Use of a Double Chip Seal to Correct a Flushing Hot Mix Asphalt Pavement in Washington State

WA-RD 760.1

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Experimental Feature Report

Post-Construction and Performance Report
Experimental Feature 10-01

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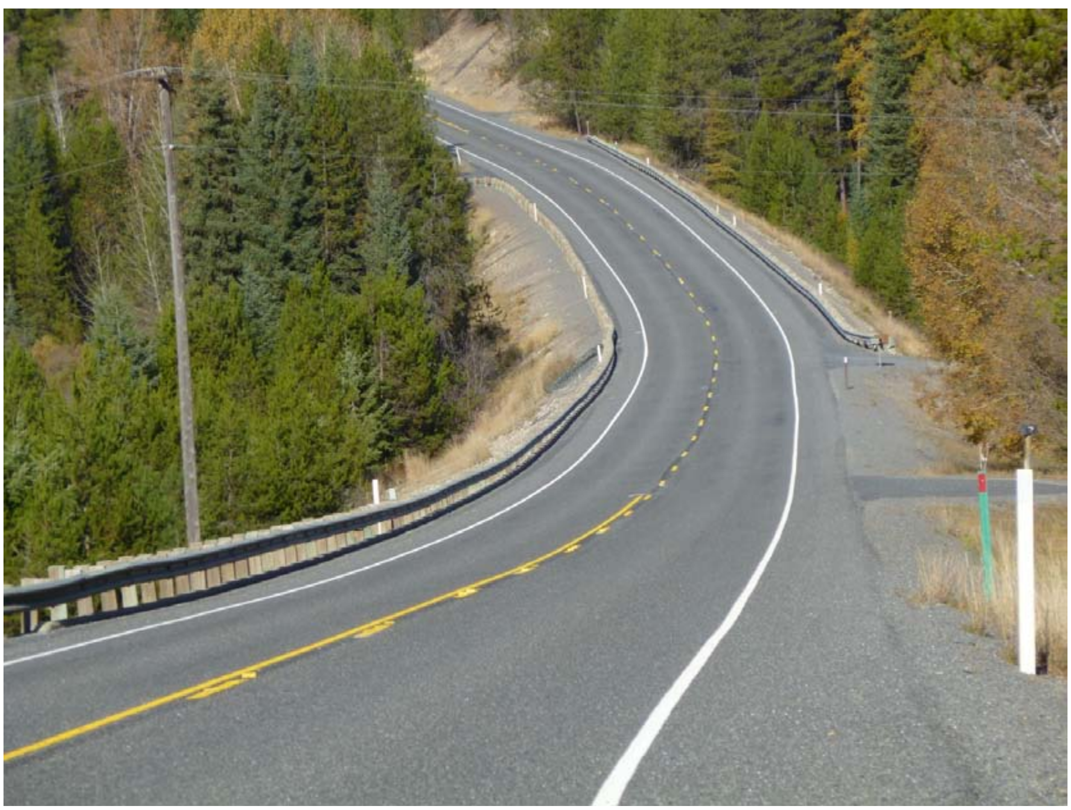
SR 20
Eastern Region Chip Seal 2010
MP 363.61 to MP 372.84



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16. ABSTRACT

A chip seal constructed on an existing flushed roadway has the potential to result in bleeding or flushing of the new chip seal. The excess binder, if not properly accounted for during design and construction, will migrate to the surface of the chip seal and fill the aggregate void spaces leaving a flushed surface. The Washington State Department of Transportation (WSDOT) elected to construct a double chip seal to mitigate a flushing section of pavement on SR 20. This report documents the design and construction of the double chip seal and provides information on its initial performance. The double chip seal will be monitored for up to five years at which a final report will be prepared including conclusions as to its success or failure.

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Introduction

A chip seal constructed on an existing flushed roadway has the potential to result in bleeding or flushing of the new chip seal. The excess binder, if not properly accounted for during design and construction, will migrate to the surface of the chip seal and fill the aggregate void spaces leaving a flushed surface. Limited information is available regarding construction of a new chip seal on a flushed existing surface. A review of the literature indicated that both an inverted double chip seal and a sandwich seal are capable of correcting a flushed existing pavement but construction details or performance data for these types of chip seals were not included. Although the chip seals reported in the literature are not conventional double chip seals, they both involve two applications of aggregate and one or two applications of binder. This led to the proposal to construct a double chip seal as a method to address a severely flushing pavement on SR 20 north of Spokane in Washington State.

A single chip seal consists of one application of aggregate over one application of asphalt binder. A double chip seal is essentially two single chip seals, one placed on top of the other. The aggregate on top is usually a finer gradation than that placed on the bottom in a standard double chip seal. An inverted double chip seal is the opposite of a conventional double chip seal with the finer aggregate gradation placed on the bottom during the first application of aggregate and binder. Double chip seals are more durable and seal the roadway against water better than a single chip seal leading to their use in locations where there is high truck traffic or on steep grades (Gransberg and James, 2005). The disadvantage of a double chip seal is higher cost due to two applications of binder and aggregate.

A double chip seal is a departure from the normal practice used by the Washington State Department of Transportation (WSDOT). WSDOT uses single chip seals almost exclusively to preserve low volume highways. If it can successfully address the flushing pavement on SR 20, a double chip seal will provide an economical method of addressing flushing on chip seal roadways in the future. This report documents the design and construction of the double chip seal on SR 20. WSDOT will monitor the double chip seal for a period of five years at which time a final report will be prepared documenting its performance.

Background

WSDOT constructed the double chip seal on a section of SR 20 north of Spokane between Colville and SR 31. In 2000 WSDOT overlaid this section with HMA to provide additional pavement structure. Soon after construction, the new HMA began to flush excessively (Figures 1 and 2). Maintenance crews periodically rolled aggregate and sand into the flushed surface in order to improve friction but the flushing persisted. Despite the flushing, the roadway is in good condition structurally, but needs a surface treatment to address the flushing, improve friction and preserve the roadway surface. Placing a single chip seal on this pavement would likely result in flushing of the newly placed chip seal. In order to find a better solution, WSDOT constructed a half mile double chip seal test section within this section of SR 20 in 2008 to evaluate the double chip seal's effectiveness at mitigating the flushing. The performance of the test section was promising resulting in the decision to place a double chip seal on the rest of the flushing pavement.

Figure 1. Flushing HMA on SR 20 soon after placement.

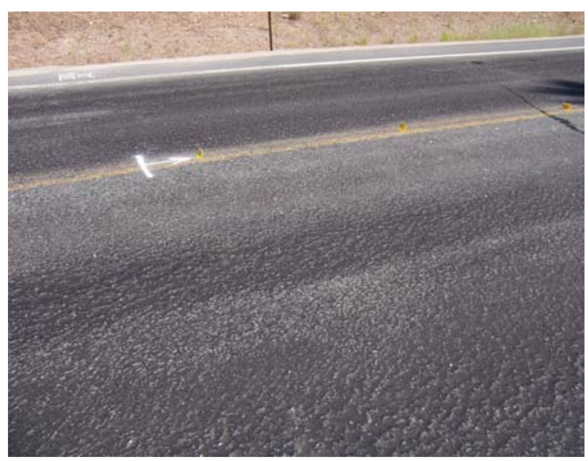

Figure 2. Condition of flushing pavement before placement of the double chip seal.

The section of SR 20 that received the double chip seal is approximately 15 miles east of Colville in Stevens County, between milepost 363.61 and 372.84. This section of SR 20 is a rural minor arterial in rolling terrain with many curves. Forest lines most of the roadside with interspersed open areas where farms or home sites are located along the route. Traffic is light with Average Annual Daily Traffic (AADT) varying between 600 and 1,400 vehicles per day of which between 20 and 25 percent are trucks. The average high temperature in July is 87°F and the average low in January is 18°F. Precipitation occurs throughout the year with December being the wettest month with 2.26 inches and August the driest with 0.74 inches. Annual precipitation is over 17 inches with an average of 42 inches of snowfall occurring during winter.

Methods for Correcting a Flushed Pavement with a Chip Seal

The available literature was reviewed to investigate methods that had the potential to correct a flushed pavement using a chip seal. The following briefly describes four methods that were identified and discusses their applicability to correcting the flushed pavement on SR 20.

Adjust the Binder Application Rate

Probably the simplest and most common method used to address a flushed existing surface is to adjust the binder application rate. The chip seal designer or field personnel simply adjust the application rate based on the condition of the existing pavement. An existing flushed pavement would have the application rate reduced to account for the excess binder. Both the McLeod and modified Kearby chip seal design methods use correction factors that reduce the application rate for flushed surfaces. The McLeod design method recommends reducing the binder application rate by up to 0.06 gal/sy for a flushed or bleeding surface (McLeod 1969). A modification to the Kearby design method recommends a reduction of 0.06 gal/sy to account for a flushed surface (Gransberg and James, 2005).

Reducing the binder application rate may be an effective way to construct a single chip seal over a flushed pavement as long as the flushing is not too excessive. It is unlikely that the binder application rate adjustments in the McLeod or modified Kearby methods was intended to address flushing of the severity of that on SR 20. WSDOT chose to reduce the binder application rate as part of its strategy to correct the flushing pavement on SR 20, but it was believed that a single chip seal with a correction to the binder application alone would not be sufficient to correct the flushing.

Retexturizing

Australia, New Zealand and the United Kingdom use retexturizing to correct a flushing surface (Gransberg and James 2005, Gransberg, Pidwerbesky and James 2005). Retexturizing is a process which uses high pressure water to remove flushed binder from the pavement surface and to restore surface texture prior to placing a new chip seal (Gransberg and James 2005). Retexturizing can address flushing over the entire pavement surface by using full width water blasting equipment or on small areas using a water cutting machine (Gransberg, Pidwerbesky and James 2005).

Although retexturizing appears promising, WSDOT does not have experience with this method and did not consider it as a method to correct the flushing problem on SR 20.

Inverted Double Chip Seal

An inverted double chip seal includes two applications of binder and two applications of aggregate. Unlike a conventional double chip seal where top application of aggregate is finer than the bottom, the finer aggregate gradation is on the bottom in an inverted double chip seal. Inverted double chip seals have been used successfully on bleeding pavements with up to 30,000 Average Daily Traffic (ADT) in Australia (Gransberg and James 2005). Despite the reported success, the literature review did not locate any details describing the design or construction of an inverted chip seal to correct a flushed pavement.

Sandwich Seal

New Zealand uses sandwich seals to correct flushing pavements and Texas has used them on a limited basis as a remedy for flushed or bleeding pavements (Gunderson 2008, Lawson and Senadheera 2009). A sandwich seal consist of two layers of aggregate and one application of binder. The first layer consists of coarse aggregate placed directly on the existing pavement without a preceding application of binder. An application of binder followed by a second application of finer gradation aggregate placed on top of the coarse aggregate layer completes the sandwich seal. It is essentially a double chip seal without the first application of binder. A sandwich seal requires about 20% less binder than a comparable double chip seal (Gunderson 2008).

It was felt that a sandwich seal would be more appropriate on a freshly placed bleeding chip seal as opposed to the 10 year old flushed HMA pavement on SR 20. The aged flushed asphalt on SR 20 may not hold the aggregate without at least some new binder applied to the existing pavement.

Instead of an inverted chip seal or sandwich seal, WSDOT elected to use a double chip seal using the same aggregate gradation on both the top and bottom application. It was felt that this type of double chip seal should perform as well as an inverted chip seal at a lower cost.

Double Chip Seal Design

The goal of the pavement design on SR 20 was to find an economical solution to the flushing pavement. In 2000, WSDOT placed HMA on this section of SR 20 to improve the structure, but this is a low traffic volume highway and it is WSDOT's intent to maintain it as a chip seal route in the future. Milling and replacing the flushing HMA would provide a reliable method of eliminating the flushing pavement but would be much more costly than using a chip seal to correct the flushing.

The successful use of a double chip seal to correct a flushing pavement in Thurston County Washington influenced WSDOT's design. The double chip seal used in Thurston County consisted of two applications of CRS-2P binder and two applications of ½ inch to U.S. No. 4 aggregate with a reduced application rate of the CRS-2P for the first application (Doolittle, 2007). To simplify design and use available materials, WSDOT selected a double chip seal similar to the Thurston County design consisting of two applications of CRS-2P binder and two applications of 3/8 inch to U.S. No. 4 aggregate (Table 1). An application of U.S. No. 4 to 0 choke (Table 1) placed after the second application of aggregate would fill surface voids and lock in the second application of 3/8 inch to U.S. No. 4 aggregate. The double chip seal on SR 20 was part of a larger project to place over 300 lane miles of single chip seal. The double chip seal used the same 3/8 inch to U.S. No. 4 gradation as the single chip seal which eliminated the need to produce a relatively small quantity of aggregate of a different gradation. The design called for reducing the first application of binder to account for the flushing pavement and not placing a fog seal over the finished surface. WSDOT's Eastern Region's standard practice is to place choke stone and a fog seal on chip seals, but the fog seal was eliminated to reduce the possibility of flushing. WSDOT constructed test sections in 2008 to evaluate the double chip seal's effectiveness at correcting the flushing and to assist in developing application rates for the CRS-2P and the aggregate.

Table 1. Double chip seal gradations.

Sieve	3/8" – U.S. No. 4	U.S. No. 4 – 0
½" Square	100	---
3/8" Square	70 – 90	100
U.S. No. 4	0 – 5	76 – 100
U.S. No. 8	0 – 3	---
U.S. No. 10	---	30 – 60
U.S. No. 200	0 – 1.5	0 – 10
% Fracture	90	90

Test Section Results

Construction of the test sections occurred in July of 2008 in both lanes of a one half mile section of flushing pavement on SR 20. WSDOT selected the location because of its relatively high rate of flushing and because its geometry was representative of most of the remainder of the flushed roadway. The plan was to use four different application rates of aggregate and CRS-2P for the test sections. Actual application rates varied from the planned application rates resulting in the first application for Test Section 1 having application rates very similar to Test Section 2 and the first application for Test Sections 3 and 4 having the same application rates. Table 2 shows the actual application rates for the first and second application of binder and aggregate. Complete details of the planned and actual application rates are included in Appendix A.

Table 2. Double chip seal test section binder and aggregate application rates.					
Test Section	Location (milepost)	First Application		Second Application[1]	
		CRS-2P (gal/sy)	3/8 inch – U.S. No 4 (lbs/sy)	CRS-2P (gal/sy)	3/8 inch – U.S. No 4 (lbs/sy)
1	366.73 to 366.98 WB	0.27	20	0.35	22
2	366.98 to 367.23 WB	0.28	20	0.36	20
3	366.73 to 366.98 EB	0.20	20	0.40	20
4	366.99 to 367.23 EB	0.20	20	0.40	20

[1] The second application also included 4 lbs/sy of U.S No 4 – 0 choke on all sections.

Checking embedment after the first applications of aggregate gave an indication of the affect the flushing pavement would have on the chip seal (Table 3). Binder application rates should be adjusted so that embedment is between 50 and 70 percent (Jackson, Jackson and Mahoney). Higher embedment rates indicate too much binder and could result in flushing. As expected, the embedment measurements for the first application were higher than they would be if the existing pavement surface was not flushing. There were also some indications of bleeding during construction especially in the sections with higher binder application rates (Figures 3 and 4).

Table 3. Embedment measured on the first application of the double chip seal test section.		
Test Section	Location (milepost)	Percent Embedment
1	366.73 to 366.98 WB	80
2	366.98 to 367.23 WB	50
3	366.73 to 366.98 EB	70
4	366.99 to 367.23 EB	70

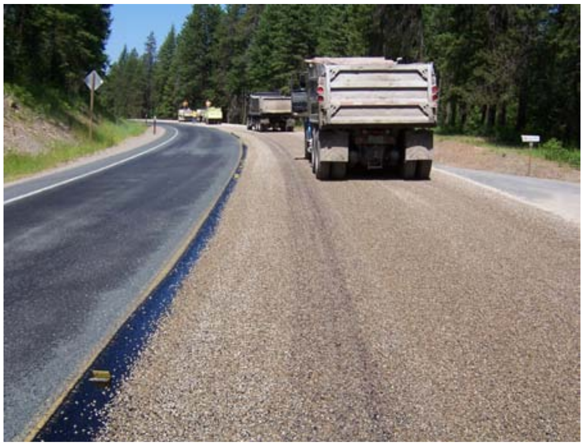

Figure 3. Chip seal placement on Test Section 1 (on right) with 0.27 gal/sy showing slight flushing in the wheel path after the first application.

Figure 4. Test Section 1 (on left) with 0.27 gal/sy shows flushing in the wheel path soon after construction while no flushing was present in Test Section 3 (on right) at 0.20 gal/sy.

Monitoring the test sections for two years after construction revealed wheel path flushing had occurred in many locations. Test Sections 1 and 2, which had higher binder application rates during the first application than Test Sections 3 and 4, appeared to have the more severe flushing (Figures 5 through 7). Despite the overall lower flushing severity, Test Sections 3 and 4 still had many severely flushed areas presumably where the flushing of the underlying pavement was more severe. By 2009 the embedment was 100 percent in the flushed areas of lanes 1 and 2 (Figure 8) but was reported to be in the 70 percent range in Test Sections 3 and 4 which had the lower binder application rates for the first application (Stephen Van De Bogert email, 2009). The test sections showed that at the lower application rates for the first application of CRS-2P a double chip seal reduced the flushing and could produce an acceptable pavement. The test sections also showed that the application rates for the first application of CRS-2P would need to be varied depending on the flushing present on the existing surface.

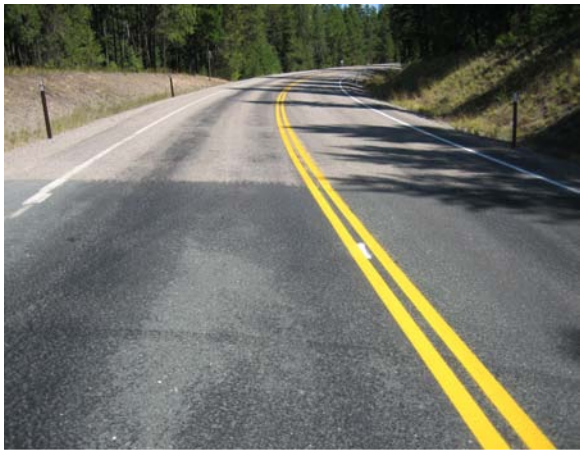

Figure 5. West end of Test Section 1 (on left) with 0.27 gal/sy and Test Section 3 (on right) with 0.20 gal/sy for the first application one year after placement.

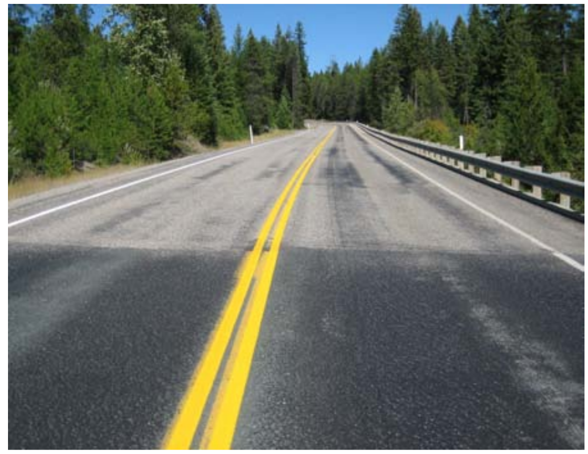

Figure 6. East end of Test Section 4 (on the left) with 0.20 gal/sy and Test Section 2 (on the right) with 0.28 gal/sy for the first application.

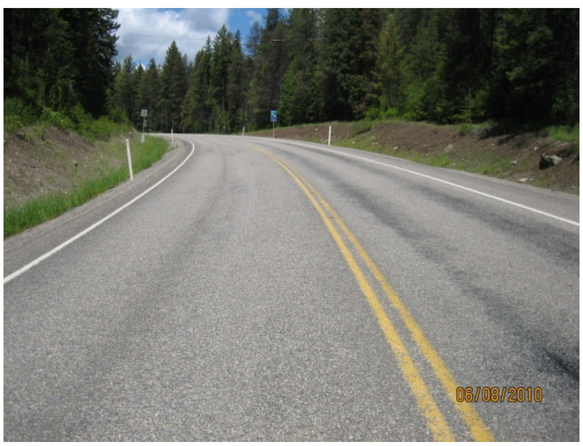

Figure 7. Test Section 4 (on left) with 0.20 gal/sy shows minimal flushing while Test Section 2 (on right) with 0.28 gal/sy shows flushing in wheel paths two years after construction.

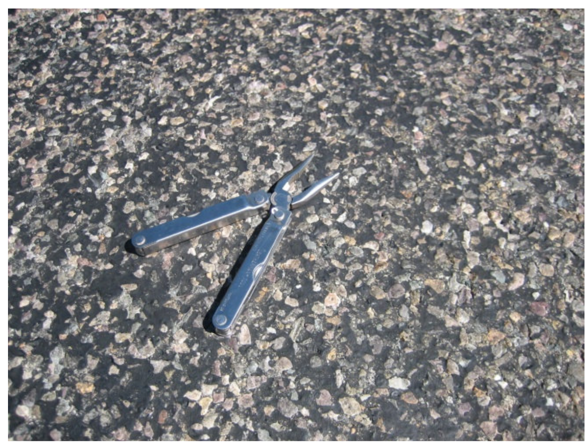

Figure 8. Typical 100% embedment area in Test Sections 1 and 2 one year after construction.

Final Design

The application rates used for Test Sections 3 and 4 were the basis for the final design included in the contract documents (Table 4). The goal was to achieve an initial embedment of about 50 percent. The CRS-2P application rate for the first application of 0.20 gal/sy was about one half of the application rate typically used by WSDOT on a single chip seal. The remaining application rates for the CRS-2P and aggregate for both applications were within the normal range for WSDOT's typical single chip seal. The complete double chip seal specification from the contract documents is included in Appendix B.

Table 4. Application rates from the contract documents.

Application	Asphalt (CRS-2P) gal. / SY	Gradation	Aggregate lbs / SY
First Application	0.20	3/8 inch – U.S. No. 4	20
Second Application	0.35 – 0.40	3/8 inch – U.S. No. 4	20 - 30
		U.S. No. 4 – 0	4 - 6

Double Chip Seal Construction

The first application of aggregate and binder for the double chip seal occurred on July 27, 2010 and the second application for the double chip seal and placement of the areas to receive the single chip seal occurred on the 28th. The weather for the most part was ideal for chip seal placement with clear skies and high temperatures in the upper 90's °F. The maximum surface temperature measured during placement was 116°F. The Contractor, Central Washington Asphalt (CWA) used conventional chip seal equipment and placement procedures. Overall the construction of the double chip seal went well. Two issues that may affect performance were that the aggregate gradations were outside of specifications limits and that the application rates of the No. 4 to 0 choke were inconsistent and lower than specified. The gradation testing results are covered further under Construction Test Results.

The intent was that the application rates in the contract documents would be a starting point and field personnel would adjust the application rates during chip seal placement to account for field conditions. Prior to placing the double chip seal, WSDOT field personnel gave each section of the roadway a 1 to 4 rating based on the extent of flushing visible with 1 being no flushing and 4 being severe flushing (Table 5 and Figures 9 and 10). Adjustments to the first application of CRS-2P and aggregate were based on the rating for each section being chip sealed. Sections with a rating of 1 did not have significant flushing and did not receive an application of binder or aggregate during the first application. Instead these areas received a single chip seal using the same applications rates as the second application of binder and aggregate for the double chip seal.

Table 5. Roadway flushing rating system.	
Visual Rating	Roadway Condition
1	No flushing
2	Intermittent flushing in the wheel path
3	Consistent flushing in the wheel path and intermittent flushing in the remaining portion of the travel lane
4	Severe flushing in the entire travel lane

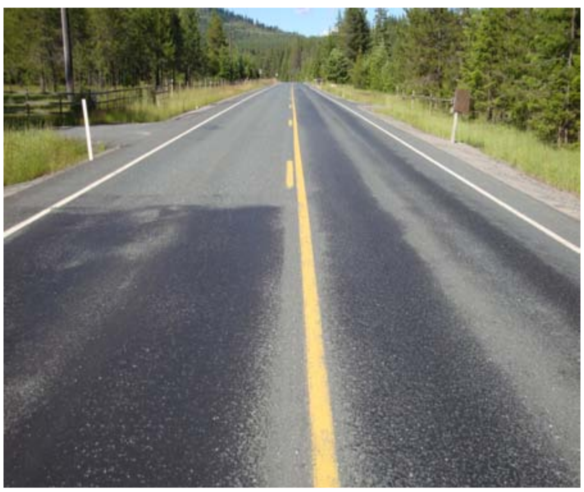
Figure 9. Upper left – Rating 1 (No Flushing), Bottom left – Rating 4 (Entire lane flushing) and Right – Rating 3 (Consistent wheel path flushing).

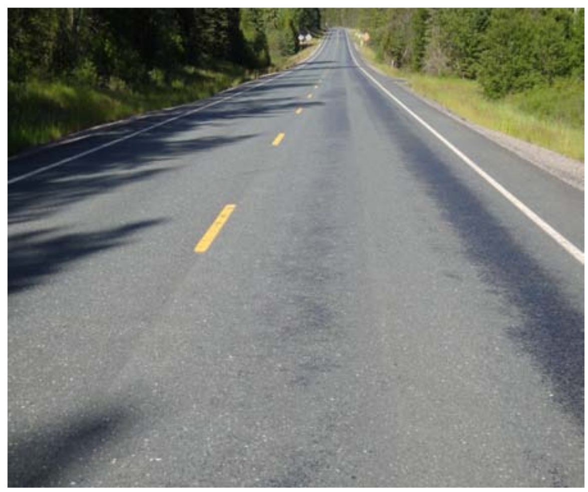
Figure 10. Left –Rating 1 (No flushing) and Right – Rating 2 (Intermittent flushing in wheel path).

Changes in application rate for the first application of CRS-2P were marked with lath placed at the beginning of each section. The application rate written on the lath was entered into the computerized application rate control system on the distributor truck to ensure the proper application of CRS-2P. WSDOT field personnel verified application rates by computing the yield based on the area chip sealed and the gallons of CRS-2P used.

Tables 6 and 7 show the actual application rates for each section along with the percent embedment. The embedment of most sections was around 50 percent but some were as low as

30 percent. The low embedment in some sections may have been due to minimal traffic allowed on the sections prior to checking the embedment.

Table 6. Flushing rating and application rates for first application of the double chip seal on west bound SR 20.

Beginning Milepost	Ending Milepost	Total Distance (miles)	Visual Rating	CRS-2P (gal/sy)	3/8 inch to U.S No. 4 (lb/sy)	Percent Embedment
363.610	364.195	0.585	1	na	na	na
364.195	365.204	1.009	3	0.18	21	45
365.204	366.734	1.530	4	0.17	21	35
366.734	367.233	0.499	2	0.16	21	50
367.233	367.849	0.616	4	0.15	21	30
367.849	367.931	0.082	1[1]	0.15	21	50
367.931	370.202	2.271	4	0.15	21	50
370.202	371.305	1.103	2	0.22	20	50
371.305	372.063	0.758	1	na	na	na
372.063	372.300	0.237	2	0.23	22	50
372.300	372.840	0.540	1	na	na	na

[1]This section was treated with a double chip seal as if it had a rating of 2.

Table 7. Flushing rating and application rates for first application of the double chip seal on east bound SR 20.

Beginning Milepost	Ending Milepost	Total Distance (miles)	Visual Rating	CRS-2P (gal/sy)	3/8 inch to U.S No. 4 (lb/sy)	Percent Embedment
363.610	365.204	1.594	3	0.15	21	50
365.204	366.734	1.530	4	0.16	21	35
366.734	367.233	0.499	1	na	na	na
367.233	367.594	0.361	4	0.14	21	50
367.594	371.340	3.746	3	0.18	21	50
371.340	372.063	0.723	2	0.21	20	50
372.063	372.300	0.237	3	0.19	22	40
372.300	372.840	0.540	2	0.23	22	50

Placement of the second application of the double chip seal and the single chip seal areas occurred at the same time as a continuous operation. The second application of the double chip seal consisted of 0.34 to 0.39 gal/sy of CRS-2P and 24 lb/sy of 3/8 inch to U.S. No. 4 aggregate with 2.3 lb/sy of U.S. No. 4 to 0 choke on all areas regardless of the condition rating. Application rates for the single chip seal areas were the same as the application rates as the second application of the double seal.

Construction Test Results

Testing of samples from the stockpiles revealed that the gradation of the 3/8 inch to U.S. No. 4 aggregate was outside specification requirements for the percentage passing the U.S. No. 4 sieve and that the gradation of the U.S. No. 4 to 0 choke was outside the specification for the percentage passing the U.S. No. 200 sieve. WSDOT used a specification for statistical acceptance of aggregates on this project. Although the aggregate gradations were outside specification requirements for individual sieves, the overall quality level was such that the specification allowed the aggregate to remain in place with a price reduction. The percentages passing the remaining sieves were all within specification and the higher percentages passing the two sieves should not affect the performance of the double chip seal. Appendix C includes the results of the gradation testing.

Double Chip Seal Performance

After three months in service the double chip seal appeared to be performing well with only a few areas in the wheel path where the embedment appears to be near 100 percent (Figures 11 and 12).

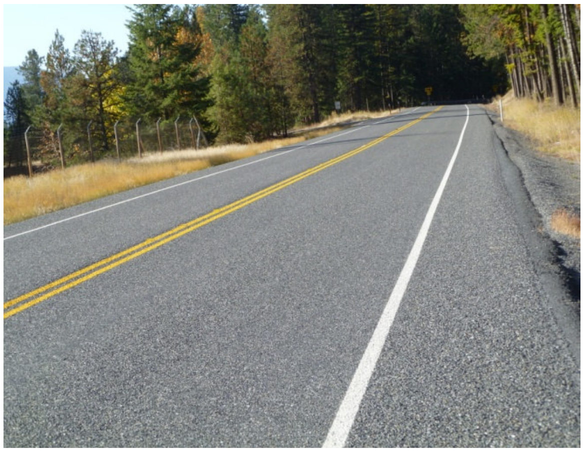

Figure 11. Appearance of the double chip seal two months after construction.

Figure 12. Area with embedment near 100 percent.

WSDOT tested the friction of the double chip seal after construction with a ribbed tire using a locked-wheel friction tester meeting ASTM E-274 requirements. As would be expected for a chip seal, the friction numbers were good with an average friction number of 62.1 and ranging between 57.5 and 68.0. Complete friction testing results are in Appendix D.

WSDOT will monitor the pavement condition, rutting and ride of the double chip seal during annual pavement surveys and report the results in the final report.

Conclusions

WSDOT designed and constructed a double chip seal to correct the flushing of an existing HMA pavement on SR 20. Design of the double chip seal was straightforward and construction was accomplished using conventional chip seal equipment and methods. Initial indications are that the double chip seal was able to correct the flushing and improve friction. Monitoring of the double chip seal will continue for at least five years at which point a final report will be prepared including conclusions as to the success or failure of the double chip seal.

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Appendix A – Test Section Application Rates -

First Shot - 7/8/2008

(Started in westbound lane heading east, pulled back and shot the eastbound lane)

Lane	Start	Section	Application	MP	Section	Application	End
Westbound	MP 366.73	Section 1	Ordered 0.28 gal/yd^2 - Shot 0.27 (CRS-2P); 20 lbs/yd^2 (Agg - 3/8"-US No.4)	MP 366.92; Ordered 0.28 Shot 0.28; MP 366.94	Section 2	Ordered 0.24 gal/yd^2 - Shot 0.28 (CRS-2P); 20 lbs/yd^2 (Agg - 3/8"-US No.4)	MP 367.23
Centerline							
Eastbound	MP 366.73	Section 3	Ordered 0.20 gal/yd^2 - Shot 0.20 (CRS-2P); 20 lbs/yd^2 (Agg - 3/8"-US No.4)	MP 366.99	Section 4	Ordered 0.24 gal/yd^2 - Shot 0.20 (CRS-2P); 20 lbs/yd^2 (Agg - 3/8"-US No.4)	MP 367.23

Embedment found on 7/9 after 7/8 application

Lane		
Westbound	80%	50%
Centerline		
Eastbound	70%	70%

Second Shot - 7/9/2008

Lane	Start	Section	Application	MP	Section	Application	End
Westbound	MP 366.73	Section 1-A	Ordered 0.35 gal/yd^2 - Shot 0.36 (CRS-2P); 22 lbs/yd^2 (Agg - 3/8"-US No.4); 4 lbs/yd^2 (Agg - US No.4-0)	MP 366.98	Section 2-A	Ordered 0.35 gal/yd^2 - Shot 0.36 (CRS-2P); 20 lbs/yd^2 (Agg - 3/8"-US No.4); 4 lbs/yd^2 (Agg - US No.4-0)	MP 367.23
Centerline							
Eastbound	MP 366.73	Section 3-A	Ordered 0.40 gal/yd^2 - Shot 0.40 (CRS-2P); 20 lbs/yd^2 (Agg - 3/8"-US No.4); 4 lbs/yd^2 (Agg - US No.4-0)	MP 366.98	Section 4-A	Ordered 0.40 gal/yd^2 - Shot 0.40 (CRS-2P); 20 lbs/yd^2 (Agg - 3/8"-US No.4); 4 lbs/yd^2 (Agg - US No.4-0)	MP 367.23

Appendix B – Double Chip Seal Construction Specification -

Double Seal

The Contractor shall apply a Double Seal to Section 8 (MP 363.61 to MP 372.84) at the following rate:

	Undiluted Asphalt Emulsion (gal. per sq. yd.) Applied	Aggregate Size	Aggregate (lbs. per sq. yd.) Applied
First Application:			
3/8 to No.4	0.20	3/8 to No.4	20
Second Application:			
3/8 to No.4 Choke Stone	0.35-0.40	3/8 to No.4 No. 4 to 0	20 - 30 4 – 6

(Target application rates are subject to change as directed by the Engineer)
The Contractor should anticipate changes to the asphalt emulsion and aggregate application rates throughout each day.

The first application will consist of CRS-2P emulsion covered by 3/8 to No.4 aggregate.

The second application will consist of CRS-2P emulsion covered by 3/8 to No.4 aggregate with an application of No. 4 to 0. The second application of bituminous surface treatment shall be applied as the first order of work the following morning when the brooming of the first bituminous surface treatment is completed.

Appendix C – Gradation Test Results -

Table C 1. 3/8 inch to U.S No. 4 gradation test results.				
Sieve	**Percent Passing**			
	Specifications	**Test 1**	**Test 2**	**Test 3**
½" Square	100	100	100	100
⅜" Square	70 – 90	84	87	82
U.S. No. 4	0 – 5	7	7	4
U.S. No. 8	0 – 3	2	2	2
U.S. No. 10	---			
U.S. No. 200	0 – 1.5	1.2	1.0	1.1
% Fracture	90	99	100	100

Table C 2. U.S No. 4 to 0 gradation test results.			
Sieve	**Percent Passing**		
	Specifications	**Test 1**	**Test 2**
½" Square	---		
⅜" Square	100	100	100
U.S. No. 4	76 – 100	88	86
U.S. No. 8	---		
U.S. No. 10	30 – 60	54	51
U.S. No. 200	0 – 10	10.9	10.5
% Fracture	90	100	100

Appendix D – Friction Testing Results -

Table D 1. Friction testing results.			
Milepost	Direction	Tested Speed (mph)	Friction Number[1]
364.00	EB	39	63.5
365.00	EB	39	62.8
366.00	EB	40	63.1
367.00	EB	42	62.8
368.00	EB	40	62.8
369.00	EB	39	62.6
370.00	EB	39	62.0
371.00	EB	40	64.1
372.00	EB	40	61.9
372.50	WB	39	68.0
371.50	WB	40	64.1
370.50	WB	40	61.2
369.50	WB	41	57.5
368.50	WB	39	59.7
367.50	WB	39	60.9
366.50	WB	41	59.8
365.50	WB	42	59.4
364.50	WB	41	62.0

[1]Based on a locked wheel friction tester with a ribbed tire meeting ASTM E-274 requirements.

Appendix E – Experimental Feature Work Plan -

Washington State Department of Transportation

WORK PLAN

Double Chip Seal Evaluation

State Route 20
Contract 7914
Eastern Region Chip Seal 2010
Milepost 363.61 to Milepost 372.84
(Section 8)

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Introduction

The section of SR 20 between milepost 363.61 and 372.84 is a bituminous surface treatment route which was overlaid with HMA in 2000 to provide additional pavement structure. Soon after construction, the new HMA began to flush excessively. Despite the flushing the roadway is in good structural condition, but a surface treatment is needed to address the flushing and friction. Placing a single chip seal on this pavement would likely result in the flushed asphalt bleeding up through the new chip seal. In order to find a better solution WSDOT's Eastern Region constructed a half mile test section of double chip seal from MP 366.73 to 367.23 within this section of SR 20 in 2008 to evaluate its effectiveness at mitigating the flushing. The results of the test section are promising resulting in the decision to place a double chip seal on the rest of the flushing pavement. The application rates used will be those that showed the best performance over the last two years (Table 1). This experimental feature will evaluate the effectiveness of the double chip seal in mitigating a flushing section of HMA and preserving the pavement on SR 20.

Table 1. Double seal application rates

Application	Undiluted Asphalt Emulsion (gal/sy)	Aggregate Gradation (Std. Spec. 9-03.4)	Aggregate (lb/sy)
First (Bottom)	0.20	3/8 to No. 4	20
Second (Top)	0.35 – 0.40	3/8 to No. 4 No. 4 to 0	20 – 30 4 – 6

Scope

Both lanes of SR 20 will be rehabilitated between milepost 363.61 and 372.84 using a double chip seal. A single shot of BST will be placed over the 2008 test section to keep this section of the highway on a coordinated schedule for treatment from MP 366.73 to 367.23.

Staffing

This research project will be constructed as an Eastern Region programmed rehabilitation project (the entire double seal section will be evaluated under this research study). Therefore, the Region Project office will coordinate and manage all construction aspects. Representatives from the WSDOT Materials Laboratory (1 – 3 people) and the Eastern Region Materials Laboratory (1-2 people) will also be involved with the process.

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Testing

Pavement performance will be monitored by the following methods:

- The pavement condition (structure, rutting and ride) will be surveyed annually
- Friction testing will be conducted after construction then annually
- The effectiveness of the double chip seal at mitigating the flushing will be evaluated visually

Reporting

A "Post Construction Report" will be written following completion of the double chip seal. This report will include construction details, construction test results, actual oil and aggregate application rates used, and other details concerning the overall process. Annual summaries will also be conducted over the next five years. At the end of the five-year period, a final report will be written which summarizes performance characteristics and recommendations for any future use of this process.

Cost Estimate

Construction Costs

No additional construction costs are required. This project will be constructed as a Region pavement preservation (P1 program) project.

Testing Costs

Condition surveys will be conducted as part of statewide annual survey so no additional cost will be incurred.

Friction Testing - $2,500 post construction + $2,500 / year for 5 years = $15,000

Report Writing Costs

Initial Report – 30 hours = $3,000

Annual Report – 4 hours (1 hour each) = $400

Final Report – 60 hours = $6,000

TOTAL COST = $24,400

Schedule

Construction: June - August 2010

Date	Condition Survey (Annual)	End of Construction Report	Annual Report	Final Report
Fall 2010	X			
Fall 2011	X	X		
Fall 2012	X		X	
Fall 2013	X		X	
Fall 2014	X		X	
Fall 2015	X		X	
Spring 2016				X