CONNECTICUT TRANSPORTATION INSTITUTE

SUMMARY OF
JOINT HIGHWAY RESEARCH PROJECTS

June 1, 1998 – May 31, 1999

JHR99-272 January 2000

University of Connecticut

School of Engineering

STORRS, CONNECTICUT

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This research was sponsored by the Joint Highway Research Advisory Council (JHRAC) of the University of Connecticut and the Connecticut Department of Transportation and was carried out in the Connecticut Transportation Institute of the University of Connecticut.

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THE UNIVERSITY OF CONNECTICUT
And
THE CONNECTICUT DEPARTMENT OF TRANSPORTATION
Summary for Program Year 1998-1999

Project Number: 93-4

Project Title: Hydrodynamic and Transport Models of Coastal Waters for Use in the Design and Management of Highway Structures

Principal Investigators: J. D. Lin, M. W. Lefor, W. G. Liao

Project Status: Active

Initial Agreement: July 1, 1993

Objectives:

The objectives of the second and last phase of the project are to:

1. Develop a graphical user interface for the 2D hydrodynamic model generated in this project for transfer to ConnDOT;

2. Conduct simulation studies using the 2D hydrodynamic model with the interface;

3. Develop a salinity transport model for coupling with the 2D hydrodynamic model;

4. Conduct field work at selected sites to collect data for model calibration and validation; and

5. Study the correlation of tidal stage, salinity, topography, and vegetation.

Progress:

1. A pseudo-2D and a 2D model have been written and are undergoing final validation and field verification. Field work at the Menunketesuck River marshes, Westbrook, is complete.

2. The graphical user interface is near completion, and the User's Manual is in draft.

3. Application testing of the 2D model on portions of the Farm River, East Haven, is near completion.

4. Correlations of vegetation and tidal stage were completed for the Oyster River, Old Saybrook, and are underway for the Menunketesuck River marsh, Westbrook.

Report(s):

Lin, J.D., Lefor, M.W., Hua, J.S., Qiu, K-J, and Liao, W.G., "A Pseudo-2D Hydrodynamic Model for a Tidal River-Wetland System," 1997, JHR 96-253.

Lin, J.D., Lefor, M.W., Hua, J.S., Qiu, K-J, and Liao, W.G., "A Pseudo-2D Hydrodynamic Model. Presented at Connections 98: Wetlands, Transportation, and the Environment, New Bern, NC, September 17, 1998.

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Project Number: 94-4

Project Title: Effective Use of the ConnDOT Base Station

Principal Investigators: C. Roger Ferguson & John E. Bean

Project Status: Active

Initial Agreement: June, 1994

Objectives:

To attempt to eliminate the proliferation of poor geographic positions from good technology by:

*Acquiring experimental results which will define the effective range of the ConnDOT GPS Base Station.

*Acquiring experimental results which will illustrate the benefits of using the ConnDOT GPS Base Station and indicate the number of other control stations required to achieve the desired accuracy of position of new stations (survey level and mapping level applications).

*Publishing a guide book for use by State Agencies using GPS and for private sector users whose data will eventually be integrated into the state, regional and local GISs of the future.

*Publicizing the results of the study by paper presentations. In addition to the national level professional meetings proposed, it is anticipated that presentations can be made in training sessions for ConnDOT, and at the Annual Connecticut GIS Symposium and Connecticut Association of Land Surveyors Annual Meeting.

Progress:

Completed additional field observations when data analysis showed that some of the initial observations did not meet required accuracy standards. Processed the additional observations.

Analyzed the results of the processed observations.

Continued writing the final report. First draft completed. PIs meeting weekly at Central Connecticut State University for their collaborative edit, beginning Sept.

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Project Number: 96-1

Project Title: Field Treatment of Soil Contaminated with Lead

Principal Investigators: Richard P. Long

Project Status: Active

Initial Agreement: June 1, 1996

Objectives:

The objective of this project is to find the most practical and economical method of applying laboratory findings on contaminated soil to the field using stabilization/solidification techniques.

Progress:

Samples of soil contaminated with lead were obtained for use on this project from the former location of the Remington Arms Co. in Bridgeport, CT. This soil was subjected to physical and chemical testing. The total lead level in this soil was below toxic but it did not pass the TCLP test, making it a good candidate for this project.

Physical tests included: particle size distribution, organic content, moisture content, Atterburg Limits, specific gravity, and compaction testing. The results showed that the soil is non-plastic with a high silt content and about 5% organic fraction. Total metals content, pH, total organic carbon, TCLP, and SPLP were included in the chemical testing. A pH edge experiment showed that lead is very mobile in low pH (3-4), relatively immobile in pH 5-7, with the mobility increasing slightly in higher pH (8-9) range. Apatite is not as effective with this soil as it was with the soil in the previous project. We have not been able to find out the cause of the problem.

In the process of investigating the blocking of the apatite from immobilizing lead in this soil we discovered that heating it to 400° C decreases the lead's mobility. This was an unexpected effect. The heat treatment of the contaminated soil was found to reduce lead mobility to below state limits for a hazardous soil.

We have also discovered that the source of cement is important. In the previous study the cement used contained Chromium. This batch of cement contains lead.

We examined the effects of various amounts of cement on solidified strength and lead mobility. The three ratios of cement tried, i.e. 30, 35 and 40% on a weight basis, all

yielded strengths above the lower limit of 50psi. Strength declined with a decrease of cement content. The samples used in the strength tests were crushed to test the effect of the solidification on the mobility of the lead after weathering. We found a reduction in lead mobility but this reduction was not sufficient to comply with CT remediation standards. There was no correlation between the cement content and lead mobility.

We found that Stabilization/Solidification processes, although widely used for remediation of metal contaminated soils, may not be applicable to all soils. Remediation programs must consider site-specific conditions. Batch leaching tests such as TCLP and SPLP may not always model leaching under field conditions.

A final report has been drafted and submitted to ConnDOT for review.

Report(s):

Bruell, R., "Evaluation of Remedial Alternatives of Lead from Shooting Range Soil," A Thesis submitted in Partial Fulfillment of the Requirements of the Degree of Master of Science at the University of Connecticut.

Bruell, R., Nikolaidis, N.P. and Long, R.P. "Mobility and Remediation of Lead from Shooting Range Soils," Proc. of the Thirteenth Mid-Atlantic Industrial and Hazardous Waste Conference, Villanova, PA, June, 1998.

Bruell, R., Nikolaidis, N.P. and Long, R.P. "Evaluation of Remedial Alternatives of Lead from Shooting Range Soils," Environmental Engineering Science, Vol. 16, No. 5, pp. 403-14, 1999.

Long, R.P., Nikolaidis, N., and Bruell, R., "Field Treatment of Soils Contaminated with Lead," Res. Rpt. JHR 99-xxx, Department of Civil and Environmental Engineering, University of Connecticut. (Under review)

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Project Number: 96-2 (1)

Project Title: Protection of Reinforcement with Corrosion Inhibitors, Phase 1

Principal Investigators: Gregory C. Frantz and Jack E. Stephens

Project Status: Active

Initial Agreement: June 1996

Objectives:

1. To test if concrete containing diammonium salt or disodium salt protects steel reinforcement from corrosion. Test specimens will replicate sections of bridge decks or pavements and will be subjected to alternating deicer salt ponding and drying cycles.
2. To test if using deairing to reduce the normally high entrained air content of diammonium salt concrete will eliminate the decrease in compressive strength but still retain the good freeze-thaw durability observed in previous tests with diammonium salt.
3. To measure the concrete compressive strength development, freeze-thaw resistance, and air-void system of the concrete.

Progress:

1. Completed and submitted project report.
2. Submitted an Invention Disclosure for possible patenting of the two prototype chemicals studied.

Report(s):

Allyn, M.A., Frantz, G.C., and Stephens, J.E., "Protection of Reinforcement with Corrosion Inhibitors, Phase I," November, 1998, JHR 98-266.

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Project Number: 96-2 (2)

Project Title: Protection of Reinforcement with Corrosion Inhibitors, Phase 2

Principal Investigators: Gregory C. Frantz and Jack E. Stephens

Project Status: Active

Initial Agreement: June 1998

Objectives:

1. To continue work began in Project 96-2 (1) to test if concrete containing diammonium salt or disodium salt protects steel reinforcement from corrosion. Test specimens replicate sections of bridge decks or pavements subjected to alternating deicer salt ponding and drying cycles.
2. To continue to monitor for an additional 48 weeks the development of corrosion in the specimens, which began testing in Project 96-2 (1).
3. To perform corrosion testing on lollipop specimens with a preformed "crack" that allows salt water a direct path to the reinforcing bar.

Progress:

1. Completed testing program for project, including:
   a. Developed a new lollipop specimen with a preformed "crack",
   b. Cast "precracked" specimens of control concrete, and with Inhibitors A and B, and with the DAS and DSS chemicals at 1/8, 1/4 and 1/2 % concentrations,
   c. Performed strength testing on the new mixes,
   d. Monitored the new "precracked" specimens for corrosion,
   e. Monitored slab and lollipop specimens from Phase I portion.
2. Completed data analysis.
3. Began writing project report.

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Project Number: 96-5

Project Title: Evaluation of Source Separated Compost for Connecticut DOT Projects

Principal Investigators: Kenneth R. Demars and Richard P. Long

Project Status: Completed

Initial Agreement: December 31, 1997

Objectives:

The objective of this study is to evaluate two CONEG applications for source-separated compost: 1) as an erosion control mulch on slopes, and 2) as an erosion control filter berm. Both laboratory and field testing are performed to determine the physical and chemical properties and behavior of compost for use on ConnDOT construction projects. Particular goals include: 1) identification of the sources (in Connecticut), particle composition and variability of available compost materials, 2) determination of the physical and engineering properties of compost such as moisture content, organic content and density, 3) assessment of the compost chemistry and degradation/pollution potential, and 4) evaluation of the CONEG specifications for using compost and wood mulch as an erosion control and filtration medium.

Progress:

The field test site in Chaplin, CT was cleaned, maintained and monitored through summer, 1997. The site contains eight erosion test cells and a free-standing erosion control filter berm which had been constructed at the site to evaluate the CONEG specifications with each cell having a different surface treatment for erosion protection. Rainfall runoff from each cell was collected from several storm events and the runoff was tested for total solids content, pH, conductivity and nutrients. Before closing the site, soil, compost and mulch samples were acquired from each cell and the erosion control berm was dissected and sampled. Grass samples were taken from the seeded cell areas to assess plant growth. The erosion control performance of composts was observed to be comparable to the standard treatment of hay and seed and more than an order of magnitude better than an untreated surface. Also, the erosion control filter berm was very effective at preventing sediment migration.

All compost materials were subjected to physical and chemical properties test. Evaluation of testing protocols for measuring CONEG specification parameters continued. Testing protocols for measuring grainsize, pH and soluble salt content by

conductivity were further evaluated. A brief report on "Modifications to CONEG Specifications" was prepared for the Compost Advisory Committee.

Some filtration testing of mulches was performed using a column permeability apparatus in an effort to correlate fluid flow and particle retention to mulch gradation parameters. While the sediment filtration using mulches proved very successful, it was not possible to correlate sediment filtration performance to mulch properties in the limited time available.

Report(s):

Demars, K.R. and Long, R.P., "Field Evaluation of Source-Separated Compost and CONEG Model Procurement Specifications for Connecticut DOT Projects," Final Report JHR 98-264, Cooperative Research Program, Connecticut Transportation Institute, December, 1998.

JOINT HIGHWAY RESEARCH PROJECTS
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Project Number: 97-1

Project Title: Estimating Benefits from Specific Highway Safety Improvements:Phase 1 – Feasibility Study

Principal Investigators: John N. Ivan (Project Director), Christian F. Davis and Norman W. Garrick

Project Status: Active

Initial Agreement Date: June 1, 1997

Objectives:

Knowing the highway, traffic and environmental factors that influence accident rates is helpful, but this knowledge does not necessarily reveal the corresponding quantitative reductions in accident rates. In addition, the success of treatments aimed at reducing accident rates can depend upon the specific characteristics of the implementation site.

Consequently, the ultimate objective of this project and its follow-up is to form a procedure for predicting the success of specific accident reduction treatments according to prevailing features of the implementation site. This is accomplished by studying a small number of highway locations with varying background conditions at which specific accident reduction treatments have been applied. To focus the analysis and improve the quality of the results, locations are restricted to rural, two-lane highways. Reductions in accident rates attributable to the treatments are identified by comparing accident histories at sites with similar background conditions. Following are examples of accident reduction treatments that were considered:

- installation of left turn lanes
- increasing shoulder and/or lane widths
- improvement of intersection sight lines
- realignment of skewed intersection approaches

Sites are selected so that they fall into a small number of groups each with similar background conditions defined according to the following highway, traffic and environmental features:

- split between through and local trips
- heavy vehicle percentage

- traffic volume level
- land use patterns
- level of accident exposure, by type and time of accident occurrence
- extremes of horizontal and vertical curvature
- topography
- type of traffic control
- density of conflict points (i.e. intersections and driveways)
- facility type

While the need to update the data is clear, it is less obvious to what degree existing archival information may be used. This uncertainty is especially apparent in the case of predicting the effects of specific improvements. Similarly, although it is likely that certain field investigations will be necessary, it is not completely clear what they should be or how efficiently they can be conducted. Thus, for all the above reasons, the work proposed for program year 97-98 constitutes a feasibility study. Depending on the findings of this study, a follow-up project will be proposed.

Progress:

Analysis on four sites was completed and the draft report was prepared and submitted to ConnDOT. Once comments were received from ConnDOT, the final report was submitted.

Report(s):

Yuan, F., Ivan, J, Garrick, N. and Davis, C, "Estimating Benefits from Specific Highway Safety Improvements: Phase I – Feasibility Study," presented at Annual Meeting of Transportation Research Board, January, 1999.

Yuan, F., Ivan, J, Garrick, N. and Davis, C, "Estimating Benefits from Specific Highway Safety Improvements: Phase I – Feasibility Study," Final Report JHR 99-268, Cooperative Research Program, Connecticut Transportation Institute, May, 1999.

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Project Number: 97-1(2)

Project Title: Estimating Benefits from Specific Highway Safety Improvements: Phase 2 – Initial Implementation

Principal Investigators: John N. Ivan (Project Director), Christian F. Davis and Norman W. Garrick

Project Status: Active

Initial Agreement Date: June 1, 1997

Objectives:

The first phase of this project formed a procedure for predicting the success of specific accident reduction treatments according to prevailing features of the implementation site. The focus of that phase was to determine the feasibility of using existing ConnDOT archival data sources to support such analysis. This was accomplished by studying a small number of rural, two-lane highway locations with varying background conditions at which specific accident reduction treatments have been applied. One of the major issues examined in this feasibility study was the availability of data. Based on our work, we are confident that the data are available.

The continuation of this project is going beyond the exploratory nature of the first phase effort and focuses more aggressively on developing models for predicting the safety improvement potential of specific treatments. The first year effort (Phase 1) developed a procedure for estimating the safety benefit of a single safety treatment: realigning skewed interesections. Phase 2 is applying this procedure with additional study sites, as well as sites with similar conditions at which no improvement was applied. Background conditions are defined by the following site characteristics:

- traffic volume level
- population density
- level of accident exposure, by type and time of accident occurrence
- type of safety problem (skewed intersection, severe curve on main road)
- type of traffic control (signal v. stop control)
- density of conflict points (i.e. intersections and driveways)
- facility type

The result will be a set of accident reduction factors expected for a given treatment, stratified by any of the above site characteristics that are found to significantly affect the accident reduction rate. For example, if we find population density and facility type to be important site characteristics, then we will compute an accident reduction rate expected for straightening skewed intersection approaches for each level of population density (e.g., urban, rural and suburban) on major arterials and collectors. Most likely, the result will not be simply a set of reduction factors, but a set of prediction models, estimated using an appropriate statistical methodology (such as Poisson regression) with the above background conditions as independent variables.

Progress:

The literature review performed for the first phase was updated to include new work in the area of estimating accident reduction factors. Eleven new intersection realignment sites were selected for analysis in addition to five sites already selected in Phase I, for a total of sixteen sites to study. We finished collecting the geometric data for the new sites, grouped the study sites, and also selected control sites. The geometric database is complete. We have received all of the crash data required, and are currently building the crash database and performing the analysis.

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Project Number: 97-2

Project Title: Estimating the Temporal Distribution of Traffic Within the Peak Period

Principal Investigators: John N. Ivan

Project Status: Active

Initial Agreement Date: June 1, 1997

Objectives:

Project JHR 96-3 produced a procedure for estimating peak period link volumes within the Connecticut PERFORM statewide travel demand forecasting model. However, the resulting forecasts will only be for the three to four hour peak period, and will reflect the travel demand on each link for the period, and not provide volumes for individual hours within that period.

Consequently, this project developed a procedure for translating peak period travel demand forecasts into hourly traffic volumes within the peak period. Unconstrained by roadway capacity, the demand during the peak period will naturally distribute according to when travelers most desire to make their trips, with most settling into one particular sixty minute period. As the total volume of peak period trips increases, the physical capacity of the roadway begins to constrain this choice. The resulting procedure will therefore consider the total peak period demand and the roadway capacity in determining the proportion of trips that are made during each hour of the peak period.

This was accomplished by examining observed distributions of peak period traffic distribution on urban freeways and major arterials in Connecticut that experience significant peak spreading. Various statistical estimation model forms, including least squares regression, are being investigated. A draft final report was prepared and submitted to ConnDOT. We are now waiting for comments from ConnDOT before finalizing the report.

Progress:

Models were estimated using various site-related variables to test their significance in predicting peak hour proportions. These variables measure the following quantities: distance to CBD, land use density, number of lanes and daily trip length

distribution. The variables are intended to capture variability between sites and produce a general model which can be implemented into PERFORM. Once these models were estimated, hypotheses regarding the site variables were tested to identify the best model for predicting or explaining peak spreading. The results of these tests suggested grouping study sites by region in the state, or common characteristics of each region. New models were then estimated for four urbanized regions in the state: the Capitol region, southeast, southwest, and the Gold Coast.

In discussion with ConnDOT Office of Forecasting staff, we decided to not fully prepare for incorporating the model into PERFORM, but instead to simply demonstrate application of the resulting prediction model with guidelines for applying it at other locations.

Report(s):

Allaire, S. and Ivan, J., "Factors Influencing Peak Spreading on Connecticut Freeways: A Preliminary Investigation," presented at Annual Meeting of Transportation Research Board, January, 1999.

Allaire, S. and Ivan, J., "Factors Influencing Peak Spreading on Connecticut Freeways," Draft Final Report, Cooperative Research Program, June, 1999.

JOINT HIGHWAY RESEARCH PROJECTS
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Project Number: 97-3

Project Title: Enhancement of Photolog Applications and Display Environment

Principal Investigators: Christian F. Davis

Project Status: Completed

Initial Agreement Date: June 1, 1997

Objectives:

The overall objectives of the project were to: review the current photolog hardware and software; catalog existing uses within ConnDOT; and identify new uses within ConnDOT and by others.

Progress:

Meetings held with a variety of ConnDOT users were summarized. Uses in connection with JHR 97-1 and by the Department of Psychology were also described. Potential new uses and users were identified. The Final Report was submitted.

Report(s):

Davis, C.F., "Enhancement of Photolog Applications and Display Environment," 1999, JHR 99-269.

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Summary for Program Year 1998-1999

Project Number: 97-4

Project Title: State-of-the-Art Rapid Non-Destructive Pavement Assessment: Ground Penetrating Radar (GPR) in Monostatic Survey Mode

Principal Investigators: Lanbo Liu

Project Status: Completed

Initial Agreement Date: March, 1997

Objectives:

As a preparation phase for future research on applications of GPR techniques for pavement and bridge assessment, the objective of this project is to conduct a feasibility investigation on state-of-the art use of ground penetrating radar to rapid pavement assessment. This study systematically acquired, summarized, and reviewed the latest developments in this research area. The performance, feasibility, and accessibility of different approaches developed in North America and other countries in the world have been evaluated and compared in terms of the hardware, software and survey methodology. This study can be viewed as a compilation of valuable information to researchers in the Connecticut Department of Transportation (ConnDOT) and the University of Connecticut (UConn) to carry out future projects using GPR in rapid non destructive pavement assessment.

Progress:

A feasibility study on investigating state-of-the-art non-destructive pavement assessment using ground penetrating radar (GPR) has been conducted. We have found substantial advance in GPR antenna design over the last several years. The ultimate goal of all new designs is achieving higher transmission efficiency. The interpretation software development mainly use the artificial neural network. In terms of survey method, besides the commonly used monostatic transmitter-receiver pairs, multiple transmitter-receiver pairs start to merge in the pavement assessment practice.

Our study was not limited to pure literature search. We have also conducted substantial research in three aspects in the field of software development: (1) Radar wave propagation forward modeling using the finite difference pseudo spectral approach; (2) Signal processing using wavelet decomposition to extract instantaneous parameters; (3) Image reconstruction using backscattering diffraction tomography. All three topics find direct application in using GPR in rapid pavement assessment. These results have been

reported and were well received at the 7th International Conference on GPR held in May, 1998.

In future studies on using GPR for rapid pavement assessment we suggest (1) using horn antennas with stepped frequency in 1 – 5 GHz; (2) using software based upon neural network with association to wavelet transform to substantially reduce the amount of data involved; and (3) using a multiple transmitter-receiver array to get *in situ* velocities.

Report(s):

Liu, L., "State-of-the-art Rapid Non-Destructive Pavement Assessment: Ground Penetrating Radar (GPR) in Monostatic Mode," Report to the Joint Highway Research Advisory Council, Connecticut Department of Transportation, 1998.

Liu, L., Habashy, T.M., and Oristaglio, M.L., "Imaging the Shape of a Two-Dimensional Cylindrical Inclusion Near a Plane Surface by Electromagnetic Wave Scattering," in the *Proceedings of the Progress in Electromagnetics Research Symposium (PIERS '97)*, Cambridge, Massachusetts, July 7-11, p. 40, 1997.

Liu, L., Lane, W., and Quan, Y., "Radar Attenuation Tomography Using the Centroid Frequency Down-Shift Method," *Journal of Applied Geophysics*, Vol. 40, No. 1-3, pp. 105-116, 1998.

Liu, L. and Oristaglio, M., "GPR Signal Analysis: Instantaneous Parameter Estimation Using the Wavelet Transform," Proceedings of *the 7th International Conference on Ground Penetrating Radar (GPR '98)*, pp. 219-223, Lawrence, Kansas, May 27-30, 1998.

Liu, L., Zhou, C., Haeni, F.P., and Lane, J.W., "GPR Attenuation Tomography Using Frequency Shift Method: Consideration of Non-Linear Frequency Dependence of Attenuation," *SEG Expanded Abstracts*, SEG 67th Annual Meeting, pp. 442-445, Dallas, Texas, November 2-7, 1997.

Liu, L., Zhou, C., and Xiao, L., "Imaging the Interior of the Nathan Hale Monument in Coventry, Connecticut by GPR Attenuation Tomography," in the Proceedings of the *7th International Conference on Ground Penetrating Radar (GPR '98)*, pp. 775-778, Lawrence, Kansas, May 27-30, 1998.

Xiao, L., Liu, L., and Cormier, V., "Three-Dimensional Finite-Difference Time-Domain Solution to Maxwell's Equations Using Pseudo-Spectral Method," Proceedings of the *7th International Conference on Ground Penetrating Radar (GPR '98)*, pp. 585-589, Lawrence, Kansas, May 27-30, 1998.

Zhou, C., and Liu, L., "Multi-Frequency Radar Diffraction Tomography Using Quasi-Linear Approximation," *Proceedings of the 7th International Conference on Ground Penetrating Radar (GPR '98)*, pp. 303-307, Lawrence, Kansas, May 27-30, 1998.

Zhou, C., and Liu, L., "Multi-Frequency Radar Diffraction Tomography Using Quasi-Linear Approximation," *Proceedings of the 7th International Conference on Ground Penetrating Radar (GPR '98)*, pp. 303-307, Lawrence, Kansas, May 27-30, 1998.

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Project Number: 98-1

Project Title: Development of a Test to Measure Tendency for a Hot Mix to Segregate

Principal Investigators: Jack Stephens, James Mahoney & Cory Dippold

Project Status: Active

Initial Agreement Date: June 1, 1998

Objectives:

1. Develop a test can which can be used to predict the probability of segregation of a Hot-Mix during handling and placing.
2. Test a sufficient number of mixes to make a preliminary estimate of the test value that can be used to differentiate between those mixes that tend to segregate and those that don't.

Progress:

A number of combinations of free fall, impact slope and collection areas were tried. Maintaining the impact slope in a constant condition proved difficult so a series of tests were devoted to finding an easily renewed surface. The best and most practical materials for the impact slope covering proved to be ordinary kitchen wax paper. The process consists of dropping a hot-mix sample onto an inclined plane. On reaching the end of the incline surface, the mix free falls into two rectangular collection pans. If segregation occurs, the finer material literally drips from the toe of the inclined plane while momentum carries the coarser material away from the toe of slope. Differences between the near and far halves of the mix are found by gradation after the binder is burnt out in the ignition oven.

Completion of the second task has been slow. DOT field personnel were asked to sample stable and segregatable mixes. Two plants with past segregation problems and two without were noted. As of June 30, mixes from the two plants with past troubles have been tested. Mixes from the other plants will be tested in July and August. Comparison of the test results should provide a first estimate of the test value that delineates the sensitive mixes from the stable. A final report should be ready by mid to late September.

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Project Number: 98-3

Project Title: Evaluation of Sign Support Structures

Principal Investigators: John T. DeWolf

Project Status: Active

Initial Agreement Date: June 1, 1998

Objectives:

The objective of this project has been to develop and verify design provisions which can be used in the evaluation of highway sign supports, both existing and proposed. The sign types studies in this research are those with truss supports, so that the compressive members are subject to both normal with loads and gravity loads.

Progress:

The literature search and review of the existing guidelines has been completed. A typical sign support has been selected for initial evaluation. An extensive review of stability approaches is now complete. This has been used to develop software that can be used by designers for the stability analysis. The software is in testing, including application to a typical sign support. Review of the existing design procedures is underway, and this will lead to development of final design guidelines.

Joint Highway Research Advisory Council Expenditures
Program Year 1998-1999

I. Regular Projects:

Project Number	Title	Original Estimated Costs	Prior Years Expended	June 1, 1998 to May 31, 1999	Total to May 31, 1999	Estimated to Complete
94-4	Effective Use of the ConnDOT GPS Base Station	$84,663.00	$66,387.56	$0.00	$66,387.56	$0.00
96-1	Field Treatment of Soil Contaminated with Lead	$32,568.00	$64,256.69	$26,914.46	$91,171.15	$0.00
96-2(1)	Protection of Reinforcement with Corrosion Inhibitors, Phase 1	$63,115.00	$114,258.35	$23,927.87	$138,186.22	$0.00
96-2(2)	Protection of Reinforcement with Corrosion Inhibitors, Phase 2	$39,087.00	$0.00	$39,014.55	$39,014.55	$25,032.00
96-4	Relaxation in High-Strength Bolted Connections on Galvanized Steel	$46,624.00	$45,963.09	$0.00	$45,963.09	Completed & Closed 6/4/98
97-1(1)	Estimating Benefits from Specific Highway Safety Improvements: Phase I – Feasibility Study	$33,566.00	$29,876.65	$123.76	$30,000.41	$0.00
97-1(2)	Estimating Benefits from Specific Highway Safety Improvements: Phase 2 – Initial Implementation	$53,561.00	$0.00	$45,592.55	$45,592.55	$6,089.00
97-2	Estimating the Temporal Distribution of Traffic Within the Peak Period	$56,131.00	$43,039.83	$22,826.27	$65,866.10	$0.00

97-3	Enhancement of Photolog Applications and Display Environment	$23,621.00	$19,441.28	$12.45	$19,453.73	Completed & Closed 7/8/99
97-4	State-of-the-Art Rapid Non-Destructive Pavement Assessment: Ground Penetrating Radar (GPR) in Monostatic Survey Mode	$14,000.00	$13,088.03	$0.00	$13,088.03	Completed & Closed 3/11/99
98-1	Development of a Test to Measure Tendency for a Hot Mix to Segregate	$35,547.00	$0.00	$29,157.88	$29,157.88	$6,389.00

II. Letter of Intent Projects:

Project Number	Title	Original Estimated Costs	Prior Years Expended	July 1, 1998 to June 30, 1999	Total to June 30, 1999	Estimated to Complete
93-4	Hydrodynamic and Transport Models in Coastal Waters for Use in the Design and Management of Highway Structures	$261,691.00	$338,929.51	$114,474.31	$453,403.82	$24,325.00
96-5	Evaluation of Source-Separated Compost for Connecticut DOT Projects	$79,523.00	$64,766.50	$0.00	$64,766.50	Completed & Closed 3/11/99
98-3	Evaluation of Sign Support Structures	$34,603.00	$0.00	$27,751.56	$27,751.56	$27,000.00

III. Other

Project Number	Title	Original Estimated Costs	Prior Years Expended	June 1, 1998 to May 31, 1999	Total to May 31, 1999	Estimated to Complete
96-100	Other (Supplies, Printing, Postage)	N/A	N/A	$3,521.95	$3,521.95	N/A
96-101	Net Vehicle Expenses	N/A	N/A	$2,510.21	$2,510.21	N/A

LIST OF COMPLETED JOINT HIGHWAY PROJECTS

Project No.	Title
51-1	Study of Hydraulic Design of the Curb Inlet Grate. Report - V.E. Scottron and C.J. Pelletier, "The Hydraulic Performance of Inlet Gratings," 1954.
51-2	Investigation of Run-off from Small Drainage Areas. Report - J.E. Stephens, "Rainfall and Runoff Study of Small Drainage Areas," Feb. 1973, JHR 73-65.
51-3	Variation in Amount of Frost Heave with Depths of Ground Water Table. Reports - R.J. Leonard, "A Study of the Effect of the Depth of Water Tables on Frost Action in Soils," 1954. E.V. Gant, "Studies of Frost Action in Soils as a Function of Selected Soil Properties, Climatic Factors and Elevation of Ground Water Table," 1963.
51-4	Effect of Washed Concrete Sand in Increasing Capillary Rise and Frost Heaving in Adjacent Soil. Report - E. Budzik, "The Effect of Concrete Sand on Capillarity in Parent Material," 1953.
51-5	Capillary Potential of Various Materials. Report - A.V. Giodano, "Criterion for Filter Stability," 1955.
51-6	Filter Test of Various Materials. Reports - E.R. Phelisse, "Some Aspects of Filter Action in Highway Underdrains," 1954. B.K. Ramiah, "Stability of Filters for Highway Underdrains," 1956.
53-1	Development of Miniature Filter Test Report - B.K. Ramiah, "Stability of Filters for Highway Underdrains," 1956.
54-1	Pile Drag Study - New Haven Harbor. Report - E.V. Gant, J.E. Stephens, and L. Moulton, "Measurement of Forces Produced in Piles by Settlement of Adjacent Soil," 1958. Published in HRB Bulletin No. 173.
54-2	Laboratory Evaluation of Frost Characteristics. Report - P.V. Cuomo, "A Study of Moisture Migration in Freezing Soils," 1956.

LIST OF COMPLETED JOINT HIGHWAY PROJECTS

Project No.	Title
57-1	Study of the Relationship Between the Degrees of Consolidation and the Snearing Strength of Varved Clays and Marine Muds. No formal report written. Results applied by CONNDOT, Division of Soils and Foundations.
57-2	Study of the Relationship Between the Orientation of the Principal Stresses and the Shearing Strength of Varved Clays. Report - T.M. Meda, "Stability Analysis of Highway Embankments," 1958.
57-3	Attempt to Correlate Laboratory Triaxial Shear Tests with Miniature Laboratory and Larger Field Vane Shear Tests. No formal report written. Results applied by CONNDOT, Division of Soils and Foundations.
57-4	Development and Use of Consolidation Apparatus Which Will Make Use of Extra-Thick Samples of Varved Clay. No formal report written. Results applied by CONNDOT, Division of Soils and Foundations.
63-1	Split Cylinder Tests of Flexible Pavements. Report - J.J. Breen and J.E. Stephens, "Split Cylinder Test Applied to Bituminous Mixtures at Low Temperatures," 1965. Published in Journal of Materials, ASTM, Vol. 1, No. 1, 1966.
63-2	Fatigue Characteristics of Flexible Pavements Under Repeated Loads at Various Temperatures. Reports - J.J. Breen, "Fatigue and Tensile Characteristics of Bituminous Pavements at Low Temperatures," 1966. Published in Journal of the Canadian Technical Asphalt Association, Vol. 11, 1967, JHR 66-3. J.J. Breen and J.E. Stephens, "Preliminary Report on the Fatigue and Bituminous Pavements at Low Temperatures," published in Journal of the Canadian Technical Asphalt Association, Vol. 10, 1966. J.J. Breen and J.E. Stephens, "The Glass Transition Temperature and the Mechanical Properties of Asphalt," Oct. 1967, JHR 67-16.

LIST OF COMPLETED JOINT HIGHWAY PROJECTS

Project No.	Title
63-4	Study of Bridge Vibrations and Deflection - Effect on Slab Durability.
	Reports - J.C. Longley, "An Investigation of the Dynamically Induced Stresses in a Typical Highway Bridge," July 1966, JHR 66-4.
	Civil Engineering Department, University of Connecticut, "Interim Report on the Study of Bridge Deck Deterioration for the Connecticut Highway Department," 1965.
63-5	Effect of Aging in Asphalt.
	Report - D. Anderson, "Artificial Aging of Some Various Penetration Grade Asphalts," 1964.
63-6	Density of Bituminous Concrete Pavement by Nuclear Methods.
	Reports - J.E. Stephens, "Connecticut Procedure for Pavement Density Measurements," published as Discussion of Compaction of Asphalt
	Concrete in Proceedings, Association of Asphalt Paving Technologists, 1967. J.E. Stephens, "Effect of Roller Passes on Density," presented at 6th Annual Paving Conference, Connecticut Bituminous Concrete Producers Association, 1964.
	Density charts, Silly Putty gauges and instructions supplied to CONNDOT.
63-7	An Investigation of the Brittle Plastic Behavior of Asphalt Mixtures by Use of an Impact Device.
	Report - J.E. Stephens and G.J. Gromko, "An Investigation of the Brittle Plastic Behavior of Asphalt Mixtures by Use of an Impact Device," 1967.
63-7	Published in Highway Research Record No. 256.
	Report - G.J. Gromko, "An Investigation of the Brittle Plastic Behavior of Asphalt Mixtures by Use of an Impact Device," Aug. 1967, CE 67-12.
63-9	Effects of Aggregate Shape on Bituminous Mix Characteristics.
	Report - J.E. Stephens, "Effect of Aggregate Shape on Bituminous Mix Characteristics, Project 63-9 Final Report, " December 1974, JHR 74-87.
64-1	Salt Concentration in Run-off Water.
	Report - W.J. Widmer, "Preliminary Study of the Effects of Highway Salt Run-off on Adjacent Surface Water," 1965.

LIST OF COMPLETED JOINT HIGHWAY PROJECTS

Project No.	Title
64-2	Erosion Control in Ditches and Waterways.
	Reports - K.B. Shivarudrappa, "Friction Flow Over Bound Rock Erosion Proofing," July 1966, JHR 66-5.
	C.J. Posey, "Erosion Prevention Experiments," presented at 1969 Meeting of the International Association for Hydraulic Research, Kyoto, Japan.
	C.J. Posey, "Erosion Protection," 30 minute 16mm color motion picture, shown at 1970 Highway Research Board Meeting, Washington, DC.
	C.J. Posey, "Design and Construction Specifications."
64-3	Triaxial Consolidation of Varved Clay.
	Reports - G.S. Ramanjaneya, "Consolidation Characteristics of a Varved Clay," 1969 Ph.D. dissertation, JHR PR 69-26.
	K.A. Healy and G.S. Ramanjaneya, "Consolidtion Characteristics of a Varved Clay," Final Report, July 1970, JHR 70-30.
65-1	Quality Control of Asphaltic Concrete.
	Report - J.E. Stephens, "Reduction of Apparent Aggregate Variation Through Improved Sampling," May 1966, JHR 66-1.
65-2	Field Control of Deck Concrete.
	Report - Civil Engineering Department, University of Connecticut, "Interim Report on the Study of Bridge Deck Deterioration," 1965.
65-3	Laboratory Simulation of Deck Deterioration.
	Reports - K.A. Healy, R.W. Borjeson and J.C. Perazella, "Investigation of Concrete Bridge Deck Deterioration," Sept. 1966, CHD 66-5
	K.A. Healy, R.W. Borjeson and J.C. Perazella, "Investigation of Concrete Bridge Deck Deterioration," May 1967, JHR 67-11.
64-4	Salt Build-Up in Roadway Soils.
	Report - G.A. Prior and P.M. Berthouex, "Study of Salt Pollution of Soil by Highway Salting," Jan. 1967, JHR 67-9.
66-1	Effect of Straightening Damaged Steel.
	Reports - M. Apostle, "The Bauschinger Effect and Its Implications on the

LIST OF COMPLETED JOINT HIGHWAY PROJECTS

Project No.	Title
66-1 (cont'd)	Straightening of Accidentally Bent Structural Steel Members," Master's Thesis, June 1974.
	E.R. Johnston, "Effect of Straightening Damaged Steel," March 1976, JHR 76-98.
66-2	I-84 Freeway Surveillance and Control.
	Report - W.B. Perruccio, "Analysis of Ramp Service Time Distribution by
66-3	Monte Carlo Simulation," 1968, JHR 65-18.
	Reports - R.F. Dawson and W.B. Perruccio, "I-84 Freeway Surveillance and Control Project," Sept. 1969, JHR 69-28.
	R.F. Dawson and W.B. Perruccio, "Summary Report I-84 Freeway Surveillance and Control Project."
66-4	Expressway Traffic Simulation.
	Report - K.C. Sinha, "The Development of a Digital Simulator for the Analysis of Freeway Traffic Phenomena," Dec. 1968. JHR 68-14.
66-5	Hyperland Function as a Traffic Model.
	Report - R.F. Dawson and L.A. Chimini, "The Hyperland Probability Distribution - A Generalized Traffic Headway Model," 1967. Published in Highway Research Record No. 230, JHR 67-13.
66-6	Salt Concentration in Vegetation.
	Report - E.F. Button and D.E. Peaslee, "The Effect of Rock Salt Upon Roadside Sugar Maples in Connecticut," 1966, Published in Highway Research Record No. 161.
67-1	Frost Susceptible Soil, I-91, Wallingford.
	Reports - K.A. Healy, G.S. Ramanjaneya and G. Meitzler, "Investigation of Shoulder Heaving in Wallingford-Meriden Area of I-91," Sept. 1966, CHD 66-6.
	K.A. Healy and G. Meitzler, "Frost Heaving in the Wallingford-Meriden Section I-91," Oct. 1967, JHR 67-15.
67-2	Prefabricated Underdrains.
	Reports - K.A. Healy and R.P. Long, "Preliminary Report - Prefabricated Undrains," January 1969, JHR 69-23.

Project No.	Title
67-2 (cont'd)	K.A. Healy and R.P. Long, "Interim Report on Prefabricated Subterranean Drains," March 1970, JHR 70-28.
	R.P. Long and K.F. Briggs, III, "Installation of Prefabricated Underdrains Along Route 44A, September 1970, JHR 70-31.
	K.A. Healy and R.P. Long, "Field Performance of Prefabricated Underdrains, Report #4," June 1979, JHR 71-39.
	R.P. Long and K.A. Healy, "Prefabricated Subsurface Drains," Dec. 1970. CE 70-33.
	K.A. Healy and R.P. Long, "Prefabricated Subsurface Drains," Publication in Highway Research Record No. 360, 1971.
	K.A. Healy and R.P. Long, "Installation of Prefabricated Underdrains on Route 82 Extension, Haddam," July 1971, JHR 71-41.
	K.A. Healy and R.P. Long, "Final Report, Prefabricated Underdrains," October 1972, JHR 72-52.
	K.A. Healy and R.P. Long, "Prefabricated Filter-Fin for Subsurface Drains," ASCE J. Irr. and Drainage Div., Vol. 98, No. IR4, December 1972, pp. 543-552.
	K.A. Healy and R.P. Long, "Design and Construction Specifications."
	R.P. Long and K.A. Healy, "Fabric Filters on Prefabricated Underdrains," April 1977, CE 77-106.
67-3	Applicability of Electro-Osmosis to Marginal Soils.
Reports -	R.P. Long, "Interim Report on the Reduction of Frost Heave of a 'Dirty' Connecticut Gravel with Chemical Dispersants," July 1969.
	R.P. Long and T.F. Zimmie, "Final Report, Application of Electro-Osmosis to Marginal Soils," March 1973, JHR 73-62.
	R.P. Long and T.F. Zimmie, "Mean Pore Size from Flow Measurements," ASCE J. Soil Mechanics and Foundations Div., July 1973.

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Project No.	Title
67-4	Correlation of Molecular Size and Asphalt Characteristics.
	No formal report written. Data presented in discussion of AAPT paper by J.E. Stephens, 1969, and used later in Project 69-1.
67-5	Bituminous Mix Density by Coated Specimens.
	Report - J.E. Stephens, "Bituminous Mix Density by Coated Specimen, Final Report," Jan. 1973, JHR 73-59.
67-6	Control of Moisture Under Pavements.
	Reports - K.A. Healy and R.P. Long, "Interim Report on Moisture Under Pavements," June 1969, JHR PR 69-25.
	R.P. Long and K.F. Briggs, III, "Final Report - A Rapid Field Test to Identify Frost Susceptible Soils," August 1972, JHR 71-45.
	R.P. Long and K.F. Briggs, III, "Device for Measuring Subsieve Sizes in the Field," HRB Highway Research Record 426, 1973.
67-7	Stresses in Curved Girder.
68-1	Study of Permeability of Calcium Chloride Stabilized and Crusher Run Bases.
	Reports - R.P. Long and K.A. Healy, "Interim Report - Suitability of Calcium Chloride Stabilized Base Material," June 1968.
	K.A. Healy and R.P. Long, "Final Report - Suitability of Calcium Stabilized Bases," July 1972, JHR 72-49.
68-2	Pilot Roadway Design Project ROADS Subsystem of ICES.
	Report - R.F. Dawson, "Final Report - Roadway Design Research Project," May 1969, JHR 69-24.
69-1	Effect of Heat and Air on Asphalt by Gel Permeation Chromatography.
	Report - C.E. Dougan, "Molecular Size Distributions of Asphalt as Determined by Gel Permeation Chromatography (Final)," Research Project 175-210, published by Research and Development Section, Bureau of Highways.
70-2	Analysis of Thermally Loaded Laminated Circular Plates.
	Reports - J.F. Carney, "Analysis of Thermally Loaded Laminated Circular Plates:
	Report #1, May 1971, JHR 71-37.

Project No.	Title
70-2 (cont'd)	Report #2, August 1971, JHR 71-43.
	Report #3, March 1972, JHR 72-50.
	Final Report, Dec. 1972, JHR 72-58.
70-3	Field Consolidation of Varved Clay.
Reports -	R.P. Long and K.A. Healy, "Preliminary Report, Field Consolidation of Varved Clay, Phase I," January 1971, JHR PR 71-34.
	Field Consolidation of Varved Clay, Report #2," June 1971, JHR 71-38.
	"Field Consolidation of Varved Clay, Report #3," Aug. 1972, JHR 72-55.
	"Analyzing Field Data for Initial Settlements," Oct. 1972, JHR 72-56.
	"Field Consolidation of Varved Clay, Report #4," March 1974, JHR 74-78.
	"Field Consolidation of Varved Clay, Report #5, June 1975, JHR 75-89.
	"Field Consolidation of Varved Clay, Final Report," April 1978, JHR 78-113.
70-4	Air Jet Snow Plow.
Reports -	M.M. Kasinskas, "Development of the Air Jet Snowplow, Report #1," June 1970.
	"Final Report," July 1972.
70-5	Simulation of Traffic Flow of the I-291 and Route 15 Three-Level Diamond Interchange.
Reports -	R.P. Jain, "Traffic Flow Simulation on I-291 and Route 15 Three-Level Diamond Interchange," July 1971, JHR 71-40.
	C.H. Knapp and R.P. Jain, "Simulation of Traffic Flow on the I-291 & Route 15 Three-Level Diamond Interchange," Jan. 74, JHR 74-79.

Project No.	Title
70-5 (cont'd)	C.H. Knapp and R.P. Jain, "Simulation of Traffic Flow on the I-291 & Route 15 Three-Level Diamond Interchange," Jan. 74, JHR 74-79.
71-1	Multiple Truck Loading on Bridges.
	Report - R.D. Desrosiers and R.J. Grillo, "Estimating the Frequency of Multiple Truck Loadings on Bridges, Project 71-1," May 1973, JHR 73-68.
72-1	Effects of Deicing Salts and Lead Particulates Upon Chemical Composition of Trees and Shrubs.
	Reports - E.F. Button, "Determination of the Effects of Deicing Salts Upon Trees, Shrubs and Soils - Report I," November 1973.
	E.J. Rubins, "Summary 175-331 Soil Samples - 1973," December 1973.
	E.F. Button, E.J. Rubin, W.A. Woodward and G.F. Griffin, "Effects of Deicing Salts and Lead Upon Trees, Shrubs, and Soils in Connecticut - Final Report," January 1977, Report No. 331-F-76-9.
72-2	Measurement of Bridge Deck Status by Dynamic Modulus.
	Reports - J.E. Stephens, "Measurement of Bridge Deck Status by Dynamic Modulus, Final Report," August 1979, JHR 79-129.
	J.F. Risley, "A Method of Investigating Bridge Deck Quality Through Dynamic Analysis and Appropriate Testing Comparison," Master's Thesis, May 1977.
73-1	Negative Skin Friction on Piles and Foundation Design Methods for Poles and Towers.
	Reports - R.P. Long and K.A. Healy, "Final Report - Foundation Design Methods for Poles and Towers," Dec. 1973, JHR 73-71.
	R.P. Long and K.A. Healy, "Final Report - Negative Skin Friction on Piles," Jan. 1974, JHR 74-77.
73-2	Analysis of Connecticut Department of Transportation Traffic Paints.
	Reports - L. Shih and R.M. Fitch, "Analysis of Traffic Paints," Research Report, June 1973.

LIST OF COMPLETED JOINT HIGHWAY PROJECTS

Project No.	Title
73-2 (cont'd)	J.E. Stephens, L. Shih and R.M. Fitch, "Hot White Traffic Paint, Laboratory and Summer Condition Study," Feb. 1974, JHR 74-76.
73-3	Short Term Effects of Highway Construction.
	Report - B.J. Houghton and R.H. Wortman, "Short Term Consequences of Highway Construction - The Allyn Street Connector Case Study," May 1975, JHR 74-82.
73-4	A Portable Energy Absorbing System for Highway Service Vehicles.
	Reports - J.F. Carney, "A Portable Energy Absorbing System for Highway Service Vehicles," June 1974, JHR 74-80.
	J.F. Carney, "A Portable Energy Absorbing System for Highway Service Vehicles, Final Report," Sept. 1974, JHR 74-83.
	J.F. Carney, "Experimental Evaluation of a Portable Energy Absorbing System for Highway Service Vehicles, Final Report Phase I," June 1977, CE 77-109.
74-1	Measurement of Foundation Strains Under Lateral Loads.
	Report - R.P. Long, K.A. Healy, P.J. Carey and M. Powers, "Measurement of Foundation Strains Under Lateral Loads," December 1976, JHR 76-102.
74-3	A Review of Traffic Restraint Concepts and the Potential Application in Connecticut.
	Report - H. Miller, R.H. Wortman, "The Potential Application of Traffic Restraint in Connecticut," February 1977, CE 77-103.
74-4	Design of Test Installation of Bitumen Coated Piles.
	Report - R.P. Long, "Design of Test Installation for Bitumen Coated Piles, Final Report," Feb. 1976, JHR 76-96.
75-2	Split Cylinder Test for Tension Strength of Concrete.
	Report - T. Pastor, J. Pelliccione, and J.E. Stephens, "Split Cylinder Test for Tension Strength of Concrete," March 1976, JHR 76-97.
75-4	Statistical Utilization of Part Quality Control Data.
	Report - J.E. Stephens, T. Pastor, and J.R. Pelliccione, "Statistical Analysis Applied to Management Decisions," February 1977, JHR 77-104.

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Project No.	Title
77-1	Reducing Highway Maintenance Through Effective Drainage.
	Report - R.P. Long, K.A. Healy, P.J. Carey, and W. Hover, "Reducing Highway Maintenance Through Effective Drainage, Final Report," March 1979, JHR 79-124.
77-2	Development of a Process for the Review of Queueing Models to be Used in Air Quality Analysis.
	Report - C.F. Davis and T. Ryan, "Queueing Models for Pollution Analysis," February 1979, JHR 79-123.
77-3	A Legal Determination of the Navigability of the Quinebaug and Shetucket Rivers.
	Report - K. Fox, "Legal Determination of the Navigability of the Quinebaug and Shetucket Rivers," May 1978, JHR 78-114.
77-4	Solar Energy Augmentation for Hot Water Needs in Connecticut Highway Rest Areas.
	Report - D.R. Jackson, J. Callahan, and W.W. Bowley, "Solar Energy Augmentation for Hot Water Needs in Connecticut Highway Rest Areas, Final Report," March 1982, (JHR XX).
77-5	False-Color Infrared Aerial Photography as an Aid in Evaluating Environmental Impacts on Inland Wetlands by Proposed Highway in Connecticut: A Feasibility Study.
	Report - W.C. Kennard, M.W. Lefor, and D.L. Civco, "False-Color Infrared Aerial Photography as an Aid in Evaluating Environmental Impacts on Inland Wetlands by Proposed Highways in Connecticut: A Feasibility Study, Final Report," Sept. 1978, JHR 78-120.
77-6	Chemical Reactivity of Selected Connecticut Rock Strata.
	Report - I. Kaseoru, "Chemical Reactivity of Selected Connecticut Rock Strata," Term Paper 1979.
78-1	Development of a Steel Pipe Vehicle Impact Attenuation System.
	Reports - J.F. Carney, "Development of a Steel Pipe Vehicle Impact Attenuation System, Final Report," September 1978, JHR 78-121.
	J.F. Carney, "Experimental Evaluation of a Portable Energy Absorbing System for Highway Service Vehicles, Final Report for Phase II," April 1979, CE 79-125.

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Project No.	Title
78-2	Assessment of Highway Environmental Impact in Connecticut Using Remote Sensing Procedures.
	Report - W.C. Kennard, M.W. Lefor, and D.L. Civco, "Identification on Inland Wetlands for Transportation Planning Using Color Infrared Aerial Photography, Final Report," May 1980, JHR 80-132.
78-3	Analysis of Air Pollution, Traffic Congestion and Fuel Consumption by Computer Simulation.
	Report - C.F. Davis and T.A. Ryan, "Analysis of Air Pollution, Traffic Congestion and Fuel Consumption by Computer Simulation, Final Report," February 1980, JHR 80-131
78-4	Determining the Shear Strength of Varved Clay Using Vane Shear.
	Report - R.P. Long, P.J. Carey, and W.H. Hover, "Determining the Shear Strength of Varved Clay Using Vane Shear, Final Report," February 1980, JHR 80-130.
79-1	A Study of Para-Transit in Connecticut.
	Report - C.F. Davis and M.F. Makuch, "Final Report - Paratransit: A Review of Selected Connecticut Programs and Comparison with National Experience," May 1983, JHR 83-150.
80-1	Residential Relocation as a Conservation Strategy to Cope with Rising Gasoline Prices and Uncertain Supply.
	Report - C.B. Monroe and T. Maziarz, "Residential Relocation as a Conservation Strategy to Cope with Rising Gasoline Prices and Uncertain Supply," July 1981, JHR 81-139.
80-2	A Performance Test for Bitumen Coated Piles.
	Report - R.P. Long, "Performance Test for Bitumen Coated Piles, Final Report," February 1982, JHR 82-142.
80-3	The Addition of Lignin from Gasohol Plants to Asphalts.
	Report - D.W. Sundstrom, H. Klei, and J.E. Stephens, "Final Report - The addition of Lignin from Gasohol Plants to Asphalts," April 1983, JHR 83-139
80-4	Energy Efficiencies of Transportation Modes.
	Report - C.F. Davis and O.G. Brown-West, "Final Report - Energy Efficiencies of Transportation Modes," October 1982, JHR 82-147.

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Project No.	Title
80-6	Estimating Bus Ridership.
	Reports - H.S. Levinson and O.G. Brown-West, "Interim Report 1, Hartford Bus Rider Characteristics."
	"Interim Report 2, Hartford Bus Ridership Penetration Curves."
	"Final Report - Estimating Bus Ridership," July 1983, JHR 83-152.
81-1	Rate and Quantity of Distillate Evaporation from Bitumen Concrete.
	Report - J.E. Stephens and G.E. Hoag, "Volatiles in MC-3000 Bituminous Paving Mixture," June 1982, JHR 82-143.
82-1	PCB Analysis in Bituminous Materials.
	Reports - G.E. Hoag and S.E. Alexander, "Polychlorinated Biphenyls Analysis in Bituminous Materials, Final Report," August 1984, JHR 84-160.
	G.E. Hoag and S.E. Alexander, "Executive Summary - Polychlorinated Biphenyls Analysis in Bituminous Materials. Based on Final Report: Project 82-1," October 1984, JHR 84-161.
82-3	Transportation Management in Connecticut.
	Report - H.S. Levinson and K.G. Zografos, "Transportation System Management in Connecticut, Final Report," May 1987, JHR 87-172.
82-4	Development of Optimum Pavement Maintenance/Reconstruction Strategies Based on Serviceability and Fiscal Parameters.
	Report - J.E. Stephens and C.F. Davis," An Analysis of Highway Pavement Deterioration and a General Technique for Optimization of Maintenance/Reconstruction, Final Report," January 1984, JHR 84-156.
83-1	Further Development of Optimization Procedures in Pavement Management.
	Report - J.E. Stephens and H.H. Ridgeway, "Further Development of Optimization Procedures in Pavement Management," June 1989, JHR 89-186.
83-3	Aging of Recycled Bituminous Binder.
	Report - J.E. Stephens and J. Rivenburgh, "An Evaluation of Aging of Recycled Asphalt, Final Report," May 1986, JHR 86-166.

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Project No.	Title
84-1	Study of Bridge Vibrations for Connecticut. Report - J.T. DeWolf, E.V. Gant, S.M. LaShomb, and J.W. Kou, "Study of Bridge Vibrations for Connecticut, Final Report," October 1985, JHR 85-165.
84-2	Monitoring & Remediation of Gasoline Storage Facilities. Report - G.E. Hoag and B. Cliff, "Method Development for the Gas Phase Analysis of Gasoline and Solvent Contaminated Soil, Final Report," March 1988, JHR 88-177.
86-2	Monitoring and Remediation of Gasoline Storage Facilities. Report - G. Hoag, D. Ahlfeld, A. Dahmani, and D. Strother, "Monitoring & Remediation of Gasoline Storage Facilities: Aqueous Leachability of Gasoline in Connecticut Sand,Final Report," April 1991, JHR 91-200.
86-3	Development of An Automated Bridge Monitoring System. Report - J.T. DeWolf, "Development of An Automated Bridge Monitoring System," May 1990, JHR 90-192.
86-5	Determining the Permeability of Granular Soils by Air Flow. Report - R.P. Long, K.R. Demars, R. Mankbadi and A. Covo, "The Relationship Between Permeability Coefficients for Soil Obtained Using Liquid and Gas," Sept. 1988, JHR 88-180.
86-6	Conversion to Unified Soil Classification System. Report - R.P. Long and K.R. Demars, "Conversion to Unified Soil Classification System, Final Report," December 1987, JHR 87-176.
86-7	Adapting the Quick-Load Method of Pile Testing to Connecticut Soils Needs. Report - R.P. Long, K.R. Demars, W.A. Shaheen and V. Mekagaroon, "The Applicability of the WEAP-86 Pile Capacity Prediction Method for Connecticut Soils and Behavior of a Sheetpile Wall for Stabilization of a Slope in Portland," Oct. 1988, JHR 88-181.
86-8	Evaluation of Rubber Modified Pavement Sections. Report - J.E. Stephens, "Nine Year Evaluation of Recycled Rubber in Roads," May 1989, JHR 89-183.
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86-13	A Feasibility Study of the Use of Video as an Aid in the Guidance/Navigation Driving Task.
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87-1	Evaluation, Training and Reevaluation of Management at the Connecticut Department of Transportation.
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87-2	High Pressure Gel Permeation Chromatographic Color Analysis of Asphalt.
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88-2	Measurement of Capacity of Drilled Shaft Foundation. Report - R.P. Long and F. Huang, "Corrosion of Driven Steel Piles," May 1990, JHR 90-193.
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