CP Road Map E-News August 2015

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 August 2015 MAP Brief, "Spirit of St. Louis Airport Concrete Overlay" takes a look back at one of the first large-scale concrete overlay projects at the Spirit of St. Louis Airport in Chesterfield, Missouri. The overlay was completed in 1995 and is still performing well 20 years later.

Download the August 2015 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.

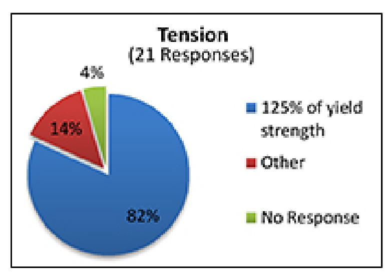
Summary of NCC State Survey on Mechanical Rebar Splices

A member state of the National Concrete Consortium (NCC) requested information on mechanical rebar splices from other NCC member states. Responses were received from 22 of the 29 member states. A summary of the questions and responses is provided below:

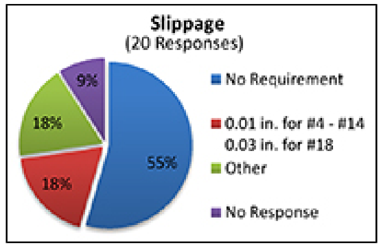
Q1: What are your requirements for mechanical splices?

Responses were provided for requirements on tension, slippage, and fatigue.

Tension:
Responses on tension requirements were received from 22 states. The vast majority of the respondents (18) indicated their basic requirement for mechanical splices was 125% of the specified yield strength of the bar being spliced. Several of these states had additional requirements (generally 150% of yield strength) depending on the type of splice or the type of reinforcing bar being spliced.

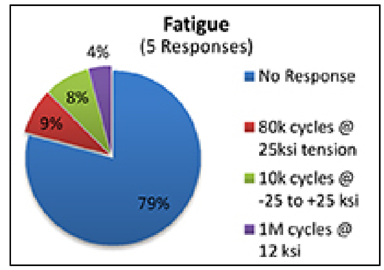


Slippage:
Twenty responses were received regarding slippage requirements for mechanical splices. Twelve of those states indicated that they did not have



requirements for slippage. Of the eight states that did have slippage requirements, half of them restricted slippage to 0.01 inches for bar sizes up through No. 14 and no more than 0.03 inches for No. 18 bars. The four remaining states had slippage requirements that varied significantly.

Fatigue:
Only five states responded with their fatigue testing requirements. Two states (Iowa and Texas) require 80,000 loading cycles from 5 ksi to 30 ksi of tension. Two other states (California and Pennsylvania) follow the Caltrans standard of 10,000 cycles from -25 ksi to +25 ksi.



Q2: If you have a slippage requirement, how is it handled with offset bar splices?

Of the five states that have slippage requirements, three responded. California indicated that their requirements for offset connections are the same as end-to-end splices. Indiana indicated that they prohibit offset connections in axial applications and only allow them for ring and spiral reinforcement. Texas noted that they have not had to address this situation as no producers of offset splices have requested approval to date.

MnROAD: Evaluating Recycled Aggregate in New Concrete Pavement

In 2013, MnDOT constructed a concrete pavement test section (Cell 613) on the Mainline Interstate of the MnROAD Research facility to investigate sustainable initiatives. A 7.5 inch thick sustainable concrete pavement was constructed using a 75% recycled concrete aggregate (RCA) mix to study the performance of recycled aggregates in new concrete. Durability test results for recycled aggregate indicated that the relative dynamic modulus (RDM) was comparable to the concrete from virgin aggregates. Trial mixing optimized the recycled content at the substitution value at 75% and showed that lower recycled content (40%) indicated very low mechanical properties.

Researchers showed by microscopic evaluation of fractured faces of flexural beams that there was an enhancement of the interfacial transition zone (ITZ) in the recycled aggregate concrete. This advantage was attributed to the potential absorption properties of recycled aggregates absorbing the excess (strength reducing and performance impairing) water from the ITZ. This research accentuated the sustainable properties of performance, environmental friendliness and economic viability of recycled aggregate concrete. Durability test results (ASTM C-666) indicated that the change in relative dynamic modulus (RDM) was insignificant and comparable to that observed in concrete of virgin aggregates. Recent monitoring indicated an IRI of 85 in / mile and no evidence of faulting or spalling.

This project, "Development of Aggregate Avoidance Index for Evaluating Recycled Aggregate Concrete" was completed by Akkari, A.K., Izevbekhai, B.I, & Olson, S.C. and was published in the Transportation Research Record: Journal of the Transportation Research Board (DOI: http://dx.doi.org/10.3141/2441-08. Pages 53-59). For more information, contact Bernard Igbafen Izevbekhai, P.E., Ph.D., Acting Manager (Research Section) of MnDOT Office of Materials & Road Research.

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

Ground Tire Rubber as Component in Concrete Mixtures

The objectives of this project were to determine the effects of replacing a portion of the fine or coarse aggregate in a standard concrete mix with ground tire rubber (GTR). The research investigated the effects on flexibility, temperature sensitivity (expansion and contraction), workability, and mechanical properties. It also evaluated the practicality of incorporating GTR in concrete at a ready mix plant.

The following summarizes some of the study's observations:

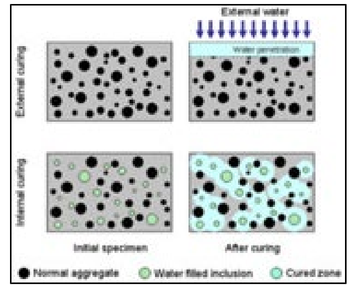
- GTR reduced the concrete's modulus of elasticity, making it more flexible.
- The addition of GTR did not have a dramatic effect on the coefficient of thermal expansion (CTE).
- The optimal content of GTR for a paving mixture is 15% replacement (by weight) of the fine aggregate. Concrete mixtures with this replacement value were able to achieve 28-day compressive strengths of 3,000 psi at a water/cement ratio of 0.44.
- In general, slump decreases with addition of GTR, but use of the water-reducer could counteract this issue.
- Air content increased with the addition of GTR to the mix, but the use of a defoaming agent could reduce foam and control air content.
- Examinations of GTR concrete under the Scanning Electron Microscope (SEM) indicated that there is good bonding between the rubber particles and the cement matrix in the concrete.
- Pretreatment of GTR by simple washing and drying may improve the compressive strength of the GTR concrete.
- GTR concrete has very good plastic and dry shrinkage attributes, with the ability to resist shrinkage cracking.
- GTR could be incorporated into mixtures at ready mix plants; however, plants will require dry-safe storage of the GTR and customized packaging (bag sizes or bag material) of the GTR for convenient batching.
- GTR concrete has potential for use in the following applications: sidewalks; curbs, intake structures, or applications where the compressive strength of 3000 psi or less is adequate and also where shrinkage may be a problem.

This project was sponsored by the Florida Department of Transportation and completed by Sobanjo, Tawfiq, Twumasi-Boakye, and Inkoom at Florida State University and Sheldon Gibbs with Gibbs Group Engineers. Click here to access the full document.

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

Freeze-Thaw Resistance of Internally Cured Concrete

Internally cured concrete has been rapidly emerging over the last decade as an effective way to improve the performance of concrete. Internal curing (IC) holds promise for producing concrete with an increased resistance to early-age cracking and enhanced durability. IC is a simple and effective way to cure



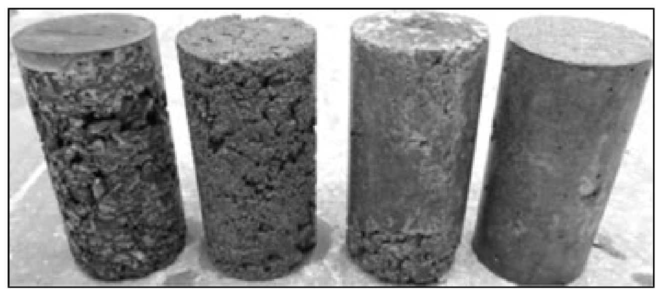
concrete. Proper internal curing supplies water that is necessary to relieve stress buildup due to self-desiccation. Typically this is done using pre-wetted lightweight aggregates (LWAs), as this is the most commercially available application at the present time. IC has shown reduced autogenous and drying shrinkage cracking, improved fluid absorption resistance, improved compressive strength, and reduced ion diffusion. It is becoming increasingly clear that internal curing has great potential for the concrete industry to create a longer lasting, more sustainable product.

This report specifically examines the freeze-thaw resistance of internally cured concrete. The results show that internally cured concrete, using the recommended mixture proportions (i.e., pre-wetted fine LWAs to replace only the water lost due to chemical shrinkage), is freeze-thaw resistant.

This project was sponsored by the Colorado Department of Transportation and completed by Jones, House, and Weiss at Purdue University. Click here to access the full document.

This research is contributing to objectives identified in CP Road Map Track 9: Evaluation, Monitoring, and Strategies for Long Life Concrete Pavement.

Innovative Proportioning for Concrete Mixtures



Mixture proportioning is routinely a matter of using a recipe based on a previously produced concrete, rather than adjusting the proportions based on the needs of the mixture and the locally available materials. As budgets grow tighter and increasing attention is paid to sustainability metrics, agencies are beginning to focus on making mixtures that are more efficient in their usage of materials yet do not compromise engineering performance.

The objective of this study was to develop an innovative performance-based mixture proportioning method by analyzing the relationships between the selected mix characteristics and their corresponding effects on tested properties. The proposed method provides step-by-step instructions to guide the selection of required aggregate and paste systems based on the performance requirements. The report lays out the following iterative steps for mixture proportioning:

- *Select the aggregate system.* The aggregate gradation should be selected to achieve a density as close to maximum as possible while still providing good workability and finishability. In addition, the voids between the combined aggregates should be determined.
- *Select the paste system.* Select the paste system to achieve the required performance criteria. Mix components such as the type and amount of cementitious material, w/cm ratio, target air content, and chemical admixtures all influence the strength and durability performance.
- *Select the paste volume*. Enough cement paste is needed to coat the aggregate, fill the voids between aggregates, and separate them to reduce inter-particle friction. In determining this volume, this report introduces a new concept by using a paste-to-voids volume ratio.

In addition to providing procedures for proportioning concrete mixtures, this report also aims to dispel several misconceptions about what features make well performing concrete pavements. These misconceptions include the following:

1. Increasing cement content increases concrete strength.
2. Concrete strength correlates with durability.

3. Supplementary cementitious materials dilute concrete properties.

The report expands on why each of these common misconceptions is inaccurate.

This project was sponsored by the FHWA and Pooled Fund Partners (Colorado, Iowa, Kansas, Michigan, Missouri, New York, Oklahoma, Texas, and Wisconsin) and was completed by P. Taylor, et al., at the National Concrete Pavement Technology Center at Iowa State University. Click here to access the full document.

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

Newsletter staff

- Steve Klocke, Snyder and Associates, Program Manager
- Dale Harrington, Snyder and Associates, Program Manager
- Sabrina Shields-Cook, Editor

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