REMR TECHNICAL NOTE CS-ES-1.8

WATER ABSORPTION AND WATER VAPOR TRANSMISSION TESTING

PURPOSE: To provide information on water absorption and water vapor transmission tests that can be performed in a laboratory to evaluate the effectiveness of various types of surface treatments used to protect and repair concrete subjected to aggressive agents in the environment.

APPLICATION: Water absorption and water vapor transmission tests performed in the laboratory make it possible to evaluate concrete sealers and coatings before they are applied in the field. Water absorption tests can be used to determine how effective a surface treatment is in preventing the intrusion of water into concrete. Water vapor transmission tests can provide information on the rate at which a material allows water vapor to escape from the substrate.

BACKGROUND: Concrete subject to deterioration from cycles of freezing and thawing, penetration of salts, weathering, chemical attack, and erosion can be sealed or coated with a surface treatment more resistant to these forces than the concrete. These surface treatments can slow the rate of or stop deterioration. However, the success of the treatment depends upon the correct choice of material and proper application. For a surface treatment to protect non-air-entrained concrete from damage, the ideal material is one that prevents water intrusion but allows the concrete to breathe (transmit water vapor).

In a study conducted at Waterways Experiment Station (WES), a water absorption test based on ASTM C 642-82 and a water-vapor transmission test developed at WES by Dennis Bean were used to evaluate surface treatments for concrete (Ref a).

PROCEDURE:

Test Specimens: The 4-in. cubes used in the tests were cast from a mixture proportioned to produce concrete with a relatively high permeability. The concrete specimens were proportioned to have: water-to-cement ratio of 0.62; 3.5 ± 0.5 in. slump; non-air-entrained; durable aggregate, 1/2-in. maximum size; and minimum compressive strength of 3,500 psi. The concrete was mixed and the cubes were cast and compacted in accordance with standard concreting and fabricating practices. The cubes were cured in the molds for 24 hr in a moist curing room (100 percent humidity and 73 ± 3 'F) and then stripped and moist cured for a minimum of 28 days. These cubes were used as both test and control specimens.

Water Absorption Tests: The cured specimens were cleaned by light sandblasting, dried at 225 ± 5 'F for 24 hr, and cooled overnight. Surface treatments were applied to the cubes and cured in accordance with the manufacturer's recommendations. After drying at 73 ± 3 'F in laboratory air for 7 days, the cubes were weighed to the nearest 0.1 g to establish initial weight. Following this procedure, specimens and controls were immersed in 73 ± 3 'F water. A minimum of 1/2-in. of water covered the specimens at all times. At 1, 2, 3, 4, and 7 days, each cube was removed, blotted with a paper towel to dry the surface, weighed to the nearest 0.1 g, and returned to the soaking tank. The percent of water absorbed was determined by calculations based on the initial weight of the concrete and the weight after submersion.

Another test for measuring water absorption is the inverted funnel method. An inverted funnel with a calibrated tube attached to the spout is placed over the surface of a treated specimen. A 3/8-in.-wide bead of silicone caulk placed around the edge of the funnel seals it against leakage. Water is poured into the funnel to the zero calibration line (care must be taken not to entrap water.) Water absorption is then measured over time by reading the volume change. This method can possibly be used to determine the effectiveness of surface treatments applied in the field.

Water-Vapor Transmission: The procedures for the water-vapor transmission test were the same as those for the water absorption test through curing of the surface treatment. After surface treatments were cured, a 2-in.-deep hole was drilled in the center of one face of each of the cubes with a 1/2-in. masonry bit. Specimens were then dusted and soaked in 73 ± 3 'F water for 5 days. When the soaking period was completed, the cubes were removed one at a time. All of the water was poured out of the hole, a paper towel was used to dry standing water, and the hole was sealed with a size 0 rubber stopper. The stopper-hole interface was sealed with hot paraffin wax. As a precaution a layer of petroleum jelly was layered over the seal. As soon as the specimens were sealed, they were weighed to the nearest 0.1 g to establish initial weight. Specimens were placed in an environmental room at 100 ± 4 'F and 40 5 'F percent relative humidity. Cubes were weighed to the nearest 0.1 g at 2, 4, and 7 days. The water-vapor transmission rate was determined by calculations based on initial weight and weight after drying.

REFERENCE: Husbands, Tony B., and Causey, Fred E. 1990 (Mar). "Surface Treatments to Minimize Concrete Deterioration, Report 2, Laboratory Evaluation of Surface Treatment Materials," Technical Report REMR-CS-17, US Army Engineer Waterways Experiment Station, Vicksburg, MS.