

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

<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: Error! Bookmark not defined.</b>	<b>Approved Starting Date: Oct 1, 1999</b>
<b>Approved by COR/Steering Committee: \$97,740.00</b>	<b>Approved Ending Date: Feb 28, 2002</b>
<b>Project Investigator (agency &amp; contact): Steve Cramer: UW-Madison</b>	

**Description: Error! Bookmark not defined.**

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$97,740.00</b>	<b>\$32,580.00</b>	<b>\$0.00</b>	<b>\$0.00</b>

**Progress This Quarter:**

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

This research so far has indicated little or no difference in concrete strength or durability associated with the presence or absence of coatings on coarse aggregate particles. If true, this is a significant finding in that to meet WisDOT specifications coarse aggregate is typically washed to remove small particles and coatings. In addition to the expense of washing, this creates a waste stream of very fine particles that has no other practical use. We theorized that it is not the mere presence of the coating but the mineralogy of the coating which is critical in determining concrete performance. Coatings gathered and tested to date have consisted of primarily dust type particles with trace amounts of clay. A developing theory is that the dust type coatings (small particles derived from the parent rock) up to certain limits are harmless but that the presence of clay particles in even small amounts can be detrimental. We were unable to locate a naturally occurring concrete coarse aggregate that pushed the limits of clay content and would allow us to test our hypothesis. As a last resort, we recently requested and were granted a no-cost extension to allow us to manufacture and evaluate an aggregate with predominantly a clay coating. These efforts went beyond the original study plan.

Early in the quarter, a clayey soil from Sauk County was identified as a potential source for a worst-case aggregate coating. A preliminary methylene blue test resulted in a methylene blue absorption value of 14.21, or approximately double the value measured from the Dodge County aggregate coating. A dirty aggregate was created by attaching fines to the Marathon aggregate. The aggregate had a p200 value of 1.5%. Because the water absorption of the fines was not taken into account (as standard procedure dictates), the concrete mixed with the aggregate resulted in a very low slump of 0.25 in. and a low air content of 3.7%.

A research article, *Absorption Water Content and Liquid Limit of Soils*, suggested that the water absorption of clay fines could be as high as 97%. If the water absorption of the fines is not taken into account, the net water-cement ratio of the concrete could be lowered by as much as 0.04. This might explain why some of the earlier washed mixes performed worse than their unwashed counterparts. Based on the findings presented in the article, liquid limit tests using the cone penetrometer method were used to determine an initial estimate of the absorption of the Sauk County fines. A water absorption of 72% was predicted from a liquid limit of 77%.

A final mixture using the Sauk County fines (p200 = 1.3%) was prepared to correct for the absorption of the fines. Two trial mixtures were used to gauge the effects of additional water on slump and air content readings. For the final 3 ft<sup>3</sup> mix, an additional 2.60 lbs of water was added to give a slump of 1.5 in. and an air content of 6.3%. The effective absorption of the fines was approximately 95%, slightly higher than that predicted from the cited research article. At this time, methylene blue testing and cleanness value readings have not been completed for the Sauk County fines. From the first Sauk County concrete mixture, a cleanness value of 16 was recorded. This is significantly below the CalTRANS specification limit of 75 and suggests that the test does not account for the differences between clay and dust coatings.

Strength testing was completed on the first Sauk County mix. However, the values did not seem to differ significantly from the other similar mixes. This is probably due to the low air content of the mix and the lower water-cement ratio from the clayey fines. Some additional work on air dry shrinkage was conducted that will clarify trends between washed and unwashed aggregates.

Hardened concrete air void analyses have been completed for all mixes except the recently manufactured clay coating mixture. Air contents ranged from 5.1% to 8.3%. In general, the air void contents were similar to the fresh air void contents measured with the air meter. The three specimens tested from Mix 2 ranged from 5.3% to 6.3% suggesting that some variability can occur within one freeze-thaw specimen.

Freeze-thaw testing is complete on all mixes part of the original work plan. Testing of the two Turtle Lake fines mixes, the two Sauk County fines mixes, and the Marathon washed remix will begin on April 22.

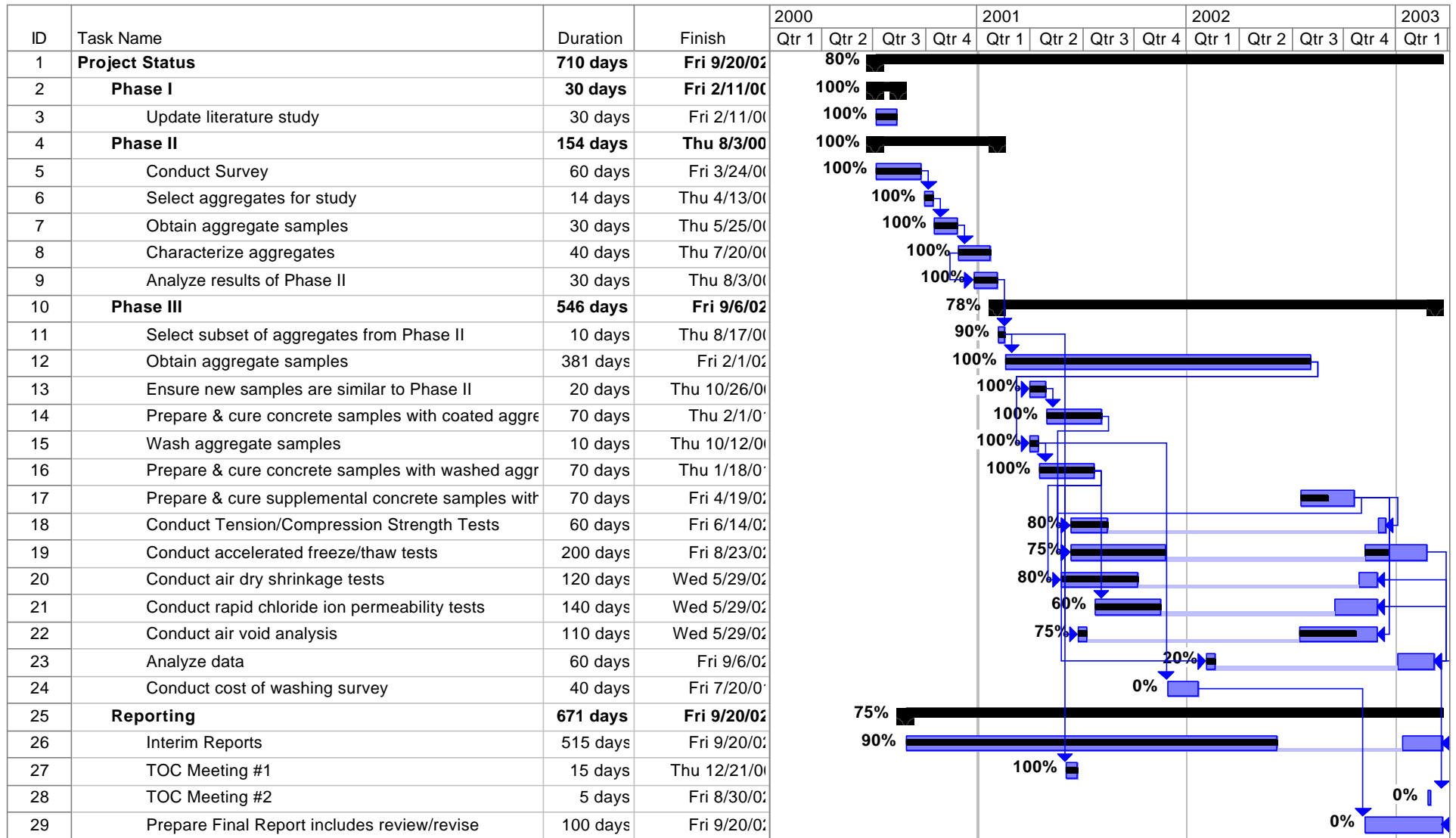
**Work Next Quarter:**

Work next quarter will primarily consist of freeze-thaw testing of the specimens prepared and data analysis

**Circumstances affecting progress/budget:**

None

**Gantt Chart:**



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

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

<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: Nina McLawhorn</b>	<b>Sponsor:</b>
<b>WisDOT Technical Contact: Error! Bookmark not defined.</b>	<b>Approved Starting Date: Mar 28, 2000</b>
<b>Approved by COR/Steering Committee: \$39,857.00</b>	<b>Approved Ending Date: Nov 28, 2005</b>
<b>Project Investigator (agency &amp; contact): James Crovetti: Marquette University-CEEN Hagg</b>	

**Description: Error! Bookmark not defined.**

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$39,857.00</b>	<b>\$5,693.85</b>	<b>\$0.00</b>	<b>\$0.00</b>

**Progress This Quarter:**

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

Meeting with WisDOT and contractor personnel have been held in an effort to identify candidate 2002 construction projects that could be included in this study. One potential project which was identified was converted to an HMA surface over rubblized PCC, effectively eliminating it from consideration for this study. At this point, no other PCC over rubblized PCC projects are scheduled for completion in 2002.

**Work Next Quarter:**

A modified work plan which will include the testing of isolated PCC slabs over rubblized PCC will be developed and submitted to the Rigid Pavement TOC for consideration. The goal of this modification is to collect FWD data on in-place PCC slabs over rubblized PCC to quantify the structural contribution of the rubblized PCC and to compare to theoretical values developed during the finite element analysis.

This testing would be conducted in lieu of testing on full-scale PCC pavements over rubblized PCC.

**Circumstances affecting progress/budget:**

The availability of constructed PCC over rubblized PCC pavement sections in Wisconsin is necessary for this research project to advance.

WHRP Project 0092-00-11  
 Portland Cement Concrete Pavement Over Rubblized PCC  
 Gantt Chart of Project Activities Through March 31, 2001

Project Task	Calendar 2000											Calendar 2001											% Complete
	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	
1. Literature Review	Actual																						90
2. Data Refinement		Actual																					70
3. Construction of Test Sections				Actual																			0
4. Performance Monitoring							Actual															0	
5. Interim Report 1						Actual																	0
6. Interim Report 2																			Actual			0	
7. Interim Report 3																							0
5. Final Report																							0
Overall project																							25

Proposed   
 Actual 

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

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Early Opening of PCC Pavements to Traffic</b>	<b>Project ID: 0092-01-04</b>
<b>Administrative Contact: Nina McLawhorn</b>	<b>Sponsor:</b>
<b>WisDOT Technical Contact: Error! Bookmark not defined.</b>	<b>Approved Starting Date: Jun 18, 2001</b>
<b>Approved by COR/Steering Committee: \$58,648.00</b>	<b>Approved Ending Date: Dec 18, 2002</b>
<b>Project Investigator (agency &amp; contact): James Crovetti: Marquette University-CEEN Hagg</b>	

**Description: Error! Bookmark not defined.**

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$58,648.00</b>	<b>\$19,549.33</b>	<b>\$0.00</b>	<b>\$0.00</b>

**Progress This Quarter:**

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

Laboratory testing of doweled specimens using materials obtained from STH 57 was completed. Maturity curves for in-place pavements and companion cylinders and beams were developed. Finite element analysis of early loading effects was initiated. Contacts with WisDOT personnel were made to identify 2002 construction projects that may be included into this research study.

**Work Next Quarter:**

The finite element analysis of various loading conditions should be completed. Field testing on selected projects, including the fabrication of test cylinders and exposed dowel specimens and installation of maturity/temperature probes, will be conducted on all candidate projects scheduled for completion during this quarter.

**Circumstances affecting progress/budget:**

None

WHRP Project 0092-01-04  
 Early Opening of Concrete Pavements  
 Gantt Chart of Project Activities Through March 31, 2002

Project Task	Calendar 2001							Calendar 2002												% Complete
	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	
1. Literature Review/Survey		■	■																	80
2. Interim Report		■	■	■	■	■	■													50
3. Pavement Analysis					■	■	■													20
4. Field Sampling/Testing							■	■	■	■	■	■	■	■						30
5. Final Report														■	■	■	■	■	■	0
Overall project																				40

Proposed ■  
 Actual ■

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

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Performance of Shoulders Adjacent to Concrete Pavements</b>	<b>Project ID: 0092-02-05</b>
<b>Administrative Contact: Nina McLawhorn</b>	<b>Sponsor:</b>
<b>WisDOT Technical Contact: Error! Bookmark not defined.</b>	<b>Approved Starting Date: Sep 17, 2001</b>
<b>Approved by COR/Steering Committee: \$73,467.00</b>	<b>Approved Ending Date: Sep 17, 2002</b>
<b>Project Investigator (agency &amp; contact): Sam Owusu-Ababio: UW-Platteville</b>	

**Description: Error! Bookmark not defined.**

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$73,467.00</b>	<b>\$36,733.50</b>	<b>\$0.00</b>	<b>\$0.00</b>

**Progress This Quarter:**

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

The objective of Task 1 is to identify, collect, review, and synthesize literature and research on the design, standards, performance, costs, and maintenance practices utilized by states, as well as those recommended by national trade associations and professional organizations dealing with pavement products.

Task 1 is 95% complete.

*Subtask 1.1 - Reports and Papers*

The research team has completed the identification, collection, and review of literature related to the design, standards, performance, costs, and maintenance practices of paved shoulders adjacent to PCC pavements.

As the study progresses, the research team will monitor any new literature in this area. In particular, the state of South Dakota conducted a similar study, and the research team just contacted the state to receive a copy of their report for incorporation into our work..

Subtask 1.1 is 100% complete.

*Subtask 1.2 - Survey*

Two separate survey designs (design/construction and maintenance) were mailed on December 26, 2001 to 7 states: Illinois, Iowa, Minnesota, Michigan, Indiana, Ohio, and Wisconsin.

The design/construction survey was designed to collect information regarding the policies and procedures used in paved shoulder type selection, shoulder design, drainage treatment, shoulder condition evaluation method, costs, and typical sections. To-date, 3 of 7 states have responded to the survey (Illinois, Michigan, and Minnesota). Letters were sent to the remaining states (excluding Wisconsin) to encourage survey response.

The maintenance survey was designed to seek information regarding maintenance practices and policies, costs, freeze-thaw behavior, and specific maintenance concerns. To-date, 23 of 54 (42.5% response rate) maintenance

districts from the 7 states have responded to the survey. Follow-up phone calls have been made to increase survey response. Surveys have been received from all WisDOT districts.

A majority of the maintenance survey responses suggested that freeze-thaw behavior has a significant effect on maintenance practices and costs. As a result, emphasis will be placed on collecting field data in Task 3 while the shoulder and base are frozen.

Subtask 1.2 is 90% complete.

## **Task 2 - Identification and Review of Paved Shoulder Types in Wisconsin**

The objective of Task 2 is to identify and review different paved shoulder types adjacent to mainline Portland cement concrete (PCC) pavements constructed in the last thirty years by WisDOT.

The design team contacted all WisDOT districts in January 2002 to collect cross-section plans for all PCC projects constructed in the last 30 years. Only the following pavement types were identified: Jointed Plain Concrete Pavement (JPCP) with and without dowels, and Continuously Reinforced Concrete Pavement (CRPC). The research team has been advised that Jointed Reinforced Concrete Pavement (JRCP) should be omitted from the study.

The total number of projects identified has not been finalized, since plans and cross-section details are still under review. Several items are being collected for each project, including as-built cross-section geometric details for the PCC pavement and adjacent shoulder, under-drain system design and construction, subbase and base material, and construction costs.

A review of all projects in Districts 2, 4, and 5 has been completed.

Task 2 is 85% complete.

## **Task 3 – Shoulder Condition Survey**

The objective of Task 3 is to evaluate the field performance of paved shoulders.

On March 19, 2002, the research team met with WisDOT pavement management staff, including Mr. Bill Duckert, Mr. Mike Malaney, and Mr. Dwight Johnson, to review the proposed pavement distress measures for paved shoulders found in a February 15, 2002, memo to the TOC. The research team proposed several changes, additions, or deletions to the existing WisDOT *PDI Survey Manual* for evaluating paved shoulder distresses. One new distress indicator is proposed to evaluate the distresses associated with longitudinal joint between the PCC mainline pavement and AC shoulder. Presently, there is no distress evaluation category for the PCC-AC longitudinal joint.

On the same day (March 19) after the morning meeting, WisDOT and the research team conducted a trial survey of the AC shoulder on USH 151 near Sun Prairie, using the proposed shoulder distress categories. However, the reality of collecting all survey distresses in the field was realized during this trial survey. On the basis of the trial survey and comments received from the meeting with the WisDOT pavement monitoring experts, the field survey sheet for collecting distress on paved shoulders was modified. Appendix I contains the modified field data collection sheet and survey categories for both PCC and AC shoulders.

The research team explored the possibility of using the WisDOT automated distress survey van, however, after learning of the capabilities and potential damage to the van while surveying the shoulders, it was determined that a manual data collection effort would be required.

The research team began field collection on March 24, 2002 in Districts 1, 4, and 5

Task 3 is 20% complete.

**Work Next Quarter:**

## **Task 1 - Literature Review**

### **Subtask 1.1 - Reports and Papers**

Review South Dakota's shoulder study report and include it in the literature report

#### *Subtask 1.2 - Survey*

Follow-up phone calls to encourage survey responses. Compile any new survey data with the existing surveys.

## **Task 2 - Identification and Review of Paved Shoulder Types in Wisconsin**

Complete review of project plans collected from Districts 1, 3, 6, 7, and 8.

## **Task 3 – Shoulder Condition Survey**

Continue data collection.

## **Task 4 – Data Analysis**

Start data analysis.

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

The research project is about one month behind schedule. The delay in schedule is due to the difficulty of tracking down As-built plans from the various districts. The reference point system currently in use by WisDOT does not relate to project Ids. Hence, the identification of specific projects on the basis of reference points has been very slow. Some projects found in district files also have incomplete information, thus making them ineligible to include in field surveys. Further inquiries about “questionable projects” takes days to get a response back.

**Gantt Chart:**

Task	Description	2001			2002									Percent Complete	
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
1	Literature Review and Survey	█	█	█	█	█	█								95
2	Review of Shoulder Types	█	█	█	█	█	█								90
3	Shoulder Condition Survey		█	█			█	█	█	█	█	█	█		20
4	Data Analysis		█	█	█	█	█	█	█	█	█	█			0
5	Development of Guidelines									█	█	█	█		0
6	Final Report											█	█		0
		Proposed	█												
		Actual	█	Project											35

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

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

<b>Program: SPR-0010(36) FFY99</b>	<b>Part: II Research and Development</b>
<b>Project Title: Effects of Ground Granulated Blast Furnace Slag in Portland Cement Concrete</b>	<b>Project ID: 0092-02-14a</b>
<b>Administrative Contact: Nina McLawhorn</b>	<b>Sponsor:</b>
<b>WisDOT Technical Contact: Error! Bookmark not defined.</b>	<b>Approved Starting Date: Nov 7, 2001</b>
<b>Approved by COR/Steering Committee: \$194,251.00</b>	<b>Approved Ending Date: Dec 31, 2003</b>
<b>Project Investigator (agency &amp; contact): Steve Cramer: UW-Madison</b>	

**Description: Error! Bookmark not defined.**

Total study budget	Current FFY budget	Expenditures for current quarter	Total Expenditures to date
<b>\$194,251.00</b>	<b>\$64,750.33</b>	<b>\$0.00</b>	<b>\$0.00</b>

**Progress This Quarter:**

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

Over the past three months the following items have been completed. A literature review has been assembled, and will continue to be updated. Materials have been collected. A survey on the industry's perception of GGBFS in concrete is being finalized. Modifications to the ASTM scaling tests have been investigated to meet project objectives. The study plan is being re-examined in conjunction with WisDOT and industry to ensure the research provides the most impact possible.

A literature review consisting of 32 sources has been summarized and is under review. Some of the topics covered include strength gain, scaling resistance, sulfate attack, and chloride penetration. Several issues concerning scaling tests were of particular interest. Instead of using the specified CaCl<sub>2</sub> salt solution, more aggressive solutions were employed including NaCl and KCl. Also, more quantitative procedures for recording scaling resistance are being used. Along with taking a visual rating, the blocks and the wash-off have been weighed. Refining the ASTM C672 test procedure is critical to this research.

A list of survey questions has been drafted. Once the questionnaire has been finalized, it will be sent to regional companies, DOT's and GGBFS suppliers. From this, we will be able to get an idea on the industry's perception on the use of GGBFS and problems that have occurred.

Materials for concrete mixing are being collected. The fine aggregate has been obtained. Coarse aggregate and GGBFS samples are being collected. After talking with some GGBFS suppliers, it was found that it might be of interest to run tests with both Grade 100 and Grade 120 GGBFS. In addition to the Grade 100 we already have, we have asked for a sample of Grade 120 for preliminary activation tests.

The ASTM C672 scaling test is the prevailing standard but extremely subjective. Based on the literature review we have begun collecting the wash-off from the scaling samples every five cycles on a related project to assess different means to render the C672 test a more scientific and quantitative procedure. The samples are washed off over a #200 sieve and the water is collected in a pan below. Both the sieve and pan material are oven-dried and weighed. It was determined that the weight of the fines was insignificant compared to the weight of the material captured by the sieve. Now, in addition to a visual inspection every five cycles, the blocks and wash-off are weighed. It appears that this refinement will meet the project needs.

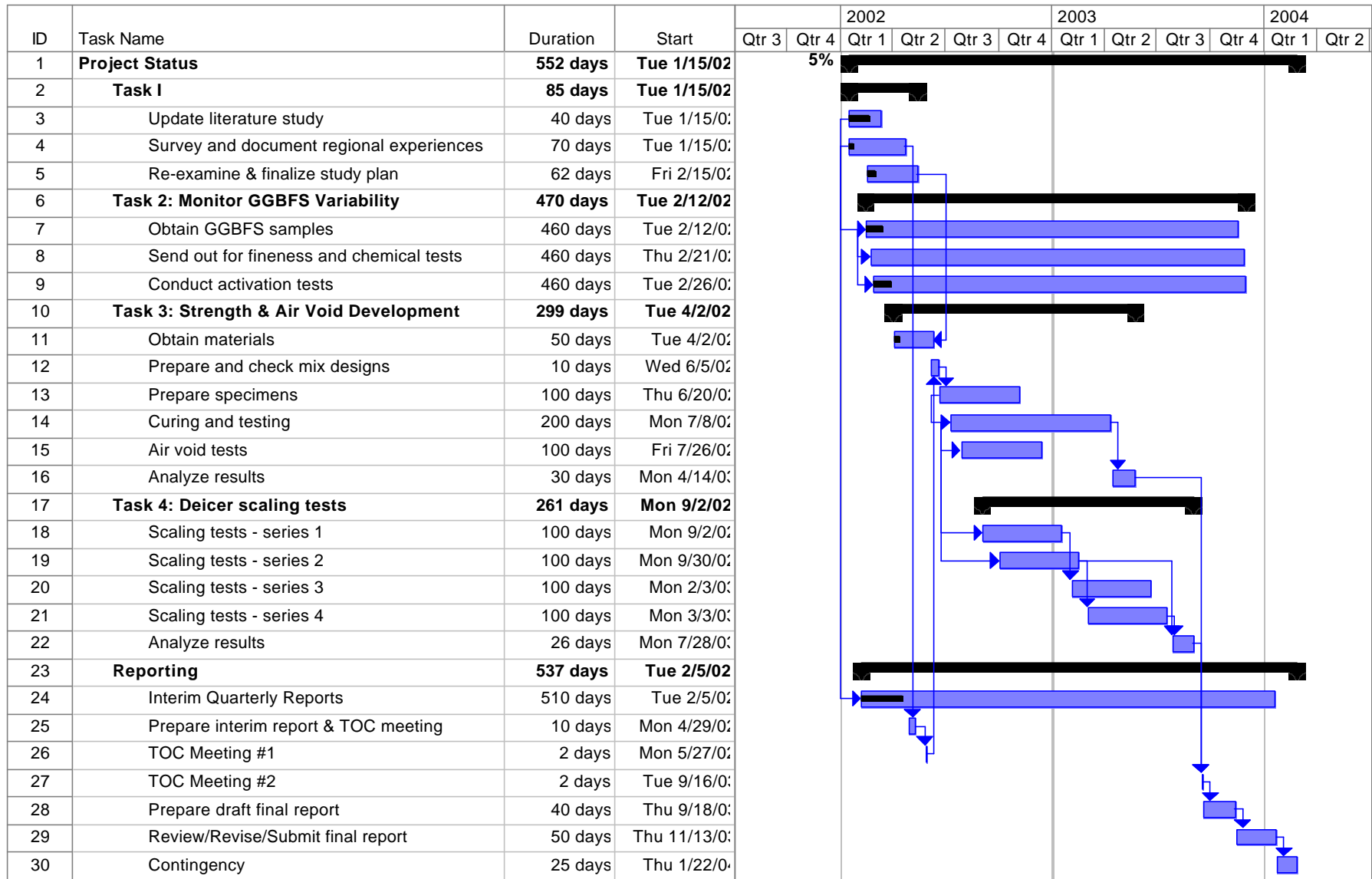
**Work Next Quarter:**

The most pressing work is to finalize the work plan so that the research stays on schedule. We plan to be mixing concrete and preparing the specimens late in the next quarter if possible.

**Circumstances affecting progress/budget:**

At the time this research was proposed, one company was selling one grade of GGBFS in Wisconsin. It was proposed to examine the performance of one grade of GGBFS from one supplier. This situation has changed with two companies now selling their product and two different grades of GGBFS in the Wisconsin market. If the original proposal is followed, the question remains which supplier and which grade to use in the study. This uncertainty has caused a delay in proceeding with the study plan. Some are proposing the study be expanded to include both sources of slag. We are investigating the options with the associated parties and will seek resolution of the work plan during the next quarter.

**Gantt Chart:**



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