C-04-04
APPLICATIONS OF GROUND PENETRATING RADAR FOR HIGHWAY PAVEMENTS

January 2005

RESEARCH PROBLEM STATEMENT:

As part of the Department's effort to develop a comprehensive policy covering the movement of superloads in and through New York State, TR&DB is analyzing the impact of superheavy trucks in NY corridors using various failure modes. To accomplish this task, the Technical Services Division has been working with regional engineers in obtaining information on pavement structural systems, including thickness, materials, and subgrade conditions, for the highways that are part of the corridors. To date, the Regions have not be able to provide needed data because of resources constrains and difficulty of retrieving data.

There is a need to collect pavement thickness data for the analysis of the impact of Superloads on NYS Corridors. Among the technologies available today, Ground Penetrating Radar (GPR) has been proven to be a valuable tool for such application. GPR is a Non-destructive Testing (NDT) field survey method used to obtain an image of pavement structures for determining thicknesses, voids, and moisture content. The advantage of using GPR to assess pavement conditions is that it can collect data at highway speed without the need for maintenance and protection of traffic, and it does not require extensive coring and laboratory testing. Other GPR applications for highway pavements include: 1) At project level, GPR can be used to assess pavement uniformity, anomalies, conditions of asphalt pavements, subase, and subgrade, pavement rehabilitation studies, load transfer evaluation, and identify underground utilities. In conjunction with Falling Weight Deflectometer testing, use of GPR could enable engineers to achieve a more reliable backcalculated resilient modulus of pavement structures because of a better-determined layer thickness. 2) At network level, GPR can be used to determine pavement layer thicknesses and pavement conditions for the entire network. The Department's Pavement Management manager has expressed strong interest in determining network structure condition that could be derived from network pavement thickness data using GPR.

With regard to underground utility applications, the Department's Capital Program experienced 161 underground utility contacts during 2002, 124 underground utility contacts during the 2003, and 77 underground utility contacts reported to date during the 2004 construction season. Each underground utility contact has tremendous potential for catastrophe. The root causes of these utility contacts include: contractor failure to maintain utility marks, contractor failure to verify utility locations, utility company failing to locate/mark underground utility accurately, underground utilities not installed in straight predictable paths, utilities that are within highway pavements and very shallow utilities. Mapped highway subsurface features will depict underground utility depth and directions that will enable contractors accurately verify the location of marked utilities and will assist utilities company to check marked underground utility location

To evaluate, demonstrate, and facilitate the applications of GPR for highway pavements and subsurface underground utility exploration, there is a need to collect, analyzes, and report GPR

data at five selected pilot project sites: three in Region 1, one in Region 2, and one in Region 8. Results of these pilot projects will be calibrated/validated using in-situ data. Based on the experience gained from the pilot studies, recommendations on implementation strategy and future work plan for network level application and highway subsurface utility exploration will be made.

OBJECTIVE:

The objectives of this project are to demonstrate the applications of GPR for highway pavements and subsurface exploration through collection of pavement thickness, condition data, and three dimensional underground subsurface features data from ground level to a depth of 1.7 meters at five project sites located in Regions 1, 2, and 8, and to recommend an implementation strategy and a work plan for network level and highway subsurface utility exploration applications.

PROPOSED RESEARCH TASKS:

Proposals must present the proposer's current thinking in sufficient detail to demonstrate their understanding of the issues and the soundness of their approach to meeting the research objectives.

The research will be done through the following tasks:

TASK 1/April 1, 2005 (Start date)

Collect and review literature related to the use of GPR for highway pavements and highway subsurface utility exploration. Topics shall include project and network-level applications, summary of GPR technology such as equipment, frequency, penetration depth, data acquisition and processing protocols and software, and specifications. From the literature review, provide a synthesis of applications of GPR for highway pavements. (See Special Note 1)

Milestone 1: *Due May 15, 2005*
Deliverables: *A synthesis of Applications of GPR for Highway Pavements and subsurface Utility exploration.*

TASK 2

Collect GPR data for determining pavement thickness and pavement conditions at three project sites selected by the Department in Regions 1 and 2, as well as highway subsurface exploration at two project sites selected by the Department in Region 1 and/or Region 8. Analyze data to determine thicknesses, uniformity, anomalies, joint deterioration, underground utilities location, etc., calibrate/validate results using coring and other available in-situ data provided by the Department; provide a detailed report. (See Special Note 2)

Milestone 2: *Due September 15, 2005*
Deliverables: *An Interim Report detailing GPR data analysis for the six sites tested. The reported data needs to be compatible with the Department's database systems; i.e., Visidata and*

HDMS, including the location referencing method. A meeting with the Technical Working Group (TWG) to discuss progress is required.

TASK 3

Using the Synthesis and Interim Report in Tasks 1 and 2, develop an implementation strategy for the use of GPR which addresses the following issues:

1. How to report the data to the end user in a format that can facilitate the adoption and implementation of the GPR technology,
2. Determine the costs associated with different applications,
3. Sample service contract,
4. Sample equipment procurement specification,
5. Can improved decisions be made regarding capital projects using this technology?
6. Training that is needed for implementation,
7. Work Plans for Network-level applications and subsurface utility exploration applications using GPR. At the network level, it is envisioned that thicknesses and condition data can be used to provide a structural condition indices of the network, which would assist NYSDOT in making more effective project selections and will lead to improved efficiency of subsequent project level pavement rehabilitation treatments or reconstruction decisions.

Milestone 3: *Due December 1, 2005*
Deliverables: *An implementation plan for the use of GPR at the Project level and work plans for Network Level and subsurface utility exploration Applications.*

TASK 4

Subtask 4.1 Write a final report that documents the entire research effort with a revised implementation plan based on TWG's comments.

Interim Milestone 4: *Due February 1, 2006*
Deliverables: *A Draft Report for review and comment by the TWG.*

Subtask 4.2 Based on TWG's comments, submit a revised final report.

Milestone 5: *Due March 31, 2006*
Deliverables: *Submit a final report that includes data report, implementation plan, and work plans for Network-level and Subsurface Utility Applications. NYSDOT will need 20 hard copies and an electronic copy of the final report.*

RESEARCH PRODUCTS:

1. A report detailing GPR data collection and analysis for the four sites tested.

2. An implementation Plan for the Project-level GPR applications.

3. A Work Plan for Network applications using GPR

4. A Work Plan for Highway Subsurface Utility Exploration applications using GPR

5. A final report that documents the research effort.

URGENCY, EXPECTED BENEFITS AND IMPLEMENTATION

The research products will provide the necessary tools for the use of GPR for highway pavements in New York State. The data report for the pilot sites will benefit the Superloads Trade Corridor analysis work, project-level pavement condition assessment, and pavement rehabilitation treatments selection, and identify underground utilities. Implementation plan for Project-level applications and work plans for Network and highway subsurface utility exploration applications will facilitate the GPR implementation.

FUNDING:
$100,000.

RESEARCH PERIOD:
Twelve months with start date April 1, 2005 and completion date March 31, 2006

SPECIAL NOTES:

1: Significant ground work exists and could be a starting point for completing the above stated objectives. These are:

a. FHWA Research and Technology: "Priorities, Market-Ready Technologies and Innovations – Ground Penetrating Radar"

b. AASHTO Technology Implementation Group - Ground Penetrating Radar

2: Site locations

The location of the five highway pavement sites has been tentatively identified as follow:

a. I-87, Albany, north bound, between exits 1-6 for pavement thicknesses determination,
b. I-90 West bound, for subase/joint conditions assessment under existing PCC, MP 5.6 through 5.6 through 3.9,
c. Rte-12, Utica for load transfer evaluation and subgrade conditions assessment.
d. The location of the two highway subsurface utility exploration sites will be determined by the Department's 2005 Capital Program schedule.