TREATMENT OF FROST AND MOISTURE SUSCEPTIBLE AGGREGATE IN NORTHERN MINNESOTA

Following is a copy of article published in Better Roads magazine that describes a the use of **EMC SQUARED** Stabilizer products to armor the gravel surfacing of an unpaved road that services traffic driving to the northernmost point of the contintental United States. In fact, this gravel surfaced road traverses a peninsula known as Northwest Angle that is connected by land to Manitoba, Canada, and not the United States. Reaching the community of Angle Inlet via the Northwest Angle Road requires leaving the United States and driving through a portion of Ontario. In order to avoid having to present passports and clear customs twice each direction of a round trip drive, the alternative is to boat across the U.S. portion of Lake of the Woods from Lake of the Woods County to this remote peninsula that is also part of the County. This situation makes this road even more remote for the County's road maintenance crews, and thus explains their vested interest in upgrading the Northwest Angle Road to being as maintenance-free as possible.

Bruce Hasbargen, the monitoring County Engineer, last reported in 2010 that the six mile section treated with the **EMC SQUARED** Stabilizer remained in excellent condition since its construction 13 years prior. Considering the poor quality pit run aggregate, a nonplastic material with just 4.5% #200 fines content, the near proximity of ground water, the extreme cold climate, and service as a running surface for logging truck and vehicular traffic without protection by asphalt pavement or bituminous surface treatment, the **EMC SQUARED** product technology has proven effective under what are truly worst case field testing conditions.

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SOIL Stabilization

Graded road treatment cuts costs

Stabilizer and geotextile strengthen Lake of the Woods County road in Minnesota.

Frost-heave and freeze-thaw cycling are problems that damage both paved and unpaved roads in states as far south as California, Arizona, New Mexico, Texas, Arkansas, and North Carolina. In the northern states and Canada, the fall and spring frost-heave periods so weaken highway base materials and subgrade soils that load limits must be imposed, restricting fully loaded trucks from these roads on a seasonal basis and slowing the pace of local commerce.

Much of the traditional research of state highway and transportation departments has been focused on how to better determine when load limits should be imposed and when they may be lifted. Attention is now also being focused on addressing the problems which create the need for these seasonal load limits, the moisture and frost susceptibility of the aggregate base course materials and the dynamic movements in the soil subgrade below them.

In Minnesota

Minnesota is noted for its cold climate, but Lake of the Woods County, bordering the Canadian provinces of Manitoba and Ontario, has double trouble: a high ground water table as well as cold winter temperatures. The entire county suffers freeze-thaw weakening of its road bases and subgrade each year. Roads are accordingly subject to seasonal load limits that are costly to logging and other local businesses which must cease operations when heavy loads are not permitted on the roads for months at a time. Pavement damage is high even with seasonal load limits in place. Unstabilized roadbed materials lose their flexural stiffness and their ability to properly support the asphalt pavements. Unpaved roads are equally problematic. They rut, pothole, and erupt in frost boils during freeze-thaw cycles, and grading is required on a constant basis.

> ONE OF THE GOALS WAS TO IDENTIFY A TREATMENT WHICH COULD MAINTAIN THE PAVING GRADE OVER A PERIOD OF MONTHS OR YEARS.

A four-year-old statewide survey determined that a typical aggregate-surfaced road in Minnesota is graded every 8.6 days. Constant grading accelerates gravel loss, a problem which is not only costly but also indicative of a road surface which is eroding and contributing to the sedimentation of nearby streams, rivers, and lakes.

The county engineer, an active member of the Local Roads Research Board of Minnesota, was interested in stabilization technology that would provide more permanent improvement for gravel surface roads than the usual calcium chloride dust palliative treatments applied by Minnesota counties for summertime dust control. New aggregate surfacing materials are regularly being placed on county roads as part of incremental construction projects where chip seals and asphalt pavements are often in the plans at some future time when funding becomes available.

One of the goals of the Local Roads Research Board was to identify a treatment which could retain gravel materials and maintain the paving grade over a period of months or years. With county costs running approximately $100,000/mi. for placement of subbase and aggregate base course materials, an effective and economical aggregate treatment would clearly be cost effective.

Following his attendance at a presentation session on stabilization technology during the annual meeting of the Transportation Research Board, the county engineer decided to move forward in early summer of 1997 on stabilization of one of his most remote and high maintenance roads, using funding available from

Photo shows the North West Angle Road in Minnesota. Even though the road is located in a wet, wooded area, use of liquid stabilizer reduced grading time and costs.

the Local Roads Research Board of Minnesota.

The road selected, Northwest Angle Road, which is located out on the end of a wet and wooded peninsula, is in a portion of the United States that is accessible only by driving through Canada, or by boating up the middle of Lake of the Woods through U.S. Waters to reach this isolated portion of Lake of the Woods County. Northwest Angle Road was the county engineer's top priority for stabilization, not only because of its extremely remote location, but also due to the high frequency of maintenance grading (two to three gradings per week) required for this road constructed across swampy terrain. The deep winter freezes heave the silty soil subgrade upwards by a foot or more, and during spring thaw the soil becomes so saturated that the entire length of a shovel handle can be pushed down into the ground with relative ease. Given these soft subgrade conditions, the unavoidable seasonal heaving, and the poor quality of the locally available pit run gravel surfacing, Northwest Angle Road presented a worthy challenge for stabilization technology.

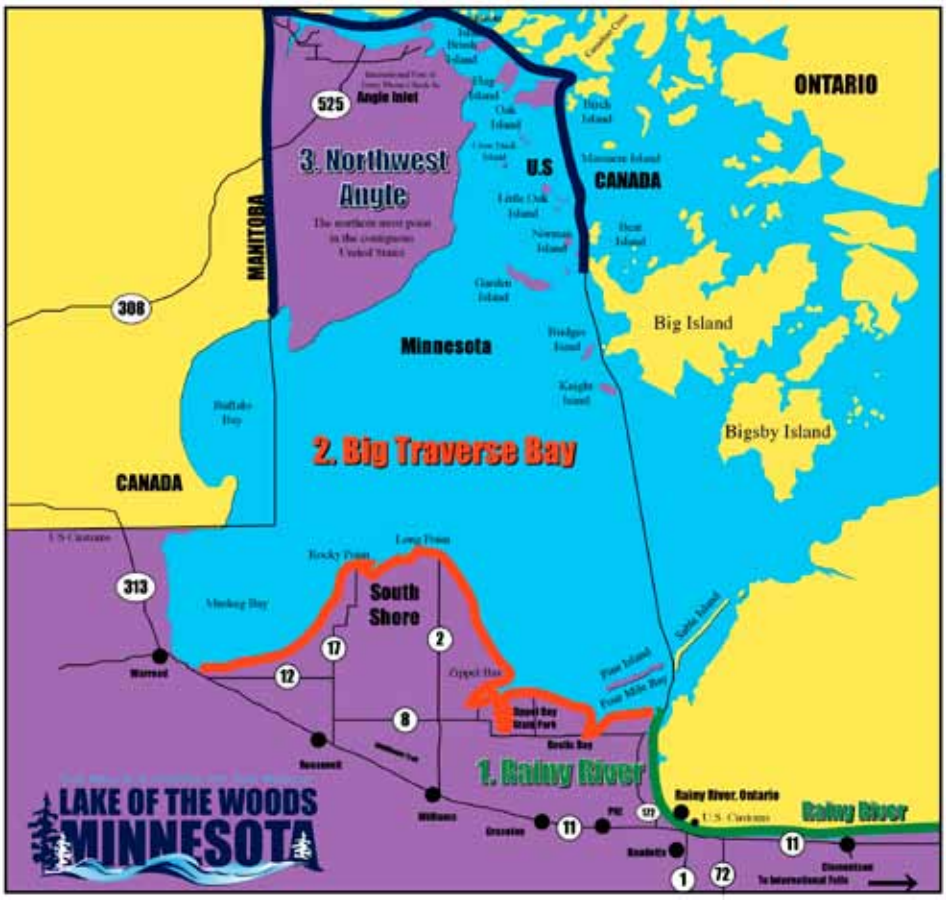
The county engineer identified two primary problems, the first being the huge heave, while the second was the stability of the gravel running surface. To help retain the integrity of the gravel structural section through the periods of heaving and thawing, high strength woven geotextile fabric was selected. The geotextile fabric was intended to keep the gravel layer intact and stop the eruptions of subgrade soils up through the gravel in a spring thaw phenomenon known as frost boil. The county had previous experience with lightweight geotextile fabrics and had found that they ripped apart during the dramatic seasonal ground movements. The high-strength woven geotextile was installed as an underlayment for the new pit run gravel surfacing that was being placed along the 17-mi. length of Northwest Angle Road.

Even with the geotextile underneath, the gravel surfacing itself would still be affected by frost-heave and rainfall, resulting in ruts and potholes necessitating constant maintenance. To solve this problem, the EMC SQUARED Stabilizer was selected for the project. This concentrated liquid stabilizer treatment from Soil Stabilization Products Company, Inc., Merced, California, was proven in cold climate applications and was effective with non-plastic (non-cohesive) aggregates and recycled pavement materials as well as with cohesive aggregates and clayey soils.

Working with the remaining funds available from the Local Roads Research Board of Minnesota, 6 mi. of the newly placed gravel surfacing was treated with the stabilizer to a 3-in. depth by the county road maintenance crew. The liquid stabilizer solution was blade mixed with the gravel during application. The treated gravel mixture was then graded to shape and compacted with a steel drum vibratory roller.

The relatively shallow 3-in. depth of the gravel treatment ensured that the underlying geotextile would not be damaged during construction. The county crew was working on their first stabilization project, and they perfected their technique for shaping of the running surface and timing their compaction operations as the stabilizer application progressed down the road. The cohesive forces added by the stabilizer treatment were obvious, and they commented that the treated gravel mixture got very heavy to process and shape with the motor grader as they prepared the surfacing for compaction.

The county engineer reported that the stabilized aggregate set up just like concrete once the compaction and final grading work was completed. Within several weeks of construction, while they were applying a heavier calcium chloride treatment to the 11 mi. of gravel surfacing that had not been stabilized, the crew also applied a light calcium chloride dust control treatment on top of the stabilized run-



SOIL Stabilization

ning surface.

While other gravel roads in Lake of the Woods County continued to suffer severe frost boils and a need for constant grading maintenance, the 6-mi. length of stabilized pit run surfacing performed through the fall, winter, and spring seasons without frost boils, soft spots, or potholes.

The only problem? The county engineer reported that he was barraged with springtime calls from county residents and Canadians, asking why a road this solid was subject to load restrictions established for unstabilized gravel roads and for paved roads with unstabilized base courses. The high-strength geotextile also proved effective in performing its role in these very difficult circumstances. It provided the additional tensile strength needed to keep the gravel layer above intact and protected from rupture by frost boils. On the 11-mi. section of road where the top 3 in. of gravel was not stabilized, the unstabilized surfacing required major maintenance grading to bring it back into shape after the spring thaw. The moisture and frost susceptibility of the untreated gravel left it subject to rutting, potholes, and washboarding.

As the reconstructed Northwest Angle Road is going on its fourth year of service, both Bruce Hasbargem, the current county engineer, and Greg Johnson, the engineer monitoring the project for the Minnesota Department of Transportation, report that the 6-mi. section treated with the stabilizer remains in excellent condition. Considering the poor quality pit run aggregate, the near proximity of ground water, the extreme cold climate, and service as a running surface for logging trucks and vehicular traffic without protection by asphalt pavement or bituminous surface treatment, the product technology has proven effective under what are truly worst-case field testing conditions. ❐