Table of Contents

5.17 CARBONATION TESTING

5.17.1 Introduction

Concrete begins reacting with carbon dioxide the instant it is exposed to the air. Concrete itself is highly alkaline (high pH). This high alkalinity reacts with the bare steel on reinforcing steel and creates an oxide film around the steel called a passivation layer. This layer protects the steel from corrosion. The reaction of concrete with carbon dioxide reduces the pH in the concrete. This process starts at the surface and works its way into the concrete. The reaction can be expedited by cracking in the concrete surface.

The reaction of concrete with carbon dioxide does not necessarily compromise the strength of the concrete. As an inspector, the concern is if the extents of the reaction reach the reinforcing steel, the pH will drop to the point where the oxide film around the steel becomes compromised. Once this occurs the steel is vulnerable to the electrochemical process of corrosion.

Carbonation testing provides a means with which the inspector can determine the extent of carbon dioxide infiltration into the concrete. The process is similar to chloride ion testing where a sample is either removed, either by coring or drilling and the sample is tested by the application of a revealer. The revealer commonly used is phenolphthalein.

When phenolphthalein comes into contact with high pH (>10) concrete the solution shows as bright pink. When the solution comes into contact with low pH (<10) the solution shows no color change and the concrete can be considered carbonated.

Cracking in concrete allows the open air to penetrate further into the concrete surface. Cracking near reinforcing steel allows the pH in the concrete surrounding the reinforcing to be reduced that much sooner. Refer to Figure 5.17.1-1 for an image of various test results on cracked concrete samples.

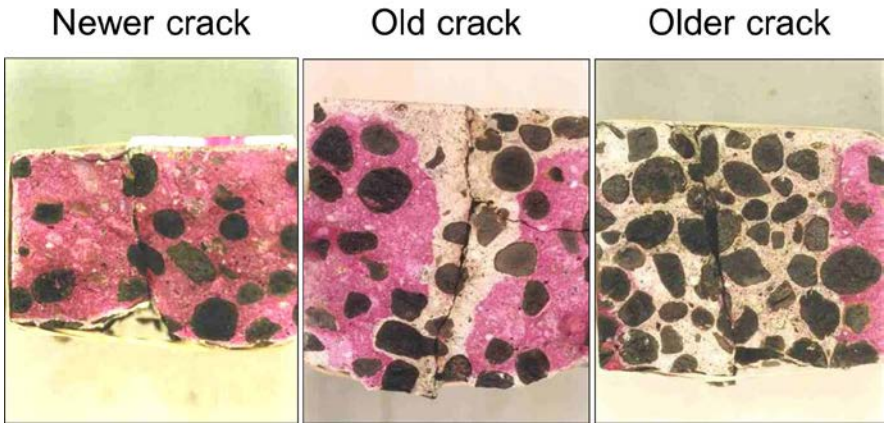

Figure 5.17.1- 1: Image of Cracked Concrete Samples After Carbonation Testing. Note the Older Crack and the Amount of Carbonation in the Concrete.

Some benefits of the Carbonation Test are that the results are immediate. There is no need to remove the sample and ship to a laboratory. All testing can be done in the field. Also the

revealer (phenolphthalein) is environmentally safe. Moreover the test can be performed by anyone. There is no need for special training. However, determination of where tests are to be taken should be discussed and planned upon beforehand.

5.17.2 Applications

Carbonation testing can be performed on any concrete component. Field kits allow inspectors to perform the test on-site and determine carbonation extents immediately.

5.17.3 Limitations

Collecting samples to perform this test requires a portion of the concrete member be damaged and the tested area to be destroyed. Therefore, several samples can't be taken from a single location to validate results. The test determines when the concrete is approximately above or below a pH of 10. Steel is protected in a pH of 12.5 or greater. Therefore the test may not indicate the carbonation extents if the pH is between 10-12.5 even through this level is compromising the steel passivation layer. In the case of a bridge deck, the bridge may need to be closed to traffic during the sampling process.

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