STANDARD OPERATING PROCEDURE
FOR
REPAIR OF SPALLED OR CRACKED CONCRETE

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Flood protection structures including floodwalls, pumping stations, gatewells, etc., require periodic inspection as prescribed by the Regulations. Concrete structures should be checked for spalling, porosity, cracking, and failures of expansion-joint seals.

This document provides general guidance for the repair of concrete flood protection structures that have spalled or cracked concrete. Please note that cracks or spalls that have occurred as a result of unusual loadings should be brought to the attention of USACE and a determination can usually be made regarding the cause and a plan for repair can be developed. Additionally no large concrete repair job should be undertaken without prior approval of USACE.

Spall Repair

"Spalling" is defined as a condition where a piece of the completed concrete surface has been removed. Spalling may be caused by an impact from a vehicle or tool, or it may be caused by "pop-out" from the expansion of piece of unsuitable coarse aggregate. Spalling may also occur when the underlying reinforcement is located too close to the concrete's outer surface. In some unusual cases, spalls have been observed where a piece of large structural steel was left within the concrete forms and impinged on the required rebar cover. Another cause of spalling is when concrete has cracked as a result of shrinkage or some other stress, and water enters the rigid concrete matrix via the cracking. Freezing of water in the cracks is a common cause of spalling. When spalling is present on a structure and is not repaired, progressively greater damage may be expected to be caused to the structure over time. The required cover for the underlying reinforcement steel is compromised when a section of concrete has been removed. It should therefore be repaired as soon as possible.

(1) Repair concrete surfaces with shallow spalling – less than one inch in depth - with special cements designed to permit carrying the patch to a "feathered" edge. A line of products suitable for this kind of repair is available from CTS Cements under the "DOT" brand name.

(2) Patch deeply spalled concrete with ordinary concrete made with cement; the mixture should be as similar as possible to the original concrete, but with the addition of a shrinkage compensating admixture. Saw cut the concrete around the spalled area to a depth of approximately three-quarter inch, being careful not to cut underlying reinforcing steel; remove a roughly rectangular area that encompasses the entire spall, and remove the concrete to a fairly uniform depth. Roughen the sides of the saw cut area to promote a bond between the original concrete and the new concrete. Concrete must be free of materials such as paint, oil, curing compound, bond breaker, or any material that will inhibit bonding. Mechanically remove loose,

unsound, contaminated concrete. Clean any exposed reinforcing steel by sandblasting or other mechanical means to achieve a “white metal” finish. Thoroughly clean extraneous material such as dirt, loose chips, and dust from concrete surface. If compressed air is used, it shall be free of oil. Concrete surface shall be saturated with potable water. Standing water shall be removed from surface to achieve a saturated-surface-dry (SSD) condition. Then fill the removed area with fresh concrete. A very low slump or zero slump “dry patch” mortar such as is used to repair shallow defects in new concrete is suitable for repair of spalls on vertical or near vertical surfaces. A concrete mix with excessive cement will tend to shrink. It is further suggested that a curing compound be added in accordance with manufacturer’s recommendations to reduce drying shrinkage.

Spall Prevention

Keep cracked concrete from spalling by sealing the surface with a soluble reactive silicate concrete treatment product such as "ChemTec One" or “CEMSEAL 55” or an approved equivalent product. The approved sealant will be a sodium silicate based product formulated for application by spray, roller or brush to new or old concrete. The approved product will chemically react with soluble calcium compounds (free lime) and form insoluble calcium silicates resulting in a dense, breathable, synthetic quartz-type material. The approved product will protect concrete surfaces from abrasion, freeze-thaw damage and chloride ion intrusion. The approved product will stop water seepage when the seepage is not caused by cracking or other structural flaws and will strengthen, harden, densify, dustproof and waterproof concrete permanently.

Crack Repair

Cracks also tend to lead to more serious damage, especially when structures are exposed to heavy freezing. Therefore, it is important that all cracks be repaired immediately on discovery. Cracks should be repaired by undertaking a sequenced sealing and repair program. Cracks on the top surface of the floodwall should be sealed first to prevent the further intrusion of water into the substrate. Cracks on the top, nearly horizontal surface should be repaired using either a cement-based grout or an injectable epoxy compound, depending on the crack width. Injected epoxy crack filler should be applied in strict accordance with the manufacturer’s recommendations. After all cracks have been filled and the crack filler has cured, the top surface should be sealed using the material described in “Spall Prevention” above.

After the top surface’s cracks have been filled and sealed, it is suggested that a delay of at least 72 hours be allowed for previously infiltrated water to drain out of the wall. Then cracks on the vertical side surfaces of the wall should be sealed using either a cement-based grout or an injectable epoxy compound, again depending on the crack width. Again it is important that injected epoxy crack filler should be applied in strict accordance with the manufacturer’s recommendations. Cracks down to approximately 0.0010-inches in thickness may be repaired with some of the injectable epoxy crack repair materials available on the market. Cracks less than this thickness generally will not allow the infiltration of water into the substrate and therefore do not warrant repairs.

Cracks on vertical or near vertical surfaces should be repaired starting from the bottom and proceeding up to the top. The epoxy filler should be injected through ports installed in drilled holes that are spaced evenly along the length of the crack. When epoxy begins to flow out of the port directly above the port into which the epoxy is being injected, it is time to stop the injection in that port. The injecting nozzle is removed from the port and that port is capped. Then the injection process begins again into the next port above, and the sequence is repeated until the top. After all cracks have been filled, the vertical surfaces should be sealed using the material described in “Spall Prevention” above. Sealing of the vertical wall faces may require the sodium silicate based sealant to be sprayed on.