R&T UPDATE
Concrete Pavement Research & Technology

HOW TO HANDLE RAINED-ON CONCRETE PAVEMENTS

Construction projects cannot be postponed until the most ideal weather conditions occur. The looming specter of liquidated damages, penalties, and user costs to the traveling public are often the deciding factor in when to pave. In day-to-day decisions, the issue of weather is a primary factor. The probability of a rain event often means that the paving crew stays home that day. Nevertheless, if construction schedules are tight, the engineer or superintendent may give permission to proceed.

Inclement weather can occur without notice. When rain occurs, it plays havoc with the paving schedule by creating problems with haul roads, subgrade, subbase, and stockpiled materials as well as concrete placement and finishing. However, the paving contractor must utilize all potential paving time, including days when rain may occur, rather than await ideal weather conditions.

If a rain event does occur before a pavement has hardened sufficiently, remedial measures may be necessary, but the pavement does not normally require removal and replacement. Less invasive and less costly techniques can be used to restore the pavement to a good-as-new condition. This R&T Update explains how to prevent and repair rain damage to freshly-placed concrete pavements.

Climatic conditions during a rain event can actually be conducive to good concrete curing. During rain, the humidity is at or near 100% and there is little chance for evaporation of mix water. Temperatures are generally moderate during rain, which is also beneficial. In these situations, the rain essentially provides a beneficial “moist” curing environment, which assists with strength development and decreases the chance for uncontrolled cracking. However, any additional water on the pavement surface will elevate the surface water-cement ratio, potentially reducing durability, but only if the rainwater is finished into the surface.

Preventing Rain Damage

A paving contractor should have plastic sheeting and steel side forms or wooden boards available at all times to protect the surface and edges of the newly placed concrete pavement when it rains. If rain is expected on newly placed concrete pavement that has not hardened, cover the surface with the plastic sheeting. The sheets must be weighted down to prevent them from blowing in the wind. When it starts raining, a “rule of thumb” to determine how much of the pavement to cover is to go back to the point where the rain is not indenting the pavement surface. The covering does not need to be extended to areas where the rain is only washing the curing membrane from the pavement without indenting the surface.

Some marring of the concrete surface may occur from the plastic sheeting used to protect the slabs from rain. Except for an undesirable appearance, there is nothing wrong with surfaces affected by plastic sheeting. A similar appearance can occur when using plastic sheeting to cure concrete.

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Figure 1. Marring of the pavement surface due to plastic sheeting. Does not require remediation unless ride quality or skid resistance is unduly affected.

Do not finish rainwater into the concrete surface. This elevates the water-cement ratio, creating a non-durable top surface, susceptible to crazing, scaling, and dusting (Figure 2).

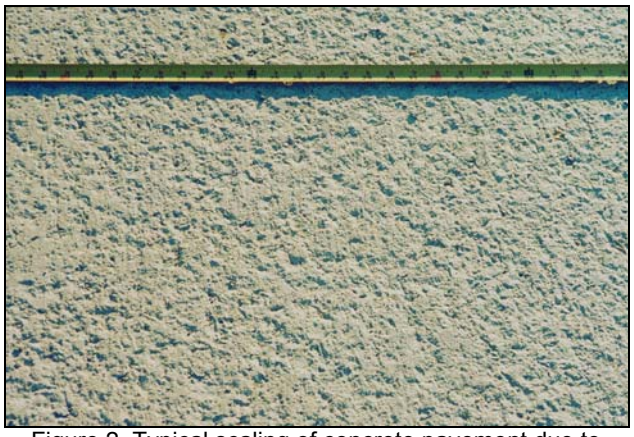

Figure 2. Typical scaling of concrete pavement due to non-durable paste on surface.

For slipform paving operations, it is advantageous to install side forms where severe erosion of the fresh concrete edge occurs. After the side forms are set, place fresh concrete and finish prior to texturing and curing.

Assessment of the Damage

If the rain is extremely hard and occurs soon after concrete placement, such that the surface mortar is seriously damaged, it is likely that the rain has increased the water-cement ratio near the surface (within about 0.25 inches). If the surface layer is adversely affected, corrective action is necessary – the affected surface should be diamond-ground.

Past reports indicate skid test and sand patch results on pavements exposed to rain are comparable to normal pavements (Figure 3). Skid test results on diamond-ground pavements are also comparable to or better than normal pavements. Abrasion resistance tests from some rained-on concrete samples do indicate that the surface mortar may be more susceptible to scaling than normal pavements. However, the depth of scaling is often minor and diamond grinding can easily correct the concrete surface by removing only the non-durable top surface.

Figure 3. Using sand patch method (ASTM E 965) to test for surface texture depth.

Older survey data from state agencies shows that almost all states report satisfactory long-term service from rained on pavements that were left in place. Except in extreme cases, removal and replacement of slabs exposed to rain is unnecessary and unwarranted.

Occasional edge slumping up to ½ inch in the outer 2 feet of a lane that will not be adjacent to another lane or a speed change lane is not considered detrimental to pavement performance or service and, therefore, does not require corrective work.

Repair of Rained-On Pavements

The primary method to repair a rain-damaged surface is diamond grinding (Figure 4). Areas where water diluted the surface paste should be ground to remove the weak surface layer. As long as minimum thickness requirements are still met after grinding, no structural deficiencies are introduced by this corrective measure. Grinding can commence when the pavement has reached the strength specified for opening to construction traffic.

Figure 4. A diamond grinding machine is used for removing the non-durable surface, re-texturing the pavement, and smoothing out the ride.

The only instance requiring repair other than diamond grinding for a rained-on pavement is when severely eroded edges cannot be corrected prior to the concrete hardening (Figure 5). Where pavement lanes, concrete shoulders, or curb and gutter are to be constructed adjacent to the eroded edges, a new existing edge can be created by making a full-depth saw cut parallel to the planned pavement edge and a sufficient distance in from the edge to remove all unsatisfactory concrete. Where there is no adjacent concrete section, it may be necessary to remove all or a portion of a lane and reconstruct it. If a portion of a lane width is to be removed, make a full-depth saw cut parallel to the planned edge and a minimum of 2 feet from it. Drill holes and install tiebars or hookbolts using an expanding grout or epoxy.

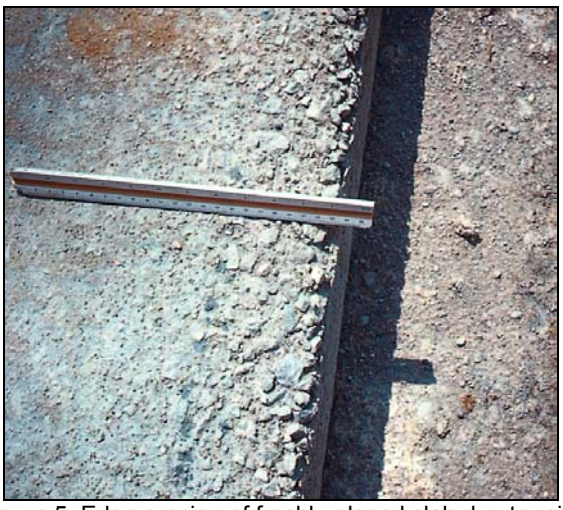

Figure 5. Edge erosion of freshly-placed slab due to rain.

Another method of correcting severe edge erosion is to place a bonded patch similar to a partial-depth patch or bonded concrete overlay. A 1½-inch deep saw cut can be made near the eroded edge to outline the extent of the erosion. After removal of the concrete from this area, a form is placed along the edge of pavement and a bonding grout of sand-cement or epoxy is applied to the concrete if required. Concrete can then be placed to restore the edge.

A petrographic examination of cores taken from the pavement is usually not necessary for rained-on pavement situations, but it does provide helpful information to determine the extent of the damage. A petrographer can indicate how deep any damage extends and provide recommendations for effective repair, such as diamond grinding. Before considering removal and replacement of rain-damaged pavement, it is advisable to send a few cores to an experienced petrographer for analysis of the concrete's water-cement ratio, air content, air-void spacing factor, and general appearance using ASTM C 856. If a general petrographic evaluation does not answer all of the questions on the concrete's durability, consider a more detailed analysis of the air-void system using ASTM C 457. Surface scaling tests can also be conducted in accordance with ASTM C 672. Rain damaged concrete needs to be removed only if it has been determined to be non-durable in terms of abrasion, skid resistance, or freezing & thawing.

Summary

Rain is not detrimental to the quality of concrete pavement if appropriate action is taken to protect and correct the unhardened concrete pavement. Prior planning and immediate action are mandatory to minimize the effects of rain. Using the procedures outlined herein should provide the service life for which the pavement was designed.

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