MEETING SUMMARY

SHRP2 SERVICE LIFE DESIGN FOR BRIDGES (R19A) SOUTHEAST PEER EXCHANGE

TO	Raj Ailaney, Patricia Bush, Pam Hutton
COPY	Sam Rosenblum
PREPARED BY	Mike Bartholomew
MEETING DATE	March 27, 2019
LOCATION	Embassy Suites Richmond, 2925 Emerywood Parkway, Richmond, Virginia

Background

The Federal Highway Administration (FHWA) in conjunction with the American Association of State Highway Transportation Officials (AASHTO) and the Transportation Research Board (TRB) have established the 2nd Strategic Highway Research Program (SHRP2) to address four focus areas – Safety, Renewal, Capacity, and Reliability. Project R19A – Service Life Design of Bridges, one of the Renewal projects, is an innovative technology approach being promoted to ensure that new more durable bridges are designed to remain operational for 100 years or more.

To assist agencies with advancing the implementation of Service Life Design, FHWA sponsored—and the Virginia Department of Transportation (ODOT) hosted—a peer exchange with the Florida Department of Transportation (FDOT), Tennessee Department of Transportation (TDOT), Louisiana Department of Transportation (LaDOT), and the R19A Subject Matter Expert (SME) team in Richmond, Virginia, on March 27, 2019. The peer exchange provided a forum for participants to discuss and exchange ideas on Service Life Design.

Twenty-five attendees participated in the peer exchange, including representatives from AASHTO, FHWA Headquarters, State representatives, and representatives from private engineering consulting firms. The peer exchange was formatted to provide a mix of presentations and facilitated roundtable discussions, as shown on the agenda in Appendix A. This structure provided attendees with several opportunities to collect information from their peers and examine different ways to implement Service Life Design. Representatives from Virginia shared their noteworthy practices and strategies as wells as the challenges and barriers they experienced in applying Service Life Design. The event began with opening remarks from AASHTO, FHWA, and ODOT, and was followed with the technical sessions and group discussions.

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Service Life Design - Key Peer Exchange Findings

Virginia, as an IAP Lead Adopter agency has previously researched the concept of Service Life Design. They have already adopted the Avoidance of Deterioration approach with the use of different levels of Corrosion Resistant Reinforcement (CRR). They conducted the work on R19A to investigate the latest research in Service Life Design. They have acknowledged they need to investigate the use of more durable concrete mixes in conjunction with the lowest grades of their CRR to achieve longer service life.

As has been found at other Peer Exchanges, the terminology regarding AASHTO's definitions of Design Life and Service Life causes confusion.

The Nordtest NT Build 492 Test for chloride migration coefficient is a European standard. The test has not been known by many of the states prior to the R19A project. VDOT sees it as difficult to push for adoption of these tests without putting out a mandate for its use.

The through-life process integrating Design, Construction, and In-Service Operations appears difficult to implement on an organizational level. The agency's internal structure does not typically have the necessary communication protocol for the different groups to work together to implement this process. It was suggested that FHWA could investigate developing a program that can help states better organize themselves.

Peer Exchange Discussion Notes

1. Introduction to SLD

Why are there not as many publications regarding steel structure standards for service life design as there is for concrete?

Unsure, currently publications are based on real world data of steel structure deterioration, rather than research leading to development of equations.

Development of coating systems and new coating types seems to be the focus of EuroCode, as well as stainless steel types or galvanized steel types (specifically zinc contents).

Reliability Index relies on materials remaining pristine.

Good point.

What do you consider differently between a coastal and non-coastal environment for the SLD mathematical models?

Average temperature of exposure and concentration of chlorides (de-icing salts vs atmospheric or splash exposure) are the main differences. Cited two bridges that were looked at: one in NY, one in FL.

What is the goal for the AASHTO R19A? Will it be included in future specs?

To create standalone guide specifications. Sometime in the future incorporate them with LRFD specs after a few years of feedback and voluntary adoption by individual agencies.

Has the fib included considerations for climate change in the reliability models?

There is a standard deviation in variables used. Typically, when collecting exposure information, weather stations and historical data were used to determine the mean temperature of the standard deviation near the structure. University of Denmark has a project on climate change's effects on structures (wind, wave, temperature, loading, etc.).

States could potentially research climate change individually.

Confederation Bridge pier design is a phenomenal way to mitigate splash zone damage.

We know the splash zone is the worst place for deterioration and are working on design methods to mitigate this, including changing geometric designs over time

2. Implementing SLD for Concrete Structures

Is AAR (Alkali-Aggregate Reaction) the same as ASR?

Alkali-Silica Reaction is a form of AAR. There is also Alkali-Carbonate Reaction (ACR).

Why is the water-cement ratio so high in fib Bulletin 34?

The data is available despite not being needed in most cases.

Based on fib Bulletin 34 the Fly Ash mix performs better than the Silica Fume mix?

Not exactly. It's hard to have an exact comparison due to different ageing factors (and time to cure). Not apples to apples since different mixes are used for different reasons.

3. Group Discussion – What does 100yr SLD mean?

100yr service life =/= 75yr design life.

There are bridges in VA standing for 80yrs fine but 40yrs in bad condition despite prior specifications requiring 50yr design life. Geography and other confounding factors contributed to this.

Inspection and maintenance cycles should be critically examined to determine how they affect the life of structure.

In 2007 the designers and maintainers of the Confederation Bridge came together and ran tests utilizing concrete samples placed in the splash zone of the bridge and found deterioration results to be what was expected. There should be a way to monitor the expected vs actual service life and deterioration rate of your structures to adjust maintenance and inspection plans over time. A durability monitoring schedule/program using core samples of the bridge vs mathematical models for deterioration would be useful going forward.

ADT of different bridges is not included in the equations shown?

ADT is included in design, load ratings, and maintenance. Falls under structural design rather than service life design. No durability models seem to include ADT, but it could potentially be a good idea for the future.

The asphalt industry is also having an issue where ADT and axle loads are being said to not matter if designed correctly.

There are load factors in design for the ADT. Including it in durability models might be double dipping.

Perhaps talk about the service life of the wearing surface in regard to the ADT (sometimes even considered sacrificial) rather than the service life of the structure underneath. Wearing surfaces are not structural in nature.

Most of the presentation does not take into account the wearing surface.

There is always a fight between pavement and structures on how to quantify loads (point vs distributed).

I think flexibility is one of the biggest contributors to the problems we're seeing. We're designing our bridges to be too flexible.

If you have a crack that's exposed to salt water, the model does not cover that. Water pressure on one side, with oxygen on the other.

Load factors come into play with the flexure. Cover is not necessarily the solution either since it allows cracks to open wider. Good materials need to be the focus.

There has been a tendency to make flexure requirements looser (or ignore it all together) causing recent structures to be too flexible.

4. Goals of VA's R19A Participation

A slide showed there was little difference between Epoxy-Coated steel and Carbon steel reinforcement service life. (A VDOT research council study published in 2006)

Even though there is an epoxy coating, there is propagation of corrosion inside the steel underneath the epoxy. There is not much difference between black bars and epoxy once a crack has occurred. There is a disconnect between the labs and field results. There are a few different factors that potentially cause this: concrete cover quality and depth, maintenance and inspection routines, and others.

5. Overview of Material Testing for SLD

What values do you use for permeable concrete?

2500 coulombs. 1500 for the Hampton Roads.

28 days to cure and 24hrs to test is a long time to wait during construction for the NT Build 492 Test.

Typically, samples are lab cured. But cores can be used from the site.

How expensive is the testing equipment for NT Build 492 Test?

I can find the price points, Iowa has bought some. A single test from an external lab will cost about $1000 though.

Is the NT Build 492 Test something you recommend for all concrete, deck concrete, or something else?

This test is for when the controlling deterioration is chloride.

What is one of the more sensitive values that affect the NT Build 492 Test?

W/C ratio, fly ash, pour solution (cementitious material), etc. Anything that affects electric potential will affect this test more. There is literature available. Generally, we use the test method that the model is calling for.

Do we want the coefficient to be higher or lower for the NT Build 492 Test?

Like golf, we want it to be lower.

What is the target value/what is a good value for the Measured Chloride Migration Coefficient?

We had may tests, assumed a normal distribution, took the mean, applied a 95% confidence level (multiplied by 1.64). If this was less than the target, we deemed it acceptable. This is described in the fib Bulletin code and covers non-conformance.

Did you look at weathering steel etc. for the coating?

ASTM A1010 steel was used. We looked at corrosion loss for embedded piles. The webinar last week shows codes with recommended corrosion rates.

6. Chloride Penetration Resistance and Link to SLD of Virginia Bridge Decks

What is the map based on?

The actual exposure. The usage of de-icing salt would be up to the districts though, so that is something to consider going forward.

What was assumed for the migration coefficient, and is that location specific?

The data gathered is on slide 1a, from here the migration coefficients are derived, not assumed. At least 3 samples per bridge at 28 days cured. The coefficients are bridge specific. You may want to go back and look at the product put out by specific suppliers.

Sometimes the data we have was not meeting the suggested data from fib. Overall what is being done is the correct course of action based on this analysis.

7. Group Discussion – Challenges of Durability Testing

VDOT sees it as difficult to push for adoption of these tests without putting out a mandate. Structural members are either go or no-go, buy or don't buy, there is no reduced payment option or pay factor option.

Do you think mandating these tests is beyond our ability?

Perhaps it can be used as a pay factor; if it passes by a sufficient margin, there's a bonus, if it barely passes, the payment is the normal pay, if it barely doesn't pass there's reduced pay, and if it fails by too much it is rejected fully.

Do you see any value in trying to implement NT Build 492 Test?

If found to be viable, we can start with 10 or so bridges and use them as an experiment. The first step is to make a correlation between NT Build 492 and the other AASHTO verified tests. There is a better chance for adoption if it comes through an AASHTO spec.

The model for NT Build 492 already gives thresholds for acceptance. Maybe look at the implications of the model and use that to assess the impacts.

We have so many concrete suppliers for bridge decks. We cannot just implement NT Build 492 without other plans in place. We tried to implement 2016 standards in a similar time frame but could not.

What results do you get from these current tests?

29 coulomb/cm

So, you need to be able to relate these results to NT Build 492. There have been parallels made in the past.

8. Service Life of Bridge Decks – Influence of Cracks

Are the cracks in the top of the deck? Did you investigate cracks in positive/negative regions?

I left some information out that was not necessary for the presentation but can send the report later if necessary.

The modeling shows that the influence of cracking is negative. Do you observe corrosion taking place as well?

Yes, we measured the rust in each location and found a higher concentration of rust in cracked areas than uncracked as well.

9. VDOT Materials – Low Crack Concrete

We specify 4000psi but the chart for Compressive Strength and Permeability shows 4000-6000psi. We have talked about changing to 3000-5000psi to further reduce cracking.

If you stay below 5000psi with the correct water content ratio (0.4) you will be fine.

What's the maximum number of bags per yard you're looking at?

1 bag = 94lbs so 6 bags.

How much of the component did you use?

We used the pre-blended. In earlier days we'd buy the component and add it, but our experience was not that good.

In my experience with these types of concrete is to add the additives on site and pour, not before.

Yes, the concrete can lose its slump very quickly otherwise.

10. VDOT Specification for Corrosion Resistant Reinforcement

What was the crack size to reduce reinforcement?

Same size. The greater the depth, the greater the crack. VT research shows when the bar size is smaller, the concrete cracks before a larger bar would.

Roughly what do you use for longitudinal steel?

1% over the native area. Over the piers is 1% of the cross-section area.

We started using 7" rebar spacing with #5 bars.

The other way we design is to design for the beams in the positive moment, then put 50% in the negative moment areas.

In VA we're using stainless steel in the decks, right?

For the Interstates.

All the concerns for concrete decks cracking are due to the rebar being used?

You want good concrete regardless of the steel inside. The steel used may change based on price, but the concrete should always be good and that should help the most.

What is the cost per pound for stainless?

$2/lb vs less than $1/lb for black steel.

Is MMFX better than stainless?

It depends on quality and size and other factors. Chromium content differs which is the controlling factor. Chloride resistance is better as well. Regardless, the focus is put on the good concrete to ensure that chloride ingress does not affect whichever steel is used. [Summary Guide Appendix C, Chloride Threshold…. Word Doc was brought up on the screen here. A couple tables, including C2.4 Low-Carbon Chromium Steel were referenced. Figure 2 with the fib distribution in orange, black, and red were compared and Table 10 was shown to be derived from there. Table 11 referenced MMFX using both good and poor-quality concrete. So, with MMFX you still have to take care of the concrete.]

Is $2.25/lb the installed price? What is MMFX price?

Yes. High Steel has a chart somewhere. MMFX is in the $1.50/lb range.

For the chlorides, is there a difference between Calcium and Sodium chlorides?

The issue with the chlorides is the chloride, the other chemicals don't matter as far as the steel goes. But other chemicals used in de-icing compounds are harmful to the concrete. Magnesium does stick better and thus has more chance to stick to the concrete than other compounds.

There is paint that is $300/gal we had put on concrete blocks and left on the shores of HRBT for 3 years. Nothing has happened to them. So, we are looking at putting that in more places where chlorides accumulate and don't wash/move away easily.

11. Group Discussion – Avoidance of Deterioration vs. Design Based on the Environment

Virginia has pretty much adopted the avoidance approach, but we wanted to open up the topic to what you all thought was the best approach.

It seems getting to the source and fixing the problem (stainless) is the obvious approach

While true, finances are not always in place to make this happen.

VA uses traditional deck design, whereas other states use a lot less steel in the deck, but VA sees this as bringing about greater maintenance issues. We need to look at the deck concrete placement. Sometimes, because of construction time or traffic control issues, we allow the pour to be done a certain way, but others we allow the contractors to decide if they will assume the risk of pouring a certain way. We need to look at a multitude of solutions, not just one at a time. Some say we should focus on design life, some say focus on service life, but focusing on both sounds like the right call.

When I first heard the terms I thought the two, design and service life, were the same thing and considered all variables.

I don't know how the terminology originated, but it did mess up how people think about the terms.

When LRFD came out it was like "oh, do this and you have a 75-year design life," but now we're seeing that isn't the case. Maybe service life design is the answer to that. But there are components that seem like they will never last that long.

It isn't just about replaceable vs. non-replaceable components. There are components that will not last that long like bearings, joints, and coating systems.

What is the difference in maintenance between avoidance and design approaches?

Generally, for non-replaceable reinforced concrete items, the owner desires no major repairs to be done during the life span. Preventative maintenance (cathodic protection) extends the service life. Cyclical maintenance (bridge washing, deck crack repairs) are also necessary. If these are difficult, the design should better take them into account. The aim for these easier/cheaper maintenances is to avoid more difficult/expensive repairs and maintenance later. In the summary, there are RFP language guides to ask for these things.

Simply cleaning the bridge can be expensive, but if we had gotten the money every 5 or so years to preventatively clean the bridges, we might not have had to replace some of the ones we did.

I think the original question about design vs service life needs clarification. We see design, service, design-service, and service-design. It's confusing for people.

This seems like we're harping on a single design style when it needs to be incorporated into the current design style. We did the same thing with ASD and plastic design before realizing we needed them both.

Agreed, but this currently isn't in the codes, so we are trying to raise awareness and get it to be adopted as well. Local available materials, skill of labor, and environmental aspects all need to be considered during the design vs avoidance debate. Let's say you have a 2.5" cover dimension you want to use in the plans. For the math you use 2" instead, with a half inch sacrificial layer.

In some places, the deterioration of steel is up to 1" in 20yrs.

For piling, since you can't take them out, we had to go with a corrosion allowance design style. This means for a 75yr life we had to account for all the corrosion that can take place during that time, and let it happen. It was buried in soil with contaminants.

There was a Navy pier where the piles were designed with the same thought process, and they eventually had to be jacketed since the assumptions were incorrect. It's a good idea to periodically check and ensure your assumptions are correct. Moving forward, other piles were jacketed from the get go in an avoidance approach to ensure the same issue doesn't happen again.

12. Design Issues – How is Concrete Cracking Taken into Account?

fib says that cracks 0.012in or smaller can be considered uncracked, but there may need to be discussion about if that is acceptable.

A problem with specifying a crack width is that they change all the time due to expansion and contraction. The density of cracks also matters. Concrete will always crack though.

For concrete pipe there are two standards: a 1/100" crack with a certain length and depth is the greatest defect that will be accepted. This came about from someone picking up a feeler gauge from the ground and deciding to use that as the quality assurance tool (hilarious).

Contractors seem to be giving pushback in some states when it comes to testing the concrete.

Some contractors do resist testing the concrete early and end up having to do more tests during pours, which drives the contractors crazy. The onus is still on the contractor to meet the demands of the owner/designer/agency, even if they drive up their own costs through non-compliance and dragging their feet.

13. Steel Coatings – Webinar Presentation

The Indirect De-Icing Salts zone, what is the size of the zone?

There is guidance in EuroCode that describes the envelope that includes 1m below the roadway.

Most bridges in VA are 16'-6", so would we have to consider this for all the bridges?

There are studies that show the cloud can go up to 22' regularly.

In Iowa there is widespread de-icing salt usage, and the lane where trucks drive a lot there is considerable corrosion in the girders of the overpass bridges.

[EuroCode 3, Del 1-4 design of steel structures was referenced.]

14. Construction – How can we verify the durability properties specified in design are achieved during construction?

It's easy to talk about these considerations, it's another thing to actually do it. VDOT has so many sections that need to work together, but they don't always. We have construction inspectors that are supposed to do the job, follow the books, and come to the office if they need anything, but many inspectors don't do their jobs. When issues do arise, there is a lot of finger pointing rather than fixing the issue.

So, what can you do to change that?

We have training for construction inspectors going to work on bridges since they do not have the knowledge. The training program is going statewide so that those who are wrong can be corrected.

Standards for testing and an addendum to guide inspectors on proper inspection techniques will help.

You're suggesting a document that would cover all this?

During P3 projects they don't have time to be looking for answers, so this way all the answers are contained in one place.

Current R19A publications do part of this already, but not everything. The Summary Guide has five main sections and six appendices. The first two appendices are RFP, there's an appendix for critical chloride threshold, there are design example reports, and an example construction specification. This goes through the AASHTO specification and provides supplemental provisions. This is partially what you want, but you also want instructions for the construction managers and staff.

Obviously, you can't include everything since this is the initial document. But if you could reference it and build another appendix as a referencing system.

The current publications are very general because it would be tough to get specific on exactly how to have the CIs and CMs do their jobs in every case in all 50 states.

A lot of what we've talked about is new construction and initial testing with a program to identify this down the road. Another issue is tracking all of the data and keeping it organized. One bridge can be an issue now with the current methods, what about a new method applied to thousands of bridges?

A "birth certificate" would show what was intended in the design to help keep track of a baseline model, what was actually built to show what you're working with in comparison, a maintenance plan that can be checked off as you go, and for long term monitoring you could keep everything together in one folder.

There is something similar being started in the records at VDOT, but it is slow to adopt.

The birth certificate would include everything from the get go, and not require finding information later as everything would be properly and easily filed away together, including data on individual components.

The question isn't necessarily how to do it, it's how to do it practically, as that is a lot of data to collect and keep in one place.

Excel would be a simple program to use for a lot of the information. Important information should naturally be prioritized. How you store that information would be up to interpretation and best ideas.

In VA, everything is controlled by an outside agency from VDOT. For the last 4 years we've been trying to get high performance laptops for engineers. So, we are still taking baby steps. For instance, we had to do GPR on a bridge, and the client had to take all the data, create a report, and send it to us because we have nowhere to store the data.

When bridges first began being designed for cars (1914ish) a basic code was developed. We're at that same point now with service life design right now (well, maybe 1915ish). We're still ironing out the Service Life Design process, but we aren't going to go anywhere if we just say: "well this is too hard."

Do you have any NDT technique to check for chloride infiltration?

There's a corrosion ladder system that can be used. Steel bars on a plastic frame are installed during construction with known depths and you periodically measure the potential to see if the steel is corroding over time.

We're worried about the tech being obsolete and forgotten in 20yrs. We've had cathodic protection systems where people didn't plug in the wires and deterioration happened quicker than expected to the bridge.

The entire Confederation Bridge was wired for future cathodic protection. It's good practice to have it ready to be plugged in when needed, rather than design for it later.

15. What Organizational Structures are required to successfully achieve longer lasting bridges?

VDOT chief engineer loves bridges, so that's a good outlook.

Louisiana DOT has a lot of individual groups that may or may not interact with the chief engineer and the design/construction process. This causes tribalism and each department looking out for their own best interests as far as reporting bridge conditions and maintenance programs. There are a lot of political justifications for things rather than data-based justifications.

VDOT has begun creating their own lists and giving them to the commissions to choose from, rather than letting the commissions do what they want. This allows for better transparency and best practices to pull through.

VDOT gives funding to the district engineers rather than to the maintenance groups to ensure the money is better spent. CIs though do just about everything from roadways to signage to bridges and don't have the necessary specialized training for it.

At the district office there is a bridge crew that has specialized bridge knowledge and are very effective.

Maybe the FHWA should look into developing a program that can help states better organize themselves.

Everything seems to fall into asset management. How does a state actually use preservation activities and consider life cycle planning? Right now some of VDOT is working under closed doors to get a budget, asset management plan, and performance measurements together.

Appendix A – Agenda

SHRP2 R19A Service Life Design for Bridges
Southeast Region Peer Exchange

March 27, 2019 – Richmond, VA
Embassy Suites Richmond, 2925 Emerywood Parkway

Time	Topic	Speakers
8:30 – 8:50 am	**Welcome and SHRP2 Introduction** • FHWA, AASHTO, & State Introduction (20 min)	Raj Alainey, FHWA Patricia Bush, AASHTO Prasad Nallapaneni, VDOT
8:50-10:15	**Service Life Design Concepts** • Introduction to Service Life Design (SLD) (30 min) • Implementing Service Life Design for Concrete Structures (30 min) • Group Discussion Topic – What does 100-yr SLD mean? (20 min)	Mike Bartholomew, Jacobs Brad Pease, COWI All participants
10:15-10:30 am	**Break**	
10:30-12:00 am	**R19A Implementation Updates** • Goals of Virginia's R19A Participation (10 min) • Overview of Material Testing for Service Life Design (25 min) • Chloride Penetration Resistance and Link to Service Life Design of Virginia Bridge Decks (30 min) • Group Discussion Topic – Challenges of Durability Testing (25 min)	Prasad Nallapaneni, VDOT Brad Pease, COWI Madeleine Flint, Virginia Tech All participants
12:00-1:00 pm	**Lunch**	
1:00-2:20pm	**R19A Implementation Updates (continued)** • Service Life of Bridge Decks – Influence of Cracks (20 min) • VDOT Materials – Low Crack Concrete (20 min) • VDOT Specification for Corrosion Resistant Reinforcement (20 min) • Group Discussion Topic – Avoidance of Deterioration vs. Design Based on the Environment (20 min)	Soundar Balakumaran, VRC Harikrishnan Nair, VRC Prasad Nallapaneni, VDOT All participants
2:20-2:40 pm	**Break**	
2:40-4:30 pm	**Group Discussion Topics** • Design Issues – How is concrete cracking taken into account? • Construction – How can we verify the durability properties specified in design are achieved during construction? • In-Service – How can a regular monitoring plan be implemented to verify that performance matches design intent? • What Organizational Structures Are Required to Successfully Achieve Longer Lasting Bridges?	Mike Bartholomew, Jacobs – Facilitator All participants
4:30-5:00 pm	**Wrap Up & Adjourn** • Fill Out Evaluation Forms	Mike Bartholomew, Jacobs

Appendix B – List of Attendees

SHRP2 R19A — Mar 27, 2019

Keith Williams	VDOT - Materials
Ron Simmons	FDOT - SMO
Alan Johnson	VDOT - Richmond S&B
Rajendra Dhakal	VDOT - CO
Kinda Katrib	VDOT - CO
Hamid Ghazizahedi	VDOT - CO S&B
RAJU IYER	VDOT CO S&B
Cody Miear	VDOT Richmond Dist. S&B
JOHN WRIGHT	VDOT RICHMOND DIST. S&B
Jim Swiswer	VDOT MATERIALS - ELKO
Joseph DeJesus	Jacobs Engineering
John Gzal	Jacobs
Houston Walker	Tenn. DOT - Structures
John Schuler	VDOT Material
Thomas E Darby	VDOT Materials
Ehsan Abdullah	VDOT ~~structure & Bridge~~
Kelly Kemp	LA DOTD Bridge Design
Junyi Meng	VDOT CO. S&B
Harikrishnan Nair	VTRC/VDOT
Soundar Balakumaran	VTRC / VDOT
Prasad Nallapaneni	VDOT S&B.
Ray Mulaney	FHWA HQ.
Ben Rogers	Cowi A/S
Mike Bartholomew	Jacobs

Appendix C – Summary of Evaluations

What were the most important ideas you learned from the workshop?

Protective coatings in SLD
Concrete quality importance.
Introduction to this subject. Introduction to service life because as a junior engineer, my experience was low.
Service life design for steel structures.
Different perspective to address service life design.
Material vs. workmanship vs. environment vs. specifications.
Learned that sister states are coming up with similar solutions.
General principles
Peer exchange from other state DOTs.
Consideration for concrete permeability, pozzolans and impact of DEF.
Using SLD as an effective measure to achieve higher performance of structures.
Use and experience with Type K cement.

Are there questions or issues you wished the workshop had addressed that it didn't?

More best practices or service life resources.
ADT would be a parameter. A design example would be good.
Would prefer being handed power point presentation prior to delivery.
The presenters showed some projects that were designed for 100-300 years. How these projects addressed SLD?
Worked example comparing two or three alternates.
Cost effectiveness and evaluation of SLD

Would you like to learn more about the SHRP2 R19A product?

Yes. I'm sure I will.
I feel I am too busy, but I would hope I find time for it someday.

Additional comments:

Very useful event.
(?) bulleting 34 software would be a good distribution if available.
Great event. I really enjoyed hearing VDOTs expertise and the direction they are going.

Rating	Subject knowledge level prior to workshop	Subject knowledge level after workshop	Knowledge of SHRP2 prior	Knowledge of SHRP2 after	Overal Content Effective	Presentation Effectiveness	Provided a better understanding of implementing	I understand how Service Life Design can benefit my agency	Encouraged Active Participation	Was worthwhile	Expectations Met
1	3	0	5	0	0	0	0	0	0	0	0
2	1	0	1	1	0	0	0	0	0	1	0
3	2	1	2	0	0	0	0	0	1	0	0
4	2	2	4	1	0	0	0	0	0	0	0
5	1	2	1	3	1	0	0	1	0	1	0
6	3	0	2	2	2	1	1	1	1	1	1
7	3	3	1	3	3	5	1	1	1	4	2
8	1	7	2	5	7	7	8	4	4	4	6
9	1	2	0	3	4	3	4	5	6	4	5
10	1	1	0	0	1	2	4	6	5	3	4
strongly disagree (1-2)	4	0	6	1	0	0	0	0	0	1	0
moderately disagree (3-5)	5	5	7	4	1	0	0	1	1	1	0
moderately agree (6-8)	7	10	5	10	12	13	10	6	6	9	9
strongly agree (9-10)	2	3	0	3	5	5	8	11	11	7	9
sum	18	18	18	18	18	18	18	18	18	18	18
% strongly disagree	22%	0%	33%	6%	0%	0%	0%	0%	0%	6%	0%
% moderately disagree	28%	28%	39%	22%	6%	0%	0%	6%	6%	6%	0%
% moderately agree	39%	56%	28%	56%	67%	72%	56%	33%	33%	50%	50%
% strongly agree	11%	17%	0%	17%	28%	28%	44%	61%	61%	39%	50%