ASPHALT: SMOOTH DURABLE QUIET SAFE WINTER 2009

TEXAS ASPHALT

www.txhotmix.org

An Official Publication of the Texas Asphalt Pavement Association

HIGH PRICE HMA GOING THE WAY OF THE CAVE MAN?

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GEICO may be able to save you a ton of money on your car insurance, but saving money on a ton of hot mix asphalt (HMA) is where you can find the real action. The following article describes the staggering savings that can be realized by making a few changes to the way we think about HMA.

While it might not be "so easy even a cave man can do it," you might be surprised to learn how millions of dollars can be saved by using substitute binders as well as recycled asphalt pavement (RAP) and recycled asphalt shingles (RAS).

Background

In 2008, for reasons beyond our control, the supply of both asphalt and polymers became very tight, or in some cases nearly non-existent. As a result, the price of liquid asphalt and polymers skyrocketed along with the price of HMA and highway construction in general. All of this combined with serious funding shortages caused us to re-examine how we do business.

In 2009, material and construction prices have dropped considerably. However, TxDOT is still experiencing serious funding shortages, causing the Department to look for various ways to stretch the available funding. From bulldozers to paper clips, the Department is cutting costs elsewhere to preserve funds for pavement construction, rehabilitation, and maintenance, while at the same time implementing ways to reduce the cost associated with these three activities. The Construction Division of TxDOT has worked with TxAPA, The Associated General Contractors of Texas, and other industry partners to develop specifications that emphasize both cost reduction and quality improvements to HMA in Texas.

Special Provision 341-024 was recently approved and will be required for use on all projects beginning with the January 2010 construction letting. This special provision contains at least five significant changes that will affect the paving industry.

Here, we will focus on the three issues that have potential to significantly reduce the cost of hot mix: substitute binders, RAP, and RAS. The proper use of substitute binders as well as RAP and RAS enable suppliers to reduce the cost of HMA by more than $15 per ton in some cases. Combining these three options will produce a mixture that is more affordable and arguably more flexible than using RAP or RAS alone.

Some would argue that the Department may be going too far in allowing the use of these materials to proliferate. It should be pointed out that TxDOT's administration previously made the commitment to allow the use of RAP on almost all HMA projects, and the Department is already benefitting from the cost savings associated with its use.

Since RAS contains roughly four times as much asphalt as RAP, it is logical that if the Department allows RAP, it should also allow RAS. Note that RAS is currently used successfully in HMA in a number of other states and has been used on a limited basis in Texas.

A valid concern about the use of both RAP and RAS is that these materials contain asphalt binder that is highly oxidized, which if not used properly, can adversely stiffen HMA. There is no doubt that a mixture with PG 76-22 virgin binder plus RAP and/or RAS will be very stiff. As a general rule, the use of 20 percent RAP or 5 percent RAS will have about the same effect on the HMA as raising the binder grade (as an example) from a PG 64-22 to a PG 70-22.

Results from the Hamburg Wheel Test (HWT) confirm this stiffening effect. As a result, it is often recommended that the binder be dropped one grade (e.g., from PG 70-22 to PG 64-22)

when using more than 20 percent RAP; some engineers refer to this as "grade dumping."

Since TxDOT does not require the use of RAP or RAS but allows for their use, it is difficult for the engineer to specify a lower binder grade, or grade dump, in anticipation of the contractor choosing to use RAP or RAS. In addition, the amount of stiffening in HMA is a function of both the quality and quantity of RAP on any given project.

Because of these issues, the best approach is to test how much stiffening will occur rather than to assume. Historically, testing of the chemically recovered binder has been used as an indication of how much stiffening occurs with the use of RAP or RAS. However, in lieu of testing recovered binder, TxDOT chooses to use the HWT as an indication of HMA stiffness since binder stiffness is only one component of mixture stiffness. The quantity and quality of both the asphalt binder and the aggregate component all factor into the stiffness and durability of HMA.

Combining softer binders with highly oxidized materials such as RAP and RAS makes good sense from a performance standpoint. One example is TxDOT's SPS-5 test section in the Dallas district, where the HMA with RAP performed very well for more than 17 years. It makes even better financial sense, as you will see from the following examples.

Examples of HMA Cost Savings Opportunities

The assumptions shown in Table 1 were used to determine the HMA cost estimates in Table 2. Note that the cost estimates in Table 2 represent material costs only. These costs do not reflect the total 'as constructed' cost of HMA. The cost figures in Table 1 are estimates based only on current available data. The HMA supplier's true cost for these materials may vary significantly from the values shown in Table 1.

It is also assumed that the theoretical Type D HMA used in the examples below has a design asphalt content of 5.0 percent by weight of the total mixture. Table 2 illustrates the HMA costs for virgin materials and then shows how much the price can be reduced if RAP, RAS, and binder substitution are used. Figure 1 also graphically illustrates the affects RAP, RAS, and substitute binders have on the price of a Type D mix with PG 76-22 binder.

A Type D mix with a specified binder grade of PG 76-22 (5 percent by weight of mixture) would cost $47.80. This same mixture would cost $41.24 if 20 percent RAP were used, $42.54 if 5 percent RAS were used, and $37.64 if both 15percent RAP and 5 percent RAS were used.

But as they say in advertising "that's not all," because the price could be further reduced if PG 70-22 or PG 64 22 were substituted for the PG 76-22 originally specified. The resulting cost would be $35.74 and $32.39, respectively, for PG 70-22 and PG 64-22 binders. It should be noted that the price for the substitute binder mixes also assumes 15percent RAP and 5 percent RAS were used in the HMA.

The new special provision SP 341-024 will allow the use of these substitute binders when the HMA mixture meets the HWT requirement for the originally specified binder. This can sometimes be accomplished without using RAP or RAS, depending on the quality of the aggregate and PG binder.

Table 1: Assumptions Used for HMA Cost Estimates

Material	Cost Per Ton	Notes
Aggregate	$22	Includes processing & freight
PG 76-22	$538	Based on September 2009 *Index (freight not included)
PG 70-22	$480	Based on September 2009 *Index (freight not included)
PG 64-22	$377	Based on September 2009 *Index (freight not included)
RAP	$15	Contains 5% AC, includes processing & freight
RAS	$20	Contains 20% AC, includes processing & freight

* Source: Louisiana Asphalt Pavement Association

Table 2: HMA Cost Estimates

Cost of Mix ($/Ton)					
Binder Grade	Virgin Mix	20% RAP	5% RAS	15% RAP+ 5% RAS	*One Grade Substitute
PG 76-22	47.80	41.24	42.54	37.64	35.74
PG 70-22	44.90	38.92	40.22	35.74	32.39
PG 64-22	39.75	34.80	36.10	32.39	NA

* Includes 15% RAP and 5% RAS

It can almost always be accomplished when RAP or RAS or a combination of RAP and RAS are used with the substitute binder. The cost reduction can be very significant. The example above shows how a $47.80/ton HMA can be reduced to as low as $32.39/ton, which is a savings of $15.41/ton—more than a 32 percent cost reduction. Using the same logic, a virgin PG 70-22 Type D HMA could be reduced in cost from $44.90/ton to $32.39/ton, which is a savings of $12.51/ton—almost a 28 percent cost reduction.

Polymer-modified binders, such as PG 76-22 and PG 70-22, are significantly more expensive than unmodified binders, such as PG 64-22. As a result, binder substitution (grade dumping) and the use of RAP and RAS are most cost effective for HMA that contains polymer-modified binders. However, the cost reductions are still significant when RAP and RAS are used in HMA that contain unmodified binder. Table 2 illustrates how HMA with PG 64-22 can be reduced from $39.75/ton to $32.39/ton, which is a savings of $7.36/ton—almost a 19 percent cost reduction.

Conclusions

TxDOT typically uses between 5 million and 15 million tons of HMA each year. If we can save $10/ton by using RAP, RAS, and substitute binders, the overall savings will be between $50 million and $150 million per year.

If TxDOT were to save only half that much, we would still be looking at a tremendous opportunity to stretch our available funding. Allowing the use of substitute binders will not only save money, but it will also help to ensure that HMA containing RAP or RAS does not become overly stiff. There are many factors that go into the cost of HMA that we have little to no control over, including the price of liquid asphalt and polymers. However, through the use of substitute binders, RAP, and RAS, we will be better positioned both now and the next time the price of asphalt spikes.

It is clear that we no longer have the financial luxury to specify HMA using 100 percent virgin asphalt and aggregate. The days of specifying HMA with PG 76-22 and not allowing RAP or RAS are quickly fading; some may even argue that those days are long gone. The good news is that HMA costing $100/ton or more may also go the way of the cave man, thanks in part to the proper use of substitute binders, RAP, and RAS. ✪

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