Geosynthetics Reinforced Railway Twinning Project – Canadian National Railway – Aurora, ON

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Background

The Canadian National Railway (CN) Bala Subdivision is a major railway service line running between Toronto and Capreol in Northern Ontario, thus forming part of CN's transcontinental link between Southern Ontario and Western Canada. In addition to heavy rail traffic on this line, there is also weekday rush hour GO service and a handful of weekly Via Rail trips. In 2017, CN completed a two-kilometre rail line extension project which involved twinning the line to accommodate the considerable growth in rail traffic anticipated into the future.

Problem Statement

A portion of the twinning project between Mile 29.2 and 29.5 in Aurora, Ontario contained peat deposits up to 10 m in depth. In order to construct the twinned rail line, it was first necessary to build an access road across this peat deposit. Conventional construction techniques with the required heavy equipment operating on this soft, unconsolidated material would be impossible.

Solution

The final design incorporated a multi-layered geosynthetic reinforced raft intended to act as a working platform for construction operations and to ultimately carry the future train loads. In order to construct the twinned rail line, it was first necessary to build an access road across the peat deposit. The project designer proposed a solution that consisted of several elements including three different reinforcement geosynthetics and an embankment surcharge to act in concert to form a floating beam. In two locations along the peat deposit, fiber optic monitoring showed evidence of track settlement after placement of the initial surcharge. The designer and owner decided to bridge these zones with pile supported platforms.

Details

In order to construct the twinned line, it was first necessary to build a temporary road that would provide access to the variety of construction equipment required to complete the project. To erect this structure, the Engineer designed a temporary surcharge embankment that would allow the underlying peat to settle. To provide surrounding confinement to the surcharge, a series of five – 4.6m widths of high-tenacity polypropylene geotextile (GEO1) were sewn together at the factory to create 20-metre wide panels and deployed on top of the wet area (See Figure 1). This product was chosen due to its capacity to provide sewn seams in the 70 to 80 kN/m range. Subsequent 20-metre wide panels were then field laced together using 5-meter overlaps. This overlap was determined to be necessary as it was not possible to create a strong enough field seam on location due to the soft, wet site conditions. A 1.5 m surcharge was then placed on the GEO1 and allowed to settle. After placement of the initial surcharge, intermediate layers of a 70 kN/m @ ultimate strength polypropylene geotextile (GEO2) were installed at 0.5 m vertical spacing to allow the peat to consolidate uniformly and form a stable working platform for construction. See Figure 1 for section showing location of geosynthetics.

In two locations along the north end of the project, fibre optic monitoring showed evidence of track settlement after the placement of the initial surcharge on the GEO1. Further investigation determined this was due to the thickness of the peat in these areas (> 6 m). It was decided to bridge these zones with pile supported platforms. The piled platform consisted of 560 piles which were installed in the two affected areas. The piles were laid out in a series of rows evenly spaced parallel to the existing track. Each row consisted of 5 piles; the first 3 piles were vertical while the outer two piles inclined towards the new track. The pile furthest from the new track was given a larger catchment area given there were no train loads. The piles were covered with a granular geotextile reinforced layer followed by a typical railway structure. Figure 2 shows a plan view of the pile sections and Figure 3 shows a typical section view of the helical piles with a floating beam.

A reinforced soil beam composed of several layers of geotextile and granular material was designed to properly spread the load among piles 1-4. The soil beam consisted of three layers of an 800 kN/m x 100 kN/m ultimate strength polyester geotextile (GEO3) placed at equal intervals with the top and bottom layers being a single sheet of geotextile wrapped around to form a soil beam to support the track structure. In addition, a 32 oz/yd^2 nonwoven geotextile (GEO4) was placed on top of the pile caps to protect the GEO3 geotextile from being damaged by the pile cap edges. The design was adapted from the basic geotextile and pile platform design method described in the British Standard (BS) 8006.

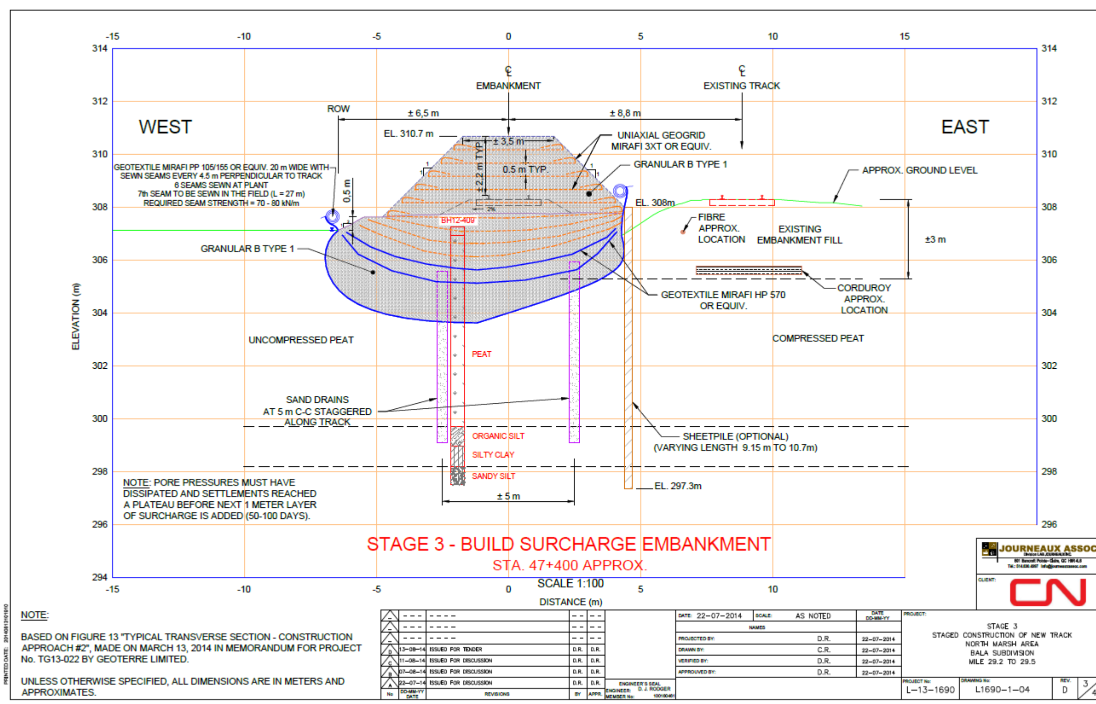

Figure 1: Section showing location of geosynthetics

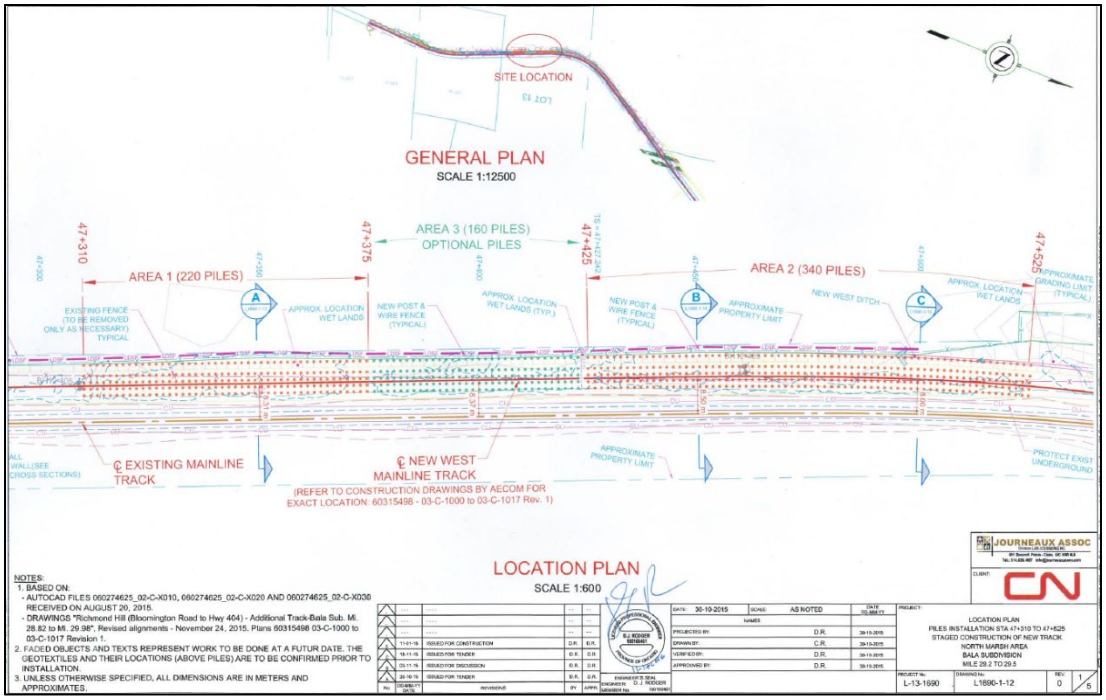

Figure 2: Plan view of the pile sections

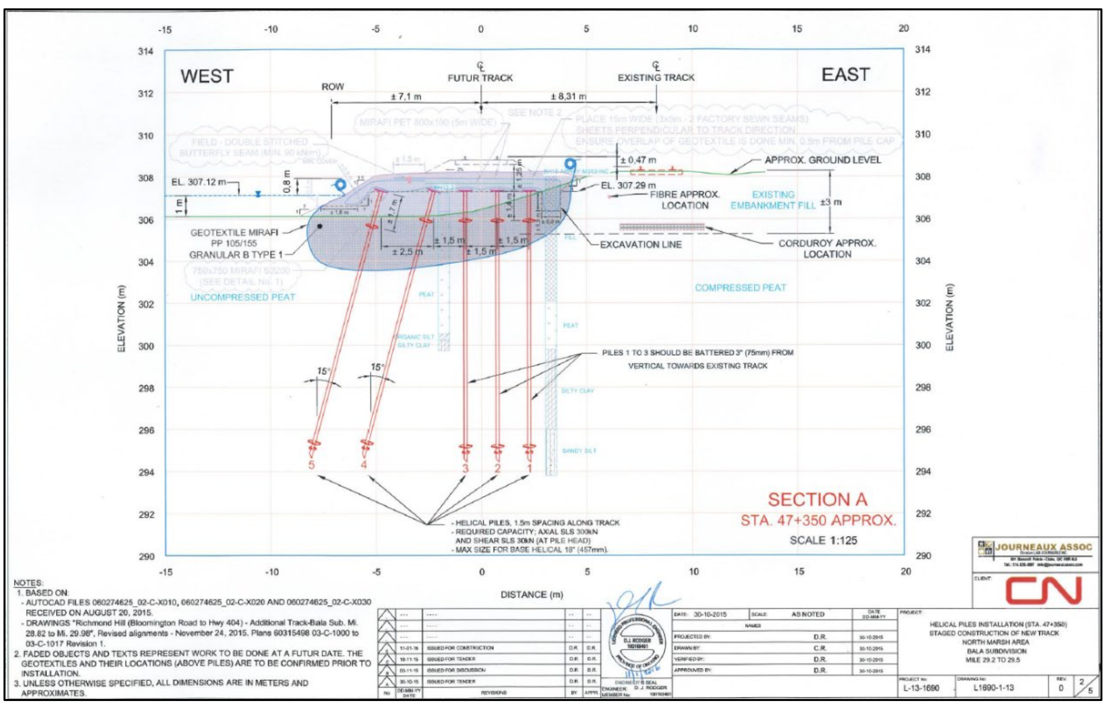

Figure 3: Typical section of helical piles with a floating beam