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TRANSPORTATION

FIXED AUTOMATED SPRAY TECHNOLOGY (FAST) ON ANTHONY HENDAY DRIVE BRIDGE IN EDMONTON

AN INNOVATIVE AND ADVANCED SOLUTION IN WINTER ROAD MAINTENANCE

SUBMITTED BY AECOM CANADA LTD.

THE ONLY WAY TO DISCOVER THE LIMITS OF THE POSSIBLE IS TO GO BEYOND THE IMPOSSIBLE

-Arthur C. Clark, Author

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3. Project Highlights

The Province of Alberta continues to make significant investments in new highway infrastructure to improve mobility and safety. Alberta has installed its first ever Fixed Automated Spray Technology (FAST) on Anthony Henday Drive Bridge over the North Saskatchewan River, Edmonton. The FAST system enables an automated and proactive treatment of the bridge surface before problems related to ice formation and snow covered conditions arise.

The installation of FAST in Edmonton is significant for several reasons:

- Northern Alberta's extremely cold winters and high winds were an important consideration. FAST is more effective at temperatures as cold as -30°C, than traditional salt or sand /grit. FAST is also an anti-icing process, preventing ice from forming rather than a de-icing process which tries to melt the ice after it has formed. Anti-icing uses much less chemical than de-icing.

- This was the first time a bridge was prepared for FAST installation, and then the FAST system installed years after, once traffic volumes increased and Alberta Transportation felt the site warranted installation.

- The system uses potassium acetate, an environmentally friendly chemical, to de-ice the road instead of the traditional road salts or chlorides.

- This was the first time a web enabled FAST / Maintenance Decision Support System (MDSS) enabling user interface was used in Canada, allowing multiple users to access an internet web browser to view detailed performance information collected remotely from the site.

- The system was installed only on the eastbound lanes of the twin bridges over the North Saskatchewan River, allowing the effectiveness of the system to be monitored and assessed against the traditionally maintained westbound bridge.

The FAST system uses advanced sensing instrumentation that continuously (24/7) monitors road and weather conditions. The system sensors identify critical surface conditions "just before" frost or ice forms. When these conditions are about to occur, the on-site computer program activates the hydraulic system which sprays liquid anti-icing chemical onto the road's surface thereby preventing ice formation. The liquid anti-icing chemical used is potassium acetate which has a freeze point of -50° C.

FAST uses advanced winter maintenance technology for self-monitoring, diagnostics, and alerting for the web-based delivery of daily operational information. This information can also provide valuable alerts for other bridges in the area with similar microclimates.

This FAST project is one of the first North American bridges where provisions for FAST components were included at the time the bridge was constructed in 2005. In 2011 Alberta Transportation completed the installation of the full system by adding the sensors, instrumentation, pump house, the hydraulic system and other electronics. This FAST project was also constructed during very difficult winter conditions and within a short period of time (November 2010 to February 2011), where design, review and installation processes had to be modified to ensure that all system functionalities were achieved and were staged to suit weather conditions and the onset of winter conditions and the inherent limitations of a cold climate.

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While the use of this technology is innovative in itself, the true innovation in this project lies in the development of engineering management skills and cooperation of partners to implement a robust, autonomous and cost-effective system that was installed within a tight schedule and during less than optimal weather.

The main benefits of FAST include more consistent conditions and a higher level-of-service to the traveling public during winter conditions. Safety is immediately enhanced by reducing the risk of collision. FAST uses less corrosive and environmentally inert non-chloride de-icing chemicals. The reduction of road patrols and snow plowing represent potential savings in labour and materials.

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Where warranted in construction projects, Alberta Transportation may request safety review studies which can include winter operations risk assessment. These safety review studies involve conducting reviews that focus on winter safety issues and appropriate countermeasures. These studies review the site specific risk potential and then assess the effectiveness of a range of countermeasures to mitigate the winter risks. Recommendations and conclusions are developed and supported by benefit-cost analyses. Until now there has been limited quantifiable data available on the benefits of FAST systems in such cold conditions as experienced in Central /Northern Alberta. This project facilitates acquisition of this important data and operational experience.

The FAST project satisfied the provincial transportation needs identified under two of the four pillars of the Alberta 20 Year Strategic Plan:

1) Unleashing innovation – the system uses advanced winter maintenance technology that enhances and protects the existing infrastructure, one of the province's traditional economic strengths. FAST will better sustain their infrastructure and environment. The implementation of the system also creates economic opportunities for the road maintenance industry sector by making the winter road treatment process more efficient and effective. Finally, it places Alberta among the leaders in advanced winter maintenance; and this experience could potentially be used by other jurisdictions in North America.

2) Making Alberta the Best Place to Live, Work and Visit: This project was completed on time and on budget. The FAST system has been playing a significant role in creating a safer travel environment for commuters, inter-regional and inter-provincial travelers along this vital link between the largest metropolitan urban centre in Alberta and the provincial highway system.

Flush mounted spray nozzle

4. Project Description

4.1 New application of existing techniques originality innovation

- **Creativity that challenges the status quo resulting in a better outcome.**

This FAST system is the first of this kind ever implemented in Alberta, is the coldest climate installation in Canada, and will pave the way for the use of similar installations in Alberta. The system implements proactive road treatment strategies which are more effective and achieve much higher level-of-service at the treated site, than through the utilization of the traditional methods (i.e., treating the roads after ice has formed) and it does so in an environmentally friendly manner.

Implementation of the system promotes new opportunities for FAST industries, and new relationships were formed with North American and European suppliers and trades which fostered the finding of suitable instrumentation and equipment for the FAST system.

New technical specifications were developed specifically for this FAST system to ensure the materials system engineering, and operations and maintenance practices were suitable for the Alberta climate.

Road Weather Information System (RWIS)Tower

Pump house

Pavement sensor

This is the first time in Canada a FAST system was planned for in the design of the bridge. Components were installed on embedded fit ups previously installed with the original bridge construction. This is also the first time in Canada that Boschung's Borrma web, an advanced web-enabled user interface to monitor the system performance, was employed.

The project has been successfully used as a test bed allowing side by side comparison of conditions between the treated east bridge and untreated west bridge. It provides a model for other similar FAST systems in locations such as Fort McMurray. Potential exists for future applications at other "hot spot" bridge sites in the province.

The public, the main stakeholder, received a system which will make travel safer and more efficient at a much reduced environmental impact.

Consulting, construction and government stakeholders learned unique processes needed for the implementation and operation of FAST and similar systems in Alberta. It was the first FAST project managed by the contractor (Graham) and vendor (Boschung America) in Western Canada.

- **A definite advancement in transportation infrastructure (with a focus on safety, roads and bridges) sector practice.**

Bridges have typically presented safety challenges since they are often located near water and are subject to icing conditions earlier than approach roads, even in Alberta's dry climate.

FAST provides automated, "just in time delivery" of advanced anti-icing, 24/7, even at remote locations.

This project needed a partnership between the contractor, consultant, vendor and Alberta Transportation to get the system installed on time and operated successfully. The project provided an opportunity for Alberta Transportation to establish relationships within the industry in Canada and North America in the area of advanced winter maintenance systems.

Potential exists for further utilization of the proactive treatment strategies at other bridge sites using road sensing instrumentation technologies.

FAST experience could potentially be used by Alberta Transportation and Boschung to enhance their products and to develop technical specifications more suited for cold climates (the Alberta system provides empirical assessment of the FAST performance in very low temperatures). The project helps develop knowledge in the industry and encourages other Contractors to bid on similar work in the future.

Spray covering eastbound lanes

4.2 Complexity

FAST Systems involve a hydraulic subsystem, automated remote monitoring of pavement and atmospheric conditions, prediction of freeze points for moisture on the driving surfaces, remote electronic monitoring, wireless communications and archiving of remote data, to automate, and replicate process and activities which traditionally have only been undertaken by skilled personnel with years of winter maintenance experience. The system uses biodegradable, liquid anti-icing chemicals applied at temperatures much colder than traditional de-icing chemicals are effective. Chemicals are applied, and their effectiveness monitored every 15 minutes, 24 hours a day, each day and reapplied as necessary. The system not only monitors and archives its activities, climatic and atmospheric conditions, and video images but it also issues email alerts of its activities, which can be extrapolated to other bridges in the vicinity.

Alberta provides a unique setting for trial of this technology given its particularly cold temperatures, and extensive use of sand and other abrasives on the bridge and approaches.

This was the first time a bridge was prepared for FAST installation and then the FAST system installed years after once the traffic volumes increased and Alberta Transportation felt the site warranted installation. This situation added to the complexity of the project, because there was no previous experience or lessons learned to draw from, and there were no established standards.

4.3 Environmental Impact

Although road salt has proven to be the most cost effective highway de-icing chemical, Environment Canada has expressed significant concerns over its use and the use of other similar chlorides-based de-icing chemicals because of their harm to the environment. The Anthony Henday FAST system uses potassium acetate as a liquid anti-icing chemical instead of the traditional road salt or chlorides. Potassium acetate does not corrode concrete or steel and it's not a chloride.

It is biodegradable and essentially dissipates in two weeks. Chlorides, once introduced to the environment, cannot be effectively removed.

- **Meets or exceeds safety requirements.**

The system has the ability to monitor itself with the advanced software and alerting system, has minimum intrusion with traffic and built-in protection provisions (lock-in mechanisms and a confinement area in the event of chemical spills). The system program also limits the frequency of spraying to prevent over-use of the chemical.

- **Meets or exceeds environmental requirements.**

The project went through a rigorous environmental assessment before obtaining approval to proceed. The system is more efficient and effective than traditional maintenance operations, because less chemical is applied to the road with lesser impact on water sources. Also, the chemical has been tested to be non toxic to the environment/wildlife or humans, whereas chlorides are considered toxic to environment and wildlife.

4.4 Social + Economic Benefits

Anti icing prevents ice formation

- **Demonstrated value to the people of Alberta, and visitors to the province**.

The system has successfully operated during two winter seasons (2010 to 2012) with consistent "ice free" surface. The expectation is that the investment will be repaid within the next 5-10 years by ensuring a low collision risk environment and high level-of-service, as well as the efficient use of road treatment materials and maintenance forces. These outcomes and benefits represent a qualitative improvement, reduction of risks to all bridge users, cost and time savings.

The FAST system will result in long term societal benefits in terms of reduction of collision costs (expected 80-100% collision reduction per year in comparison with other similar bridge sites), reduced congestion and delays on the bridge resulting in improved economics of passenger and commercial travels (cost and time savings, qualitative improvement).

Final spray disk adjustments

The system uses a low corrosion and environmentally friendly chemical (potassium acetate) instead of traditional chlorides or salt. The chemical frequency usage and volumes are optimized which ensures high cost-effectiveness, and qualitative improvement.The AHD installation on the eastbound North Saskatchewan Bridge provides an opportunity for Alberta Transportation to test a new automated anti-icing technology. The technology has

4.5 Meeting + Exceeding Owner's/ Client's Needs

been proven to reduce ice build-ups, improve driving conditions, and increase safety for motorists. Pending the results of the testing the technology will be considered for use on the westbound lanes. The testing results will also be evaluated to see if the technology may be suitable for elsewhere in the province.

Pump house

This was the first time the automated anti-icing technology will be used in Alberta. The installation of the anti icing system was completed on time and on budget even though the installation followed a compressed schedule. The installation time line was important as the Province of Alberta wanted to be able to compare the statistics of previous winters to the winter of 2011, to determine effectiveness of the FAST system and begin planning for other potential installations at locations further north in the province.

Spray disk alignment

Previous winter warrant review studies in Alberta have recommended fixed automated anti-icing spray technology at other high risk locations, but were based on benefit/ cost analysis that extrapolated findings from other locations in Canada. However until the completion of this project, the question remained if the FAST system, although previously installed in warmer clients, could be designed, supplied, installed, operated and would perform effectively in Alberta's northern environment.

Road side pressure tank and valve

Preliminary findings from the first two seasons of operation have confirmed the system has performed as intended. For example, the system effectively applied the anti-icing chemical over 300 times during the winter of 2011- 2012, a much higher frequency than would be possible with manual monitoring and treatment. The cost to install and operate the system over the study period was $2.3 million dollars. The preliminary findings show an improvement in winter driving conditions during potentially icing conditions. This improves the safety and mobility of the traveling public and commercial carriers while at the same time minimizing environmental impact.