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REPAIR SERIES: TDS-4

Title: Concrete Removal and Surface Preparation for Overlays and Partial Depth Repairs

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The primary objective when removing and preparing concrete surfaces for overlays and partial depth repairs is to provide a clean sound surface with correct amplitude and geometry. Proper surface preparation is an integral part of any repair. It enhances the performance of the new material and ensures the life expectancy of the repair.

The most common methods used for removal of concrete are pneumatic hammers, scarifiers, hydromillers, and shotblasters—each with corresponding benefits and limitations. Before concrete removal, information regarding the original construction should be obtained. Age, existing concrete strength and original mix design, location and size of existing reinforcing steel, and depth of contaminates (usually chlorides) are important factors to note. This information and other factors such as cost, speed of removal, damage to remaining concrete, and expected longevity of repair will determine which method is appropriate for concrete removal.

Patching delaminated areas that will be partial depth requires that several procedures be followed. First, the deck should be sounded using a steel hammer or chain drag. The hollow sounding areas (delaminations) should be marked. Second, shore the area for repairs, if necessary. Third, sawcut the concrete to define the repair boundaries. Sawcut depths should be approximately 1 inch (25 mm) without cutting the reinforced steel. The repair boundaries should be generally square or rectangular with vertical edges. Caution should be used not to feather edge the repair boundary. Fourth, remove the delaminated concrete using the selected method. Simple geometric shapes for patches will minimize shrinkage cracks due to stress concentrations. The sawcut shoulder will enhance the integrity of the patch. Removal should be uniform in depth to minimize stresses that can cause cracking. Remove delaminated concrete under reinforcing steel, a minimum depth of 3/4 inch (19 mm) is appropriate. Fifth, remove corrosion product from the reinforcing steel. This is usually done by sandblasting. The sandblasting will also remove loose material from the remaining concrete surface. Finally, re-clean the concrete with a minimum of 3000 psi (20MPa) high pressure water.

Technician prepares surface for partial depth repair with 15 lb. chipping hammer

REMOVAL EQUIPMENT

Pneumatic hammers are widely used for concrete removal. The hammer delivers a rapid compressive series of blows that "chip" the concrete away. Jack hammers come in various sizes. Usually a weight rating is used. Hammer sizes of 15, 30, 60, and 90 lb. (6.8, 13.6, 27.2, 40.8 kg) are common. A variety of bits are available for use with pneumatic hammers. The 15 lb. hammer is a light tool for detailed excavation around reinforcing steel as well as vertical and overhead removal. This hammer has the disadvantage of slower production rate. Its advantage is the elimination or minimization of concrete microfracturing. The 30 lb. hammer is more productive above and between rebar, but it is too big for detail work and overhead applications. Concrete microfracturing is probable when jack hammers larger than 15 lb. are used. The largest hammers, 60 and 90 lb., should be restricted to full depth repairs only—the potential for damage to the structure is very high if used for partial depth repairs.

Hydromilling or hydrodemolition employs high pressure water to remove concrete. Past research has shown hydromilling to provide the highest tensile pull-off values for new/old concrete bond strengths. Extremely high water pressures, 15,000-40,000 psi (103-275 Mpa) will remove concrete without damaging the remaining concrete or reinforcing

steel. The water will also clean the reinforcing steel. Only a final washing is needed prior to placement of the repair material. Even sound concrete can be removed to specified depths using hydromilling. This is applicable for removal of chloride-contaminated concrete that is not delaminated. This process leads to an overlay of the repair area. The benefit of greatly increased production rates for concrete removal are somewhat offset by the cost of handling the water run-off. Water volumes can be as high as 1250 gal./hr/ (4732 L/hr.) Methods for removing the suspended pulverized concrete and alkaline runoff are considerations when using hydromilling. Generally, hydromilling is subcontracted to specialists that own the equipment.

Scarifiers and milling machines are also used primarily for overlay preparation. Different machine sizes are available to match a project application. Regardless of size, the operation is the same. A drum with carbide or tungsten teeth will dig into the concrete as the drum is rotated. The weight of the machine and speed of travel will dictate the removal depth. Generally, it is more productive to remove less concrete and pass over the repair area more times. Scarifiers provide a very good profile or amplitude for concrete overlays. In a few passes the machine can remove deleterious laitance and create a substrate with approximately 1/4 inch (6.35 mm) amplitude for bonding. Scarifier production rates are faster than chipping hammers. This is offset by the fact that removals are limited to above the reinforcing steel.

Shotblasters have a variety of uses. Two examples are concrete removal and coating surface preparation. They provide good amplitude of the remaining concrete in all cases. A shotblaster propels steel shot onto the concrete surface with enough energy to abrade the concrete surface. Next, a vacuum picks up the shot and debris. The two materials are separated and the shot re-used. The self-contained unit provides continuous operation. The operator can vary the size of shot and speed of the equipment to vary the concrete removal depth. The equipment is usually available through specialized subcontractors or rental companies. Power availability should be reviewed when considering shotblasting. Shotblasters usually require 220-volt three phase power sources. Larger diesel powered ridden machines are also available.

FINAL PREPARATION

Sandblasting is an important part of final surface preparation. Two goals are achieved when sandblasting is used. Corrosion product is removed from the reinforcing steel, providing good bond with the repair material and new "life" to the rebar. Care should be taken to clean the rebar on the underside if it is exposed. Loose, bond-inhibiting materials are also removed from the parent concrete. Areas of microfracturing may be mitigated by a hard sandblast. Sandblasting can be performed either wet or dry. Wet sandblasting will minimize the dust created by dry sandblasting. However, wet sandblasting is slower and requires more cleanup.

Waterblasting is a technique used in conjunction with sandblasting to clean the repair cavity surface. This step will remove bond-inhibiting loose particulates left by the previous repair steps. It will also serve to pre-wet the substrate if completed just prior to placement of the repair material.

Removal and preparation methods, as with any other aspect of repair, must be evaluated on a case-by-case basis. The project team should consider all factors prior to work commencement. However, using the outlined methods as a guideline will generally improve your chances for success.

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