

Rapid Set Concrete Bridge Deck Overlays

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ABSTRACT

Latex Modified Concrete (LMC) Overlays have been used to overlay and repair bridge decks since the 1960's. LMC was designed by the DOW Chemical company as an overlay product to repair bridge decks and to withstand the harsh environments and heavy traffic loads that bridge decks are subjected to. There is not a more proven or more widely used concrete bridge deck overlay system in the United States. LMC Overlays are a structural, long term bridge deck repair method that will add more than 25 years of maintenance free service life to a bridge deck. LMC Overlays also will waterproof and shield a bridge deck from chloride intrusion. An excellent riding surface with great skid resistance is also provided. Tens of thousands of bridge decks in just about every state have been repaired using LMC Overlays. With the introduction of Hydrodemolition Surface Preparation to replace jackhammers in the early 1980's and Very Early Strength Latex Modified Concrete (VESLMC) to reduce cure times in the early 1990's, the durations to install LMC Overlays has been significantly reduced. Entire bridge decks could now be repaired during "weekend only" closures or sections of bridge decks could be repaired during "nighttime only" closures. There is not a faster way to structurally repair a deteriorating concrete bridge deck. By using LMC Overlays to preserve bridge decks, costly and time consuming bridge deck replacements can be avoided for many years.

INTRODUCTION

On many bridges, due to high traffic volumes or long detours, it is very difficult to perform much needed long term bridge deck repairs without causing major traffic delays. Fast Track Hydrodemolition combined with VESLMC Overlays offers an owner the opportunity to repair their bridge decks during "non-peak" traffic volumes – typically during nighttime or weekend hours. Accelerated bridge deck preservation work of this type takes a great deal of planning and hourly scheduling. All work items on a weekend or overnight hourly schedule are typically critical therefore project coordination and past work experience are a necessity. States such as OH, KY, WV, PA, IN, NC, SC, AR, MO + others have all utilized VESLMC Overlays to successfully repair and preserve bridge decks cost effectively, with accelerated construction and with high quality. A detailed focus on a SCDOT weekend overlay job utilizing Fast Track Hydrodemolition and VESLMC Overlays in Columbia, SC performed in October 2019 is a focus of this paper. Appropriate specifications, construction procedures, pay items, plan details, schedules and typically liquidated damages are all important in the DOT bid package to insure highly quality overlays are installed that are completed on time. Contractors must have experienced workers, proper equipment, plenty of resources, excellent subcontractors, high quality material suppliers and a tolerance for risk in order to successfully perform these projects. The key work items included in all VESLMC bridge deck overlay projects are mechanical milling, fast track hydrodemolition, cleanup & water control and VESLMC Overlay installation.

SCDOT – Project P026813 – Three Bridge Rehabilitations, Richland, Co

The SCDOT Three Bridge Rehabilitations project involved "weekend only" concrete overlays and utilized Fast Track Hydrodemolition and VESLMC Overlays. Bridges S-1036 over SC277, US 21 over I-20 and US321 over I-20 just outside of Columbia, SC were scheduled be repaired and preserved while minimizing traffic impacts. All three bridge decks were in a very poor condition and repairs had to be done soon or the decks would need to be replaced. Archer Western was the low bidder on the project and selected Hydro-Technologies as their hydrodemolition subcontractor and Modified Concrete Suppliers as their VESLMC material supplier. Over 5,500 sy of bridge deck area had to be repaired in just 6 weekends. Lane closures were permitted from Friday 7 pm until Monday 5 am. The contractor faced heavy liquidated damages for lane closures that were in place outside of these allotted hours. By utilizing hourly scheduling, planning and

coordination, the job was completed in the allotted 6 weekends with minimal inconvenience to the traveling public. The SCDOT had developed excellent project specifications and plans for the project. Pay items were included for Deck Milling (5,582 SY), Fast Track Hydrodemolition (5,582 SY) and VESLMC Placement & Materials (302.3 CY). Quality control utilizing sampling & testing of the concrete, calibration & monitoring of the hydrodemolition equipment, sounding the deck after hydrodemolition to insure all deteriorated concrete was removed, pouring the decks during nighttime hours (low evaporation) and straight edging to check surface smoothness were all used to insure high quality, long lasting overlays. The project was a great success for the SCDOT, for the contractors, for the material suppliers and for the general traveling public. The new VESLMC Overlays on the decks will remain bonded and protect the existing concrete in the decks for 25+ years. At the end of the 25 year period, the VESLMC can be replaced with a second generation VESLMC Overlay and an additional 25 years of service life can be achieved.



US 21 over I-20 – Columbia, SC - Existing Bridge Deck in Very Poor Condition – Fast Track Hydrodemolition and VESLMC Overlays were selected by the SCDOT to structurally repair the deck for 25 + years.

Bridge Deck Surface Preparation using Fast Track Hydrodemolition

The fastest way to prepare a bridge deck for a new VESLMC Overlay is to utilize Fast Track Hydrodemolition. The bridge deck is first mechanically milled approximately 1" to 1 ½". Any existing overlay material on the deck should be removed with this operation. Scarification will open the pores in the concrete and expose the cracks in the structural slab for the water jet to attack. Proper milling equipment should be used for this operation to insure uniform removals and to not overload or damage the structure. The milling drum cannot ever contact or damage the top mat of reinforcing steel in the deck. Hydrodemolition will not damage the reinforcing steel. After the milling operation is complete, the deck should be cleaned and inspected for full depth cracks, for potential full depth removal areas and for any visual problems. Any necessary slab repairs should be addressed prior to the hydrodemolition operation. Before starting the hydrodemolition, the equipment should be calibrated on the existing deck concrete to determine the required flow rate, pressure, machine step, nozzle type, nozzle size and nozzle travel speed. By utilizing a trial process, the optimum hydrodemolition settings are determined so that all deteriorated concrete will be

removed with one pass of the hydrodemolition robot and a rough, highly bondable surface in the existing concrete deck is achieved. Unnecessary removal of sound concrete shall be avoided. The approved settings are locked in and then production hydrodemolition can begin. The robot then performs hydrodemolition over the entire total surface of the bridge deck. Production rates of 100 sy/hr can be achieved when utilizing Fast Track Hydrodemolition. The cut shall be checked periodically to insure that the desired results are being achieved. Upon completion of the hydrodemolition surface preparation, the deck is cleaned and washed simultaneously utilizing a specialized vacuum truck. Lightweight jackhammering (35# max) is required in areas where the milling and hydrodemolition equipment cannot access. The entire deck is sounded to insure that all deteriorated concrete has been removed from the deck. It should be noted that all hydrodemolition equipment is not equal. The recommended hydrodemolition settings for selective removal of deteriorated concrete to occur are pressure = 13,000 to 20,000 psi, flow rate = greater than 55 gal/min, the water jet hits the surface on an angle (avoids rebar shadowing) vs perpendicular and a direct impact/oscillating nozzle is used. The use of high pressure / low water volume equipment that contacts the surface with a spinning head perpendicular to the bridge deck surface should be avoided for bridge deck hydrodemolition because all deteriorated concrete will not be removed. Hydrodemolition equipment of this type is typically used for membrane removals, rubber removals from airport runways or paint stripe removals. This equipment is designed to not damage the existing concrete below. An understanding of the equipment being used is very important to any hydrodemolition project. The correct equipment must always be used or poor results will occur.



Hydrodemolition Robot performing Bridge Deck Surface Preparation on a weekend project next to live traffic

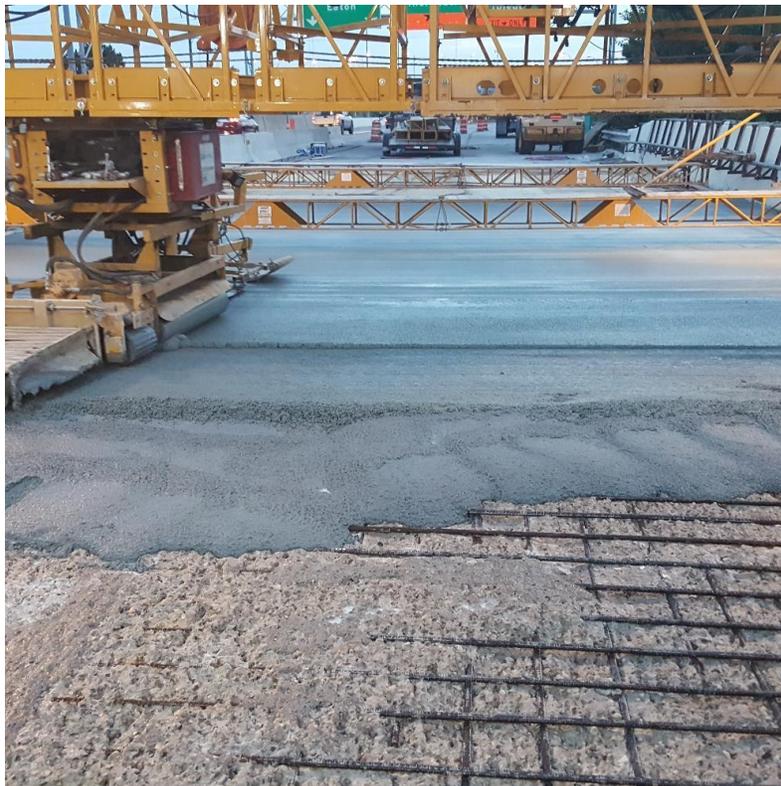
Very Early Strength Latex Modified Concrete

VESLMC is produced in mobile volumetric mixers on site at the time of the bridge deck overlay pour.

VESLMC consists of the following mix design:

- Fine Aggregate (Sand) - 1575 - 1855 lbs/cy
- Course Aggregate (# 8's) - 1106 - 1386 lbs/cy
- Rapid Set Cement (7 bags) - 658 lbs/cy
- Latex Emulsion - 24.5 gal/cy
- Water - 17.5 gal/cy - .45 w/c ratio
- Maximum Air - 7 %
- Slump - 6 to 10 in

The addition of the 24.5 gal/cy of Latex Emulsion (styrene butadiene) is what makes it a modified concrete. Using CTL Rapid Set Hydraulic Cement is what makes VESLMC an Accelerated Strength Concrete. ½" size max course aggregates are used because the material is placed at a minimum 1 ½" thickness. The smaller aggregates are ideal for this application. VESLMC has increased durability, flexibility, and bondability, when compared to conventional Portland cement concrete mixes. VESLMC is traffic ready at 2500 psi after a 3 hour wet cure. It will achieve over 6000 psi in 28 days. The cost average for VESLMC is \$1000/cy. This is significantly cheaper than Ultra High Performance Concrete = \$5,000/cy or Polyester Polymer Concrete = \$3,000/cy. Thousands of bridge decks have been repaired with VESLMC Overlays when long term, structural bridge deck repairs had to be done fast.



VESLMC being finished on a Fast Track Hydrodemolition Prepared Surface



VESLMC being placed on a Fast Track Hydrodemolition Prepared Surface

CONCLUSION

VESLMC Overlays are a dense concrete overlay system. They provide long term structural bridge deck repairs. VESLMC Overlays should never be compared or deemed equal to Epoxy Overlays, Polyester Polymer Concrete Overlays or Asphalt Overlays. These bridge deck overlay systems are temporary waterproofing overlays and do not add durability or strength to a deteriorating bridge deck. These overlay systems should only be used if the bridge deck NBI Rating is 6 or higher. The use of VESLMC Overlays offers a much wider application range. There are four applications for VESLMC Overlays. 1.) VESLMC Overlays can be used on new bridge decks to provide an immediate protective riding surface for the bridge deck that will prevent chloride intrusion. 2.) VESLMC Overlays can be used to preserve and waterproof a deck that has only initial forms of deterioration. These might be bridges that have NBI bridge deck ratings in the 6 or 7 range, meaning it is a sound deck. Hydrodemolition surface preparation is not required on these bridge decks. 3.) The most commonly used application for VESLMC Overlays is on bridge decks that are experiencing more significant deterioration and are in need of a more thorough deck surface rehabilitation. These decks are likely in an NBI condition 5 status or in some cases a 4, meaning the deck is still fair or just getting to a poor condition. The entire top surface of these decks are prepared utilizing fast track hydrodemolition. 4.) The fourth application is to replace a previously installed VESLMC Overlay that is nearing the end of its service life. This is known as a "second generation overlay". The failing overlay is removed using mechanical milling, the surface is prepared using Fast Track Hydrodemolition and the second generation VESLMC Overlay is installed. VESLMC overlays have been used during all stages of a bridge decks life span.