TEXAS DEPARTMENT OF TRANSPORTATION

Texas Department of Transportation

TECHNICAL ADVISORY

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Revised Guidelines on Minimum Roadway Placement Temperatures

Introduction

On March 14, 2006, a technical advisory was published by the Construction Division (CST) addressing "Guidance on Minimum Roadway Placement Temperatures." That technical advisory is available on-line at http://www.dot.state.tx.us/cst/technical_advisories.htm and a copy was sent via email to each TxDOT district. This revision to the technical advisory provides more detailed guidance and recommendations to the districts on this topic.

A recent survey generally concluded that the districts do not believe that placement temperature is a major issue and that the wording under "Weather Conditions" in the current hot mix specifications is adequate. That language allows the Engineer the latitude to relax the placement temperature requirements when necessary. Despite the fact that most feel that the Department has all the tools it needs to address this issue, there is a strong desire from the hot mix paving industry for TxDOT to be more explicit via the use of special provisions or general notes concerning minimum placement temperatures. The two major issues raised by the hot mix industry are night paving operations and paving of subsurface layers. Ideally, contractors need to know what the Engineer is going to allow in terms of minimum roadway placement temperatures and they need to know this prior to the letting for bidding and scheduling purposes.

There are many factors that affect compaction and pavement performance related to cold temperature paving. In addition to a contractor's equipment and processes, the ability to compact HMA is a function of mix temperature, lift thickness, radiant heat from sunlight, wind speed, humidity and mixture properties such as binder stiffness and gradation as well as other factors. Assuming that a mix is adequately compacted, long term performance of the mix is a function of HMA properties and pavement structure as well as factors such as traffic volume, location of the HMA layer within the pavement structure, bonding between layers, climatic conditions and other factors. The minimum allowable placement temperatures of 60°F/70°F in the 2004 standard specifications for HMA were intended to address the worst case scenario for HMA placement. Generally speaking, this would be a relatively thin lift of polymer modified HMA placed on the surface mix on a high traffic roadway. These types of mixtures have a higher risk of failure if placed when the daytime temperature is relatively low and there is no radiant heat from sunlight to warm the pavement. In these situations, some of the higher risk of failure comes from the fact that the overnight temperature will typically drop significantly and debonding between pavement layers can occur.

Regarding minimum placement temperatures, a "one size fits all" approach is obviously not practical to cover all of the conditions that exist throughout Texas. Since it is impossible to address every condition in a standard specification, the conservative approach of addressing the worst case scenario was chosen for the 2004 HMA specifications. The minimum placement temperatures of 60°F/70°F were chosen for the 2004 standard specifications with the expectation that engineers would use the latitude allowed in the specification to relax the temperature requirements when warranted by the conditions of the project.

Provided below under the section entitled "Recommended Contract Language" is an example specification or general note language that districts can use in lieu of or in conjunction with the standard language for "Weather Conditions" that currently exists in the 2004 hot mix specifications. Districts are encouraged to take the following course of action.

1. Use the recommendations below to develop district wide special provisions or general notes to hot mix Items 340, 341, 342, 344, 346 and special specifications 3000 and 3001. If necessary districts should modify the recommendations below to reflect local experience and climatic conditions.
2. As a minimum, districts should use the recommendations below as guidelines when constructing HMA pavements under the 2004 standard specifications.

➡ Delaying Morning Paving Operations

In accordance with the specification, paving is not allowed to begin until the pavement reaches the required placement temperature. On daytime paving operations, this can result in delays of up to several hours in the early portion of the morning. Ultimately it is the Engineer's call as to when paving can begin; however, delaying the paving operations is not recommended if it is known that the pavement will reach the required placement temperature within a reasonable time frame. As an example, it may be unnecessary to wait for the pavement temperature to increase from 55°F to the required temperature of 60°F if the 60°F will likely be reached within a couple of hours. On a sunny day the pavement temperature at the beginning of the morning may be slightly less than the required temperature yet by the middle of the day, the pavement temperature may be in excess of 100°F. The wording provided under the section entitled "Recommended Contract Language" addresses this particular issue.

➡ Paving Subsurface Layers

It is recommended to allow the placement of subsurface layers at the minimum placement temperatures listed in Table 1. There are two primary justifications for using these values which are lower than the standard values of 60°F/70°F: 1) subsurface layers are typically placed in relatively thick lifts and 2) subsurface layers are not directly exposed to traffic loading. Both of these factors reduce the probability of a premature failure occurring in the subsurface layer as a result of colder temperature paving.

➡ Night Paving Versus Day Paving Operations

The popularity of nighttime paving operations has grown rapidly in recent years. This is especially true in urban areas because traffic volumes are significantly lower at night. Night paving operations tend to be less disruptive to traffic flow. The recommendations in Table 1 permit lowering the allowable pavement temperature for night paving operations. One of the reasons that this can be justified is that the temperatures at night are "as bad as it gets" if one were to consider the temperature over a 24-hour period. As an example: on nights when the pavement temperature gets down to 50°F, it is very likely that the pavement will reach a range of 70°F to 100°F during daylight hours. Conversely, if the daytime pavement temperature was to reach only 50°F then it is likely that the pavement temperature can dip to a range of 30°F or less at night. Most premature failures attributed to cold temperature paving are the result of paving when the daytime temperature was in the 40s and the nighttime temperature dipped into the low 20s or teens. Due to the rapid cooling that happens overnight, paving during low daytime temperatures is often much more risky than paving at lower nighttime temperatures.

➡ Use of Processes/Equipment That Eliminates Thermal Segregation

One of the most common failure modes on HMA pavements that are paved in cold weather is attributed to thermal segregation. The failures are manifest as raveling and/or potholes that occur in a cyclic pattern that repeats every 100 feet or less. The cause of the raveling and/or potholes can often be traced back to HMA that became too cold during the placement operations. Cold spots in the mat do not get compacted to the same degree as the rest of the mat. In addition, the cold spots often do not bond to the underlying pavement. After opening the pavement to traffic, the fines in these cold spots get "whipped out" and raveling can begin to occur. Cold spots that do not bond to the underlying pavement can disintegrate and form pot holes when exposed to traffic. The process can start any where from several days to several years after the pavement is open to traffic. When windrow paving operations are used it is common to see sections of the windrow that are 100°F colder at the beginning and end of the windrow compared to the middle of the windrow. The windrow elevator and paver can remix some of the cold material back with the hot material; however, it is often the case that the cold material is not aggressively remixed with the hot material resulting in cold spots in the mat. Contractors can use various processes and equipment to mitigate thermal segregation prior to the mix being discharged from the paver so that it does not affect the long term performance of the pavement.

As seen in note 1 under Table 1, lowering the minimum allowable pavement surface temperature by 10°F is recommended for contractors that use processes or equipment that eliminate thermal segregation. Insulated trucks, insulated tarps, material transfer devices, hopper inserts, remixing pavers and other means can be used to eliminate thermal segregation. Research has shown that some devices are highly effective at eliminating thermal segregation by remixing the HMA and that other methods

are less effective or not effective at all. Equipment alone is usually not enough to eliminate thermal segregation but good equipment combined with good paving processes have the ability to virtually eliminate thermal segregation. Note 1 requires that the contractor demonstrate that their equipment and/or process results in an uncompacted mat that has no more than 10°F of thermal segregation. On jobs with very short haul distances, contractors may be able to meet this requirement without using any special process or equipment; however, it should be noted that, on a cold day with a typical haul distance, most paving operations in the state would not meet this requirement with the exception of those that use good paving processes combined with specialized equipment such as remix pavers or material transfer devices that aggressively remix the HMA.

➡ Recommended Contract Language

The following contract language, provided below in italics, is written so that it can be used by districts as a special provision or general notes. As mentioned earlier, districts may wish to modify the language below to reflect local experience and climatic conditions.

Place mixture when the roadway surface temperature is equal to or higher than the temperatures listed in Table 1 unless otherwise approved or shown on the plans. Measure the roadway surface temperature with a handheld infrared thermometer. The Engineer may allow mixture placement to begin prior to the roadway surface reaching the required temperature requirements if conditions are such that the roadway surface will reach the required temperature within 2 hrs. of beginning placement operations. Unless otherwise shown on the plans, place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the Engineer.

Table 1. Minimum Pavement Surface Temperatures

		Minimum Pavement Surface Temperatures in Degrees Fahrenheit	
Specification Item Number	**High Temperature Binder Grade**	**Subsurface Layers or Night Paving Operations**	**Surface Layers Placed in Daylight Operations**
Items 340, 341 & 344	PG 64	45	50
	PG 70	55[1]	60[1]
	PG 76	60[1]	60[1]
Items 342 and 346 SS 3000 & SS 3001	PG 76	65[1]	70[1]
	Asphalt Rubber (A-R)	65[1]	70[1]

1. Contractors may pave at temperatures 10°F lower than the values shown in Table 1 when utilizing a paving process or equipment that eliminates thermal segregation. In which cases, the contractor must use either an infrared bar attached to the paver or a handheld thermal camera or a handheld infrared thermometer operated in accordance with Test Method 244-F to demonstrate to the satisfaction of the Engineer that the uncompacted mat has no more than 10°F of thermal segregation.

➡ Conclusions and Recommendations

Wording in the current hot mix specifications allows the Engineer latitude to relax the minimum placement temperature requirements. Many engineers have verbally relaxed the specification or plan to relax the specification in the future when warranted. On March 14, 2006, a technical advisory was published by the Construction Division (CST) addressing "Guidance on Minimum Roadway Placement Temperatures." These guidelines describe when it appropriate to relax the minimum surface placement temperature requirements. The contracting community has expressed the desire for the Department to be more explicit regarding when and how much the minimum placement temperature is going to be relaxed. They have expressed the need for this information to be written into the contract documents.

For letting, bidding and scheduling purposes, it is recommended that districts develop special provisions or general notes regarding minimum roadway placement temperatures. While the Engineer has the authority to modify the requirements during the construction phase, special provisions or general notes are recommended for making allowances for night paving, paving

of subsurface layers, and paving with equipment or processes that eliminate thermal segregation so that contractors can bid projects with more confidence on how the specifications will be enforced.

➡ Contact Information

Please contact Dale A. Rand, P.E., at 512/506-5836 or drand@dot.state.tx.us if you have questions regarding this topic.