

TSB NEWSLETTER

TECHNICAL STANDARDS BRANCH

VOLUME 2, ISSUE 2, JUNE 2003

GEO-CELLS – A FIRST FOR ALBERTA TRANSPORTATION

Fred Cheng

Background

The Drumheller area is part of the Badlands of south-eastern Alberta and is characterized by an arid to semi-arid climate. Vegetation cover is sparse or completely absent. The area geology consists of relatively weak bedrock of the Oldman Formation, of Late Cretaceous age, and consists of alternating layers of non-marine sandstones and shales, with coal seams and occasional scattered dinosaur fossils. Large rivers, such as the Red Deer River, have cut deeply into the bedrock leaving steep valley walls. The exposed bedrock is visible as horizontal bands of different color and texture which dominate the landscape. Rainfall is infrequent but can be intense, which results in severe erosion conditions which are unique to the region. Deep erosion channels, scour and sink holes can be readily seen along highway ditches.

In the past, eroded ditches and gullies have been repaired using a range of techniques. Erosion control matting, rock ditch checks, straw bales, gully filling, and even extending guardrails to prevent vehicles running into the gullies, have been used to combat erosion problems. The results have been poor or only achieve temporary success. The conventional philosophy is to establish a vegetation cover to protect the soil from erosion. However, this is not possible due to arid conditions. The maintenance process of in-filling erosion gullies is repeated often annually which quickly exhausts the maintenance budget. A more robust and permanent solution is required to provide a long lasting erosion control.

In recent years, several ambitious remediations have been completed along highway ditches in the Drumheller area (Highways 27, 56 and 9). These included construction of gabion-lined channels, drop structures and burying 150 mm polyethylene pipe at some ditch sections. So far these repairs have been successful, but with a big price tag.

Cellular Confinement System

A suitable erosion control measure that was considered to be a cost-effective alternative to gabions is the Cellular Confinement System (with proprietary names such as Geoweb, GeoCel and Geo Cell). This is especially cost-effective in areas where rocks are rare and the cost of transporting and placing the rocks is expensive. The geo-webs or geo-cells are manufactured from high density polyethylene (HDPE) panels that are UV stable and chemically inert. Once laid, expanded in the ditch, and pinned in place, gravel can be filled into the cells and smoothed. Geo-cells are manufactured by a number of manufacturers, with varying depths (typically 10 cm, 15 cm and 20 cm). The web joints are thermally bonded and once gravel has filled the cells, the whole mattress forms a robust mat unit that can resist heavy runoff erosion. For approximate comparative purposes, the cost of geo-cell installation is \$25 per m² versus gabions installation of \$50 per m². The geo-cell cost advantage can be even more significant if gabion rock is not readily available near the project site.

Construction on Highway 837:02 and Highway 841:02

Two major erosion problem sites were identified by Klohn-Crippen Engineering during their annual inspection of geo-technical hazard sites in the summer of 2001. These two sites, along Highway 837:02 and Highway 841:02 presented serious environmental and safety concerns.

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Subterranean erosion channel is formed below the east ditch in Highway 837:02



Deep erosion gully is formed on the west ditch in Highway 841:02



Geo Cell (brown gravel) channel

Rather than in-filling the erosion gullies as done several times previously, an erosion control design was requested from the consultant. The consultant presented several alternatives, including geo-cell and gabion-lined channels. At Alberta Transportation's request it was decided to pursue the geo-cell alternative at a trial site since the department had no experience with geo-cell technology. If geo-cells turn out to be a successful alternative to gabion channels, the department can install it in other locations with confidence.

Ledcor, the maintenance contractor for the Drumheller area installed the geo-cell in October, 2002, under the supervision of department operations personnel. Construction was quite straightforward. First, the gullies were in-filled, the channels shaped and graded to the design grade and width. Geotextile was laid, the geo-cell extended over the geotextile, and pinned into the channel bed. Gravel was then placed into the geo-cell open matrix, and levelled. Check weirs constructed of gabions were also installed along steeper portions in order that runoff velocity would be further reduced. Gabion baskets and ripraps were also placed at the inlets and outlets of culvert pipes to reduce scouring.



Geo-Cell webs stretched and laid on geotextile



Geo-Cell – filled with gravel and sand and levelled

The following table summarizes potential cost savings in the maintenance of the ditches in these two highway sections before and after geo-cell construction. Based on these values, the Geo-Cell technology could pay for itself, through maintenance cost savings, in about four years.

Location	1999	2000	2001	2002 (geo-cell construction)
Highway 837:02	700 m ³ fill	300 m ³ fill	-	\$22,578
Highway 841:02	-	300 m ³ fill	-	\$39,900
Annual cost to place fill in both locations	\$17,074	\$11,652	Nil ^{Note}	\$62,478

Note: No major maintenance work was done in 2001. Reviewing consultant's recommendation and geo-cell design.

The results and performance of the geo-cells are not yet known but will be closely monitored and evaluated by Central Region staff.

Special thanks are extended to Nelson Chipiuk, MCI, Hanna District for providing some photographs and summary of annual maintenance and Geo-Cell construction costs, and Melvin Mayfield for reviewing the article.

If there is any question regarding this article please contact Fred Cheng at (780) 415-1039.

Reference

- Nilex site <http://www.nilex.com/proderos.html>
- Layfield Plastics site http://www.layfieldplastics.com/index_lpi.cfm

A 511 CRASH COURSE

Allan Lo

What does 511 signify and how is it related to transportation? In July 2000, the US Federal Commission of Communications (FCC) authorized the assignment of 511 for nationwide telephone access to traveller services. It was born out of a US Intelligent Transportation System (ITS) initiative to offer the public easier access to the local travel information network including the latest traffic/travel information. There are currently about eight states that have implemented this program state-wide, with another 14 states on the verge of doing the same. The US goal is to blanket their country by 2005 (and in the process, replaces about 300 unique ten-digit traveller telephone numbers), and the use of 511 for traveller information will be as ubiquitous as 911 is for emergency uses. A key distinction between 511 and 911 is there are no "live" operators on the 511 end. More details can be found at <http://www.its.dot.gov/511/511.htm>.

One excellent example of a 511 deployment was showcased during the Winter Olympics 2002 in Salt Lake City. The Utah Department of Transportation used services from a voice portal vendor who deployed a VoiceXML (a voice-actuated extension of the hypertext markup language or HTML) interface to deliver voice information based on updated text and graphic information from the department's web site. Callers anywhere in the state could use the system to get real-time information on traffic, incidents, road closures, construction activities, weather advisories and expected delays. During the Olympics, event schedules and venue information were also made available, as well as public transportation information, and tips to avoid traffic congestion.

The US national coordination program is spearheaded by the 511 Deployment Coalition, made up of the American Association of Highway and Transportation Officials (AASHTO), the US Department of Transportation, the American Public Transit Association (APTA), and ITS America. The Coalition has also developed the *Implementation Guidelines for Launching 511 Services* to help standardize and instill consistency in the message contents, voice usage and menu navigation.

Although there are federal grants to help agencies to convert their systems to a 511 system, it is still up to the local agencies to shoulder all capital and operating costs.

The type of communication technology and protocols to be used, whether it is landline based or wireless, are important factors. One suggested business model is that each 511 call costs no more than a local telephone call. The FCC mandate leaves it flexible for the local agencies to decide on cost-free (for the callers) or cost-recovery models and other potential public/private partnerships.

ITS Canada is about to launch a nation-wide effort to petition the Canadian government to implement a similar 511 system for the same purpose. To that end, a Canadian 511 Consortium will be formed using the US 511 Coalition as a model, and it intends to make a formal application to the Canadian Radio-television and Telecommunication Commission (CRTC) when it is ready. This Consortium to be composed of members from the private and public sectors is expected to be up and running by fall 2003.

You may ask if there is a 911 and a 511, what about the other numbers in-between? All other N11 numbers are already in use or reserved for future uses in the US:

- 211 – reserved for community information and referral services
- 311 – reserved for non-emergency police and other government services
- 411 – directory assistance (you knew that!)
- 611 – local exchange carrier repair office
- 711 – telecommunications relay services for deaf, hard-of-hearing or with speech disabilities
- 811 – local exchange carrier business office

The 311 service has not started pending a five-year review of the 511 service. There is also another initiative called the E911 (Enhanced 911) or WE911 (Wireless Enhanced 911) which requires a Global Positioning System-like (GPS) locator capability in cellular phones. Unlike landlines, cellular phones generally do not provide a caller ID or geographical reference for the 911 operator to identify and locate. Further information on E911 is available at <http://www.itspublicsafety.net/>. The WE911 can also be linked to the so-called Mayday services such as the GM's OnStar or Mercedes-Benz's Telematics monitoring service. A "smart car" can literally initiate an emergency call when it detects a collision has occurred and the driver is incapacitated. Through either the car's built-in GPS system or the cell phone's own locator system, the operator receiving the call can immediately locate the caller and send out an appropriate emergency response.

LAMONT TEST ROAD 10 YEARS AFTER PLUS ONE Marta Juhasz and Jim Gavin

In 1991, Alberta Transportation constructed the Lamont Test Road (Highway 637:02, km 20.0 – 32.8) as part of the Canadian Strategic Highway Research Program (C-SHRP). The objective was to evaluate the low temperature transverse cracking performance of seven asphalts. Asphalt penetrations varied (80-100 to 300-400) and temperature susceptibility grade (an “A” grade is less susceptible to temperature extremes than either a “B” or “C” grade). Additionally, two of the test sections used asphalt that was “air blown”, a process meant to improve temperature susceptibility characteristics.

Eleven years of monitoring confirm that softer and less temperature susceptible grades result in pavements with less transverse cracking. Similarly, the 80-100 air blown asphalt shows a modest reduction in transverse cracking in comparison to the standard 80-100 asphalt. However, the air blown asphalt pavements are performing poorly with regards to aggregate loss and isolated areas of raveling.

In Alberta, 150-200A asphalt is used on heavily travelled highways while 200-300A asphalt is used on lower volume roadways. The 300-400A grade is used on some very low volume northern highways as rutting is less likely to occur. The Technical Standards Branch continues to explore new asphalt cements, including modified Performance Grade (PG) asphalt, which provides better low temperature performance.



80-100A air blown, 102 cracks/km



80 – 100B air blown, 146 cracks/km



150-200A 33 cracks/km



150-200B 183 cracks/km



200-300A 10 cracks/km



300-400A 1 crack/km

REHABILITATING OIL BOUND ROADS

Glen Murray

In the Lethbridge District there are over 160 km of gravel highways which have been “oiled” to eliminate dusty conditions. Proper maintenance of these oil bound highways is vital to the safety of the travelling public. When these roads were under the jurisdictions of the Counties and Municipal Districts, they had their own programs and techniques of rehabilitating these roads. A common method is to use a distributor truck to apply the oil and then using graders to mix the oil and gravel to produce a quality-driving surface. Oiling roads is relatively new for Alberta Transportation and finding qualified personnel with this know-how is a challenge.

In the late summer of 2002, Volker Stevin Contracting attempted a new technique to rehabilitate oiled roads. An eleven-kilometre section of highway 506:02 had an oiled surface that was breaking up extensively in several places. As a result of this developing safety hazard, the speed limit had to be reduced. The maintenance plan was to salvage the existing oil and gravel by adding and mixing in new oil and gravel to re-establish a dust free oiled surface. It was recognized that time and money would be saved if the process of breaking up the road and adding/mixing new oil and gravel could be made in one pass.

To accomplish this multi-task capability, the contractor used a pulverizer machine called the Reclaimer/Stabilizer. A lift of gravel was spread on the existing road surface, and then the pulverizer was used to mix the gravel with the road surface while applying the new oil. The mixed material was then compacted using a rubber tire roller. The intent was to create a durable cold-mix-like surface.



Pulverizer pushing oil tanker on first pass



Mixed gravel/road surface after first pass of pulverizer



The pulveriser and the grader mixing and laying out the material

Several problems were encountered. The first major setback was not being able to monitor the amount of oil being added to the mixture. The intention was to add only two to three percent oil content but the resultant mixture had over five percent (MC-250¹ was used). The monitoring device on the pulverizer was inaccurate and fluctuated depending on the speed of the machine. As a quick fix, the so-called “snowball” test (squeeze a handful of oily gravel - if it barely sticks together, then the oil content is about right) was used and appeared to work satisfactorily. For future work, it is highly recommended to install a calibrated pump system on the pulverizer.

The second problem that plagued the project was the condition of the existing road. In some places there was ten to fifteen cm of gravel and in others the clay subgrade was right at the surface. The variability resulted in clay being added inadvertently to the oil and gravel mix, and creating a finished road surface with clay lumps dispersed throughout. This problem could have been avoided through better knowledge of the existing road, a surface evaluation beforehand and closer monitoring of the pulverizing.

The third problem was inclement weather. When the road was most vulnerable, rain would set in, turning one kilometer of broken-up road into an oily mud bog.

¹ MC-250 refers to a type of medium-curing asphalt

Needless to say, complaints flooded the district office for a period of time. Barricades, flashing beacons, and flagpersons were deployed to direct traffic. It took several days for the material and the subgrade to dry completely. Any future rehabilitation should be planned earlier in the summer and greater attention should be paid to the weather forecast.

A final major problem was inadequate compaction of the road surface. A few months after the job, the driving lanes were rutted with evidence of shoving. These failures were attributed to poor compaction. So another challenge for the future is how to test compaction on an oil bound road when conventional testing methods do not apply - oiled roads can't be cored and there is not enough material for proper nuclear densometer readings.

To sum it up, some valuable lessons were gained through this experiment and the experiences will go a long way to help with the next trial!

HOW TRUCK WEIGH SCALES WORK

Ron Stoski

Truck scales are built out of steel and concrete to handle an enormous amount of weight throughout the year.



Some truck scales are designed to handle gross weights of 72,000 kg (60,000 lb). Common systems use load-cell, bending-plate, or piezoelectric technology.

Load-cell systems are the most popular. Each cell is comprised of a durable material such as steel or concrete with one or more strain gauges attached to or embedded in it. A strain gauge consists of a wire (or wires) that transmits an electric current. As the cell is subjected to weight, the wire in the strain gauge is altered or compressed slightly. The change in the wire results in a difference in the resistance to the current passing through it. The signal from each cell is sent to a junction box, where sensors measure the variance in the current

and calculate the amount of weight the scale is supporting. The strain gauges in load cells can be either compression or tension based. A compression strain gauge is based on how much the cell compresses when pressure is applied, while a tension strain gauge is based on the slight change in shape of the cell caused by the weight.

A bending-plate system uses metal plates with strain gauges attached to the plates. As weight is applied to the scale, the strain gauge on each plate measures the amount of stress and calculates the load required to cause it. The amounts from each gauge are added together to get the total for that axle.

Piezoelectric systems use a series of piezoelectric sensors. The sensors are embedded in a conducting material. When weight is applied, the pressure changes the voltage of the electrical charge flowing through the conductor. The sensors measure the change in voltage and calculate the load. The amounts from each sensor are added together.

In addition to the different scales used, there are at least three methods of getting the total weight of a truck:

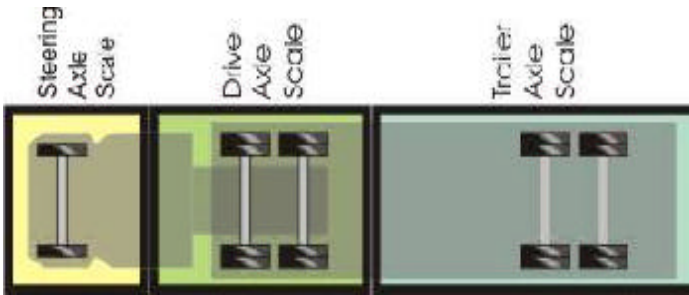
- One-axle - The most cumbersome method, a truck drives across a single scale, stopping each time a set of wheels is on the scale. Once all the axles have been weighed, the total is added together.
- One-stop - A series of scales are used so that the entire truck can be weighed at once. The scales are typically connected to a single electronic controller that automatically combines the axle weights to get the gross weight.
- Weigh-in-motion (WIM) - A method that is gaining momentum, WIM uses a series of embedded sensors to calculate the weight per axle as a truck drives over the sensor pad. Unlike the other two methods, there is no need for the truck to come to a complete stop while on the scales. In fact, many WIM systems are installed in highways so that all traffic is monitored at highway speed.

Maximum allowed weights vary from province to state. The current legal weights in Alberta are based on:

- Axle weight - the weight carried by each axle
- Gross Vehicle Weight (GVW) - the combined weight of all axles

Maximum Legal Weights in Alberta:

Steering Axle:: 7,300 kg
Tandem Axles: 17,000 kg
Tridem Axles: 23,000 kg
GVW: not to exceed 65,000 kg



Many provincial and state trucking taxes are based on the weight of transported goods. Truck weigh stations are used for tax purposes and to monitor the weight of a truck to ensure that it falls within the safety guidelines each state and province has in place for its highway system.

Source: www.howstuffworks.com/question626.htm

ALBERTA TRANSPORTATION WEIGH-IN-MOTION Peter Kilburn

A weigh-in-motion monitor or WIM is a traffic monitoring device that records the load a vehicle applies to a travel surface. These sensors in the road surface detect the pressure exerted as the vehicles tires pass over them and the WIM devices record axle by axle weights and store them in vehicle by vehicle files.

Alberta Transportation operates two weigh-in-motion (WIM) monitoring sites. Both are equipped with dual piezoelectric sensors.

Both sites were installed in September 1999 to collect vehicle load data for Alberta's "Strategic Highway Research Program Long Term Pavement Performance" (SHRP LTPP) Test Sites.

The first WIM site near Edson, Alberta is located on Highway 16, Control Section 06 at kilometre 38.6 in the westbound right lane near SHRP LTPP Special Pavement Study (SPS -5) test site 81-0500.

The second WIM site near Fort MacLeod Alberta is located on Highway 3, Control Section 08 at

kilometre 13.0 in the eastbound right lane near SHRP LTPP Special Pavement Study (SPS-9) test site 81-A900.

Calibration of the WIM monitors indicate that they measure speed and vehicle type correctly but do not measure vehicle weights accurately enough to be used for enforcement purposes.



Installing Piezo Sensor into Slot
Edson WIM Site 1999.09.16



Completed Installation
Edson WIM Site 1999.09.16

The Edson site recorded 953,516 events for the period of January 1, 2001 to December 31, 2001 of which 924,895 or 97.00 percent were correctly classified and weighed.

- This translates into an average annual daily traffic (AADT) volume of 2614 for the westbound right lane.
- Trucks and buses comprise 36.47 percent of the traffic.
- The daily Equivalent Single Axle Loading (ESAL) on the westbound right lane was 1573.
- The average Equivalent Single Axle Loading (ESAL) was 1.65 per heavy vehicle.
- Of the 2,767,198 axles weighed in 2000 77,261 or 2.79 percent were overweight.

- Of the 924,895 vehicles recorded, 96,294 or 10.41 percent were travelling faster than 120 kilometres per hour
- On average 11 Long Combination Vehicles (LCV's) exceeding 25 metres in length were recorded each day.

The Fort MacLeod WIM site recorded 945,445 events for the period of January 1, 2001 to December 31, 2001 of which 930,569 or 98.43 percent were correctly classified and weighed.

This translates into an average annual daily traffic (AADT) volume of 2591 for the westbound right lane.

- Trucks and buses comprise 21.69 percent of the traffic.
- The daily Equivalent Single Axle Loading (ESAL) on the westbound right lane was 888.
- The average Equivalent Single Axle Loading (ESAL) was 1.58 per heavy vehicle.
- Of the 2,321,990 axles weighed in 2000 46,102 or 1.99 percent were overweight.
- Of the 930,569 vehicles recorded 133,946 or 14.39 percent were travelling faster than 120 kilometres per hour.
- Daily 21 Long Combination Vehicles (LCV's) exceeding 25 metres in length were recorded.

MOBILE DATA COLLECTION

Eric Solomonson

Alberta Transportation's spatial and inventory data is the lifeblood for the department's many functions. Without data, department staff cannot evaluate the performance of the road surfaces; consultants cannot design pavement overlays, or determine when roadways should be rebuilt because they do not meet geometric standards. Without highway videologs, a field trip would be necessary every time staff needed to conduct visual evaluations of highway locations. In fact, many department applications such as the Transportation Infrastructure Management Systems (TIMS), the Roadway Maintenance and Rehabilitation Application (RoMaRa), and the Collision Location Identification System, simply cannot exist.

Recognizing the importance of collecting this data efficiently, the department had long ago implemented a mobile data collection system. In the mid-seventies, the department was one of the first North American jurisdictions to design and build a videolog van

dedicated to collect highway inventory data, as well as purchasing an Automated Road Analyzer (ARAN) to collect pavement data. In the early nineties, the department upgraded the videolog van significantly by integrating it with the Global Positioning System (GPS) to increase the position data accuracy.

Following the latest evolution in mobile inventory technology, the Highway Geomatics and Highway Asset Management Sections recently let a tender for a new digital platform that will combine both videolog and pavement inventory gathering in one vehicle pass. In other words, the new system will capture International Roughness Index (IRI), rut depth, videologs of appurtenances, GPS coordinates and highway geometrics (horizontal and vertical curves, superelevation and gradelines) using one vehicle that drives over the road once.

The final product is to be able to derive position accuracy for all the highways to within ± 1.5 metres. All data including high-definition video images will be stored in digital format so that they can be randomly accessed through a commonly available medium such as the digital versatile disc (DVD) and eventually distributed via the network to staff who needs this information for their daily work. Another value-added function is the ability to measure objects accurately (lane widths, signs, markings, guardrails, etc.) from within the digital images.

EBA Engineering Consultants (Edmonton) and Roadware Inc. from Ontario were each awarded a three-year contract to operate their vehicles and deliver the video, pavement and geometric data for the 62,000 lane kilometres that make up the Provincial Highway System. EBA was contracted to deliver the western half of the province's roads and Roadware the eastern half. Collection is to commence June 1 of each year of the contract, and must be completed by October 15.



A brief description of the technologies involved:

- High-resolution 1300x1030 pixels x 12 bit CCD camera captures a picture every eight metres at 80 km/h (almost four terabytes of image data will be collected in one year, which equates to about eight million jpeg images)
- High-precision real-time differential Trimble GPS receivers
- Satellite-based differential GPS corrections that are transmitted on-the-fly
- The [Applanix POS-LV](#) is an ex-military grade guidance system that integrates fibre-optic gyroscopes, silicon accelerometers, distance measurement indicators (DMI) and GPS measurements to produce accurate computation of the geometric data
- Curve radius will be accurate within $\pm 5\%$ of the true radius, and within ± 10 metres of its true start/end location; tangent deltas will be calculated with $\pm 1^\circ$; crown slope and superelevation within $\pm .01\text{mm/mm}$; grades within $\pm 1\%$ of actual value
- IRI and rut data are collected by a bar containing either laser (laser beams can scan the road surface 32,000 times/s) or ultrasonic sensors
- [Géo-3D's Trident-3D Analyst](#) software from Quebec will be used to view videologs and perform measurements off the images; a "light" version will be used strictly for viewing purposes
- Data can be stored in Microsoft ACCESS, GIS maps, or eventually in ORACLE formats

At the start of the survey, each vendor must traverse calibration sites and pass stringent error tolerances for IRI/RUT and geometric measurements. The IRI/RUT calibration sites have been measured using the Dipstick, and the signs and painted lines have been measured using conventional GPS surveys. For quality assurance, verification sites also measured by conventional means have been scattered around the province, and the vendors must traverse these sites once every seven days, or 2,000 kilometres, and then send the results to the department within 24 hours. If the data is not within the specified tolerance, collection must stop and the vendor must recalibrate equipment or find the error source. As well, department staff will review all data that is captured, to ensure that it meets specifications.

The imagery data will be stored on one master set of DVDs at the head office with duplicate copies to be stored at the regional offices. Funding to acquire on-line storage has also been requested, but has not yet been approved.

What is in store for future versions of mobile data acquisition? One interesting possibility is automated surface distress detection and collection. During the request for information, the department reviewed various hardware and software techniques that claim to automatically recognize pavement cracking, raveling and other distresses. It was the reviewers' opinion that this technology has not matured enough for consistency and reliability, and that it has long-term data storage implications that cannot be addressed at this time.

If you have an interesting technical article or know of an interesting project that you would like to share, we will be happy to hear about your ideas and newsletter-related comments.

Allan Lo	(780) 415 1021
Nur Versi	(780) 415 1005
Ron Stoski	(780) 415 1020
Terry Willis	(780) 427 7761
Allan Kwan	(780) 427 8990