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Asphalt Rubber – Rubberized Asphalt

Ron Stoski

Crumb rubber is a component of asphalt-rubber (A-R) and rubberized asphalt but these paving materials are radically different.

Crumb rubber is derived from recycled scrap tires and is reported to provide the following advantages:

- Increases pavement life
- Resists rutting, aging and reflective cracking
- Reduces pavement thickness
- Provides optimum skid resistance

One side benefit of A-R is a 65 - 85% traffic noise reduction, eliminating the need for expensive sound barriers.

Crumb rubber has been used to modify asphalt for thirty years. Many asphalt-rubber trial projects have required very little or no maintenance for many years. This makes it hard to ignore the claims of A-R's superior performance. The proof is in the A-R pavement.

The "Wet" Process (Asphalt Rubber)

The "wet" process was developed in the 60's, tested and researched extensively, and used for 30 years in 45 states and 10 countries. The "wet" process is called "asphalt-rubber" and has the following ASTM definition: *"A blend of asphalt cement, reclaimed tire rubber, and additives in which the rubber component is at least 15% by weight of the total blend and has reacted in hot asphalt cement sufficiently to cause swelling of rubber particles."*

There are formulation distinctions within the asphalt-rubber blends, depending on application and climatic zones. The manufacture of asphalt-rubber consists of ground recycled rubber, mixed with a liquid paving grade asphalt in a specialized blending unit at 200° C. This produces a thick fluid binder that is pumped from the blender to a distributor as the "reaction" takes place. The reacted asphalt-rubber is pumped directly into a pug mill or drum mixer and mixed with the aggregate.

Ultraviolet inhibitors, anti-oxidants and other chemicals contained in the scrap tire rubber are transferred to the asphalt, giving the asphalt-rubber material greater age and crack resistance which helps to contribute to a longer pavement life.

In the hot plant mixing process, the material is known as "Asphalt-Rubber Hot Mix (ARHM). Varying mix designs are utilized with the ARHM, Gap Graded being the most commonly used in Southern California and the open graded in Arizona. The ARHM is placed as a surface course with conventional paving equipment. A 25mm thick application of ARHM uses 700 recycled tires per lane km.

In addition A-R has been used as the binder in spray applied layers, such as seal coats, as a Stress Absorbing Membrane (SAM) and Stress Absorbing Membrane Interlayer (SAMI). In both methods the binder is spread by a distributor and covered by hot, pre-coated aggregate. The spray applied "membrane" application process recycles 500 recycled scrap tires per lane km.

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The "Dry" Process (Rubberized Asphalt)

The various “dry" processes of utilizing crumb rubber in hot mix all have the common characteristic of being an additive to aggregate. In the "dry process, *crumb rubber in solid form is substituted* for up to 5 percent of the aggregate in the asphalt mix. The asphalt used in the dry process is of the same paving grade as conventional mixes. Specialized equipment is not required for the manufacture or application of this material. However, higher mixing (170° C) and higher compaction temperatures (160° C) are required. Unlike Asphalt-Rubber, little, if any, reaction takes place between rubber and asphalt particles. The lack of reaction leaves the asphalt in the "dry" process unmodified and does not release ultraviolet inhibitors and anti-oxidants contained in scrap tire rubber.

Rubber modified asphalt concrete pavements ("dry" process) have been used as overlays and surface wearing courses. It was marketed as having good skid resistance and de-icing properties and was of interest in cold regions. The most widely known "dry" process products were proprietary products. Some “dry process products were tested and were not recommended for routine use.

The Oregon State University led "Pooled Fund Study" in 1995 considered both the "wet" and "dry" processes. However, only the "wet" process was studied due to the lack of success with "dry" process projects throughout the nation.

Currently, some "dry" processes are being marketed as equal to asphalt-rubber; but they have yet to meet the "time tested and proven" standards achieved by the "wet" process. Many different paving processes use some form of rubber and claim to be asphalt-rubber or to be equal to asphalt-rubber. Many of these processes are called "Rubberized Asphalt" and contain synthetic rubber materials or recycled rubber from other sources such as tennis balls. The "dry" process is marketed under various “trade” names and is often confused with A-R.

This article is based on the following websites:
http://www.rubberpavements.org/library/difference.asp
http://www.dot.ca.gov/hq/esc/Translab/pubs/Caltrans_Asphalt_Rubber_Usage_Guide.pdf

Picture: State of California Department of Transportation

Asphalt Rubber in Alberta

Marta Juhasz

Asphalt rubber is a mixture of asphalt and recycled tire crumb. The rubber crumb in a pavement surface provides better traction. Asphalt rubber should require less maintenance because mixtures are reported to have greater resistance to cracking and rutting. Asphalt rubber pavements are expected to provide longer service lives than traditional asphalt pavements.

In 2003, sections of asphalt rubber pavement were placed in Edmonton, Sherwood Park, Lethbridge, and on a seven km section of Highway 623:04. The seven-km asphalt rubber pavement test section is being evaluated against a 14 km traditional asphalt pavement control section.

A Stress Absorbing Membrane, an asphalt-rubber chip seal (8.5 km) test section and a 28km conventional chip seal control section were placed on Highway 507:04.

The Tire Recycling Management Association of Alberta and Alberta Asphalt Rubber Steering Committee brought in the following experts to an Asphalt Rubber Seminar on August 14, 2003:

- George Way, Chief Pavement Design Engineer, Arizona Department of Transportation, to explain the history of asphalt rubber and the Arizona experience.

- Jack van Kirk, Basic Resources and formerly CalTRANS', Chief of the Flexible Pavement Section, to present a contractor perspective on asphalt rubber.
- Dr. Kamil Khaloush, Arizona State University, to discuss performance testing, and
- Hugh Donovan, City of Edmonton to outline the performance of the 2002 Alberta test sections.

The afternoon portion of the seminar took 100 attendees to the asphalt rubber mixing and placing operation on Hwy 623:04 and to the 2002 asphalt rubber trial on 137th Avenue in Edmonton.

Although it is too early to judge the performance, the trials have confirmed the initial noise reduction benefit of asphalt rubber compared to conventional asphalt. However, on the downside, Alberta's harsh winters and its large number of freeze-thaw cycles stressed the asphalt rubber mixture and the expected reflective transverse cracking benefits have not materialized.

So what is the future of asphalt rubber in Alberta?

One of the biggest challenges to asphalt rubber in Alberta's is the climate. Discussions during the seminar with the experts indicate that some improvements could be made to asphalt rubber mixes that were placed in Alberta. With this in mind, and in order to give new technology every opportunity to prove itself, the Department will likely experiment with more asphalt rubber in 2004 and 2005.

For more information,
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The Circle
Ron Stoski

It is a good thing that history repeats itself
Because nobody listens the first time

STOP SIGNS
Ron Stoski

Have you ever wondered why stop signs are necessary? After all, by the rules of the road, drivers must yield to vehicles approaching from the right (i.e. they must stop to allow the vehicle on the right to proceed) unless there is some other form of assigning right-of-way. Basically, without stop signs or signal lights, traffic on the major roads would be slowed down by traffic on the intersecting minor roads thus increasing road user costs. In addition, under the Traffic Safety Act, vehicles approaching a provincial highway are required to stop before entering or crossing the highway.

The main purpose of a stop sign is to assign right-of-way to the major road at an intersection. Signs are installed at intersections that have demonstrated problems involving right-angle turn and left-turn collisions; at intersections with sight distance obstructions, on approaches that restrict sight lines of conflicting traffic; and at intersections with high traffic volumes on the conflicting approaches.

Stop signs should not be used to control speed, to eliminate cut-through traffic on residential streets or to provide a safer environment for pedestrians. This is based on studies showing that stop signs do not work for these ends, and in fact can be detrimental. Another frequent request is for a stop sign is after a collision. Reducing collisions is a valid use of stop signs, but again studies have shown that installing stop signs at low volume intersections with less than one collision per year does not reduce the accident rate. This is especially true in cases when unnecessary multi-way stops are created.

There are many hidden costs for a stop sign. The annual highway user cost for a stop sign used by 1,000 vehicles on a 50km/h street result in about:

$18,000 extra in vehicle operation costs,
1,400 hours of lost time,
15 000 liters of extra fuel,
4000 kg of carbon monoxide emissions,
400 kg of hydrocarbon emissions,
300 kg of nitrogen oxide emissions,
plus the wear and tear on the highway.

CARSELAND - BOW RIVER HEADWORKS SYSTEM REHABILITATION

Dinesh Ejner

The Carseland - Bow River Headworks (CBRH) system is a multi purpose water delivery system located in Southern Alberta, approximately 60 km southeast of Calgary (see attached location plan). The CBRH system consists of diversion headworks on the Bow River near the hamlet of Carseland, 65 km of main canal, the McGregor, Travers and Little Bow storage reservoirs and 4.6 km of connecting canals between the reservoirs. The system diverts water to 85,000 ha of agricultural land in the Bow River Irrigation District (BRID) and 2,000 ha in the Siksika Nation. In addition to irrigated agriculture, the system supplies water to a number of municipalities, domestic users, livestock operations, a sport and commercial fishery on McGregor and Travers reservoirs, and industrial and recreational users.

Construction of the main canal system was originally started in 1906 and was completed in 1920. The system was completely upgraded, enlarged and rebuilt by the Prairie Farm Rehabilitation Administration (PFRA) between 1951 and 1954. In 1973, the ownership of the CBRH system was transferred to the Provincial Government from the Federal Government. Alberta Environment (AENV) owns and is responsible for operating and maintaining the headworks system. The BRID is responsible for all the works downstream of Little Bow Reservoir. Prior to 1995, AENV rehabilitated 8 km of main canal, replaced the West Arrowwood Syphon, and completed some rehabilitation of the North McGregor Dam. Since then, Alberta Transportation (AT) has managed the rehabilitation of the Province's water management infrastructure. AT has replaced the East Arrowwood Syphon and rehabilitated an additional 3 km of canal. However, the remainder of the CBRH system needs rehabilitation to ensure the continued supply of water to the users.

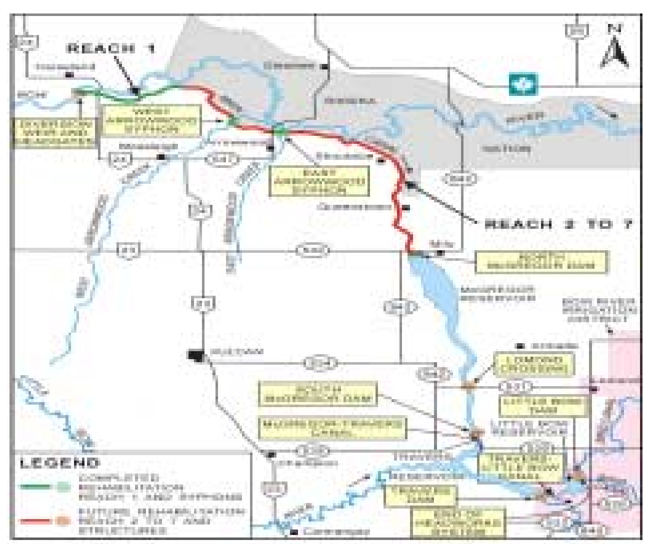
The 65 km long main canal is badly deteriorated. Extensive erosion, silting and seepage from the canal are causing operation and maintenance problems. Some of the reservoir structures are badly deteriorated, outdated and at the end of their useful lives.

The following work needs to be done in order to ensure the supply of water to the BRID and the Siksika Nation:

- rehabilitate the main canal and connecting canals between the reservoirs;
- replace the irrigation outlet structure on McGregor Reservoir and the inlet structure on Travers Reservoir;
- and rehabilitate or replace the irrigation outlet structure on Travers Reservoir and both the inlet and outlet structures on Little Bow Reservoir.

It is anticipated that the rehabilitation program will be completed by the year 2010, depending upon funding availability, at an estimated cost of $125 million. This estimate includes all costs of land acquisition, engineering, construction and administration. The components of this program include rehabilitation of six reaches of main canal, modification of the diversion works, replacement and upgrading of structures on the three reservoirs, and upgrading of a reservoir crossing near the Village of Lomond.

Construction contracts for the rehabilitation of Reaches 2 and 3 of the main canal were awarded in September 2003 with construction to begin in October. During the period from October 15 to April 15 there is no water flowing in the canals, therefore, this is the time to carry out major reconstruction without interrupting the water supply to users along the canal. AT will also provide employment opportunities to Siksika Nation members on the CBRH rehabilitation projects that are adjacent to the Reserve. Private consultants reporting to AT's Project Director are providing the engineering services for the rehabilitation program. Their work is reviewed internally at all stages of development and also by independent reviewers in the case of the major reservoir structures. The attached location plan shows the CBRH system, one of the vital water delivery systems in southern Alberta.



Carseland - Bow River Headworks System

SOIL BIO-ENGINEERING EROSION CONTROL Highway 11:10 ROCKY MOUNTAIN HOUSE

Fred Cheng

Soil bio-engineering erosion control is a method of soil and slope stabilization using native live plants as the main structural component. The root structure developed by live plants acts to bind soil and inhibit soil erosion. As well, plants stabilize soil against surface erosion by reducing the impact of raindrops and absorbing moisture from rainfall. Plants have been proven to improve slope stability by helping to control the groundwater table within the slope, and by providing a structural resistance to shallow slope movement by the root mass itself. Live plants can be used alone or in combination with more robust armouring to protect the banks of watercourses. By their live nature, they are flexible and self-repairing. They provide an environmentally friendly design alternative, as well as being aesthetically pleasing, as branches and leaves start to grow.

Alberta Experience and Project Background

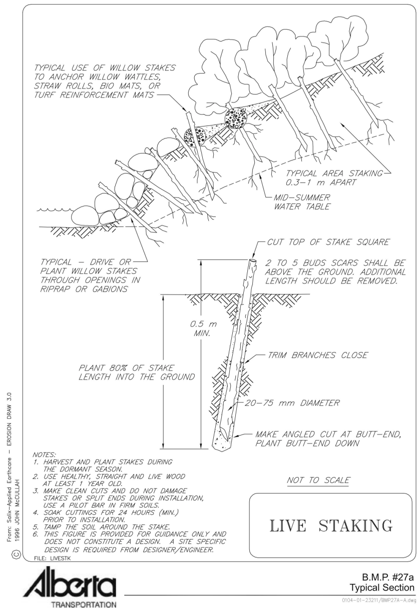
The technology of soil bio-engineering is not new to Alberta Transportation. A number of sites in the Kananaskis Country and the southeast of Grande Prairie were tried in 1986, however the long-term performance has not been well documented. However, local knowledge suggests that some sites are performing well, with trees and bushes growing profusely. Stream bank protection schemes that incorporate live plants are now a common feature of many current bridge projects. In the fall of 2003, a trial site was selected to the west of Rocky Mountain House on the west of the T-intersection of Highway 11 and Highway 22. This site was the backslope of a wide and deep highway ditch that was situated on the west side of Highway 11. The west ditch slope backed onto a private property where a septic field was installed.

Ditch erosion and slope instability problems have periodically plagued this site for many years. The west slope of the ditch has been ‘repaired’ several times over the past 10 years. Repair options are limited at the site due to the presence of centerline culverts and landowner concerns. A compromise was installed in 2001 where the ditch bed was raised to provide a buttress to the slope movements; and a gabion drop structure was installed to transition between the elevated ditch bed and the original ditch bed at the point where the centerline culverts entered the ditch immediately downstream of the main slide area. Unfortunately the gabion structure failed, once again endangering the west slope. In the fall of 2002, a more robust and appropriately designed gabion structure was built to replace the failed structure and the slopes were re-graded. In June 2003, a small portion of the south slope slumped again and the Regional Geo-technical Consultant was called out for an emergency assessment. The consultant recommended a solution that utilized bio-engineering techniques to stabilize the south slope.

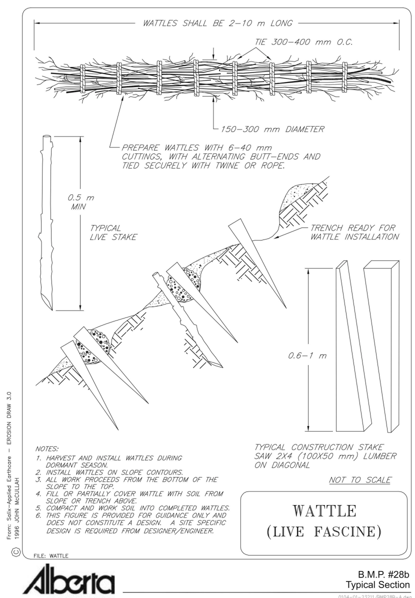
Site Description and Bio-engineering Design

The slope failure was considered to be relatively shallow based, lending itself to a bio-remediation solution. The failed mass encompassed the entire slope from the ditch bottom up to the tree line in the shape of a rectangle - with a width of approximately 40 m and a slope height of approximately 13 m. Soil material is high plastic clay. The bio-engineering design required minor grading of the slope surface to seal cracks and prepare a suitable surface for planting. Three rows of willow wattles, as shown on the attached schematic, were installed at approximate 2 m spacing along the bottom half of the slope. The wattles will act as a slope break to reduce the flow velocities of surface runoff. Poplar stakes were used as anchors for the wattle bundles. Five-hundred and seventy (0.5 m long) live stakes, comprising a mixture of poplar and willow, were installed on a 1 m x 1 m grid throughout the slope surface. These live plantings will help to stabilize the slope.

(*A photo showing the development of root growth is provided. The poplar live stake shown was ‘planted’ in a soil filled pot at the Twin Atria and watered regularly for a period of 8 weeks prior to retrieval. It is interesting to note that the root development occurs along the entire portion of the stake in contact with soil, not just at the angle cut tip*.)



Drawing showing live staking



Drawing showing wattle


A live poplar stake with root growth after 8 weeks

Construction

The contract was awarded to Ledcor, the maintenance contractor for the Central Region, in October 2003. Live poplar stakes and willow wattles were supplied by Eagle Lake Nurseries Ltd. of Strathmore. The species supplied were golden willow (*Salix alba vitellina*), laurel leaf willow (*Salix penlandra*) and tower poplar (*Populus x. canescens*), commonly found in Western Canada. Live poplar and willow stakes were approximately 2 cm in diameter and cut at 45^{o} angles to lengths of 0.5 m. Stakes were inserted 0.3 m into the ground after a pilot hole was made with a metal bar. Willow branches were supplied in 1 cm branches and were bundled on-site into 4.9 m lengths and 0.2 m diameter wattles. Live stakes were cut in the nursery during their dormant period, a few days before project start-up. Once cut, they were transported to the Ledcor maintenance yard in Rocky Mountain House. All live stakes were soaked in water and wattle branches sprayed with water to keep moist for at least 24 hours before installation.

An on-site pre-construction meeting was held on October 20. The Ledcor Project Manager and Alberta Transportation (AT) Regional and Technical Standards Branch (TSB) staff were on site for the meeting. Details of slope re-grading and plant placement locations, installation method and requirements were discussed. As minor grading was required to prepare the site for installation of the plantings, a bob-cat dozer was used to undertake this work. Three ditches of about 0.2 m deep and wide were hand dug to accommodate the 0.2 m wattles. Wattles were anchored into the trenches by live poplar stakes. Fill material was placed on top the wattles and lightly tamped. Three crews were utilized. By noon, October 21, all wattles and stakes were placed and the slope was ready to be seeded the following week. A final inspection by AT (Regional and TSB) and Ledcor staff was conducted on October 22 and the work accepted. Pictures were taken and some are shown in the attached photos.

South slope where live stakes and wattles are installed

A live poplar stake

Three rows of willow wattles were installed

Close up of willow wattle

Conclusion

The bid cost was $21,400 and the final bills totaled $21,000. Due to site constraints and cost factors, this site was considered to be a good candidate for bio-engineering technology. Alternative remediation schemes would have severely disrupted the site and would have been more costly. As soil bio-engineering has proven successful in projects in the U.S. and other warm weather countries, success of this alternate slope stabilization and erosion control technology on this project, in Alberta, will provide verification of the viability of the technology, and support for use on more projects along our highways. As the slope is stabilized it is expected there will be a reduction in future maintenance costs while maintaining a green and aesthetic slope. The slope will be monitored closely in the Spring and Summer of 2004 for plant growth and the performance of soil bio-engineering.

If there are any question regarding this article please contact Fred Cheng at (780) 415-1039
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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 all newsletter-related comments.

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