Iowa Carbonate Aggregate Durability Classification

Todd Hanson- Iowa DOT

Carbonate aggregates in Iowa are classified by assessment of clay content, pore system, and salt susceptibility to produce a quality number. The quality number has been correlated to service history.

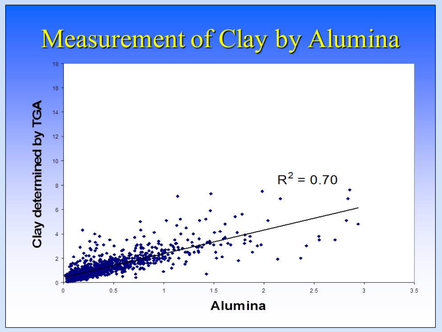
Clay Content

Clays are the main mineral containing alumina in limestone and dolomite

Al_2O_3 as determined by XRF is an excellent way to measure clay in carbonate aggregates.

Aggregates with elevated clay content are associated with early deterioration of PCCP concrete.

PANalytical Axios X-Ray Spectrometer



Correlation of alumina (XRF) to clay (TGA)

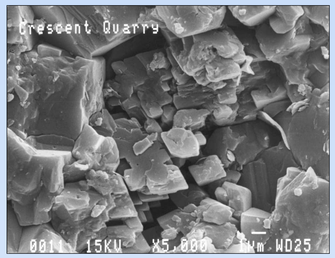
Pore System

Aggregates with extensive capillary pore systems are subject to durability problems due to failure after repeated freeze thaw cycles.

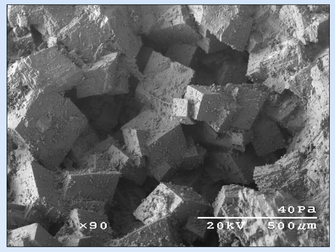
Iowa Pore Index test is used to evaluate the pore system of the aggregate. 4500 grams sample placed vessel filled with water and pressurized to 35 psi to force water into the pore system. Readings are taken at 1 minute to determine the large pore system (primary load) and 15 minutes to determine the small capillary size pores (secondary load).

Aggregates with high primary and low secondary load are more F/T durable.

Iowa Pore Index Test Equipment



SEM image (5000X)- Grain size of poor performing aggregate



SEM image (90X)- Grain size of good performing aggregate

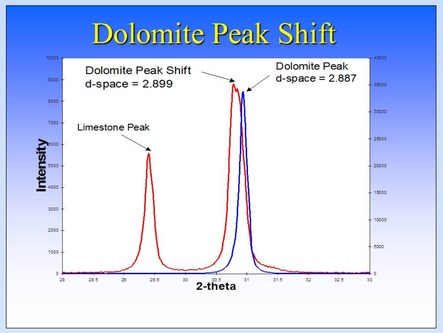
Salt Susceptibility

Dolomite quality is determined by XRD peak shifts of 2.900 or greater.

The greater the peak shift the lower the quality (less stable) the dolomite mineralogy.

Elevated sulfur levels resulting from microcrystalline pyrite (FeS_2) are extremely significant in aggregates with high dolomite fraction. The more sulfur the lower the quality.

Siemens D500 X-ray diffractometer



X-ray diffraction pattern showing peak shift from pure dolomite.

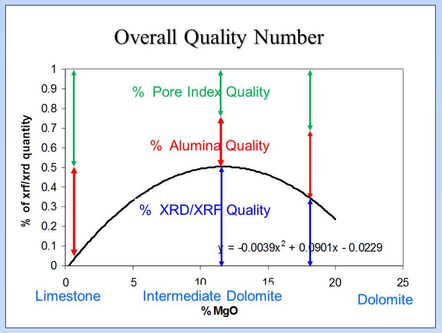
Overall Quality

Pure limestones are evaluated based on 50% pore index and 50% alumina quality.

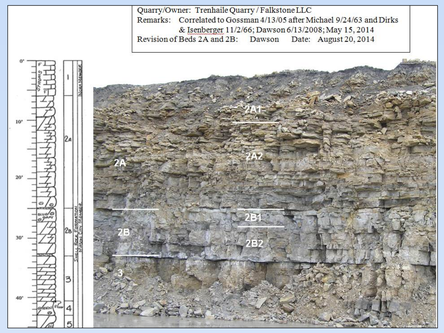
Intermediate dolomites are evaluated on 50% XRF-XRD, 25% pore index and 25% alumina quality.

Pure dolomites are evaluated on 33% XRF-XRD, 33% pore index and 33% alumina quality.

For dolomites, elevated levels of manganese also correlate with poor performance and a factor is applied.



Graphic representation of quality number equation.



Ledge control is important.

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