RAPID BRIDGE DECK RESTORATION WITH “FAST TRACK” HYDRODEMOLITION AND VERY EARLY STRENGTH LATEX MODIFIED CONCRETE

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ABSTRACT

"Fast Track" Hydrodemolition with Very Early Strength Latex Modified Concrete (VESLMC) is an effective and expedient process for performing bridge deck rehabilitation and preservation. The robotic removal process includes the use of high pressure water blasting in order to selectively remove all weakened or deteriorated concrete with a single pass of the waterjet. The resulting surface preparation is very roughened and highly bondable for a dense concrete overlay.

The use of rapid setting cement in a latex modified concrete produces a dense concrete that cures out and is traffic ready in as little as three hours. VESLMC can be poured to as thin as 1 1/2" in nominal thickness, and it will shield the deck from the penetration of chlorides, giving upwards of 25 years and beyond of renewed surface life.

The "Fast Track" process has been used by numerous agencies in addressing the quick overhaul of bridge deck surfaces while minimizing inconvenience to traffic. Work can easily be accomplished in a limited work window, such as over weekends. This makes it a popular choice in metropolitan areas and along interstates and other highly congested routes. For extremely sensitive traffic areas, the work can even be performed during overnight hours.

INTRODUCTION

The most important aspect to any dense concrete overlay installation is establishing an effective and tenacious bond with the substrate. This means making sure all delaminated, deteriorated, or weakened concrete is removed from the deck surface prior to placing the overlay. This preparation is most efficiently done with the use of hydrodemolition equipment. In addition to the removal of all weakened concrete, hydrodemolition will provide a very rough surface profile. Combine this surface profile with the use of a rapid-setting concrete overlay, and there is the opportunity to complete bridge rehab projects in 48 to 60 hours. This can only be done though with the use of a calcium sulfo-aluminate cement, combined with Latex Modified Concrete, which provides a mix that is traffic ready in as little as three hours.

A four step process is used to perform the needed work to completely rehabilitate the deck surface. This includes milling of the surface, hydrodemolition, deck clean-up, and the installation of the VESLMC.

THE “FAST TRACK” HYDRODEMOLITION PROCESS FOR RAPID BRIDGE DECK RESTORATION

The first step to the process in achieving a rapid restoration is preliminary cold-milling of the surface prior to the hydrodemolition operation. This provides two very important functions. First it removes any existing overlay material (including any existing wearing surface) to gain initial access to the original deck. Second, milling opens up the concrete deck surface to allow the waterjets to engage immediately with the cutting process. If the top of the original surface is not roughened, the jets will initially ricochet off the top of the smooth deck surface. This will result in a longer time period to cut the deck concrete.

For rapid restoration type work (such as over weekends), it is critical to remove as much material from the deck, as fast as possible. Cold-milling is the best means to do this. By limiting the mill size (25 tons or less), damage to the deck is avoided. Any microfracturing that might be left in the surface after milling will be incidental, and should be eliminated with the hydrodemolition operation through the impact or pressurization obtained by the waterjet. Most important to the milling operation is to avoid coming into contact with the top mat of deck steel to prevent damage.

The second step in the process is the hydrodemolition process, which is robotic. This includes calibration of the robot and a total surface treatment of the entire top surface of the deck. The objective of the waterblasting is to selectively remove all the delaminated or weakened concrete that now remains in the top surface, and simultaneously provide a very roughened and bondable surface.

The calibration will be determined through factors such as water pressure, optimum water flow rate, correct speed of the cutting head, step of the machine, and characteristics of the jet itself, such as the nozzle diameter, type, movement pattern of cutting head, and distance between the nozzle and the concrete surface. The initial calibration is achieved in two distinct test areas on the deck. First a desired cutting depth in a designated area of sound concrete (normally ½") is performed to show the equipment can achieve the desired removal on the sound slab and also provide a roughened and bondable surface. For "Fast Track" hydrodemolition, this requires a single pass of the waterjet to perform the necessary removal. With the same settings, the equipment is then moved to a designated area of the deck, where deteriorated concrete is perceived to exist, and with the same settings, the hydrodemolition operation is performed. After corresponding clean-up of the debris, the second test area should show that all defective concrete has been removed. If not, further calibration is necessary. When both test areas are performed satisfactorily, the calibration is deemed complete and the parameters are set for the waterjet.

After calibration is confirmed, the process of performing total surface hydrodemolition of the bridge deck can begin. The operation will begin on one end of the bridge and move along in various passes until the entire surface is completely hydroblasted. For rapid restoration projects, production is paramount in expediting the work. The key to this is in the volume of water consumed by the robot during the operation. The more water that can be run through the unit, the faster the hydrodemolition work can be performed. Some hydrodemolition pumping units can produce over 70 gallons of water per minute through the cutting nozzle, which can mean in the neighborhood of 100 square yards per hour in cutting production.

Step three includes the deck clean-up of all slurry and rubble that is left in place by the hydrodemolition operation. This needs to take place as quickly as possible behind the robot, and prior to the debris drying on the deck surface. This should be done with vacuum collection type equipment that is capable of removing both wet debris and standing water within the operation. Upon completion of the clean-up, the areas of selective removal will be quite apparent (figure 1).

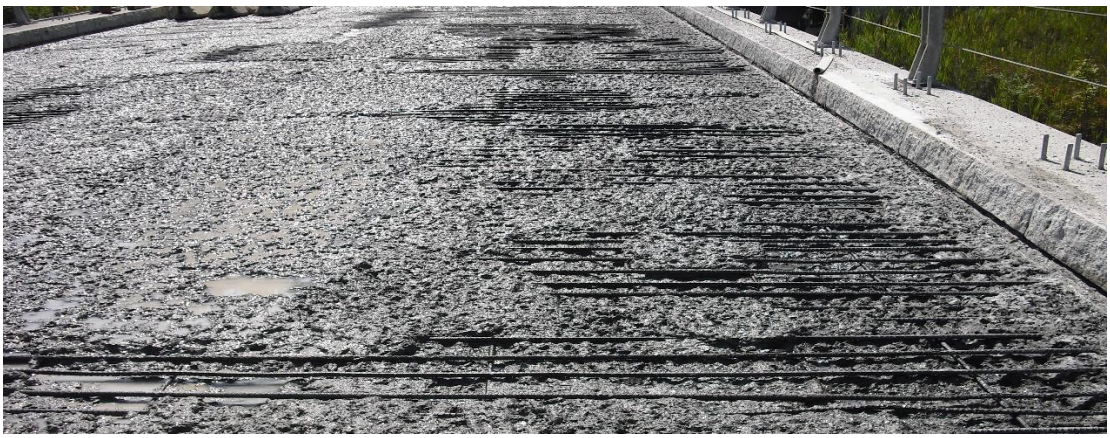

Figure 1 – Selective removal obtained through "Fast Track" hydrodemolition.

The fourth step is the actual overlay installation. Placement is done with a Bidwell finish machine designed specifically for bridge deck placements. Prior to the placement of the overlay, as a final measure, to insure a clean surface, either an abrasive blast or (preferably) a high pressure water blast in excess of 7000 psi, is performed. This insures all contaminants and laitance are removed from the surface and the pores in the deck substrate are opened up for the latex overlay to bond to it. The deck is then wetted to a saturated surface dry condition and covered with plastic to keep the deck from drying out prior to the pour. For hydroblasted surfaces, no grouting of the roughened deck surface is required for the VESLMC.

Upon placement, an immediate wet burlap cure is essential to the success of the installation. The burlap needs to stay in a very saturated state throughout the curing period, which is a minimum of three hours. The burlap is also covered with plastic to help keep the moisture locked in. After the curing period, the overlay is deemed traffic ready, provided the specified compressive strength is met within the curing period. In warmer temperatures, 3000 psi is easily achievable in three hours or less.

VESLMC

The only difference between conventional LMC, which uses a type I Portland cement, versus VESLMC is the substitution of the cement type – a calcium sulfo-aluminate cement is used with VESLMC. This cement provides for the rapid setting capabilities. Other ingredients of the mix are essentially the same. The latex is added in the form of an emulsion through the mixing water and acts as a water reducer.

The latex itself is a suspension of tiny, microscopic styrene-butadiene polymer particles in water. These particles are hydrophobic in nature, or excellent water resistors, and prefer to attach to a nonaqueous surface. Upon mixing with the other ingredients in the concrete, the polymers work to separate themselves from the emulsion and start to form an attachment to the other components in the mix (cement, aggregates), the deck surface itself, and also attract to fuse together to each other. Styrene-Butadiene latexes, such as the Modifier A, used within Latex Modified Concrete, are excellent adhesives, and provide good chemical adhesion to the existing deck concrete [1]. Because of their small size, the particles can also enter and seal capillaries that is formed as free water is used up during the hydration process. The left in place polymers densify the mix and make it very impermeable. The resulting VESLMC surface becomes the wearing surface and shielding mechanism for the original deck surface to protect it from infiltration of water and chemicals.

These specialty concrete mixes are produced on site through a mobile, volumetric mixer. Calibration of each mobile mixer used for the job is performed to verify the appropriate mix proportions and yield of the machines. Nighttime pours are highly recommended with a rapid set mix.

Due to the rapid setting nature of the VESLMC, citric acid will often be used to help control the mix temperature and delay the set time in the field operations.

CHARACTERISTICS OF VESLMC

Latex Modified Concretes (including VESLMC) offer increased durability, flexibility, and bondability, when compared to conventional Portland cement concrete mixes. This makes it an ideal product for thin lift overlays. Latex overlays can be placed as thin as 1 ½" in nominal thickness, but they are adaptable for the variable depths created with a hydrodemolished surface.

CONCLUSION

The "Fast Track" hydrodemolition methodology for preparing and preserving bridge decks has been used for over 30 years in numerous states as a tool for rehabilitation of decks. It incorporates a selective removal of deteriorated concrete while employing a monolithic repair product that is also very dense in order to prevent the infiltration of chlorides to the deck. When used as an overlay system, Latex Modified Concrete protects and extends the deck life by as much as 25 years and beyond. When it becomes necessary to make repairs in an accelerated fashion, such as over weekends, Very Early Strength Latex Modified Concrete becomes a viable option. This can be invaluable in metropolitan areas, on high volume interstates, or where ever traffic is a consideration in the project development.

REFERENCES

1.Doty, Peter A, 2004. Covered in Latex. *Roads & Bridges Magazine.*