CP Road Map E-News October 2014

The ***CP Road Map E-News*** is the newsletter of the Long-Term Plan for Concrete Pavement Research and Technology (CP Road Map), a national research plan developed and jointly implemented by the concrete pavement stakeholder community. To find out more about the CP Road Map, or to get involved, contact Steve Klocke, 515-964-2020.

New Moving Advancements into Practice (MAP) Brief

Moving Advancements into Practice (MAP) Briefs describe promising research and technologies that can be used now to enhance concrete paving practices.

The October 2014 MAP Brief, "Optimized Aggregate Gradation," describes the effect that different aggregate gradations can have on the properties of concrete pavements.

Download the October 2014 MAP Brief.

News from the Road

News from the Road highlights research around the country that is helping the concrete pavement community meet the research objectives outlined in the CP Road Map.

Corrosion Sensitivity of Concrete Mix Designs

This study compared the durability of concrete mixtures containing supplementary cementitious materials (SCMs) by evaluating the permeability, absorption, and corrosion resistance of seven mix designs and two types of reinforcement.

Permeability and alkalinity are contributing factors to the durability of portland cement concrete and can strongly influence the service life and corrosion resistance of the embedded steel. In reinforced concrete systems, the ingress of chloride ions increases the probability of corrosion of the reinforcing steel. Reducing the permeability of concrete enhances its durability by hindering the ingress of chloride ions from reaching the embedded steel surface and initiating corrosion. SCMs such as Class F fly ash, silica fume, and slag cement are widely used in concrete in an effort to reduce permeability. In addition, the alkaline environment of concrete enables the formation of a passive film on the surface of the steel. As long as this protective environment is maintained, the corrosion rate of the reinforcing bar will be insignificant for the majority of applications.

The results of this study indicated that the use of SCMs can reduce the permeability and absorption of the concrete, leading to more durable structures than those with plain concretes; therefore, their continued use in structures by the Virginia Department of Transportation is recommended. However, different SCMs have varying levels of durability, and the agency should consider this information when selecting SCMs for specific applications.

The absorption test results in this study provided a reasonable correlation with the corrosion test results. Therefore, the absorption test should be more closely investigated as a means of evaluating the corrosion

protection provided by SCMs. This study also demonstrated that the corrosion-resistant reinforcement plays the most vital role in minimizing corrosion. SCMs provide durable concretes and in combination with the corrosion-resistant reinforcement ensure reinforced concrete structures with longer service lives.

This project was completed by Stephen Sharp et al. at the Virginia Center for Transportation Innovation and Research for the Virginia Department of Transportation. Click here to read the full report.

This project is contributing to research objectives identified in CP Road Map Track 1: Materials and Mixtures for Concrete Pavements.

Shedding Light on Colored Concrete's Fading Performance

The incorporation of full-depth colored concrete into street and roadway projects has been rapidly increasing in Minnesota. Unfortunately a number these projects have exhibited significant early distresses, particularly near contraction joints. The objectives of this project were to identify the causes of this early deterioration, develop improved specifications for colored concretes, and recommend suitable repair and rehabilitation techniques for distressed colored concrete.

The investigation identified the following potential causes leading to the early deterioration of colored concrete pavements: 1) The colored concrete mixes tend to be produced with a high water-cement ratio exceeding the maximum value of 0.45 recommended for freeze-thaw durable concrete. 2) Chemical attack was discovered in several samples, along with the presence of ASR gel in aggregates that have not previously shown reactivity in standard concrete. The precise source of the attack and ASR were not identified. 3) The paste-to-aggregate bond for all samples was classified as poor to fair, which is likely due to the non-cementitious nature of the pigments. This may provide the opportunity for freeze-thaw forces to develop the microcracking that is observed. 4) Colored concrete slabs experience surface temperatures approximately 30% greater than non-colored concrete. This can lead to failures caused by thermal expansion.

To counteract these problems, the following recommendations were made for improving the construction methods and mix design for future projects: 1) Produce colored concrete mixes with a water-to-cement ratio no greater than 0.43. 2) Provide adequate vibration during consolidation, but do not over-vibrate. Use a vibrating screed when possible. 3) Provide an adequate finish to the surface. At a minimum, a broom finish should be applied. 4) Curing colored concrete is critical. Alternative curing methods may be necessary. 5) Allow for extra thermal expansion when colored concrete is placed next to non-colored concrete or structures. 6) Consider alternative methods to colored concrete such as surface applied colored stains, colored concrete pavers, or other surface treatments.

This project was completed by the Minnesota Department of Transportation. Click here to read the full report. For additional information on this project, please contact Tom Burnham.

This project is contributing to research objectives identified in CP Road Map Track 1: Materials and Mixtures for Concrete Pavements.

MnRoad: A Legacy of Concrete Overlay Research

MnROAD has constructed and researched 21 different concrete overlay designs since 1997. These designs have included thin bonded concrete overlays of asphalt pavements (BCOA; also known as whitetopping), thin unbonded concrete overlays of concrete pavements (UBOL), and a thin pervious concrete overlay of concrete. The data from these experimental sections has been instrumental in improving the knowledge of design and performance of thin concrete overlays. Recently, the new design procedure BCOA-ME, developed by Julie Vandenbossche with the University of Pittsburgh, relied heavily on MnROAD data for development and

calibration. MnROAD data is also being used in the national pooled fund project TPF-5(269) that is developing an improved design procedure for unbonded concrete overlays.

Questions still exist related to both the use of concrete fibers and the use of fabric interlayers in ultra-thin unbonded concrete overlays. To help answer these questions, MnROAD built a test section on the low volume portion of the MnROAD test track in 2013. The design involved placing a three-inch thick fiber-reinforced concrete overlay over two different thicknesses of nonwoven fabric interlayer placed over an existing seven-inch thick concrete pavement with moderately faulted transverse joints. After one year of LVR traffic, several transverse reflective cracks are beginning to appear. Continued monitoring will determine whether the fiber-reinforced concrete and fabric interlayer will benefit long-term performance of the overlay and how it should be accounted for in future concrete overlay designs.

For more information, please contact Tom Burnham at MnROAD.

This research is contributing to objectives identified in CP Road Map Track 8: Concrete Pavement Construction, Reconstruction, and Overlays.

International News

Influence of Water Absorption of Recycled Coarse Aggregates on Properties of the Resulting Concretes

In this paper, three recycled coarse aggregates (RCAs) with different 24-h water absorptions (5.67, 3.12, and 1.98 wt%) were used to produce recycled coarse aggregate concretes (RCACs). Different water absorption rates were obtained by modifying the surface of RCAs with low and high concentrations of alkaline organosilicone modifier that is stable in concrete. A normal aggregate concrete mixture was also prepared to serve as a control mixture. The effect of RCA absorption on the microstructure (interfacial transition zone), mechanical properties (compressive strength, modulus of elasticity, and concrete-rebar bonding strength), and durability (shrinkage and water permeability) of the resulting RCAC was investigated. Test results showed that the surface modification of RCA was effective in reducing the water absorption. From micrographs, RCAC prepared with a low concentration of surface modifier (No. 2 RCA) showed mechanical interlocking with the surrounding cement matrix. Among RCAC, No. 2 RCA (with a low concentration of surface modifier) showed better mechanical and durability performance due to the mechanical interlocking, which served as an effective force transmission medium between the aggregate/cement matrix. It can therefore be concluded that RCA prepared with a low concentration of surface modifier improved the properties of RCAC. In addition, it may be used as a potential tool to reduce possible slump loss in fresh concrete thereby resulting in consistent mix and providing greater flexibility in mix design.

This work was completed by H.Z. Cui et al. at the Shenzhen University, Guangdong, China and was published in the ASCE *Journal of Materials in Civil Engineering*, 2014. A full transcript of the report is available by clicking here.

This project is contributing to research objectives identified in CP Road Map Track 12: Concrete Pavement Sustainability.

Internal Curing Efficiency of Prewetted LWFAs on Concrete Humidity and Autogenous Shrinkage Development

Internal curing (IC) technology using prewetted lightweight fine aggregates (LWFAs) as additives has been proved an effective means for mitigating both autogenous shrinkage and early-age cracking under the sealed-cured conditions. However, complete elimination of autogenous shrinkage may not be necessary, as negative effects, such as durability problems, might be induced by an excessive amount of LWFAs

introduced. To better utilize internal curing technology for durable concretes, this study investigates the microstructure and the desorption properties of sintered fly ash and expanded shale LWFAs. The influences of these two types of LWFAs on autogenous shrinkage and internal RH development were experimentally evaluated in concrete with water content (w/c) of 0.3 and 0.4. The internal curing efficiency, defined as the relative volume ratio of LWFAs in paste matrix as compared to that used for completely mitigating autogenous shrinkage, is a function of particle size and spacing of LWFAs. The results show that 100% internal curing efficiency (no autogenous shrinkage at the age of 28 days) can be achieved if the ratio of the LWFA particle/paste proximity and the particle size (2L/(R)) approach 1.1.

This work was completed by Ya Wei et al. at Tsinghua University, Beijing, China and was published in the ASCE *Journal of Materials in Civil Engineering*, 2013. A full transcript of the report is available by clicking here.

This project is contributing to research objectives identified in CP Road Map Track 1: Materials and Mixes for Concrete Pavements.

Updates from the States: Georgia

GDOT's research program is aligned with CP Road Map strategic goals and is a needs-based, internally driven program. The program is developed and implemented through the Research Technical Advisory Group (RTAG) process with the assistance and guidance of the Office of Research. GDOT Research Advisory Committee (RAC) sets the direction and priorities for the research program. GDOT RAC is headed by the Chief Engineer as Chair and the Director of Organizational Performance Management as Vice Chair. The State Research Engineer is the Secretary. Division Directors from across the department are members.

GDOT's four Research Technical Advisory Groups are Policy/Workforce, Safety, Asset Management, and Mobility. The RTAGs are composed of a cross-section of members appointed by the office heads or division directors in GDOT, along with a number of GDOT friends that are interested in research. Each RTAG has a secretary from the Office of Research.

Read on for more information about concrete pavement research at Georgia...

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