concrete paving workforce reference no. 2

CONCRETE PAVING SITE PREPARATION AND CONSTRUCTION

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November 2004.

Major funding and support for this publication were provided by the Iowa Concrete Paving Association, Iowa Department of Transportation, and Iowa State University. The Center for Portland Cement Concrete Pavement Technology (PCC Center) partners with industry, government, and academia to find solutions to the concrete paving industry's critical challenges and deliver the best technologies and methods to the people who will use them.

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2.1. Preparing the Subgrade and Subbase

Overview

Concrete pavement failures are often not caused by failure of the concrete slab, but by problems with the materials beneath the slab. Adequate preparation of the roadbed, including subgrade and subbase, is essential for a strong, durable concrete pavement system.

Common Problems

- Unstable or non-uniform materials
- Poor compaction of utility trenches or the subgrade itself
- A rough or rutted subgrade, resulting in pavement of varying thickness and poor overall smoothness
- Separation of fine aggregates during the subbase trimming process, resulting in reduced subgrade permeability
- Dry subbase that draws water from the concrete mixture
- Poor drainage leading to standing water

Subgrade

Description

The subgrade is earth graded to the desired elevation.

Recommended Procedures

- Extend the subgrade at least 3' beyond the outside edge of the planned pavement. This provides a foundation for a solid pad line for paving equipment tracks.
- Cut high points and fill low areas to achieve the desired roadway profile elevation. For embankment fill, use cut material, except for peat, organic silt, or soil with high organic content.
- Remove localized pockets of undesirable material and replaced with soil similar to the surrounding subgrade or with select backfill, or treat with stabilizing additives such as lime, portland cement, or fly ash.
- Compact the subgrade with proper moisture control to the required density.
- Proof-roll the subgrade to detect soft areas that require additional stabilization.
- Trim the subgrade surface to achieve the desired profile grade.
- When conditions warrant and it is practical, avoid operating equipment on the subgrade.

Subbase

Description

The subbase is a course of material placed on the subgrade to provide drainage and stability. Different kinds of subbases are used based on the need to balance drainability and stability. A granular subbase (mixture of uniformly shaped and minimally compacted granular material) is the most drainable subbase, but it does not provide significant structural support. A subbase containing a greater percentage of crushed particles and a denser gradation than a granular subbase is moderately drainable and provides more stability than a granular subbase. Special backfill (such as a uniform mixture of crushed concrete or crushed limestone, or a mixture of gravel, sand, and soil with or without crushed stone) may provide more stability and support but is the least drainable.

Recommended Procedures

- Place the subbase course on the subgrade.
- Keep the subbase surface moist prior to paving. Spray water on the grade as needed, but do not leave standing water.

2.2. Setting String Line

Overview

The string line controls the alignment and elevation of the fine grader, paver, and sometimes belt placer and tining machine. String lines should be carefully protected and maintained because even small disturbances in a string line can reduce pavement smoothness. A damaged or loose string line can cause a dip or hump in the pavement profile.

Description

The string line can be wire, cable, woven nylon, or polyethylene rope. The string line is usually set up on both sides of the proposed pavement edge and is supported by stakes outside the edge of the pad line.

Common Problems

- Surveyor error in staking string line
- Misalignment of string-line pins, causing the distance between string lines on each side of the road to vary, resulting in variation from desired alignment
- Sag in string line
- People, equipment, or wild animals bumping string line

Recommended Procedures

- Install string line as low as possible.
- Make sure string line is tight, with no sags between stakes, and is free of obstructions including weeds.
- Eyeball the string line immediately before and during paving as a final check for horizontal or vertical alignment.
- Notify supervisor if you notice a disturbance or possible error in the string line.

2.3. Placing, Spreading, Striking Off, and Consolidating Concrete

Overview

After the grade and subbase have been prepared, the mix is placed. The slip-form paving machine has three main parts—augers or plows, profile pan, and vibrators—to spread, strike off, and consolidate the concrete as it travels forward.

Placing Concrete

Description

Concrete mixes are best deposited from off the grade or the side of the grade by belt placers. Alternatively, to prevent trucks from driving on the grade after it's been trimmed, special conveyors are sometimes used to move the mix from delivery trucks over the fine grade trimmer to the grade just in front of the paver.

Common Problems

- Uneven depositing of concrete mix
- Inconsistent workability and/or durability due to different rates of mix production and delivery
- Surface smoothness problems due to inconsistent paver speed or excessive stopping

Recommended Procedures

- Deposit concrete as uniformly as possible in front of the paver.
- Do not overload either side of paver. Adjust the height of placement for the size of the paver so that the head of the concrete does not cause the paver pan to rise.
- Operate the paver at a slow, consistent speed and avoid unnecessary stops to ensure a smooth pavement. The paver speed should match production rate of the batch plant and the rate of concrete delivery to the paver.

Spreading Concrete

Description

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

Common Problems

- Too much concrete in front of the paver, causing the profile pan to rise, resulting in a bump in the finished pavement
- Too little concrete in front of the paver, resulting in voids in the finished pavement

Recommended Procedures

- Maintain a uniform head of concrete—not too big and not too small.

Striking Off Concrete

Description

The profile pan, located behind the augers or plow, strikes off excess concrete to the desired pavement elevation and smooths the surface.

Recommended Procedures

- Adjust the profile pan to construct the specified crown or super-elevations.

Consolidating Concrete

Description

Vibrators on the paver consolidate the concrete mix. Consolidation should be carefully monitored because the vibrators have the potential to produce concrete mix segregation and adversely affect the air void system. Proper vibration should be controlled to not adversely affect the strength or long-term durability of the concrete.

Common Problems

- Too little vibration, resulting in low concrete strength and large pockets of entrapped air. Possible causes:
  - Concrete mix design that produces poor workability
  - Vibrators not functioning properly
  - Too fast a paver speed
- Too much vibration, resulting in aggregate segregation, vibrator trails, and freeze-thaw durability problems. Possible causes:
  - Concrete mix design that produces poor workability
  - Improperly installed vibrators or excessive frequency
  - Reducing paver speed without compensating vibrator frequency

Recommended Procedures

- Install vibrators according to the manufacturer recommendations or specifier's requirements.
- Synchronize and monitor vibrators within the specified range.
- Check vibrator frequencies and amplitudes under load at the beginning of the process.
- For large pours, equip pavers with continuous monitoring.
- Adjust the vibrator frequency for varying paver speeds.
- Turn off vibrators when the paver stops.

2.7. Hot, Dry Weather Paving

Overview

Hot, dry weather can impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and the rate of cement hydration. Hot weather precautions are important because once heat-related problems develop in concrete, it may be too late to correct them. Hot, dry weather precautions typically apply when the air temperature is above 90°F and there is low relative humidity, high wind speed, and sun exposure.

Common Problems

- Drying out of aggregate stockpiles and subbase, resulting in aggregate absorbing water from the concrete mix, impairing workability
- Rapid water evaporation from the pavement surface, resulting in shrinkage cracking
- Difficulty controlling air entrainment
- Rapid hardening of the concrete, resulting in accelerated slump loss
- Delayed joint sawing, possibly leading to cracking

Recommended Procedures

- Keep aggregate stockpiles, grade, subbase, forms, and equipment moist.
- Use fly ash and slag in the mixture to slow hydration.
- Use retarders to aid in placement.
- Pave in the morning, evening, or night when it is cooler.
- Apply curing compound immediately after final finish treatment. Increased dosage of curing compound may be needed.

2.8. Cold Weather Paving

Overview

Special precautions must be taken when paving in cold weather. Cold weather precautions apply when the air temperature is 50°F or colder for more than one-half of any 24-hour period, or when the average daily air temperature is less than 40°F for three consecutive days.

Common Problems

- Aggregate with frozen lumps
- Concrete cooling faster at the surface than inside the slab, resulting in stress & cracking
- Frozen concrete, resulting in lack of strength gain and deterioration

Recommended Procedures

- Do not pave on frozen subgrade.
- Do not use aggregates with frozen lumps.
- Heat materials.
- 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 new concrete pavement from cold weather with adequate layers of burlap or other insulating material.

2.9. Preventing Rain Damage

Overview

Layers of burlap or plastic film are used to protect fresh concrete in case of rain.

Common Problems

- Surface damage of concrete that has not achieved final set
- Thermal restraint stresses in pavement that has achieved final set leading to uncontrolled cracking, even if saw cutting is underway.
- Surface texturing damage
- Strong wind blows the covering off the slab

Recommended Procedures

Rain Damage Prevention

- Subscribe to and monitor weather forecasting services.
- Have protective materials such as burlap or plastic film available on site at all times.
- Stop batching and transporting of mix in a timely manner.
- Use early-entry saws to quickly cut the joints.

When It Starts Raining

- Cover fresh concrete as soon as possible.
- Do not finish the concrete surface after unprotected pavement is exposed to rain.
- Do not try to remove extra surface water prior to covering the concrete.
- Do not add dry cement to the surface.

After the Rain

- Apply curing compound as soon as the concrete surface is dry.
- Saw joint as quickly as possible to reduce potential early-age cracking by rapid surface cooling.
- Diamond grind the surface to remove blemishes and add texture.
- Remove the concrete if it was exposed to significant rain while it was loose or unconsolidated since it likely absorbed enough water to affect the water/cement ratio and strength of the surface.

2.4. Finishing

Overview

Finishing determines the final appearance, smoothness, and other surface properties of concrete that affect the long-term durability of a pavement surface.

Description

Longitudinal, Oscillating Floats

Longitudinal, oscillating floats (Auto-Floats) may be either attached to the paver or self propelled. The floats are attached parallel or near parallel with the center line of the slab and move from one side of the slab to the other while oscillating front to rear. The floats are used to shape and smooth the surface.

Mechanical Truss Floats

Mechanical truss floats (V-Floats) consist of a truss with narrow floats attached. They are normally attached to the paver near the centerline and fan out toward the edge of the pavement. The floats rest on the slab and are typically pulled by the paver.

Hand Floats

When hand floats are used for finishing, the surface is first checked behind the paver with straight edge and surface imperfections are then corrected with a hand float.

Hand Trowels

Hand trowels can be used to create a hard, smooth finish; shape or finish pavement curbings or edges; finish around structures in the pavement (box-outs, manholes, utility appurtenances, etc.); and round the edges of formed joints.

Common Problems

- Too much water on the concrete surface
- Aggregate dragged along or out of the surface
- Excessive finishing of the concrete

Recommended Procedures

- Do not add water to the concrete surface while finishing
- Do as little surface finishing as possible

2.5. Texturing

Overview

Pavement surfaces are textured to roughen the surface.

Microtexturing

Description

Microtexturing is accomplished by dragging wet burlap, artificial turf, or coarse carpet longitudinally along the concrete surface.

Recommended Procedures

- Do not allow turf drags to disrupt or pull aggregate to the surface.
- If a bridge is used, pull it with the paver so that it provides a straight, uniform texture. Do not hand pull or push the bridge because that can result in a cracked or wavy surface texture.

Macrotexturing/Tining

Description

Macrotexturing is generally required on pavements with speed limits greater than 35 mph. Macrotexturing is created by a mechanical device (tining machine) that makes grooves typically longitudinally or sometimes transversely in the pavement surface.

Common Problems

- Bent tines
- Tine length not uniform, causing non-uniform depth
- Tines too deep
- Tining machine wandering off of parallel to centerline

Recommended Procedures

- Follow specifier's recommendations for tine groove spacing, width, and depth.

2.6. Curing

Overview

Curing is a process of protecting the new pavement to regulate moisture loss from the concrete surface. Curing also ensures that concrete gains strength uniformly. Applying curing compounds is the most commonly used curing technique.

Description

Curing compounds reduce the rate of water evaporation from the concrete surface. White pigments in the compounds reduce solar heat gain on sunny days and are a way to visually judge the application rate.

Common Problems

- Dirty or poorly maintained equipment, resulting in clogged nozzles and nonuniform application
- Too little curing compound applied
- Non-uniform application of compound, especially by hand spraying
- Vertical edge of slab not cured

Recommended Procedures

- Clean spray nozzles frequently to prevent clogging.
- Thoroughly mix and agitate compound using diaphragm pumps or mechanical agitators. Do not use gear pumps and high shear devices.
- Mix compound daily before application and at least once every 4 days when not in use.
- Check that the temperature is above 40°F before applying.
- Mount spray equipment on a self-propelled frame that spans the entire width of the slab.
- Provide wind protection to avoid spray drift.
- Set application rate and calibrate equipment to ensure specified coverage. Application rate may have to be increased during extremely hot weather.
- Apply curing compounds evenly immediately after finishing and texturing, especially during extremely hot, dry, or windy weather.
- Spray the entire concrete surface and all exposed vertical edges, including the back of the curb.
- Perform yield checks to ensure proper rate of application.
- Store well-mixed material in clean bulk containers with clearly marked batch numbers on the bulk tanks.