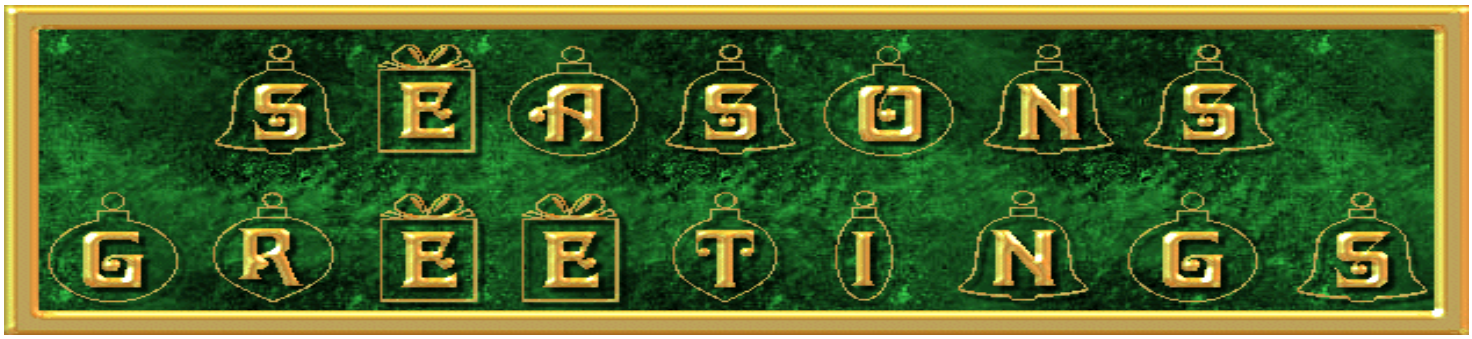
TSB NEWSLETTER

TECHNICAL STANDARDS BRANCH VOLUME 4, ISSUE 2, DECEMBER 2005



Editor's Remarks

The December Newsletter contains articles on Snow Plow Lights, Rutted Intersection Treatments, Illumination on Provincial Highways, the Bio-engineering and Bio-technical Streambank Stabilization Techniques Workshop, and Technical Training Courses.

All of us in TSB look forward to working with all of you in the New Year.

More importantly, this newsletter contains wishes for a Happy Holiday Season.

This is also the time of year when most of mankind comes together to give thanks in a special way to those who are dear to us. In the next weeks, remember to take some time to spend and enjoy with the special people in your life.

May the coming year be filled with good health, prosperity, and peace for you and your loved ones.

Allan Kwan
Editor-in-Chief

Nur Versi..... Peter Ing
Roger Skirrow.....Ron Stoski
Associate Editors

IN THIS ISSUE

Snow Plow Trucks
- To Strobe or Not to Strobe -

Peter Ing
Geotechnical and Materials

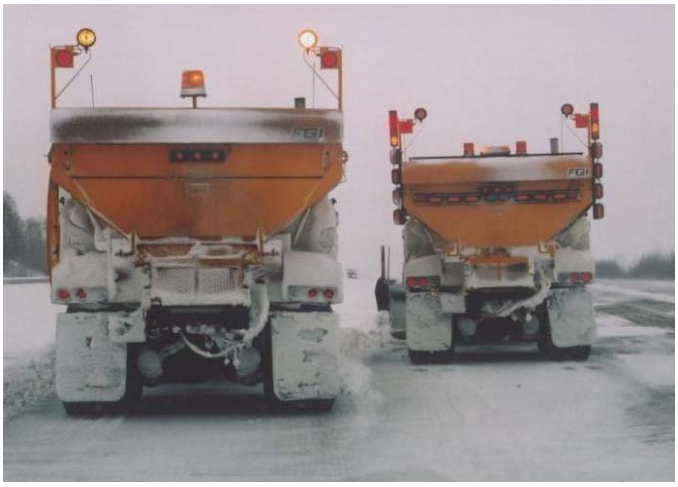
New Technologies

How effective is the new strobe light compared to the existing revolving lights?…...That is just one of the many questions answered by the research study conducted last winter on the snowplow lighting systems. For as long as the snowplow has been in operation, safety has always been a concern for the motorists sharing the highways. Enhancing and improving visibility of the plow truck is one of the many ways to improve safety for all drivers.

Many advances in the lighting technologies have been made since the last review of snowplow lighting and operations. The advances include the numerous types of lights available as well as the materials used to construct the lights themselves. One of the biggest driving forces for the lighting review is the advent of Light Emitting Diodes (LED) and its rapid improvements over the recent years. Also the maintenance contractors have requested approval to use LED lights as the literature researches have indicated many advantages and safety implications with the use of these types of lights. The most obvious benefits being the high intensity, long life (up to 20 times the traditional incandescent bulbs), extremely durable and require less power to operate. The obvious disadvantage is the initial high cost of LED lights. However, the actual lifetime cost is less than the incandescent lights because of its long life and durability. In fact, the downtime cost for replacing conventional burn-out bulbs would more than offset the initial higher cost of LED lights.

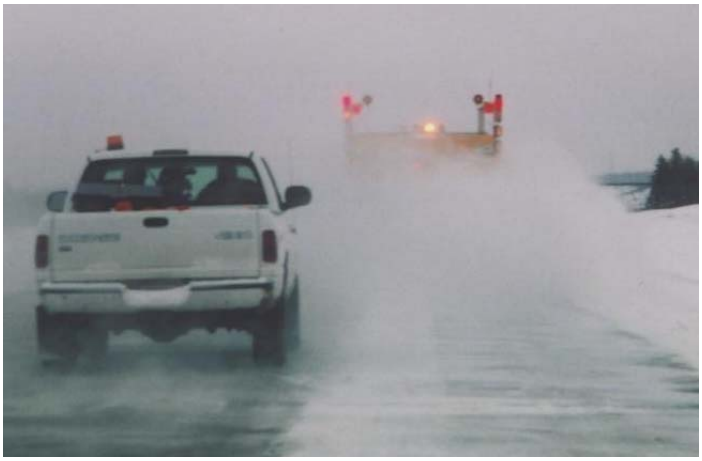
Field Trials

It has been more than ten years since our specification update and review of lighting on the snowplow trucks. More than ten different lighting configurations were field tested in day time and night time snow storm conditions. One of the biggest challenges was to provide a light source that would enhance the visibility of the plow truck in daylight conditions without being overpowering (blinding glare) at night and not put a strain on the power source. The field trials were recorded by Cine-video and edited to a summation of 30 minutes. It was clear that the LED lights provided much more intensity but use less power and hence less draw on the vehicle's power supply. As for strobe versus revolving lights, the clear winner is the revolving lights. It definitely provided a greater visual effect and the perception of distance from the snowplow truck for the approaching drivers.



Panel Review

After the field trials, a panel review was conducted with many stakeholders to disseminate the results of the tests. The stakeholders included representatives from AMA, RCMP, AIT and the trucking industries. The responses and comments were very positive. Some very good suggestions and feedback were recorded for future considerations. Comments included their own experiences and generally some of the hazards they have encountered on their day to day travels.



Results and Recommendations

The results and conclusions of the trial have been documented in a summary report. A video cd has been compiled to summarize and show actual visibility of the various lighting configurations during the field trial. Anyone interested in reading or viewing the video can request to get a copy on loan.

Photo: Compliments of Alliant Engineering

The existing snowplow specification governing the types of lights and configurations will be updated to reflect the findings from this research. Snowplow trucks will start to phase in recommended changes this coming winter. You will no doubt see an improvement in the enhanced visibility of the snowplow trucks thanks primarily to the innovative lighting technology.

So remember when you are cruising on Alberta's highway this winter, **"amber and red"** means snowplow ahead. **Please approach the snowplow with care and help our operators make our roads safer for all drivers**.

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Learn to Live
And
Live to Learn

Rutted Intersection Treatment – Highway 37

Marta Juhasz
Surface Engineering and Aggregates

In general, the department's pavement surfacing strategies have not looked at specialized intersection treatments to prevent rutting. Yet there are numerous intersections where, due to heavy truck traffic and stop conditions, the pavements are rutting well before the next pavement rehabilitation is programmed. Two intersections in the Stony Plain district along Highway 37, at Highways 15 and 44 were experiencing this. Table 1 provides the as-measured rut depth information (4' straight edge) at 37 and 15. Rut depths of up to 37 mm were measured at the intersection of 37 and 44, with on average 10 – 25 mm of rutting extending 80 to 90 m from the intersection.

A traffic analysis at 37 and 15 showed that the 20 year design ESALs are $6.7 \times 10^{6.}$ At 37 and 44, with up to 23% truck traffic due to nearby gravel pits, the 20 year design ESALs are up to 9.4×10^{6}. Based on the department's pavement design manual, both intersections should be treated with a mix type H2 using 150-200A asphalt cement. However, since the existing overlays at these intersections had lasted 6 years on average, it was determined that a more specialized mill and inlay[1] treatment would be needed to prevent premature rutting.

Table 1
Hwy 37 EB left turn lane at Hwy 15

Distance from STOP Line (m)	Inner Wheel path (mm)	Outer Wheel path (mm)
0	22	17
10	25	33
20	23	34
30	23	24
40	17	23
50	14	18
60	14	18
70	10	14
80	10	12

[1] From the pavement management system, existing pavements depths were determined to be 250 mm or more, which provided adequate depth to some deeper milling and inlaying.

Photo 1 - Rutting at Jct. of Highway 37 and 44.

A number of options exist for specialized intersection treatments: use of harder asphalt cement; used of polymer modified asphalt cement meant specifically for these types of intersections; use of larger top size aggregate and/or higher fracture counts; use of speciality mixes such a stone mastic asphalt (SMA); use of concrete. However, in reality, delivering such specialized treatments under the maintenance contracts can be complex. Operations personnel are often limited by budgets, the lack of expertise of maintenance contractors and difficulty in obtaining speciality mixes, particularly in small quantities such as the 300 tonnes needed for this project. Numerous options, including piggy-backing onto a nearby construction projects, were considered for this project with many being rejected due to time, traffic, budgetary or expertise constraints (e.g. concrete was not an option due to the relatively high volume traffic volumes and reluctance to close any traffic lanes for an extended period of time). Ultimately it was decided that the mill and inlay needed to be delivered through maintenance.

What did prove advantageous was this project's proximity to the City of Edmonton. For arterial surface course applications, the City uses an asphalt concrete overlay (ACO) mix, a 12.5 mm maximum aggregate size mix with 90% 2-face coarse aggregate fracture count and 150-200A asphalt cement. The ACO mix is similar to the department's H2 mix. However, for high volume intersections, the City has started to specify a stiffer 80-100A asphalt cement to provide extra rut resistance. ACO 80-100A mix was used for this project with the hope that it will provide better rut resistance than the previous overlays at these intersections and more importantly better rut resistance than the typical maintenance mix.

Photo 2 – Inlay of Hwy 37 at the Jct. of Hwy 44

A few additional project details: total cost was $63,000; based on the rule of thumb of 2.5 to 3 times the rut depth, depths of 50 to 100 mm were milled on the various intersection legs; an added benefit was the relatively late time of year it was done (September 16 2005) meaning the mix should stiffen over the winter before experiencing hot ambient temperature which can prematurely rut fresh mix. Although the finished product looks good (photo 2 shows roughly the same view as in photo 1 prior to finish rolling) and it was hoped that this mill and inlay would have a service life of 8 or more years, plant QC data shows an asphalt content of 6.0% and 2.4% air voids (0.5% above and 1.6% below target respectively). These results likely mean a reduction in service life and point to some of the issues in delivering through the maintenance contracts.

Addressing rutted locations under maintenance contracts can be challenging due to many factors as afore-mentioned. The Surface Engineering and Aggregates section is looking at developing a standardized method to address such locations as well as the benefits of a province-wide intersection treatment strategy.

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Illumination at Intersections

Beata Bielkiewicz
Highway Operations

Driving at night has become a necessity for a modern society that operates around the clock. Consequently, road authorities across North America have recognized the need to invest in roadway improvements to enable motorists to safely and efficiently use the roadway network during day and night. Street lighting, retro-reflective signs and enhanced pavement markings have become standard measures for nighttime motorists.

Road authorities, through national and provincial discussion forums and meetings have searched for effective ways of dealing with nighttime driving problems and have reached a consensus on when and how roadway improvements should be implemented. Subsequently, national and provincial best practice guidelines and standards were developed to ensure that similar measures are applied across the country.

In the area of street lighting, the Transportation Association of Canada (TAC) provides design guides and best practice guidelines on issues ranging from lighting warrants to design, construction and maintenance of street lighting. The two main TAC guides n the design and application of street lighting are: the Guide for Design of Roadway Lighting and the Guide for Illumination of Isolated Rural Intersections.

In Alberta, many commuter highways, intersections and interchanges use illumination to improve comfort and safety for nighttime drivers. Alberta Infrastructure and Transportation (AIT) has been responsible for ensuring that roadway illumination is provided at locations where it is needed and that all locations are evaluated in a fair manner. AIT receives many requests from stake-holders for lighting systems and the main challenge is to ensure that lighting is installed where justified.

AIT uses TAC guidelines and warrants for assessing the need for lighting along a roadway. The need and scope of lighting at a given location is determined through an engineering study which in addition to the lighting warrants considers several factors related to roadway operation and safety. Currently, a request to provide illumination at a given location is initiated by a local group of stakeholders (road authority or municipal council), after public complaints are received about potential nighttime traffic conflicts.

Transportation districts that monitor the roadway network on a daily basis are often aware of problems arising in their area and make attempts to deal effectively with the issue of lighting before serious safety problems are experienced.

AIT envisions that in the future a systematic approach will be used to conduct frequent and regular network screening. This will be accomplished with the use of a computer program that will allow for the selection of candidate sites by using key operational parameters such traffic volumes, and delays, and collisions.

Most transportation practitioners are familiar with the lighting assessment process so there is no need to describe all the components of an assessment. Instead, this article focuses on the application of lighting warrants and identification of problem areas which-when not properly recognized and addressed - influence operation and safety on highways.

As previously mentioned, the lighting assessment process utilizes a set of warrants to determine if illumination along a roadway segment (an intersection, interchange component) is justified and cost-effective. The two TAC guides, mentioned before, are the main sources of such illumination warrants.

Assessment for Illumination Needs at Rural Intersections

The Guide for Illumination of Isolated Rural Intersections contains a set of warrants for evaluating rural and semi-urban intersections.

A candidate intersection is evaluated using criteria related to geometric, operational and environmental conditions of the site. Each condition is rated with points and weighting factors with complex or difficult conditions given higher rating and higher weight. The total score which is the sum of all sub-scores for all intersection conditions is then compared to the minimum threshold values which warrant intersection lighting. The TAC warrant procedure for isolated intersections recognizes three lighting states: partial lighting (i.e., illumination of critical geometric areas), delineation lighting (i.e., sentry or cross-street traffic lighting) and full lighting.

Partial lighting is justified when the combination of the total score and sub-score for the geometric factors exceeds the TAC minimum threshold values are (i.e., the total score is between 120 and 240 points and the sub-score for the geometric factors exceeds 80 points). Delineation lighting is justified when the combination of the total score and sub-score for the operational factors exceeds the TAC minimum threshold values (i.e., the total score is between 120 and 240 points and the sub-score for the operational factors exceeds 120 points). Full lighting means that the total score is above 240 points.

The TAC lighting warrant has proven to be a reliable method assisting roadway administrators in evaluating when roadway lighting is really needed.

There are many locations in our province which already benefited from having illumination and as a result have experienced improved operations and safety during night time hours. There are also many locations in Alberta waiting for installation of lighting and these locations must be addressed as soon as funding becomes available.

Photo – Courtesy of Gary Faas

There are also many intersections which operate well without lighting. These intersections provide access to small settlements which have small populations and where night time activities are infrequent. Those intersections will likely continue to operate without lighting since the need for lighting is minimal.

There are many additional operational and environmental factors which influence the need or scope of lighting at a given location and they need to be considered in conjunction with the lighting warrants. These factors are:

- Presence of adjacent street lighting system (when a crossing road is illuminated) or presence of illuminated development resulting in an undesirable glare to motorists.
- The need for lighting continuity (when two lighting systems need to be connected to eliminate “dark patches”)
- Consistency of lighting application across Alberta.

Assessment of the Need for Illumination at Roadway Components

The planning component of the TAC *Guide for Design of Roadway Lighting* contains best practice guidelines and warrants for assessing the need for lighting along various roadway components in rural and urban areas (interchanges, arterial roads, freeway sections and other elements).

Each of these components is evaluated individually with the use of unique assessment criteria. For example, the interchange illumination warrant considers factors related to the interchange geometric, operational and environmental conditions. Each aspect is rated with points and then a weighting factor is applied to this condition to calculate the sub-score. The sum of all sub-scores for all conditions forms a total rating which is then compared to the minimum threshold value

A warrant to assess the need for lighting along an arterial road is a complex system which applies various factors to the roadway conditions. The total score received during the rating process is compared to the minimum threshold value and the decision whether to install a lighting system is depended on whether the minimum threshold value has been reached.

Some warrants use a set of two or three criteria (exit or entrance ramp illumination warrant) and some are formulated as look-up tables (guidelines for the use of continuous lighting). Others require the use of engineering judgement (illumination of pedestrian facilities).

Photo – Courtesy of Gary Faas

To conclude, we need to ensure that local or community needs are addressed but at the same time we have certain obligations to the public to use public money effectively and for projects that are most needed. We understand that safety should never be compromised however those conditions that imply safety problems should be analyzed carefully so that real not perceived problems are addressed with adequate measures.

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Bio-engineering and Bio-technical Stream Bank Stabilization Techniques Workshop
September 27-29, 2005

Fred Cheng,
Geotechnical and Materials

Soil bio-engineering refers to the use of plants to arrest and prevent slope failures and erosion. Bio-technical slope stabilization is the combined use of mechanical elements (or structures) and biologic elements (or plants) to arrest and prevent slope failure and erosion.

The root structure developed by live plants binds soil and inhibits soil erosion. As well, plants stabilize soil against surface erosion by reducing the impact of raindrops and absorbing moisture from rainfall. Plants improve slope stability by controlling the groundwater table within the slope, and by providing a structural resistance to shallow slope movement by the root mass itself. Plants are flexible, self-repairing, and gain strength over time. Bio-engineering and bio-technical methods are environmentally friendly design alternatives, providing habitat and shelter for aquatic and terrestrial animals. Most people consider these designs to be aesthetically pleasing as well.

Bio-engineering is not new to Alberta; however, these environmentally friendly designs are not part of our mainstream design alternatives. In 1986 bio-engineering techniques were first used by the department to stabilize a cut slope in Kananaskis Country, and to stabilize streambanks and culvert inlets at a number of stream crossings along H68 and the Forestry Trunk Road, south of Grande Prairie. Field inspections of these sites conducted in 2004 revealed that these projects can be very successful over a long period of time, even through periods of drought, heavy rainfall and flood.

Several classroom-based training sessions have been held over the past few years, with the primary intent on providing training in various erosion and sediment control (ESC) design methods and best management practices. While the quality and appropriateness of ESC designs appears to be improving, most stakeholders continue to use the hard armor approach to ESC design, citing unfamiliarity and uncertainty with bio-engineering and bio-technical designs and associated warranty issues.

In order to foster a shared knowledge of bio-based ESC measures as a means of encouraging the use of these methods, the idea of a classroom and field workshop on Bio-engineering and Bio-technical Streambank Stabilization Techniques was developed.

A 2001 Functional Planning Study was undertaken by AMEC Infrastructure Ltd to evaluate potential improvements to the alignment of Hwy 734 between Robb and Nordegg. Terrace Engineering was retained by AMEC to review bridge crossings along the highway. Terrace identified a dozen or so areas where the Pembina River was actively eroding the stream bank in close proximity to the highway. These sites were prioritized for repair based on risk and severity factors. Two sites in particular were targeted for repair in 2005 where the eroded bank was within 2 m of the edge of the road and where a portion of the highway was undermined by the river erosion. Thurber Engineering prepared mitigation designs for both sites.

An erosion control expert, John McCullah of Salix Applied Earthcare, Sacramento, California had been contacted and the concept of a construction project linked to a bio-engineering/bio-technical field training workshop was born. Over the past year AIT staff, Thurber and Salix worked together on mitigation designs, preparation of a unique construction tender document, and development and delivery of the training workshop. Materials suppliers willingly came forward with free materials to support the course objectives, these included Cascade Geotechnical and Top Spray. The mitigation design utilized both bio-technical and bio-engineering practices that Alberta had little familiarity with.

In mid-September the construction contract was awarded to Farlinger & Associates. They mobilized and began site preparations a week in advance of the field training session. Much of the ‘technical’ portion of the bio-technical designs was installed prior to the training course; this consisted of installation of re-directive vanes in the river and resistive measures such as longitudinal peaked stone toe protection (LPSTP).

The 3-day classroom and field workshop on Bio-engineering and Bio-technical Streambank Stabilization Techniques was held Sept 27-29, 2005 with 67 registrants. (28 AIT staff, 21 consultants, 11 Department of Fisheries and Oceans staff, 2 City of Edmonton staff and materials suppliers and stakeholders). Room and board, and class room training was provided at the Hinton Forestry Training Centre, an excellent facility with well equipped tiered-style classrooms, dormitory style rooms, good food and a comfortable lounge areas for after hour activities.

Day 1 was reserved for classroom training, where we learned about ESC BMP's that would be implemented during the field training. On day 2 and 3 of the training, participants were shuttled to and from the field training site along scenic gravel roads in yellow school buses. The course participants enjoyed the crisp mountain air while they cut and trimmed willows, and installed the various bio-based ESC measures such as live siltation, vegetated riprap, vegetated mechanically stabilized earth (VMSE) and brush layering. Finally, erosion control BMPs were applied on all disturbed land – consisting of seeding, and straw and coir erosion blankets supplied by Cascade. Top Spray was on site to showcase the application of compost blankets, berms and logs.

There were challenges in staging the training:

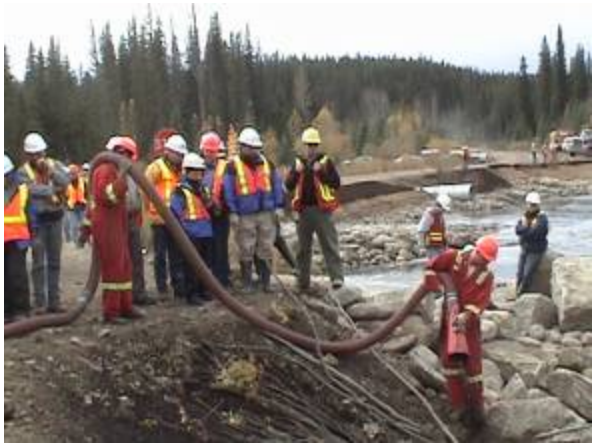
- Workshop venue – matching a suitable field training site with classroom facilities
- Safety – having 70 course participants contained in a small work area presented traffic accommodation concerns for the contractor. Course participants went through the contractor's mandatory field training and safety issues Site Hazard Assessment and reviewed OH&S issues prior to going on site. Two registered first-aiders stay with the group all the time. The hospital was notified and an evacuation plan prepared. Since the field site was a dead zone for cell phones, a satellite phone had to be used. Potable water, portable toilets and a warm up trailer were provided. Waders, life jackets, safety ropes and first aid kits were on site. A waiver was signed by participants to protect the department against injured liabilities.
- Contract tendering difficulties – the unique combination of untried ESC designs, the coordination of the construction with the training session and rapidly changing water levels presented a significant challenge for our consultant to develop a tender document, and for the contractor to provide a bid price. The contractor's perception of risk heightened due to a heavy rainfall during the tender preparation period which resulted in very high river levels and an increased cost assigned to 'isolation' of the works as required by DFO. As it turned out the water levels dropped rapidly prior to actual construction and no significant isolation costs were incurred.
- Water quality monitoring – To comply with DFO requirements, Farlinger hired a professional fish biologist to monitor water turbidity and sediment deposition during construction. Knowing that 10 DFO officers would be on site during field training added to the contractor's anxiety.

Bio-engineering and bio-technical techniques introduced:

- Rock vanes – are re-directive rock structures angled upstream 20-30 degrees. They are constructed along the outer bank of a bend in order to re-direct flow from near the bank to the center of the channel.

- Longitudinal peaked stone toe protection (LPSTP) – a continuous bank protection consisting of a stone dyke placed at the toe of an eroding bank, usually just below bank full elevation.
- Live staking – Insertion of live woody stake cuttings, typically 0.5-1 m lengths, on slopes or stream banks. The portion of the stem in the soil will grow roots (reinforcing soil) and the exposed portion will develop into a bushy riparian plant.
- Pole planting – They are larger and longer than live stakes and can provide better mechanical bank protection during plant establishment. Dense array of posts can reduce velocities near the bank and posts reinforce banks against slumping.
- Live siltation – Installation of willow cuttings along a trench excavated at the water's edge. The cuttings are inclined to overhang the river with soil placed back in the trench. This increases the bank roughness which encourages deposition and reduces bank erosion.
- Branch layering – Live brush layers are layers of live willow cuttings that alternate with successive lifts of soil fill. Several layers are built to reinforce the slope or embankment.
- Brush mattress – is a thick blanket 6-12'' of live brushy cuttings and soil fill. The dense layer of brush increases roughness, reduces velocities at the bank face and protects it from scour, while trapping sediment and providing habitat.
- Vegetated mechanically stabilized earth – consists of alternating layers of live willow cuttings soil wrapped in natural fabrics, TRMs or geogrids. Several offset layers are built up to make the stream bank.
- Vegetated riprap (bent pole method/willow bundle method) – willow poles or cuttings are placed inclined against a prepared slope and a layer of stone and/or boulder armoring is placed on top of the willow cuttings and poles. The willows are woven up through the rock mat during the placing of the rock.
- Erosion control BMPs also included: Rolled erosion control products –blankets made from straw, coconut fibres, or excelsior, and; Compost - blankets, sock, and berm – the compost source was from the Spray Lakes Mill, and was a coarse fibrous wood processing byproduct. The compost passed a certification process to ensure it is environmentally safe.

As part of the training, proceedings were videotaped and a professionally prepared video will be available for department training purposes.



Conclusion

The interest and enthusiasm of participants confirmed the department's commitment to encourage and accept the use these innovative environmentally friendly ESC methods. Course feedback was very favorable and a follow-up course is being considered. Interaction between AIT/consultants/DFO was encouraging and the casual course setting offered ample opportunity to gain perspectives into each stakeholder's point-of-view. The project demonstrated that it is possible to construct along a river bank without the use of costly isolation techniques. Several consultants indicated that they would try to incorporate some bio-designs into future projects.

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Technical Training

Ron Stoski
Geotechnical and Materials

One important activity of Technical Standards Branch (TSB) is to get the right information to the right people at the right time. Although email is a good method to provide information and just in time updates, sometimes it is necessary to hold workshops in order to bring participants together to discuss problems and changes. Recently, technical training and upgrading has been identified as an important way to update and improve job skills of new and old employees.

The following is a summary of courses TSB arranged for and/or delivered since the start of the fiscal year:

Pavement Materials and Evaluation (PPS1) - June
Pavement Management (PPS2) - September

BIM Class B Bridge Inspection - September
BIM Field Training Program - October

Bio-engineering and Bio-technical Stream Bank and Stabilization Techniques Workshop -September

RWIS - Automatic Vehicle Location System/Road Weather Information System in Peace River, Grande Prairie, Edson, Edmonton, Athabasca, Red Deer, and Calgary - October

Traffic Noise Seminar November/December

Pavement Treatment and Preservation Designs (PPS 3) December

Thank you to the Regions for your input and feedback into the need for training and for the type of training courses required. Your input was reviewed and the result is that some of the courses will be delivered at a regional Level. Similarly, comments from participants in the trial run of the Asphalt Pavement Materials and Performance Measures (PPS1), Pavement Management (PPS2), and Pavement Treatment and Preservation Design Module (PPS3) suggested that the PPS modules be combined into a single three to four day Pavement Preservation Course.

TSB Training Courses
Calendar of Events for January to May - 2006

TSB will be delivering and/or arranging for delivery of the following technical training courses in 2006:

Pavement Preservation**:**
Peace River - February 14-16
Calgary Area - March 14-16
Edmonton TBA

RWIS Calgary - February 1
Edmonton - February 2

Highway Design Guideline Overview - April 11-12

BIM Inspection Seminars
Edmonton January 11
Red Deer January 18
Airdrie January 19
Barrhead January 25
Peace River February 1
Lethbridge February 8

BIM Class B Inspection Course April 24-28
BIM Class A Inspection Course June 5-9

Detailed course outlines and registration procedures for the above will be posted and emailed in January.

Center for Transportation Engineering and Planning (CTEP) Courses

In 2006 CTEP will be holding the following courses:

Urban Geometric Design for Canadian Roads
Joint Venture by TAC/CTEP –
Edmonton March 13 - 15
Calgary March 15 - 17

Grading, Base Course & Paving for Project Managers
Edmonton April 5 - 7

Bridge Construction Inspection for Project Managers
Edmonton March 6 - 8

For additional information and/or suggestions and/or comments on training needs and events please contact:

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Time Pressure and Creative Thinking

The higher the time pressure on a given day, the lower the likelihood of creative thinking that day.

Creative thinking is 45% less likely at the highest level of time pressure.

The higher the time pressure on a given day, the lower the likelihood of creative thinking the next day and the day after that. A time pressure increase of 1 standard deviation is associated with a 19% drop in the probability of creative thinking the next day.

The higher the time pressure at the beginning of each half of the project, the lower the average level of creative thinking during the following half.

From a study by
Teresa Amabile, Research Professor
Harvard Business School

If you would like to forward an article or would like to share something old or something new or something nice to know:

Please forward your articles and newsletter-related comments to:

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