

State of Wisconsin/Department of Transportation
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: Sep 30, 2002

Program: SPR-0010(36) FFY99	Part: II Research and Development
Project Title: Geosynthetics in Stabilizing Soft Subgrade w/ Breaker Run	Project ID: 0092-45-15
Administrative Contact: Nina McLawhorn	Sponsor:
WisDOT Technical Contact: Bob Arndorfer	Approved Starting Date: Aug 31, 1999
Approved by COR/Steering Committee: \$55,000.00	Approved Ending Date: Oct 31, 2002
Project Investigator (agency & contact): Tuncer Edil: UW-Madison	

Description: Pavement sections needing breaker run stabilization will be constructed with and without a geosynthetic reinforcement resulting in different breaker run thicknesses. The laboratory properties of geosynthetics and breaker run and their interaction will be determined and used to guide the thickness design of the subbase. 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. Additionally, the temperature and moisture profiles will be measured using in situ instrumentation. Based on this comparison, guidelines and specifications for breaker run in soft subgrade stabilization will be recommended.

Total Study Budget	Current FFY Budget	Expenditures for Current Quarter	Total Expenditures to Date	Percent Complete
\$55,000.00	\$13,750.00	\$0.00	\$45,952.09	80 (%)

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Progress This Quarter:

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

Geosynthetics-reinforced test sections in which geosynthetics (geoweb, geotextiles, geogrid, and geocomposite) were used were monitored continuously at STH 60, Lodi. Monitoring included collection of environmental data, gage strains, and deflection surveys. Processing data is still in progress.

To investigate the integrity of the pavement structure at the field site, distress data measured Fall 2001 was analyzed and evaluated. Based on WisDOT PDI Survey Manual, the current status of the pavement at STH 60 is in perfect condition (PDI = 0) in all geosynthetics sections.

The procedure for large-scale test pit experiments using geosynthetics was developed based on a literature review. To determine the optimum layer thickness of Grade 2 with geosynthetics, a deflection test in the test pit was performed with 9 inches of Grade 2 itself without any geosynthetics, as a reference thickness.

Work Next Quarter:

The deflection data from large-scale model experiment test will be analyzed and their results will be compared with the test results from 12 and 18 inches thickness of Grade 2. Also, resilient modulus will be back-calculated using Kenlayer program. Based on the performance of three different thickness of Grade 2 as a subbase material, the test pit experiments using the geogrid will be performed. The layering location of geosynthetics will be on the top of the subgrade.

Testing geosynthetics involve extra instrumentation so within this quarter before each test is performed some time will be spent on mounting the instruments (e.g., strain gages) on the geosynthetic test specimens. Once the tests are completed the data obtained from each test will be analyzed and sorted before starting a new test. The results from large-scale laboratory test will be processed for parameter study using program and compared with the results from the field, STH 60.

Circumstances affecting progress/budget:

None to date.

State of Wisconsin/Department of Transportation
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: Sep 30, 2002

Program: SPR-0010(36) FFY99	Part: II Research and Development
Project Title: Field Performance of Sub-bases Constructed with Industrial Byproducts	Project ID: 0092-45-18
Administrative Contact: Nina McLawhorn	Sponsor:
WisDOT Technical Contact: Bob Arndorfer	Approved Starting Date: Aug 31, 1999
Approved by COR/Steering Committee: \$90,000.00	Approved Ending Date: Oct 31, 2002
Project Investigator (agency & contact): Tuncer Edil: 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	Percent Complete
\$90,000.00	\$22,500.00	\$0.00	\$75,205.58	90 (%)

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Progress This Quarter:

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

The pavement test sections in which industrial by-products (foundry slag, foundry sand, bottom and fly ash) were used were monitored continuously at STH 60. The environmental data (meteorological data and subsurface water samples) and deflection surveys were monitored and collected.

To investigate the integrity of the pavement structure at the field site, the distress data measured Fall 2001 was analyzed and evaluated. Based on WisDOT PDI Survey Manual, the current status of the pavement at STH 60 is in perfect condition (PDI = 0) in all test sections. Also, the results from rolling wheel deflectometer test performed by Marquette University were analyzed and used to determine the deflections of the subbase layer. The data from AASHTO T294 method and large-scale model tests with foundry slag, foundry sand, and bottom ash were analyzed and compared with the data for breaker run and Grade 2 materials. For this purpose, additional large-scale model tests were required and performed on breaker run with different thickness. The results from each material were compared with the corresponding RWD and FWD test results.

Work Next Quarter:

FWD and PDI tests will be performed sometime in Fall 2002 and field pavement test sections will be monitored using automatic data acquisition system continuously. The FWD test results will be compared with the corresponding the large-scale model test-measured resilient moduli to evaluate the equivalent subbase performance of by-products. Processing data from large-scale model tests with foundry sand is still in progress. Especially, comparison between large-scale model test results and field test results from rolling wheel deflectometer and distress survey tests will be performed. Also, the comparisons will be made between the predicted and measured deflections and the laboratory and field-measured moduli. Deviation between predicted and measured conditions will then be correlated with results of the cracking/distress surveys and the environmental data that were collected. The test results and field performance of subbase constructed with by-products will be reported to WisDOT.

Circumstances affecting progress/budget:

None to date.

Gantt Chart:

PROJECT I.D. 0092-45-18	STARTING DATE AUG 31, 1999	COMPLETION DATE Oct 31, 2002	QUARTER 3 - 2002	REPORT NUMBER	PERCENT OF																	
CONSULTANT FIRM NAME UNIVERSITY OF WISCONSIN - MADISON		% TIME ELAPSED 100.0%	TOTAL PROJECT FUNDING	CONTRACT FUNDING																		
NAME OF STUDY Field Demo Foundry Sand as Sub-base Material																						
TASK *	YEAR	1999		2000				2001				2002		Project								
	MONTH	QTR 3	QTR 4	QTR 1	QTR 2	QTR 3	QTR 4	QTR 1	QTR 2	QTR 3	QTR 4	QTR 1	QTR 2									
TASK 1 : LABORATORY TESTS ON BY-PRODUCTS																						
TASK 2 : TEST SECTION DESIGN																						
TASK 3 : TEST SECTION CONSTRUCTION AND INSTRUMENTATION																						
TASK 4 : TEST SECTION MONITORING																						
TASK 5 : DATA ANALYSIS																						
TASK 6 : DESIGN IMPLICATIONS																						
SHOW PROGRESS BY USE OF A BAR CHART:	SCHEDULED																					
	COMPLETED																					
															TOTALS				100			91

(Submitted by)

(Date)

Note: Gantt chart shown in State Fiscal Year Quarters

State of Wisconsin/Department of Transportation
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: Sep 30, 2002

Program: SPR-0010(36) FFY99	Part: II Research and Development
Project Title: Equivalency of Subgrade Reinforcement Methods	Project ID: 0092-00-12
Administrative Contact: Nina McLawhorn	Sponsor:
WisDOT Technical Contact: Bob Arndorfer	Approved Starting Date: Oct 1, 1999
Approved by COR/Steering Committee: \$100,616.00	Approved Ending Date: Oct 31, 2002
Project Investigator (agency & contact): Craig Benson: 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	Percent Complete
\$100,616.00	\$25,154.00	\$0.00	\$77,194.64	85 (%)

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Progress This Quarter:

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

Downloading data from the field test site as a part of field demonstration continues. Data obtained weekly from the field site is used to monitor the long-term performance of all the test sections built at STH 60.

All of the laboratory and large scale tests for breaker run, grade 2 gravel, bottom ash, foundry sand, and foundry slag are completed. Based on the results an interim equivalency report is written where comparison of the large-scale model tests and the field rolling weight deflectometer tests could be made. With this report equivalency of breaker run and all the by-products can be obtained in terms of total deflections expected during construction. The report is in review.

Work Next Quarter:

Large-scale tests with geosynthetics could not have been started due to the reasons explained in previous quarterly report. Tests with woven and nonwoven geotextiles, geocomposite, geogrid, and geoweb will be performed during this quarter. Therefore there will be laboratory activities of attaching the strain gauges to the various different geosynthetics. Once completed each of the geosynthetic will be tested in the large-scale test pit. The large-scale test data will be obtained by testing each geosynthetic with grade 2 gravel as a fill material. Each geosynthetic will be tested at 2 different thicknesses, i.e., 12 and 18 inches. Results of un-reinforced and reinforced grade 2 gravel will be analyzed to demonstrate the effect of the use of geosynthetics. Both data for the short-term construction stabilization and the long-term contribution to pavement structure will be obtained in each test.

Collecting data from the field demonstration will continue.

Circumstances affecting progress/budget:

None to date

State of Wisconsin/Department of Transportation
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: Sep 30, 2002

Program: SPR-0010(36) FFY99	Part: II Research and Development
Project Title: Investigation of Bridge Approach Settlements	Project ID: 0092-00-13
Administrative Contact: Nina McLawhorn	Sponsor:
WisDOT Technical Contact: Stan Woods	Approved Starting Date: Apr 18, 2000
Approved by COR/Steering Committee: \$99,979.00	Approved Ending Date: Apr 18, 2007
Project Investigator (agency & contact): Sam Helwany: UW-Milwaukee	

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	Percent Complete
\$99,979.00	\$12,497.37	\$0.00	\$70,741.57	50 (%)

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Progress This Quarter:

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

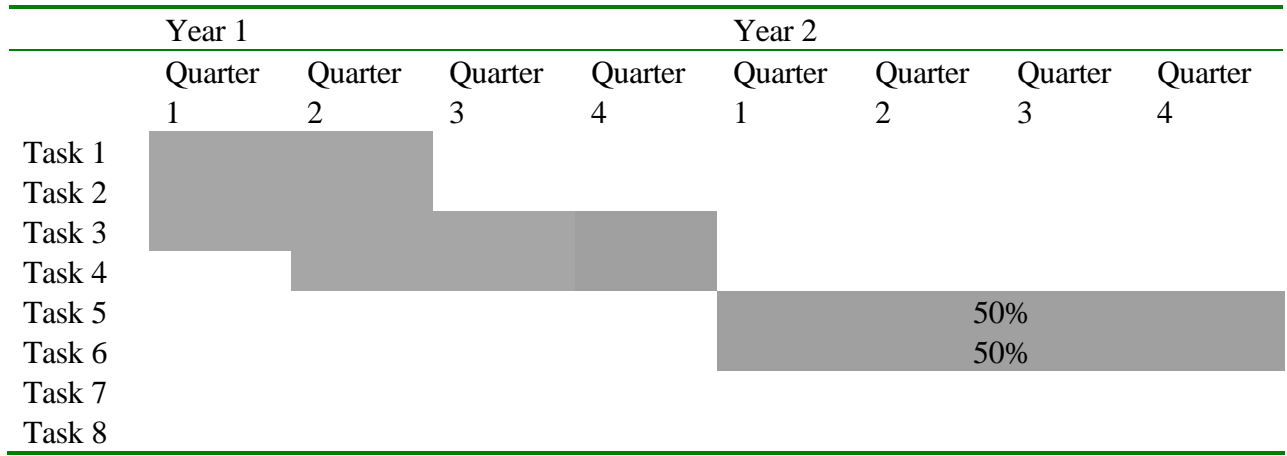
Two bridges have been identified in District 4 near Wisconsin Rapids. The approaches of these bridges have been constructed using CLSM fill and geosynthetic-reinforced soil fill. The approaches of these bridges have been instrumented with inclinometers, both on the treated and untreated approaches. Monitoring has started at end of construction and will continue for five years thereafter. This includes profiling the pavement surface and inclinometer readings.

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

State of Wisconsin/Department of Transportation
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: Sep 30, 2002

Program: SPR-0010(36) FFY99	Part: II Research and Development
Project Title: Investigation of the DCP and SSG as Alternative Methods to Determine Subgrade Stability	Project ID: 0092-01-05
Administrative Contact: Nina McLawhorn	Sponsor:
WisDOT Technical Contact: Bob Arndorfer	Approved Starting Date: May 1, 2001
Approved by COR/Steering Committee: \$58,075.00	Approved Ending Date: May 1, 2003
Project Investigator (agency & contact): Tuncer Edil: UW-Madison	

Description: 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	Percent Complete
\$58,075.00	\$19,358.33	\$t.00	\$5,680.63	70 (%)

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Progress This Quarter:

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

In continuing research with the Dynamic Cone Penetrometer (DCP), Soil Stiffness Gauge (SSG or Geogauge), and Nuclear Density Gauge (NDG), five (5) Wisconsin Department of Transportation highway construction sites were visited around the state during the summer of 2002. Road subgrade, either natural or compacted fill, was tested at each site.

One site was in the Madison district, one was in the Superior district, and three were in the LaCrosse district. The soils tested included silty sand, clayey sand, and clean sand. Following past protocol a series of the three tests were carried out on a continuous stretch at each site, moisture content samples were collected at each testing location along the stretch, and one disturbed 5-gallon bucket sample was collected for each site for laboratory testing.

A paper was written on the relationship of SSG modulus to moduli determined from other tests, e.g., resilient modulus test, resonant column test, etc. This paper was submitted to TRB for presentation in the 2003 annual meeting and for publication in the Journal of the Transportation Research Record.

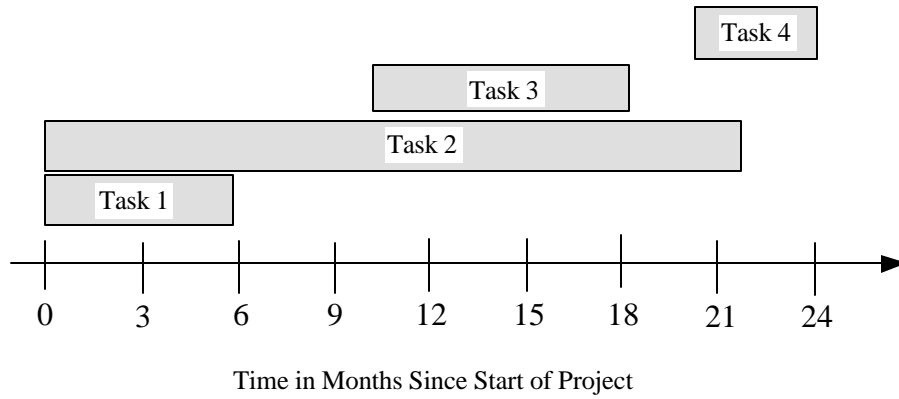
Work Next Quarter:

Field data collected in Summer 2002 will be analyzed and supplemented by the laboratory tests. They will be analyzed for statistical correlations. More laboratory investigation will be undertaken to provide insight to what SSG really measures.

Circumstances affecting progress/budget:

None.

Gantt Chart:



- Task 1: 90% complete
- Task 2: 90% complete
- Task 3: 60% complete
- Task 4: 15% complete

Note: Gantt chart shown in State Fiscal Year Quarters

State of Wisconsin/Department of Transportation
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: Sep 30, 2002

Program: SPR-0010(36) FFY99	Part: II Research and Development
Project Title: Determination of Influences on Support Strength of Crushed Aggregate Base Course Due to Gradational, Regional and Source Variations	Project ID: 0092-02-01
Administrative Contact: Nina McLawhorn	Sponsor:
WisDOT Technical Contact: Bob Arndorfer	Approved Starting Date: Sep 6, 2001
Approved by COR/Steering Committee: \$99,972.00	Approved Ending Date: Jul 6, 2003
Project Investigator (agency & contact): Richard Reusser: OMNNI	

Description: 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 it's 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	Percent Complete
\$99,972.00	\$33,324.00	\$25,869.00	\$55,253.96	73 (%)

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Progress This Quarter:

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

In the third quarter of 2002 we obtained the resilient modulus test results from Braun Intertec. Results obtained at 3.0 psi confining pressure were averaged and included in the attached data table. Also included in the data table were the triaxial shear strength results performed at 5 psi confining pressure at the end of the resilient modulus tests as well as the as-tested moisture and density condition of each sample. As-tested void ratios were calculated for each sample from the information provided in the resilient modulus test results. The results were analyzed with statistical software to determine if there was a statistical correlation among individual test results.

In general, there was no clear distinction between resilient modulus test results from sand/gravel pits and tests from quarries. Both groups had test results that varied from the high and low end of the range of test values. However, carbonate quarries tended to have higher resilient modulus results than non-carbonate quarries and tended to group near the top of the range of resilient modulus test results (see attachment). Conversely, granitic quarries from the central part of the state tended to group at the bottom of the range of resilient modulus test results. A moderate positive correlation was observed for quarries between resilient modulus and fine aggregate specific gravity, fine aggregate % carbonate, and coarse aggregate % carbonate and a moderate negative correlation observed between resilient and fine fraction % quartz and % feldspars. A moderate positive correlation was observed between resilient modulus and fine fraction quartz content in the pits sampled (see attachment).

Resilient modulus and triaxial shear results for the samples that were re-blended to vary the coarseness of the gradation were summarized and reviewed. Nine samples had been re-blended to produce gradations that were on the fine and coarse sides of the current WisDOT Section 304.2.6, gradation no. 2 specification band and on or near the maximum density line when plotted on a FHA .45 power curve. In general, triaxial shear strength was higher for gradations that were blended on the coarse side of the current WisDOT Section 304.2.6, gradation no. 2 specification band (see attachments).

We also investigated field methods to verify laboratory resilient modulus results. Hand-held falling weight deflectometer, Humboldt geogauge, plate load and dynamic cone penetrometer testing are all under consideration. We are currently consulting with WisDOT Central Office Geotechnical section to determine what field test method will be the most appropriate.

Work Next Quarter:

In the fourth quarter of 2002 we plan to continue to analyze the test results obtained to date. The triaxial shear strength results will be correlated to other test results. In addition, we plan to use statistical modeling techniques that will look for correlations between resilient

modulus and a combination of other variables. We also should be receiving CBR results from the University of Wisconsin, which will be included in the analysis.

We will attempt to sample aggregates from the pre-Wisconsin age glacial deposits located in the central part of the state.

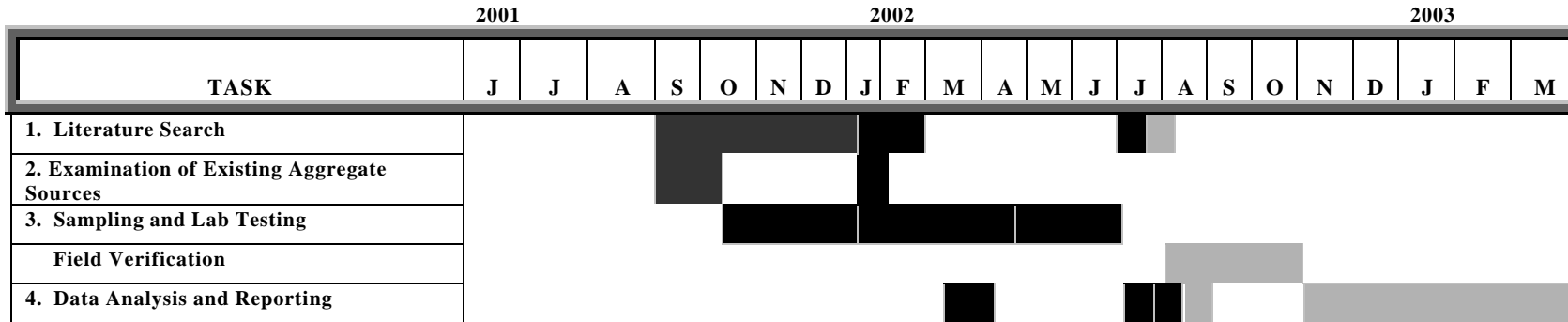
Discussions with WisDOT Central Office Geotechnical section will continue to determine the most appropriate method for field verification .

Circumstances affecting progress/budget:

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

Gantt Chart:

Project Progress and Schedule



Project Start: September 2001

Project Completion: Approximately April 2003

	Estimated Percent Task	Complete
Literature Search	90%	
Examination of existing aggregate sources	100%	
Sampling and testing	95%	
Field verification	0%	
Data analysis and reporting	20%	

Note: Gantt chart shown in State Fiscal Year Quarters