

Aggregate Optimization

It's Time has Come

Credit Jim Lafrenz, Director of Airports at ACPA National, for challenging some of us in the concrete industry here in North Dakota to expand our understanding of current concrete technology. Specifically, Jim has offered insight into the matter of aggregate optimization to achieve mixes that resist segregation, enhance durability and improve workability. This topic is very timely as we search for answers to ride and smoothness issues on newly constructed Continuously Reinforced Concrete Pavements (CRCP) for highways.

Aggregate optimization has been one of the least understood tools for ride and smoothness enhancements in all of the concrete paving industry up until recently. In addition to Mr. Lafrenz, recent comments from James Shilstone, a noted national expert in concrete mix technology, and Jim Mikulanec, National Staff Member of ACPA, have added credibility to the benefits of aggregate optimization.

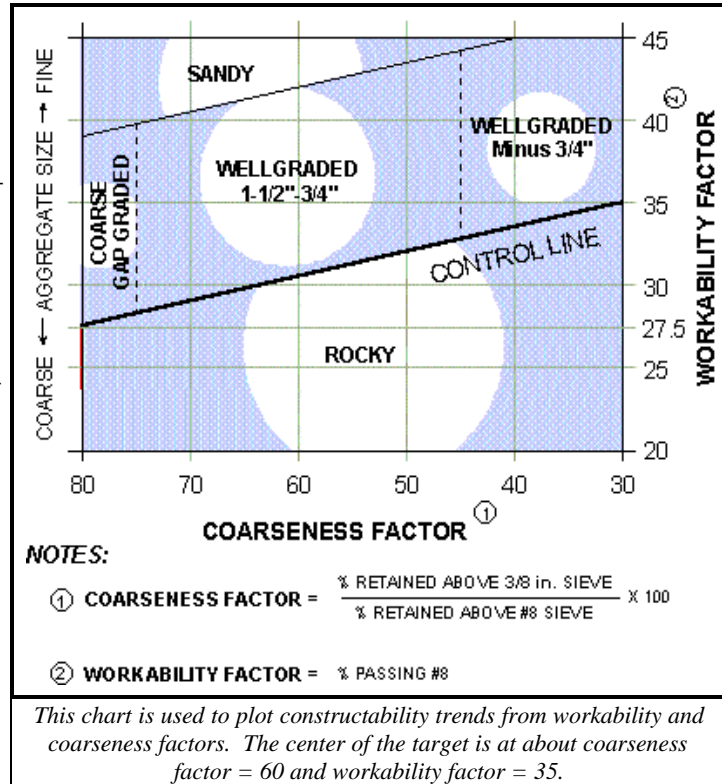
Much of the dialogue that has followed aggregate optimization in recent years has been based on durability benefits of reducing mix paste (cementitious and water) contents through the use of uniformly graded aggregates to fill voids in the matrix. The theory has followed that paste is the least durable component of concrete, while aggregate is the most durable. Therefore, following optimization techniques similar to the 0.45 Power Curve for asphalt aggregate gradations seemed to benefit concrete also. Even nominal attempts to fill gaps in concrete gradations have brought profound benefits for lower concrete permeability characteristics at lower paste contents, as shown by recent NDDOT funded research at University of North Dakota.

Mr. Lafrenz' interest in mix improvements come from his work with the U.S. Air Force in the early 1990's. While Chief Engineer in charge of runway construction at air bases throughout the country, he noted an excessively high rate of durability issues on new pavements, mostly due to FOD (foreign object damage) on high performance aircraft. After much investigation, it was determined that mixes would sometimes segregate, allowing a small curl of paste and sand to form at the edges of the slip-form paver box which would then be placed at the construction joint between paver passes. This paste was determined to be the primary source of the

FOD, so investigations into ways to prevent the segregation lead to creation of the tools we now have available. Included in our new tool box is the Constructability Chart, as shown in inset. The spreadsheet that leads to the calculation of points on the Chart reflects the benefits of adding mid-size aggregates to the mix proportions. The use of more uniformly graded aggregates has been found to be a major solution to problems of segregation in normal mixes, as compared to our ordinary gap graded mixes composed of large stone and sand.

From the ride and smoothness side of the discussion, major contributions were made to the discussion by Mr. Mikulanec at the 2003 Spring Concrete Conference in Bismarck. Jim noted that as the National Sales Manager for CMI, a major U.S. paver manufacturer, about 90% of his troubleshooting visits to projects for ride and smoothness issues by the contractor were related to aggressive (un-optimized) aggregate gradations. Workability on these projects was so poor that the pavers were incapable of compensating without excessive vibration. Use of

Mr. Lafrenz has offered a spreadsheet to be used for evaluating aggregate gradations for workability. Engineers at the Fargo and Valley City Districts of the NDDOT, as well as others in the private sector, have received some simple training in the spreadsheet usage. Others who would like to advance the benefits of durability and workability through usage of



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aggregate optimization techniques, he reported, improved workability to the extent that pavement smoothness was no longer an issue.

these techniques should contact the ND concrete associations for help. The NDRMCPA Administrative Offices are at (701) 2550-7250, while ACPA Chapter offices are 701-232-6972. You may also contact Dave Sethre directly at (701)371-4497. Hank Hauge (LaFarge Dakota) has also offered to assist in working with the spreadsheet; you may contact him at (701)840-8032.

For additional information on background and interpretation of aggregate optimization and Constructability Charts, check out an article co-written by Mr. Lafrenz and Mr. Shilstone as posted on our website at www.ndconcrete.com/techarticles.html. We wish to thank the hard work that these gentlemen have endured to contribute to this all important work in mix design enhancement.

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