The Transportation Research and Development Program at NYSERDA seeks to develop and demonstrate, and then assist in the successful commercialization of advanced transportation products, systems, and services in New York State. Proposals for funding are sought twice each year, through a series of Program Opportunity Notices.

Submitted proposals are typically directed at enhancing mobility and improving transportation energy efficiency with advanced vehicles and vehicle components, as well as innovative infrastructure. Currently, the NYSERDA program is funding and actively supporting over 80 innovative transportation research projects. NYSERDA is contributing in excess of 16 million dollars to projects costing a total of 38 million dollars, the balance provided by industry partners and other co-funders.

Compressed natural gas (CNG) vehicles have found a defined market within government fleets due to federal EPACT requirements. The vast majority of CNG vehicle deployment has occurred in fleets comprising light duty, rather than medium and heavy duty vehicles. One barrier to heavier duty vehicle use is the reduction in pay-load area due to the large volumetric storage requirements for CNG and the cost of a CNG-ready engine to replace existing diesels. While dual fuel retrofit kits have been developed, sufficient testing and environmental performance verification is lacking to support widespread deployment. Various fleets in New York State, including those operated by the New York State Department of Transportation and by public utility companies, could benefit substantially by the availability of vehicles with compression ignition engines having both CNG and diesel fuel capability.

Through past research and development by BAF Technologies, Inc. and others, the present state-of-the-art hybrid fuel Compression Ignition System (CIS) has been developed. However, due to anti-tampering laws and the recent strengthening of exhaust emission regulations, especially diesel engine oxides of nitrogen (NOx) and particulate matter, installation of the CIS system is prohibited without verified compliance under guidelines established by either U.S. EPA or California Air Resource Board (CARB). The NYSERDA-funded project was designed to accomplish the engineering of specific initial development vehicle platforms in order to showcase the CIS system.

Though the CIS is applicable to most any diesel engine, the project has specifically targeted late model, 4-stroke diesel engines, utilizing electronic control protocols established under SAE J1939 as the main emphasis. BAF has successfully installed and demonstrated the CIS hybrid fuel system on several trucks in the NYSDOT fleet that employ International T444E and Cummins ISM11-305 engines. Currently, emissions levels tested sufficiently low for U.S. EPA and CARB certification,
NYSDOT has participated from the start of the development and demonstration project, not only as a co-funder, but as a fleet demonstration partner, allowing the CIS system to be installed and successfully demonstrated within its fleet of heavy duty, diesel powered trucks, including snow plows and dump trucks. All total, 15 trucks were converted to dual fuel operation with a combination of NYSDOT, NYSERDA, and USDOE Clean Cities funds.

NYSDOT Snow Plow with Dual Fuel System

For additional information contact Frank Ralbovsky Sr. Project Manager - Transportation and Power Systems Research, New York State Energy Research & Development Authority at (518) 862-1090 ext 3260.

SEASONS OF CHANGE IN PAVEMENT DESIGN

The Cornell University Local Roads Program, working with NYSDOT, recently completed the first phase of a research program to develop seasonal models for pavement materials. The models can be used to help implement the new mechanistic-empirical pavement design guide (MEPDG) being developed by the National Cooperative Highway Research Program (NCHRP) and for use with the NYSDOT Comprehensive Pavement Design Manual (CPDM).

For a pavement design model to be effective, it must take into account the spatial and seasonal stochastic (random) variations that exist in real world situations. Also, it must predict the pavement material properties due to seasonal changes (including freezing and thawing) that occur in New York State.

The first phase of the project was exploratory, to set up a framework for the study that could be used in the second phase to complete the model development. In order to provide NYSDOT with the most practical models possible, the experimental plan calls for a large number of Falling Weight Deflectometer (FWD) tests over a single year. In Phase 1, the collected data were used to determine seasonal and spatial variations at four sites in New York State. By analyzing the variables between the sites, a combined model of seasonal pavement variation was developed.

The two primary goals of the project are:

- Using a practical set of evaluation tests; determine a predictive seasonal model of resilient modulus of unbound materials (subbases and subgrades) to be used in pavement design for a limited inference space in New York State.
- Determine a method of approach whereby NYSDOT can develop seasonal models for locations not included in this project while keeping expenses as low as practical.

We were more successful in Phase 1 than we originally thought we would be. As a result, we have developed seasonal models that are applicable to about 60 percent of the land area in the state. Currently, Cornell is working with NYSDOT to develop a second phase of the research to investigate the locations in New York State outside of the initial inference space. We anticipate this will expand the model applicability to 95 percent of the state area.
GIS Maps of Soil and Weather in NYS

In addition to the seasonal models, maps of soil and weather in New York State were prepared using existing data. The maps include information on expected soil types, seasonal lengths, and other information of interest to pavement engineers. These maps are available now in the NYSDOT MAGIS system.

Field Testing

The field testing in Phase 1 took place over a year and included an initial geotechnical investigation by NYSDOT at each of four testing sites. This was followed by up to twenty-four tests with FWDs owned by Cornell or NYSDOT. In all cases, NYSDOT provided the traffic control.
Seasonal Models

The combined seasonal models used various factors for the layers in the pavement and up to five different critical pavement seasons. A **pavement season** is defined as a period of significant difference in the modulus of one or more layers in a pavement. It is important that any pavement design done using a critical seasonal pavement design model must be within the inference space of the model. Due to the limited number of testing sites in Phase 1, the models can only be used in locations with average frost depths between 600 to 1,100 mm (24 to 44 in), low plasticity soils, and good drainage.

Using the Models with the CPDM

Although the primary focus of the seasonal pavement models was on the new MEPDG, the results of the research can be used to determine the subgrade resilient modulus (MR) needed in Table 4-5 of the CPDM. A preliminary spreadsheet to perform the necessary calculations was provided to the NYSDOT Research Bureau, and an updated tool as well as training on the seasonal models, is anticipated as part of the next phase of the project. Phase 2 is currently in the planning stage. It is expected to be completed in about two years.

Finally, while the models can be used with only laboratory index tests for the subbase and subgrade materials, on-site FWD testing improves the reliability of the models and should improve the reliability of the pavement design. Details on how to do this, and on the entire research, are available in the Final Report. Copies of the Phase 1 report *Seasonal Variations of In Situ Materials Properties in New York State* are available from the Cornell Local Roads Program and the NYSDOT Library.

--- submitted by Dr. David Orr and Prof. Lynne Irwin, Cornell University

For further information please contact Makbul Hossain of TR&DB at mhossain@dot.state.ny.us

## TRANSPORTATION RESEARCH AT NYSERDA: DEMONSTRATING ELECTRIC-POWERED TRAILER REFRIGERATION TECHNOLOGY

After an initial feasibility study ([http://www.nyserda.org/publications/ElectricPoweredTrailerRefrigeration.pdf](http://www.nyserda.org/publications/ElectricPoweredTrailerRefrigeration.pdf)), the New York State Energy Research and Development Authority (NYSERDA) is now conducting a one-year demonstration of electric Transport Refrigeration Units (eTRU) at Maines Paper & Food Services in Conklin, NY. With co-funding from the U.S. EPA SmartWay Transport Partnership℠, this first-in-the-nation demonstration project brings together several leaders in the transport industry working cooperatively on Maines’ behalf: Shurepower LLC serving as general contractor; New West Technologies LLC for engineering and consulting services; New York State Electric & Gas Corp. providing three-phase power to the site; Great Dane supplying the trailers, and Carrier Transicold supplying the eTRU technology.

Figure 1. Great Dane Trailer with Carrier eTRU technology

Previously only available in Europe, the Vector 1800MT™ unit is Carrier’s new hybrid diesel electric system for the North American marketplace. It does away with conventional mechanical components such as belts, pulleys and clutches and instead uses electricity from a high performance onboard generator to run the compressor, evaporator and condenser fans, and the heating system. Because the Vector 1800MT unit is electric, it can be plugged into an AC power supply when the trailer is parked, and the diesel motor that drives the generator can be shut down, totally eliminating fuel consumption and emissions from the refrigeration system. A 460-volt power supply and proper connections are all that are required.

Figure 2. Parking lot power pedestal

(Continued on Page 5)
Electric-Powered Trailer Refrigeration, (Continued from Page 4.)

From nine distribution centers Maines supports restaurants, healthcare and educational facilities and other food service customers in 35 contiguous states throughout the Northeast, Mid-Atlantic, Gulf States and the Midwest. The Conklin facility, which is also headquarters for Maines, is a major provider to the cruise ship industry operating out of the ports in Boston, New York, New Jersey and Philadelphia. In Conklin, NYSERDA is upgrading and installing several electrified loading docks and ten electrified parking spaces for the eTRUs as part of this innovative demonstration project. Ten Vector 1800MT™ units are also being added to the Maines fleet, installed on new Great Dane trailers based at the facility.

During a recent Carrier interview, Claude Boisson - vice president of operations for Maines, expressed high expectations for the project. He sees it especially helping with the cruise ship work, which “doesn’t fall into the mold of regular business.” Trailers destined for ocean liners start loading early in the week for weekend delivery to the ports. “There is a lot of attention to detail,” Boisson explained, “double checking and triple checking for accuracy.” And all throughout that time, the trailer refrigeration systems need to run to protect the cargo. Without electrification, that means burning diesel.

For more information, contact Joe Tario at 862-1090 ext 3215 jdt@nyserda.org

WATCHING THE EARTH MOVE FROM THE COMFORT OF YOUR CHAIR: REAL-TIME REMOTE GEOTECHNICAL MONITORING

Geotechnical engineers are routinely tasked with decision making based largely on incomplete information. From a few scattered drill holes, a designer must make assumptions about the extents and properties of non-uniform soil deposits and try to predict how they will respond under the load of a bridge or highway embankment. It comes as no surprise that observations and direct measurement of soil behavior in the field are considered crucial methods of dealing with uncertainty in geotechnical engineering. Two examples of the “observational method” in geotechnical engineering are monitoring embankment settlement using survey stakes, and tracking deep ground slips in a landslide with a slope inclinometer.

Recently, with the help of the Transportation Research and Development Bureau (TR&DB) and Rensselaer Polytechnic Institute (RPI), the Geotechnical Engineering Bureau (GEB) has made a technological leap forward by employing an experimental piece of instrumentation that wirelessly collects measurements of soil movement and acceleration and relays that information back from a remote location via the internet. The ShapeAccelArrayJ (SAA) is a device under development by Measurand Inc. with the assistance of RPI. It is essentially a long chain of rigid 300 mm segments of pipe, connected end-to-end and sealed inside a rubber sheath so that it can only bend at the joints. At every joint are special sensors which are able to collect tilt and acceleration data.

Data from the tilt readings at a joint are used to calculate the relative x, y, and z displacement of the segment above. Displacements are then tallied to display the three dimensional shape of the entire chain. When the device is installed in a flexible casing in a vertical drill hole, it can automatically take readings to track its own profile as it deforms with the ground over time.

The GEB has long used slope inclinometers (SI) to monitor landslides and construction activities in a similar manner. These devices operate on exactly the same principle except that instead of a chain of sensors remaining in the ground there is only one probe which is manually lowered and raised in the drill hole in special grooved casing (see Figure 1, Below). To collect the readings, the engineer lowers the instrument to a known depth and presses a button Which activates the sensor. This is repeated twice, generally every 600 mm along the length of the drill hole. The readings are stored on a portable logging device which is brought back to the office and loaded onto a PC for data reduction and presentation.

(Continued on Page 6.)
The great advantage of the traditional SI is that several sites can be monitored using one relatively inexpensive probe. A disadvantage, however, is that the frequency of monitoring relies upon a trained engineer physically traveling to and from the site. Furthermore, in certain instances (such as on a very active landslide or in a situation where access is limited by traffic or construction activities) collecting the readings could pose a safety concern.

The SAA is able to remotely collect readings anywhere there is cell phone coverage. When the device is activated it will take readings on every sensor 100 times in less than one second. An averaging procedure is then performed to produce a precision within 1 mm.

Readings are stored to an on-site data collector which is connected to a deep-cycle battery with a solar panel trickle charger. Depending on the amount of sunlight at the site and frequency of readings, a single battery can last for over a year. The data is then transmitted to a web server by a cellnet connection where it can be downloaded by the engineer. Currently, GEB is working with the staff at RPI to create a user-friendly website to automatically update and view the data.

Readings can be taken at any frequency: weekly, daily, hourly, or even continuously (for a short period of time). The engineer can change the schedule or take a live reading by accessing the device via the web. There is also a continuously monitored accelerometer which can be set to activate the rest of the sensors if a certain intensity of ground shaking is detected; caused for instance by an earthquake or a sudden large soil movement. This feature can be used to send a message directly to a cell phone, alerting the engineer that the site may need immediate attention.

The TR&DB has purchased two 30 m long SAA’s to evaluate as experimental features. With the help of RPI and Measurand, GEB drillers installed the first SAA in October 2006 at the site of the Clay Hill Road over the Champlain Canal bridge replacement in Fort Ann, Washington County. Contract plans call for the placement of wick drains and surcharge loads to remove settlement prior to beginning construction of the bridge. The first device is located in a drill hole near the canal, in the area in front of where the bridge abutment will eventually be built. Once the surcharge is placed the SAA is expected to detect a phenomenon known as “lateral squeeze” in the soft clay layer. This is a horizontal deformation of the foundation soils caused by the vertical load of the embankment material. Deformation can be tracked along with the magnitude and rate of settlement of the surcharge embankments to ensure that there won’t be any lateral squeeze left to potentially tilt the bridge abutments once they are built. The second SAA will be installed horizontally under the surcharge embankment (perpendicular to the centerline) to directly measure the settlement profile across the full width of the embankment. Conventional instrumentation (SI’s and settlement platforms) will be used for comparison and verification purposes.

The Fort Ann site was primarily chosen for the field demonstration because the magnitudes of movement are predicted to be measurable but not so great that the devices become irretrievable. After construction the SAA’s will be carefully removed from the ground by flushing them out with water. This past summer, GEB drillers developed and successfully tested this procedure on a dummy device to ensure that it could be extracted with minimum tension on the joints. (See Figure 2, Below)

The potential of the SAA is wide ranging. Future uses may include other forms of construction monitoring, emergency landslide monitoring, soil structure interaction monitoring (such as behind integral abutments or retaining walls), and construction vibration monitoring.
Real-Time Remote Geotechnical Monitoring, (Continued from Page 6)

For further information about this project, contact Matthew Barendse at 518-457-4796 or mbar-endse@dot.state.ny.us

Figure 1: Principle of traditional Slope Inclinometer operation (from “Geotechnical Instrumentation for Monitoring Field Performance”, by John Dunnicliff, 1988)

Figure 2: 3-D displacement of the vertical SAA from the first 30 days of monitoring at the Fort Ann site. (Note that the small movements thus far are due to the instrument settling inside of the casing.)
AAA HONORS THOSE WHO MAKE COMMUNITIES SAFE

It takes a community, individuals, and organizations to make our local roads safe for motorists, pedestrians, and bicyclists. In recognition of this fact, AAA New York has been handing out Community Traffic Safety Awards annually for 42 years.

AAA presented its 2006 Platinum Awards for the outstanding effectiveness of engineering, enforcement and education programs to New York City, Nassau County’s Garden City and three Westchester County municipalities: Larchmont, Tuckahoe and White Plains. Safety programs in all five communities contributed to marked reductions in roadway injuries.

The club also presented an Outstanding Achievement Award for an individual to traffic engineer, Joseph G. Pecora, who has chaired the Nassau County Traffic Safety Board for more than a decade and formerly served as commissioner of Nassau’s Department of Public Works, where he implemented the county’s centralized computer traffic safety system.

Recipient of this year’s Outstanding Achievement Award to an organization was the Cornell Local Roads Program. The initiative, funded by Cornell University, the Federal Highway Administration and New York State’s Department of Transportation, promotes safer roads through technical assistance and training given to local highway agencies within the state.

From the left : Lynn Irwin, Lois Chaplin, Marta Genovese, David Orr, Cornell University, Christine Torkildsen, FHWA, Gary Frederick, N.Y. State Department of Transportation.

Are you working on something new and innovative that could be included in the next newsletter?
Please contact Ossama Elrahman or Colin Campbell, Transportation Research and Development, or send us an e-mail at trdb@dot.state.ny.us

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