Wicking Geosynthetic Used for Frost Heave Prevention Pioneer Mountain Scenic Byway

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Disclaimer

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ABSTRACT

Problem
The Pioneer Mountain Scenic Byway, located just 30 miles West of Dillon Montana, seasonally experiences frost heave over a 20 mile stretch of roadway. The road is closed to winter traffic and typically opened in May. Longitudinal cracks are commonly found. The Moose Park location experiences the most dramatic problems and had been recently repaired in 2004.

Solution & Design
Federal Highways subsurface investigations indicate a high water table and a variable subgrade strength consisting of silts and pit run materials. The preference is to minimize over excavation and looked to geosynthetics as an option. The new wicking geosynthetic provided by TenCate was recently used on an Alaska DOT project with early indications of success. Three design solutions were proposed and presented to the county for review. The dual layer solution was selected to minimize the cross section depth and keep the wicking geosynthetic above the water table to mitigate the frost heave effects.

Construction
In the fall of 2013, the site was excavated to the required depth finding a mix of materials to include 4 drain tiles and miscellaneous geosynthetics used in previous repairs. The first layer of wicking geosynthetic was installed and covered with select pit run aggregate. Early wicking was witnessed shortly after installation. The project was put on hold as snow started falling and temperatures dropped at this 7625 foot elevation. The final installation will be completed in early summer of 2014.

INTRODUCTION

Pioneer Scenic Byway near Dillon, Montana is a seasonally open road travelled by tourists, ranchers, snow enthusiasts and makes a connection between Polaris and Wise River, Montana. The road traverses through an elevation differential of 2000-7500 ft and grants access to locations such as Maverick Mountain Ski Resort, Elkhorn Hot Springs, and the Gem Field.

The road is typically cleared from snow in late April-early May (Figure 1). Once uncovered, a longitudinal crack forms during the freeze-thaw cycle (Figure 2), and extends for over 20 miles, some of which are wider than a motorcycle tire and requires immediate maintenance attention for safety. The Moose Park location displays the most severe of these cracks generated by freeze thaw.

Figure 1 – Road Clearing

Figure 2 – Longitudinal Crack, Moose Park

Construction 2004

In 2004, the repair of the Moose Park location utilized traditional methods to combat frost heave. This included sub-excavation, geotextile, and a drain system. (Figure 3)

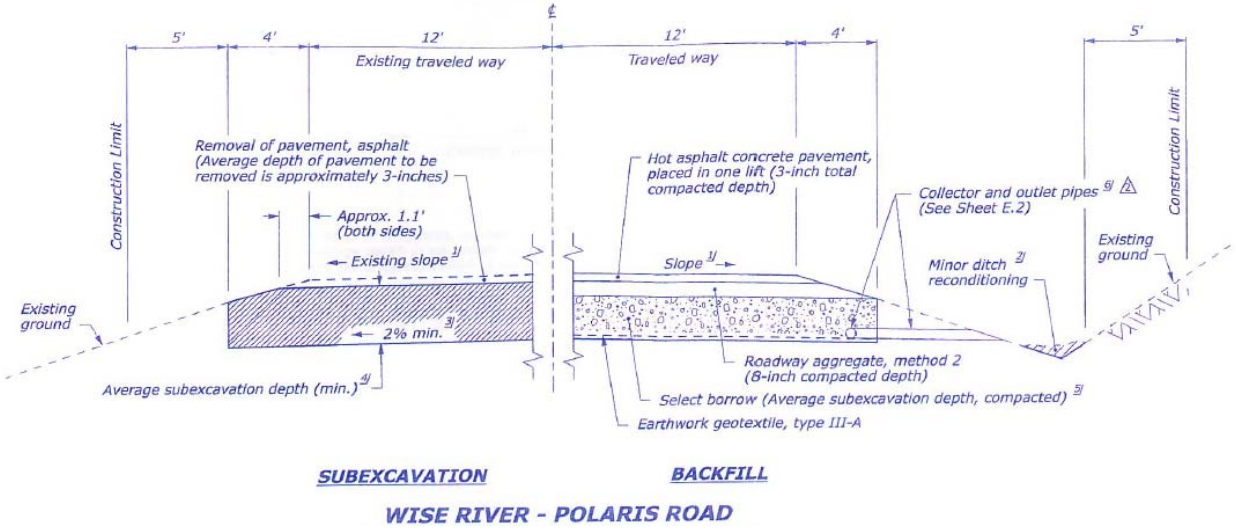

Figure 3 – 2004 Typical Detail

In 2008, the longitudinal cracks began re-appearing, and maintenance sub-excavation and chip sealing was used to repair the sections.

DESIGN

Background

In discussions with Federal Highways, Western Federal Lands in Vancouver, Washington, a geosynthetic solution would be reviewed. A new wicking geosynthetic from TenCate was recently used in Alaska to mitigate the effects of frost heave. Early testing conducted by Xiong Zhang, at the University of Alaska Fairbanks, Beaver Slide, provided the design guidance, (Figure 4).

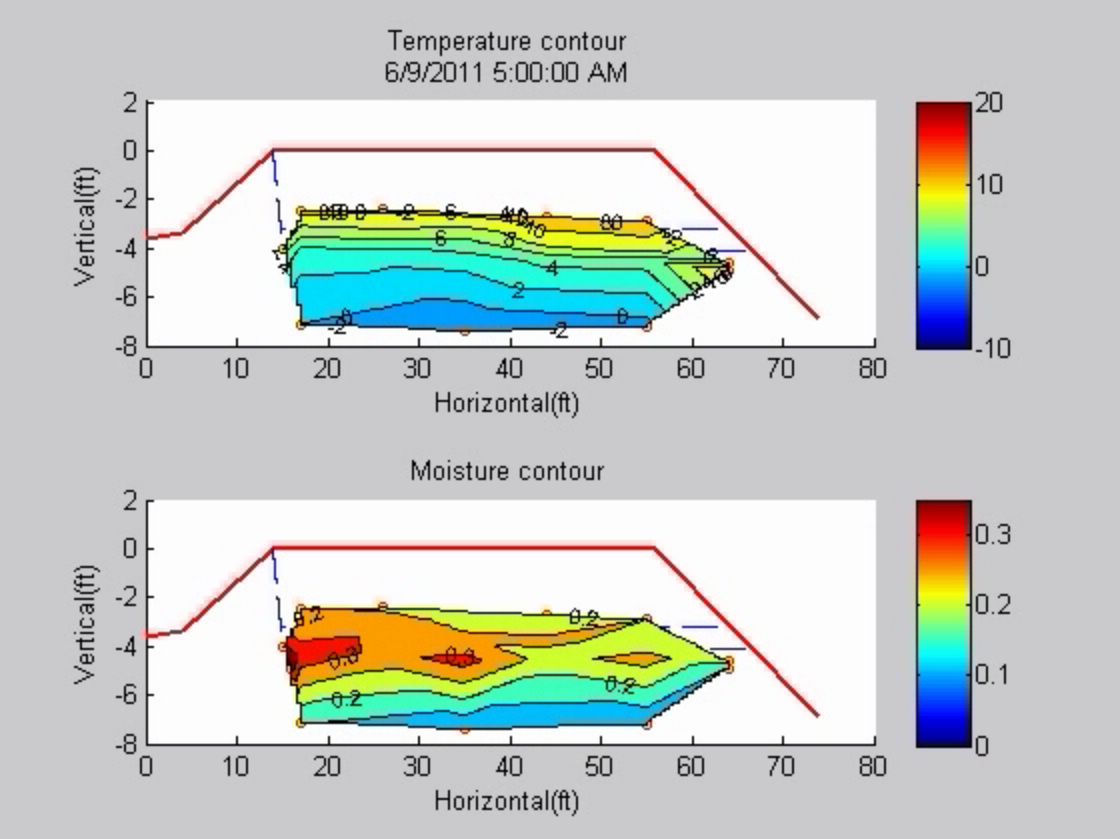

Figure 4 – Temperature and Moisture Contours on the Beaver Slide Study

Another project of a much larger scale was installed in 2012 by the Alaska DOT on the Dalton Highway 30 miles north of Coldfoot, Alaska. This road experiences severe frost heave and early success of the geosynthetics wicking capability was seen during the first spring break-up. (Figure 5)

Figure 5 –Dalton Highway - Mirafi H2Ri capillary break and wicking seen May 30, 2013

Moose Park

Data such as borings, piezometer, and a gradation analysis were provided by FHWA to come up with design scenarios. Design constraints were listed as the following.

- Budget
- High water table
- Blend in with the surroundings (important for daylight considerations)

These items were reviewed with associate engineers from TenCate. The wicking geosynthetic (Mirafi® H_2Ri) also performs sub-grade stabilization, however needs to be located above the water table to perform wicking and act as a capillary break to the pavement structure.

Three solutions to repair the 1,100 feet of Moose Park roadway proposed by WFLHD are shown in Figure 6. Option #1 would not be an improvement over the existing roadway design conditions. Although better, Option #2 would not significantly extend the pavement life. The option chosen was Option #3. This option is anticipated to result in “less differential deformation at the surface, fewer surface cracks and lower long-term maintenance cost” according to WFLHD. The estimated repair costs were $475,000, $585,000 and $675,000 for options #1, #2 & #3 respectively.

The maintenance of the Scenic Byway roadway falls to Beaverhead County which in addition to this roadway has over 1600 miles of county roads spread over 5560 square miles to maintain with a annual road budget of less than $2.4 million. Beaverhead County's matching share for the three options ranged from $70,000 for the no improvement option #1 to $99,650 for the extended longevity associated with Option #3.

Beaverhead County determined that the minimal increase in matching funds far out weighted the added long-term maintenance costs associated with the other two options. In addition upon reviewing the initial costs estimates for the three option, that due to the hauling of the aggregates to the remote site location, the actual cost difference in construction between the options was only the costs of the geosynthetics. This reinforced the decision to install the two layer system; a wicking geosynthetic layer on top of the subgrade fill and a second layer of geosynthetic under the base aggregates.

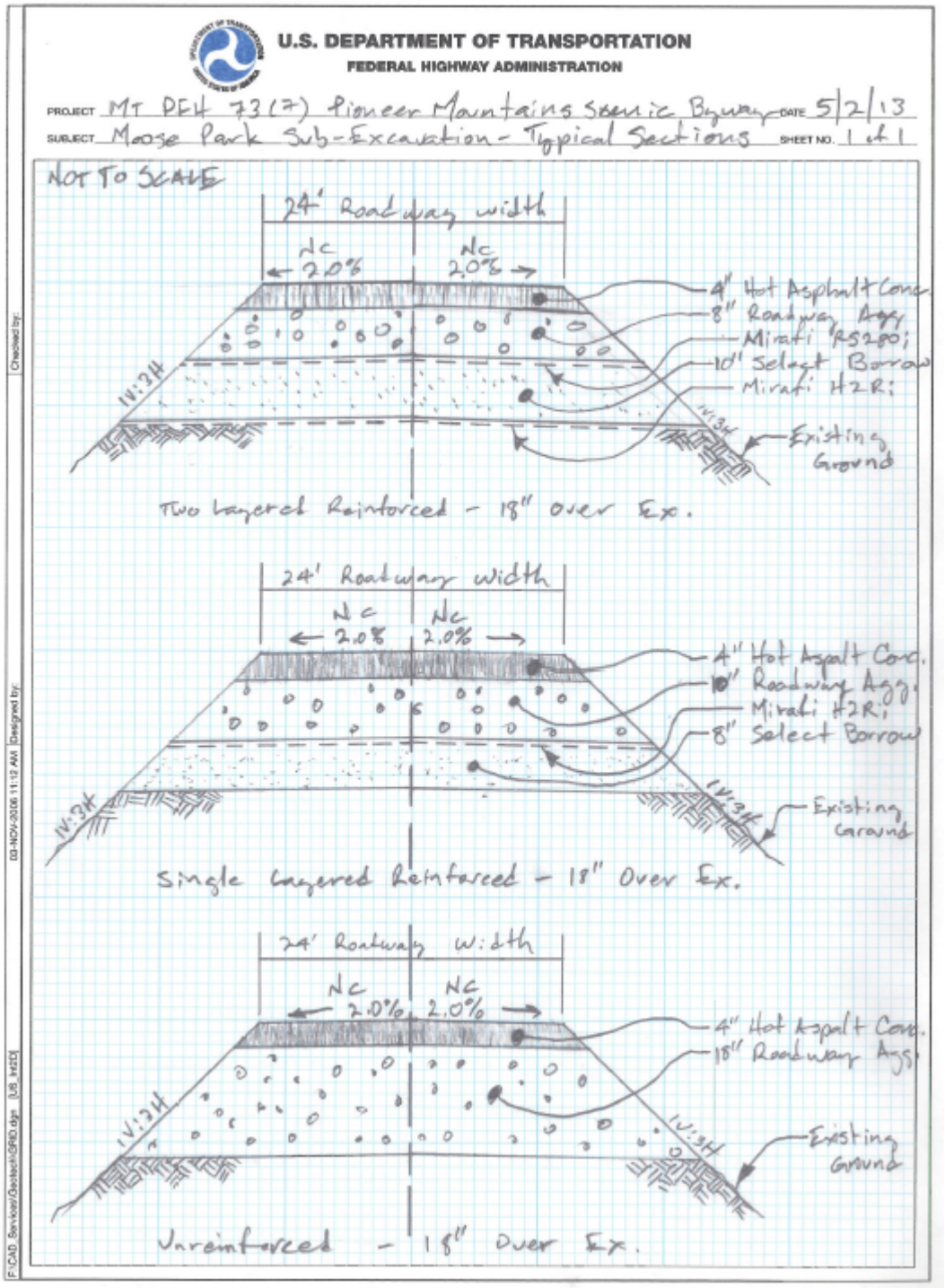

Figure 6 – Typical Cross-section Repair Options

Construction 2013

Construction began in October 2013 by the Beaverhead County maintenance department. Excavation uncovered the drainage pipe and geosynthetic that was utilized in 2004.

Beaverhead County Engineer was onsite along with technical representation from TenCate. Often geosynthetics are installed with a minimum overlap requirement. In the case of the wicking geosynthetic, the overlaps were installed “shingle style” so as to optimize water movement to the sides of the road. In super elevation cases, the material was overlapped from one side of the road to the next (Figure 7), and for a typical crown, the material was installed with the middle roll at the highest point similar to a roof shingle. (Figure 8)

Figure 7 – Overlap in Super Elevation

Figure 8 – Overlaps transitioning from Super Elevation to Crown

The select borrow was placed in a compacted 10” lift. At this point the project was put on hold through as winter in Montana began to set in. Final construction is expected in June of 2014.

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