

**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Minimum Pavement Thickness for Superpave Mixes</b>	<b>Project ID: 0092-00-04</b>
<b>Administrative Contact: Nina McLawhorn</b>	<b>Sponsor:</b>
<b>WisDOT Technical Contact: Len Makowski</b>	<b>Approved Starting Date: 10/1/99</b>
<b>Approved by COR/Steering Committee: FY 00 \$25007 over 10 months, contract amount \$25,435</b>	<b>Approved Ending Date: 7/31/00</b>
<b>Project Investigator (agency &amp; contact): H. Bahia-UW-Madison</b>	

**Description:** The research will determine guidelines in establishing the "minimum" pavement thickness for different size Superpave mixtures using Wisconsin materials and methods.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ 25,435.00</b>	<b>\$ 25,435.00</b>	<b>\$4,967.41</b>	<b>\$14,893.98</b>

**Progress This Quarter:**

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

**Extractions**

Extractions were completed this quarter for the two different Waukesha blends (19mm and 12.5mm Nominal Maximum Size.) Gradations were performed on all the gradations with the following results:

**12.5 mm Waukesha Mix**

Specimen ID	125W15A	125W20B	125W25B	125W30B	125W47A	
Sieve	%Pass	%Pass	%Pass	%Pass	%Pass	JMF
<b>25</b>	100.0	100.0	100.0	100.0	100.0	<b>100</b>
<b>19</b>	100.0	100.0	100.0	100.0	100.0	<b>100</b>
<b>12.5</b>	90.1	94.8	94.3	94.3	94.1	<b>95.2</b>
<b>9.5</b>	73.6	76.0	76.2	75.6	75.5	<b>74.8</b>
<b>4.75</b>	48.3	49.0	49.9	48.7	49.2	<b>46.9</b>
<b>2.36</b>	30.3	30.1	31.8	30.1	30.4	<b>28.4</b>
<b>1.18</b>	18.7	18.5	19.9	18.8	18.3	<b>17.5</b>
<b>0.6</b>	11.0	11.4	12.6	12.0	11.5	<b>10.8</b>
<b>0.3</b>	6.7	7.0	7.8	7.5	7.6	<b>6</b>
<b>0.15</b>	4.7	4.9	5.7	5.3	5.7	<b>4</b>
<b>0.075</b>	3.6	3.7	4.4	4.1	4.5	<b>3.7</b>

Table 1

### 19 mm Waukesha Mix

Specimen ID	19W15Ad	19W20A	19W25A	19W30B	19W47B	
Sieve	%Pass	%Pass	%Pass	%Pass	%Pass	<b>JMF</b>
25	100.0	100.0	100.0	100.0	100.0	<b>100</b>
19	98.7	98.1	98.1	99.4	99.5	<b>98.2</b>
12.5	88.8	88.3	89.8	89.7	88.2	<b>88.8</b>
9.5	77.0	77.1	78.3	77.0	76.8	<b>76.4</b>
4.75	49.0	48.5	50.3	49.0	48.4	<b>46.5</b>
2.36	31.2	30.3	33.0	31.4	31.6	<b>29.3</b>
1.18	19.9	20.5	23.0	20.4	21.8	<b>18.7</b>
0.6	12.8	13.6	15.7	13.7	15.3	<b>11.8</b>
0.3	7.5	8.3	9.7	8.4	9.3	<b>6.3</b>
0.15	5.2	5.9	6.9	6.0	5.9	<b>4</b>
0.075	4.0	4.7	5.4	4.8	4.6	<b>3.7</b>

Table 2

These results haven't yet been corrected for fines in the extracted material. All of the results are very similar from all the different sample sizes ranging from 1500g. to 4700g. This can be seen in the gradation plots:

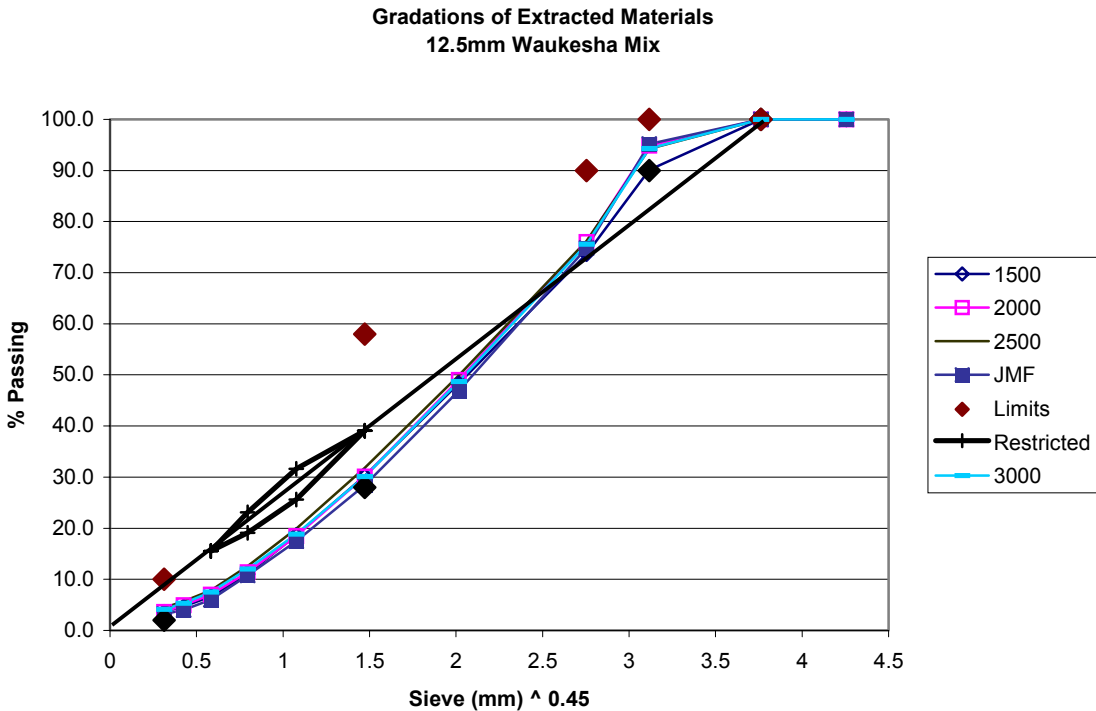


Figure 1

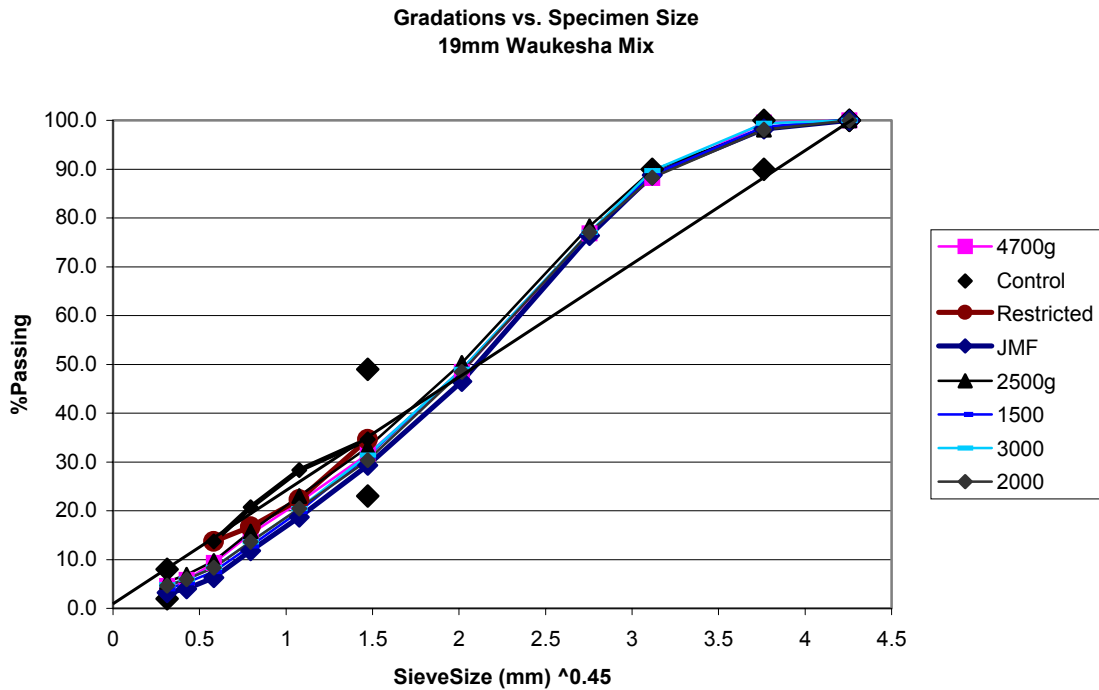


Figure 2

The trends so far show that aggregate degradation in Superpave Mixtures in the Gyratory compactor isn't a significant problem, at least not for this aggregate.

**Survey:**

Surveys have been sent out to the different DOT's in the Midwest. As of the time of this report, 4 have been returned. All of the responses state that they use a minimum of 3 times the Nominal Maximum aggregate size for Superpave layers. Most of the DOT's use 4 times the Nominal Maximum Size for the target layer thickness. All of the states have reported some compaction problems with Superpave mixture, in which states some contractors have gotten heavier rollers to combat the problem. Superpave mixtures have required more work on the contractors part in order to reach design compaction.

All of the states also say they have seen high permeability in Superpave mixtures, but haven't seen any problems to date with permeability. One state is even working on a study to see if payment can be based on permeability and not % Compaction.

**Work Next Quarter:**

Unfortunately, machine breakage and technical problems have greatly hampered my work on this project over the last quarter. Currently, it seems that these roadblocks are in the past, so I am looking forward to advancing this project greatly over the next quarter. Testing on K&N samples was put on hold the last quarter in order to get a mix that would match a field test section.

Much is planned for the next quarter. In the end of July, pending approval from the Waukesha Public Works department, a section will be paved with varying layer thickness on County VV. Lab testing of these mixes will occur early in the month. Testing of the Waukesha mixes will be finished and the literature review will be brought forward significantly. Hopefully, early in the quarter, most of the remaining surveys will be returned. Progress will also be made in the shear

properties and the scanned analysis of the Nmax specimens. Contact will be frequent between UW-Madison and Payne & Dolan.

**Circumstances affecting progress/budget:**



**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Development of Rational Overlay Design Procedures for Flexible Pavements</b>	<b>Project ID: 0092-00-05</b>
<b>Administrative Contact: Nina McLawhorn</b>	<b>Sponsor:</b>
<b>WisDOT Technical Contact: Len Makowski</b>	<b>Approved Starting Date: 12/15/99</b>
<b>Approved by COR/Steering Committee: FY 00 \$45000 over 1 year</b>	<b>Approved Ending Date: 12/15/00</b>
<b>Project Investigator (agency &amp; contact): J. Crovetti, Marquette Univ</b>	

**Description:** The objectives of this research are to (1) develop rational procedures for quantifying the effective structural capacity of existing flexible pavements, (2) recommend guidelines for the collection and use of data to determine the effective structural capacity of existing flexible pavements, and (3) develop procedures for designing structural asphalt concrete overlays on existing flexible pavement systems.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$45,000.00</b>	<b>\$ \$45,000.00</b>	<b>\$7,189.01</b>	<b>\$7,189.01</b>

**Progress This Quarter:**

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

*No Report after three reminders.*

**Work Next Quarter:**

**Circumstances affecting progress/budget:**

**Gantt Chart:**



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

**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Determining a Temperature-Density Relationship after Completed Rolling of HMA</b> <b>Administrative Contact:</b> Nina McLawhorn <b>WisDOT Technical Contact:</b> Len Makowski <b>Approved by COR/Steering Committee:</b> FY 00 \$50000 over 18 months <b>Project Investigator (agency &amp; contact):</b> Hanna, Russell & Bahia-UW-Madison	<b>Project ID:</b> 0092-00-06  <b>Sponsor:</b> <b>Approved Starting Date:</b> 2/21/00 <b>Approved Ending Date:</b> 8/21/01

**Description:** The primary objective of this study is to determine whether asphalt density significantly increases after cooling and if a statistically significant correlation exists between asphalt density as measured after finish rolling and the following day using the nuclear gauge method of testing the density.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$50,000.00</b>	<b>\$ \$50,000.00</b>	<b>\$24,052.17</b>	<b>\$24,052.17</b>

**Progress This Quarter:**

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

Analysis of site and lab data from 1999 projects continued this quarter. Meetings were held between Awad Hanna, Hussein Bahia, Tom Amon, Stephen Schoenfelder and Ssu-Wei Loh to determine what future analysis needs to be performed.

Analysis of last year's projects showed that there was no significant change between asphalt densities on day one versus day two. However, the projects were not always similar, so for future analysis an increased number of factors will be taken into account, such as job size, ambient temperature, and lift thickness.

**Work Next Quarter:**

Three more projects are to be studied starting beginning the first week in July to attempt to recreate results from last year's efforts. Should the new data confirm the previous findings, conclusions will be drawn and the analysis will be completed. Should the new data vary from the old data, that is, determine that there is indeed a relationship between the temperature and density of newly paved asphalt, the research may continue.

**Circumstances affecting progress/budget:**

**Gantt Chart:**



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

**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Effects of Aggregate Coatings and Films on Concrete Performance</b>	<b>Project ID: 0092-00-07</b>
<b>Administrative Contact: Nina McLawhorn</b>	<b>Sponsor:</b>
<b>WisDOT Technical Contact: Dave Larson</b>	<b>Approved Starting Date: 10/1/00</b>
<b>Approved by COR/Steering Committee: FY 00 \$97740 over 2.25 years</b>	<b>Approved Ending Date: 9/30/01</b>
<b>Project Investigator (agency &amp; contact): S. Cramer-UW-Madison</b>	

**Description:** This research will consider the impact of different types of coarse aggregate coatings and films on concrete strength and durability and the potential relation to concrete performance.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$97,740.00</b>	<b>\$ \$97,740.00</b>	<b>\$5,253.11</b>	<b>\$9,294.01</b>

**Progress This Quarter:**

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

Work this quarter, included data collection on a survey of the aggregate coating problem in Wisconsin, follow-up research on precise locations of quarries containing aggregates with coatings, collection of test equipment and personnel to conduct the aggregate coating tests, and project meetings.

A survey was prepared and sent to 20 WisDOT staff in the 9 different DOT districts and concrete pavers. Of the 20 surveys, 19 surveys were received. From the responses, we have located 7 potential sites in which aggregate coatings have been perceived to affect concrete performance. An additional 5 sites we are attempting to locate or determine whether coatings actually exist at these sites.

We have identified the sand equivalency test, methylene blue test, x-ray diffraction and ICP spectrometry as tests we intend to employ in the initial screening of the aggregates. Equipment has been order and received, and training is in-progress for the x-ray diffraction. Efforts to locate and hire a geologist to assist in these efforts so far have not been successful.

The project team meets once every two weeks.

**Work Next Quarter:**

Our next tasks are to obtain aggregate samples, complete training on the test procedures and to obtain representative samples for characterization.

**Circumstances affecting progress/budget:**

We encountered problems in receiving some survey responses with sufficient detail to locate the aggregate source. After considerable effort we have located several sites but this required more effort and time than originally budgeted. Finding a geologist to assist in the initial characterization of aggregate coatings has been a problem and thus some of this work must be assumed by the main research team.

**Gantt Chart:**



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

**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Wet Pavements Accident Study of Longitudinal and Transverse Tined PCC Pavements</b> <b>Administrative Contact:</b> Nina McLawhorn <b>WisDOT Technical Contact:</b> Dave Larson <b>Approved by COR/Steering Committee:</b> FY 00 \$74901 over 18 months, contract amount \$75000 <b>Project Investigator (agency &amp; contact):</b> Drakopoulos & Kuemmel-Marquette University	<b>Project ID:</b> 0092-00-08  <b>Sponsor:</b> <b>Approved Starting Date:</b> 12/15/99 <b>Approved Ending Date:</b> 4/15/01

**Description:** The research will develop guidelines for the use of longitudinal and transversely tined PCC pavements.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$75,000.00</b>	<b>\$ \$75,000.00</b>	<b>\$17,987.73</b>	<b>\$17,987.73</b>

**Progress This Quarter:**

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

Data has been received from the Highway Safety Information System Lab and preliminary analysis has been performed. Pavement surface information data availability and compatibility with crash databases is under way.

**Work Next Quarter:**

Pavement information will be integrated with the crash and geometry information received from the Highway Safety Information System Lab and analysis of the comprehensive database will be performed.

**Circumstances affecting progress/budget:**

**Gantt Chart:**

TASK	2000												2001				
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
1. PCC Data and State Participation	30% completed																
2. Assembling Database and Interim Report	40% completed																
3. Analysis				15% completed													
4. Draft and Final Report																	

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

**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Portland Cement Concrete Pavement over Rubblized PCC</b>	<b>Project ID: 0092-00-11</b>
<b>Administrative Contact:</b> Nina McLawhorn	<b>Sponsor:</b>
<b>WisDOT Technical Contact:</b> Dave Larson	<b>Approved Starting Date:</b> 3/28/00
<b>Approved by COR/Steering Committee:</b> FY 00 \$39880 over 5 years 8 months, contract amount \$39857	<b>Approved Ending Date:</b> 11/28/05
<b>Project Investigator (agency &amp; contact):</b> J. Crovetto, Marquette Univ	

**Description:** An analysis is needed to determine the cost effectiveness of paving a PCC pavement over a rubblized base. By tracking roadway performance and construction cost, the Department can determine if this type of application is feasible or beneficial to Wisconsin's roadway system. Research would be able to determine the economical and structural benefits of a PCC pavement over a rubblized base. Structural benefits such as increased serviceability or increased pavement life can be monitored and compared to historical data on typical Portland cement concrete pavements or asphalt concrete pavement over rubblized PCC.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$39,857.00</b>	<b>\$ \$39,857.00</b>	<b>\$1,300.00</b>	<b>\$1,300.00</b>

**Progress This Quarter:**

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

*No Report after three reminders.*

**Work Next Quarter:**

**Circumstances affecting progress/budget:**

**Gantt Chart:**



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

**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Equivalency of Subgrade Reinforcement Methods</b>	<b>Project ID: 0092-00-12</b>
<b>Administrative Contact:</b> Nina McLawhorn	<b>Sponsor:</b>
<b>WisDOT Technical Contact:</b> Robert Arndorfer	<b>Approved Starting Date:</b> 10/1/99
<b>Approved by COR/Steering Committee:</b> FY 00 \$100617 over 3 years, contract amount \$100616	<b>Approved Ending Date:</b> 9/30/01
<b>Project Investigator (agency &amp; contact):</b> Benson & Edil-UW-Madison	

**Description:** This study will consist of three phases. Phase 1 will consist of a literature review of the existing research conducted in this area and a survey of the practices of other state transportation agencies. Phase 2 will involve instrumentation under both laboratory and field conditions to determine the load transfer characteristics and stability of each of the proposed eight systems. Phase 3 will include preparation of recommendations for revisions to the depths and dimensions of each of the proposed eight systems to achieve equivalency of response and reaction.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$100,616.00</b>	<b>\$ \$100,616.00</b>	<b>\$5,466.10</b>	<b>\$15,394.14</b>

**Progress This Quarter:**

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

Highway 60 is approved as a field demonstration site by District 1 of WisDOT.

In order to finalize the design of test sections of Highway 60, compaction, CBR, resilient modulus, as well as unconfined compressive strength laboratory tests are completed with all construction materials. Based on these test results the design of the test sections that contain different materials is finalized. Thus, the process of designing all of the test sections of Highway 60 is completed.

Upon completion of the load frame design of the test pit, load frame is built and ready to be used. An MTS Structural load actuator, which will be capable of simulating expected cyclic loads during large-scale load tests, is installed. During testing, in order to provide confinement on the sides of the test pit, walls around the test pit are designed, built, and placed. This large-scale testing facility will be used to test all alternative subgrade stabilization options including those covered in the geosynthetics and by-products projects. This project will utilize the findings of these two projects but also add additional options and synthesize all of the results.

To demonstrate the field performance of the proposed test sections of Highway 60, mechanical monitoring had to be designed. A thorough literature review of available instrumentation methods is completed.

**Work Next Quarter:**

Large-scale model experiments will be conducted as soon as cabling of the load actuator is completed. As a reference reinforcement method, a series of tests using various thickness of breaker run will be performed. Tests will then be continued with alternative subgrade systems using similar configuration.

To be able to store the breaker run that will be used during the large-scale model testing, a storage area will be build outside the laboratory where the test pit is located. Breaker run will then be purchased from one of the local construction companies in Madison.

In order to test the performance of the monitoring instruments, which are planned to be used in Highway 60, laboratory tests will be conducted with these instruments. After the tests to choose appropriate instruments are finalized the ones that yield the best performance will be purchased or constructed for use during the field demonstration.

**Circumstances affecting progress/budget:**

**Gantt Chart:**

Task No.	Progress	1999	2000				2001		
		Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3
Task 1- Literature review	100%								
Task 2- Laboratory Investigation	60%								
Task 3- Analysis of Large-Scale Test Data	0%								
Task 4- Field demonstration and mechanical Monitoring	0%								
Task 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: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Investigation of Bridge Approach Settlements</b> <b>Administrative Contact:</b> Nina McLawhorn <b>WisDOT Technical Contact:</b> Robert Arndorfer <b>Approved by COR/Steering Committee:</b> FY 00 \$98834 over 7 years, contract amount \$99979 <b>Project Investigator (agency &amp; contact):</b> Helwany & Ghorbanpoor-UW-Milwaukee	<b>Project ID:</b> 0092-00-13 <b>Sponsor:</b> <b>Approved Starting Date:</b> 3/2/00 <b>Approved Ending Date:</b> 3/1/07

**Description:** 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.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$99,979.00</b>	<b>\$ \$99,979.00</b>	<b>\$0.00</b>	

**Progress This Quarter:**

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

*No Report after three reminders.*

**Work Next Quarter:**

**Circumstances affecting progress/budget:**

**Gantt Chart:**



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

**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Estimating Pile Setup for Wisconsin</b> <b>Administrative Contact:</b> Nina McLawhorn <b>WisDOT Technical Contact:</b> Robert Arndorfer <b>Approved by COR/Steering Committee:</b> FY 00 \$30035 over 1 year, contract amount \$30000 <b>Project Investigator (agency &amp; contact):</b> Wagner/Komurka	<b>Project ID:</b> 0092-00-14 <b>Sponsor:</b> <b>Approved Starting Date:</b> <b>Approved Ending Date:</b>

**Description:** This study will consist of personal interviews and a literature search of all existing work and research in this area. This may involve contacting Engineering Consultant firms with expertise in this area, generating a database of available project data and analyzing this data to check the design methodologies being investigated. A report will discuss which method(s) appear to be the most promising for estimating the amount of set-up in the design stage of a project. This analysis will include identifying the subsurface investigation needs and costs associated with this design method(s).

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$30,000.00</b>	<b>\$ \$30,000.00</b>	<b>\$0.00</b>	

**Progress This Quarter:**

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

New Proposal accepted by Geotechnics TOC and Steering Committee. Contracting in July/August, 2000.

**Work Next Quarter:**

**Circumstances affecting progress/budget:**

**Gantt Chart:**



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

**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Non-Destructive Testing of Highway Bridge Structures for Purposes of Structure Evaluation</b> <b>Administrative Contact:</b> Nina McLawhorn <b>WisDOT Technical Contact:</b> Stan Woods <b>Approved by COR/Steering Committee:</b> FY 00 \$49745 over 2 years <b>Project Investigator (agency &amp; contact):</b> A. Ghorbanpoor-UW-Milwaukee	<b>Project ID:</b> 0092-00-15  <b>Sponsor:</b> <b>Approved Starting Date:</b> 12/22/99 <b>Approved Ending Date:</b> 11/30/01

**Description:** The objective of this study is to evaluate methods to non-destructively test and rate the condition of each individual unit of a highway bridge in order to be able to rationally recommend either total structure replacement or a cost-efficient rehabilitation scheme. Testing methods currently in use should be researched, evaluated for suitability, and verified by use in the field. Testing methods not currently widely recognized for this purpose should also be evaluated. The development of new testing methods is also encouraged. Test results are to be verified by other means and methods to provide a base of reference. Bridge units to be tested are abutments, wingwalls, piers and columns, steel beams and girders, concrete girders, concrete box beam superstructures, concrete decks, reinforcing steel in all units including the condition of the coating on any epoxy coated reinforcing, and foundations. Special consideration shall be given to fracture critical members. Units shall be evaluated for current in-place strength, the presence of cracking, the presence of chloride ions and related concrete and/or steel deterioration, and other physical properties that determine the structural capacity of the bridge unit. Testing and test evaluation shall be followed by the development of a program that can be implemented by the Wisconsin Department of Transportation in its bridge inspection program.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$49,745.00</b>	<b>\$ \$49,745.00</b>	<b>\$0.00</b>	<b>\$1,789.21</b>

**Progress This Quarter:**

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

*No Report after three reminders.*

**Work Next Quarter:**

**Circumstances affecting progress/budget:**

**Gantt Chart:**



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

**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Structural Analysis of Sign Bridge Structures and Luminaire Supports</b>	<b>Project ID: 0092-00-16</b>
<b>Administrative Contact:</b> Nina McLawhorn	<b>Sponsor:</b>
<b>WisDOT Technical Contact:</b> Stan Woods	<b>Approved Starting Date:</b> 5/3/00
<b>Approved by COR/Steering Committee:</b> FY 00 \$47372 over 2 years, contract amount \$49969	<b>Approved Ending Date:</b> 5/3/02
<b>Project Investigator (agency &amp; contact):</b> C. Foley-Marquette University	

**Description:** The scope expected for the research can be broken down into two parts. With reference to luminaire supports, the research will seek to develop inspection guidelines to assess the need for replacement and/or retrofit of both high-mast and standard luminaire supports.

The research related to sign bridge structures should address the following: (a) determination of the causes of the stress cracking in the sign bridge elements; and (b) an attempt to correlate stress-crack severity and/or location to structural integrity. Specific sign bridges to be considered are included at the end of this problem statement. The results of (a) and (b) should be used to develop inspection criteria for the determination of retrofit and/or replacement of the structure. Finally, the sign bridge research should address the effect of the T-stub truss bridge support retrofit detail on future performance of the modified truss bridge.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$49,969.00</b>	<b>\$ \$49,969.00</b>	<b>\$0.00</b>	

**Progress This Quarter:**

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

The work plan includes three phases. The percentage completion of each of these tasks (as of 7/1/00) is listed below.

Phase I: Evaluation of Loading and WI DoT Inspection Procedures

Task 1 - Obtain Wind Velocity Data for Wisconsin from NCDC (5 %)

Task 2 - Generation of Wind Velocity Histograms (0 %)

Task 3 - Synthesis of Truck-Induced Wind Loading Research (50 %)

Task 4 - Assessment of Current WI DoT Inspection Procedures (0 %)

Phase II: Luminaire Support Research

Task 5 - Collect and Synthesize WI DoT Luminaire Support Failure Information (5 %)

Task 6 - Synthesize Past Luminaire Support Research (50 %)

Task 7 - Develop Analytical Prediction of Luminaire Anchor Bolt Failure (0 %)

Task 8 - Develop Inspection Protocols for Luminaire Support Structures (0 %)

Phase III: Sign Support Structure Research

Task 9 - Synthesis of Data Related to Cracking of Sign Support Structures (50 %)

Task 10 - Field Reconnaissance of Problem Structures and Material Testing (5 %)

Task 11 - Analytically Simulate Crack Formation in Sign Supports via FEA (0 %)

Task 12 - Development of Inspection Protocols for Sign Support Structures (0 %)

Task 13 - Perform Experimental Testing of T-Section Retrofit Detail (0 %)

Phase IV: Project Synthesis

Task 14 - Research Reports to WHRP (0 %)

Electronic conversation(s) were conducted with Phil Fish (WI DoT, also, TOC Project Oversight Committee Chair) and other individuals on the Project Oversight Committee (Dave Bechtoldt: Zenith Tech, Larry Bank: U. Wisconsin - Madison). Currently, ongoing discussion with Phil Fish is being conducted to shape the research direction and obtain inspection reports, failure analysis reports, etc..., for the problem structures. Reports pertaining to past sign and luminaire support research were obtained from the Florida DoT, Rowan Williams Davies and Irwin, Inc. (Guelph, Ontario, Canada), the University of Texas, and Lehigh University (ATLSS).

Work on the contract began (essentially) May 19, 2000. The contract was received by MU on or about May 6, 2000. This makes the calendar years contained in the proposed work plan obsolete, however, the monthly durations are expected to be the same as those contained in the proposed work plan. There are several organizational aspects to completion of Tasks 5 and 10 that require coordination with WI DoT personnel at Districts #2 and #6. These are not expected to be a problem.

#### **Work Next Quarter:**

The work next quarter is expected to be a continuance of Tasks 1, 3, 5, 6, 9, and 10 above. It is hoped to have tasks 3, 5, 6, and 9 completed during the next quarter. Task 10 also has an excellent possibility of being completed. It is expected that Task 1 will continue into the next quarter (9/00 - 12/00).

#### **Circumstances affecting progress/budget:**

**Gantt Chart:**



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

**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Assessment and Rehabilitation Strategies/Guidelines to Maximize the Service Life of Concrete Structures</b>	<b>Project ID: 0092-00-17</b>
<b>Administrative Contact: Nina McLawhorn</b>	<b>Sponsor:</b>
<b>WisDOT Technical Contact: Stan Woods</b>	<b>Approved Starting Date: 10/1/99</b>
<b>Approved by COR/Steering Committee: FY 00 \$50000 over 2 years</b>	<b>Approved Ending Date: 9/30/01</b>
<b>Project Investigator (agency &amp; contact): T. Adams-UW-Madison</b>	

**Description:** Bridge maintenance and design engineers need a range of strategies from preventive maintenance to rehabilitation and replacement to be applied over the life cycle of a given bridge in order to maximize its useful life while minimizing the overall cost. Guidance needs to be developed for bridge owners and managers which will outline effective strategies that are available, when is the optimal time to apply each of the various strategies, and what information is needed to accurately assess structure condition and functionality. Ideally these concepts should be developed into a methodology which will suggest timely actions to be taken on specific bridges and provide an estimate of the remaining useful life based on the condition of the element and projected functional needs. The methodology developed will need to be compatible with and able to be integrated into WisDOT maintenance and improvement processes.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$50,000.00</b>	<b>\$ \$50,000.00</b>	<b>\$8,083.40</b>	<b>\$9,991.37</b>

**Progress This Quarter:**

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

**Task 1. Identify concrete bridge elements**

This task is 90% complete.

In the previous QPR, the Research Team presented a scope of 11 concrete bridge elements (Table 4).

No further progress.

**Task 2. Evaluate NDE techniques**

This task is 65 % complete.

The Research Team is reviewing Nondestructive Evaluation (NDE) techniques in two ways: questionnaire and literature review. In order to get information about the current and potential uses of NDE methods by the districts, a questionnaire was sent to each district. All districts have responded as listed in Table 1. The Research Team compiled the questionnaire responses from the districts.

**Table 1. NDT Questionnaire**

District	Bridge Maintenance Engineer	Phone Number
1	Matthew Murphey	(608) 246-3250
2	Bunmi Olapo	(262) 548-6470
3	Howard Krook	(920) 492-5647
4	Thomas J. Hardinger	(715) 421-8323
5	Peter A. Luebke	(608) 785-9056
6	D.Patrick Kern	(715) 836-3918
7	Francis Bennett	(715) 365-5756
8	Allan Bjorklund	(715) 392-7951

Most districts use NDT to inspect bridges. The eight NDT methods listed in Table 2 are used to inspect concrete bridges. Other methods are used to measure deformation (strain gages, laser displacement, electronic tilt meters, and magnetic particle). Districts Three and Five report that NDT is done by the Central Office. Most districts think NDT has potential uses in bridge inspection.

**Table 2. NDT in use**

<u>Method in use</u>	District Number							
	1	2	3*	4	5*	6	7	8
Impact Echo	X							
Acoustic Emission	X							
Chain Drag	X			X		X	X	X
Hammer Sounding	X					X		X
(Infrared) Thermography		X		X		X		
Ultra Sonic		X						
Dye penetrant		X						
Ground Penetrating Radar				X		X		

\*NDT is done by the Central Office.

Based upon literature review, the Research Team developed a preliminary scope of 14 Nondestructive Testing (NDT) methods for concrete elements as shown in Table 3. These 14 methods were identified from the following three references - Manual for Condition Evaluation of Bridges, American Association of State Highway and Transportation Officials (AASHTO), Manual of Concrete Practice, 228.2R-98: “Nondestructive Evaluation of Concrete in Structures”, American Concrete Institute (ACI), and Nondestructive Testing Handbook, American Society of Nondestructive Testing (ASNDT).

For each method in Table 3, the Research Team is preparing a narrative summary report that describes the purpose, basic principle, use or application, test results and data interpretation, case studies, reliability of procedure, costs, advantages and limitations, applicability to bridges, and references of each method. The purpose section describes simply what kind of information the method can gain. The basic principle section describes the physical mechanism upon which the method is based. The use or application section focuses on the usage or application procedures. The test results and data interpretation section describes data analysis and post-processing. The case studies section summaries current research about the method. The reliability of procedure section describes the result reliability or reasons that will affect the test results. The costs section focuses on the cost of using the method. The advantages and limitations section lists the advantages and limitations of the method. The applicability to bridges section describes which bridge element the method can be applied on. The references section list the correlated references.

The current results of the Research Team’s evaluation of NDE techniques is summarized in Table 4. Table 4 lists the eleven most frequently occurring concrete elements in the WisDOT bridge inventory according the “State 97” bridge inspection dataset. The white regions in Table 4 indicate the distresses that are currently used by WisDOT to determine element condition in the Pontis BMS. Hence, the table shows which distresses are currently relevant to WisDOT for determining condition state.

The criterion used to rate of each type of element varies. In other words, different elements are examined for different distresses (Bridge 1998). For example, columns, abutments, and railing are checked for exposed reinforcement, but decks and slabs are not. Decks and slabs are checked for potholes, but columns, abutment and railing are not.

Table 4 serves to identify the nondestructive test methods can be used to detect distresses on concrete bridge elements. The three distresses that can be tested for and are used by WisDOT to rate the condition of elements are cracks, delaminations, and corrosion of reinforcement (they are in white regions). There are two other distresses that can be tested for, but are not used by WisDOT, these are scaling and voids/honeycombs (they are in darkened regions).

Nondestructive test methods have various capabilities to detect distresses. Some methods detect cracks, others detect corrosion of reinforcing and so forth. This information is also indicated in Table 4. It is possible for NDT methods to detect distresses that are not currently used to determine condition states, this is indicated when the test method occurs in a region that is darkened.

Table 4 shows no NDT methods for six types of distresses. Five of these distresses are readily detected visually, so there is little need for detailed nondestructive testing: spalls (which are areas where concrete fragments have detached from the larger mass), potholes, wear outs (damage by snow plows or street sweepers), exposed reinforcement, and loss of concrete section. However, one of the distresses cannot readily be detected visually: deterioration of the prestressed system. This is an important distress for which complete and comprehensive methods to so have not been developed.

**Table 3. NDT Methods to Evaluate the Condition of In-service Concrete**

Method	Narrative Summary Report Status
Sounding with hammer	In revision
Sounding with chain drag	<b>In revision</b>
Impact Echo (IE)	In revision
Ultrasonic Pulse Velocity (UPV)	In review
Covermeter	In revision
Half cell Potential	In revision
Resistivity	In revision
Polarization Resistance	In revision
Infrared Thermography	In revision
Ground Penetrating Radar (GPR)	In revision
Radiography	In review
Endoscopes	In revision
Dye Penetrants	In revision
Acoustic Emission	In review

**Table 4. Nondestructive Test Methods for Detecting Distress in Concrete Bridge Elements**

Pontis Element Number	Element Description	Distress									
		Cracks	Spalls	Scaling	Delaminations	Potholes	Wear Outs	Exposed Reinforcement	Deterioration of prestressed system	Corrosion of Reinforcement	Loss of Concrete Section
12	Concrete Deck - Bare	Impact Echo Dye Penetrant	Ground Penetrating Radar	Impact Echo Infrared Thermography Sounding with Hammer Sounding with Chain Drag Ground Penetrating Radar			Exposed Reinforcement	Deterioration of prestressed system	Corrosion of Reinforcement	Loss of Concrete Section	Voids and honeycombs
22	Concrete Deck - Protected w/ Rigid Overlay										
26	Concrete Deck - Protected w/ Coated Bars										
48	Concrete Slab - Protected w/ Rigid Overlay										
52	Concrete Slab - Protected w/ Coated Bars										
13	Concrete Deck - Unprotected w/ AC Overlay										
14	Concrete Deck - Protected w/ AC Overlay	Ultrasonic Pulse Velocity Impact Echo Dye penetrant	Ground Penetrating Radar	Impact Echo Infrared Thermography Ground Penetrating Radar			Exposed Reinforcement	Deterioration of prestressed system	Corrosion of Reinforcement	Loss of Concrete Section	Voids and honeycombs
109	P/S Concrete Open Girder/Beam										
205	Reinforced Concrete Column or Pile Extension										
331	Reinforced Concrete Bridge Railing	Impact Echo Dye penetrant	Ground Penetrating Radar	Impact Echo Sounding with Hammer	NA	NA	Exposed Reinforcement	Deterioration of prestressed system	Corrosion of Reinforcement	Loss of Concrete Section	Voids and honeycombs
215	Reinforced Concrete Abutment										
NA Distress is not applicable to the element											
Distress not currently used in Pontis to determine the condition state of the element											

**Work Next Quarter:**

**Task 1. Identify concrete bridge elements**

The Research Team recommends that the Project Committee review and approve the scope of concrete elements listed in Table 4.

**Task 2. Evaluate NDE techniques**

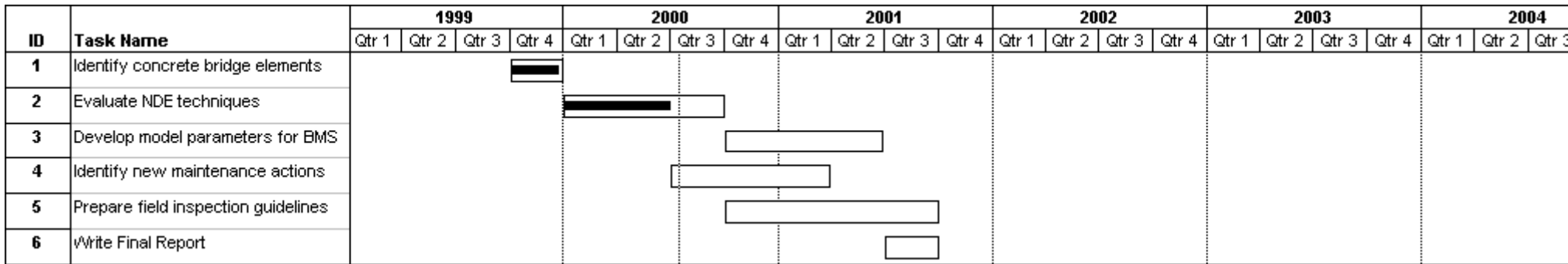
The Research Team will complete the narrative summary reports listed in Table 3. The Research Team will begin to assess the expected cost of NDE techniques.

**Task 3. Develop model parameters BMS**

The Research Team will meet with WisDOT personnel to discuss potential methods for integrating NDE results into the Pontis BMS.

**Circumstances affecting progress/budget:**

**Gantt Chart:**



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

**State of Wisconsin/Department of Transportation**  
**RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Geosynthetics in Stabilizing Soft Subgrade w/ Breaker Run</b>	<b>Project ID: 0092-45-15</b>
<b>Administrative Contact: Nina McLawhorn</b>	<b>Sponsor:</b>
<b>WisDOT Technical Contact: Robert Arndorfer</b>	<b>Approved Starting Date: 8/31/99</b>
<b>Approved by COR/Steering Committee: FY 99 \$54826 over 2 years, contract amount \$55000</b>	<b>Approved Ending Date: 5/31/01</b>
<b>Project Investigator (agency &amp; contact): Edil &amp; Benson-UW-Madison</b>	

**Description:** The research will determine quantitatively the advantages accrued when a subgrade is reinforced by geosynthetics and determine the guidelines in establishing the effectiveness of geosynthetics in stabilizing soft subgrades.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$55,000.00</b>	<b>\$ \$55,000.00</b>	<b>\$4,231.29</b>	<b>\$20,523.72</b>

**Progress This Quarter:**

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

To evaluate the benefits of geosynthetic subgrade reinforcement and to simulate the soft subgrade condition, an experimental laboratory test was proposed. A large-scale model is being developed in a test pit (3 x 3 x 3 m) at the University of Wisconsin Structures and Materials Testing Laboratory. A loading frame was designed and fabricated to accommodate a dedicated 22-kip load actuator. Currently, a plate to transfer loads and its connections to the actuator is manufactured. The model requires handling of materials exceeding 10 tons in weight. A bobcat was ordered to facilitate construction and dismantling of the models in the laboratory.

During the last couple of months, the test pit area was prepared to allow for performance of large-scale laboratory tests that were intended to allow for direct comparison of numerous modified pavement sections. Attention was focused on synthetic materials (expanded polystyrene, and polypropylene) that simulated such a soft subgrade and are easier to use. Along with several compatibility issues, results of the molded materials, in particular, expanded polystyrene, appeared promising as a simulator of soft subgrade.

Furthermore, evaluation of instrumentation for measuring deflection, strain and pressure at various depths of base course was completed. Trial tests and calibrations were conducted to ensure successful outcome in the future pavement section tests. Setup for the deflection and pressure measurements were completed. For strain measurements, a thin constantan bonded-wire type strain gage was utilized with additional special bonding technique. The bonding of the gages is underway. Also recently, effort is focused on preparing a data acquisition system.

Parallel to the laboratory efforts, test sections for incorporation in Highway 60 were developed incorporating four different geosynthetics: geotextile, geogrid, geocomposite drain, and geoweb. Equivalent pavement sections utilizing these materials have been designed based on available design procedures. The results were compared with each other and final design sections were determined. Investigation on the necessary instrumentation is underway. A project meeting was organized with the involved parties, i.e., WisDot District 1, suppliers, and the contractor. The approval of the test sections has not yet been received.

The monitoring of Highway 45 in Antigo resumed in March. FWD testing was conducted in soft spring-thaw conditions. Interpretation of strain measurements obtained in the field and back-calculation of layer moduli from the FWD data have been completed.

**Work Next Quarter:**

While the load actuator is being put in place, the electrical and pump system necessary for the operation are ordered. Then, a series of tests will be conducted with various thicknesses of breaker run and base course with or without geosynthetic reinforcement to simulate a pavement during its construction phase. The resilient subgrade modulus will be computed from each test as the change in load over a cycle of loading. The parameters from the laboratory tests will be used to establish performance criteria between a given thickness of base course with or without geosynthetic reinforcement of varying tensile strengths and moduli. Deflection and thickness of each layer will be used as inputs for the backcalculation procedure of moduli. Strain and pressure information allows for better understanding of the pavement response to the cyclic load and reinforcement mechanism induced by the geosynthetic products.

If approved, the preparations of instrumented geosynthetics will be undertaken for Highway 60 test sections.

**Circumstances affecting progress/budget:**

Putting together a specialized test equipment in the Wisconsin Structures and Materials Testing Laboratory is taking time. There is concern over obtaining approvals for Highway 60 test sections.



**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Field Measurement of Water Cement Ratio for PCC - Phase II</b>	<b>Project ID: 0092-45-16</b>
<b>Administrative Contact:</b> Nina McLawhorn	<b>Sponsor:</b>
<b>WisDOT Technical Contact:</b> Dave Larson	<b>Approved Starting Date:</b> 12/6/99
<b>Approved by COR/Steering Committee:</b> FY 99 \$55000 over 18 mos, contract for \$55510	<b>Approved Ending Date:</b> 12/31/00
<b>Project Investigator (agency &amp; contact):</b> S. Cramer-UW-Madison	

**Description:** The objective of this study is to evaluate in the field, technologies previously identified that provide a relatively rapid, simple, and reliable method of determining in-place w/c for Portland cement concrete (PCC). It is anticipated that only one or two technologies from the laboratory study will show sufficient promise to warrant field evaluation. At least several construction projects that represent a range of concrete paving conditions will be identified and used as evaluation case studies. Construction projects will be identified with the assistance of the WisDOT and the Wisconsin Concrete Pavement Association. Comparisons between measured w/c ratios and ratios suggested by batch plant tickets will be conducted.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$55,510.00</b>	<b>\$ \$55,510.00</b>	<b>\$4,684.35</b>	<b>\$9,473.40</b>

**Progress This Quarter:**

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

Work this quarter, included data analysis, collection of field data and project meetings.

Data analysis in the second quarter focussed on discovering the underlying reasons for variabilities in the microwave oven method. After eliminating an ineffective correction factor proposed by the Indiana DOT and one-by-one establishing sources of error in the laboratory, we were able to cut the error in the laboratory in half (standard error in w/c of 0.018).

The field microwave oven measurements present a more vexing problem, however. Field measurements showed more variability than in the lab. We generally measure more water in the field mix than is indicated by the batch plant records and the measured aggregate moisture contents. In June, we visited another field site (Hwy 10 in Waupaca Cty) to specifically investigate this problem. We hypothesized and have supporting evidence that the uncertainty in the batch plant aggregate moisture contents are the cause of the major differences between batch plant water/cement ratio and microwave oven water/cement ratio.

The research team meets approximately once every 2 weeks.

**Work Next Quarter:**

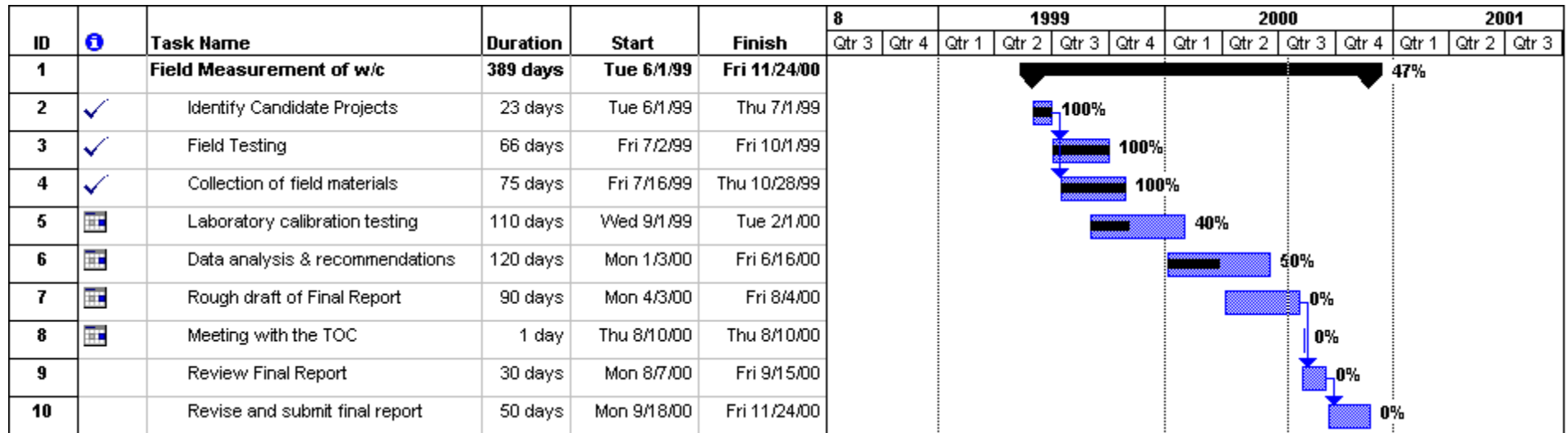
The primary goal in the next quarter is to complete the analysis of microwave oven method and the associated data gathered. We plan to begin analyzing the Troxler w/c guage results and complete most of the calibration mixes.

**Circumstances affecting progress/budget:**

Variability in sampling and variability in the testing method intermingle resulting in test error that may be too large for either of these methods to gain wide acceptance. Tracking and isolating individual components of the variabilities has been a

larger challenge than we envisioned, but these problems are now mostly resolved. As a result we have fallen slightly behind our proposed schedule. We have included some additional tests and data analysis that were never part of the original work plan.

**Gantt Chart:**



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

**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Field Performance of Subbases Constructed with Industrial By-products</b>	<b>Project ID: 0092-45-18</b>
<b>Administrative Contact:</b> Nina McLawhorn	<b>Sponsor:</b>
<b>WisDOT Technical Contact:</b> Robert Arndorfer	<b>Approved Starting Date:</b> 8/31/99
<b>Approved by COR/Steering Committee:</b> FY 99 \$94599 over 2 years, contract amount \$95000	<b>Approved Ending Date:</b> 5/31/01
<b>Project Investigator (agency &amp; contact):</b> Edil & Benson-UW-Madison	

**Description:** Pavement sections needing subbases will be constructed using foundry sand as subbase. The laboratory properties of foundry sands determined in the previously mentioned research will be used to guide the thickness design of the pavement sections. These pavements will then be monitored for two years. Monitoring will consist of distress surveys and falling-weight deflectometer testing. Field behavior of the pavements (e.g., layer moduli, cracking, etc.) will then be compared to predictions made using the laboratory test results. Based on this comparison, guidelines and specifications for foundry sand subbases will be recommended.

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$95,000.00</b>	<b>\$ \$95,000.00</b>	<b>\$8,196.58</b>	<b>\$23,522.36</b>

**Progress This Quarter:**

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

The current design guidelines for pavement structures were reviewed to develop equivalent sections involving subbases constructed with bottom ash, foundry slag, foundry sand and fly ash. Five pavement test sections using these by-products and including a control section were designed based on the material properties measured in Task1. The unconfined strength, compaction, CBR, and resilient modulus tests with different water contents were performed in the laboratory. Based on the test results, the final pavement cross sections were determined. In addition, the available software was run and compared to insure the final subbase thickness for different materials.

For field implementation in Highway 60, an instrumentation program including the mechanical and environmental instruments such as pressure cell, strain gage, thermocouple, TDR, and lysimeter was prepared to monitor the ambient and subsurface temperatures and moisture contents with an automated data acquisition system. To examine the beneficial use of industrial by-products as a subbase material, stress transfer to the subgrade in different test sections should be monitored during construction and afterwards. To estimate the stress and strain levels at the top of each cross section layer, an analysis using KENLAYER program was performed for the given material properties and geometry from Task 1 and 2. The results from analysis were used to select the proper instruments.

**Work Next Quarter:**

The finalized construction of the pavement test sections and field instrumentation program will be coordinated with WisDOT personnel before field application. Also, construction of the pavement test sections will be coordinated with other WisDOT construction activities. Based on field program, test sections will be constructed in the site. The test sections will be located adjacent to one another so that the subgrade and traffic conditions are consistent. Before constructing the test pads, borings

will also be made adjacent to each test section to thoroughly define the subsurface conditions. Each test section will be tested and documented extensively to facilitate interpretation of the monitoring data. Each test section will be instrumented for monitoring of subsurface temperatures and moisture contents as well as monitoring mechanical properties of each layer, with an automated data acquisition system. A weather station and a traffic counter will also be located near the test sections. The test sections will be monitored throughout the duration of the project. Monitoring will include collection of environment data (meteorological and subsurface data), deflection surveys, and cracking/distress surveys.

**Circumstances affecting progress/budget:**

**Gantt Chart:**

Task	1999				2000				2001			
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4
[Redacted]	[Redacted]											
[Redacted]	100 %											
3					33 %							
[Redacted]					0 %							
5									0 %			
[Redacted]									0 %			
[Redacted]												
[Redacted]												

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

**State of Wisconsin/Department of Transportation  
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: June 30, 2000**

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Lab &amp; Field Evaluation of Superpave Mix Designs</b>	<b>Project ID: 0092-45-98</b>
<b>Administrative Contact:</b> Nina McLawhorn	<b>Sponsor:</b>
<b>WisDOT Technical Contact:</b> Len Makowski	<b>Approved Starting Date:</b> 12/6/99
<b>Approved by COR/Steering Committee:</b> FY 99 \$80001 over 2 years	<b>Approved Ending Date:</b> 7/31/00
<b>Project Investigator (agency &amp; contact):</b> H. Bahia-UW-Madison	

**Description:**

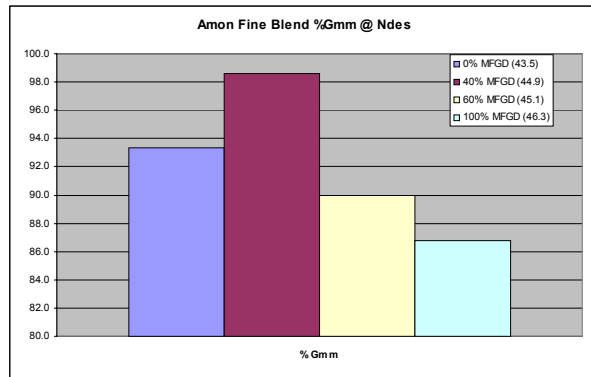
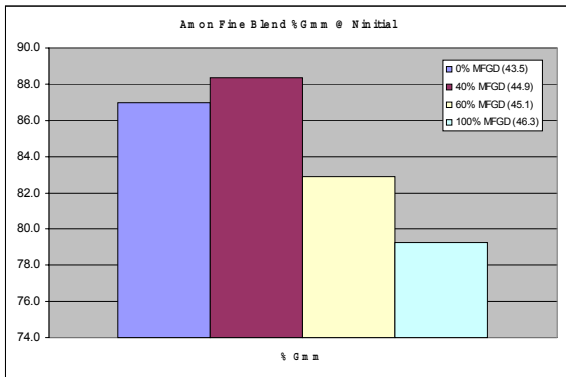
Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$ \$80,001.00</b>	<b>\$ \$80,001.00</b>	<b>\$1,368.90</b>	<b>\$3,650.14</b>

**Progress This Quarter:**

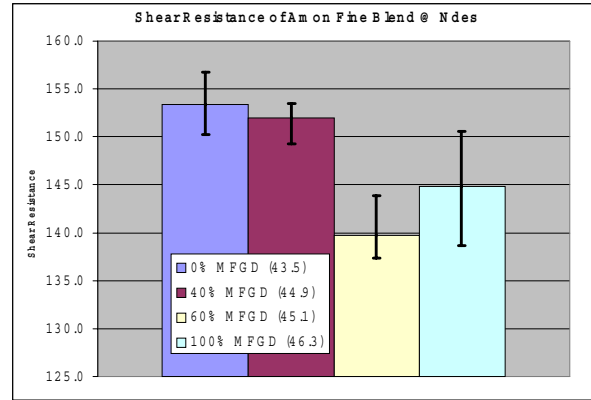
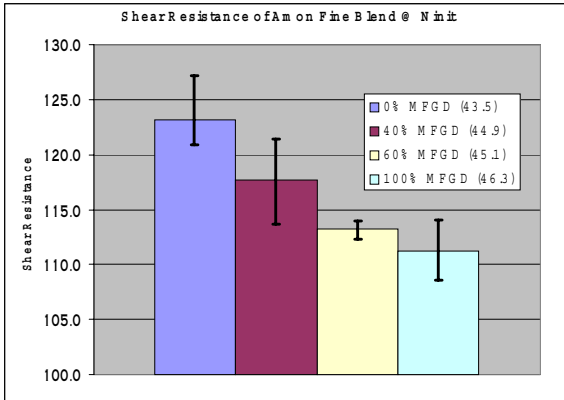
(Includes project committee mtgs, work plan status, contract status, significant progress, etc.)

Materials have been obtained from 3 of the 4 sources (Payne and Dolan, Mathy, and Amon). FAA values have been calculated for all of the Payne and Dolan and Amon blends. Compaction testing was completed for Payne and Dolan and Amon, and analysis was conducted.

Data analysis showed that the air voids data was well out of range for all samples tested. An investigation revealed that the angle of gyration of the gyratory compactor had fallen from 1.25 degrees to 1.00 degrees. The shear data that has been collected is useful in terms of defining trends, but the volumetric data is not valid.



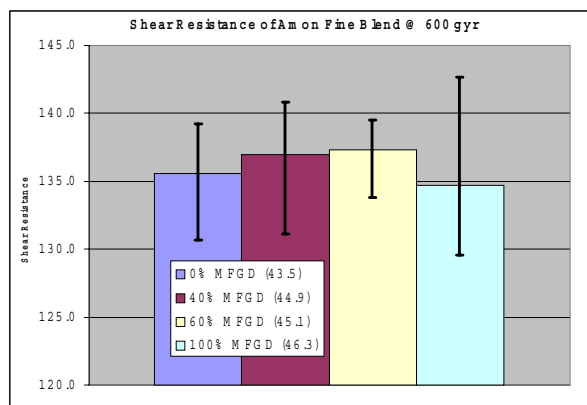
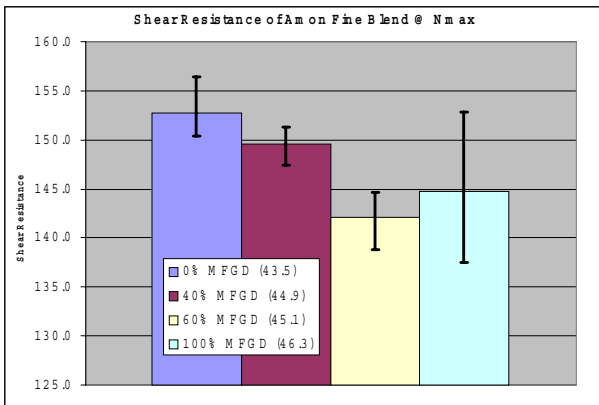
The above plots are the air voids for the Amon mix fine blend. It is apparent that the air voids are too low in most cases at Ndes. Based on this information, the decision has been made to re-test several of the Amon and Payne and Dolan samples to obtain accurate shear and volumetric information.



The following are plots showing the shear resistance of various Amon mixes. It is believed that this information is still quite useful in determining trends, but should be interpreted with caution.

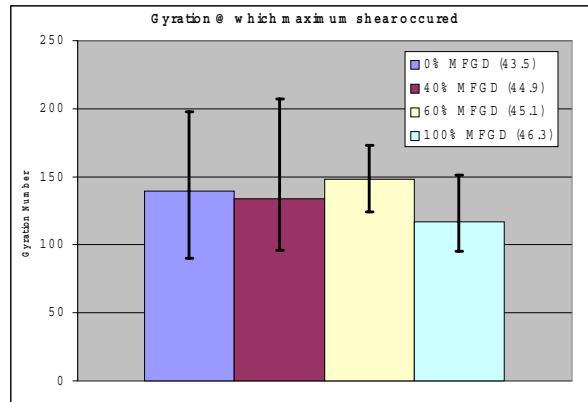
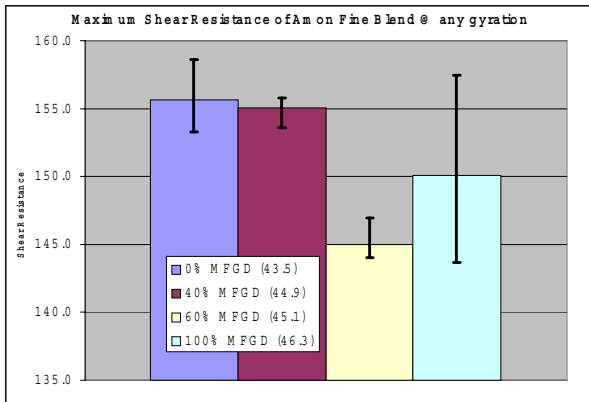
The plots show that shear resistance tends to go down as the fine aggregate angularity of the blend increased at both Ninit and Ndesign.

The plot below on the left shows a very similar trend to the above plots. It again shows that the shear resistance goes down as the fine aggregate angularity goes up. The plot below on the right indicates that the fine aggregate angularity had very little effect on the shear resistance of the mix.



The following two plots are related to each other. The plot on the left gives the maximum shear resistance that the mixes exhibited at any gyration level during testing. The plot on the right shows at what gyration level this maximum

occurred. The left plot confirms the trend that increasing fine aggregate angularity decreases the shear resistance of the mix. The right plot shows that most of the mixes are reaching their maximum shear resistance at close to Nmax (160 gyr).



**Work Next Quarter:**

Blending, mixing, and compacting will be repeated for Amon and Payne and Dolan, and will begin for Mathy. Analysis will be conducted at regular intervals. Materials will be obtained from Mathy in early August. The tests that will be conducted have changed slightly since the inception of the project. The following is the updated testing matrix for this project. Notice that the 12.5mm testing has been removed for Pitlik and Wick, and Amon and Sons. This is because neither company currently produces Superpave mixes at 12.5 mm. Also, Mathy will likely be able to provide only one 19 mm mix design.

Nominal Max Size	Type of Blend	Aggregate Supplier			
		Payne and Dolan (D)	Pitlik and Wick (W)	Amon and Sons (A)	Mathy Construction (M)
19mm max (A)	Fine Blend (F)	100% MFGD	100% MFGD	100% MFGD	100% MFGD
		60 / 40	60 / 40	60 / 40	60 / 40
		40 / 60	40 / 60	40 / 60	40 / 60
	S-Shaped Blend (S)	0% MFGD	0% MFGD	0% MFGD	0% MFGD
		100% MFGD	100% MFGD	100% MFGD	100% MFGD
		60 / 40	60 / 40	60 / 40	60 / 40
12.5mm max (B)	Fine Blend (F)	40 / 60			40 / 60
		0% MFGD			0% MFGD
		100% MFGD			100% MFGD
	S-Shaped Blend (S)	60 / 40			60 / 40
		40 / 60			40 / 60
		0% MFGD			0% MFGD

Each combination in the matrix will be tested four times. Two samples will be compacted to 100 gyrations (Ndes) to obtain accurate volumetrics. Two other samples will be compacted to 600 gyrations to obtain accurate shear data. In the event that there are large discrepancies between tests, additional tests will be run to identify trends and outliers.

**Circumstances affecting progress/budget:**

The gyratory compactor's mechanical error has made it necessary to repeat the Payne and Dolan and Pitlik and Wick samples.

