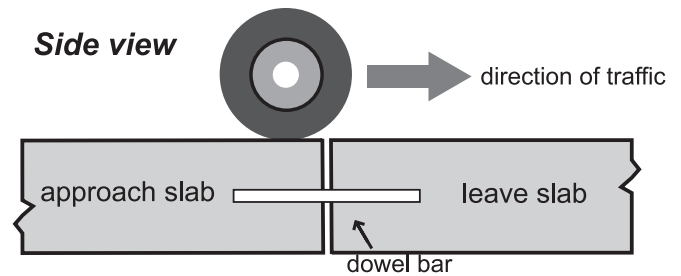
Practices vary from state to state, but dowel bars are typically required in eight-inch or thicker pavements.

Dowels must be positioned and aligned perfectly so that, as joints open in winter and close in summer with contraction and expansion of the concrete, the pavement on either side of the joints can move in a straight line along the smooth dowels.

If a dowel bar is not aligned truly across the joint, the pavement can't move and a stress results. The stress can crack the pavement.



**Without dowels, the slab on either side of a joint tends to move up and down; that is, there is little "load transfer" at the joint.**



**Dowels help provide load transfer at the joint.**

### Basket placement

After the subbase has been properly trimmed and inspected, dowel baskets are set on the road bed, perpendicular to the pavement edge or at a slight skew (often 6:1). The bars should be located at the mid-depth of the slab and carefully aligned, horizontally and vertically.

As mentioned above, location and alignment of the bars is critical. If they are too close to the edge, the paving equipment will snag them.

When the bars are correctly aligned, the baskets must be secured with stakes. Practices vary from state to state, but a minimum of eight stakes (for 12- or 14-foot lane widths) are placed on the leave side of the basket wire to secure the basket against movement.

The location of dowel centers is then marked on both sides of the roadbed, either by setting pins or painting marks. The markers indicate where joints should be sawed, ensuring that they will be sawed across the center of the dowel assembly.

### Final check

Dowel positions should be checked from three perspectives:

1. Sight down the grade to make sure all dowels are parallel to center line.
2. Sight across the dowel baskets to make sure all dowels are level. The basket assemblies should be parallel to and aligned with each other.
3. Sight across the basket, imagining a line from the pin or mark on one side to the pin or mark on the other side. Make sure the middle of the dowels falls exactly along that line.

After dowels have been placed, an inspector should check basket spacing, alignment, and skew.



**Here, misalignment of the dowel bars could eventually lead to joint damage.**

## Slip-form paving operations

From delivery of the concrete mixture to curing the slab, slip-form paving operations should proceed at a consistent pace. Every construction worker should have a basic understanding of the entire operation.

### Wetting the grade

A dry subbase draws water from the bottom of the concrete mixture. This can produce stress due to differential moisture levels throughout the slab, causing cracking.

To help prevent these stresses, thoroughly spray the subbase with water shortly before placing the concrete, allowing the water to soak in adequately. The subbase should be noticeably wet but should not have standing water.

Wetting may not be necessary after a recent rain.

### Delivering the mix

When transporting the mixture from plant to construction site, the goal is to deliver well mixed, workable concrete to the construction site. It is essential that the mixture be uniform and consistent from batch to batch.

Generally, concrete mixtures are transported by dump trucks, agitator trucks, or ready-mix trucks. One factor affecting choice of transport methods is the time available for delivery. Exceeding the appropriate delivery times affects the concrete's workability. Extensive delays may make it necessary to shut down paving operations and construct a header joint.

#### Dump trucks

Dump trucks have a limited time—only 30 minutes by some specifications—after the concrete is mixed to deliver and place it at the job site. Retarding admixtures are sometimes used to extend the delivery time (e.g., to 60 minutes).

#### Agitator trucks

Agitator trucks have an agitator paddle inside the truck box.

If the paddle is not rotating, the vehicle is no different from a dump truck, and the 30-minute rule applies. If the paddle is constantly rotating, agitator trucks generally have up to 90 minutes from initial mixing to delivery.

#### Ready-mix trucks

Ready-mix trucks can be used for both mixing and delivery. They are most commonly used for dry batch operations and lower-volume paving projects, such as urban paving.

They generally have up to 90 minutes from initial mixing to delivery.



**Top to bottom: ready-mix truck, dump truck with agitator paddle, mixture in front of paver**

## Placing the concrete

To prevent differential compaction that can interfere with good drainage, haul trucks should not be driven on the sub-base. If the grade provides adequate space, delivery vehicles should deliver the concrete from a haul road adjacent to the area to be paved.

The mix is deposited, from off the grade, in front of the paver. It may be deposited by a belt placer or other method.

(Modified subbase and special backfill may be specified on some projects; these materials can be driven on for concrete delivery and deposit.)

## Spreading and consolidating the concrete

Slip-form paving is used when large amounts of concrete must be placed efficiently. Unlike fixed-form paving, where stationary forms are placed to hold the concrete mixture, slip-form pavers form and consolidate fresh concrete while they travel.

Slip-form pavers should be operated at a consistent speed. This helps provide steady productivity and a smooth pavement. Maintaining a consistent speed is tied to scheduling the appropriate number of concrete delivery trucks. If there are too few trucks, the paver will have to slow down or stop. If there are too many trucks, they may get backed up at the construction site and risk exceeding concrete placement time limits.

The slip-form paver/finishing machine has three main parts: augers, vibrators, and a profile pan.

### Augers/plows

Augers, large horizontal screws in front of the paver, or plows spread the concrete sideways across the width of the pavement to create uniform depth ahead of the pan.

A uniform head of concrete (not too big and not too small) should be maintained. A large head of concrete can cause the paver to rise, creating a bump in the finished pavement. On the other hand, too little concrete can leave gaps at the edge of the pavement. If this happens, the paver may have to be stopped and the gaps filled.

### Vibrators

Vibrators consolidate the concrete as it passes under the paver.

Under-vibration may leave large pockets or voids in the concrete. Over-vibration may cause aggregate to settle, causing variations in consistency and strength within the concrete slab. It can also cause loss of entrained air in the slab, which can reduce concrete pavement life and durability.

Electronic vibrator monitoring systems should be used to monitor vibrator frequency.

### Profile pan

The profile pan is located behind the augers and vibrators. It trims excess concrete (also called screeding or strikeoff) at the proper elevation and smooths the surface. It can be adjusted to trim a straight grade and to construct superelevations. Superelevations are horizontal pavement curves that slope to the inside of the curve. This slope is an important roadway safety feature.

The paver may include finishing equipment as well, such as oscillating screeds or V-floats.

## Setting header joints

Header joints are built at the end of a section of pavement where, in the future, pavement construction will continue. Header joints must be constructed at the end of a pour or a day's run, or if paving is delayed by 30 minutes or more.

### Header construction (fresh concrete)

1. A header board is placed just beyond the line where the paver has pulled away from the slab.
2. Tie-bars protruding through the header board are placed into the fresh concrete and stick out beyond the board. (The protruding ends will be incorporated into the next pavement section.)
3. The header area is hand-poured, then vibrated, finished, and cured. Concrete should be well consolidated against the header board and finished with an edging tool.

### Sawed header (hardened concrete)

1. The paving machine paves beyond the header location and leaves an irregular pavement end.
2. The next day, a full-depth saw cut is made at the header location and the irregular portion removed.
3. Holes are drilled into the sawed face of the pavement and tie-bars secured in the slab with epoxy grout.

The sawed method of header construction is preferred and generally reduces the severity of a potential bump along the header joint.

### Resuming placement at a header

- Fresh concrete header: wait at least six hours before resuming paving at the header.
- Remove header boards and all supports before resuming paving.

## Placing tiebars during construction

When two or more lanes are placed, tiebars must be placed across the centerline or lane lines to prevent movement along the line. If the paver does not install tie bars mechanically, a crew member rides on the paver and inserts them manually. In either case, a timing device—usually a wheel of a specific circumference riding on the paver track—is used to ensure the correct spacing.

## Finishing

Immediately after the paver passes, the surface is normally finished to close holes and create a tight surface. Crews standing along the slab edge run finishing tools (floats and straightedges) across the surface.

If the concrete is not workable, crews tend to overwork the surface or add water in an effort to close the surface.

Both overfinishing and adding water, however, can lead to surface scaling caused by freeze-thaw damage.

If the concrete is not workable, notify the project manager so the concrete mixture and/or the paver can be adjusted for better concrete workability.

## Texturing

After finishing, two operations are used to create micro-texture (to provide adequate surface friction during dry weather) and macro-texture (to help prevent hydroplaning during wet weather).

Micro-texture is created by dragging astroturf, burlap, or course carpet along the pavement surface. Finally, macro-texture is created with a tining device or rake that makes transverse or longitudinal grooves in the wet pavement surface. The orientation, depth, and spacing of the grooves are specified for each job.



**Longitudinal tining**

## Curing

The importance of managing moisture in concrete immediately after placement cannot be overemphasized.

Concrete moisture is managed primarily through proper curing—that is, by applying curing compound uniformly to the entire surface and exposed edges of the concrete to slow the evaporation of water from the concrete.

Curing preserves water for hydration, maximizing pavement strength and durability. It also helps prevent the surface from drying out more quickly than the rest of the slab, reducing the possibility of surface damage due to differential shrinkage. (The appearance of small, plastic shrinkage cracks on the concrete surface is a sign that moisture has evaporated too quickly.)

## Insulating

If air temperatures drop quickly during the first night after placement, the concrete surface will cool quickly compared to the rest of the concrete. Such extreme temperature variations in the slab can cause concrete to change volume at different rates (differential thermal contraction), which in turn can cause tensile stress and random cracking in the slab.

Covering the new concrete can help reduce extreme variations in temperature throughout the depth of the slab.

# Jointing

## Why joints are important

Joints help relieve stresses in concrete in a controlled fashion. An effective, well constructed pattern of joints accomplishes the following:

- prevents random cracking and other potential problems,
- allows concrete to crack at predetermined locations,
- prevents faulting, and
- extends pavement life.

## Rules of thumb

- Follow the joint layout on project plans. The engineer must approve any change.
- If joint layout plans are not available, work with the engineer.

Joints are either sawed into hardening concrete or constructed (as in header joints) where new pavement abuts existing pavement. The following information focuses on constructing joints with saw cuts.

## Sawing joints

Although conventional saws are still used on some projects, early-age sawing is fast becoming the norm.

### **Transverse contraction joints**

Early-age saw cuts should be stopped just short of the pavement edge to prevent “blowing out” spalls at the slab edge and to prevent joint sealant from flowing out of the joint end. Once the crack forms at the joint, it will easily proceed through the small uncut portion of the slab.

### **Longitudinal contraction joints**

Most longitudinal joints are constructed by conventional sawing.

### **Expansion joints**

All expansion joints are sawed or formed.

### **Saw cut timing (“sawing window”)**

There is a brief period of time—the “sawing window”—during which joints can be sawed successfully.

Begin saw cuts after the concrete has hardened enough to permit sawing without raveling or moving aggregates. Finish saw cuts before random, uncontrolled cracking takes place.

With conventional saws, the window generally begins 8 to 12 hours after placement, depending on weather conditions and mixture properties.

If light, early-age saws are used, the window begins as soon as walking on the pavement is permitted, generally within about 3 hours of placement.

To finish sawing joints before the window ends, it may be necessary to continue sawing operations regardless of weather or daylight conditions.

If cracks develop ahead of a saw, stop sawing that joint. Later, use crack saws to form joint-sealant reservoirs along the crack line.

### **Depth of saw cuts**

The joint layout shows the joint pattern and location. The contract documents should indicate the width and depth of saw cuts.

The design depth of saw cuts is the minimum depth required to create a properly functioning joint. Cuts that are too shallow may not relieve stresses adequately, allowing random cracks to occur. Cuts that are unnecessarily deep require additional effort (take longer), cause unnecessary equipment wear, and reduce aggregate interlock.

In general, the depth of conventional saw cuts is one-third of the pavement thickness. Early saw cuts are approximately 1 inch deep, regardless of pavement thickness.

### **Effect of aggregate on saw cutting**

Hard aggregates like river gravel, quartzite, or granite do not saw easily and can dull or damage saw blades more quickly than other aggregates.

Sawing concrete made with hard aggregate will require more time, so sawing should begin as soon as possible and may require additional saw operators.

## Cleaning and sealing joints

Within three hours of sawing, joints must be cleaned to remove incompressible residue like saw-cut swarf, soil, sand, or gravel. These materials in joints can prevent proper sealant adhesion, resulting in joints that do not function properly.

After wet-sawing, flush the residue away with a high-pressure water blast. After dry-sawing, residue can be air-blasted.

Sealing joints ensures proper joint performance (expansion and contraction). It also prevents incompressible materials from getting lodged in the joint space, which can cause spalls.

Place joint sealer only when the joint surfaces appear dry. Joint sealer is sensitive to temperature and should be placed when the pavement and surrounding air temperature are about 40°F (4°C) or higher.

Most sealants are approved by manufacturer and product name.



# Weather considerations

## Hot, dry weather paving

### Definition

Temperatures generally above 90°F (32°C), low relative humidity, high wind speed, sunny conditions

### Challenges

- Concrete loses moisture more rapidly during hauling and placing.
- Aggregate stockpiles dry out, affecting moisture consistency between batches.
- The pavement subbase dries out before the mixture is placed, then absorbs water from the mixture.
- Rapid water evaporation at the pavement surface can result in shrinkage cracks.
- It's more difficult to entrain air when temperatures are high. Entrained air is important for pavement durability.
- Concrete sets rapidly, perhaps twice as fast, making finishing more difficult.
- Sawing operations must proceed more rapidly. Additional saws may be required.

Once heat-related problems develop, it may be too late to fix them.

### Precautions

- If possible, do not pave in very hot, dry weather.
- Pave in the morning, evening, or night when air temperatures are cooler.
- Maintain uniform moisture in stockpiles.
- Use retarders in the mixture to slow hydration.
- Use fly ash and slag in the mixture.
- Keep subbase, forms, and equipment damp and cool.
- Apply curing compound as soon as possible. Additional compound may be required.

## Cold weather paving

### Definition

Air temperature of 50°F or less (10°C) for more than half of any 24-hour period, or when the average daily air temperature is less than 40°F (5°C) for three consecutive days.

### Challenges

During cold weather, hydration slows, slowing strength development. Concrete cools faster at the surface than inside

the slab, causing stress in the slab. If the stress is severe enough, the slab will crack randomly.

### Precautions

- Do not pave on frozen subgrade.
- Do not use aggregates with frozen lumps.
- Heat materials to raise concrete temperature and promote hydration.
- Minimize use of fly ash and slag.
- Do not pave if the concrete cannot reach adequate strength before it freezes.
- For the first two to three days, protect concrete from freezing with insulating material.

## Rain

### Challenges

- Before final set, rain can damage the new pavement surface by leaving imprints or washing away paste at the surface.
- After final set, rain can induce rapid cooling at the surface, leading to rapid development of thermal restraint stresses and possibly early-age, uncontrolled cracking.

### Precautions

If it starts to rain during operations, take the following actions:

- Stop batching and placing operations and cover the fresh concrete immediately with protective coverings like polyethylene sheeting or burlap. (Do not try to remove extra surface water first. Do not add dry cement to the surface.)
- As soon as the surface has dried, apply curing membrane.
- After the curing period, diamond grinding may be required to remove surface blemishes and provide texture to any surface exposed to rain where damage has occurred.



**A heavy rain before final set can wash away cement paste and expose course aggregates.**

# Troubleshooting

## Common problems

Problems	Potential Result(s)	Possible Cause(s)	What to Do
False set	Stiff, unworkable mixture	Form of gypsum in cement and/or admixture incompatibility	Perform additional mixing
Flash set	Reduced workability, poor rapid set (can not be fixed)	Low gypsum content in portland cement	Get new supply of portland cement
Equipment breakdown	Costly reductions in productivity and pavement quality	Poor maintenance	Maintain equipment regularly
High water/cement (w/c) ratio	Reduced strength	Adding water on site	Adjust the amount of water added at plant; do not add water at the construction site
Inadequate consolidation and workability	Reduced strength and durability	Vibrator problems; inadequate mixing	Monitor vibrators for compliance and repair as needed; provide adequate mixing
Inadequate entrained air	Reduced concrete durability; possible negative effect on pay factors	Weather, short mixing time	Monitor consistently, especially on extreme weather days
Dips in pavement profile	Reduced pavement smoothness; Variations in slab thickness	Moved or otherwise disturbed stringline; ruts or irregularities in subbase surface	Place stringline as low as possible; monitor stringline regularly and notify supervisor of stringline disturbances; ensure smooth, rut-free subbase surface
Bumpy, rutty haul road	Increased mix delivery time; reduced productivity; possible pumping of stringline pins	Poorly maintained haul road	Maintain road during construction
Sudden weather change: rain	Increased w/c ratio on the surface; reduced durability on the surface; loss of texture		Stop paving; cover the slab to protect it from rain damage
Sudden weather change: cold front	Stresses due to sudden temperature change that can result in increased random cracking		Protect fresh concrete with additional curing; consider insulation

## Hot and cold weather

Weather	Characteristics	Possible Effect(s) and Problem(s)	What to Do
Hot and Dry	High air temperature (above 90°F or 32°C); low relative humidity; high wind speed; sunny	<ul style="list-style-type: none"> <li>• High rate of water evaporation from mixture, especially with hot concrete (above 90°F)</li> <li>• Dry stockpiles</li> <li>• Rapid slump loss</li> <li>• Long-term strength loss due to added water</li> <li>• Rapid setting; less time for finishing</li> </ul>	<ul style="list-style-type: none"> <li>• If possible, do not pave in very hot, dry weather</li> <li>• Plan ahead (once problems are noticed, it may be too late to correct them)</li> <li>• Pave in the morning, evening, or night</li> <li>• Maintain stockpile moisture</li> <li>• Keep subbase and/or forms damp and cool</li> <li>• Keep equipment cool</li> <li>• Take extra care with curing; use additional curing compound</li> </ul>
Cold	Low air temperature (below 50°F or 10°C)	<ul style="list-style-type: none"> <li>• Low heat of hydration; very slow set</li> <li>• Frozen concrete mixture</li> <li>• Low strength gain</li> <li>• Increased concrete permeability</li> </ul>	<ul style="list-style-type: none"> <li>• If possible, do not mix or pave in very cold weather</li> <li>• Heat materials</li> <li>• Add accelerator to mixture</li> <li>• Increase portland cement in mixture</li> </ul>

## Sawing problems

Problems	Potential Result(s)	Possible Cause(s)	What to Do
Cracks form before sawing	Random, irregular cracks	Sawing too late	Immediately begin skip sawing: jump ahead to saw every second or third joint
Cracks form during sawing, in front of the saw	If sawcutting continues near a crack, the sawed joint will not function correctly; this could lead to spalling and other performance problems	Sawing too late	Immediately begin skip sawing: jump ahead to saw every second or third joint
Sawcut ravel during sawing	Spalled joints	Sawing too early	Stop sawing and wait for more strength to develop in the concrete
Joint face ravel or spalls	Poor joint performance over the long term	Sawcutting performed too early; poor sawcutting operation; joint area not cured properly	Review and correct sawcutting operations; review joint face curing process

## Sealing problems

Problems	Potential Result(s)	Possible Cause(s)	What to Do
Poured joint sealant does not adhere	Water or incompressible materials may enter joint, causing poor joint performance	Joint face is dirty; joint shape factor is incorrect; concrete is too green when sealed and therefore contains too much moisture	Check joint face for cleanliness and dryness; check joint shape factor; replace sealer
Poured joint sealant fails (it is not cohesive)	Water or incompressible materials may enter joint, causing poor joint performance	Poor sealant properties due to over or under heating	Reduce heat; apply proper heat; use insulated hoses; replace sealant
Preformed sealant is loose	Water or incompressible materials may enter joint, causing poor joint performance	Sealant is not sized properly; joint too wide; stretched sealant	Use properly sized sealant (check joint width); check sealant quality; review installation procedure

# National Concrete Pavement Technology Center



## **Concrete Pavement Construction Basics: Tech Note August 2006**

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### **About the Contributors**

Jim Grove is PCC paving engineer at the National Concrete Pavement Technology Center. Marcia Brink is communications manager at Iowa State University's Center for Transportation Research and Education.

To ensure the accuracy and usefulness of this publication, a committee representing state and local agencies, contractors, and practitioners reviewed drafts and provided technical input.

### **About this Publication**

This tech note has been produced for developers, consultants, and engineers planning concrete pavement construction projects, superintendents and supervisors who want a basic training aid and reference, and crew members new to the concrete paving industry with the collective responsibility of delivering a well constructed, durable pavement.

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The mission of the National Concrete Pavement Technology Center (CP Tech Center) is to unite key transportation stakeholders around the central goal of advancing concrete pavement technology.

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