

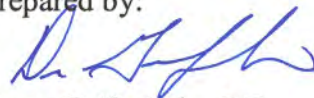
**Redi-Rock™
Retaining Wall System
Initial Report 2006-6
December 2006**

**Reporting on Work Plan 2003-S-1
Category II Experimental Project**

State of Vermont
Agency of Transportation
Materials and Research

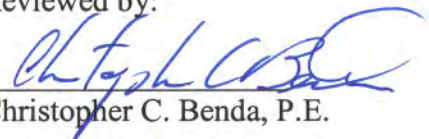
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Introduction

During the summer of 2006 the Vermont Agency of Transportation constructed a Redi-Rock™ retaining wall system as part of the Burlington MEGC 5000(15) project. There were 2 Redi-Rock™ retaining walls designed into the project as part of the roadway reconstruction.

Souhegan Valley Engineering, Inc (SVE) provided the shop drawings for the project, based upon design criteria provided by CLD Consulting Engineers. 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. Both walls vary in height from 3.0 feet to 7.5 feet. Wall #1 is 89 feet in length and Wall #2 is 93 feet in length, for a total wall area of approximately 768 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.
- 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.
- According to the manufacturer, the Redi-Rock™ retaining wall system does not require a 4 foot embedment for frost protection. A 1 foot embedment was specified, significantly reducing the amount of excavation required when compared to a cast in place concrete retaining 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 and nodules cast into the blocks 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.

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.

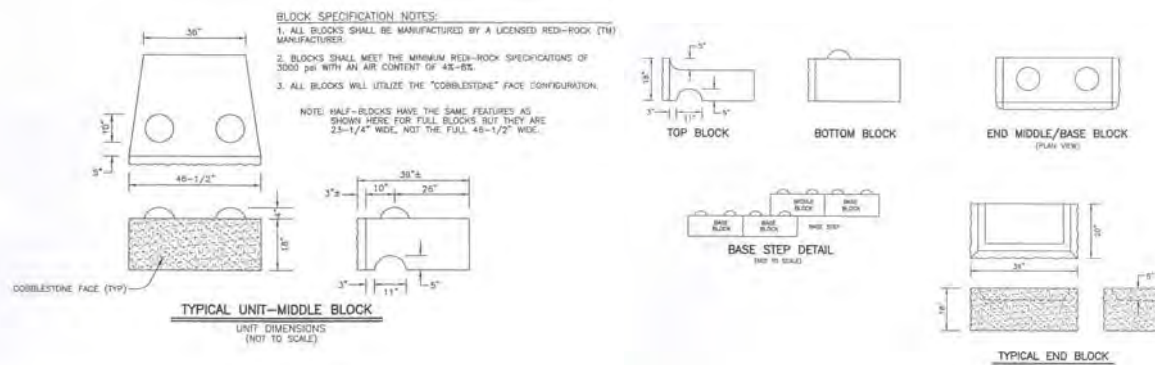


Figure 2: Typical block dimensions

Leveling Pad

The leveling pad is the base for the Redi-Rock™ retaining wall system. It needs to be constructed of granular fill 12 inches thick and extending a minimum of 12 inches beyond either side of the base block.

Design Considerations

The height of the walls ranged from 3.0 to 7.5 feet high. Although not a tall wall, a standard cast in place concrete wall would have required an embedment of 4 feet for frost protection. This would have required a substantially larger excavation and replacement of material than the 1 foot embedment required for the Redi-Rock™ wall. There was also no field form work as would be necessary for a cast in place concrete wall allowing for construction during a broad range of weather conditions. The design required 2 feet of Granular backfill for structures placed behind the wall to prevent the build up of hydrostatic pressures and a geotextile fabric to separate the insitu soils from the granular backfill. Geotextile was also placed directly behind the wall facing unit to allow for drainage, but prevent erosion of the granular backfill.

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

Construction

The Redi-Rock™ retaining wall system was assembled by the Don Weston Excavating Inc from Williston, Vermont. See Figure 3 for Typical Cross-Section.

The first stage of construction involved placing the 12 inch thick granular borrow layer. The contractor was originally going to use 12 inches of ¾" crushed stone, but it was found that it was difficult to get a slight batter on the bottom row of blocks. By using 10 inches of the ¾" crushed stone beneath 2 inches of a 3/8" crushed stone the desired grade was more readily achieved. This recommendation was provided by

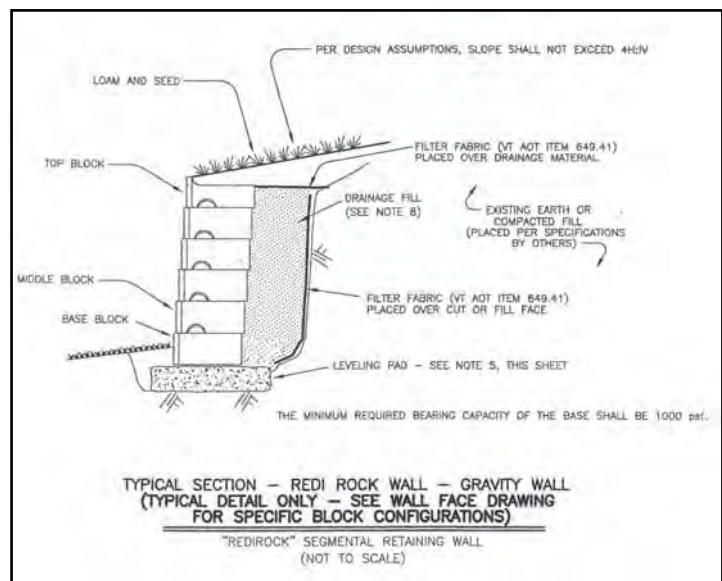


Figure 3: Typical cross section of Redi-Rock™ retaining wall.

the manufacturer's representative, but was not detailed in the plans.

The plans called for a 15 foot radius curve in each of the Redi-Rock™ walls as shown in Figure 4. It was found during installation that this could not be achieved for this location. The installation plan was changed to have the walls turn at a 90° angle, replacing the 15 foot radius curve. Figure 5 shows the walls as constructed.

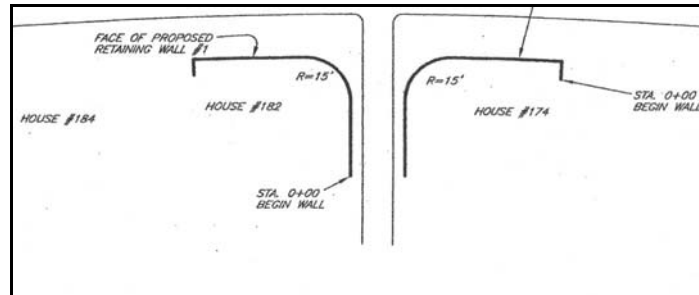


Figure 4: Proposed radius curve



Figure 5: Retaining Walls 1 and 2 constructed with a 90° turn.

During construction retaining wall #1 was extended approximately 80 feet to include an adjacent property (Figure 6) and a third Redi-Rock™ wall was added to the project. The additional wall is approximately 60 feet in length and has a face area of 320 square feet. The contractor after having installed the first 2 walls, found the third to proceed at a much faster pace. It only required 2 days to install the third Redi-Rock™ wall after having been through the learning curve required to install the first 2 walls. The installed price for the third wall was approximately \$30 per square foot compared with approximately \$33 per square foot for the first 2 walls. In the contract the pay item for the wall was based upon a linear foot measurement. This method of

payment does not easily allow for payments due to field fit variations in wall design or changes in design. The pay item should be per square foot of wall face.



Figure 6: Retaining Wall 1 extended west to include adjacent property.

Observations

- The original plans did not require or show underdrain below or behind the bottom row of blocks. The resident engineer felt that this was an oversight and should have been included. A drainage system was added to the project during construction.
- On gradual curves there is enough “play” in the interlocking nodules such that the wall can be constructed unimpeded. The nodules are on the tops of the blocks and the receiving dimples on the bottom of the blocks are placed during the casting process. They appear to be placed assuming that the wall will be linear. When the wall is constructed on a curve the nodules and dimples do not line up adequately causing the contractor to saw cut some of the nodules. It would seem that this process would reduce the interlocking shear capacity of that wall section.
- The wall system allowed for the easy addition of another row of blocks. One of the property owners was not satisfied with the original wall and requested that the wall height be increased.
- The Resident Engineer felt that the specifications did not provide enough detail with regards to quality control. The special provisions should be more specific in the requirements for acceptance of the modular blocks.

- 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 specification should be written in such a manner as to allow the inspector more authority to reject blocks. Section 540 of the 2006 Vermont Standard Specifications for Construction adds some of the needed requirements for the construction of this wall system, but it does not include tolerances for fabrication, damage that allows refusal of a block, and construction tolerances.
- There should be more details for drainage around the Redi-Rock™ Retaining walls.
- The ability to construct a specific radius curvature needs to be investigated prior to incorporation into the plans.
- The pay item for the wall was based upon a linear foot. This should be changed to a square foot of wall face.

The walls discussed in this report did not incorporate the use of geogrids as a stabilizing force in the performance of the structure. The scope of this report is intended to only include the Redi-Rock™ wall system for structures 8 feet in height without geogrid reinforcements. In the future, the Redi-Rock™ retaining wall system will need to be designed on a project specific basis due to the variability 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 walls 8 feet or less in height with a back slope up to 30°.

As the walls were constructed during the summer 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.