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LMC Overlays For Bridge Deck Preservation

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INTRODUCTION

- The number one cause of bridge deterioration is corrosion.
- In 2004 FHWA reported $10.5 billion spent for repairs.
- Latex-Modified Concrete (LMC) Overlays have been used since 1969 to repair, protect and preserve decks.

INTRODUCTION

- LMC overlays are usually placed on bridge decks to reduce infiltration of water and chloride ions and improve skid resistance, ride quality, and surface appearance.
- The construction of conventional LMC overlays has become increasing difficult in recent years because of traffic congestion.
- Lanes can not be closed for extended periods because of traffic concerns.

Need for Rapid Overlays

- Contractors are often forced to work at night and on weekends and during cooler weather to accommodate traffic.
- Most of the conventional overlay materials can not be used under these conditions.
- LMC prepared with a very early hardening cement has been used to construct rapid concrete overlays (LMC-VE) on bridge decks in Virginia since 1997.

Need for Rapid Overlays

- In 2009 a new very early hardening polymer modified cement was used to construct rapid overlays (PMCC-VE) on bridge decks in Missouri.
- The PMCC-VE overlays are constructed and cured the same way as LMC-VE overlays with the exception that the polymer is in the cement rather than being added as a liquid.
- VDOT constructed its first PMCC-VE overlay in November 2010.

Purpose of Presentation

- Compare the properties and performance of LMC, LMC-VE and PMCC-VE overlays.
- The presentation covers the VDOT experience as follows:

  LMC: 41 years

  LMC-VE: 13 years

  PMCC-VE: < 1 year

Results

- Construction
- Mixture proportions
- Compressive strength
- Permeability to chloride ion
- Shrinkage
- Bond Strength
- Costs
- Conclusions
- Recommendations

Construction of LMC Overlays

- Close lane for 7 days or more
- Install concrete barriers and other traffic control
- Mill deck surface
- Patch deck (if done prior to overlay placement)
- Cure patches
- Shot blast surface
- Wet surface
- Place overlay
- Cure overlay 48 hours wet and 48 hours dry
- Remove concrete barriers and other traffic control
- Open lane

Construction of LMC-VE & PMCC-VE Overlays Using 8 Hour Lane Closures

- Patching phase
- Close lane at 9 pm
- Mill deck surface
- Patch deck
- Cure patches
- Open lane at 5 am

- Overlay Phase
- Close lane at 9 pm
- Shot blast surface
- Wet surface
- Place overlay
- Cure overlay 3 hours
- Open lane at 5 am

Construction of LMC-VE & PMCC-VE Overlays Using Weekend Lane Closures

- Patching Phase
- Close lane at 9 pm
- Mill deck surface
- Patch deck
- Cure patches
- Open lane at 5 am

(may be done during weekend closure)

- Overlay Phase
- Close lane at 9 pm Friday
- Shot blast surface
- Wet surface
- Place overlay
- Cure overlay 3 – 24 hours
- Open lane at 5 am Monday

(may open earlier)

LMC-VE Overlay Construction at Night, 1998

LMC-VE Overlay Curing

PMCC-VE Overlay Over Muddy Creek, 11-19-10

LMC, LMC-VE and PMCC-VE Concrete Specifications

Property	LMC	LMC-VE	PMCC-VE
Slump, inches	4 - 6	4 - 6	5 - 9
Air, Percent	3 - 7	3 - 7	3 - 6
Lab. CS @ 2 hr, psi	-	≥ 2500	≥ 2500
Field CS @ traf., psi	≥ 3500	≥ 2500	≥ 2500
Lab. CS @ 1 day, psi	-	≥ 3500	≥ 3500
Lab. Comp. Str. @ 28 days, psi	≥ 3500	-	-
Lab. Perm. @ 28 days, coulombs	-	-	≤ 1000

VE Cement Specifications

- Cement shall be approximately 1/3 calcium sulfoaluminate and 2/3 dicalcium silicate or other hydraulic cement that will provide a Latex-Modified Concrete that meets the physical requirements for LMC-VE as indicated in this special provision.
- Cement shall be approximately 1/3 calcium sulfoaluminate and 2/3 dicalcium silicate and admixtures or other hydraulic cement that will provide a Polymer-Modified Cement Concrete that meets the physical requirements for PMCC-VE as indicated in this special provision.

Typical Mixture Proportions, lb/yd3

Mixture	LMC	LMC-VE	PMCC-VE
Cement Type	I/II	VE	VE
Cement	658	658	611
Fine aggregate	1571	1600	1620
Coarse aggregate	1234	1168	1487
Latex	205	205	-
Water (w/c $\leq$ 0.40)	137	137	244
Air, per cent	3 to 7	3 to 7	3 to 6
Slump, in	4 to 6	4 to 6	5 to 9

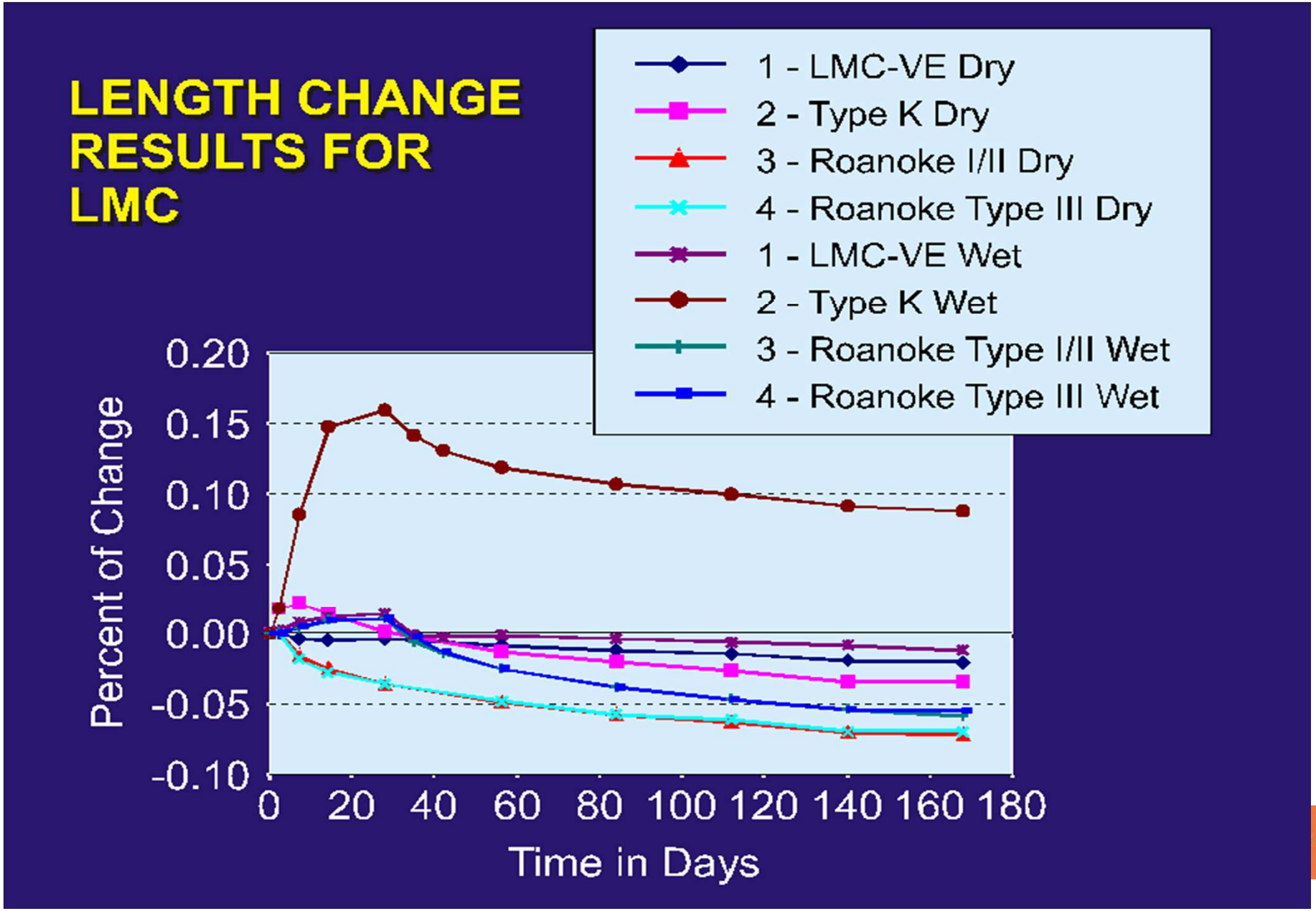
Average Compressive Strength and Modulus, psi

Age	LMC	LMC-VE	PMCC-VE
3 hour	-	3660	5210
1 day	1810	5570	6500
7 day	5400	6470	7610
28 day	5990	6980	8370
28 day Modulus	3,290,000	3,140,000	4,070,000

Permeability to Chloride Ion, Coulombs

Age	LMC	LMC-VE	PMCC-VE
28 day	1500 - 2560	300 - 1400	645
1 year	200 - 2060	0 - 10	-
3 year	300 - 710	-	-
5 year	450 - 500	-	-
9 year	100 - 400	0 - 60	-

Drying Shrinkage, ASTM C157



Drying Shrinkage

Length change (ASTM C157) of LMC-VE specimens at 170 days is approximately 0.02 percent as compared to 0.06 per cent for specimens of LMC.

Bond Strength, psi

Age	LMC	LMC-VE	PMCC-VE
1-6 months	114 - 260	153 - 276	-
3- 5 years	200 - 310	-	-
9-10 years	246 - 296	176 - 301	-

Test results are primarily for failures in the concrete deck below the bond interface.

Cost of Overlays 2006-2009 ($/yd2)

Mixture	LMC	LMC-VE	PMCC-VE
Overlay	83	90	< 90
Misc.	32	32	32
Traffic	44	28	28
Total	159	150	< 150

I64 Over Rivanna River, 2006

User Costs

- Road user cost calculations for I64 over Rivanna River for LMC-VE and LMC Overlay options were computed by Michael Fontaine of VTRC.
- Costs are based on the methodology described in the Texas Transportation Institute Urban Mobility Report (Schrank and Lomax, 2007, TTI).
- The report provides default values for time and vehicle occupancy.
- Assumptions include one of two lanes closed at Mile Marker 136, 16 % trucks, and maximum queue of 3.6 miles between 6 and 7 pm, 2006 dollars.

User Costs, I64 over Rivanna River

Option	LMC		LMC-VE		LMC-VE	
Closure	2 Weeks		2 Weekends +Mon		4 Weekends	
Days, $	Days	Cost, $	Days	Cost, $	Days	Cost, $
Weekday	10	648,730	2	129,746	0	0
Saturday	2	3,854	2	3,854	4	7,708
Sunday	2	2,656	2	2,656	4	5,312
Total	14	655,240	6	136,256	8	13,020
Savings	-	0	-	518,984	-	642,220

Construction cost= $750,000 for 5,000 yd2 overlay.

Conclusions

1. LMC overlays have very low to low permeability to chloride ion and good to excellent bond strength and perform well.
2. LMC-VE overlays are performing as well or better then LMC overlays.
3. LMC-VE overlays are typically used for situations in which lane closures cause major traffic congestion.
4. The higher cost of materials for LMC-VE overlays can be off set by lower costs for traffic control.

Conclusions

5. Including user cost savings LMC-VE overlays are even more cost effective and supportive of a sustainable environment.
6. PMCC-VE overlays are performing as well as LMC-VE overlays based on short term experience.

Recommendations

1. DOT s should continue to use LMC and LMC-VE overlays.
2. DOT s should try the new PMCC-VE overlay introduced in 2009.

References

1. Sprinkel, M. M., “Very-Early-Strength Latex-Modified Concrete Overlay,” Transportation Research Record, Transportation Research Board, Washington, D.C., 1999.
2. Sprinkel, M. M. and H. C. Ozyildirim, “Evaluation of Latex-Modified and Silica Fume Concrete Overlays Placed on Six Bridges In Virginia,” VTRC 01-R3, August 2000.
3. Sprinkel, M. M., “Condition of Concrete Overlays on Route 60 Over Lynnhaven Inlet After 10 Years” VTRC 09-R13, February 2009.

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Thank You.

QUESTIONS ?