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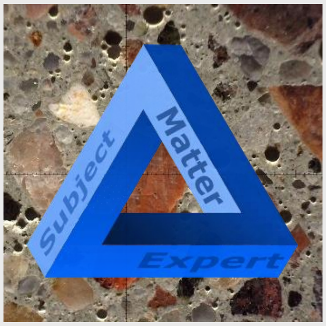
Using Ultrasonic Testing to Evaluate Concrete Exposed to Fire



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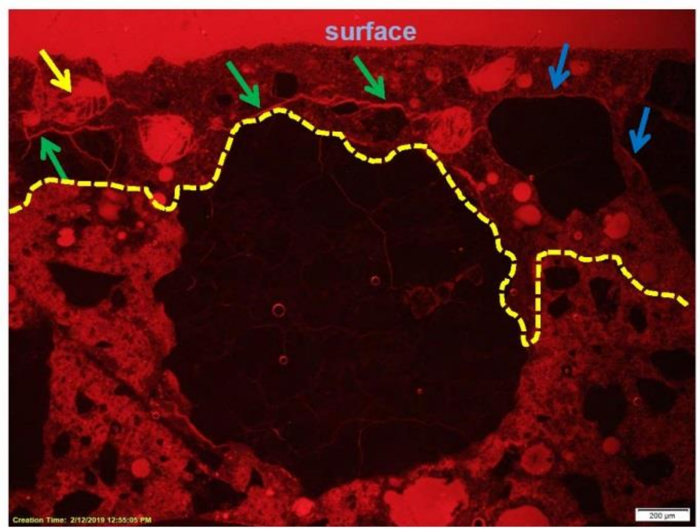
Concrete is a common building and structural component that can be impacted by exposure to fire. Concrete is fairly heat resistant to approximately 500 to 600 °F. Once concrete reaches that range of temperature or beyond, damage can occur. Rapid cooling, which can occur during firefighting activities, can also adversely affect the concrete by creating thermal shock. Fire-exposed concrete can be evaluated by several methods: including visual examination of cracks, spalls, or color changes; extraction of core samples to evaluate concrete strength or perform petrographic analysis for microscopic evidence of damage; and/or evaluation through nondestructive means such as ultrasonic pulse velocity (UPV) testing, discussed further below.



Microphotograph of the surface of concrete affected by fire, showing the depth of thermally-altered paste (yellow line) and associated cracks within the paste (arrows).

Visual examination and compressive strength determination provide valuable information, but these methods may not evaluate the depth of the damage, if present. This is where UPV testing can improve the evaluation. The fundamental theory of the test is outlined in ACI 228.2R-13, *Report on Nondestructive Test Methods for Evaluation of Concrete in Structures*. The damaged concrete has a lower modulus and therefore a lower wave speed than that of the underlying sound concrete. Ultrasonic waves travel from the transmitter to the receiver along two paths: path 1 along the surface through the fire damaged concrete, and path 2 through the underlying sound concrete. At smaller transducer spacing, the travel time is shorter for path 1, and for larger transducer spacing, the travel time is shorter for path 2.

The images below, from ACI 228.2R-13, graphically represent the two paths of travel (Figure A). By plotting the transducer spacing as a function of travel time, the depth of fire damage can be determined.

The depth of fire-damaged concrete can be determined by the change in the path slopes (Figure B). The distance X_0 is the intersection of the slopes of the two paths, and the depth of the fire-damaged layer, d, is calculated using the equation in Figure B, where V_s and V_d are the reciprocal of the slopes and represent the wave speeds in the sound and damaged concrete, respectively.

Figure A

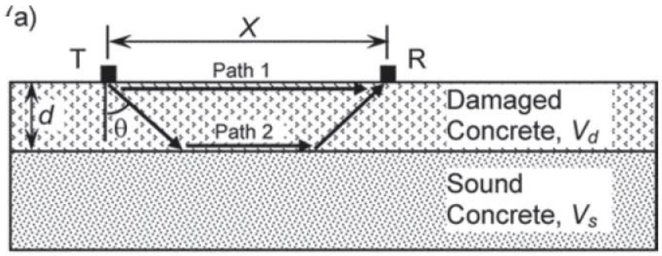
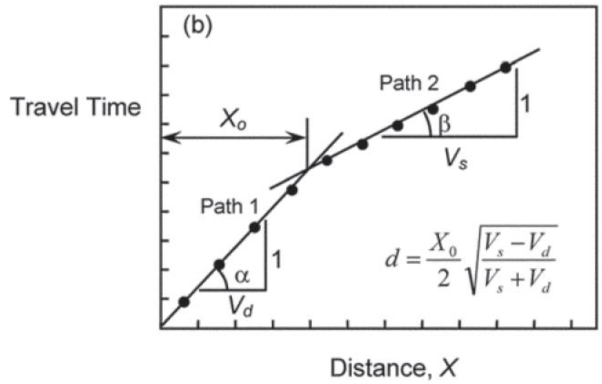


Figure B



If you have a structure that was exposed to fire, ATL can assist you in evaluating the extent of the damage by performing petrographic analysis, visual examinations, compressive strength, and/or ultrasonic testing. For more information, contact Steven Moore, PE at 518-383-9144 or info@atlantictesting.com, or visit AtlanticTesting.com.

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ASTM C856 Petrographic Examination of Hardened Concrete

ASTM C457 Determination of the Air-Void System in Hardened Concrete

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