



**Washington State
Department of Transportation**

CONSTRUCTION BULLETIN

**State Construction Office
Engineering and Regional Operations**

**HMA Paving on Bridge Decks:
HMA Compaction**
Bulletin #2016-05
Date: October 28, 2016

Purpose

1. To explain the reasoning behind recently implemented contract requirements which increase the number of compaction tests to be taken on HMA paving on bridge decks.
2. To request Region feedback on the attached draft Amendment to the Standard Specifications (attachment 1).

Background

It is a certainty that HMA overlays on bridge decks haven't been lasting as long as they could, as evidenced by lower HMA performance (raveling, delamination, and potholes) when compared to adjacent HMA off of bridges. It is also a certainty that one of the major causes of this has been lower-than-desired HMA compaction.

Several things are occurring that individually are minor but collectively have exacerbated the trend in lower than desired HMA compaction on bridge decks.

- 1) The Standard Specifications disallow the vibration mode of rollers on bridge decks.
- 2) An industry-wide trend in roller equipment technology has been to increase the energy for compaction from vibration and amplitude, with a commensurate reduction in the gross static weight of rollers.
- 3) Our current Standard Specification for HMA does not specifically target testing on the bridge deck for percent compaction - instead, such testing only happens when a random test location happens to fall on the deck.
- 4) With statistical evaluation as the basis of acceptance for most of WSDOT's projects, for those instances when a random test location does fall on a deck, it is statistically evaluated with 15 other sublots. This can tend to mask compaction test results that are on the low end of desirable.
- 5) For about the last year, we have had contracts which (a) restricted the weight of, and (b) stipulated minimum spacing of equipment in the paving train. (This will be addressed in a separate Construction Bulletin.) Each of the above will have a tendency to make achieving the specified compaction more difficult.

When these factors are viewed together, lower than desired compaction is not an unforeseeable outcome, and lower than desired compaction is a well-recognized cause of reduced service life of HMA.

Is Obtaining the Desired Compaction Achievable Under these Circumstances?

Yes, because it has been done successfully on many projects. Things Contractors have done or could do are:

- Use warm mix technology.
- Use optimal amount of asphalt binder in the mixture.
- Make more roller passes on bridges.
- Use a heavier roller.
- Use a pneumatic roller with preheated tires.
- Adhere to best practices to keep HMA temperature up.
 - Pave during off-peak hours to minimize haul time.
 - Tarp trucks.
- Adhere to best practices to apply compactive effort as soon as possible.
 - Keep rollers as close to the paver as possible consistent with the contract.
 - Add another roller.

Things WSDOT can do to facilitate increased HMA compaction on bridge deck overlays are:

- Specify 3/8 inch Nominal Maximum Aggregate Size (NMAS) for use on bridge decks in order to increase the ratio of depth/NMAS.
- Modify volumetric property specifications such as voids in mineral aggregate (VMA), air voids (V_a), and dust-to-asphalt ratio during production to ensure optimum binder content is provided.
- Eliminate use of reclaimed asphalt pavement (RAP) and recycled asphalt shingles (RAS) in the HMA used to pave bridge decks to ensure full benefit of asphalt binder in mixture
- Specify polymer modified asphalt binders to provide rut and crack resistance.
- Consider using 3/8 inch HMA for an entire paving project, particularly where a project encompasses several bridges. The use of a single 3/8 inch mix, rather than using 1/2 inch off bridges and 3/8 inch on bridges, would simplify design and construction.

The Problem and the Solution

The problem is that compaction on bridge decks is generally not meeting the intended requirements of the Standard Specifications, which is a compaction Pay Factor of 1.00 or greater. The solution is to increase the asphalt compaction on bridge decks by specifically targeting mix design modifications and compaction testing on bridge decks.

The Current Process

Most contracts advertised in fall 2015/spring 2016 which included HMA paving on a bridge deck included the following language in a GSP for bridge deck overlays:

HMA Overlay on Bridge Deck

“HMA overlay shall be placed on the bridge deck in accordance with Section 5-04.3(7), and compacted in accordance with Section 5-04.3(10) and the following specific bridge and Structure requirements:”

“Pneumatic rollers are required for bridges with a total length of 125-feet or more.”

“HMA compaction on bridges will be evaluated collectively as a separate lot. Sublots on bridges shall not exceed 50-tons with at least one subplot per lane. Compaction on bridges will be evaluated by using random core samples of the lot in accordance with WSDOT Test Method T 716 where the relative density of the core in accordance with WSDOT FOP for

AASHTO T 166 will be used for acceptance of the HMA compaction and the calculation of the CPF.”

A few changes are needed to the above language to address concerns that have surfaced during its use. Regions have been swamped with coring requests as a result of this spec and therefore have asked that the cores be taken by the contractor. Projects with multiple bridges have sometimes produced illogical results because the specification calls for all bridges to be evaluated with one collective pay factor; a separate pay factor is needed for each bridge. And finally, since this spec is intended to apply to all bridge decks, and owing to the complexity of the bridge deck HMA overlay GSP, it makes sense to take this language out of the GSP and make it an amendment to the Standard Specifications. The proposed language for insertion into the Standard Specifications on January 1, 2017 is attachment 1.

HMA Compaction – Why So Many Tests, and Why Cores?

It’s already been said that one of the chosen solutions is to increase frequency of density testing on bridge decks. Along with the difficulty of achieving the compaction requirements on bridge decks comes the increased risk of failing compaction tests. This, in turn, increases the likelihood of requests for retests (which is always by cores) and the requirement to evaluate failing results by statistical evaluation (requiring a minimum of 3 sublots). Therefore, it is felt that in the long run or at least until there is a few year’s data, it will be less work to go straight to cores and statistical evaluation.

HMA Compaction – Doesn’t Coring Create a Risk of Damaging the Deck?

Using Cores for density testing on bridge decks does increase the risk of damage to the waterproofing membrane and the bridge deck. Occasionally, damage the membrane or the bridge deck concrete will occur, but changes will be made by January 2017 to WSDOT SOP 734 (Sampling Hot Mix Asphalt After Compaction (Obtaining Cores)) to require the bottom of the core hole to be swabbed with asphalt binder before being backfilled to help mitigate any damage. More importantly, the issue of low density is of such a concern to the Bridge and Structures Office that it’s felt that the risk and consequences of coring damage is overshadowed by the benefit of increased compaction.

Other Future Changes to the Process

- The Bridge and Structures Office and HQ Construction are working with WAPA to consider allowing “oscillatory” rollers on decks. These purportedly create motion in a plane parallel to the deck which is reported to impose less force into the structure, as opposed to “vibratory” rollers which impose vertical forces on the structure.
- Implement training on these changes in our processes, which will rely on this Construction Bulletin for content.

Additional Information Contact:

- HQ Bridge & Structures Office - DeWayne Wilson and Dick Stoddard
- HQ Construction – Bob Dyer
- Pavement Design – Jeff Uhlmeier

Comments on the Proposed Amendment to the Standard Specifications (attachment 1):

Please send comments on these proposed changes to Bob Dyer: DyerB@wsdot.wa.gov. Comments should be submitted by close of business on Thursday, November 10th.

Attachment 1

5-04.3(10)A HMA Compaction – General Compaction Requirements

Immediately after the HMA has been spread and struck off, and after surface irregularities have been adjusted, thoroughly and uniformly compact the mix. The completed course shall be free from ridges, ruts, humps, depressions, objectionable marks, and irregularities and shall conform to the line, grade, and cross-section shown in the Plans. If necessary, alter the JMF in accordance with [Section 9-03.8\(7\)](#) to achieve desired results.

Compact the mix when it is in the proper condition so that no undue displacement, cracking, or shoving occurs. Compact areas inaccessible to large compaction equipment by mechanical or hand tampers. Remove HMA that becomes loose, broken, contaminated, shows an excess or deficiency of asphalt, or is in any way defective. Replace the removed material with new HMA, and compact it immediately to conform to the surrounding area.

The type of rollers to be used and their relative position in the compaction sequence shall generally be the Contractor's option, provided the specified densities are attained. An exception shall be that pneumatic tired rollers shall be used for compaction of the wearing course beginning October 1st of any year through March 31st of the following year. Coverage with a steel wheel roller may precede pneumatic tired rolling. Unless otherwise approved by the Engineer, operate rollers in the static mode when the internal temperature of the mix is less than 175°F. Regardless of mix temperature, do not operate a roller in a mode that results in checking or cracking of the mat.

On bridge decks and on the five feet of roadway approach immediately adjacent to the end of bridge/back of pavement seat, operate rollers in static mode only. On bridges of a total length of 125 feet or more, at least one roller in the paving compaction train shall be a pneumatic roller.

5-04.3(10)C1 HMA Compaction Statistical Evaluation – Lots and Sublots

HMA compaction which is accepted by Statistical Evaluation will be evaluated by the Contracting Agency dividing the project into compaction lots, and each compaction lot will be evaluated using stratified random sampling by the Contracting Agency subdividing each compaction lot into compaction sublots. All mixture in any individual compaction lot shall be of the same mix design. The compaction sublots will be numbered in the order in which the mixture (of a particular mix design) is paved.

Each compaction lot comprises a maximum of 15 compaction sublots, except for the final compaction lot of each mix design on the Contract, which comprises a maximum of 25 sublots.

Each compaction subplot shall be uniform in size as shown in Table 17, except that the last compaction subplot of each day may be increased to a maximum of two times the compaction subplot quantity calculated. Minor variations in the size of any subplot shall not be cause to invalidate the associated test result.

Table 17

HMA Compaction Sublot Size

Attachment 1

HMA Original Plan Quantity (tons) ¹	Compaction Sublot Size (tons) ²
<20,000	100
20,000 to 30,000	150
>30,000	200
¹ In determining the plan quantity tonnage, do not include any tons accepted by test point evaluation.	

All HMA which is paved on a bridge and accepted for compaction by Statistical Evaluation will compose a bridge compaction lot. If the Contract ~~contract~~ includes such HMA on more than one bridge, compaction will be evaluated on each bridge individually, as separate bridge compaction lots.

Bridge compaction sublots will be determined by the Engineer subject to the following.

- All sublots on a given bridge will be approximately the same size.
- Sublots will be stratified from the lot.
- In no case will there be less than 3 sublots in each bridge compaction lot.
- No sublot will exceed 50 tons.
- Compaction test locations will be determined by the Engineer in accordance with WSDOT FOF for AASHTO T166.

The following will cause one compaction lot to end prematurely and a new compaction lot to begin:

- For a compaction lot in progress with a compaction CPF less than 0.75, a new compaction lot will begin at the Contractor’s request after the Engineer is satisfied that material conforming to the Specifications can be produced. See also Section 5-04.3(11)F.

5-04.3(10)C2 HMA Compaction Statistical Evaluation – Acceptance Testing

Comply with Section 1-06.2(1).

The location of HMA compaction acceptance tests will be randomly selected by the Contracting Agency from within each sublot, with one test per sublot. The Contracting Agency will determine the random sample location using WSDOT Test Method T 716.

Use Table 18 to determine compaction acceptance test procedures and to allocate compaction acceptance sampling and testing responsibilities between the Contractor and the Contracting Agency. ~~Roadway~~HMA cores shall be taken or nuclear density testing shall occur after completion of the finish rolling, prior to opening to traffic, and on the same day that the mix is placed

Table 18

HMA Compaction Acceptance Testing Procedures and Responsibilities			
	When Contract Includes Bid Item “ HMA Core - Roadway Cores ”	When Contract Does Not Include Bid Item “ HMA Core - Roadway Cores ” ⁴	
Basis for Test:	Roadway Cores	Roadway Cores ³	Nuclear Density

Attachment 1

			Gauge ³
In-Place Density Determined by:	Contractor shall take cores ¹ using WSDOT SOP 734 ²	Contracting Agency will take cores ¹ using WSDOT SOP 734	Contracting Agency, using FOP for WAQTC TM 8
	Contracting Agency will determine core density using FOP for AASHTO T 166	Contracting Agency will determine core density using FOP for AASHTO T 166	
Theoretical Maximum Density Determined by:	Contracting Agency, using FOP for AASHTO T 209		
Rolling Average of Theoretical Maximum Densities Determined by:	Contracting Agency, using WSDOT SOP 729		
Percent Compaction in Each Sublot Determined by:	Contracting Agency, using WSDOT SOP 736	Contracting Agency, using WSDOT SOP 736	Contracting Agency, using FOP for WAQTC TM 8
<p>¹The core diameter shall be 4-inches unless otherwise approved by the Engineer.</p> <p>²The Contractor shall take the core samples in the presence of the Engineer, at locations designated by the Engineer, and deliver the core samples to the Contracting Agency.</p> <p>³The Contracting Agency will determine, in its sole discretion, whether it will take cores or use the nuclear density gauge to determine in-place density. Exclusive reliance on cores for density acceptance is generally intended for small paving projects and is not intended as a replacement for nuclear gauge density testing on typical projects.</p> <p><u>⁴The basis for test of all compaction sublots in a bridge compaction lot shall be cores. These cores shall be taken by the Contractor when the Proposal includes the bid item "HMA Cores – Bridge Deck". When there is no bid item for "HMA Cores – Bridge Deck", the Engineer will be responsible for taking HMA cores for all compaction sublots in a bridge compaction lot. In either case, the Engineer will determine core location, in-place density of the core, theoretical maximum density, rolling average of theoretical maximum density, and percent compaction using the procedure called for in this Section.</u></p>			

When using the nuclear density gauge for acceptance testing of pavement density, the Engineer will follow WSDOT SOP 730 for correlating the nuclear gauge with HMA cores. When cores are required for the correlation, coring and testing will be by the Contracting Agency. When a core is taken for gauge correlation at the location of a sublot, the relative density of the core will be used for the sublot test result and is exempt from retesting.

5-04.5 Payment

Payment will be made for each of the following Bid items that are included in the Proposal:

~~“Roadway Core”, per each.~~

Attachment 1

~~The Contractor's costs for all other Work associated with the coring (e.g., traffic control) shall be incidental and included within the unit Bid price per each and no additional payments will be made. "HMA Core – Bridge Deck", per each.~~

The unit Contract price per each for "HMA Core – Bridge Deck" shall be full payment for all costs, including traffic control, associated with taking HMA density cores in pavement that is on a bridge deck.

"HMA Core – Roadway", per each.

The unit Contract price per each for "HMA Core – Roadway" shall be full payment for all costs, including traffic control, associated with taking HMA density cores in pavement that is not on a bridge deck.