CONSTRUCTION BULLETIN

Washington State Department of Transportation

State Construction Office
Engineering and Regional Operations

HMA Paving on Bridge Decks:
Restrictions on Equipment Weight & Spacing
Bulletin #2016-04
Date: October 28, 2016

Purpose

(1) To explain the reasoning behind recently implemented contract requirements for restricting the weight and spacing of equipment in the Contractor's HMA paving and milling trains when working on a bridge deck.
(2) To request Regional feedback on the current General Special Provision (GSP) and plan sheet (Attach. 1A and 1B).

What Are These "Restrictions on Paving/Milling Train Weights/Spacing on Bridge Decks"?

The restrictions are defined in a GSP and plan sheet which together make sure the contractor's paving/milling equipment is not too heavy, and that this heavy equipment doesn't get too close together, ensuring the continued structural integrity of the bridge. This equipment could include pavers, MTD/V, hauling vehicles, milling machines, rollers, etc. See Attachment 1A and 1B for a sample of the GSP and plan sheet. Features of this GSP/plan sheet are:

1. They would be included in any project that places heavy equipment on a bridge deck, if the bridge is identified by the Bridge and Structures Office as requiring load restrictions on paving or milling equipment.
2. They do not require the paving contractor to do any structural analysis because they provide a pre-approved (by the Bridge and Structures Office) weight and spacing on a plan sheet.
3. Equipment weights on the plan sheet will have been vetted with industry to assure reasonable availability and functionality.
4. The GSP allows each bidder to submit a maximum of 2 contractor-specific paving trains to the Bridge and Structures Office for review and approval prior to submitting a bid.
5. After contract execution, even though the GSP does not explicitly state as much, the Contractor may propose changes to the WSDOT preapproved plan sheet by submitting working drawings showing the Plan and Elevation views of the equipment train that includes axle weights and spacing between all axles. Axle weights must be reflective of a fully loaded vehicle. Track loads may be represented by contact length, width, and gross weight. This proposal requires review and approval by the Bridge and Structures Office.

Are These Restrictions the Same for Every Project?

These restrictions are not the same for every project. Allowable equipment weights may vary from one project to another, equipment spacing may vary, or MTD/V's may or may not be allowed.

Most projects will not include the restricted equipment weight GSP. That's because, for the time being, the Bridge and Structures Office evaluates only those bridges considered to have a high potential for being at risk. The bridges identified as having the high potential for being at risk are structurally evaluated to determine whether the need to restrict paving equipment loads exists, and if so, what those restrictions are. Experience has shown that not all of the bridges evaluated ultimately require equipment weight restrictions in the contract. For those bridges that are not evaluated, at the present time they are assumed to have capacity to support modern paving equipment based on past experience.

Of the 43 HMA paving projects placed on Ad by WSDOT from September 2015 through August 2016 for the 2016 paving season, 25 included paving on bridge decks requiring bridge deck repair, membrane, and/or overlay profile revision. Of those 25, nine included a plan sheet outlining a milling train and/or paving train arrangement, and another 5 included specifications outlining load restrictions on bridges within the paving limits (some being paved and others not paved).

A very rough forecast from review of the list of projects for the 2017 season looks to have 17 projects with some form of bridge deck paving, out of 43 HMA paving projects overall. Of the 17 that will have paving on bridge decks, it has not yet been determined how many will require restricting the weight of paving equipment.

Why Now?

Several factors happening at the same time have made it necessary for WSDOT to consider whether our bridges, and in particular our older bridges, are being overstressed during HMA milling and paving operations. Some of these factors have been happening for decades, and some are recent developments. For example, highway bridges age, and as a natural result they deteriorate. Causes of this deterioration include concrete shrinkage cracking, ground settlement, seismic ground movement, rebar corrosion, structural steel corrosion, vehicle damage, insect infestation (timber), tire wear, fatigue cracking, and a myriad of other causes. These in turn cause the load capacity to diminish from the original design intent. At the same time, bridge design loads have increased to accommodate the need for heavier truck loads. Also at the same time the size, capacity, and weight of HMA paving equipment has increased in order to optimize efficiency and increase quality. More recently, new technology such as transfer vehicles and pavement grinders have appeared on the scene that further increase the overall weight of the paving train.

It turns out that some of our bridges are being overstressed by HMA paving and grinding operations as determined by bridge-specific calculations that take into consideration weights and spacing of typical, modern, paving and milling equipment.

The primary goal of this effort is to prevent structural damage to a bridge as a result of the HMA paving operation.

Doesn't Standard Specification 1-07.7 "Load Limits" Already Address This Issue?

Not really. The 35% axle overload no longer complies with the code so it will be removed from the Standard Specs soon.

Isn't The Proposed Spec More Restrictive Than Legal Load Limits?

After all, if legal loads can be up to 80,000 or 105,500 lbs., how does it make sense to restrict a truck and pup to less than 80,000 pounds? The short answer is that the code and the law address more than merely gross vehicle weight. The longer answer is that pavers, grinders, and MTD/V's of the size typically used on WSDOT projects almost never meet the requirements of a legal load. When any piece of construction equipment exceeds legal loads or axle spacing (such as a paver, MTD/V, or milling machine) you cannot locate an 80,000 truck just adjacent to it merely because the 80,000 truck is a "legal" load; once one piece of equipment is known to exceed the legal load criteria, the structural effect of all equipment in the vicinity must be considered. Then, the type, size and geometry of the bridge can affect the size of truck the bridge can carry. Therefore, a structural analysis is required, based on axle spacing (i.e., concentration of loads), proximity of adjacent heavy equipment, bridge type, bridge size, and bridge geometry.

For example, an MTD/V might weigh 100,000 lbs., but because its axle spacing is so close and it has tracks instead of wheels, it doesn't meet the code or the law for vehicle weight. Only a bridge-specific structural analysis can determine if the bridge can withstand the specific MTD/V loads, and that analysis must also evaluate the weight and geometry of other heavy equipment (such as 10-wheelers) that might be in the vicinity. If it can, the analysis will show where the bridge will overstress first and what influence the adjacent equipment has on the overstress. If it's the deck, maybe adjacent equipment must stay farther away. If it's the superstructure, perhaps a lighter combination of adjacent equipment is the only solution between the piers. There is a complex matrix of weight/spacing/structural support that need to be considered.

Refer to Attachments 2, 3, and 4 for a brief summary of Washington legal loads, Washington permit loads, and the AASHTO Bridge Design Code.

Project Scoping and PS&E Process to Determine Paving/Grinding Equipment Weight Restrictions

As part of project programming the HQ Bridge Asset Management unit creates Bridge Condition Reports (BCR) that state the paving design and identify bridge conditions that could limit or impact construction procedures. Beginning in 2016, if the bridge Operating Load Rating is 42 tons or less, the BCR automatically includes a statement that equipment weight restrictions might be required in the PS&E. For BCR's that were developed before 2016, an update should be requested before finalizing a PS&E.

During PS&E development, the Bridge Design Office will use the existing Bridge Load Rating models and software that are maintained by the Bridge Preservation Office to investigate equipment limitations. Also, the Bridge Design Office is working with the Washington Asphalt Paving Association (WAPA) to establish two paving train models that will be used as "bookends" to define the limits of heaviest-typical and lightest-practical paving trains. These will be used in the initial analysis of the potential for load restrictions. These bookends - the WAPA Heavy Paving Train and WAPA Light Paving Train - will be evaluated using Overload Permit vehicle criteria, which allows heavier vehicle loads for occasional live loads. If the analysis calculates a Load Rating Factor less than 1.0, the Bridge Capacity is judged to be inadequate to resist the equipment loads. When that happens, additional analysis is performed to determine if increasing equipment spacing will help or if equipment weights need to be reduced. In many cases, the MTV must be lightened or eliminated to produce a Load Rating of 1.0 or greater. The

objective is to provide potential contractors with paving equipment diagrams that show the allowable maximum weights and minimum spacing.

Contractor-proposed configurations will be considered during the bidding phase and after contract award. The Bridge Design Office will have the structural models and spreadsheet available and ready to go in order to provide timely responses.

Here's A Way to Increase Max Allowable Weight of Some Equipment

In doing the structural analysis, the more certainty the Bridge and Structures Office has about what the maximum equipment weights will be, the higher the maximum allowable equipment weights can be. Known as "load validation", this reduces the uncertainty of the equipment weights and allows the structural engineer to reduce conservatism in the load rating analysis. Use of on-site, certified scales will typically result in a 15% increase in maximum allowable equipment weight when compared to what has been allowed in projects in the last year. The process that will be used to convey this information to the Bridge and Structures Office, and the process WSDOT inspectors will play in validating actual equipment weights, is being worked out as this is written (and by this Construction Bulletin Region input is requested as to how this can best be accomplished), but is expected to be in the January 2017 spec and Construction Manual.

Future Changes to the Process

- The Standard Specification that allows WSDOT Contractors to increase construction equipment weights to 35% over legal will be removed from the specifications because it is no longer valid.
- Bridge and Structures Office is working with WAPA on defining the lightest practical and heaviest typical equipment weights.
- Update the GSP and Construction Manual to designate how equipment weights will be verified.
- Certainty of actual loads and actual axle spacing will reduce load factors, which in turn will increase the allowable equipment weights. Establish inspection and documentation procedures to this effect.
- Implement training, which will rely largely on this Construction Bulletin.

Additional Information or to Comment on the GSP/Plan Sheet:

The following groups/individuals were involved in this effort:

- HQ Bridge Preservation – Harvey Coffman
- HQ Bridge Design – Dick Stoddard
- HQ Construction – Bob Dyer
- Pavement Design – Jeff Uhlmeyer

Please send comments on this Construction Bulletin to Bob Dyer: DyerB@wsdot.wa.gov

GSP FOR WEIGHT AND SPACING RESTRICTIONS
ON HMA PAVING/MILLING ON BRIDGES
(current a/o September 20, 2016)

Planing Bituminous Pavement

The gross vehicle weight (GVW) of the planer and haul truck allowed on the bridges shall not exceed the maximum GVW specified in the Plans, and the spacing of the vehicles shall not be less than that specified in the Plans unless otherwise accepted as described in this Special Provision.

After planing, the Contractor shall remove all loose and unsound surfacing not firmly bonded to the bridge deck, as specified by the Engineer, using methods and equipment that do not damage the bonded layer of surfacing to remain.

HMA Overlay on Bridge Deck

HMA overlay shall be placed on the bridge deck in accordance with Section 5- 04.3(9), and compacted in accordance with Section 5-04.3(10) and the following specific bridge and Structure requirements:

Use of an MTD/V on Bridge Nos. 107/5 and 107/6 will not be allowed. The Contractor may directly transfer HMA from the hauling equipment to the paving machine for paving of Bridge Nos. 107/5 and 107/6.

The gross vehicle weight (GVW) of the paving train vehicles (haul truck, asphalt paver, and breakdown pneumatic, intermediate, and finish rollers) allowed on the bridges shall not exceed the maximum GVW specified in the Plans, and the spacing of the vehicles shall not be less than that specified in the Plans unless otherwise accepted as described in this Special Provision.

Static mode compaction is required for all compaction equipment operating over the bridges and 5-feet of Roadway approach immediately adjacent to the end of bridge/back of pavement seat. At least one roller in the paving compaction train shall be a pneumatic roller.

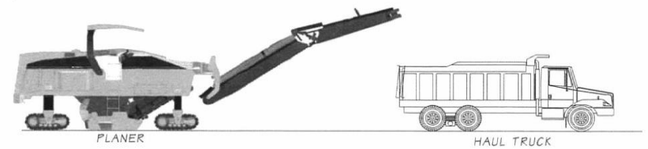
HMA compaction on bridges will be evaluated collectively as a separate lot. Sublets on bridges shall not exceed 50-tons with at least one sublet per lane. Compaction on bridges will be evaluated by using random core samples of the lot in accordance with WSDOT Test Method T 716 where the relative density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

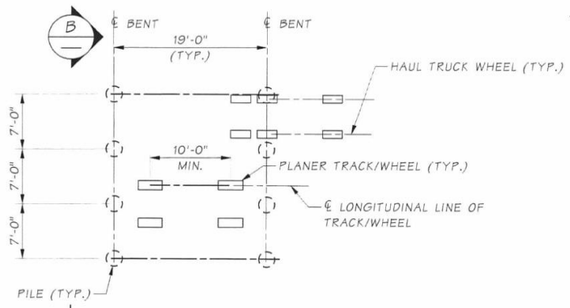
Submittal of Alternative Asphalt Removal and Paving Trains

During the Bid period, prospective Bidders may submit a maximum of two asphalt removal trains and two asphalt paving trains for review and comment. The submittal shall contain the maximum gross vehicle weights including loaded weights for haul trucks, paver, material transfer vehicle, etc., the axle spacing of the equipment and the minimum spacing between adjacent pieces of equipment. Submittals must be received by the Contracting Agency's representative identified in the Notice to All Plan holders by April 26, 2016 at 5:00 PM. Electronic submittals will be accepted. All submittals received by the required date and time, both accepted and not accepted, will be posted on the Contract Ad & Award information page no later than the Friday prior to Bid opening.

ITEM	MAXIMUM GROSS WEIGHT (LBS)
HAUL TRUCK	45,000.0 *
LIGHT PLANER WITH LOCATIONS UNRESTRICTED	26,000.0*
HEAVY PLANER WITH LOCATIONS RESTRICTED	45,000.0*

* FULLY LOADED TOTAL WEIGHT





PLAN VIEW

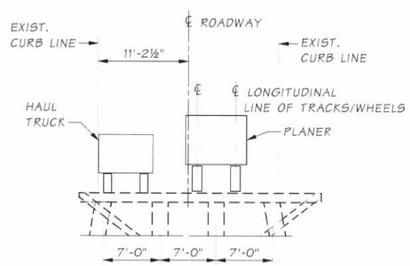
ASPHALT REMOVAL TRAIN

FOR BRIDGES 107/5 AND 107/6

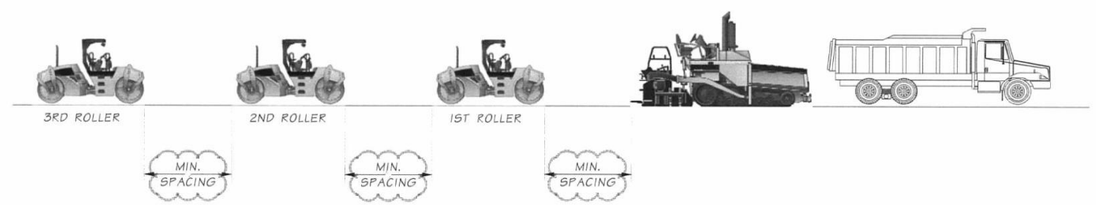
REMOVAL EQUIPMENT LIMITS ARE BASED ON EXPECTED AXLE WEIGHTS AND GROSS VEHICLE WEIGHTS BUT DO NOT SPECIFY EQUIPMENT MODELS OR MANUFACTURERS.

FOR EACH BENT:

THE HEAVY PLANER SHALL BE POSITIONED SUCH THAT ONLY ONE LONGITUDINAL LINE OF TRACKS/WHEELS IS LOCATED BETWEEN ANY PAIR OF ADJACENT PILES OF THE BENT, SEE "PLAN VIEW" AND SECTION B, THE HAUL TRUCK SHALL BE POSITIONED IN AN ADJACENT LANE SUCH THAT NO ONE LONGITUDINAL LINE OF WHEELS IS BETWEEN THE SAME PILES AS A LONGITUDINAL LINE OF PLANER TRACKS/WHEELS.



SECTION B



ASPHALT PAVING TRAIN

FOR BRIDGES 107/5 AND 107/6

VIBRATION MODE IS NOT ALLOWED FOR ANY ROLLERS.

PAVING TRAIN LIMITS ARE BASED ON EXPECTED AXLE WEIGHTS BUT DO NOT SPECIFY EQUIPMENT MODELS OR MANUFACTURERS.

A THREE ROLLER PAVING TRAIN IS SHOWN TO ILLUSTRATE EQUIPMENT SPACING ADDITIONAL ROLLERS MAY BE USED IF EQUIPMENT SPACING IS MAINTAINED.

MINIMUM SPACING FOR EACH PIECE OF EQUIPMENT SHALL BE MAINTAINED IN FRONT OF AND BEHIND THE EQUIPMENT. THE SPACING BETWEEN A LIGHT ROLLER AND A HEAVY ROLLER SHALL NOT BE LESS THAN PRESCRIBED FOR THE HEAVY ROLLER.

ITEM	MAXIMUM GROSS WEIGHT (LBS)	MIN. SPACING
ASPHALT PAVER & HAUL TRUCK COMBINED	60,000 LBS **	-
LIGHT ROLLER	30,000 LBS	20 FT.
HEAVY ROLLER	45,000 LBS	30 FT.

** COMBINED TOTAL WEIGHT OF HAUL TRUCK, ASPHALT PAVER AND HMA SHALL NOT EXCEED THE MAXIMUM GROSS WEIGHT.

Bridge Design Engr.	Khaleghi, B		M:\RAIL RETROFITS\1-OVERLAYS\XL4866_SR8-SR107_PAVING TRAIN\window files\ADD1-HMA PAVING TRAIN.wnd			REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Supervisor	Stoddard, RB					10	WASH.			
Designed By	Stoddard, RB	01/16				JOB NUMBER 150916				
Checked By	Chu, A	03/16								
Detailed By	Andreotti, L	01/16				CONTRACT NO.				
Bridge Projects Engr.										
Prelim. Plan By			4/15/16	CHANGED MAXIMUM GROSS WEIGHT & MIN. SPACING	RBS	BK				
Architect/Specialist			DATE	REVISION	BY	APP'D				

Fri Apr 15 08:54:02 2016

BRIDGE AND STRUCTURES OFFICE

Apr 15 2016 9:33 AM cosign

Washington State Department of Transportation

SR 8 & SR 107
MCCLEARY & MONTESANO VIC
PAVING

PLANER & PAVING EQUIPMENT WEIGHTS AND SPACING

BRIDGE SHEET NO. 1

SHEET 8 OF 18 SHEETS

SR ____ FILE NO. ____ SHEET 1

Legal Loads in Washington State

Legal weight limits in Washington State, which are found in RCW 46.44, are based on Federal regulation 23 CFR 658.17 which was enacted into law by Congress in 1974. The federal regulation limits the gross vehicle weight on the National System of Interstate and Defense Highways to a maximum of 80,000 pounds. When the RCW was enacted in 1975-76, the state legislature increased the maximum gross vehicle weight to 105,500 pounds and the weight on the steer axle was limited to the lesser of 20,000 pounds or 600 pounds per inch width.

The maximum gross weight is calculated based on the Federal Formula, which is known as Formula B:

$$W = 500(\frac{LN}{N-1} + 12N + 36)$$

Where *L* is the total length between a group of axles in feet and *N* is the number of axles.

As an example, a 60 foot long configuration with 6 axles will carry:

$$W = 500\left(\frac{60 * 6}{6-1} + (12 * 6) + 36\right) = 90{,}000 \text{ pounds}$$

Additionally, the maximum load on a single axle is 20,000 pounds. The weight is controlled by the width of tire where it is limited to 500 pounds per inch of width except for the steer axle where it is limited to the lesser of the 20,000 pounds or manufacturer rating.

Tandem axles are limited to 34,000 pounds and are defined as two or more consecutive axles where the distance between the first and last axle is over 40 inches and less or equal to 8 feet.

The lesser of the above calculations will govern the gross weight of the configuration.

The Washington State Legislature adopted the federal regulation in 1975-76 per RCW 46.44.042. At the same time our Legislature of tire.

Permit Loads in Washington State

There is no national standard to regulate permit loads, so each state has its own laws that govern the permitting of overloads. In Washington State, permits for weight are regulated under RCW 46.44.091. Permit loads are defined as non-divisible loads or those that can't be reduced in a reasonable amount of time.

Permit loads are limited by the following:

- 600 pounds per inch of tire width
- 22,000 pounds on a single axle; this limit can be exceeded if the tire has a rim width greater than 20 inches and a diameter greater than 24 inches.
- 43,000 pounds on a tandem axle

Additionally, the maximum load on a group of axles is limited by the following formulas:

- Length of the group is from 7 feet to less than 10 feet: $L*6500$
- Length of the group is from 10 feet to less than 30 feet: $(L+20)*2200$
- Length of the group is from 30 feet and greater: $(L+40)*1600$

Where L is the length of the combination

The lesser of any of these calculations or axle weight limits will control the maximum gross weight on a combination.

Permits for over-legal loads can always be considered on a WSDOT contract.

AASHTO LRFD Allowed Loads

Pavement removal equipment and paving equipment will be evaluated by the same structural Load Rating Criteria that is used by the Bridge Preservation Office to evaluate overload truck permits. They require a moving load analysis of the equipment, including tire sizes, axle spacing, gross and net vehicle weight, and stresses with various relative locations of equipment to evaluate equipment spacing. The structural analysis reviews all components of the bridge to see what controls the failure mechanism. The objective of the analysis is to find the heaviest allowable scenario that does not overstress the structure.

The paving removal equipment with haul trucks and the paving training are analyzed as a single overload truck with axle loads and spacing that match the proposed equipment weights and equipment spacing. Spreading the paving loads longitudinally in a lane and transversely into adjacent lanes are techniques that can help reduce the maximum stresses in the bridge. However, when a capacity limit is exceeded by a single axle load from one of the pieces of equipment, the only solution is to look for lighter equipment to reduce the load.