

**State of Wisconsin/Department of Transportation**  
**RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: Dec 31, 2002**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Investigation of the DCP and SSG as Alternative Methods to Determine Subgrade Stability</b>	<b>Project ID: 0092-01-05</b>
<b>Administrative Contact: Nina McLawhorn</b>	<b>Sponsor:</b>
<b>WisDOT Technical Contact: Error! Bookmark not defined.</b>	<b>Approved Starting Date: May 1, 2001</b>
<b>Approved by COR/Steering Committee: \$58,075.00</b>	<b>Approved Ending Date: May 1, 2003</b>
<b>Project Investigator (agency &amp; contact): Tuncer Edil: UW-Madison</b>	

**Description: This study will be conducted over 24 months, and will be completed in four (4) phases.**

**Task 1: Literature Study**

**Task 2: Laboratory Investigation and Data Analysis**

**Task 3: Field Testing and Data Analysis**

**Task 4: Final Report**

**Background:**

Over the years WisDOT has used various methods to determine the stability of earth subgrades during construction. These have included proof rolling, moisture/density tests, visual inspection and observation of construction equipment. All of these methods have drawbacks and some are very subjective and may even indicate misleading degrees of stability. An accurate determination of subgrade stability is important during the construction process to insure the construction of economical and long lasting subgrades and pavement structures.

Several agencies have recently proposed/used two new methods to measure subgrade stability. These separate methods involve the use of two test devices: the dynamic cone penetrometer (DCP) and the soil stiffness gauge (SSG). To date, only limited research of these devices has occurred on WisDOT projects. In addition to these devices, there may be other methods that accurately determine subgrade stability. The focus of this research is to investigate the two identified devices to determine their applicability and limitations to use on Wisconsin soils and WisDOT construction projects. Additional work will involve a literature search to determine if other devices/methods offer enough potential for future investigation.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
\$58,075.00	\$19,358.34	Error! Bookmark not defined.	\$63,604.29

**Progress This Quarter:**

(Includes project committee mtgs, work plan status, contract status, significant progress, etc.)

A laboratory study to investigate the effects of soil fabric and density on the SSG stiffness was performed using a pulse echo test and the results correlated well with the SSG measurements. However, these results will be verified with the resonant column test with a computer-automated built-in control system. The boundary effects (i.e., floor effect) must be taken into account when the SSG stiffness measurement is made on a sample in a compaction mold. The field study to investigate the SSG and the DCP was continued incorporating the data collected in the 2002 summer season. The analysis of all of the data collected (both in 2001 and 2002) promises an acceptable correlation between the SSG and the DCP at a certain depth of measurement and the soil types.

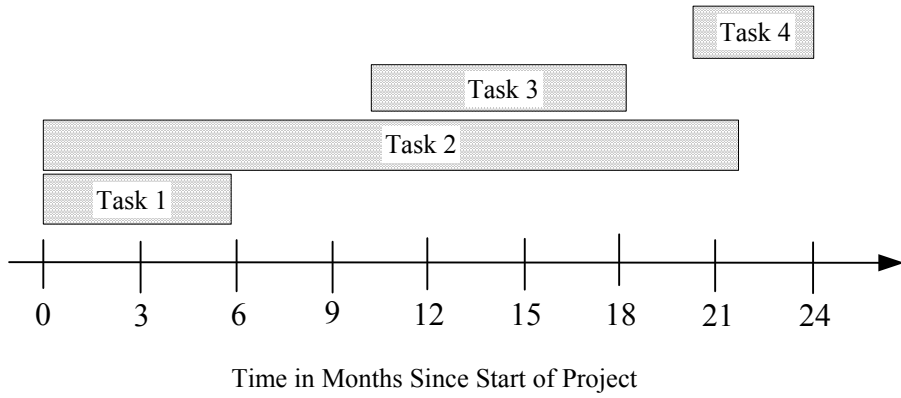
**Work Next Quarter:**

The evaluation of the SSG test will continue. The effort to date concentrated on granular materials. The zone of testing below the SSG, effects of layering, and correlation of SSG modulus to other well established moduli were the focus of the investigation. The use of SSG over cohesive soils will be investigated. The analysis completed on the field data and SSG-DCP correlation will be reviewed.

**Circumstances affecting progress/budget:**

**None**

**Gantt Chart:**



- Task 1: 95% complete
- Task 2: 80% complete
- Task 3: 80% complete
- Task 4: 20% complete

**Note: Gantt chart shown in State Fiscal Year Quarters**

**State of Wisconsin/Department of Transportation**  
**RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: Dec 31, 2002**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Development of Methodology to Include the Strength Contribution of Select Subgrade Materials in Pavement Structure</b> <b>Administrative Contact:</b> Nina McLawhorn <b>WisDOT Technical Contact:</b> Error! Bookmark not defined. <b>Approved by COR/Steering Committee:</b> \$120,034.00 <b>Project Investigator (agency &amp; contact):</b> Tuncer Edil: UW-Madison	<b>Project ID:</b> 0092-03-12  <b>Sponsor:</b> <b>Approved Starting Date:</b> Jul 25, 2002 <b>Approved Ending Date:</b> Oct 25, 2004

**Description:** The study will be conducted over 27 months, and will be completed in five (5) phases.

**Task 1:** Review

**Task 2:** Laboratory Investigation

**Task 3:** Analysis of Large-Scale Test Data

**Task 4:** Field Evaluation

**Task 5:** Synthesis of Results, Recommendations, and Technology Transfer

**Background:**

This study will determine what impact the inclusion of select materials in a subgrade will have on the pavement design parameters of that subgrade. It will also provide specific determinations for the relative impacts of each of the eight defined select materials systems now used by WisDOT. The study will recommend a proposed methodology to include these impacts in the pavement design process. The results of the study will provide WisDOT with the basis to make an informed policy decision on the inclusion of select materials impacts in pavement design.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$120,034.00</b>	<b>\$30,008.50</b>	Error! Bookmark not defined.	<b>\$0.00</b>

**Progress This Quarter:**

(Includes project committee mtgs, work plan status, contract status, significant progress, etc.)

A thorough review of all WisDOT policies, procedures, and practices relating to pavement design is undertaken.

We have started the laboratory investigation, which includes two elements: (1) characterization of the pertinent properties of the materials involved in the alternative systems proposed and (2) large-scale model experiments.

Material properties of breaker run, grade 2 gravel, and granular by-products – bottom ash, foundry slag, and foundry sand are characterized. Compaction characteristics, stiffness, and strength are determined. These properties will be used to interpret the large-scale model experiments and in calibrating computer models.

Large-scale model experiments (LSME) have been started in a 3 x 3 x 3 m test pit in the University of Wisconsin Structures and Materials Testing Laboratory. Testing layers of all the materials listed above are completed. Non-recoverable permanent (plastic), and recoverable (elastic) displacements accrued during 10,000 cycles of loading are determined for each material.

Alternative methods for providing a stable platform over soft subgrades are being evaluated using a 1.4 km section along STH 60 that incorporate twelve test sections including three control segments to evaluate nine different stabilization alternatives. Bi-annual falling weight deflectometer (FWD) surveys as well as pavement distress surveys are scheduled to evaluate the stiffness and performance of the pavement structure in a comparative manner. An FWD survey has been conducted on Fall 2002. The evaluation of the field observations and measurements will provide a basis to interpret the mechanical improvements determined in the laboratory tests in the context of field behavior.

**Work Next Quarter:**

Laboratory investigations will continue. Material properties of geogrid, geocomposite, woven and non-woven geotextiles will be characterized. Investigation will include determining the tensile strength, flexure stiffness, survivability, and interface friction of the geosynthetics mentioned above.

LSME will continue using geosynthetics filled with grade 2 gravel. Analysis of large-scale test data will start. Operating resilient modulus will be back-calculated using a numerical model program, KENLAYER, for grade 2 gravel and granular by-products. This way a basis for the comparison of the operating resilient modulus to that measured on specimens in a resilient modulus test can be done in the future.

Monitoring the field experiment will continue. A new FWD survey will be scheduled to evaluate the field experiment during the thaw season of Wisconsin. This test will be performed sometime during the Spring 2003.

**Circumstances affecting progress/budget:**

None to date.

**Gantt Chart:**

Tasks		2002				2003				2004			Progress
		Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	%
1	Literature Review			■									100
2	Laboratory Investigation			■	■	■	■	■					65
3	Analysis of Large Scale Test Data							■	■	■	■		0
4	Field Evaluation			■	■	■	■	■	■	■			38
5	Synthesis of Results									■	■	■	0

**Note: Gantt chart shown in State Fiscal Year Quarters**

**State of Wisconsin/Department of Transportation**  
**RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: Dec 31, 2002**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Determination of Influences on Support Strength of Crushed Aggregate Base Course Due to Gradational, Regional and Source Variations</b>	<b>Project ID: 0092-02-01</b>
<b>Administrative Contact: Nina McLawhorn</b>	<b>Sponsor:</b>
<b>WisDOT Technical Contact: Error! Bookmark not defined.</b>	<b>Approved Starting Date: Sep 6, 2001</b>
<b>Approved by COR/Steering Committee: \$99,972.00</b>	<b>Approved Ending Date: Jul 6, 2003</b>
<b>Project Investigator (agency &amp; contact): Richard Reusser: OMNNI</b>	

**Description: This study will be conducted over 22 months, and will be completed in four (4) phases.**

**Phase 1: Literature Research**

**Phase 2: Examination of Existing Aggregate Sources in Wisconsin**

**Phase 3: Sampling and Testing of Individual Sources**

**Phase 4: Data Analysis and Reporting**

**Background:**

The State of Wisconsin uses approximately 10,000,000 tons of crushed aggregate base course (CABC) annually, primarily as a base course layer, in its highway improvement projects. CABC is produced from both sand and gravel deposits, typically deposited in glacial and fluvial environments, and stone quarries. It is intended not only as a pavement support layer, but also as a stable working platform during the construction of the surface layer.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$99,972.00</b>	<b>\$33,324.00</b>	Error! Bookmark not defined.	<b>\$121,761.27</b>

**Progress This Quarter:**

(Includes project committee mtgs, work plan status, contract status, significant progress, etc.)

In the fourth quarter of 2002, we used statistical methods to analyze the test results obtained to date. Source information and physical characteristics were analyzed to determine their effect on the resilient modulus of the material.

In order to determine whether regional or depositional differences exist, the “analysis of variance” statistical test was used. We looked for differences in aggregate quality between quarries and pits, and also compared aggregate quality among the various lithologies in bedrock quarries, and among the different gravel pit locations, based on the glacial lobes transporting the material to them.

During the laboratory testing phase of the project, each of the sample sources was characterized using test results from many different physical tests. To gain a better understanding of the interrelationships among the various physical parameters of the aggregate resources in Wisconsin, statistical correlation tests were performed between all pairs of parameters. In particular, the relationship between the resilient modulus value and other physical parameters was of interest. To gain a better understanding of whether multiple physical parameters interacting together might be useful in predicting the resilient modulus value of a sample, a “regression analysis” was performed.

During the fourth quarter, we also obtained two samples of crushed aggregate base course, gradation no. 2 from the pre-Wisconsin age glacial deposits located in southern Lincoln County. To characterize the pre-Wisconsin glacial deposits sampled from Lincoln County, laboratory tests were performed and the lithologies were characterized. Neither resilient modulus or associated Standard Proctor testing was performed on these samples.

Some discussion was had with project oversight committee chairman Dan Reid about determining the most appropriate method for field verification. Through our review of the current research literature, it doesn’t appear that there is a reliable method for determining the resilient modulus of a base course layer in the field. We agreed to discuss the issue further at our next meeting with the project oversight committee in January, 2003.

**Work Next Quarter:**

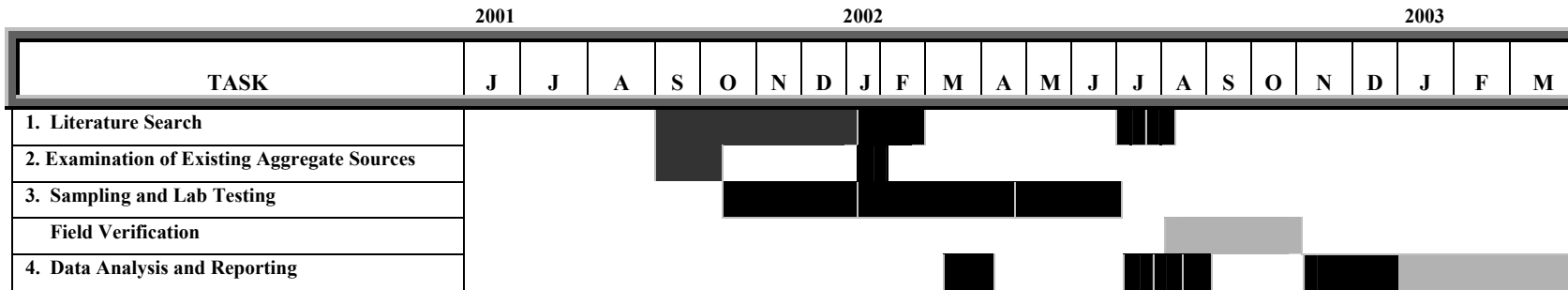
Meet with the project oversight committee in January to review our progress and findings and to determine what needs to be done to complete the research project. We will also continue to clarify and summarize our data and conclusions for inclusion into the final report.

**Circumstances affecting progress/budget:**

Field testing to verify laboratory resilient modulus values was scheduled to take place last fall. Because the appropriate test method has yet to be identified, field testing would likely occur in the spring to early summer.

**Gantt Chart:**

**Project Progress and Schedule**



*Project Start:* September 2001

*Project Completion:* Approximately June 2003

Task	Estimated Percent Complete
Literature Search	99%
Examination of existing aggregate sources	100%
Sampling and testing	100%
Field verification	0%
Data analysis and reporting	75%

**Note: Gantt chart shown in State Fiscal Year Quarters**

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<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Investigation of Bridge Approach Settlements</b>	<b>Project ID: 0092-00-13</b>
<b>Administrative Contact: Nina McLawhorn</b>	<b>Sponsor:</b>
<b>WisDOT Technical Contact: Error! Bookmark not defined.</b>	<b>Approved Starting Date: Apr 18, 2000</b>
<b>Approved by COR/Steering Committee: \$99,979.00</b>	<b>Approved Ending Date: Apr 18, 2007</b>
<b>Project Investigator (agency &amp; contact): Sam Helwany: UW-Milwaukee</b>	

**Description: The study will be conducted over 7 years (84 months), and the five (5) tasks will be completed in two (2) phases.**

**Phase I: Synthesis of Previous and Current Work on Bridge Approach Settlement**

**Task 1: Literature Review and Personal Interviews**

**Task 2: "Best Practices" Summary Report**

**Task 3: Methods for Settlement Calculations**

**Phase II: Effectiveness of the Selected Mitigation Methods**

**Task 1: Instrumented Full-Scale Tests**

**Task 2: Interim and Final Reports**

**Background:**

This study will be broken into two phases. Phase one will consist of personal interviews and a literature search of all existing work and research in this area. After this portion of the study is completed, a 'best practices' summary report will be submitted. This report will discuss which methods appear to be the most promising for solving the identified approach problems. Phase two will involve performing field pilot studies of a limited number (2-5) of the 'best practice' methods that show the most promise for WisDOT use. This will include construction of the bridge approaches as well as monitoring of them for a period of several years. Monitoring may include such items as pavement distress, maintenance history and vertical displacement. A cost comparison of the various methods will also be performed. Interim reports will be submitted yearly until the final report is written at the conclusion of the testing period.

<b>Total study budget</b>	<b>Current FFY budget</b>	<b>Expenditures for current quarter</b>	<b>Total Expenditures to date</b>
<b>\$99,979.00</b>	<b>\$12,497.37</b>	Error! Bookmark not defined.	<b>\$60,500.28</b>

**Progress This Quarter:**

(Includes project committee mtgs, work plan status, contract status, significant progress, etc.)

Monitoring of the two bridges in District 4 continues. Monitoring of the College avenue bridge in District 2 (South Milwaukee) continues. The search for two more bridges is ongoing.

**Work Next Quarter:**

Monitoring of the two bridges in District 4 will continue. Monitoring of the College avenue bridge in District 2 (South Milwaukee) will continue. The search for two more bridges will also continue.

**Circumstances affecting progress/budget:**

**Gantt Chart:**

**Note: Gantt chart shown in State Fiscal Year Quarters**