Redi-Rock™
Mechanically Stabilized Earth Retaining Wall System
Initial Report 2007-8
July 2007

Reporting on Work Plan 2005-S-8
Category II Experimental Project

State of Vermont
Agency of Transportation
Materials and Research

Neale Lunderville, Secretary of Transportation
Richard Tetreault, Director of Program Development
William Ahearn, Materials and Research Engineer

Prepared by:

Drew Gelfenbein, P.E.
Geotechnical Engineer

Reviewed by:

Christopher C. Benda, P.E.

Date: 7/11/07

Introduction

During the fall of 2006, the Vermont Agency of Transportation (VTrans) constructed a Redi-Rock™ retaining wall system as part of the Bethel BRF 0241(33)C2 project. The Redi-Rock™ retaining wall constructed during the project was designed to butt up against another Redi-Rock™ retaining wall that was previously constructed on an adjacent property. It was the designer's intent to have a finished product that appeared to be one continuous wall.

During the summer of 2006 a Redi-Rock retaining wall was built and subsequently added to the VAOT list of approved earth retaining systems for walls 8 feet or less in height with a back slope up to 30^{o}. This scope of the current report expands to wall heights in excess of 8 feet in height by adding the use of geogrid reinforcements into the soil mass creating a mechanically stabilized earth wall.

Souhegan Valley Engineering, Inc (SVE) provided the shop drawings for the project, based upon design criteria provided by VTrans. Since this was the State of Vermont's first time using this particular type of retaining wall on a federal aid project, it was designated a Category II Experimental Feature.

The Redi-Rock™ retaining wall system is an economical and aesthetically customizable product that worked reasonably well for this project. The wall height is 12 feet high by 68 feet long for a total area of 816 square feet.

The Redi-Rock™ retaining wall system was thought to be beneficial for several reasons:

- Complete details of the wall system would be solicited in advance and incorporated into the contract documents. This would allow contractors in this area not familiar with this type of construction to become better acquainted with the construction requirements.

- The design could be reviewed in advance by the Agency of Transportation. This would allow the Agency to resolve any problems it had with computations, allowable stresses, design loads, construction details and specifications, before bid letting.

- The Redi-Rock™ retaining wall system does not require a concrete footing. According to the manufacturer, it can be placed directly on a compacted crushed stone. Although for this project it was placed on a concrete footing due to the location along the river.

- In accordance with the Agency's "Policy on Earth Retaining Structures" dated November 1995, successful completion and satisfactory performance of this wall in the field would allow the addition of another retaining wall system to the Agency's Approved Product List and more competitive bidding of future projects.

- A Redi-Rock™ retaining wall would be more tolerant of differential settlement than a conventional reinforced concrete wall.

This report documents our observations during and post construction and provides a summary of our recommendations.

Product Description

The retaining wall system supplied by Redi-Rock™ International Inc was produced locally through Redi-Rock™ Walls of New England, a Carroll Company. The wall system achieves its structural integrity through the use of both its weight, the nodules cast into the blocks and a geogrid reinforcement as seen in Figure 1. The molds used during casting provide the appearance of an aesthetic stone facing.

Figure 1: Segmental piece of Redi-Rock wall illustrating the interlocking nodules cast into the blocks and geogrid reinforcement to be embedded in to the soil.

Wall Units

For this project, there were 4 different block types used. The type used was based on location, Top Blocks, Middle Blocks, Bottom Blocks or End Blocks. Figure 2 shows the shop drawings illustrating the dimensions of the different block types.

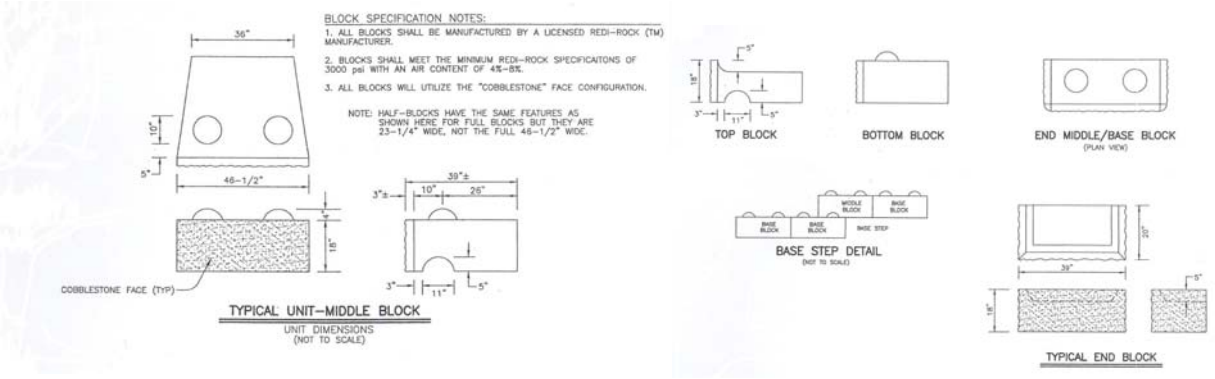

Figure 2: Typical block dimensions

Leveling Pad

This project required a concrete foundation for the Redi-Rock blocks due to scour concerns along the 3rd Branch of the White River. If the wall was constructed at a location where scour was not a concern, a leveling pad constructed of granular fill 12 inches thick and extending a minimum of 12 inches beyond either side of the base block would be a suitable foundation.

Design Considerations

The original design for the wall called for a stepped concrete footing on bedrock to be constructed with the wall height ranging from 13 feet to 18 feet tall. The contractor requested a change to the original plan. The contractor requested building a single level concrete footing on bedrock such that the wall height was 12 feet. Although this would require a larger volume of concrete this was requested because they felt it would be easier for them to construct a level footing then a stepped footing at this location. Due to the height of the wall geogrids reinforcements were required to be attached to the blocks and extended back into the soil mass for a distance of 13 feet. The original design included 3 different strength geogrids installed in 3 different lengths. The final design utilized 2 different geogrids which the contactor installed to the same length for ease of installation. The type of geogrids was based on the height of the wall and was specified on the plans. The geogrids were installed in a compacted select granular backfill. Geotextile was also placed directly behind the wall facing units as shown in Figure 3, to allow for drainage, but prevent erosion of the granular backfill.

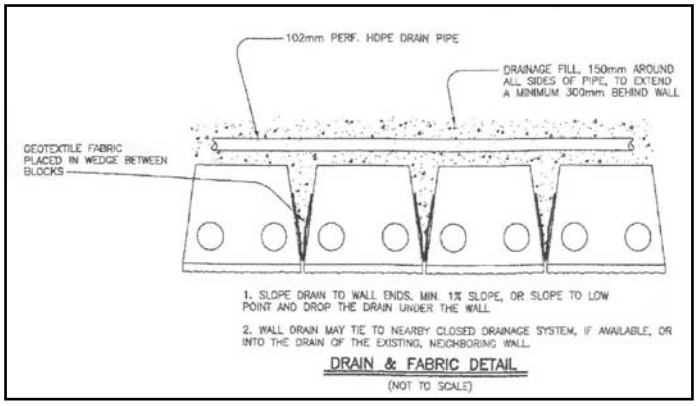

Figure 3: Typical geotextile placed between Blocks to prevent erosion of granular backfill.

A subsurface investigation for the project should include an analysis on the frost susceptibility of the insitu soil below the Redi-RockTM retaining wall. If frost susceptible materials are present it might be necessary to remove and replace the insitu soils with a granular borrow and to provide a drainage system.

Construction

The Redi-Rock™ retaining wall system was assembled by Kubricky Construction. See Figure 4 for Typical Cross-Section.

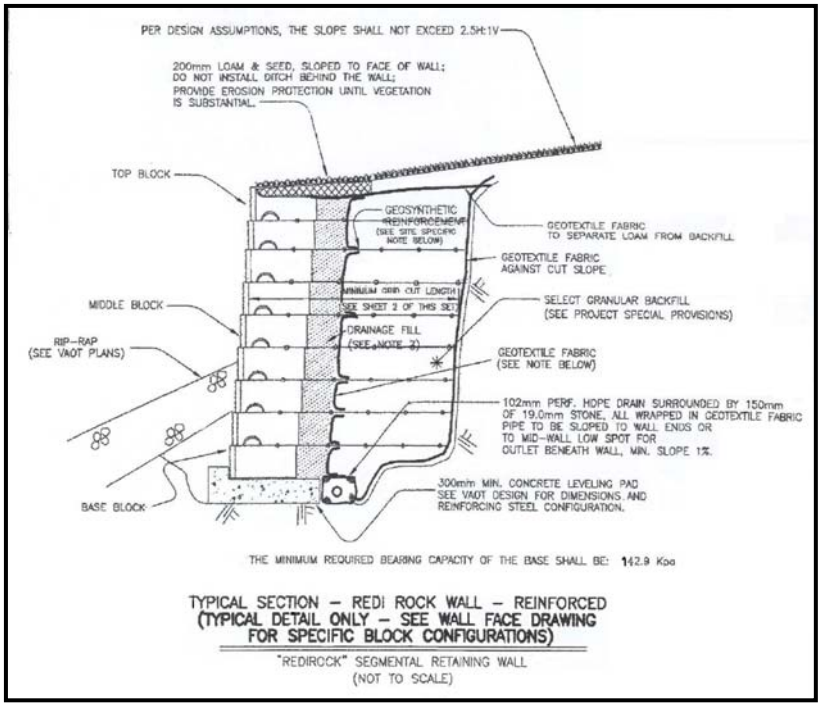

Figure 4: Typical cross section of Redi-Rock™ retaining wall.

The first stage of construction required the excavation of the insitu soil and construction of the concrete footing. Blocks were then installed in rows, setting the first block of each row adjacent to the existing Redi-Rock™ retaining wall (Figure 5). A concrete shear key was constructed into the footing. This is used to help resist lateral earth pressures and for the alignment of the first course of blocks. As the rows of blocks were installed the select granular backfill would be placed behind the blocks and compacted. The geogrid would be installed per the manufacturer's recommended attachment procedure. Figure 6 shows a typical view of the construction

Figure 5: Installation of 1st row of blocks

sequence. The select granular backfill has been placed over the geogrid, the excavator moved onto the backfill material so the other half of the row could be constructed. The excavator was not permitted to ride directly on the geogrid. A minimum of 12 inches of backfill material had to be placed prior to the excavator being allowed over the location of the geogrid. The geogrid is attached to the wall system by wrapping the geogrid around a piece of reinforcing steel that is placed in a channel that is pre-cast into the top of the block.

Figure 6: Geogrid installation

The design of the project required that a drainage pipe be installed through the front face of the retaining wall. The Redi-Rock system easily accommodated this feature. The contractor used a half size block adjacent to the drainage pipe as shown in Figure 7. Some of the blocks at the end of each row were saw cut to fit next to the bridge abutment.

Figure 7: Drainage pipe installed through Redi-Rock™ wall.

The final step in constructing the wall was the installation of the railing into the top row of blocks. Holes were cored into the concrete to allow for the installation of the railing. The railing system installed was chosen to match the railing on the existing Redi-Rock™ retaining wall.

The installed price for the wall was approximately $51.50 per square foot.

Observations

- The only issue that the contractor brought up as a concern was the alignment of the channels to secure the reinforcing steel wrapped by the geogrid. As shown in Figure 8 the channels do not line up well. This required the contractor to use shorter lengths of reinforcing steel bars. The contractor was generally limited to bar lengths equivalent to 2 block widths. This does not affect the overall wall design.

Figure 8: Reinforcing steel channels out of alignment

- The Contractor was pleased with the ease of installation of the wall system and stated that they would not hesitate to use this system on other projects.

Recommendations

The walls discussed in this report incorporated the use of geogrids as a stabilizing force in the performance of the structure. This wall system provided an acceptable Mechanically Stabilized Earth Wall to this project (Figures 9a & 9b). In the future, the Redi-Rock™ retaining wall system will need to be designed on a project specific basis due to the wall height, variability in soil conditions and external loads acting on the retaining wall.

In conclusion, it is recommended that the Redi-Rock™ retaining wall system be approved for use on Agency projects and be added to the Vermont Agency of Transportation Earth Retaining System Selection Chart for Mechanically Stabilized Earth walls.

As the walls were constructed during the fall of 2006, we have not had the opportunity to monitor the long term performance. It is also recommended that this project be monitored into the future for any adverse changes and the changes be reported in future updates.

Figure 9a: Completed Redi-Rock Retaining Wall

Figure 9b: Completed Redi-Rock Retaining Wall