NW-ACPA/WSDOT Meeting Agenda
Thursday March 25th 1:30 PM – 4:00 PM
Virtual – MS Teams

Present	Name	Company	Present	Name	Company	Present	Name	Company
	Berg, Gary	Salinas	X	Pipinich, Bob	GMCC	X	Seghetti, Robert	Acme
X	Brasch, Tom	WSDOT	X	Powell, Jim	NWACPA	X	Uhlmeyer, Jeff	WSDOT
X	Clark, Steve	Acme	X	Rivera, Angel	FHWA	X	Waligorski, Kevin	WSDOT
	Fuller, Brian	Salinas	X	Russell, Mark	WSDOT		Watts, Troy	WSDOT
	Huang, Shin-Che	FHWA						
X	Kane, Ed	WSDOT	X	Salinas, John II	Salinas		Webster, Garrett	WSDOT
	Keeth, Jon	WSDOT	X	Schofield, Kim	WSDOT	X	Williams, Kurt	WSDOT

Introductions, team changes, and general ACPA and WSDOT update: Mark Russell Retiring end of March '21, Jeff Uhlmeyer moving to a consultant end of April '21, Kim Schofield has been selected as Jeff's replacement as State Pavement Engineer. FHWA is bringing on Shin-Che Huang who will take over for Angel Rivera on this team.

OLD BUSINESS:

16-10 – Spall repair –

October 11, 2018 – Attachment #5.5 – Mark Russell - The new specification is currently available as a special provision. It has been deemed acceptable to Industry and WSDOT. It needs to be moved into the Standard Specs. Bob Dyer will get this spec into the January 2019 Amendments to the Standard Spec.

May 30, 2019 – Mark Russell – Turned into a GSP for the time being. (Attach #16-10) Comments on the attached spec were as follows: Need to talk to HQ Materials Lab about the gradation spec. Need to specify acceptance criteria. Need to add that using a large hole saw (for cutting circles) is acceptable for small spalls and better than cutting rectangles around small spalls.

November 14, 2019 – Discussion focused on a couple items. First, there is a continued request to allow hole saws to repair small spalls. Also, a concern was raised about getting the materials approved. Need to follow up with Materials Lab to see about using Mfg. Certs and or getting product approvals that span a year, not individual approval for every job and lot.

September 2, 2020 – Circle cuts for partial depth spall repairs have been added to the GSP's and have been incorporated into the '21 book. Jeff to follow up on questions regarding speeding up the approval process for Epoxy Concrete. Can it be approved based on MFG Cert noting it meets the ASTM requirement rather than additional testing?

March 25, 2021 – In reviewing the Epoxy Concrete WSDOT is looking into removing Epoxy Concrete as an option for spall repair and moving forward with only Polyester Concrete. Epoxy Concrete is being removed as an option for spall repair.

18-08 – Lowering the required strength of epoxies used for dowel bars and tie bars

October 11, 2018 – Some discussion led by John Salinas. Uhlmeyer and Russel will look into and report back at next meeting.

May 30, 2019 – WSDOT seemed to think that a minimum of 6000 psi would be acceptable. Mark Russel to check with Kurt Williams to see if that value makes sense.

November 14, 2019 – Mark Russell status update. Nothing definitive in this meeting, continued discussion until next meeting. Nothing new at the 9/2/20 meeting.

March 25, 2021 – Mark Russell has put together some information on this issue. Looking at tying down the epoxy specification to require a Type IV Grade 3 Class A, B, or C. See Attach 18-08 While non-shrink grout may

also be used it was noted that epoxy is much more efficient, particularly on large jobs. The issue revolves around the amount of testing and the ability to rely on ordering significant quantities of materials then submitting for testing. Type IV Epoxy requires 10,000 psi after 7 days. Typical failures seem to be falling just short of the 10,000 psi ASTM C881 standard. After some additional review, it appears the bulk products do fail a significant percentage of the time depending on the product. All type IV epoxies are tested similarly regardless of the use, the lab often does not know how the epoxy is to be used. Epoxies strengths are over designed to ensure they are not the failure mechanism, there are issues with "lane drift" where panels pull apart particularly on the outside lanes and on superelevated curves. Kurt Williams is taking a deeper look into this issue and reviewing additional data.

19-01 Changes to Specs for Relief Cuts

May 30, 2019 Jeff Uhlmeyer – (Attach 19-01) Twisted Uhlmeyer and Russell's arms to consider developing a Standard Plan instead of describing it all in text.

November 14, 2019 – Bob Dyer draft drawing Attach 19-01. Discussed possible new standard plan restricting overcutting per attachment 19-01 sketch. In follow up meeting on 1/21/20 it was decided to revise the spec rather than utilize a standard plan.

September 2, 2020 – Kevin Waligorski draft specification Attach 19-01R2.

There was a request to allow the relief cuts to be closer to the joints. Revision 3 changes the relief cut location from 12-18 inches to 6-18 inches from the joint. Also clarifies overcutting is allowed on "perimeter" saw cuts along the joints. Verify attach 19-01R3 is what was agreed to and we can get this incorporated.

March 25, 2021 – Modifications were made to the specifications based on comments from last meeting, Attachment 19-01R3. Agreement reached to proceed with 19-01R3 noting it still allows for contractors to request a modification. May continue to discuss specific situations where overcutting could be allowed.

19-03 MIT thickness testing calibration and challenge procedures

May 30, 2019 Mark Russell – Kurt Williams is working on a calibration procedure – Jim Powell will propose something for Kurt to review. Cores could be used as a challenge to the MIT scan measured depths, but nothing decided – Jim Powell will prepare a draft proposal for WSDOT to consider.

November 14, 2019 – Jim Powell to discuss with Kurt.

Nothing new in 9/2/20 meeting.

March 25, 2021 – This issue was discussed at a sub group meeting on 11/2/20. Seems the equipment doesn't require calibration and the spec's already allow additional cores to determine limits of thickness deficiency, thus this doesn't seem to be an issue and will be removed from the next agenda. This topic will be removed from the next agenda.

19-05 Concrete Friction

November 14, 2019 – Jeff Uhlmeyer – Summary of data regarding PCCP friction (handout). Proposal to make the following changes to improve friction values of new PCCP: Attach 19-05

1. Increase the longitudinal tining depth from 1/16 to 3/16th inch depth to form tines 1/8 to ¼ inch depth.
2. Require the use of an astro turf drag rather than carpet drag prior to the longitudinal tining.
3. Allow diamond grinding as an option for finishing concrete pavements.

Lots of discussion on this item. There are a variety of things that can be the issue depending on the conditions and how the mix is reacting. In general, industry has concerns with increasing the tining depth, concerns with

pulling up aggregate and impacting IRI. May be difficult to achieve. The astro turf drag had some traction as a positive change to improve the micro texture. Jeff and Mark will take another look at the draft modifications in Attachment 19-05 and revise for the next meeting. In follow up meeting on 1/21/20 it was discussed to leave the tining depth and allow the Astro Turf drag, revised spec coming.
September 2, 2020 – Mark Russell review revised draft specification Attach 19-05R1
There were some industry concerns regarding the impact of the increased tine depth and the astro turf affecting IRI. Jim will check on whether or not the astro turf drag has an impact on IRI. Some concern was also expressed regarding the increased tine depth dislodging rocks and affecting IRI. Jim will check on this.
March 25, 2021 – Leave the tine depth as it was but add the Astro Turf Drag. Review Attach 19-05R1 and verify we can include in the '22 book. Decision to move forward with 19-05R1. Topic to be removed from the next agenda.

19-06 – Maturity Meters and Strength at Depth

November 14, 2019 –Jeff Uhlmeyer – Should we place maturity sensors at both the top of the concrete surface and mid panel depth to determine if surface strength is lower than the mid panel at the time of opening the pavement to traffic? This will need to be coordinated on a future PCCP project. Need more research on types of sensors and depths of placement.

September 2, 2020 A question was raised if this could be a research opportunity?
March 25, 2021 – Looking into research opportunities. Item will be removed from next agenda.

NEW BUSINESS

20-01 – Repair of Defective Pavement Slabs (5-05.3(22))

September 2, 2020 – Jim Powell to discuss issue
Discussion surrounds Standard Specification 5-05.3(22) which notes "Spall repairs that encounter dowel bars or are within 6 inches of a dowel bar will not be permitted" thus resulting in a half or full panel replacement. The concern is that removing panels to address minor transverse edge issues, more frequent at construction joints, seems excessive. Jim is suggesting opening up this specification on new paving and allowing some spall repairs. Jim, Jeff, and Mark will discuss this issue, and develop recommendations.
March 25, 2021 – See Draft Rewrite Attach 20-01 After concerns were raised regarding language associated with opening to traffic there was additional discussion on the revised language. We settled on the attached final 20-01.

20-02 – Concrete Pavement Smoothness Limits

September 2, 2020 – Jim Powell to discuss issue
This discussion involves 5-05.3(12) Surface Smoothness. The request is to increase the corrective action requirements as a result of MRI testing to 175 inches per mile instead of the current 125 in/mi. This request would not impact the price adjustment tables in 5-05. The request is based on similar specs in other states. WSDOT localized roughness requirement is based on a fixed 52.8 foot interval but many states use a 25 foot moving average which yields higher MRI values. Jim, Jeff, and Mark will discuss this issue.
March 25, 2021 – Review Mark Russell's analysis of the different specifications. No changes are being made at this time.

21-01 – Concrete Thickness Payment Specification

March 25, 2021: Thickness Payment spec was raised as an issue at the recent AGC/WSDOT team. This spec was just updated in the 2020 book. Contractors concerned it is overly pensive for paving thicker than plan. There

was discussion surrounding modifying the payment spec to add a Finishing item per square yard along with the cubic yard concrete item. See attachment for a comparison of Washington payment specs with Oregon and Idaho. Current Washington spec is significantly more forgiving than neighboring states.

Next Meeting:
Date: TBD
Location: TBD

Recommended Material Requirements for Epoxy used for Grouting Dowel Bars and Tie Bars

February 16, 2021

Purpose

This document evaluates the properties of epoxy used to anchor dowel bars and tie bars to cement concrete pavements to determine the appropriate requirements of ASTM C881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete to specify the epoxy. This document also looks at specifications used by other states to validate the ASTM C881 requirements and makes a recommendation for the specification for epoxy used to anchor dowel bars and tie bars into concrete pavement on WSDOT construction contracts.

Epoxy Classification

The requirements for bonding epoxy to concrete is contained in ASTM C881 and its AASHTO equivalent AASHTO M 235. Within these specifications there is a classification system that allows the selection of an epoxy with the desired properties for the intended use. The system using three classifications: Type I through VII for the intended usage, Grade 1 through 3 for the required viscosity of the resin, and Class A through F for the usage temperature. Tables 1 through 3 show the characteristics for each of the classifications as specified in ASTM C881.

Table 1. ASTM C881 Epoxy Type Classification

Type	Usage
I	Non-load bearing application of hardened concrete to hardened concrete of other materials and as a binder in epoxy mortars.
II	Non-load bearing applications of hardened concrete to fresh concrete.
III	Bonding skid resistant materials to hardened concrete, as a binder in epoxy mortars or epoxy concrete used as traffic bearing surfaces.
IV	Load bearing application of hardened concrete to hardened concrete of other materials and as a binder in epoxy mortars.
V	Load bearing applications of hardened concrete to fresh concrete.
VI	For bonding and sealing segmental precast elements with temporary post tensioning.
VII	As a nonstress carrying sealer for segmental precast elements without temporary post tensioning.

Table 2. ASTM C881 Grade Classification

Grade	Viscosity or Consistency
1	Low Viscosity
2	Medium Viscosity
3	Non-Sagging Consistency

Table 3. ASTM C881 Class Classification	
Class	**Temperature**
A	Below 40°F
B	40 - 60°F
C	Above 60°F
D	40 - 65°F for Type VI and VII
E	60 - 80°F for Type VI and VII
F	Above 75°F for Type VI and VII

WSDOT currently requires Type I or IV epoxy for dowel and tie bars. Type I and IV are the only types applicable to dowel and tie bars. The choice between Type I or Type IV would depend on whether dowel bars and tie bars are considered a structural application. WSDOT does not specify a grade of class.

Epoxy Properties Important to Dowel Bar and Tie Bar Performance

Compressive Strength (Dowel Bars Only)

Epoxy is used to embed dowel bars into adjacent previously placed cement concrete pavement. The dowel bars transfer loads across the transvers joint by imparting compressive loads on the surrounding epoxy which transfers the load into the concrete. The epoxy benefits from being contained within the narrow space between the dowel and the concrete making it able to resist higher stress provided it is contained within the hole and there are no air voids.

Dowel stress for a 1.5-inch diameter steel dowel is calculated using the method in The Guide to Dowel Bar Load Transfer Systems (Snyder 2011) for a 9-inch and 13-inch slab are (Appendix A):

9-inch slab – 2110 psi

13-inch slab – 1764 psi

Compressive strength tests methods for epoxy are different than compressive strength test methods for concrete making compressive strength values not directly comparable between the two. To account for the uncertainty the required strength of epoxy should be increased by a factor two yielding a required epoxy strength of about 4,000 psi. This loading is much lower than the minimum requirement in ASTM C881 for both Type I and Type IV epoxy.

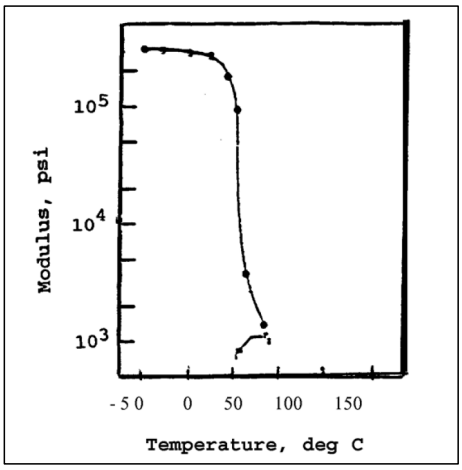
Bond Strength (Tie Bars Only)

The pullout strength of epoxy is mostly due to its bond strength and the cleanliness of the hole (ACI 503.5R). Calculations show that Type I and Type IV epoxy have 14-day bond strength about twice the yield strength of the tie bar (Appendix B).

Heat Deflection Temperature (HDT)

Epoxy properties decline rapidly when the temperature exceeds its HDT. To ensure performance the HDT should be above the pavements service temperature. Figure 1 ACI 503.5R shows the rapid decline in modulus as the temperature of the epoxy rises above its HDT.

Figure 1



Various sources indicate that the typical upper end of temperature for concrete pavement is around 120°F. This temperature is likely exceeded during heat waves especially east of the mountains. For good performance the epoxy should have a HDT of at least 120°F. Type IV epoxy includes a HDT requirement but Type I does not.

Cure Time

Stressing during curing can damage the epoxy and affect the bond between the epoxy and concrete (ACI 503.5R). Epoxy should be left undisturbed until it has reached sufficient strength to prevent damage. The compressive strength requirement in ASTM C881 is measured at 7 days. In situations such as panel replacements and rapid construction 7 days of cure time is not available before the pavement is opened to traffic. Strength of epoxy is a function of cure time, curing temperature and 7-day strength. In situations where a full 7-day cure is not available the 7-day strength and curing temperature should be optimized as much as possible. Using a Type IV epoxy with a higher compressive strength and choosing the Class of epoxy for the expected curing temperature will maximize the epoxy strength at opening to traffic.

Viscosity and Thixotropy

The epoxy needs to be "thick" enough to stay in the hole until it sets. ASTM C881 grade 3 should be used for dowel and tie bar drill holes due to its not sagging consistency.

Summary

Compressive strength of both Type I and IV epoxy is sufficient to anchor dowel bars but Type IV should have a slight advantage in strength gain for early opening. HDT is a critical factor in making sure epoxy performs at higher temperature and Type IV has an HDT requirement but Type I does not.

The bond strength of both Type I and Type IV epoxy is sufficient for tie bars. Loading of tie bars is assumed to occur slowly over time so the potential of rapid strength gain is not as important.

To prevent voids or epoxy running a Grade 3 epoxy would work better in the horizontal drill holes for anchoring dowel and tie bars.

Other States Specifications

Specifications for 15 State Departments of Transportation were investigated to determine how other states specify epoxy for grouting dowel and tie bars (Appendix C). Out of the 15 states, 11 used epoxy to anchor dowel bars, ties bars or both. Of the four that did not specify epoxy, no specification could be found for three and the fourth specified a pullout strength but did not specify a material. Table 4 shows the various specification requirements for the 11 states that indicated epoxy use and the number of states using each. The number using each type and grade is further broken down for the state using ASTM C881 or its equivalent AASHTO M235. Noe of the states that specified ASTM C881 or AASHTO M235 modified any of the requirements of the specification.

Table 4. State Epoxy Specificaitons

Epoxy Requirements	Number of States
None Specified	3
Pre- Approved Material (QPL)	1
Other epoxy or epoxy type not specified	4
ASTM C881 or AASHTO M235	7
ASTM C881 Type	
No Type Specified	1
Type I	2
Type IV	4
AASTM C881 Grade	
No Grade Specified	1

Grade 2 or 3	1
Grade 3	5

Seven of the states that used the ASTM C881 or AASHTO M235 specification also included the Classes of epoxy allowed. Of the seven states, five related the class used to the temperature of the concrete while two specified the allowable classes but did not relate the class to temperature.

Summary

Most states that use epoxy to anchor dowel or tie bars require the epoxy to meet ASTM C881 or its equivalent AASHTO M235. The specifications are used without any modifications.

The higher strength Type IV epoxy is the most common as is Grade 3 with its non-sagging consistency.

States also specify that the class of epoxy match the field conditions.

Proposed Specification Modification

Section 5-01.3(4)C
The third paragraph is revised as follows:

After drilling, secure dowel bars and tie bars into the existing pavement with ~~either an~~ a epoxy bonding agent Type ~~I or~~ IV Grade 3, Class A, B or C as specified in Section 9-26.1, or a grout Type 2 for nonshrink applications as specified in Section 9-20.3. The Class of epoxy used shall be appropriate for the pavement temperature at the time of application.

Commented [WKR1]: Add temperature ranges? Note: Type IV is limited to Class A, B or C, so stating that here clarifies the class to inspectors. Otherwise does the inspector need to look up the ASTM to verify the temporary range?

Commented [WKR2]: Already stated in 9-26.(1), but doesn't hurt to state here. See yellow highlighted sentence in 9-26 below.

9-26.1 Epoxy Bonding Agents

9-26.1(1) General

Epoxy bonding agents shall be two-component epoxy resin-base systems that meet the requirements of ASTM C881, shall be furnished in the type, grade, and class specified, and shall meet the requirements below. For pre-packaged cartridge kits, the epoxy bonding agent shall meet the requirements of ASTM C881 when mixed according to the manufacturer's instructions, utilizing the manufacturer's mixing nozzle. When not specified, an appropriate grade and class shall be selected for the particular application. Epoxy bonding agents for patching external concrete shall be concrete-gray in color.

9-26.1(1)A Type I and Type IV

Epoxy bonding agents used for bonding hardened concrete to hardened concrete and other materials shall be Type I for non-load bearing applications and Type IV for load bearing applications.

9-26.1(1)B Type II and Type V

Epoxy bonding agents used for bonding freshly mixed concrete to hardened concrete shall be Type II for non-load bearing applications and Type V for load bearing applications.

9-26.1(1)C Type III

Epoxy bonding agents used for bonding skid-resistant materials to hardened concrete and as a binder in epoxy mortars and epoxy concretes used on traffic bearing surfaces shall be Type III.

Appendix A

Equations for dowel load:

$$\ell = (E_C h^3/12k(1 - \mu^2))^{0.25}$$

$$\sigma_b = Ky_0 = KP_t(2 + \beta z)/4\beta^3 E_d I_d$$

$$\beta = (Kd/4E_d I_d)^{0.25}$$

Source: Snyder, M. Guide to Dowel Load Transfer Systems for Jointed Concrete Roadway Pavements, National Concrete Pavement Technology Center, Iowa State University Institute for Transportation. Aims Iowa, 2011.

Calculation by spreadsheet. The load used is the maximum allowed overload.

Load	Ec	h	v	k	L	Dowel 1	Dowel 2	Dowel 3	Dowel 4	Effecive Dowels	Load on Critical Dowel (lbs)
11500	4000000	9	0.17	400	28	1	0.573	0.147	-0.280	1.72	2808
11500	4000000	13	0.17	400	37	1	0.676	0.352	0.028	2.06	2348

Load (Pt)	Ed	d	Id	Joint Width (z)	K	β	y_0	σ_b (psi)
2808	29000000	1.5	0.248505	0.25	1500000	0.528564	0.001407	2110
2348	29000000	1.5	0.248505	0.25	1500000	0.528564	0.001176	1764

Appendix B

Evaluation of Epoxy Strength Requirement for Anchoring Tie Bars

According to ACI 503.5R the pullout strength of the bar depends mostly on the bond strength and cleanliness of the hole. Creep resistance should also be considered when the adhesive is under constant stress.

No. 5 grade 60 reinforcing bar yield strength = 60,000 X π X $(5/8)^2/4$ = 18,400 lbs

ASTM C881 Bond Strength for Type I and IV epoxy at 7 days = 1,500 psi[1]

Hole diameter per Std. Plans = 7/8 to 1 inch

Minimum concrete bond area = 7/8 X π X 15 = 41.2 in^2

Pullout Strength = 1,500 X 41.2 = 61,900 lbs[3]

ACI uses a load resistance factor of 0.55 for epoxy anchors[4]

0.55 X 61,900 = 34,000

The results show that the pullout strength of the epoxy bond between the bar and concrete is about twice the yield strength of the bar. Several assumptions were required to arrive at this result. It should not be taken as conclusive without verification.

According to ACI 503.5R, information is not available regarding creep, fatigue and dynamic loading of polymer adhesives. A testing program that simulates loading conditions should be conducted or field experience using similar materials used to determine suitability under these conditions.

Notes

1 – Bond strength is determined using ASTM C882. ASTM C882 tests to concrete surfaces bonded with a thin film 0.5 to 2.0 mm of epoxy. This is assumed to be equivalent to epoxy grouting of tie bars which consists of bonding concrete to epoxy coated steel with a 3.2 to 4.8 mm film of epoxy.

2 - The epoxy to concrete bond is assumed to be critical bond even though the epoxy bond area to the tie bar is about 25% less.

3 - This assumes that epoxy bond strength to the bar is greater than its bond strength to the concrete, the entire void is filled with epoxy, the bar is oriented correctly in the hole and there is no dust or other material in the hole that will affect the bond.

4 – There is no load resistance factor for epoxy grouted rebar. The factor of 0.55 for epoxy anchors is used for lack of a value for this application.

Appendix C

Specifications from Other States

AK Epoxy-resin used to anchor dowels and tie bars in pavements shall conform to the requirements of AASHTO M 235, Type I, Grade 3, Class C. Class A or B shall be used when the surface temperature of the hardened concrete is below 60 ºF.

DE Not in Std. Plan

IA Pullout, QPL

ID AASHTO M 235, or ASTM C 881; Type I or II, Grade 2 or 3, with class selected to match field temperature of epoxy for grouting tie bars and dowels. (2018 SS 420.02)

IN Approved chemical anchor system

MN The ERA will meet AASHTO M 235 Type IV (Load Bearing Applications), Grade 3 (Non-sagging consistency) and of a Class (Temperature Range) to match the pavement temperature at the time of application. (2015 Special, 2302.3)

MO **Epoxy-resin.** All epoxy-resin materials shall be two-component materials conforming to the requirements of ASTM C881, Class as appropriate for each application temperature to be encountered, except that in addition, the materials shall meet the following requirements:

a. Material for use for embedding dowels and anchor bolts shall be Type IV, Grade 3.

NC Not on Std. Plan

ND Install tie bars by drilling and grouting with a high viscosity epoxy, meeting the requirements of AASHTO M 235, Class 3. (2008 SS 570.04)

NJ USE AN APPROVED EPOXY GROUT MATERIAL TO WITHSTAND THE NECESSARY MINIMUM PULL-OUT RESISTANCE.

NM Not on Std. Plan

OH The dowel and tie bars must be anchored with this material, and must set up within 30 minutes. The specification calls out a Type IV, Grade 3, Class A, B, or C material meeting ASTM C 881.

TX See pdf

WI Furnish epoxy consisting of a 2-component epoxy material of contrasting colors and conforming to AASHTO M235, grade 3 - non-sagging consistency, type IV epoxy, except as modified below:

1. Use class B material for mid-depth slab temperatures between 40 and 60 F.
2. Use class C material for mid-depth slab temperatures between 60 F and the highest temperature allowed by the manufacturer of the product.

WY Epoxy resin grout

5-01.3(4)B Sawing and Dimensional Requirements

Concrete slabs to be replaced as shown in the Plans or staked by the Engineer shall be at least 6~~.0~~ feet long and full width of an existing pavement panel. The portion of the panel to remain in place shall have a minimum dimension of 6 feet in length and full panel width; otherwise the entire panel shall be removed and replaced. There shall be no new joints closer than 3~~.0~~ feet to an existing transverse joint or crack.

A vertical full depth saw cut is required along all longitudinal joints and at transverse locations~~, and, unless the Engineer allows otherwise, an~~ An additional vertical full depth relief saw cut located ~~12~~ 6 to 18 inches from and parallel to the initial longitudinal and transverse saw cut locations is also required unless the Engineer approves an alternate relief saw cut location. Removal of existing cement concrete pavement shall not cause damage to adjacent slabs that are to remain in place. Overcutting adjacent concrete pavement that will not be replaced under the Contract is allowed to the extent necessary to make ~~a~~ full depth perimeter saw cuts ~~of the concrete to be removed~~along ~~all existing~~ longitudinal joints and ~~existing~~at transverse ~~joints~~locations. Overcutting is not allowed on relief saw cuts. In areas that will be ground, slab replacements shall be performed prior to pavement grinding.

Side forms shall meet the requirements of Section 5-05.3(7)B whenever a sawed full depth vertical face cannot be maintained.

5-05.3(11) Finishing

The final pavement surface shall be a tined finish or a finish produced by cement concrete pavement grinding.

5-05.3(11)A Tined Finish

After the concrete has been given a preliminary finish by means of finishing devices incorporated in the slip-form paving equipment, the surface of the fresh concrete shall be checked by the Contractor with a straightedge device not less than 10 feet in length. High areas indicated by the straightedge device shall be removed by the hand-float method. Each successive check with the straightedge device shall lap the previous check path by at least ½ of the length of the straightedge. The requirements of this paragraph may be waived if it is successfully demonstrated that other means will consistently produce a surface with a satisfactory ~~profile index~~Mean Roughness Index and meeting the 10-foot straightedge requirement specified in Section 5-05.3(12).

Any edge slump of the pavement, exclusive of specified edging, in excess of ¼ inch shall be corrected before the concrete has hardened. If edge slump on any 1 foot or greater length of hardened concrete exceeds 1 inch, the concrete shall be repaired as provided in Section 5-05.3(22).

~~The standard method of surface finish shall be longitudinal tining.~~ In advance of curing operations, ~~where longitudinal tining is required,~~ the pavement shall be given an initial and a final texturing. Initial texturing shall produce striations parallel with the centerline using an artificial grass type carpeting meeting the following requirements: ~~be performed with a burlap drag or broom device that will produce striations parallel with the centerline.~~

1. Molded polyethylene pile face,
2. Blade length from 5/8 to 1 inch, and
3. Total weight of at least 70 ounces per square yard.

~~–~~Final texturing shall be performed with a wire comb tine device that will produce grooves parallel with the centerline. The wire comb tine device shall be operated within 5 inches, but not closer than 3 inches, of pavement edges.

Artificial grass type carpeting~~Burlap drags, brooms~~, and tine devices shall be installed on self-propelled equipment having external alignment control. The installation shall be such that, when texturing, the area of artificial grass type carpeting~~burlap~~ in contact with the pavement surface shall be maintained constant at all times. Artificial grass type carpeting~~Broom~~ and tine devices shall be provided with positive elevation control. Downward pressure on pavement surface shall be maintained at all times during texturing so as to achieve uniform texturing without measurable variations in pavement profile. Self-propelled texturing machines shall be operated so that travel speed when

texturing is maintained constant. Failure of equipment to conform to all provisions in this paragraph shall constitute cause for stopping placement of concrete until the equipment deficiency or malfunction is corrected. The wire comb of the final texturing device shall be rectangular in cross section, 3/32 to 1/8 inch wide, on ¾-inch centers, ± 1/8-inch, and of sufficient length, thickness, and resilience to form grooves approximately 1/8 inch deep in the fresh concrete surface. Final texture shall be uniform in appearance with substantially all of the grooves having a depth between 1/16 and 3/16 inch.

On projects requiring less than 1,000 square yards of cement concrete pavement, for irregular areas or areas not accessible to slip-form pavers, the surface finish may be either longitudinal tined or transverse tined.

Transverse tining shall be done by texturing with a wire comb perpendicular to the centerline of the pavement. The wire comb tines shall be rectangular in cross section, 3/32 to 1/8 inch wide, on ½-inch centers ± 1/8 inch, and of sufficient length, thickness, and resilience to form grooves approximately 1/8 inch deep in the fresh concrete surface. Final texture shall be uniform in appearance with substantially all of the grooves having a depth between 1/16 to 3/16 inch. Finishing shall take place with the elements of the wire comb as nearly perpendicular to the concrete surface as is practical, to eliminate dragging the mortar.

If the tining equipment has not been previously approved, a test section shall be constructed prior to approval of the equipment.

Regardless of the surface finish, if the pavement has a raised curb without a formed concrete gutter, the texturing shall end 2 feet from the curb line.

~~At the beginning and end of paving each day, the Contractor shall, with an approved stamp, indent the concrete surface near the right hand edge of the panel to indicate the date, month, and year of placement.~~

~~At approximate 500-foot intervals where designated by the Engineer the Contractor shall, with an approved stamp, indent the concrete surface near the right hand edge of the pavement with the stationing of the Roadway.~~

5-05.3(11)B Cement Concrete Pavement Grinding Finish

The entire pavement surface shall be ground to produce a uniform corduroy like texture. The final surface shall comply with Section 5-01.3(9)A.

Cement Concrete Pavement receiving a ground surface finish shall not be open to traffic until grinding is complete.

5-05.5(1) Pavement Thickness

Cement concrete pavement shall be constructed in accordance with the thickness

requirements in the Plans and Specifications. Tolerances allowed for Subgrade construction and other provisions, which may affect thickness, shall not be construed to modify such thickness requirements. The thickness measurement for pavement receiving a ground surface shall be the measurement after grinding.

Thickness measurements in each lane shall comply with the following:

Thickness Testing of Cement Concrete Pavement	
Thickness Lot Size	15 panels maximum
Thickness test location determined by	Engineer will select testing locations in accordance with WSDOT TM 716 method B.
Sample method	AASHTO T 359
Sample preparation performed by	Contractor provides, places, and secures disks in the presence of the Engineer[1]
Measurement method	AASHTO T 359
Thickness measurement performed by	Contractor, in the presence of the Engineer[2]
[1]Reflectors shall be located at within 0.5 feet of the center of the panel. The Contractor shall supply a sufficient number of 300 mm-diameter round reflectors meeting the requirements of AASHTO T 359 to accomplish the required testing. [2]The Contractor shall provide all equipment and materials needed to perform the testing.	

Thickness measurements shall be rounded to the nearest 0.01 foot.

Each thickness test location where the pavement thickness is deficient by more than 0.04 foot, shall be subject to price reduction or corrective action as shown in Table 2.

Table 2 Thickness Deficiency

0.04′ < Thickness Deficiency ≤ 0.06′	10
0.06′ < Thickness deficiency ≤ 0.08′	25
Thickness deficiency > 0.08′	Remove and replace the panels or the panels may be accepted with no payment at the discretion of the Engineer.

The price reduction shall be computed by multiplying the percent price reduction in

Table 2 by the unit Contract price by the volume of pavement represented by the thickness test lot.

Additional cores may be taken by the Contractor to determine the limits of an area that has a thickness deficiency greater than 0.04 feet. Cores shall be taken at the approximate center of the panel. Only the panels within the limits of the deficiency area as determined by the cores will be subject to a price reduction or corrective action. The cores shall be taken in the presence of the Engineer and delivered to the Engineer for measurement. All costs for the additional cores including filling the core holes with patching material meeting the requirements of Section 9-20 will be the responsibility of the Contractor.

5-05.3(22) Repair of Defective Pavement ~~Slabs~~

~~Broken slabs, slabs with random cracks, nonworking contraction joints near cracks, edge slumping and spalls along joints and cracks~~Cracked panels, spalled panels or panels that otherwise do not meet contract requirements shall be replaced or repaired as specified at no expense to the Contracting Agency~~, and~~. ~~Repair shall be accomplished prior to completion of joint sealing.~~

~~Pavement slabs containing more than one crack shall be entirely removed and replaced. Pavement slabs containing a single crack shall be removed and replaced such that the minimum dimension of the removed slab is 6 feet long and full panel width. The portion of the panel to remain in place shall have a minimum dimension of 6 feet in length and full panel width, otherwise entire removal and replacement of the slab is required. There shall be no new joints closer than 3 feet to an existing transverse joints. Saw cutting full pavement depth is required along all longitudinal joints and at transverse locations. Tie bars and dowel bars shall be used in accordance Section 5-05.3(10).~~

~~Opening the pavement to traffic shall not relieve the Contractor of responsibility for repairing cracked panels.~~

Defective panels shall be repaired in accordance with Section 5-01.3(4) and the following.

Partial panel replacement meeting the requirements of Section 5-01.3(4)B will be allowed if approved by the Engineer.

Materials for replacement panels shall be in accordance with 5-05.2. Concrete mix design used for replacement panels shall be in accordance with 5-05.3(1) and 5-05.3(2).

Damaged base or subbase shall be replaced using the same material and thickness as required by the contract for the cement concrete pavement replaced. There shall be no additional compensation for replacing the base or subbase.

~~Spalls and edge slumping shall be repaired by making vertical saw cuts at least 3 inches outside the affected area and to a minimum depth of 2 inches. Spall repairs that encounter dowel bars or are within 6 inches of a dowel bar will not be permitted. These spall areas shall be repaired by replacing a half or full panel as permitted by the Engineer. Removal of the existing pavement shall not damage any pavement to be left in place. If jackhammers are used for removing pavement, they shall not weigh more than 30 pounds, and chipping hammers shall not weigh more than 15 pounds. All power-driven hand tools used for the removal of pavement shall be operated at angles less than 45 degrees as~~

Commented [WK1]: This sentence deleted per discussion with ACPA

Commented [WK2]: This section deleted as agreed with ACPA

Commented [RMA3]: Revised.

~~measured from the surface of the pavement to the tool. The patch limits shall extend beyond the spalled area a minimum of 3 inches. Repair areas shall be kept square or rectangular. Repair areas that are within 12 inches of another repair area shall be combined.~~

~~The Contractor shall remove material within the perimeter of the saw cut to a depth of 2 inches, or to sound concrete as determined by the Engineer. The surface patch area shall be sandblasted and all loose material removed. All sandblasting residue shall be removed.~~

~~When a partial depth repair is placed directly against an adjacent longitudinal joint, a bond-breaking material such as polyethylene film, roofing paper, or other material as approved by the Engineer shall be placed between the existing concrete and the area to be patched.~~

~~Patches that abut working transverse joints or cracks require placement of a compressible insert. The new joint or crack shall be formed to the same width as the existing joint or crack. The compressible joint material shall be placed into the existing joint 1 inch below the depth of repair. The compressible insert shall extend at least 3 inches beyond each end of the patch boundaries.~~

~~Patches that abut the lane/shoulder joint require placement of a formed edge, along the slab edge, even with the surface.~~

~~The patching material shall be mixed, placed, consolidated, finished, and cured according to manufacturer's recommendations. Slab/patch interfaces that will not receive pavement grinding shall be sealed (painted) with a 1:1 cement-water grout along the patch perimeter.~~

Spalls and unsound concrete shall be repaired in accordance with Section 5-01.3(5) and the following.

Commented [RMA4]: Added unsound concrete.

Spalls or unsound concrete that intersect transverse joints in the wheel path greater than 1 inch in length as measured parallel to centerline, greater than 3 inches in width measured along the transverse joint and greater than 1 inch in depth at the deepest point require panel replacement. The wheel path is defined as the portion of the panel between 1.5 feet and 4.5 feet from the nearest edge stripe or lane stripe of a 12-foot travel lane. The Engineer will determine the location of the wheel path in other configurations.

Commented [RMA5]: Revised.

Spalls or unsound concrete within 1 foot of a doweled transvers joint where the bottom of the repair is less than 3 inches from the top of dowel bar require panel replacement.

Commented [RMA6]: Added.

Spalls or unsound concrete in other locations less than 6 inches in both width and length and having a depth of no more than 1 inch at the deepest

location may be filled with Polymer Modified Asphalt Mastic in accordance with Section 9-06.2(1)C with the approval of the Engineer. Spalls filled with Polymer Modified Asphalt Mastic do not require perimeter saw cuts and 2 inch removal of additional sound material.

Commented [RMA7]: Revised.

Commented [RMA8]: Revised.

~~The Contractor shall reseal all joints in accordance with Section 5-03.3(3)C.~~

Surface smoothness of repairs shall meet the straightedge requirements for travel lanes not subject to MRI testing in Section 5-05.3(12).

Opening to traffic shall meet the requirements of Section 5-05.3(17).

~~Low areas which grinding cannot feasibly remedy, shall be sandblasted, filled with epoxy bonded mortar, and textured by grinding. The epoxy bonding agent shall meet the requirements of Section 9-26.1(1)B for Type II epoxy.~~

Measurement Comparison

Washington Cubic Yard	
Thickness	**Price Adjusment**
Over 0.50"	Actual Cubic Yardage up to 0.5" over
0 to +0.50"	Actual Cubic Yardage up to 0.5" over
0 to -0.50"	Actual Cubic Yardage no penalty
-0.50" to -0.74"	90% of Actual Cubic Yardage
-0.75" to -1.00"	75% of Actual Cubic Yardage

Idaho Square Yard	
Thickness	**Price Adjusment**
Over 0.50"	100% of Measured Area
+0.35" to +0.50"	102% of Measured Area
+0.25" to +0.34"	103% of Measured Area
+0.11" to +0.24"	105% of Measured Area
+0.10" to -0.10"	100% of Measured Area
-0.11" to -0.24"	85% of Measured Area
-0.24" to -0.34"	70% of Measured Area
-0.35" to -0.50"	50% of Measured Area
Over -0.50"	0%

Oregon Square Yard	
Thickness	**Price Adjusment**
0 to Over +0.50"	100% of Measured Area
0 to -0.20"	100% of Measured Area
-0.21" to -0.30"	83% of Measured Area
-0.31" to -0.40"	76% of Measured Area
-0.41" to -0.50"	73% of Measured Area
-0.51" to -0.75"	63% of Measured Area
-0.76" to -1.00"	59% of Measured Area

Notes:

1) Washington uses thickness measured in feet so this was converted to inches. (0.04' = 0.48" or approximately a half inch)
2) Washington pays based on actual CY, Idaho and Oregon pay based on Area SY
3) Washington pays actual CY up to 1/2" over, Oregon pays nothing, Idaho pays a declining bonus based on area ending at 1/2" over
4) Washington pays actual CY with no penalty up to 1/2" short, Idaho takes 50% penalty based on area, Oregon takes 27% penalty based on area.
5) Washington max penalty of 25% at 1" short, Idaho pays 0 for anything more than 1/2" short, Oregon takes 41% penalty at 1" short.