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SPOTLIGHT ON RESEARCH PROJECTS IN PROGRESS

NATIONAL POOLED-FUND RESEARCH INITIATED BY NDOT

Nevada Leads the Nation with Proposed Research on "Future Highway Technology" and "Concrete Cancer"

By: Tie He

Last year, on the ABC evening news, Peter Jennings reported the "Solution" to building stronger and more durable highways nationwide by implementing a new technology called "high-performance concrete." The so-called high-performance concrete is often just conventional concrete in combination with some mineral admixtures such as fly ash, silica fume and natural pozzolans. In fact, high-performance concrete technology has been available for years, with the use of mineral admixtures dating back to Roman times. However, it has not been widely used because many technical problems are associated with applying this technology, in addition to high costs. One of the problems is how to evaluate the effectiveness of mineral admixtures such as what type and how much to use.

After years of study, the beneficial effects of mineral admixtures are believed to be related to a denser pack of very fine particles of a mineral mixture between the larger particles of the fine aggregate and Portland cement. Further studies show that it is the transition zone or interfacial zone in concrete that seems to derive the most benefit. However, the reaction chemistry at the particle interfaces remains unknown, conveying many unanswered questions in practical concrete operation.

Another problem associated with using high-performance concrete is related to concrete aggregate. Aggregates play a key role in high-performance concrete. Fine aggregate affects the finishing characteristics and the water demand while coarse aggregate largely determines compressive and flexural strength, shrinkage and creep, and freeze-thaw durability of concrete pavements. However, the limiting factor in high-strength concrete is often the aggregate-paste bond strength rather than the strength of the aggregate. Unfortunately, our understanding of the chemical reactions between the aggregate and paste particles is very poor. Therefore, implementing the technology of high-performance concrete, that is our "future highway," largely depends on further study of the chemical reactions among the particles of aggregate, cement and mineral admixtures.

Alkali-silica reactivity (ASR) is another well-known problem in concrete, also referred to as "concrete cancer" by many engineers. Actually, ASR is the reaction of alkalies in the concrete pore solution with certain types of silica that occur in the aggregate, resulting in internal stresses that can cause concrete expansion and cracking. ASR has been known since the late 1930's to be a potential source of distress in highway pavements and other Portland cement concrete structures. In Nevada, ASR was first identified in 1987 on a section of

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In This Issue

Product Evaluation Committee

PEC RECAP

Dec. 9, 1997

APPROVED

Round Inductance Loops

A six-foot inductance loop in less than three minutes!

It was hard to believe that a round inductance loop could be cut into the pavement using a circular saw blade, but they did it and they did it very quickly! In May 1997, Signal Installation & Repair of San Francisco, Inc. provided a demonstration of their process for cutting round inductance loops into pavement. With a dish-shaped saw blade and a pavement-cutting saw designed to travel around a pivot on a three-foot radius, they were able to cut six-foot round loops in less than three minutes.

Although the round loop configuration is new to Nevada, they have been used in Oregon and California for a number of years with an excellent record of performance and low maintenance. In addition to the speed of installation and low maintenance, round loops provide a much more precise inductance field which is capable of accurately detecting high-bed trucks and bicycles that are sometimes not detected by the more commonly used square and octagonal inductance loops.

After considering these benefits, the PEC approved the Research Division's request to allow the six-foot-diameter round inductance loop as an alternate to six-foot square and octagonal inductance loops. It is expected that our use of round loops will lower the cost of loop installations overall, while also reducing the especially long traffic delays associated with loop cutting on urban projects.✪

FIELD TEST

K&K Systems' Safety Assist Lights

The K&K Systems company has developed a new portable traffic signal they call a safety assist light (see figure 1). The whole system is easily transported in its own storage case which also serves as the device's base and battery compartment. To assemble the safety assist device is a simple matter of removing the extension support assembly and connnecting it to the base at the bottom and to the lens housing at the top. The two-way lens housing is currently available in three configurations: remote-controlled yellow and red lights, timed dual flashing red lights, or timed dual flashing yellow lights. While fairly standard in design, the K&K Systems' safety assist light is unique in its addition of a strobe light mounted on top of the lens housing.

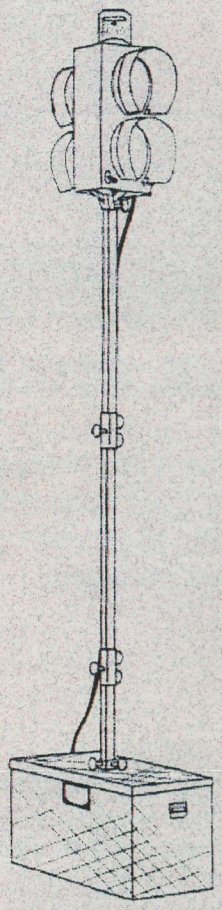

Fig. 1 Safety Assist Lights

The K&K Systems' representatives explained that the strobe light has proven effective in getting the attention of motorists when used in locations having poor visibility due to weather conditions or competing traffic control devices. The strobe light is pointed upward to provide added visibility without the danger of negatively affecting a motorist's vision, and a switch is provided to allow the user to determine when the strobe will be used.

Another feature of this device is that it can be powered by AC or DC power sources including simply connecting it to a vehicle's battery. Using a deep-cell battery, the safety assist light is claimed to run continuously for five to seven hours. Based on the information provided

and the presentation made by the manufacturers of this product, the PEC has approved a field test of the safety assist light to be incorporated into an appropriate traffic control plan by the Traffic Engineering Section. ✪

FIELD TEST

Qwick Kurb Traffic Guidance System

Manufactured in Germany by the Klemmfix company, this product was presented to us by the Qwick Kurb company. Designed as a portable curb incorporating flexible delineator panels similar to surface-mounted channelizers, this product has many possible applications for temporary and permanent traffic control. In this case, the PEC reviewed the product as a deterrent to motorists driving around lowered cross bars at railroad crossings.

By placing the Quick Kurb device along the centerline for approximately 100 feet on either side of a railroad crossing, vehicles are forced to drive over it to go around the cross bars when they are in their down position. This concept has proven effective at several railroad crossings in North Carolina where it has reduced "drive-around" motorists by up to 77 percent. With this in mind, the PEC approved a field test of the Quick Kurb at a location to be determined by Safety Engineering's Anita Boucher in cooperation with the affected district.

While there may be limited railroad crossings where this device can be utilized in Nevada, the PEC also expects that this field test will provide us the opportunity to determine its potential for other applications. ✪

Research

(continued from page 1)

Interstate pavement near Winnemucca. Later, more was found on other pavement sections and structures. It is estimated that the ASR problem alone has cost the department millions of dollars. Although hundreds of millions have been expended to study the ASR problem and to search for remedies worldwide, our ability to predict or control ASR is still limited due to the lack of knowledge of the mechanisms of ASR and its damage to concrete.

Recently, a research proposal, entitled "Electrochemical Properties and Reactions At the Surfaces, and Intersurfaces of Concrete Aggregate, Cement, and Mineral Admixtures," was submitted to the FHWA National Pooled-Fund Program by Tie He, a chemist with the department's Materials Division. The proposal has been approved as a pooled-fund study due to support from state transportation agencies across the country. The proposed research aims to tackle the problems associated with high performance concrete and concrete cancer "ASR" from a new aspect: surface electrochemistry. The objective of this research is to characterize the electrochemical properties and reactions at the particle surfaces and interfaces of aggregate, cement and mineral admixtures. This three-year project will investigate the validity of the electric double layer theory, ion adsorption, ion exchange, and major factors that govern the reactions. The action modes of ASR and inhibitive effect of mineral admixtures will also be proposed and tested according to the electric double layer theory. In the effort to measure and control surface charge reactions, chemical methods of evaluating reactivity of aggregates and effectiveness of mineral admixtures will be developed. It is anticipated that this research will greatly improve the abilities of all transportation agencies, in combating ASR and adopting the new technology to build high-performance concrete highways. ✪

Product Status Listing

A New Tool To Help NDOT Employees

A natural byproduct of the department's product evaluation program has been an extensive database of highway-related products. Realizing the value of the information contained in this list, the Research Division has developed a publication entitled the Product Status Listing (PSL).

The PSL contains virtually all of the products ever reviewed through our evaluation process in addition to a number of products contained in approved-product lists initiated prior to the institution of our current Product Evaluation Program. Unlike approved-product lists, however, the PSL contains the status of all products evaluated whether they are approved for use,

conditionally approved, pending evaluation, or rejected. As such, it is intended exclusively for the use of NDOT employees.

The goal of the PSL is to assist all NDOT employees responsible for selecting or approving the use of products for maintenance and contracted projects. It is designed to be very user friendly, with products broken into recognizable groups and categories and a quick indexing feature that we hope will prove especially useful in the field. In an effort to encourage user feedback, the back side of each page contains an area for field notes that we hope will be used to make notes that will be forwarded to the Product Evaluation Coordinator to continually improve the accuracy and usefulness of this publication as a whole.

Upon receiving your first issue of the PSL, the Product Evaluation Coordinator encourages your comments and hopes that everyone will continue to do everything they can to help ensure that this publication remains as current as possible. Its initial reviews have been very positive, but its continued usefulness can only be accomplished through the cooperation of all its users.

The first edition will be distributed in March 1998, with updates provided on a quarterly basis. If you would like to have a copy of the PSL and one has not been made available to you by the end of March, please contact Sue Modarelli at 888-7223.✪

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If you have comments, questions, or need additional information regarding any of the topics discussed in this issue, please contact Alan Hilton, Research/Special Studies Manager, *at (702) 888-7803*

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