NW-ACPA / WSDOT Meeting Minutes - Revised
Monday, April 6, 2015 10:00 AM – 12:00 Noon
WSDOT Cle Elum Maintenance Conference Room, I-90 Exit 80

Present	Name	Company	Present	Name	Company	Present	Name	Company
X	Dyer, Bob	WSDOT	X	Larson, Larry	WSDOT		Seghetti, Robert	Acme
	Davari, Moe	WSDOT		Pipinich, Bob	GMCC	X	Uhlmeyer, Jeff	WSDOT
	Erickson, Dave	WSDOT	X	Powell, Jim	NW ACPA	X	Williams, Kurt	WSDOT
X	Jones, Dave	WSDOT		Russell, Mark	WSDOT		Zabel, Johnnie	Salinas

Old Business:

11-01 Spall repairs within 6 inches of dowel bars.

10/3/2011- The Department was asked to reconsider the specification that does not allow a patch within six inches of dowel bar.

4/16/2012- The Department express concerns with patches within six inches of the dowel bar. The industry representatives did not see a concern with spall repairs closer to the dowel bars and felt the real issue was in the definition of what a spall repair was. The industry will work with WSDOT to better define spall repair.

10/1/2012 – Nothing to report on this item.

4/15/2013 – The discussion centered on the concrete cover needed to transfer loads across the dowel bar joints. It was mentioned that there is research available that suggest that you need at least 3 inches of concrete cover to transfer the loads. Jim Powell agreed to pass that information along for consideration.

10/7/2013 – Jim Powell said that since bars are ok anywhere in the middle third and we need three inches of cover above the bar, based on research. On a 12 inch slab the bars could be within four inches of the surface and with a three inch cover requirement you could allow a one inch spall repair over the bars.

10/20/2014 - It was agreed that the issue is not with retrofit jobs, but rather with spalls near dowel bars on new construction. It was also agreed that Jim Powell should report back at the next meeting on national best practices for patching new PCCP in the proximity of dowel bars.

4/6/2015 –Discussed sticking with 6 inches. Jim Powell suggested 3 inches, and noted that, of the six states he works with, Washington is the only one to have a different spec for fixing spalls in new versus old PCCP . Decided not to change the spec. Item Closed.

13-01 Time of placement for end dump trucks needs to be extended to match 6-02.3(4)D.

4/15/2013 – The time constraint is in Section 5-05.3(3)B. This specification allows the concrete to be delivered to the job site in nonagitator trucks provided it is fully discharged no later than 45 minutes after the introduction of mixing water to the cement and aggregates. Section 5-05.3(8)C, states that when a pour is discontinued for more than 45 minutes a transverse construction joint shall be installed. The goal is to insure the concrete is plastic enough when placed to prevent a cold joint from forming. The real issue is not the time in the nonagitator truck but the travel distance. The longer you travel the more likely you are going to have segregation, caused by vibration of the concrete. It was asked if a conveyor system between the truck and the paving machine would remix the concrete. There are some screws in the hopper to move the material, but they were not meant to remix the concrete. It was decided that the Industry would come back with a proposal for change to the time limit.

10/7/2013 - Wisconsin has developed a specification that Jim Powell handed out. This specification is based on concrete temperature at the time of placement. It suggests that you could place concrete pavement up to

60 minutes after batching when a retarder is used. ACPA has no guide lines on this issue. It was noted that we would rarely have a problem placing concrete within 60 minutes.

10/20/2014–It was agreed that the next step to move this issue forward is for Industry to propose spec changes. WSDOT was inclined to like the example from Wisconsin provided at the last meeting. It allows added time for placement (1) if the temperature (concrete or air?) is below a specified temperature or (2) if a set retarder is approved in the mix design.

4/6/2015 – Agreed that if the mix stays below certain temperatures we could extend the time. Jim Powell provided a draft of a proposed spec (attached)~~will investigate language that could be used to allow additional time when a retarder is used~~. Dyer agreed to prepare a draft spec to extend time if temperatures are low enough.

13-02 The requirement for that the asphalt surface temperature not exceed 90ºF needs to be examined. It was believed that this relates to placing concrete pavement over the top of recently placed Hot mix Asphalt (HMA) and that the temperature of the HMA should cool down to 90ºF before the concrete is placed.

4/15/2013 – The group wasn't sure there is a problem here, there are options paving at night, or using water to cool down the surface temperature. Pavecool was mentioned as a tool that can be used to predict HMA pavement cooling rates. The concern is with early age cracking. Jim Powell and Jeff Uhlmeyer agreed to use HIPERPAV and determine if we are being too conservative.

10/7/2013 – It was suggested that we use HIPERPAV to analyze and allow increases in temperature. It was noted that the risk of cracking is from the bottom up. It is basically a strength gain vs. shrinkage issue. We rarely see pavement cracking outside the contraction joints. The HMA acts as a heat sink. HIPERPAV would allow for condition specific temperatures to be utilized. Kurt suggested using the standard specification temperature of 90° F and allow for HIPERPAV to be utilized to demonstrating that a higher temperature could be allowed. Jim and Jeff will demonstrate HIPERPAV at our next meeting. Action Item: Jim Powell and Jeff Uhlmeyer prepare a demonstration of HIPERPAV.

4/21/2014 – We were not able to demonstrate the HIPERPAV program.

10/20/2014 - It was stated that HIPERPAVE is not useful at this time. It was noted that the 2012 Standard Specifications required that asphalt treated base temperature shall not exceed 90°F and the 2014 Standard Specifications no longer has this requirement. Dave Erickson agreed to review WSDOT records to find out why the maximum temperature of the underlying asphalt treated base was deleted in the 2014 spec book. Industry indicated it would prefer to manage the risk for cracking caused by warm underlying asphalt treated base without a contractually mandated maximum temperature of the underlying asphalt base material.

4/6/2015 – Jim Powell will look at what other States do.

13-03 Smoothness requirements for PCCP rehabilitation

10/7/2013 – The bid item under section 5-05.5 "Ride Smoothness Compliance Adjustment" was recently placed in a PCCP grinding project (section 5-01). This created an issue in that the adjustment is calculated by multiplying the unit contract price for cement concrete pavement, times the volume of concrete, times the Ride Smoothness Profile index. The problem is that we pay for grinding by the square yard not cubic yards. Currently we wouldn't pay an incentive for grinding. The question was asked if we should pay an incentive for grinding. It was concluded that the small panel replacements were not a big deal and would not be considered for incentive. Jim Powell pointed out the International Grooving and Grinding Association (IGGA) is working on a smoothness specification. Jim Powell said he will see if he can get a copy and send it out to the group.

4/21/2014 – Jim reported that the IGGA Specifications were not available yet. The Departments van is being equipped with a line laser that should take out any variability due to tinning. There are two ways to go about smoothness specifications absolute or percent improvement. The Department uses three different schedules of pay factors for the smoothness of HMA. IRI can vary depending on the time of the day. You can use a lightweight vehicle or a Ride Van. Contractors prefer to have the information collected by the Ride Van when bidding. The walk through worked well on a recent project. Having the ability to get out and look at the road with traffic control in place is great. Action Item: Jim Powell to get a copy of the IGGA smoothness Specifications.

10/20/2014 – The IGGA smoothness spec is still not published. Contractors did not support using IRI for smoothness. They prefer the California Profilograph (CP) for measurements. Dave Erickson said he is drafting a new smoothness specification using IRI and that it will likely be sent to industry committee members for comment before our next meeting.

4/6/2015 – Jim Powell provided the IGGA Guide Specification: Conventional Diamond Grinding for Pavement Preservation (Attached). WSDOT indicated it is waiting for a new PCCP contract to obtain data. WSDOT has a line laser for PCCP. WSDOT has a draft of a draft spec that is waiting on data from the Snoqualmie Pass contract before sharing the draft outside the department.

14-01 Air in rapid setting concrete used for fast track Panel Replacements

April 21, 2014 - Per 5-01.3(1)A2 Portland Cement Concrete says '…air entrained with a design air content of 5.5 percent'. 5-01.3(1)A Concrete Mix Designs allows the use of patching materials. Patching materials generally are either mixed in a small mixer or a volumetric truck style mixer. In small mixers you do not add air to the mix. These styles of mix design are very "high slump", they still meet the water cement ratio but are what most would call wet. There is not WSDOT guidelines to test this style of mix designs for air. In a few project we performed this last year there was controversy between contractor/Redi-Mix supplier/WSDOT on how to perform testing. Generally these mixes are low air, they are so high slump that they are unable to hold air. These mix design also are very high strength generally 10,000 - 14,000 psi. I would like to discuss eliminating the use of air in this style of mix designs. The discussion centered on the need for air in these higher preforming mixes. These mixes come to the job site or are mixed with mobile mixers with high slump, but set rapidly. It is difficult to get air into these mixes. The currently don't fit under the 9-20 standard specification and are there for treated as a concrete mix. It was suggested that they behave more like a SCC mix than a conventional concrete mix. It was suggested that the WSDOT should consider not having air requirement if the Mix design indicates good freeze/thaw resistance per ASTM C 666. It was also suggested that we look at using WSDOT Test Method T 818 Air Content of Freshly Mixed Self-compacting Concrete by pressure method. Action Item: Jim Powel agreed to look into this and come back with a proposal.

10/20/2014 - A consistent approach to testing or accepting air content is needed. Johnnie Zabel stated that PE offices are not consistent in whether to test, and in the method of the testing of the rapid setting concrete used in panel replacements. Dave Jones stated that with the high strength of the concrete that the air content may not be important. We may want to accept by a certification and not require air content testing. Dave Jones will look in to.

4/6/2015 –It was agreed that we still need to test for air. Item closed.

14-02 Stringless/laser control for slip-forming

April 21, 2014 Section 5-05.3(7)A Slip-Form Construction is kind of bland on this issue. As of now it says "The alignment and elevation of the paver shall be regulated form outside reference lines establish for this purpose". With todays advancement in slip-form paving the move to laser/stringless controls need to be addressed. I would propose something like this. "If the Contractor proposes to use any type of automatic

laser controls, submit a detailed description of the system and perform a trial field demonstration in the presence of the Engineer at least one week prior to start of paving. Approval of the control system will be based on the results of the demonstration and on continuing satisfactory operation during paving." Johnnie Zabel of Salinas Construction reported that they completed a one hundred percent string less job by change order. They used a Leica product. They basically generated a 3 D model of the job, set up two total stations that sent information to the paver, and used GPS rovers behind the paver as a check. The project was 500 foot section of flat ground. Jim Powell noted that the industries uses laser screeds to produce super flat floors fast.

10/20/2014 – It was suggested that stringless technology be allowed by the specifications. WSDOT seemed to have no objection. Bob Dyer will provide a draft of the change before the next meeting.

4/6/2015 – Bob Dyer – Nothing to report.

14-03 Alternate material for the installation of dowel bars and tiebars in existing PCCP

4/21/2014 – Jim Allen of ACME Paving brought samples of and discussed using AMBEX Cementitious Anchoring Capsule for tie bars and dowels. This is a dry pre-mixed cement grout that is contained in a water permeable wrapping. Once the grout capsule is saturated in water it becomes a fast setting grout. The system was reported as being used in Minnesota, New York and Idaho. It was suggested that we contact Mark Gaines, The Bridge Construction Engineer to see if the structural side of the house had any experience with the system. Mark's comments were " I am not familiar with Ambex AAC and don't believe we have ever used a product like this for bridge or structure applications. Based on the data sheet, it seems like a good product with documented pull-out capacities. While you aren't looking for pull-out capacity, a high pull-out capacity provides some indication that the hole has been completely filled with a high-quality material. A couple things that could be concerns. I would imagine that dowel bars see considerable cyclic loading as heavy vehicles pass over the joints. I'd have some concern that this product would not hold up as well as an epoxy to repeated cyclic loading over a number of years. Cementitious products are likely more brittle and less pliable than epoxy-based product. The other thing you may want to look at is whether this product is suitable for horizontal anchoring like you would have with dowel bars. The data sheet doesn't identify if this is appropriate for only downward vertical anchors or if it works for horizontal anchors. Epoxy product data sheets are usually very specific with respect to what applications that are suitable for. I have not heard anything about 9-20 products bonding better to dry surfaces. However, I very quickly took a look at three of the products covered by QPL 9-20.2 (SikaQuick 2500, Tamms Express Repair and Quikrete FastSet DOT Mix). All three of these products require saturated surface dry conditions before placement. I assume the other products do as well, but I didn't check. From my experience, we would always rely on following the manufacturer's recommendations for proprietary products like these. Deviating from these recommendations could product a product that doesn't achieve the properties identified in the data sheets. If there is research on this, could you have NW-ACPA forward it on to us/me?" Action Item: Jeff Uhlmeyer to check with other states and then possibly look for a job to try them on.

10/20/2014 – No discussion at today's meeting. Robert Seghetti agreed to follow up at next meeting.

4/6/2015 – No discussion.

14-09 New detail for drilling dowel bars for dowel bar retrofit replacement

10/20/2014 - Bob shared the detail (attached) which is intended to add drilling as an acceptable alternative to sawing of the slots for dowel bar retrofits, and said that if anyone else has any changes we are willing to review. WSDOT also discussed our intent to clean up the Standard Plan for tie bars. The main change will be to slightly reduce the need for installing tie bars. This will be done by changing the current requirement for tie bars - whenever there are 3 or more contiguous panels in a given lane - to requiring tie bars when

there are four or more continuous panels in a given lane. It was discovered during the meeting that the handout (attached) does not yet reflect this particular change.

4/6/2015 - No discussion

14-11 Spec Change – increase slag in PCCP mix design from 25% to 30%

10/20/2014 - Dave Jones recommended increasing the allowable slag percentage in Section 5-05.2, to 30%.

4/6/2015 –Dave reported that it has been changed from 25% max to 30% max. Item closed.

New Business

15-01 Resurrecting the NW-ACPA/WSDOT Joint Training/conference -for PCCP

4/6/2015 Jim Powell introduced this topic. Jim Powell and Jeff Uhlmeyer will discuss the potential for setting up joint training. Jim will assemble a committee to do the planning.

15-02 Recycled Concrete Aggregate

4/6/2015 – Dave Jones reported that WSDOT is looking at using recycled concrete aggregate in Commercial Concrete, and looking into using recycled concrete aggregate in concrete pavement. Jim agreed to send Dave an example spec.

15-03 – Specs written in "active voice, imperative mood"

4/6/2015 – Bob Dyer indicated that WSDOT is considering trying a more "directive" way of writing specs in the HMA chapter (5-04), and expand its use further throughout the specs if it is well enough received. Jim Powell indicated the PCCP industry would support such a change.

ACTION ITEMS

ITEM #	WHAT	WHO	STATUS
11-01	Report back on national best practices for patching PCCP in the proximity of dowel bars	Jim Powell	closed
13-01	Propose spec change for time of placement of end dumps	Jim Powell	
13-02	Find out why 2014 spec book eliminated max temp to pave on asphalt treated base.	Dave Erickson	
13-03	Distribute draft PCCP smoothness spec based on IRI to industry for review.	Dave Erickson	
14-01	Research if there is a rational basis for lowering minimum air content of rapid-set mixes, given the strengths being so much higher than required.	Dave Jones	closed
14-02	Draft spec to allow stringless grade control	Bob Dyer	
14-03	Follow-up on alternate to epoxy for anchoring horizontally drilled-in dowel bars.	Robert Seghetti	
14-09	Issue revised dowel bar retrofit Standard Plan A-60.10 and A-60.20.	Dave Erickson	Done

14-11	Issue spec to increase allowable slag percentage to 30%	Dave Jones	done
15-02	Get draft recycled concrete in PCCP spec to Dave Jones	Jim Powell	

Meeting Minutes by Bob Dyer

4. **Non-agitator Trucks** – Bodies of non-agitating hauling equipment for concrete shall be smooth, mortar-tight, metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. Covers shall be provided when needed for protection. Plant-mixed concrete may be transported in non-agitated vehicles provided that the concrete is delivered to the site of the Work and discharge is completed within 45 minutes after the introduction of mixing water to the cement and aggregates, and provided the concrete is in a workable condition when placed. The discharge time may be extended to 60 minutes after introduction of the mixing water to the cement if the mix temperature is 60° F or below at the time of placement, or if the mix contains an approved set retarder providing at least a 1 hour delay in the initial set as ~~determined by AASHTO T197~~ recommended by mfg.

NW-ACPA / WSDOT Meeting Minutes
Wednesday, October 21, 2015 10:00 AM – 12:00 Noon
WSDOT Cle Elum Maintenance Conference Room, I-90 Exit 80

Present	Name	Company	Present	Name	Company	Present	Name	Company
X	Clark, Steve	Acme	X	Larson, Larry	WSDOT		Seghetti, Robert	Acme
X	Dyer, Bob	WSDOT	X	Pipinich, Bob	GMCC		Uhlmeyer, Jeff	WSDOT
X	Davari, Moe	WSDOT	X	Powell, Jim	NW ACPA		Williams, Kurt	WSDOT
X	Erickson, D	WSDOT		Russell, Mark	WSDOT		Sullivan, Joey	Salinas
X	Jones, Dave	WSDOT						

Old Business:

13-01 Time of placement for end dump trucks needs to be extended to match 6-02.3(4)D.

4/15/2013 – The time constraint is in Section 5-05.3(3)B. This specification allows the concrete to be delivered to the job site in nonagitator trucks provided it is fully discharged no later than 45 minutes after the introduction of mixing water to the cement and aggregates. Section 5-05.3(8)C, states that when a pour is discontinued for more than 45 minutes a transverse construction joint shall be installed. The goal is to insure the concrete is plastic enough when placed to prevent a cold joint from forming. The real issue is not the time in the nonagitator truck but the travel distance. The longer you travel the more likely you are going to have segregation, caused by vibration of the concrete. It was asked if a conveyor system between the truck and the paving machine would remix the concrete. There are some screws in the hopper to move the material, but they were not meant to remix the concrete. It was decided that the Industry would come back with a proposal for change to the time limit.

10/7/2013 - Wisconsin has developed a specification that Jim Powell handed out. This specification is based on concrete temperature at the time of placement. It suggests that you could place concrete pavement up to 60 minutes after batching when a retarder is used. ACPA has no guide lines on this issue. It was noted that we would rarely have a problem placing concrete within 60 minutes.

10/20/2014–It was agreed that the next step to move this issue forward is for Industry to propose spec changes. WSDOT was inclined to like the example from Wisconsin provided at the last meeting. It allows added time for placement (1) if the temperature (concrete or air?) is below a specified temperature or (2) if a set retarder is approved in the mix design.

4/6/2015 – Agreed that if the mix stays below certain temperatures we could extend the time. Jim Powell provided a draft of a proposed spec (attached). Dyer agreed to prepare a draft spec to extend time if temperatures are low enough.

10/21/2015 – WSDOT is OK with extending the time to 60 minutes provided the mix is 60° F or lower. Attachment #1 is the handout from our previous meeting. Bob Dyer provided another draft spec for discussion, allowing up to 75 minutes conditioned on the concrete being less than 75 degrees F at the time of placement, a set retarder is used, and the contractor accepts the risk. (attach #2) It seemed that there was agreement that 60 minutes, rather than 75 minutes, is where we want the revised spec to be. Jim Powell will review the drafts and provide a revised version at the next meeting.

13-02 The requirement for ~~that~~ the ~~asphalt~~ base surface temperature not exceed 90ºF needs to be examined. It was believed that this relates to placing concrete pavement over the top of recently placed Hot mix Asphalt (HMA) and that the temperature of the HMA should cool down to 90ºF before the concrete is placed.

4/15/2013 – The group wasn't sure there is a problem here, there are options paving at night, or using water to cool down the surface temperature. Pavecool was mentioned as a tool that can be used to predict HMA pavement cooling rates. The concern is with early age cracking. Jim Powell and Jeff Uhlmeyer agreed to use HIPERPAV and determine if we are being too conservative.

10/7/2013 – It was suggested that we use HIPERPAV to analyze and allow increases in temperature. It was noted that the risk of cracking is from the bottom up. It is basically a strength gain vs. shrinkage issue. We rarely see pavement cracking outside the contraction joints. The HMA acts as a heat sink. HIPERPAV would allow for condition specific temperatures to be utilized. Kurt suggested using the standard specification temperature of 90° F and allow for HIPERPAV to be utilized to demonstrating that a higher temperature could be allowed. Jim and Jeff will demonstrate HIPERPAV at our next meeting. Action Item: Jim Powell and Jeff Uhlmeyer prepare a demonstration of HIPERPAV.

4/21/2014 – We were not able to demonstrate the HIPERPAV program.

10/20/2014 - It was stated that HIPERPAVE is not useful at this time. It was noted that the 2012 Standard Specifications required that asphalt treated base temperature shall not exceed 90°F and the 2014 Standard Specifications no longer has this requirement. Dave Erickson agreed to review WSDOT records to find out why the maximum temperature of the underlying asphalt treated base was deleted in the 2014 spec book. Industry indicated it would prefer to manage the risk for cracking caused by warm underlying asphalt treated base without a contractually mandated maximum temperature of the underlying asphalt base material.

4/6/2015 – Jim Powell will look at what other States do.

10/21/2015 –Jim Powell update: This issue is about the base material on which the PCCP is placed, and is not limited to only asphalt base maaterial. WSDOT inadvertently removed from the 2014 [and 2016] spec book a spec stating that the max temp of asphalt treated base, when paving on asphalt treated base, is 90°F. Jim reported that Iowa, Pennsylvania, and Minnesota say no paving on any base that has a temp greater than 120°F. Dave Erickson agreed that 120 degrees F is OK based on what other states do and recommended by national research. Jim Powell agreed to provide a draft spec by the next meeting. Attachment #3 shows the spec under consideration.

13-03 Smoothness requirements for PCCP rehabilitation

10/7/2013 – The bid item under section 5-05.5 "Ride Smoothness Compliance Adjustment" was recently placed in a PCCP grinding project (section 5-01). This created an issue in that the adjustment is calculated by multiplying the unit contract price for cement concrete pavement, times the volume of concrete, times the Ride Smoothness Profile index. The problem is that we pay for grinding by the square yard not cubic yards. Currently we wouldn't pay an incentive for grinding. The question was asked if we should pay an incentive for grinding. It was concluded that the small panel replacements were not a big deal and would not be considered for incentive. Jim Powell pointed out the International Grooving and Grinding Association (IGGA) is working on a smoothness specification. Jim Powell said he will see if he can get a copy and send it out to the group.

4/21/2014 – Jim reported that the IGGA Specifications were not available yet. The Departments van is being equipped with a line laser that should take out any variability due to tinning. There are two ways to go about smoothness specifications absolute or percent improvement. The Department uses three different schedules of pay factors for the smoothness of HMA. IRI can vary depending on the time of the day. You can use a lightweight vehicle or a Ride Van. Contractors prefer to have the information collected by the Ride Van when bidding. The walk through worked well on a recent project. Having the ability to get out and look at the road with traffic control in place is great. Action Item: Jim Powell to get a copy of the IGGA smoothness Specifications.

10/20/2014 – The IGGA smoothness spec is still not published. Contractors did not support using IRI for smoothness. They prefer the California Profilograph (CP) for measurements. Dave Erickson said he is drafting a new smoothness specification using IRI and that it will likely be sent to industry committee members for comment before our next meeting.

4/6/2015 – Jim Powell provided the IGGA Guide Specification: Conventional Diamond Grinding for Pavement Preservation (Attached). WSDOT indicated it is waiting for a new PCCP contract to obtain data. WSDOT has a line laser for PCCP. WSDOT has a draft of a draft spec that is waiting on data from the Snoqualmie Pass contract before sharing the draft outside the department.

10/21/2015 – Discussion – Jim Powell focused the discussion by reminding the group that his concern is in regard to an incentive/disincentive for smoothness on grinding projects. There is currently no bid item for a smoothness penalty for pavement placed under the Section 5-01 specs. Jeff Uhlmeyer is working on a spec similar to the HMA smoothness spec – this will eliminate the issue of Section 5-01 not having a unit price for concrete. Further discussion at next meeting.

14-02 Stringless/laser control for slip-forming

April 21, 2014 Section 5-05.3(7)A Slip-Form Construction is kind of bland on this issue. As of now it says "The alignment and elevation of the paver shall be regulated form outside reference lines establish for this purpose". With todays advancement in slip-form paving the move to laser/stringless controls need to be addressed. I would propose something like this. "If the Contractor proposes to use any type of automatic laser controls, submit a detailed description of the system and perform a trial field demonstration in the presence of the Engineer at least one week prior to start of paving. Approval of the control system will be based on the results of the demonstration and on continuing satisfactory operation during paving." Johnnie Zabel of Salinas Construction reported that they completed a one hundred percent string less job by change order. They used a Leica product. They basically generated a 3 D model of the job, set up two total stations that sent information to the paver, and used GPS rovers behind the paver as a check. The project was 500 foot section of flat ground. Jim Powell noted that the industries uses laser screeds to produce super flat floors fast.

10/20/2014 – It was suggested that stringless technology be allowed by the specifications. WSDOT seemed to have no objection. Bob Dyer will provide a draft of the change before the next meeting.

4/6/2015 – Bob Dyer – Nothing to report.

10/21/2015 – Bob Dyer provided a draft spec (attachment #2). It was suggested that the options in the draft be expanded to include robotic technology, and wireless or stringless technology. Jim Powell will provide a draft at the next meeting consolidating the ideas.

14-03 Alternate material for the installation of dowel bars and tiebars in existing PCCP

4/21/2014 – Jim Allen of ACME Paving brought samples of and discussed using AMBEX Cementitious Anchoring Capsule for tie bars and dowels. This is a dry pre-mixed cement grout that is contained in a water permeable wrapping. Once the grout capsule is saturated in water it becomes a fast setting grout. The system was reported as being used in Minnesota, New York and Idaho. It was suggested that we contact Mark Gaines, The Bridge Construction Engineer to see if the structural side of the house had any experience with the system. Mark's comments were " I am not familiar with Ambex AAC and don't believe we have ever used a product like this for bridge or structure applications. Based on the data sheet, it seems like a good product with documented pull-out capacities. While you aren't looking for pull-out capacity, a high pull-out capacity provides some indication that the hole has been completely filled with a high-quality material. A couple things that could be concerns. I would imagine that dowel bars see considerable cyclic loading as heavy vehicles pass over the joints. I'd have some concern that this product would not hold up as well as an epoxy

to repeated cyclic loading over a number of years. Cementitious products are likely more brittle and less pliable than epoxy-based product. The other thing you may want to look at is whether this product is suitable for horizontal anchoring like you would have with dowel bars. The data sheet doesn't identify if this is appropriate for only downward vertical anchors or if it works for horizontal anchors. Epoxy product data sheets are usually very specific with respect to what applications that are suitable for. I have not heard anything about 9-20 products bonding better to dry surfaces. However, I very quickly took a look at three of the products covered by QPL 9-20.2 (SikaQuick 2500, Tamms Express Repair and Quikrete FastSet DOT Mix). All three of these products require saturated surface dry conditions before placement. I assume the other products do as well, but I didn't check. From my experience, we would always rely on following the manufacturer's recommendations for proprietary products like these. Deviating from these recommendations could product a product that doesn't achieve the properties identified in the data sheets. If there is research on this, could you have NW-ACPA forward it on to us/me?" Action Item: Jeff Uhlmeyer to check with other states and then possibly look for a job to try them on.

10/20/2014 – No discussion at today's meeting. Robert Seghetti agreed to follow up at next meeting.

4/6/2015 – No discussion.

10/21/2015 – Steve Clark will follow up.

15-01 Resurrecting the NW-ACPA/WSDOT Joint Training for PCCP

4/6/2015 Jim Powell introduced this topic. Jim Powell and Jeff Uhlmeyer will discuss the potential for setting up joint training.

10/21/2015 – Jim Powell and Jeff Uhlmeyer reported they are working on it. They hope to propose date at the next meeting. They are currently thinking that one class on each side of the state might be best.

15-02 Recycled Concrete Aggregate

4/6/2015 – Dave Jones reported that WSDOT is looking at using recycled concrete aggregate in Commercial Concrete, and looking into using recycled concrete aggregate in concrete pavement. Jim agreed to send Dave an example spec.

10-21-2015 Jim Powell provided several handouts: "Guidelines for Using RCA in Concrete Paving Mixtures" by ACPA (attache #4); "Aggregate for Use in Portland Cement Concrete Pavement " from South Carolina DOT (attach #5); Powerpoint presentation "PCC Recycling – I-95 Florence, S.C. " from South Carolina DOT (attach #6). Other handouts are: draft of changes to the WSDOT Standard Specs and Construction Manual regarding recycled concrete aggregate that will become effective April 4, 1016 (attach #7).

New Business

15-04 Spec Section 5-05 modifications presented to WACA

10/21/2015 –Jim Powell reports that the WACA/WSDOT committee is proposing changes to the WSDOT Standard Spec on Portland cement concrete mix designs, which affects mix designs for PCCP. The proposed changes are shown in attachment #8.

15-05 Contractor Reporting of use of Recycled Materials

10/21/2016 – Dave Erickson provided a copy of the new WSDOT form that will be required to be filled out by the Contractor for reporting use of recycled aggregate (attach #9), as recently required by the legislature.

ACTION ITEMS

ITEM #	WHAT	WHO	STATUS
13-01	Propose revised draft spec change for time of placement of end dumps.	Jim Powell	
13-02	Provide revised draft spec change for the maximum base temperature upon which to place PCCP.	Jim Powell	
13-03	Provide a draft smoothness spec for grinding contracts	Jeff Uhlmeyer	
14-02	Provide a revised draft spec to allow stringless grade control	Jim Powell	
14-03	Follow-up on alternate to epoxy for anchoring horizontally drilled-in dowel bars.	Steve Clark	
15-01	Propose date and locations for joint WSDOT/NWACPA joint training	Uhlmeyer and Powell	
15-02	Get draft recycled concrete in PCCP spec to Dave Jones	Jim Powell	done

Next meeting: April 20, 2016

Attach #1

4. **Non-agitator Trucks** – Bodies of non-agitating hauling equipment for concrete shall be smooth, mortar-tight, metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. Covers shall be provided when needed for protection. Plant-mixed concrete may be transported in non-agitated vehicles provided that the concrete is delivered to the site of the Work and discharge is completed within 45 minutes after the introduction of mixing water to the cement and aggregates, and provided the concrete is in a workable condition when placed. The discharge time may be extended to 60 minutes after introduction of the mixing water to the cement if the mix temperature is 60° F or below at the time of placement, or if the mix contains an approved set retarder providing at least a 1 hour delay in the initial set as ~~determined by AASHTO T197~~ recommended by mDg. 13-01

Attach # 2

DRAFT SPECS

5-05.3(3)B Mixing Equipment

1. **General** – Concrete may be mixed at a batching plant or wholly or in part in truckmixers. Each mixer shall have attached in a prominent place a manufacturer's plateshowing the capacity of the drum in terms of volume of mixed concrete and the speedof rotation of the mixing drum or blades.

2. **Batching Plant** – Mixing shall be in an approved mixer capable of combining theaggregates, cement, and water into a thoroughly mixed and uniform weight within thespecified mixing period.

   Mixers shall be cleaned at suitable intervals. The pickup and throw-over blades inthe drum shall be repaired or replaced when they are worn down ¾ inch or more.The Contractor shall have available at the jobsite a copy of the manufacturer's design,showing dimensions and arrangements of the blades in reference to original height anddepth, or provide permanent marks on blades to show points of ¾ inch wear from newconditions. Drilled holes ¼ inch in diameter near each end and at midpoint of eachblade are recommended.

3. **Truck Mixers and Truck Agitators** – Truck mixers used for mixing and haulingconcrete, and truck agitators used for hauling plant-mixed concrete, shall conform tothe requirements of Section 6-02.3(4)A.

4. **Nonagitator Trucks** – Bodies of non-agitating hauling equipment for concrete shallbe smooth, mortar-tight, metal containers and shall be capable of discharging theconcrete at a satisfactory controlled rate without segregation. Covers shall be providedwhen needed for protection. Plant-mixed concrete may be transported in non-agitated vehicles provided that the concrete is delivered to the site of the Work and discharge is completed within 45 minutes after the introduction of mixing water to the cement and aggregates, and provided the concrete is in a workable condition when placed. This time may be extended to 75 minutes, at the sole risk of the contractor, provided either a) the temperature of the concrete at the time of placement is less than 75 degrees F, or b) a set retarding admixture is included in the approved mix design at a dosage sufficient to delay initial set a minimum of 1 hour. } Item 13-01

5-05.3(7)A Slip-Form Construction

The concrete shall be distributed uniformly into final position by a self-propelled slip-formpaver without delay. The alignment and elevation of the paver shall be regulated from outsidereference lines established for this purpose. The reference lines may be wire supported on pins, computer-operated GPS technology, or XXX or YYY joint matching.The paver shall vibrate the concrete for the fullwidth and depth of the strip of pavement being placed and the vibration shall be adequateto provide a consistency of concrete that will stand normal to the surface with sharp well-definededges. The sliding forms shall be rigidly held together laterally to prevent spreadingof the forms. } Item 14-02

Attach #3

5-05.3(6) Subgrade

The Subgrade shall be constructed in accordance with Section 2-06.

The Subgrade shall be prepared and compacted a minimum of 3 feet beyond each edge of the area which is to receive concrete pavement in order to accommodate the slip-form equipment. Concrete shall not be placed on a frozen Subgrade nor during heavy rainfall.

The Subgrade shall be moist before the concrete is placed.

~~When the Subgrade is an asphalt treated base the surface shall be clean and free of any deleterious material. When placing concrete on a treated base, the surface temperature shall not exceed 90°F. If water is used for cooling any excess water standing in pools or flowing on the surface shall be removed prior to placing concrete.~~

Item 13-02

5-05.3(7) Placing, Spreading, and Compacting Concrete

The provisions relating to the frequency and amplitude of internal vibration shall be considered the minimum requirements and are intended to ensure adequate density in the hardened concrete. Referee testing of hardened concrete will be performed by cutting cores from the finished pavement after a minimum of 24 hours of curing. Density determination will be made based on the water content of the core as taken. WSDOT Test Method T 810 shall be used for the determination of core density. Reference cores will be taken at the minimum rate of one for each 500 cubic yards of pavement, or fraction thereof. These same cores will be used for thickness measurements as required by Section 5-05.5(1).

The average density of the cores shall be at least 97 percent of the approved mix design density or the actual concrete density when determined by the Contractor using AASHTO T 121 with no cores having a density of less than 96 percent.

Failure to meet the above requirement will be considered as evidence that the minimum requirements for vibration are inadequate for the job conditions, and additional vibrating units or other means of increasing the effect of vibration shall be employed so that the density of the hardened concrete as indicated by further referee testing shall conform to the above listed requirements. Primary units of pavement, as defined in Section 5-05.5(1)), not meeting the prescribed minimum density shall be removed and replaced with satisfactory material. At the option of the Engineer, noncompliant material may be accepted at a reduced price.

5-05.3(7)A Slip-Form Construction

The concrete shall be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well-defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms.

The plastic concrete shall be effectively consolidated by internal vibration with transverse vibrating units for the full width of pavement and/or a series of equally spaced longitudinal vibrating units. The space from the outer edge of the pavement to the outer longitudinal unit shall not exceed 9 inches. The spacing of internal units shall be uniform and not exceed 18 inches.

The term internal vibration means vibration by vibrating units located within the specified thickness of pavement section.

The rate of vibration of each vibrating unit shall be not less than 7,500 cycles per minute, and the amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least 1 foot. The frequency of vibration or amplitude shall be varied proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

Item 15-02
Attach #4

Appendix C.

GUIDELINES FOR USING RCA IN CONCRETE PAVING MIXTURES

(Note: These guidelines were derived mainly from the 1993 version of ACPA's TB014P, "Recycling Concrete Pavements," and from AASHTO MP16, "Reclaimed Concrete Aggregate for Use as Coarse Aggregate in Hydraulic Cement Concrete." Users are referred to these documents, as well as existing State and Local construction specifications, for additional details concerning the production of RCA products.)

SCOPE

These guidelines are intended to provide users with a framework for use in developing a suitable specification for using recycled concrete aggregate (RCA) in typical concrete paving mixtures.

Note 1 – *Concrete pavement structures of acceptable strength and durability can be produced using RCA materials that is properly processed and manufactured to meet the typical aggregate requirements when those materials are incorporated in a concrete mixture that is proportioned and mixed in accordance with appropriate requirements and procedures, and is placed, consolidated and cured properly. However, using RCA in new concrete mixtures requires the use of suitable quality control (QC) and quality assurance (QA) procedures to ensure that deleterious materials that might be present in the RCA will not adversely impact the quality of the concrete pavement structure.*

State and local regulations, laws and specifications may be applicable to specific projects and may supersede this guide specification. Users of this guide specification are cautioned to contact appropriate state and local authorities to identify any additional or superseding requirements/specifications.

ORDERING INFORMATION

The following information typically is included in the purchase order or contract documents:

- grading to be furnished,
- soundness testing requirements,
- designated aggregate class,
- whether any restrictions on reactive materials applies,
- exceptions or additions to this specification, and
- additional testing requirements (if any).

GRADING

RCA or RCA/virgin aggregate blends should conform to the aggregate gradation requirements prescribed for the specific intended concrete application.

Note 2 – *There is usually no reason that the gradation requirements for RCA to differ significantly from those for virgin aggregate materials used for the same application.*

Note 3 – *Depending upon the source of the concrete and the processes used in removing, crushing and processing the material, it may be necessary to produce RCA material of at least two separate sizes that can be blended together (and/or with virgin aggregate) to meet the gradation requirements.*

PHYSICAL PROPERTIES

RCA consists of crushed concrete material and virgin aggregate particles derived from the crushing of concrete pavement fragments.

Typical maximum Los Angeles abrasion loss values for the coarse RCA are 50%, measured in accordance with AASHTO T96 ("Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine").

Note 4 – AASHTO T327 ("Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus") may be required in lieu of AASHTO T96 if the specifying agency has experience with the procedure and has established appropriate testing limits.

RCA used in concrete that will be subject to in-service wetting, extended exposure to humid atmosphere, or contact with moist ground should not contain any materials that are reactive with alkali components in the cement in an amount sufficient to cause excessive expansion of mortar or concrete unless materials that will prevent harmful alkali-aggregate reactions (e.g., Class F fly ash, slag cement, etc.) will be added in appropriate quantities. If necessary, test RCA for Alkali-aggregate reactivity (AAR) in accordance with AASHTO T303 ("Accelerated Detection of Potentially Deleterious Expansion of Mortar Bars due to Alkali-Silica Reaction") and/or ASTM C1567 ("Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)") when alkali-silica reaction (ASR) is suspected, and in accordance with ASTM C586 ("Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks for Concrete Aggregates (Rock Cylinder Method)") when alkali-carbonate reaction (ACR) is suspected.

Note 5 – If the source and history of the RCA are known and no reactive failures were present in the source concrete, testing for reactive expansion may not be necessary. However, unless a precise history is known, the source concrete may have not been exposed to all elements required to cause reactive expansion and the RCA may be unknowingly reactive.

RCA used in concrete that will be subjected to freeze-thaw action should not contain aggregate components that will result in D-cracking of the concrete. When potential D-cracking is suspected, test RCA in accordance with AASHTO T161 ("Resistance of Concrete to Rapid Freezing and Thawing") or equivalent local methods. Acceptance criteria for AASHTO T161 and equivalent methods should be based on local criteria that have been developed to address the issue of D-cracking.

RCA should meet the flat and elongated particle requirements of the specifying agency if the agency has such requirements.

Test RCA intended for use in concrete mixtures should be tested according to AASHTO T85 ("Specific Gravity and Absorption of Coarse Aggregate") to determine the specific gravity and absorption of the material. For specific gravity, the total variability of tests (from minimum value to maximum value) should not exceed 0.100. For absorption, the total variability of tests (from minimum value to maximum value) should not exceed 0.8 percent. Stockpile RCA having specific gravity and absorption variability values that fall outside of these limits separately where they might be used included in a project with less stringent specific gravity and absorption values.

Note 6 – Coarse RCA may contain varying amounts of reclaimed concrete mortar, which generally has a lower specific gravity and is more absorptive than virgin aggregate. Therefore, RCA can be highly absorptive and can exhibit low specific gravity values, and the absorption and specific gravity values can be highly variable, especially between RCA obtained from different sources or produced at different facilities. The use of aggregates with variable specific gravity and absorption characteristics in concrete mixtures can adversely affect the weighing and batching processes in concrete production and can result in concrete workability and finishing problems and variability. Control of stockpile moisture conditions will help alleviate absorption problems.

DELETERIOUS SUBSTANCES

RCA should not contain clay lumps and friable particles, chert, and coal and lignite or other deleterious substances that exceed the maximum allowable amounts listed in Table 12.

Note 7 – *The presence of deleterious materials in aggregates used in the production of concrete mixtures can adversely affect concrete setting time and/or strength, and can also induce expansive reactions that could result in premature deterioration of the concrete structure. As a result, strict quality control (QC) and quality assurance (QA) procedures are required to ensure that RCA material used as coarse aggregate in the production of concrete mixtures will not adversely affect the quality of the concrete product.*

QUALITY CONTROL (QC)

If RCA or combinations of RCA and other approved virgin aggregate materials are to be used in a new concrete mixture, approval from the engineer might be necessary. The proposed percentages of combined materials should be established as part of the request. At the engineer's discretion, revised concrete mixture designs may be required when percentages or sources of materials change.

Note 8 – *A revised concrete mixture design is recommended when percentages or sources of RCA materials change. It is likely that the RCA will have different specific gravity and absorption characteristics than the virgin aggregate.*

Develop and implement a quality control (QC) plan for aggregate production. The QC plan should describe the production procedures, test methods and frequency of testing to ensure consistent production of RCA meeting the requirements of the intended

Table 12. Typical Limits for Deleterious Substances and Physical Property Requirements of RCA for Use in New Concrete Mixtures (after AASHTO MP16)

Class designation[b]	Clay lumps and friable particles	Chert (sp gr SSD < 2.40)[c]	Sum of clay lumps, friable particles and chert (sp gr SSD < 2.40)[c]	Other deleterious substances[d]	Coal and lignite
	Maximum allowable, percent[a]				
A	2.0	3.0	2.3	0.3	0.2
B	3.0	5.0	5.0	0.3	0.2
C	3.0	8.0	8.0	0.3	0.2

[a] The engineer may supplement the requirements of this table by placing limits on the amount of deleterious substances or physical properties in accordance with local experience and practice.

[b] RCA conforming to the requirements for the various classes designated in this table should generally be suitable for the following uses:

Typical suggested uses	Weathering exposure	Class of aggregate
Concrete pavements, cement-treated subbases, sidewalks, median barriers, curbing and other non-structural applications	Severe	A
	Moderate	B
	Negligible	C

[c] These limitations in this table apply only to RCA in which chert appears as an impurity. They are not applicable to gravels that are predominantly chert. Limitations on the soundness of such aggregate should be based on service records in the environment in which the material is used.

[d] Other deleterious substances include adherent fines, vegetable matter, plastics, plaster, paper, gypsum board, metals, fabrics, wood, brick, tile, glass, and asphalt (bituminous) materials. The percentages of these materials should be determined in accordance with ASTM C295 or other equivalent methods approved by the specifying agency.

application. The QC plan also should describe methods to be used to ensure that RCA source materials are not contaminated with unacceptable amounts of deleterious materials. Methods and criteria for examining RCA should be established prior to its use.

Stockpile RCA products to assist in qualitative and quantitative identification of the presence of deleterious materials. (Stockpiling can also be used as a means to qualitatively assess the uniformity of the material.) Stockpiles may represent all or part of the material to be used on a specific project. Thus, construct stockpiles in a manner that will minimize segregation and permit visual examination and representative sampling of the material.

If RCA is blended with other approved aggregates, blending should be accomplished using a method that ensures blending and prevents segregation.

RCA should be brought to and maintained at a moisture condition that approaches a saturated surface-dry (SSD) condition prior to batching. This may be accomplished by using a water sprinkling system or another approved method. Appropriate batch water adjustments should be made if the RCA is not precisely in a SSD condition at the time of batching.

Aggregate for Use in Portland Cement Concrete Pavement

Section 3 of Supplementary Technical Specification SC-M-501 is replaced in its entirety with the following:

Fine Aggregate: Use fine aggregate meeting the requirements as specified in Subsection 701.2.9 except that the use of fine aggregate derived from the recycling of Portland Cement Concrete Pavement removed from the project or other recycled PCC is not acceptable. Aggregate derived from limestone is also not acceptable.

Coarse Aggregate: Use coarse aggregate meeting the requirements as specified in Subsection 701.2.10 with the following exceptions. At the option of the Contractor, coarse aggregate derived from the recycling of Portland Cement Concrete Pavement removed from the project may be used. Ensure that the coarse aggregate produced by the recycling of the existing PCC pavement meets the requirements of Subsection 701.2.10, except that the LA Abrasion Loss and sulfate soundness requirements are waived. Do not use PCC for recycling other than that removed from the roadway within the project. Remove all joint sealant and backer material from the existing pavement prior to removal for recycling and ensure that the resulting recycled aggregate is free from sealant, steel reinforcement, wood, and other contaminants. Do not use aggregate derived from limestone or slag.

Attach #6 15-02

PCC Recycling: I-95 Florence, SC

ndrew Johnson, Ph.D., P.E.
tate Pavement Design Engineer
CDOT Office of Materials and Research

Background

- Why recycle?
  - Dwindling landfill space
  - Increased disposal costs
  - Conservation of materials
  - Scarcity of high-quality, virgin aggregates
  - Overall reduction in project costs

Background

- Early work
  - US-66, Illinois, 1945
  - Europe, post World War II
- Renewed interest in 1970's
  - States performing PCC recycling
    - Connecticut, Iowa, Kansas, Michigan, Minnesota, Oklahoma, North Dakota, Wisconsin, Wyoming

Background

- Not all projects were successful
  - Problems were encountered using recycled fines
  - Can cause complications in reinforced PCC pavement

I-95 Florence County

- From I-20 to SC Route 327
- Approximately 13 miles
- Constructed 1964-1967
  - 10" Plain Jointed PCC
  - 5" Cement Stabilized Sand-Clay Base
  - 25' Joint Spacing
  - No positive load transfer

I-95 Florence County

- 2004 ADT = 48,400 ADT, 20% trucks
- One previous CPR in 1984 with tied PCC shoulders.
- By 2001, was highly distressed with over 50% of slabs in northbound driving lane requiring repair.
- Severe faulting.
- Base erosion issues.

I-95 Florence County

- Originally planned to do widening and unbonded overlay.
- Geometric/ROW/Bridge issues would not allow major change in grade.
- Decision made to widen and reconstruct existing pavement.

I-95 Florence County

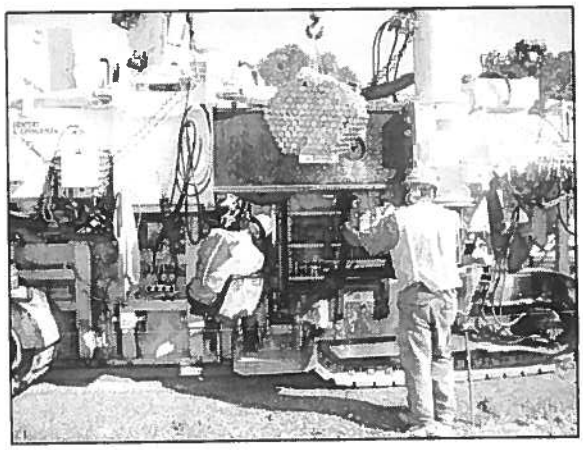
- Removed existing 10" PCC.
- Repaired base with new cement treatment where necessary.
- New pavement over existing base:
  - 11" Plain Jointed PCC (15' joint spacing)
  - 2" Asphalt Surface
  - 8" Graded Aggregate Base (new lanes)
- Traffic control/staging using lane reversals.

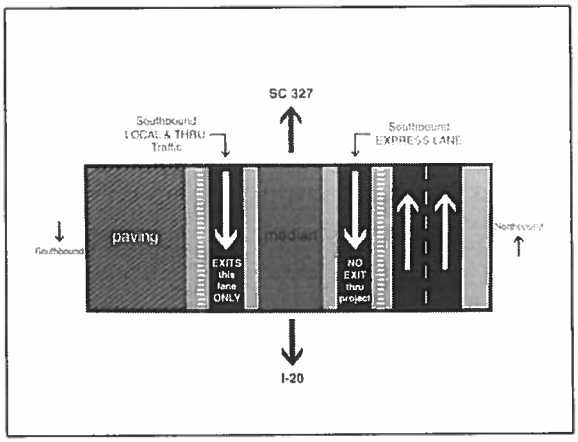
I-95 Florence County

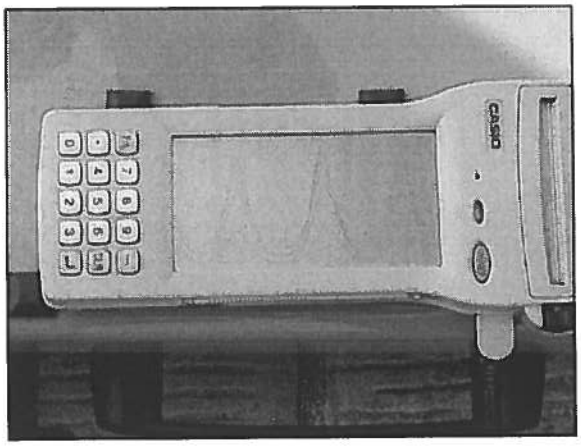
- Project let May 2002
  - Low Bid: $64,169,002.17
  - Awarded to Lane Construction Co.
  - 635,980 sy of PCC Pavement @ $30/sy
  - $3.7 million for barrier wall
  - $2.0 million for traffic control
- Work began July 8, 2002
- Project accepted May 5, 2004

I-95 Florence County

- New features:
  - Allowed the use of old PCC as coarse aggregate for new PCC.
  - PCC flexural strength requirement raised from 550 psi to 650 psi at 14 days to reduce pavement thickness by one inch.
  - Allowed the use of automatic dowel bar inserter in lieu of chairs.
  - Required diamond grinding of new surface for better rideability.







Aggregate Properties

- Gradation
  - Typically similar to virgin aggregate
- Particle Shape and Texture
  - Recycled PCC is highly angular and rough
  - Can lead to mixture harshness
  - (Harshness: Deficient workability and cohesiveness caused by insufficient sand or cement, or by improperly graded aggregate.)
  - Effect much more acute with recycled fines
  - No reported cases of harshness issues when using only coarse aggregate

Aggregate Properties

- Absorption Capacity
  - Recycled aggregate tends to have higher absorption than virgin aggregate
  - Typical range for virgin coarse aggregate in South Carolina: 0.2% to 0.8%
  - Absorption of I-95 recycled material 1.2%
  - Excessive absorption can lead to rapid loss of workability

Aggregate Properties

- Specific Gravity
  - Tends to be lower for recycled PCC
  - For I-95 Recycled Mix
    - Bulk Dry – 2.45
    - Bulk SSD – 2.48
    - Apparent – 2.52
  - For original I-95, Bulk SSD – 2.62
  - Decrease = 5.6%
  - Typical 8% decrease reported in literature

Aggregate Properties

- L. A. Abrasion Mass Loss
  - Tends to be slightly higher, but within specified limits
  - For I-95, loss = 39.7% compared to maximum allowable loss of 60%

Aggregate Properties

- Sodium Sulfate Soundness
  - Does not work on recycled PCC aggregate
  - Believed to be a reaction between the sodium sulfate and mortar
  - Typically has better magnesium sulfate results than original virgin aggregate
  - More research needed

Aggregate Properties

- Chloride content
  - Typically a concern in cold regions where large amounts of road salt are used
  - Even in these areas, no problems reported

Fresh Concrete

- Workability
  - If both coarse and fine fractions of recycled PCC are used, many reports indicate very poor workability and harshness
  - Rapid loss of workability (slump loss) has been reported
  - No problems reported when only using coarse fraction of recycled PCC

Fresh Concrete

- Water Content
  - Typically is higher for recycled PCC mixes due to greater absorption
  - Variable absorption can make setting water content difficult

Fresh Concrete

- Air Content
  - Air content tends to be higher and have greater variation
  - Assumed due to higher porosity of recycled material and entrained air in the original mortar
  - Some states adjust air entrainment requirements upward to better estimate the air content of the new mortar
  - No adjustments made on I-95 project

Hardened Concrete

- Flexural strength
  - For the same water-cement ratio, reports indicate an 8% decrease is typical when using recycled coarse aggregate (approximately 50 psi)
  - This decrease is heavily dependent on the quality of the original PCC
  - Numerous states report that PCC made with recycled PCC aggregate meet or exceed requirements
  - Using 15% to 45% recycled fines can increase flexural strength

Hardened Concrete

- Durability
  - Freeze-thaw resistance is typically superior
  - ASR potential is less
  - Very dependent on the quality of the original PCC

Hardened Concrete

- Bond strength with reinforcement
  - No problems when using only coarse PCC aggregate
  - Using recycled fines reduces bond strength
    - Thought to be due to additional water needed for workability

Hardened Concrete

- Drying shrinkage
  - Substantially higher for recycled PCC
    - Can be 40% to 60% greater
  - Joints must be sawed promptly
  - Control of moisture with curing compound
- Thermal expansion/contraction
  - May also be higher

SCDOT Approach

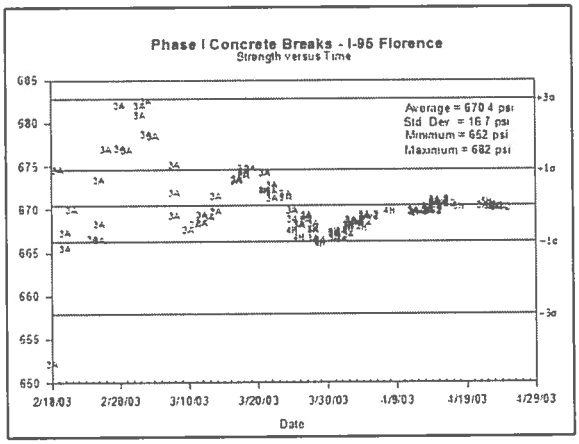
- Rule #1 – Know the original PCC
  - I-95 had performed well for 35 years
  - Average 14-day flexural strength for original PCC was 658 psi
  - All original materials met SCHD requirements in 1966
  - Many of the poor-performing recycled projects had used poor quality original PCC

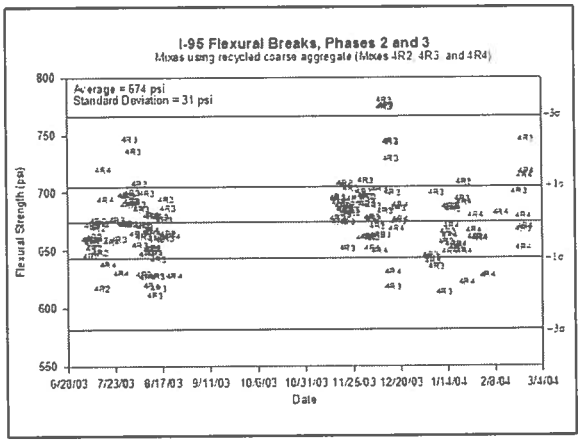
SCDOT Approach

- Rule #2 – Use only the coarse fraction unless mixes are well-documented
  - Most problems reported elsewhere were with mixes using recycled fine aggregates
  - Recycled fines make great fill material
  - May want to eventually experiment with some recycled fines to improve flexural strengths

SCDOT Approach

- Rule #3 – The basics still matter
  - Many failures of recycled PCC projects have been attributed to poor fundamental design or construction technique.



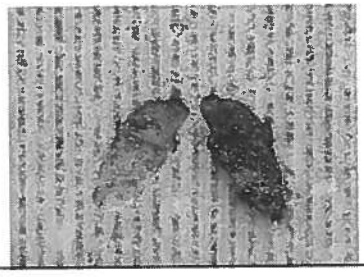


Mix Designs

- Mix 3A
  - 504 pounds Type I Cement
  - 107 pounds Class F Fly Ash
  - 1141 pounds Fine Aggregate
  - 1232 pounds #57 Coarse Aggregate
  - 660 pounds #789 Coarse Aggregate
  - 251 pounds water
  - Water reducer/retarder admixture
  - Air entraining admixture
  - Water/Cement Ratio = 0.41
- Mix 4R2
  - 504 pounds Type I Cement
  - 107 pounds Class F Fly Ash
  - 1083 pounds Fine Aggregate
  - 1773 pounds #57 Recycled Coarse Aggregate
  - 251 pounds water
  - Water reducer/retarder admixture
  - Air entraining admixture
  - Water/Cement Ratio = 0.41

Problems?

- Some contamination was encountered early from joint sealant, backer rod, and wood



Problems?

- Problem solved by cleaning joints prior to crushing

Not just PCC

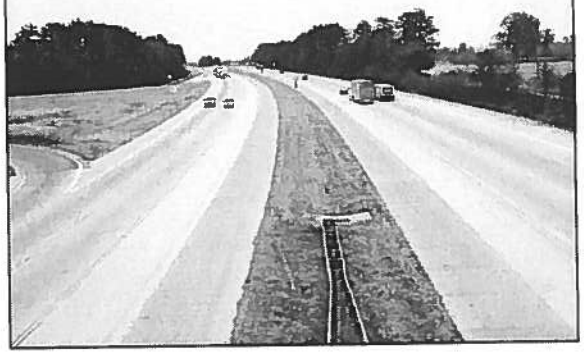
- Recycled PCC has been allowed as a base material for asphalt for many years
- Approval is on a stockpile by stockpile basis
- Problems with building rubble contamination are common
- Use with caution as a permeable base course
  - Efflorescence can blind drain system

Acknowledgment

- Thanks to:

Dr. Mark Snyder

Questions?



15-02
Attach #7

AMENDMENT TO THE STANDARD SPECIFICATIONS

1-06 Control of Material

1-06.6 Recycled Materials

The Contractor shall make their best effort to utilize recycled materials in the construction of the project; the use of recycled concrete aggregate as specified in Section 1-06.1(1)A is a requirement of the Contract.

The Contractor shall submit a Recycled Material Utilization Plan as a Type 1 Working Drawing within 30 calendar days after the Contract is executed. The plan shall provide the Contractor's anticipated usage of recycled materials for meeting the requirements of these Specifications. The quantity of recycled materials will be provided in tons and as a percentage of the Plan quantity for each material listed in Section 9-03.21(E) Table on Maximum Allowable Percent (By Weight) of Recycled Material. When a Contract does not include Work that requires the use of a material that is included in the requirements for using materials the Contractor may state in their plan that no recycled materials are proposed for use.

Prior to Physical Completion the Contractor shall report the quantity of recycled materials that were utilized in the construction of the project for each of the items listed in Section 9-03.21. The report shall include hot mix asphalt, recycled concrete aggregate, recycled glass, steel furnace slag and other recycled materials (e.g. utilization of on-site material and aggregates from concrete returned to the supplier). The Contractor's report shall be provided on DOT Form 350-075 Recycled Materials Reporting.

1-06.6(1) Recycling of Aggregate and Concrete Materials

1-06.6(1)A General

The minimum quantity of recycled concrete aggregate shall be 25 percent of the total quantity of aggregate that is incorporated into the Contract for those items listed in Section 9-03.21(E) Table on Maximum Allowable Percent (By Weight) of Recycled Material that allow the use of recycled concrete aggregate. The percentage of recycled material incorporated into the project for meeting the required percentage will be calculated in tons based on the quantity of recycled concrete used on the entire contract and not as individual items.

If the Contractor's total cost for Work with recycled concrete aggregate is greater than without the Contractor may choose to not use recycled concrete aggregate. When the Contractor does not meet the minimum requirement of 25 percent recycled concrete aggregate for the Contract due to costs or any other reason the following shall be submitted:

1. A cost estimate for each material listed in Section 9-03.21(1)E that is utilized on the Contract. The cost estimate shall include the following:
    a. The estimated costs for the Work for each material with 25 percent recycled concrete aggregate. The cost estimate shall include for each material a copy of the price quote from the supplier with the lowest total cost for the Work.
    b. The estimated costs for the Work for each material without recycled concrete aggregate.

The Contractor's cost estimates shall be submitted as an attachment to the Recycled Materials Reporting form.

9-03.21(1)B Recycled Concrete Aggregate

Recycled concrete aggregates are coarse and fine aggregates manufactured from hardened concrete mixtures.

CONSTRUCTION MANUAL

SS 1-06.6 Recycled Materials

SS 1-06.6(1) Recycling of Construction Aggregate and Concrete Materials

In 2015 Engrossed Substitute House Bill 1695 was passed. ESHB 1695 encourages the use of recycled aggregates and requires the use of recycled concrete aggregate in the amount of 25% on all WSDOT projects. The required use of recycled concrete aggregate does not apply to all materials. The law specifies that the requirement applies only to the materials included in the contract that are listed in table in Section 9-03.21 that allow the use of recycled concrete aggregate. To comply with these requirements Section 1-06.6 of the Standard Specifications was created by a task group of industry and State personnel.

Recycled aggregates may be from any approved source and include the use of aggregates from uncured concrete that is

returned to a concrete plant. Recycled concrete is hardened concrete that is crushed and may contain coarse and fine mineral aggregate with Portland cement. The Standard Specifications encourage the use of recycled aggregate and require that recycled concrete be incorporated into the Work by the Contractor.

It is important that the Contractor have a plan for recycled aggregate and concrete at the beginning of the Contract. To facilitate this need the Standard Specifications require the contractor to submit a plan detailing how they will use recycled aggregate and concrete in the Work on the contract. A Recycled Materials Utilization Plan is required to be submitted by the Contractor within 30 calendar days of execution of the contract.

The Recycled Material Utilization Plan by the Contractor includes their initial plan on how they will include recycled aggregate in the work and how they will meet the 25 percent requirement for recycled concrete. Only one submittal at the start of the Contract is required and the details of the plan are not intended to be fixed. The Contractor may alter the plan at their discretion throughout the Contract without resubmitting a new plan. Should the Contractor alter their plan the Project Engineer may choose to review with the Contractor their updated plan for meeting the recycling requirement.

At the end of the contract the Contractor is required to submit the Recycled Materials Reporting form to the Project Engineer. The Recycled Materials Reporting form include the quantities of all materials, both recycled and virgin, for aggregates and concrete that were used on the project for the items listed. The Project Engineer should review the quantities submitted on the form. If the final tally of recycled concrete aggregate does not meet the 25 percent requirement in the Contract the Contractor is required to attach cost estimates, with and without recycled concrete aggregate, for each material used on the Contract that is listed in 9-03.23(1)E that allows recycled concrete aggregate. The Project Engineer should review the cost estimate for reasonableness; an independent verification of detailed costs is not required as the Contractor certifies the accuracy of the information.

A copy of Recycled Materials Reporting form is required to be sent to the Documentation Engineer at the State Construction Office. This will be used by the State Construction Office in the annual report that is required to be submitted to the legislature.

15-04
Attach #8

5-05.3(1) Concrete Mix Design for Paving

The Contractor shall provide a concrete mix design submittal or QPL for each design of concrete specified in the Contract to the Engineer. No concrete shall be placed until the Engineer has reviewed the mix design. The proportions of the mix design shall be determined in accordance with ACI 211.1. ~~The Contractor shall use ACI 211.1 as a guide to determine proportions.~~ Concrete strength, placement, and workability shall be the responsibility of the Contractor. Following approval of the Contractor's proposal, all other requirements of Section 5-05 shall apply.

1. **Materials** – Materials shall conform to Section 5-05.2. Fine aggregate shall conform to Section 9-03.1(2), Class 1. Coarse aggregate shall conform to Section 9-03.1(4), AASHTO grading No. 467. An alternate combined gradation conforming to Section 9-03.1(5) may be proposed, that has a nominal maximum aggregate size equal to or greater than a 1½-inch sieve.
   Fly ash, if used, shall not exceed 35 percent by weight of the total cementitious material, shall conform to Section 9-23.9 and shall be limited to Class F with a maximum CaO content of 15 percent by weight.
   Ground granulated blast furnace slag, if used, shall not exceed 30 percent by weight of the total cementitious material and shall conform to Section 9-23.10. When both ground granulated blast furnace slag and fly ash are included in the concrete mix, the total weight of both these materials is limited to 35 percent by weight of the total cementitious material. As an alternative to the use of fly ash, ground granulated blast furnace slag and cement as separate components, a blended hydraulic cement that meets the requirements of Section 9-01.2(4) Blended Hydraulic Cements may be used. The water/cement ratio shall be calculated on the total weight of cementitious material. Cementitious materials are those listed in Section 5-05.2. The minimum cementitious material for any mix design shall be 564 pounds per cubic yard.

2. **Submittals** – The Contractor's mix design shall be submitted on the most current WSDOT form 350-040EF to the Engineer or the State Materials Laboratory's QPL Engineer. Mix designs that are submitted to the QPL Engineer shall be done in accordance with QC XX.
   The Contractor's submittal shall include the mix proportions per cubic yard, test results from beams and cylinders, and the proposed sources for all ingredients including the fly ash. The mix shall be capable of providing a minimum flexural strength of 650 psi at 14 days. Evaluation of strength shall be based on statistically analyzed results of five beam specimens made according to WSDOT T 808 and tested according to WSDOT T 802 that demonstrate a quality level of not less than 80 percent analyzed in accordance with Section 1-06.2(2)D. In addition the Contractor shall fabricate, cure, and test five sets of cylinders, for evaluation of 28-day strengths, according to WSDOT FOP's for AASHTO T 22 and AASHTO T 23 using the same mix design as used in fabrication of the beams

   Mix designs submitted by the Contractor shall provide a unique identification for each mix design proposal and shall include the production facility and test data confirming that concrete made in accordance with the proposed design will meet the requirements of

these Specifications and the 28-day compressive strength result. Test data shall be from an independent testing lab or from a commercial concrete producer's lab. If the test data is developed at a producer's lab, the Engineer or a representative may witness all testing.

3. **Conformance to Mix Design** – Cement and coarse and fine aggregate weights shall be within the following tolerances of the mix design:

Portland Cement Concrete Batch Weights, per cubic yard of Concrete		
Cement	+5	-1%
Coarse Aggregate	+ 30 Pounds	- 30 Pounds
Fine Aggregate	+ 30 Pounds	- 30 Pounds

If the total cementitious material weight is made up of different components, these component weights shall be within the following tolerances:

a. Portland cement weight plus 5 percent or minus 1 percent of that specified in the mix design.

b. Fly ash and ground granulated blast furnace slag weight plus or minus 5 percent of that specified in the mix design.

c. Microsilica weight plus or minus 10 percent of that specified in the mix design.
Water shall not exceed the maximum water specified in the mix design.
The Contractor may initiate minor adjustments to the approved mix proportions within the tolerances noted above without resubmitting the mix design.

Changes in production facility, aggregate source, admixtures, portland cement, low alkali cement, blended hydraulic cement, fly ash, ground granulated blast furnace slag, microsilica fume, metakaolin, blended supplementary cementitious materials, aggregate and cement weights that surpass the tolerance limits, and changes in proportions of the other listed materials will require development of a new mix design, and resubmittal to the Engineer or for QPL approval. Mix designs that require resubmittal for the QPL must be approved prior to use. ~~The Contractor shall notify the Engineer in writing of any proposed modification. A new mix design will designate a new lot.~~

Attach #9
15-02

Washington State Department of Transportation

RECYCLED MATERIALS REPORTING

CONTRACT NUMBER:	CONTRACT TITLE:
CONTRACTOR:	ENGINEER:

		RECLAIMED HOT MIX ASPHALT	RECYCLED CONCRETE AGGREGATE	RECYCLED GLASS	STEEL FURNACE SLAG	OTHER RECYCLED AGGREGATES	CONTRACT TOTAL QUANTITY
Fine Aggregate for Portland Cement Concrete	9-03.1(2)						
Coarse Aggregates for Portland Cement Concrete	9-03.1(4)						
Aggregates for Hot Mix Asphalt	9-03.8	see below					
Ballast	9-03.9(1)						
Permeable Ballast	9-03.9(2)						
Crushed Surfacing	9-03.9(3)						
Aggregate for Gravel Base	9-03.10						
Gravel Backfill for Foundations	9-03.12(1)						
Gravel Backfill for Walls	9-03.12(2)						
Gravel Backfill for Pipe Zone Bedding	9-03.12(3)						
Gravel Backfill for Drains	9-03.12(4)						
Gravel Backfill for Drywells	9-03.12(5)						
Backfill for Sand Drains	9-03.13						
Sand Drainage Blanket	9-03.13(1)						
Gravel Borrow	9-03.14(1)						
Select Borrow	9-03.14(2)						
Common Borrow	9-03.14(3)						
Foundation Material Class A and Class B	9-03.17						
Foundation Material Class C	9-03.18						
Bank Run Gravel for Trench Backfill	9-03.19						
Other Aggregate Materials (total quantity not required)	9-03						
TOTAL (recycled materials and contract total quantity)							

		RECLAIMED HOT MIX ASPHALT	RECLAIMED ASPHALT SHINGLES		STEEL FURNACE SLAG	OTHER RECYCLED MATERIALS	TOTAL QUANTITY
Hot Mix Asphalt	5-04.2						

I declare that the statements made in this document, including attachments, are complete, true and accurate.
Signed by an authorized representative of the Contractor

CONTRACTOR REPRESENTATIVE NAME	SIGNATURE	TITLE	DATE

INSTRUCTIONS:

The Contractor shall report the quantity in ***tons*** for each type of recycled material that was used for each of the listed materials. If the Contract did not include the listed material or recycled materials were not used for this material a "0" shall be entered in the box. The Standard Specifications in Section 9-03.21 do not allow the use of recycled materials in the boxes that are shaded. If the Contract Provisions allowed and the Contractor utilized recycled materials for any of these items the amount of recycled material shall be entered in the box. The contract total quantity for each aggregate material (e.g., fine Aggregate for Portland Cement Concrete) is the total weight in tons and includes both recycled and natural occurring materials. The total quantity for hot mix asphalt (HMA) is the total HMA weight in tons and includes recycled asphalt pavement (RAP) and new HMA materials.

Other recycled aggregates include other material sources that are utilized on a project. These sources include on-site recycling and aggregates from returned (uncured) concrete. Roadway excavation and embankment are not allowed in the quantity for other aggregate materials or other recycled aggregates.

Attach cost estimates as required in Section 1-06.6 of the Standard Specifications when the total percentage of recycled aggregate and concrete is less than 25 percent of the required amount for the entire Contract.

NW-ACPA / WSDOT Meeting Minutes
Wednesday, October 21, 2015 10:00 AM – 12:00 Noon
WSDOT Cle Elum Maintenance Conference Room, I-90 Exit 80

Present	Name	Company	Present	Name	Company	Present	Name	Company
X	Clark, Steve	Acme	X	Larson, Larry	WSDOT		Seghetti, Robert	Acme
X	Dyer, Bob	WSDOT	X	Pipinich, Bob	GMCC		Uhlmeyer, Jeff	WSDOT
X	Davari, Moe	WSDOT	X	Powell, Jim	NW ACPA		Williams, Kurt	WSDOT
X	Erickson, D	WSDOT		Russell, Mark	WSDOT		Sullivan, Joey	Salinas
X	Jones, Dave	WSDOT						

Old Business:

13-01 Time of placement for end dump trucks needs to be extended to match 6-02.3(4)D.

4/15/2013 – The time constraint is in Section 5-05.3(3)B. This specification allows the concrete to be delivered to the job site in nonagitator trucks provided it is fully discharged no later than 45 minutes after the introduction of mixing water to the cement and aggregates. Section 5-05.3(8)C, states that when a pour is discontinued for more than 45 minutes a transverse construction joint shall be installed. The goal is to insure the concrete is plastic enough when placed to prevent a cold joint from forming. The real issue is not the time in the nonagitator truck but the travel distance. The longer you travel the more likely you are going to have segregation, caused by vibration of the concrete. It was asked if a conveyor system between the truck and the paving machine would remix the concrete. There are some screws in the hopper to move the material, but they were not meant to remix the concrete. It was decided that the Industry would come back with a proposal for change to the time limit.

10/7/2013 - Wisconsin has developed a specification that Jim Powell handed out. This specification is based on concrete temperature at the time of placement. It suggests that you could place concrete pavement up to 60 minutes after batching when a retarder is used. ACPA has no guide lines on this issue. It was noted that we would rarely have a problem placing concrete within 60 minutes.

10/20/2014–It was agreed that the next step to move this issue forward is for Industry to propose spec changes. WSDOT was inclined to like the example from Wisconsin provided at the last meeting. It allows added time for placement (1) if the temperature (concrete or air?) is below a specified temperature or (2) if a set retarder is approved in the mix design.

4/6/2015 – Agreed that if the mix stays below certain temperatures we could extend the time. Jim Powell provided a draft of a proposed spec (attached). Dyer agreed to prepare a draft spec to extend time if temperatures are low enough.

10/21/2015 – WSDOT is OK with extending the time to 60 minutes provided the mix is 60° F or lower. Attachment #1 is the handout from our previous meeting. Bob Dyer provided another draft spec for discussion, allowing up to 75 minutes conditioned on the concrete being less than 75 degrees F at the time of placement, a set retarder is used, and the contractor accepts the risk. (attach #2) It seemed that there was agreement that 60 minutes, rather than 75 minutes, is where we want the revised spec to be. Jim Powell will review the drafts and provide a revised version at the next meeting.

13-02 The requirement for ~~that~~ the ~~asphalt~~ base surface temperature not exceed 90ºF needs to be examined. It was believed that this relates to placing concrete pavement over the top of recently placed Hot mix Asphalt (HMA) and that the temperature of the HMA should cool down to 90ºF before the concrete is placed.

4/15/2013 – The group wasn't sure there is a problem here, there are options paving at night, or using water to cool down the surface temperature. Pavecool was mentioned as a tool that can be used to predict HMA pavement cooling rates. The concern is with early age cracking. Jim Powell and Jeff Uhlmeyer agreed to use HIPERPAV and determine if we are being too conservative.

10/7/2013 – It was suggested that we use HIPERPAV to analyze and allow increases in temperature. It was noted that the risk of cracking is from the bottom up. It is basically a strength gain vs. shrinkage issue. We rarely see pavement cracking outside the contraction joints. The HMA acts as a heat sink. HIPERPAV would allow for condition specific temperatures to be utilized. Kurt suggested using the standard specification temperature of 90° F and allow for HIPERPAV to be utilized to demonstrating that a higher temperature could be allowed. Jim and Jeff will demonstrate HIPERPAV at our next meeting. Action Item: Jim Powell and Jeff Uhlmeyer prepare a demonstration of HIPERPAV.

4/21/2014 – We were not able to demonstrate the HIPERPAV program.

10/20/2014 - It was stated that HIPERPAVE is not useful at this time. It was noted that the 2012 Standard Specifications required that asphalt treated base temperature shall not exceed 90°F and the 2014 Standard Specifications no longer has this requirement. Dave Erickson agreed to review WSDOT records to find out why the maximum temperature of the underlying asphalt treated base was deleted in the 2014 spec book. Industry indicated it would prefer to manage the risk for cracking caused by warm underlying asphalt treated base without a contractually mandated maximum temperature of the underlying asphalt base material.

4/6/2015 – Jim Powell will look at what other States do.

10/21/2015 –Jim Powell update: This issue is about the base material on which the PCCP is placed, and is not limited to only asphalt base maaterial. WSDOT inadvertently removed from the 2014 [and 2016] spec book a spec stating that the max temp of asphalt treated base, when paving on asphalt treated base, is 90°F. Jim reported that Iowa, Pennsylvania, and Minnesota say no paving on any base that has a temp greater than 120°F. Dave Erickson agreed that 120 degrees F is OK based on what other states do and recommended by national research. Jim Powell agreed to provide a draft spec by the next meeting. Attachment #3 shows the spec under consideration.

13-03 Smoothness requirements for PCCP rehabilitation

10/7/2013 – The bid item under section 5-05.5 "Ride Smoothness Compliance Adjustment" was recently placed in a PCCP grinding project (section 5-01). This created an issue in that the adjustment is calculated by multiplying the unit contract price for cement concrete pavement, times the volume of concrete, times the Ride Smoothness Profile index. The problem is that we pay for grinding by the square yard not cubic yards. Currently we wouldn't pay an incentive for grinding. The question was asked if we should pay an incentive for grinding. It was concluded that the small panel replacements were not a big deal and would not be considered for incentive. Jim Powell pointed out the International Grooving and Grinding Association (IGGA) is working on a smoothness specification. Jim Powell said he will see if he can get a copy and send it out to the group.

4/21/2014 – Jim reported that the IGGA Specifications were not available yet. The Departments van is being equipped with a line laser that should take out any variability due to tinning. There are two ways to go about smoothness specifications absolute or percent improvement. The Department uses three different schedules of pay factors for the smoothness of HMA. IRI can vary depending on the time of the day. You can use a lightweight vehicle or a Ride Van. Contractors prefer to have the information collected by the Ride Van when bidding. The walk through worked well on a recent project. Having the ability to get out and look at the road with traffic control in place is great. Action Item: Jim Powell to get a copy of the IGGA smoothness Specifications.

10/20/2014 – The IGGA smoothness spec is still not published. Contractors did not support using IRI for smoothness. They prefer the California Profilograph (CP) for measurements. Dave Erickson said he is drafting a new smoothness specification using IRI and that it will likely be sent to industry committee members for comment before our next meeting.

4/6/2015 – Jim Powell provided the IGGA Guide Specification: Conventional Diamond Grinding for Pavement Preservation (Attached). WSDOT indicated it is waiting for a new PCCP contract to obtain data. WSDOT has a line laser for PCCP. WSDOT has a draft of a draft spec that is waiting on data from the Snoqualmie Pass contract before sharing the draft outside the department.

10/21/2015 – Discussion – Jim Powell focused the discussion by reminding the group that his concern is in regard to an incentive/disincentive for smoothness on grinding projects. There is currently no bid item for a smoothness penalty for pavement placed under the Section 5-01 specs. Jeff Uhlmeyer is working on a spec similar to the HMA smoothness spec – this will eliminate the issue of Section 5-01 not having a unit price for concrete. Further discussion at next meeting.

14-02 Stringless/laser control for slip-forming

April 21, 2014 Section 5-05.3(7)A Slip-Form Construction is kind of bland on this issue. As of now it says "The alignment and elevation of the paver shall be regulated form outside reference lines establish for this purpose". With todays advancement in slip-form paving the move to laser/stringless controls need to be addressed. I would propose something like this. "If the Contractor proposes to use any type of automatic laser controls, submit a detailed description of the system and perform a trial field demonstration in the presence of the Engineer at least one week prior to start of paving. Approval of the control system will be based on the results of the demonstration and on continuing satisfactory operation during paving." Johnnie Zabel of Salinas Construction reported that they completed a one hundred percent string less job by change order. They used a Leica product. They basically generated a 3 D model of the job, set up two total stations that sent information to the paver, and used GPS rovers behind the paver as a check. The project was 500 foot section of flat ground. Jim Powell noted that the industries uses laser screeds to produce super flat floors fast.

10/20/2014 – It was suggested that stringless technology be allowed by the specifications. WSDOT seemed to have no objection. Bob Dyer will provide a draft of the change before the next meeting.

4/6/2015 – Bob Dyer – Nothing to report.

10/21/2015 – Bob Dyer provided a draft spec (attachment #2). It was suggested that the options in the draft be expanded to include robotic technology, and wireless or stringless technology. Jim Powell will provide a draft at the next meeting consolidating the ideas.

14-03 Alternate material for the installation of dowel bars and tiebars in existing PCCP

4/21/2014 – Jim Allen of ACME Paving brought samples of and discussed using AMBEX Cementitious Anchoring Capsule for tie bars and dowels. This is a dry pre-mixed cement grout that is contained in a water permeable wrapping. Once the grout capsule is saturated in water it becomes a fast setting grout. The system was reported as being used in Minnesota, New York and Idaho. It was suggested that we contact Mark Gaines, The Bridge Construction Engineer to see if the structural side of the house had any experience with the system. Mark's comments were " I am not familiar with Ambex AAC and don't believe we have ever used a product like this for bridge or structure applications. Based on the data sheet, it seems like a good product with documented pull-out capacities. While you aren't looking for pull-out capacity, a high pull-out capacity provides some indication that the hole has been completely filled with a high-quality material. A couple things that could be concerns. I would imagine that dowel bars see considerable cyclic loading as heavy vehicles pass over the joints. I'd have some concern that this product would not hold up as well as an epoxy

to repeated cyclic loading over a number of years. Cementitious products are likely more brittle and less pliable than epoxy-based product. The other thing you may want to look at is whether this product is suitable for horizontal anchoring like you would have with dowel bars. The data sheet doesn't identify if this is appropriate for only downward vertical anchors or if it works for horizontal anchors. Epoxy product data sheets are usually very specific with respect to what applications that are suitable for. I have not heard anything about 9-20 products bonding better to dry surfaces. However, I very quickly took a look at three of the products covered by QPL 9-20.2 (SikaQuick 2500, Tamms Express Repair and Quikrete FastSet DOT Mix). All three of these products require saturated surface dry conditions before placement. I assume the other products do as well, but I didn't check. From my experience, we would always rely on following the manufacturer's recommendations for proprietary products like these. Deviating from these recommendations could product a product that doesn't achieve the properties identified in the data sheets. If there is research on this, could you have NW-ACPA forward it on to us/me?" Action Item: Jeff Uhlmeyer to check with other states and then possibly look for a job to try them on.

10/20/2014 – No discussion at today's meeting. Robert Seghetti agreed to follow up at next meeting.

4/6/2015 – No discussion.

10/21/2015 – Steve Clark will follow up.

15-01 Resurrecting the NW-ACPA/WSDOT Joint Training for PCCP

4/6/2015 Jim Powell introduced this topic. Jim Powell and Jeff Uhlmeyer will discuss the potential for setting up joint training.

10/21/2015 – Jim Powell and Jeff Uhlmeyer reported they are working on it. They hope to propose date at the next meeting. They are currently thinking that one class on each side of the state might be best.

15-02 Recycled Concrete Aggregate

4/6/2015 – Dave Jones reported that WSDOT is looking at using recycled concrete aggregate in Commercial Concrete, and looking into using recycled concrete aggregate in concrete pavement. Jim agreed to send Dave an example spec.

10-21-2015 Jim Powell provided several handouts: "Guidelines for Using RCA in Concrete Paving Mixtures" by ACPA (attache #4); "Aggregate for Use in Portland Cement Concrete Pavement " from South Carolina DOT (attach #5); Powerpoint presentation "PCC Recycling – I-95 Florence, S.C. " from South Carolina DOT (attach #6). Other handouts are: draft of changes to the WSDOT Standard Specs and Construction Manual regarding recycled concrete aggregate that will become effective April 4, 1016 (attach #7).

New Business

15-04 Spec Section 5-05 modifications presented to WACA

10/21/2015 –Jim Powell reports that the WACA/WSDOT committee is proposing changes to the WSDOT Standard Spec on Portland cement concrete mix designs, which affects mix designs for PCCP. The proposed changes are shown in attachment #8.

15-05 Contractor Reporting of use of Recycled Materials

10/21/2016 – Dave Erickson provided a copy of the new WSDOT form that will be required to be filled out by the Contractor for reporting use of recycled aggregate (attach #9), as recently required by the legislature.

ACTION ITEMS

ITEM #	WHAT	WHO	STATUS
13-01	Propose revised draft spec change for time of placement of end dumps.	Jim Powell	
13-02	Provide revised draft spec change for the maximum base temperature upon which to place PCCP.	Jim Powell	
13-03	Provide a draft smoothness spec for grinding contracts	Jeff Uhlmeyer	
14-02	Provide a revised draft spec to allow stringless grade control	Jim Powell	
14-03	Follow-up on alternate to epoxy for anchoring horizontally drilled-in dowel bars.	Steve Clark	
15-01	Propose date and locations for joint WSDOT/NWACPA joint training	Uhlmeyer and Powell	
15-02	Get draft recycled concrete in PCCP spec to Dave Jones	Jim Powell	done

Next meeting: April 20, 2016

Attach #1

4. **Non-agitator Trucks** – Bodies of non-agitating hauling equipment for concrete shall be smooth, mortar-tight, metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. Covers shall be provided when needed for protection. Plant-mixed concrete may be transported in non-agitated vehicles provided that the concrete is delivered to the site of the Work and discharge is completed within 45 minutes after the introduction of mixing water to the cement and aggregates, and provided the concrete is in a workable condition when placed. The discharge time may be extended to 60 minutes after introduction of the mixing water to the cement if the mix temperature is 60° F or below at the time of placement, or if the mix contains an approved set retarder providing at least a 1 hour delay in the initial set as ~~determined by AASHTO T197~~ recommended by mDg. 13-01

Attach # 2

DRAFT SPECS

5-05.3(3)B Mixing Equipment

1. **General** – Concrete may be mixed at a batching plant or wholly or in part in truckmixers. Each mixer shall have attached in a prominent place a manufacturer's plateshowing the capacity of the drum in terms of volume of mixed concrete and the speedof rotation of the mixing drum or blades.

2. **Batching Plant** – Mixing shall be in an approved mixer capable of combining theaggregates, cement, and water into a thoroughly mixed and uniform weight within thespecified mixing period.

   Mixers shall be cleaned at suitable intervals. The pickup and throw-over blades inthe drum shall be repaired or replaced when they are worn down ¾ inch or more.The Contractor shall have available at the jobsite a copy of the manufacturer's design,showing dimensions and arrangements of the blades in reference to original height anddepth, or provide permanent marks on blades to show points of ¾ inch wear from newconditions. Drilled holes ¼ inch in diameter near each end and at midpoint of eachblade are recommended.

3. **Truck Mixers and Truck Agitators** – Truck mixers used for mixing and haulingconcrete, and truck agitators used for hauling plant-mixed concrete, shall conform tothe requirements of Section 6-02.3(4)A.

4. **Nonagitator Trucks** – Bodies of non-agitating hauling equipment for concrete shallbe smooth, mortar-tight, metal containers and shall be capable of discharging theconcrete at a satisfactory controlled rate without segregation. Covers shall be providedwhen needed for protection. Plant-mixed concrete may be transported in non-agitated vehicles provided that the concrete is delivered to the site of the Work and discharge is completed within 45 minutes after the introduction of mixing water to the cement and aggregates, and provided the concrete is in a workable condition when placed. This time may be extended to 75 minutes, at the sole risk of the contractor, provided either a) the temperature of the concrete at the time of placement is less than 75 degrees F, or b) a set retarding admixture is included in the approved mix design at a dosage sufficient to delay initial set a minimum of 1 hour. } Item 13-01

5-05.3(7)A Slip-Form Construction

The concrete shall be distributed uniformly into final position by a self-propelled slip-formpaver without delay. The alignment and elevation of the paver shall be regulated from outsidereference lines established for this purpose. The reference lines may be wire supported on pins, computer-operated GPS technology, or XXX or YYY joint matching.The paver shall vibrate the concrete for the fullwidth and depth of the strip of pavement being placed and the vibration shall be adequateto provide a consistency of concrete that will stand normal to the surface with sharp well-definededges. The sliding forms shall be rigidly held together laterally to prevent spreadingof the forms. } Item 14-02

Attach #3

5-05.3(6) Subgrade

The Subgrade shall be constructed in accordance with Section 2-06.

The Subgrade shall be prepared and compacted a minimum of 3 feet beyond each edge of the area which is to receive concrete pavement in order to accommodate the slip-form equipment. Concrete shall not be placed on a frozen Subgrade nor during heavy rainfall.

The Subgrade shall be moist before the concrete is placed.

~~When the Subgrade is an asphalt treated base the surface shall be clean and free of any deleterious material. When placing concrete on a treated base, the surface temperature shall not exceed 90°F. If water is used for cooling any excess water standing in pools or flowing on the surface shall be removed prior to placing concrete.~~

Item 13-02

5-05.3(7) Placing, Spreading, and Compacting Concrete

The provisions relating to the frequency and amplitude of internal vibration shall be considered the minimum requirements and are intended to ensure adequate density in the hardened concrete. Referee testing of hardened concrete will be performed by cutting cores from the finished pavement after a minimum of 24 hours of curing. Density determination will be made based on the water content of the core as taken. WSDOT Test Method T 810 shall be used for the determination of core density. Reference cores will be taken at the minimum rate of one for each 500 cubic yards of pavement, or fraction thereof. These same cores will be used for thickness measurements as required by Section 5-05.5(1).

The average density of the cores shall be at least 97 percent of the approved mix design density or the actual concrete density when determined by the Contractor using AASHTO T 121 with no cores having a density of less than 96 percent.

Failure to meet the above requirement will be considered as evidence that the minimum requirements for vibration are inadequate for the job conditions, and additional vibrating units or other means of increasing the effect of vibration shall be employed so that the density of the hardened concrete as indicated by further referee testing shall conform to the above listed requirements. Primary units of pavement, as defined in Section 5-05.5(1)), not meeting the prescribed minimum density shall be removed and replaced with satisfactory material. At the option of the Engineer, noncompliant material may be accepted at a reduced price.

5-05.3(7)A Slip-Form Construction

The concrete shall be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well-defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms.

The plastic concrete shall be effectively consolidated by internal vibration with transverse vibrating units for the full width of pavement and/or a series of equally spaced longitudinal vibrating units. The space from the outer edge of the pavement to the outer longitudinal unit shall not exceed 9 inches. The spacing of internal units shall be uniform and not exceed 18 inches.

The term internal vibration means vibration by vibrating units located within the specified thickness of pavement section.

The rate of vibration of each vibrating unit shall be not less than 7,500 cycles per minute, and the amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least 1 foot. The frequency of vibration or amplitude shall be varied proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

Item 15-02
Attach #4

Appendix C.

GUIDELINES FOR USING RCA IN CONCRETE PAVING MIXTURES

(Note: These guidelines were derived mainly from the 1993 version of ACPA's TB014P, "Recycling Concrete Pavements," and from AASHTO MP16, "Reclaimed Concrete Aggregate for Use as Coarse Aggregate in Hydraulic Cement Concrete." Users are referred to these documents, as well as existing State and Local construction specifications, for additional details concerning the production of RCA products.)

SCOPE

These guidelines are intended to provide users with a framework for use in developing a suitable specification for using recycled concrete aggregate (RCA) in typical concrete paving mixtures.

Note 1 – *Concrete pavement structures of acceptable strength and durability can be produced using RCA materials that is properly processed and manufactured to meet the typical aggregate requirements when those materials are incorporated in a concrete mixture that is proportioned and mixed in accordance with appropriate requirements and procedures, and is placed, consolidated and cured properly. However, using RCA in new concrete mixtures requires the use of suitable quality control (QC) and quality assurance (QA) procedures to ensure that deleterious materials that might be present in the RCA will not adversely impact the quality of the concrete pavement structure.*

State and local regulations, laws and specifications may be applicable to specific projects and may supersede this guide specification. Users of this guide specification are cautioned to contact appropriate state and local authorities to identify any additional or superseding requirements/specifications.

ORDERING INFORMATION

The following information typically is included in the purchase order or contract documents:

- grading to be furnished,
- soundness testing requirements,
- designated aggregate class,
- whether any restrictions on reactive materials applies,
- exceptions or additions to this specification, and
- additional testing requirements (if any).

GRADING

RCA or RCA/virgin aggregate blends should conform to the aggregate gradation requirements prescribed for the specific intended concrete application.

Note 2 – *There is usually no reason that the gradation requirements for RCA to differ significantly from those for virgin aggregate materials used for the same application.*

Note 3 – *Depending upon the source of the concrete and the processes used in removing, crushing and processing the material, it may be necessary to produce RCA material of at least two separate sizes that can be blended together (and/or with virgin aggregate) to meet the gradation requirements.*

PHYSICAL PROPERTIES

RCA consists of crushed concrete material and virgin aggregate particles derived from the crushing of concrete pavement fragments.

Typical maximum Los Angeles abrasion loss values for the coarse RCA are 50%, measured in accordance with AASHTO T96 ("Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine").

Note 4 – AASHTO T327 ("Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus") may be required in lieu of AASHTO T96 if the specifying agency has experience with the procedure and has established appropriate testing limits.

RCA used in concrete that will be subject to in-service wetting, extended exposure to humid atmosphere, or contact with moist ground should not contain any materials that are reactive with alkali components in the cement in an amount sufficient to cause excessive expansion of mortar or concrete unless materials that will prevent harmful alkali-aggregate reactions (e.g., Class F fly ash, slag cement, etc.) will be added in appropriate quantities. If necessary, test RCA for Alkali-aggregate reactivity (AAR) in accordance with AASHTO T303 ("Accelerated Detection of Potentially Deleterious Expansion of Mortar Bars due to Alkali-Silica Reaction") and/or ASTM C1567 ("Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)") when alkali-silica reaction (ASR) is suspected, and in accordance with ASTM C586 ("Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks for Concrete Aggregates (Rock Cylinder Method)") when alkali-carbonate reaction (ACR) is suspected.

Note 5 – If the source and history of the RCA are known and no reactive failures were present in the source concrete, testing for reactive expansion may not be necessary. However, unless a precise history is known, the source concrete may have not been exposed to all elements required to cause reactive expansion and the RCA may be unknowingly reactive.

RCA used in concrete that will be subjected to freeze-thaw action should not contain aggregate components that will result in D-cracking of the concrete. When potential D-cracking is suspected, test RCA in accordance with AASHTO T161 ("Resistance of Concrete to Rapid Freezing and Thawing") or equivalent local methods. Acceptance criteria for AASHTO T161 and equivalent methods should be based on local criteria that have been developed to address the issue of D-cracking.

RCA should meet the flat and elongated particle requirements of the specifying agency if the agency has such requirements.

Test RCA intended for use in concrete mixtures should be tested according to AASHTO T85 ("Specific Gravity and Absorption of Coarse Aggregate") to determine the specific gravity and absorption of the material. For specific gravity, the total variability of tests (from minimum value to maximum value) should not exceed 0.100. For absorption, the total variability of tests (from minimum value to maximum value) should not exceed 0.8 percent. Stockpile RCA having specific gravity and absorption variability values that fall outside of these limits separately where they might be used included in a project with less stringent specific gravity and absorption values.

Note 6 – Coarse RCA may contain varying amounts of reclaimed concrete mortar, which generally has a lower specific gravity and is more absorptive than virgin aggregate. Therefore, RCA can be highly absorptive and can exhibit low specific gravity values, and the absorption and specific gravity values can be highly variable, especially between RCA obtained from different sources or produced at different facilities. The use of aggregates with variable specific gravity and absorption characteristics in concrete mixtures can adversely affect the weighing and batching processes in concrete production and can result in concrete workability and finishing problems and variability. Control of stockpile moisture conditions will help alleviate absorption problems.

DELETERIOUS SUBSTANCES

RCA should not contain clay lumps and friable particles, chert, and coal and lignite or other deleterious substances that exceed the maximum allowable amounts listed in Table 12.

Note 7 – *The presence of deleterious materials in aggregates used in the production of concrete mixtures can adversely affect concrete setting time and/or strength, and can also induce expansive reactions that could result in premature deterioration of the concrete structure. As a result, strict quality control (QC) and quality assurance (QA) procedures are required to ensure that RCA material used as coarse aggregate in the production of concrete mixtures will not adversely affect the quality of the concrete product.*

QUALITY CONTROL (QC)

If RCA or combinations of RCA and other approved virgin aggregate materials are to be used in a new concrete mixture, approval from the engineer might be necessary. The proposed percentages of combined materials should be established as part of the request. At the engineer's discretion, revised concrete mixture designs may be required when percentages or sources of materials change.

Note 8 – *A revised concrete mixture design is recommended when percentages or sources of RCA materials change. It is likely that the RCA will have different specific gravity and absorption characteristics than the virgin aggregate.*

Develop and implement a quality control (QC) plan for aggregate production. The QC plan should describe the production procedures, test methods and frequency of testing to ensure consistent production of RCA meeting the requirements of the intended

Table 12. Typical Limits for Deleterious Substances and Physical Property Requirements of RCA for Use in New Concrete Mixtures (after AASHTO MP16)

Class designation[b]	Clay lumps and friable particles	Chert (sp gr SSD < 2.40)[c]	Sum of clay lumps, friable particles and chert (sp gr SSD < 2.40)[c]	Other deleterious substances[d]	Coal and lignite
	Maximum allowable, percent[a]				
A	2.0	3.0	2.3	0.3	0.2
B	3.0	5.0	5.0	0.3	0.2
C	3.0	8.0	8.0	0.3	0.2

[a] The engineer may supplement the requirements of this table by placing limits on the amount of deleterious substances or physical properties in accordance with local experience and practice.

[b] RCA conforming to the requirements for the various classes designated in this table should generally be suitable for the following uses:

Typical suggested uses	Weathering exposure	Class of aggregate
Concrete pavements, cement-treated subbases, sidewalks, median barriers, curbing and other non-structural applications	Severe	A
	Moderate	B
	Negligible	C

[c] These limitations in this table apply only to RCA in which chert appears as an impurity. They are not applicable to gravels that are predominantly chert. Limitations on the soundness of such aggregate should be based on service records in the environment in which the material is used.

[d] Other deleterious substances include adherent fines, vegetable matter, plastics, plaster, paper, gypsum board, metals, fabrics, wood, brick, tile, glass, and asphalt (bituminous) materials. The percentages of these materials should be determined in accordance with ASTM C295 or other equivalent methods approved by the specifying agency.

application. The QC plan also should describe methods to be used to ensure that RCA source materials are not contaminated with unacceptable amounts of deleterious materials. Methods and criteria for examining RCA should be established prior to its use.

Stockpile RCA products to assist in qualitative and quantitative identification of the presence of deleterious materials. (Stockpiling can also be used as a means to qualitatively assess the uniformity of the material.) Stockpiles may represent all or part of the material to be used on a specific project. Thus, construct stockpiles in a manner that will minimize segregation and permit visual examination and representative sampling of the material.

If RCA is blended with other approved aggregates, blending should be accomplished using a method that ensures blending and prevents segregation.

RCA should be brought to and maintained at a moisture condition that approaches a saturated surface-dry (SSD) condition prior to batching. This may be accomplished by using a water sprinkling system or another approved method. Appropriate batch water adjustments should be made if the RCA is not precisely in a SSD condition at the time of batching.

Aggregate for Use in Portland Cement Concrete Pavement

Section 3 of Supplementary Technical Specification SC-M-501 is replaced in its entirety with the following:

Fine Aggregate: Use fine aggregate meeting the requirements as specified in Subsection 701.2.9 except that the use of fine aggregate derived from the recycling of Portland Cement Concrete Pavement removed from the project or other recycled PCC is not acceptable. Aggregate derived from limestone is also not acceptable.

Coarse Aggregate: Use coarse aggregate meeting the requirements as specified in Subsection 701.2.10 with the following exceptions. At the option of the Contractor, coarse aggregate derived from the recycling of Portland Cement Concrete Pavement removed from the project may be used. Ensure that the coarse aggregate produced by the recycling of the existing PCC pavement meets the requirements of Subsection 701.2.10, except that the LA Abrasion Loss and sulfate soundness requirements are waived. Do not use PCC for recycling other than that removed from the roadway within the project. Remove all joint sealant and backer material from the existing pavement prior to removal for recycling and ensure that the resulting recycled aggregate is free from sealant, steel reinforcement, wood, and other contaminants. Do not use aggregate derived from limestone or slag.

Attach #6 15-02

PCC Recycling: I-95 Florence, SC

ndrew Johnson, Ph.D., P.E.
tate Pavement Design Engineer
CDOT Office of Materials and Research

Background

- Why recycle?
  - Dwindling landfill space
  - Increased disposal costs
  - Conservation of materials
  - Scarcity of high-quality, virgin aggregates
  - Overall reduction in project costs

Background

- Early work
  - US-66, Illinois, 1945
  - Europe, post World War II
- Renewed interest in 1970's
  - States performing PCC recycling
    - Connecticut, Iowa, Kansas, Michigan, Minnesota, Oklahoma, North Dakota, Wisconsin, Wyoming

Background

- Not all projects were successful
  - Problems were encountered using recycled fines
  - Can cause complications in reinforced PCC pavement

I-95 Florence County

- From I-20 to SC Route 327
- Approximately 13 miles
- Constructed 1964-1967
  - 10" Plain Jointed PCC
  - 5" Cement Stabilized Sand-Clay Base
  - 25' Joint Spacing
  - No positive load transfer

I-95 Florence County

- 2004 ADT = 48,400 ADT, 20% trucks
- One previous CPR in 1984 with tied PCC shoulders.
- By 2001, was highly distressed with over 50% of slabs in northbound driving lane requiring repair.
- Severe faulting.
- Base erosion issues.

I-95 Florence County

- Originally planned to do widening and unbonded overlay.
- Geometric/ROW/Bridge issues would not allow major change in grade.
- Decision made to widen and reconstruct existing pavement.

I-95 Florence County

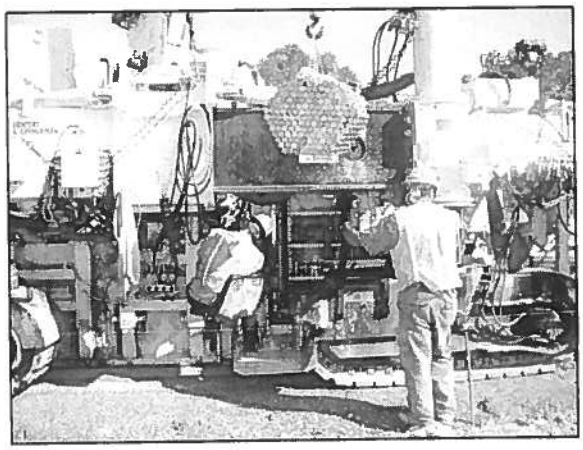
- Removed existing 10" PCC.
- Repaired base with new cement treatment where necessary.
- New pavement over existing base:
  - 11" Plain Jointed PCC (15' joint spacing)
  - 2" Asphalt Surface
  - 8" Graded Aggregate Base (new lanes)
- Traffic control/staging using lane reversals.

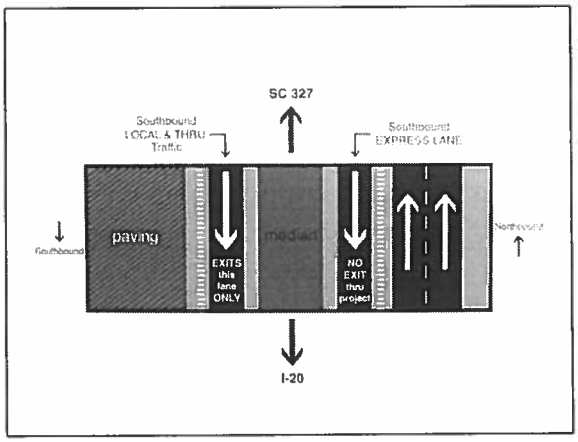
I-95 Florence County

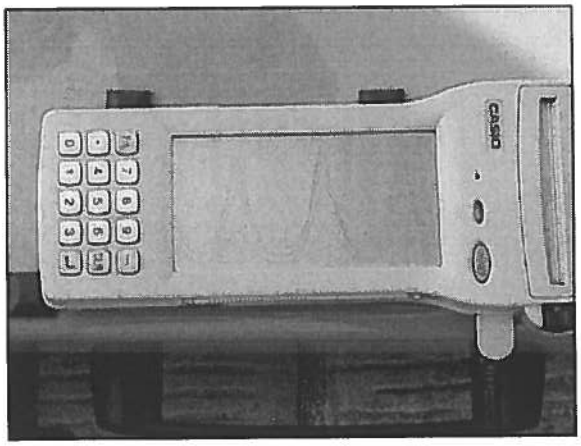
- Project let May 2002
  - Low Bid: $64,169,002.17
  - Awarded to Lane Construction Co.
  - 635,980 sy of PCC Pavement @ $30/sy
  - $3.7 million for barrier wall
  - $2.0 million for traffic control
- Work began July 8, 2002
- Project accepted May 5, 2004

I-95 Florence County

- New features:
  - Allowed the use of old PCC as coarse aggregate for new PCC.
  - PCC flexural strength requirement raised from 550 psi to 650 psi at 14 days to reduce pavement thickness by one inch.
  - Allowed the use of automatic dowel bar inserter in lieu of chairs.
  - Required diamond grinding of new surface for better rideability.







Aggregate Properties

- Gradation
  - Typically similar to virgin aggregate
- Particle Shape and Texture
  - Recycled PCC is highly angular and rough
  - Can lead to mixture harshness
  - (Harshness: Deficient workability and cohesiveness caused by insufficient sand or cement, or by improperly graded aggregate.)
  - Effect much more acute with recycled fines
  - No reported cases of harshness issues when using only coarse aggregate

Aggregate Properties

- Absorption Capacity
  - Recycled aggregate tends to have higher absorption than virgin aggregate
  - Typical range for virgin coarse aggregate in South Carolina: 0.2% to 0.8%
  - Absorption of I-95 recycled material 1.2%
  - Excessive absorption can lead to rapid loss of workability

Aggregate Properties

- Specific Gravity
  - Tends to be lower for recycled PCC
  - For I-95 Recycled Mix
    - Bulk Dry – 2.45
    - Bulk SSD – 2.48
    - Apparent – 2.52
  - For original I-95, Bulk SSD – 2.62
  - Decrease = 5.6%
  - Typical 8% decrease reported in literature

Aggregate Properties

- L. A. Abrasion Mass Loss
  - Tends to be slightly higher, but within specified limits
  - For I-95, loss = 39.7% compared to maximum allowable loss of 60%

Aggregate Properties

- Sodium Sulfate Soundness
  - Does not work on recycled PCC aggregate
  - Believed to be a reaction between the sodium sulfate and mortar
  - Typically has better magnesium sulfate results than original virgin aggregate
  - More research needed

Aggregate Properties

- Chloride content
  - Typically a concern in cold regions where large amounts of road salt are used
  - Even in these areas, no problems reported

Fresh Concrete

- Workability
  - If both coarse and fine fractions of recycled PCC are used, many reports indicate very poor workability and harshness
  - Rapid loss of workability (slump loss) has been reported
  - No problems reported when only using coarse fraction of recycled PCC

Fresh Concrete

- Water Content
  - Typically is higher for recycled PCC mixes due to greater absorption
  - Variable absorption can make setting water content difficult

Fresh Concrete

- Air Content
  - Air content tends to be higher and have greater variation
  - Assumed due to higher porosity of recycled material and entrained air in the original mortar
  - Some states adjust air entrainment requirements upward to better estimate the air content of the new mortar
  - No adjustments made on I-95 project

Hardened Concrete

- Flexural strength
  - For the same water-cement ratio, reports indicate an 8% decrease is typical when using recycled coarse aggregate (approximately 50 psi)
  - This decrease is heavily dependent on the quality of the original PCC
  - Numerous states report that PCC made with recycled PCC aggregate meet or exceed requirements
  - Using 15% to 45% recycled fines can increase flexural strength

Hardened Concrete

- Durability
  - Freeze-thaw resistance is typically superior
  - ASR potential is less
  - Very dependent on the quality of the original PCC

Hardened Concrete

- Bond strength with reinforcement
  - No problems when using only coarse PCC aggregate
  - Using recycled fines reduces bond strength
    - Thought to be due to additional water needed for workability

Hardened Concrete

- Drying shrinkage
  - Substantially higher for recycled PCC
    - Can be 40% to 60% greater
  - Joints must be sawed promptly
  - Control of moisture with curing compound
- Thermal expansion/contraction
  - May also be higher

SCDOT Approach

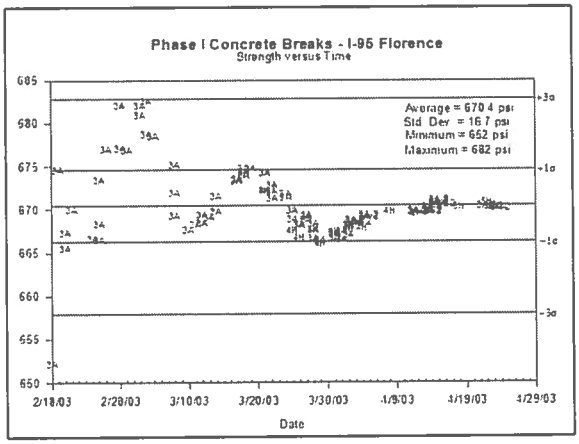
- Rule #1 – Know the original PCC
  - I-95 had performed well for 35 years
  - Average 14-day flexural strength for original PCC was 658 psi
  - All original materials met SCHD requirements in 1966
  - Many of the poor-performing recycled projects had used poor quality original PCC

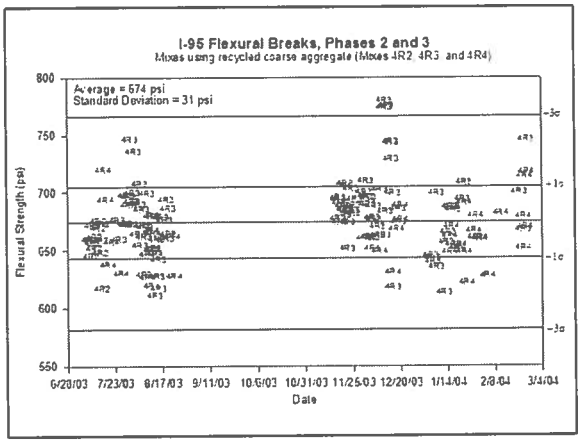
SCDOT Approach

- Rule #2 – Use only the coarse fraction unless mixes are well-documented
  - Most problems reported elsewhere were with mixes using recycled fine aggregates
  - Recycled fines make great fill material
  - May want to eventually experiment with some recycled fines to improve flexural strengths

SCDOT Approach

- Rule #3 – The basics still matter
  - Many failures of recycled PCC projects have been attributed to poor fundamental design or construction technique.



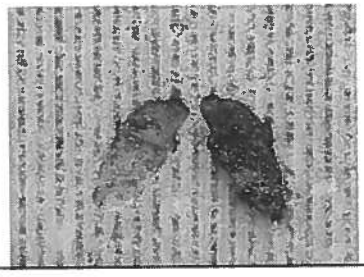


Mix Designs

- Mix 3A
  - 504 pounds Type I Cement
  - 107 pounds Class F Fly Ash
  - 1141 pounds Fine Aggregate
  - 1232 pounds #57 Coarse Aggregate
  - 660 pounds #789 Coarse Aggregate
  - 251 pounds water
  - Water reducer/retarder admixture
  - Air entraining admixture
  - Water/Cement Ratio = 0.41
- Mix 4R2
  - 504 pounds Type I Cement
  - 107 pounds Class F Fly Ash
  - 1083 pounds Fine Aggregate
  - 1773 pounds #57 Recycled Coarse Aggregate
  - 251 pounds water
  - Water reducer/retarder admixture
  - Air entraining admixture
  - Water/Cement Ratio = 0.41

Problems?

- Some contamination was encountered early from joint sealant, backer rod, and wood



Problems?

- Problem solved by cleaning joints prior to crushing

Not just PCC

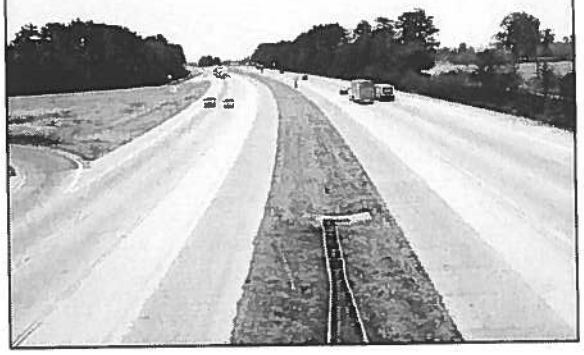
- Recycled PCC has been allowed as a base material for asphalt for many years
- Approval is on a stockpile by stockpile basis
- Problems with building rubble contamination are common
- Use with caution as a permeable base course
  - Efflorescence can blind drain system

Acknowledgment

- Thanks to:

Dr. Mark Snyder

Questions?



15-02
Attach #7

AMENDMENT TO THE STANDARD SPECIFICATIONS

1-06 Control of Material

1-06.6 Recycled Materials

The Contractor shall make their best effort to utilize recycled materials in the construction of the project; the use of recycled concrete aggregate as specified in Section 1-06.1(1)A is a requirement of the Contract.

The Contractor shall submit a Recycled Material Utilization Plan as a Type 1 Working Drawing within 30 calendar days after the Contract is executed. The plan shall provide the Contractor's anticipated usage of recycled materials for meeting the requirements of these Specifications. The quantity of recycled materials will be provided in tons and as a percentage of the Plan quantity for each material listed in Section 9-03.21(E) Table on Maximum Allowable Percent (By Weight) of Recycled Material. When a Contract does not include Work that requires the use of a material that is included in the requirements for using materials the Contractor may state in their plan that no recycled materials are proposed for use.

Prior to Physical Completion the Contractor shall report the quantity of recycled materials that were utilized in the construction of the project for each of the items listed in Section 9-03.21. The report shall include hot mix asphalt, recycled concrete aggregate, recycled glass, steel furnace slag and other recycled materials (e.g. utilization of on-site material and aggregates from concrete returned to the supplier). The Contractor's report shall be provided on DOT Form 350-075 Recycled Materials Reporting.

1-06.6(1) Recycling of Aggregate and Concrete Materials

1-06.6(1)A General

The minimum quantity of recycled concrete aggregate shall be 25 percent of the total quantity of aggregate that is incorporated into the Contract for those items listed in Section 9-03.21(E) Table on Maximum Allowable Percent (By Weight) of Recycled Material that allow the use of recycled concrete aggregate. The percentage of recycled material incorporated into the project for meeting the required percentage will be calculated in tons based on the quantity of recycled concrete used on the entire contract and not as individual items.

If the Contractor's total cost for Work with recycled concrete aggregate is greater than without the Contractor may choose to not use recycled concrete aggregate. When the Contractor does not meet the minimum requirement of 25 percent recycled concrete aggregate for the Contract due to costs or any other reason the following shall be submitted:

1. A cost estimate for each material listed in Section 9-03.21(1)E that is utilized on the Contract. The cost estimate shall include the following:
    a. The estimated costs for the Work for each material with 25 percent recycled concrete aggregate. The cost estimate shall include for each material a copy of the price quote from the supplier with the lowest total cost for the Work.
    b. The estimated costs for the Work for each material without recycled concrete aggregate.

The Contractor's cost estimates shall be submitted as an attachment to the Recycled Materials Reporting form.

9-03.21(1)B Recycled Concrete Aggregate

Recycled concrete aggregates are coarse and fine aggregates manufactured from hardened concrete mixtures.

CONSTRUCTION MANUAL

SS 1-06.6 Recycled Materials

SS 1-06.6(1) Recycling of Construction Aggregate and Concrete Materials

In 2015 Engrossed Substitute House Bill 1695 was passed. ESHB 1695 encourages the use of recycled aggregates and requires the use of recycled concrete aggregate in the amount of 25% on all WSDOT projects. The required use of recycled concrete aggregate does not apply to all materials. The law specifies that the requirement applies only to the materials included in the contract that are listed in table in Section 9-03.21 that allow the use of recycled concrete aggregate. To comply with these requirements Section 1-06.6 of the Standard Specifications was created by a task group of industry and State personnel.

Recycled aggregates may be from any approved source and include the use of aggregates from uncured concrete that is

returned to a concrete plant. Recycled concrete is hardened concrete that is crushed and may contain coarse and fine mineral aggregate with Portland cement. The Standard Specifications encourage the use of recycled aggregate and require that recycled concrete be incorporated into the Work by the Contractor.

It is important that the Contractor have a plan for recycled aggregate and concrete at the beginning of the Contract. To facilitate this need the Standard Specifications require the contractor to submit a plan detailing how they will use recycled aggregate and concrete in the Work on the contract. A Recycled Materials Utilization Plan is required to be submitted by the Contractor within 30 calendar days of execution of the contract.

The Recycled Material Utilization Plan by the Contractor includes their initial plan on how they will include recycled aggregate in the work and how they will meet the 25 percent requirement for recycled concrete. Only one submittal at the start of the Contract is required and the details of the plan are not intended to be fixed. The Contractor may alter the plan at their discretion throughout the Contract without resubmitting a new plan. Should the Contractor alter their plan the Project Engineer may choose to review with the Contractor their updated plan for meeting the recycling requirement.

At the end of the contract the Contractor is required to submit the Recycled Materials Reporting form to the Project Engineer. The Recycled Materials Reporting form include the quantities of all materials, both recycled and virgin, for aggregates and concrete that were used on the project for the items listed. The Project Engineer should review the quantities submitted on the form. If the final tally of recycled concrete aggregate does not meet the 25 percent requirement in the Contract the Contractor is required to attach cost estimates, with and without recycled concrete aggregate, for each material used on the Contract that is listed in 9-03.23(1)E that allows recycled concrete aggregate. The Project Engineer should review the cost estimate for reasonableness; an independent verification of detailed costs is not required as the Contractor certifies the accuracy of the information.

A copy of Recycled Materials Reporting form is required to be sent to the Documentation Engineer at the State Construction Office. This will be used by the State Construction Office in the annual report that is required to be submitted to the legislature.

15-04
Attach #8

5-05.3(1) Concrete Mix Design for Paving

The Contractor shall provide a concrete mix design submittal or QPL for each design of concrete specified in the Contract to the Engineer. No concrete shall be placed until the Engineer has reviewed the mix design. The proportions of the mix design shall be determined in accordance with ACI 211.1. ~~The Contractor shall use ACI 211.1 as a guide to determine proportions.~~ Concrete strength, placement, and workability shall be the responsibility of the Contractor. Following approval of the Contractor's proposal, all other requirements of Section 5-05 shall apply.

1. **Materials** – Materials shall conform to Section 5-05.2. Fine aggregate shall conform to Section 9-03.1(2), Class 1. Coarse aggregate shall conform to Section 9-03.1(4), AASHTO grading No. 467. An alternate combined gradation conforming to Section 9-03.1(5) may be proposed, that has a nominal maximum aggregate size equal to or greater than a 1½-inch sieve.
   Fly ash, if used, shall not exceed 35 percent by weight of the total cementitious material, shall conform to Section 9-23.9 and shall be limited to Class F with a maximum CaO content of 15 percent by weight.
   Ground granulated blast furnace slag, if used, shall not exceed 30 percent by weight of the total cementitious material and shall conform to Section 9-23.10. When both ground granulated blast furnace slag and fly ash are included in the concrete mix, the total weight of both these materials is limited to 35 percent by weight of the total cementitious material. As an alternative to the use of fly ash, ground granulated blast furnace slag and cement as separate components, a blended hydraulic cement that meets the requirements of Section 9-01.2(4) Blended Hydraulic Cements may be used. The water/cement ratio shall be calculated on the total weight of cementitious material. Cementitious materials are those listed in Section 5-05.2. The minimum cementitious material for any mix design shall be 564 pounds per cubic yard.

2. **Submittals** – The Contractor's mix design shall be submitted on the most current WSDOT form 350-040EF to the Engineer or the State Materials Laboratory's QPL Engineer. Mix designs that are submitted to the QPL Engineer shall be done in accordance with QC XX.
   The Contractor's submittal shall include the mix proportions per cubic yard, test results from beams and cylinders, and the proposed sources for all ingredients including the fly ash. The mix shall be capable of providing a minimum flexural strength of 650 psi at 14 days. Evaluation of strength shall be based on statistically analyzed results of five beam specimens made according to WSDOT T 808 and tested according to WSDOT T 802 that demonstrate a quality level of not less than 80 percent analyzed in accordance with Section 1-06.2(2)D. In addition the Contractor shall fabricate, cure, and test five sets of cylinders, for evaluation of 28-day strengths, according to WSDOT FOP's for AASHTO T 22 and AASHTO T 23 using the same mix design as used in fabrication of the beams

   Mix designs submitted by the Contractor shall provide a unique identification for each mix design proposal and shall include the production facility and test data confirming that concrete made in accordance with the proposed design will meet the requirements of

these Specifications and the 28-day compressive strength result. Test data shall be from an independent testing lab or from a commercial concrete producer's lab. If the test data is developed at a producer's lab, the Engineer or a representative may witness all testing.

3. **Conformance to Mix Design** – Cement and coarse and fine aggregate weights shall be within the following tolerances of the mix design:

Portland Cement Concrete Batch Weights, per cubic yard of Concrete		
Cement	+5	-1%
Coarse Aggregate	+ 30 Pounds	- 30 Pounds
Fine Aggregate	+ 30 Pounds	- 30 Pounds

If the total cementitious material weight is made up of different components, these component weights shall be within the following tolerances:

a. Portland cement weight plus 5 percent or minus 1 percent of that specified in the mix design.

b. Fly ash and ground granulated blast furnace slag weight plus or minus 5 percent of that specified in the mix design.

c. Microsilica weight plus or minus 10 percent of that specified in the mix design.
Water shall not exceed the maximum water specified in the mix design.
The Contractor may initiate minor adjustments to the approved mix proportions within the tolerances noted above without resubmitting the mix design.

Changes in production facility, aggregate source, admixtures, portland cement, low alkali cement, blended hydraulic cement, fly ash, ground granulated blast furnace slag, microsilica fume, metakaolin, blended supplementary cementitious materials, aggregate and cement weights that surpass the tolerance limits, and changes in proportions of the other listed materials will require development of a new mix design, and resubmittal to the Engineer or for QPL approval. Mix designs that require resubmittal for the QPL must be approved prior to use. ~~The Contractor shall notify the Engineer in writing of any proposed modification. A new mix design will designate a new lot.~~

Attach #9
15-02

Washington State Department of Transportation

RECYCLED MATERIALS REPORTING

CONTRACT NUMBER:	CONTRACT TITLE:
CONTRACTOR:	ENGINEER:

		RECLAIMED HOT MIX ASPHALT	RECYCLED CONCRETE AGGREGATE	RECYCLED GLASS	STEEL FURNACE SLAG	OTHER RECYCLED AGGREGATES	CONTRACT TOTAL QUANTITY
Fine Aggregate for Portland Cement Concrete	9-03.1(2)						
Coarse Aggregates for Portland Cement Concrete	9-03.1(4)						
Aggregates for Hot Mix Asphalt	9-03.8	see below					
Ballast	9-03.9(1)						
Permeable Ballast	9-03.9(2)						
Crushed Surfacing	9-03.9(3)						
Aggregate for Gravel Base	9-03.10						
Gravel Backfill for Foundations	9-03.12(1)						
Gravel Backfill for Walls	9-03.12(2)						
Gravel Backfill for Pipe Zone Bedding	9-03.12(3)						
Gravel Backfill for Drains	9-03.12(4)						
Gravel Backfill for Drywells	9-03.12(5)						
Backfill for Sand Drains	9-03.13						
Sand Drainage Blanket	9-03.13(1)						
Gravel Borrow	9-03.14(1)						
Select Borrow	9-03.14(2)						
Common Borrow	9-03.14(3)						
Foundation Material Class A and Class B	9-03.17						
Foundation Material Class C	9-03.18						
Bank Run Gravel for Trench Backfill	9-03.19						
Other Aggregate Materials (total quantity not required)	9-03						
TOTAL (recycled materials and contract total quantity)							

		RECLAIMED HOT MIX ASPHALT	RECLAIMED ASPHALT SHINGLES		STEEL FURNACE SLAG	OTHER RECYCLED MATERIALS	TOTAL QUANTITY
Hot Mix Asphalt	5-04.2						

I declare that the statements made in this document, including attachments, are complete, true and accurate.
Signed by an authorized representative of the Contractor

CONTRACTOR REPRESENTATIVE NAME	SIGNATURE	TITLE	DATE

INSTRUCTIONS:

The Contractor shall report the quantity in ***tons*** for each type of recycled material that was used for each of the listed materials. If the Contract did not include the listed material or recycled materials were not used for this material a "0" shall be entered in the box. The Standard Specifications in Section 9-03.21 do not allow the use of recycled materials in the boxes that are shaded. If the Contract Provisions allowed and the Contractor utilized recycled materials for any of these items the amount of recycled material shall be entered in the box. The contract total quantity for each aggregate material (e.g., fine Aggregate for Portland Cement Concrete) is the total weight in tons and includes both recycled and natural occurring materials. The total quantity for hot mix asphalt (HMA) is the total HMA weight in tons and includes recycled asphalt pavement (RAP) and new HMA materials.

Other recycled aggregates include other material sources that are utilized on a project. These sources include on-site recycling and aggregates from returned (uncured) concrete. Roadway excavation and embankment are not allowed in the quantity for other aggregate materials or other recycled aggregates.

Attach cost estimates as required in Section 1-06.6 of the Standard Specifications when the total percentage of recycled aggregate and concrete is less than 25 percent of the required amount for the entire Contract.