TREATMENT OF FROST AND MOISTURE SUSCEPTIBLE AGGREGATE IN NORTHERN 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 that 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.

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 subgrades each year. Roads are, accordingly, subject to seasonal load limits that are costly to logging and other local businesses who must cease operations when heavy loads are not permitted on the roads for months at a time. Pavement damage is severe even with seasonal load limits in place. Unstabilized roadbed materials lose their flexural stiffness and their ability to properly support 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. A 1997 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 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 $100,000.00 per mile for placement of subbase and aggregate base course materials, an effective and economical aggregate treatment would clearly be cost effective.

In the early summer of 1997, the County Engineer decided to move forward on stabilization of one of his most remote and high maintenance roads. 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

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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 subgrades upwards by a foot or more. 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 selected a high strength woven geotextile fabric to help retain the integrity of the gravel structural section through the periods of heaving and thawing. 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 light weight geotextile fabrics and had found that they ripped apart during the dramatic seasonal ground movements. So, a high strength woven geotextile was installed as an underlayment for the new pit run gravel surfacing that was placed along Northwest Angle Road.

Even with the geotextile underneath, it was clear the gravel surfacing would still be affected by frost-heave and rainfall, resulting in ruts and potholes that required constant maintenance. To solve this problem, the **EMC SQUARED® Stabilizer** was selected for the project. This product technology, a concentrated liquid stabilizer (CLS) treatment from Soil Stabilization Products Company (SSPCo), was proven in cold climate applications and was effective with many non-plastic (non-cohesive) aggregates and recycled pavement materials as well as with cohesive aggregates and clayey soils. Six miles of the newly placed gravel surfacing was treated with the **EMC SQUARED Stabilizer** to a three inch 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 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 commented that the stabilized aggregate set up just like concrete once the compaction and final grading work was completed. Within several weeks of construction, the crew applied a calcium chloride dust control treatment on top of the stabilized running surface.

At last report in 2010, the reconstructed Northwest Angle Road had been in service for over thirteen years, servicing an average daily traffic count of approximately 140 cars and trucks. The county applies calcium chloride treatment to the road surface each summer for dust control and to help retain the fine-sized aggregate materials on top of the stabilized gravel running surface. Bruce Hasbargen, the County Engineer monitoring the project from 1999 through 2010, reports that as of year 2010 the six mile section treated with the **EMC SQUARED** Stabilizer **remains in excellent condition**. 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.

To learn more about the EMC SQUARED System visit www.stabilizationproducts.net

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