RESEARCH AND TECHNOLOGY

REVIEW

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RESEARCH BULLETIN

Nevada Research Report

Determination Of In-Situ Footing Stiffness Using Full-scale Dynamic Field Testing

Written for a research project that was funded as part of the department's R, D and T work program beginning in FY 1995, this report presents the results of the in-situ determination of stiffness of three footings of an existing bridge, located on Interstate 80 southeast of Verdi, Nevada. Six tests were conducted by applying sinusoidal vibration force of amplitude of approximately 20,000 lb (89 KN) at a frequency of about 6.5 Hz to each footing. The response of the soil, bridge footings and the bent cap of the bridge during shaking was measured. It was found that the structural damping of the bridge, the foundation damping, the column stiffness, and the bent cap stiffness did not have significant effects on the response of the footing. The only parameter that controlled the response was soil shear modulus.

Based on the results, a design guideline and recommendations were developed as the basis for the computation of footing stiffness. The report also provided a numerical example to illustrate the use of the proposed recommendations. The approach for the calculation of footing stiffness recommended in this study is more realistic and consistent than other methods including the current FHWA approach. (*The report is available for loan from the Research Division*).✪

In This Issue

NCHRP Research Report

An Oxygen Macrocell-The Controlling Mechanism For Corrosion Of Steel In Stratified Soils

According to a recent research report from the National Cooperative Highway Research Program (NCHRP), the primary mechanism for severe corrosion of steel in soils is an oxygen macrocell. Many engineering steel structures such as pilings, pipelines, and other types of underground structures undergo severe corrosion in stratified soils mainly due to this so-called oxygen macrocell. In such a cell, the electrochemical reactions leading to the corrosion of steel occur separately on a metal surface at two different sites. The site where the oxidation (loss of electrons) occurs is called the anode and the site where the reduction (gain of electrons) occurs is called the cathode. In the metal, the electrons liberated by the oxidation

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Research Program Peer Exchange

On May 13-15, 1998, NDOT hosted a research program peer exchange. Team members included: Wesley Lum, Chief, Office of Research, Caltrans; Robert Garber, Manager, Research Management Unit, Montana DOT (Retired); Randy Bellard, Planning

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Product Evaluation Committee

PEC RECAP

June 2, 1998

Field Test

Graffiti Control Products:

Daw Inc.'s Graffiti Solution System

A 10-year performance warranty and withstanding unlimited removals are the salient features of an anti-graffiti coating system - the Graffiti Solution System (GSS) from Daw Inc., which was approved by the PEC for a field test in District I.

The GSS consists of three components: a base coating, a finish coating and a graffiti remover. The base coating provides a pinhole-free surface. There are eight different base coatings available in the system. Each base coating has different characteristics to achieve the desired performance and appearance for different substrate surfaces. After the substrate is coated with one of the eight base coatings, the finish coat is applied to provide chemical and abrasion resistance. For removing the graffiti, the system has a special graffiti cleaner called Erasol.

The system is environmentally safe and VOC-compliant. It imposes no harmful effect to the user. The major claimed advantages are: permanent coating, withstanding unlimited removals, 10-year performance warranty, and UV and stain resistance. Also, the system can be applied to various substrate surfaces including metal, concrete, brick, stone, wood, vinyl and plastic surfaces.

Currently, NDOT has no specification for this type of graffiti control system. However, a few graffiti removal products have been approved for use at the discretion of district maintenance personnel. ✪

Fig. 1 Graffiti Solution System

Specification Revision:

Water-filled barrier rail

Based on the review of a recent request for a specification change from Southwest Safety Systems, the PEC approved a revision to current NDOT specifications, section 625.02.06, on water-filled barrier rail. Acceptance or use of water-filled barriers by NDOT would require compliance with the National Cooperative Highway Research Program (NCHRP) Report 350, test level (TL)-2 for speeds up to 70 km/h (45 mph) and TL-3 for speeds up to 100 km/h (62 mph), and an acceptance letter from the Federal Highway Administration (FHWA).

The reason for the change is that our current specification on water-filled barrier rail does not reflect the requirement of FHWA to use roadside safety hardware meeting NCHRP 350 test criteria. The requirement is scheduled to become effective on October 1, 1998. Also, the PEC decided to revise the specification on water-filled barrier rail to no longer show an approved product list, but to show the FHWA requirement as the sole criterion for acceptance. ✪

Development of Performance Specification

for Pavement Marking Materials

To achieve safer and better roadway delineation, NDOT is developing a performanc specification for pavement marking

materials. The performance specification, defined as a warranty period based on product durability, retroreflectivity, etc., in lieu of a specification based on chemical and/or physical properties of a material, is believed to be more effective in promoting quality roadway delineation systems and products for Nevada.

In the pursuit of this effort, the Research Division conducted a survey of all 50 state departments of transportation on the use of performance specifications for pavement marking materials including tapes, paints, thermoplastics and epoxy systems. Based on the survey, we found that most performance specifications used are specific to the type of pavement marking. Only a few states appear to be using a generic performance specification that allows any type of pavement marking material to be used as long as it retains a specified level of retroreflectivity after a given period of time.

The survey results and some samples of performance specifications were presented to the PEC. In the meeting, some problems and practices associated with pavement marking materials, along with a prototype performance specification that we are using on a contract in District II, were discussed. Further details, such as sampling and testing procedures, quality levels and tolerance, acceptance (or rejection) criteria, and payment schedules with positive and negative adjustments as a result of departure from the acceptable quality level, will be discussed in the next PEC meeting.✪

Oxygen Macrocell

(Continued from page 1)

of iron flow from the anode to the cathode where they are consumed by the reduction of oxygen. In the soil, ions migrate from the anode to the cathode through the aqueous phase in pore spaces between the soil particles to maintain charge neutrality.

Oxygen macrocells are often created by a variation in the concentration of oxygen in the stratified soil. Oxygen deficient layers, such as wet clays or regions below the water table, become the anodes while oxygen rich layers, such as porous sands, become the cathodes. At the cathodes, the rate of corrosion is reduced due to an increase in the electrolyte pH caused by the reduction of oxygen. At the anodes, the rate of corrosion is greatly increased due to a reduction in the electrolyte pH caused by the hydrolysis of the iron atoms.

> ***Research is to see what everybody else has seen, and to think what nobody else has thought.***
>
> ***Albert Szent-Györgyi***

Other factors that control the reactions of oxygen macrocells include soil resistivity, pH, soil particle size, and the concentration of deleterious anions such as chlorides and sulfates. The NCHRP Report 408 provides the details on the role of each factor, a recommended practice for the assessment of steel corrosion, and a strategic plan to estimate the useful life of steel piling. (*The report is available for loan from the Planning Library.*)✪

Peer Exchange

(Continued from page 1)

and Research Engineer, FHWA, Nevada Division; Keith Maki, Research Division Chief and Alan Hilton, Research/Special Studies Manager, NDOT.

The purpose of this peer exchange was to give research managers a means to improve the quality and effectiveness of their research processes, both for the host department and the visiting team members. To get an idea of how the NDOT research program is currently perceived by its "customers" and those entities which conduct research for NDOT, the team interviewed representatives from the University of Nevada System and representatives from each of the divisions that make up the department's Research Advisory Committee (RAC). At the conclusion of the interviews, team members listed a number of major observations in regards to NDOT's research program which led to the development of a list of opportunities for improvement that the research managers developed for their respective programs. After developing the major observations and opportunities lists, the team made a formal presentation of this information to the Deputy Director and the Assistant Director--Planning and Program Development.

Some of the opportunities, or goals for improvement identified by the NDOT Research Division were as follows: Create a research management section separate from traffic engineering studies; simplify the research problem statement form; increase technical and field staff involvement with problem statement submittal; conduct annual reviews of projects that are more than a year in duration; provide for progress payments to be made based on project milestones for long-term research; and provide for a contingency fund and process for approving pooled-fund project participation for solicitations which occur once the Annual Research, Development and Technology Transfer (R,D&T) Work Program is set.

Along with the above-listed goals for improvement for the NDOT research program, team members from outside of NDOT identified several areas of opportunities or items that NDOT currently is involved with that they would like to see implemented in their programs. One of those items that was universally viewed as an area of strength within the NDOT research program was the department's product evaluation process featuring the formal review by the department's Product Evaluation Committee of new highway products and/or technologies.

From NDOT's perspective, the peer exchange process was of tremendous benefit, with both the strengths and opportunities for improvement of the research program identified.✪

The Research Division administers the department's research, development and technology transfer program and serves as the "clearing-house" for product evaluations.

Research and Technology Review is published quarterly by the NDOT Research Division. Its purpose is to provide the latest information on the NDOT research activities including product evaluation and other pertinent research topics.

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

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