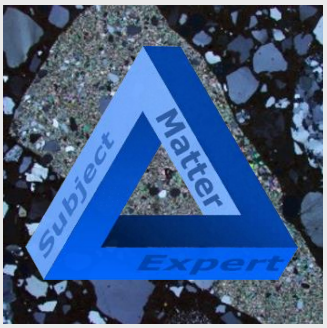
WBE certified company

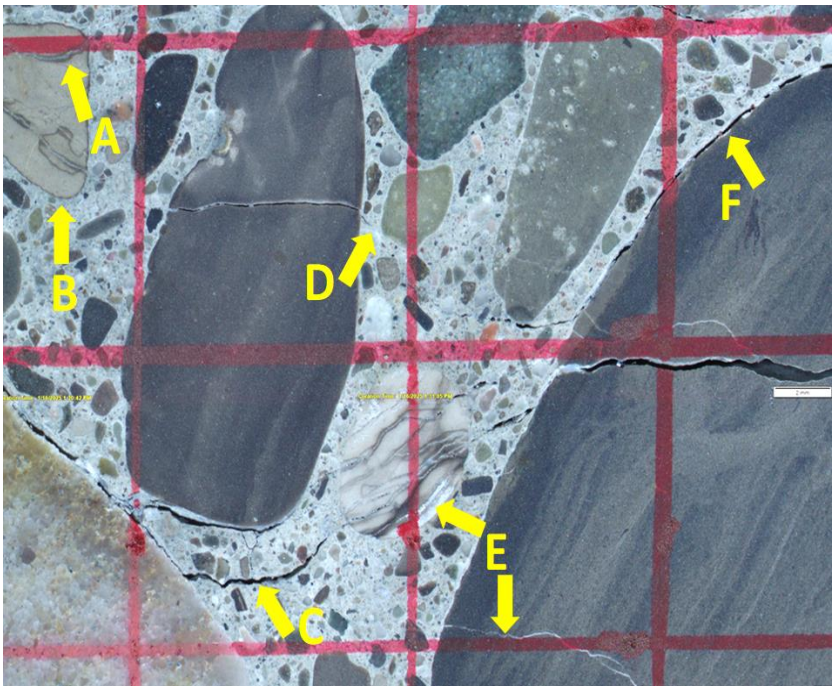
Utilizing the Damage Rating Index to Help Quantify Concrete Deterioration



Dr. Christopher R. Kelson, PhD, PG
Senior Geologist
Atlantic Testing Laboratories

Deterioration of concrete can be caused by one or more physio-chemical mechanisms. The mineralogical composition of the aggregates and paste that comprise the concrete and the extent of the concrete's exposure to environmental (e.g., temperature, moisture) and anthropogenic (e.g., deicing salts) factors are vital in determining the onset, duration, extent, severity, and type of deterioration. Cracking, scaling, efflorescence, delamination, discoloration, and aggregate pop-outs are common signs of deterioration that may shorten the service life of the concrete structure or ultimately cause complete failure.

The Damage Rating Index (DRI) was specifically developed in the 1990s by Grattan-Bellew (1995) to quantify the amount of deterioration in concrete. Although initially designed to evaluate concrete afflicted by alkali-silica reaction (ASR), it can also be used to evaluate concrete affected by other deterioration mechanisms, although the specific deterioration mechanism responsible for the damage cannot be identified.



A grid (1 x 1 cm squares) overlain on a cut and polished surface of concrete showing examples of some damage features counted for DRI calculations. A: Crack in a coarse aggregate; B: Reaction rim around a coarse aggregate; C: Empty crack in the paste; D: Gel-filled crack in the paste; E: Gel-filled cracks in coarse aggregates; F: Debonding of coarse aggregate and paste.

In general, the DRI is calculated by counting the number and types of damage features within every 1 cm^2 of a cut and polished surface (200 cm^2 area recommended) of concrete. Damage features to be counted include cracks in coarse aggregates and in paste, reaction rims around coarse aggregates, ASR gel in voids and in cracks in coarse aggregates and in paste, ASR gel in the paste, and debonding around coarse

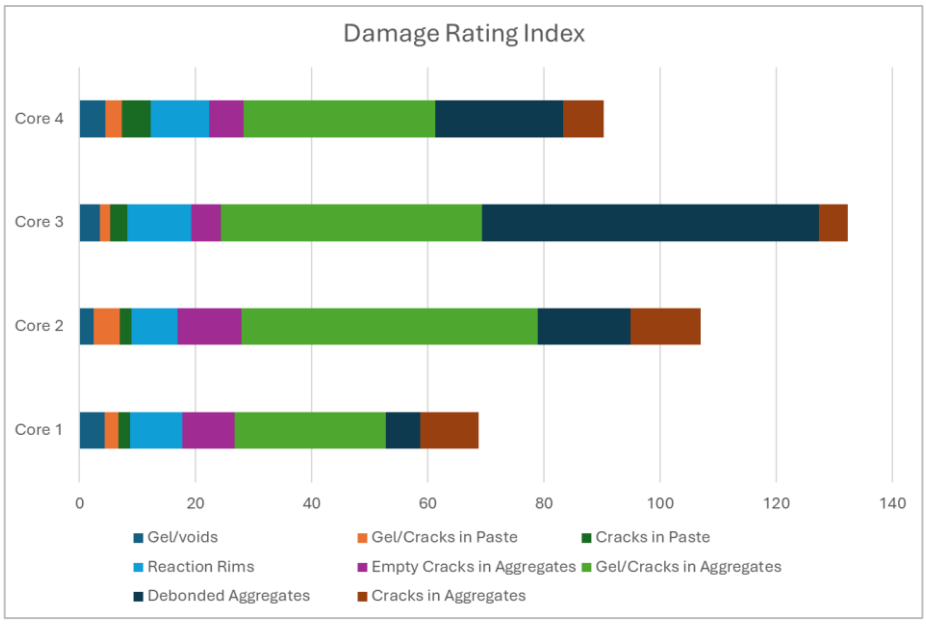
Damage feature counted in concrete	Weighting Factor
Gel in air voids	0.5
Gel-filled cracks in the paste	4.0
Cracks in the paste	2.0
Reaction rims around coarse aggregates	0.5
Empty cracks in coarse aggregates	3.0
Gel-filled cracks in coarse aggregates	2.0
Debonding (gap) between aggregate and paste	3.0
Cracks in coarse aggregates	0.25

aggregates. The total number of each damage feature is multiplied by a different weighting factor, as some features are indicative of more severe damage than others. The summation of the weighted values for all features (normalized for an area of 100 cm^2) yields a total DRI value for the concrete; a higher DRI value signifies greater damage to the concrete (Poole and Sims, 2016).

The total DRI value of a concrete sample, including the weighted proportion of each constituent damage feature, can be easily visualized on a simple bar chart. DRI values of multiple concrete samples taken from the same structure and plotted together (see chart, below) yield a valuable comparative analysis on the types and extent of deterioration within different locations of that structure.

If you have concrete exhibiting signs of deterioration or failure, ATL can assist in evaluating the impact of carbonation and effects from other potential causes of deterioration by performing visual examinations and physical testing. Common analyses include ultrasonic evaluation, petrographic analysis, chloride testing, and compressive strength testing.

For more information, contact Dr. Christopher Kelson, PhD, PG at 315-386-4578, info@atlantictesting.com, or visit AtlanticTesting.com.



References:

Grattan-Bellew, P.E. 1995: Laboratory evaluation of alkali-silica reaction in concrete from Saunders generating station, *ACI Materials Journal* 92 (2), 126-134.

Poole, A.B., and Sims, I, 2016: *Concrete Petrography*, 2nd Edition, CRC Press, New York.

ASSOCIATED SERVICES

Construction Materials Engineering and Testing

Laboratory Services

Nondestructive Testing

This document is for general informational purposes only and is provided with the understanding that the authors are not herein engaged in rendering professional advice or services. Site specific circumstances make each project unique. As a consequence, information in this document may be incomplete, inaccurate, or inapplicable to particular situations or conditions. Any use of this information should take into account all relevant factors and sources of information applicable to a project. We do not accept responsibility for any omission, inaccuracy, or error in this document, or any action taken in reliance thereon.