National Concrete Consortium (NC2) E-News March 2016
In Association with the CP Road Map Program

The NC2 E-News is a quarterly newsletter based on 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 stakeholders 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 best practices and promising research that can be used now to enhance concrete paving.

The March 2016 MAP Brief, "Concrete Pavement Recycling and the Use of Recycled Concrete Aggregate in Concrete Paving Mixtures" discusses the production methods, potential uses, benefits, and material properties of recycled concrete aggregate (RCA). The MAP Brief also highlights the use of RCA in concrete mixes in the U.S. and Europe and summarizes the performance of previous pavement projects that incorporated RCA in the pavement mixture.

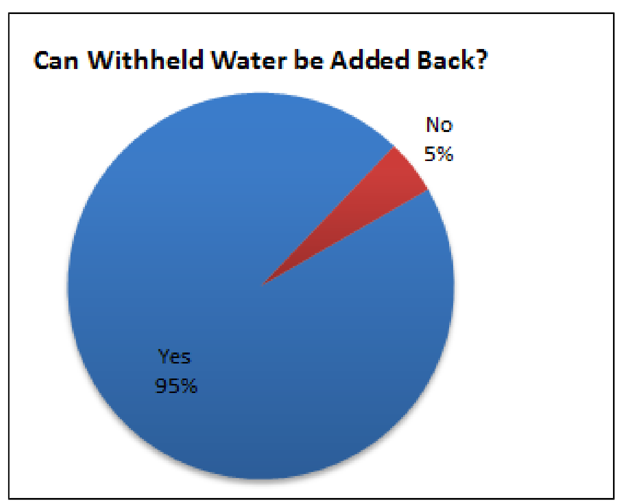
Download the March 2016 MAP Brief.

NCC State Survey Summaries

NATIONAL CONCRETE CONSORTIUM

Member states of the National Concrete Consortium have the ability to poll other member states regarding specifications, materials, construction, research, or other issues related to concrete paving. This section highlights some of the questions posed and answers received through the NCC's ListServ feature.

Addition of Withheld Water



Kansas polled the NCC group to inquire if agencies allow water that has been withheld from a mix to be added back in. Twenty-two states responded to the question and the overwhelming majority (20 states) do allow withheld water to be added back in, as long as the resulting water to cement ratio does not exceed that of the approved mix. None of the states allow the addition of water that would cause the mix to exceed the specified water-to-cement ratio. In addition, no states allow water to be added to a truck that has been partially unloaded.

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.

Factors Influencing the Drying Shrinkage of Concrete Pavements

This literature review examined the primary causes of drying shrinkage of concrete. The review determined that the primary mechanisms of shrinkage can be separated into three categories: plastic shrinkage, chemical shrinkage, and drying shrinkage. Plastic and chemical shrinkage are due to moisture loss in the concrete and occur primarily in the early age (first 24 hours) of the concrete. Drying shrinkage is also due to moisture loss, but the process is different and the effects occur after setting.

Numerous factors influence the severity of drying shrinkage, however, the most influential are related to the cement paste. This review identified the following paste qualities and their effect on drying shrinkage:

- *Paste Quantity:* Because cement paste has the greatest effect on drying shrinkage, increasing the quantity of paste is directly related to an increase in drying shrinkage.
- *Cement Chemistry:* Higher C3A and alkali contents, as well as lower sulfate content, can result in increased shrinkage.
- *Cement Fineness:* Finer cement particles provide more surface area, which leads to more rapid hydration and strength gain; however, use of finer cements also leads to increased water demand, which can increase shrinkage.
- *Supplementary Cementitious Materials:* The effects of SCMs on shrinkage appear to have mixed results. Class F fly ash appears to cause a reduction in drying shrinkage while Class C fly ash tends to result in an increase (likely due to Class C's higher Ca/Si content). The effects of slag, silica fume, and ternary mixes on drying shrinkage are inconclusive.
- *Admixtures:* Most researchers found the use of superplasticizers tended to increase shrinkage while shrinkage-reducing admixtures were effective at reducing shrinkage.
- *Water/Cement Ratio:* The effects of w/cm ratio on shrinkage were inconclusive.

The review also looked at the effects of other factors including aggregates, air content, curing, environmental factors, and construction practices.

This review was sponsored through a partnership between the FHWA and pooled fund states of Colorado, Iowa (lead state), Kansas, Michigan, Missouri, New York, Oklahoma, Texas, and Wisconsin. The review was completed by Tayor and Wang at the National Concrete Pavement Technology Center at Iowa State University. Click here to access the full document.

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

Influence of Mixing Time on Fresh and Hardened Concrete Characteristics

Most specifications place a limit of 90 minutes, or 300 drum revolution counts (DRC), between the batching and placement of ready-mix concrete. The purpose of these limitations is to maintain the quality and workability of the fresh concrete and ensure the resulting pavement or concrete product provides long-term durability. These limitations were first implemented in 1935 and are widely accepted; however, little research exists to support their validity. Considering the changes in chemical admixtures and mixing equipment that have taken place in the last 90 years, research is needed to determine if these limitations are still valid. If these limitations do not impact the performance of modern ready-mix concrete, they may unnecessarily increase materials and construction costs.

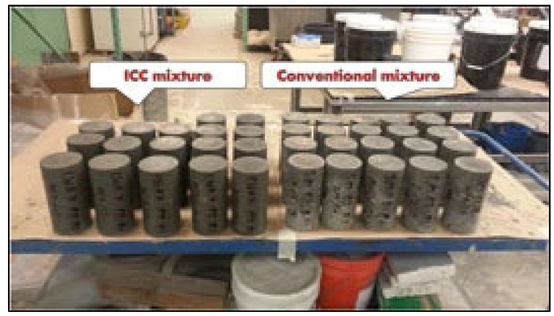
This study evaluated the influence of mixing time on fresh and hardened characteristics of concrete for several different concrete mixtures. Results from this research indicate that mixing times have no detrimental effects on the mechanical properties and durability characteristics when the mixtures exhibited good workability and castability. This research indicates that workability can be used as a key indicator for determining the acceptance of concrete and that time and truck DRC limits are not directly related to hardened concrete properties.

This research was completed by Chen and Trejo at Oregon State University and subsequently published in the ACI Material's Journal, Volume 112. 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.

Internally Cured Concrete for Pavement and Bridge Deck Applications

Internally cured concrete (ICC) has been identified as a promising technique for reducing early-age cracking due to shrinkage. Internally cured concrete utilizes lightweight aggregates (LWA) within the concrete mixture. The LWA are highly porous and, when pre-wetted, provide water to the surrounding cement paste during hydration. This promotes hydration of the cement paste and prevents drying of the mixture which can lead to shrinkage and cracking. The goal of this research project was to determine if ICC has potential in Florida. The research project consisted of both a laboratory analysis and field evaluation.



The lab analysis compared three standard mixes and three internally cured mixes. The mixtures evaluated had w/c ratios of 0.32, 0.36, and 0.4 with cement contents of 687, 780, and 860 lb / yd3. All mixes incorporated a class F fly ash at a 20% replacement rate. The ICC mixtures replaced a portion of the fine aggregate with an expanded clay LWA at a rate that supplied 7 lbs of absorbed water per 100 lbs of cementitious material. The results of the lab testing indicated the compressive strength, flexural strength, elastic modulus, and splitting tensile strength of the ICC mixes was lower than the standard mixes. However, the ICC mixes required less water reducing admixture to achieve the same workability and exhibited substantially greater resistance to shrinkage cracking when compared to the standard mixes.

The field study consisted of the construction of three test slabs. These were constructed with a standard concrete mixture with a w/c ratio of 0.40, an ICC mix with a w/c ratio of 0.40, and an ICC mix with a w/c ratio of 0.32. Repetitive wheel loads were applied to the slabs with a heavy vehicle simulator (HVS). Three months after testing and HVS loading, hairline cracks were witnessed next to the wheel path for the slab constructed from the standard concrete mix. No cracks were observed in the other two slabs constructed from ICC. From a visual observation, the ICC slabs appeared to have better performance than the standard mix slab.

This project was sponsored by the Florida Department of Transportation and completed by M. Tia et al. at the University of Florida. 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.

Research Examines the Relationship between Fuel Economy and Pavement Properties

Researchers at the Massachusetts Institute of Technology are investigating the interaction between a vehicle's wheel and the pavement structure in an attempt to quantify the effect that pavement properties have on fuel consumption. This research has found that for heavily loaded, slow moving vehicles, deflection-induced PVI results in energy losses that can lead to excess fuel consumption. Increasing the pavement stiffness minimizes the energy losses from deflection-induced PVI. This can result in increased fuel economy and reduced greenhouse gas emissions.

This research is being completed by M. Akbarian in collaboration with Louhghalam and Ulm at the Concrete Sustainability Hub at the Massachusetts Institute of Technology and is sponsored by the Portland Cement Association and the Ready Mixed Concrete Research & Education Foundation. Click here for a research brief of this project.

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

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