

Quarterly Report #6

Development of Hand-held Thermographic Inspection Technologies RI06-038

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Summary of Accomplishments and Activities

Work this quarter included completing Task 2, *Controlled Testing of Concrete Test Specimen*. Task 3, *Operational Testing*, is ongoing, with each participating State currently testing cameras during normal operations. Work on Task 4, *Final Report*, has been initiated. A summary of progress on the project is included below.

Task 1 Preliminary Study Development

All elements of Task 1 have been completed.

Task 2 Controlled Testing of Concrete Test Specimen

The test block including targets at depths of 1, 2, 3 and 5 in. has been constructed and 3 months of data was collected on the south side of the block during the months of November, 2007 through January, 2008. The data acquisition house was moved to the North side of the block to collect data on the shady side of the block, where the embedded targets are not exposed to direct sunlight. Some problems were encountered in the data acquisition system during the months of February, March and April, leading to some data being lost on the north side of the block. Some data is available during this time period, but is intermittent. Valid, continuous data was collected during the months of May, June and July. This data is being utilized to evaluate the trends for inspection of structures that are not exposed to direct sunlight. Post processing and integration of data from the thermal couple arrays, the thermal camera and the weather station have been completed.

Figure 1 show example data from the North side of the block over a period of one week. The ambient temperature variations, which are driving the thermal contrast in the block, are shown along with the thermal contrast for the 1", 2", 3" and 5" deep targets. Initial observations of this data indicate that the thermal contrast for each of the targets is maintained over a longer period of time, particularly during the night time hours, than

was typical for the south side of the block. It appears that once a certain thermal contrast is achieved, for example 1° C, that contrast is maintained over several hours. This indicates that the most effective inspection times may last for several hours. It has also been observed that the thermal contrasts, which are positive during the day, have negative contrast at night of a similar magnitude. This would suggest that nighttime inspections could be equally effective with daytime inspections. Also, thermal contrasts on the north side of the block typically have a maximum of 2.5 °C or less, much smaller contrast than were observed on the South side of the block. Complete analysis of the north side data is currently ongoing to develop more durable correlations between the ambient weather conditions and the thermal contrast observed in the test block.

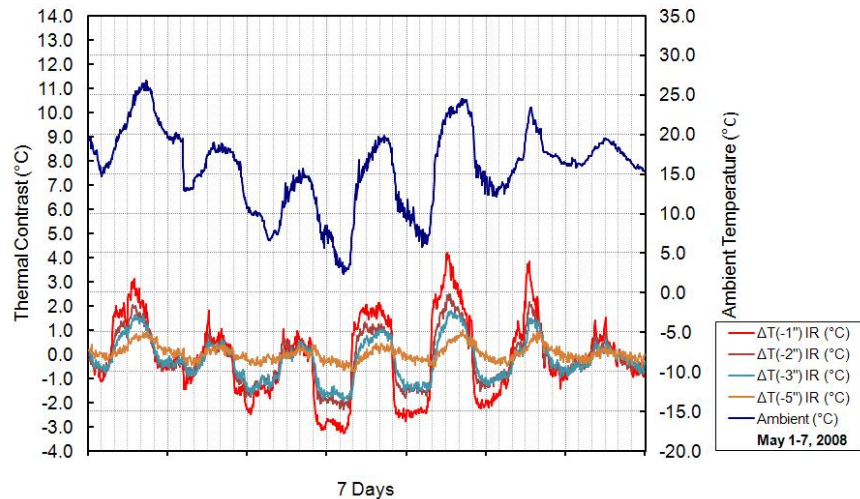


Figure 1. Ambient temperature variations and thermal contrast for the north side of the block over a time period of 1 week.

Task 3. Operational Testing

Operational testing is ongoing in the participating States. Some limited anecdotal data has been collected from States regarding their experience in using the cameras in the field. Initial results indicate that States are having positive experiences utilizing the cameras in the field.

Currently, an effort is ongoing to document the ambient weather conditions on-site during the inspections reported by State participants. This study is utilizing data from nearby airports to learn general weather conditions in the area during the inspections, to correlate the successful outcomes with the weather conditions at the time of the inspection. This data can be combined with the test block data to contribute to the development of guidelines to be developed as part of the final report.

An initial observation of significance during the field testing is the effect of moisture and/or water present in the areas being inspected. The thermal properties of water are such that areas that are saturated at the time of the inspections are out of phase with the

anticipated thermal contrast to be observed. In other words, during heating of the day, saturated concrete tends to be observed as a cold spot in the image as shown in Figure 2. This observation is not unexpected and is consistent with theoretical predictions. However, the anticipated observation of subsurface delaminations that are saturated at the time of inspection remains unclear. This is a source for variability in expected results and reliability of the method. A fuller understanding of the effects of entrapped water may be suitable for further research, as this issue was not addressed in the current project.

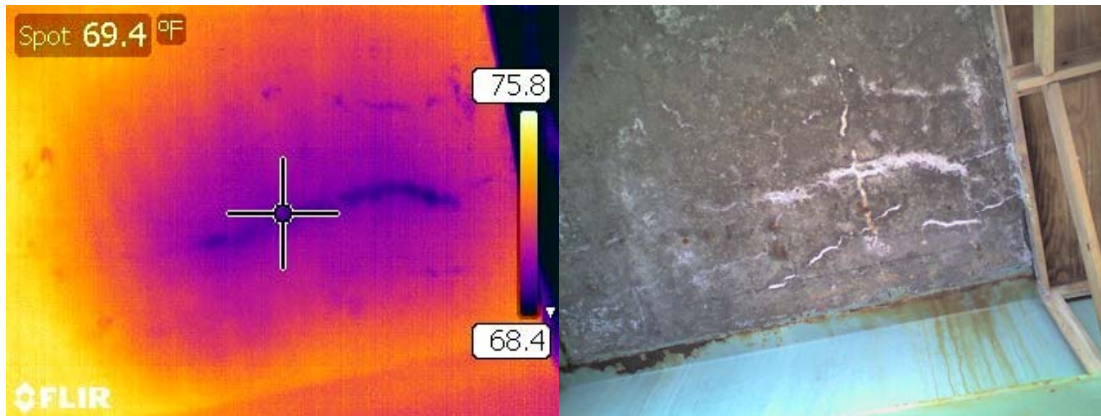


Figure 2. Saturated bridge deck soffit appears as cold spot in thermal image, New York State Department of Transportation.

Task 4 Final Report

Efforts to develop the final report and associated guidelines have been initiated but are in the early phases. Processing and analysis of data is not fully complete at this time. The data acquisition at the test block is ongoing, but data for analysis during this phase of the study has been collected and is being processed.

4. Issues or Problems that need to be addressed.

There has been an impact on the overall budget as a result of procuring four hand-held cameras rather than the three originally planned. The impact on the overall budget is currently being analyzed.

Schedule

The project is currently on schedule. The actual time involved with operational and laboratory testing is below what was originally envisioned in the proposal, however, the overall goals of these activities are being adequately addressed and this will likely not affect the achievement of the goals of the project. No-cost extension of the project is an option if necessary but is not anticipated at this time. The project team believes adequate data has been collected to date to develop effective conclusions and provide necessary guidance on the implementation of research results.

Table 1. Summary of project schedule.

		Months																										
Tasks		F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J			
1	Preliminary Study Development	█																										
2	Controlled Testing of Concrete Specimen							█																				
3	Operational Testing													█					▨									
4	Final Report																							▨	█			

% of Budget Expended: Approximately 95% of the funding provided by the participating States has been expended. Approximately 98% of the University-provided funded has been expended. Approximately 95% of the University Transportation Center budget has been expended. The overall budget is being analyzed to determine if additional funds will be necessary to complete the project, as noted in (4) above.