

T-WALL®
Precast Concrete Retaining Wall System
Initial Report #2002-1
March 2002

Reporting on Work Plan 96-S-3
Category II Experimental Project

State of Vermont
Agency of Transportation
Materials and Research Division

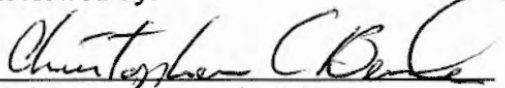
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16. Abstract In 2001 the Vermont Agency of Transportation (VTRANS) completed the State's first T-Wall® precast concrete retaining wall system in the Town of Hartford, Vermont. The project involved the construction of a 1.75 km (1.09 mile) pedestrian transportation path along U.S. Route 5. The T-Wall® system was selected as a product to reduce construction costs, to produce an aesthetically pleasing wall system and to allow for multiple configurations. This product is a proprietary system of The Neel Company. The system is a gravity structure composed of "T" shaped concrete units, which provide facing and frictional resistance to horizontal movement. The project has been monitored since the beginning of construction. An inclinometer was installed on the tallest wall and has provided important data as to the integrity of the T-Wall® precast concrete retaining wall system.			
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**Vermont Agency of Transportation
Technical Services Division
Materials and Research Section**

To: Distribution List
From: William Farley, Civil Engineer I, via Christopher C. Benda, P.E., Soils and Foundations Engineer *CCB*
Date: March 21, 2002
RE: Hartford STP Bike (8)S- Work Plan Report 96-S-3

Attached is a copy of the report on Work Plan 96-S-3 for the T-Wall® Precast Concrete Retaining Wall System built in Hartford, Vermont in the summer of 2001. The report was prepared by William Farley and Christopher Rea to report on the feasibility of using T-Wall® systems as an approved earth retaining system by the State of Vermont.

Please circulate these reports to interested individuals within your section. If you have any questions or comments or would like to request additional copies please call the Soils and Foundations office at (802) 828-2561.

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March 21, 2002

The Fort Miller Co., Inc.
P.O. Box 98
Schuylerville, N.Y. 12871-0098

Attention: Peter J. Smith, P.E.

Subject: Hartford STP Bike (8)S – Work Plan 96-S-3

Dear Mr. Smith:

Attached is a copy of the report on Work Plan 96-S-3 for the T-Wall® Precast Concrete Retaining Wall System built in Hartford, Vermont in the summer of 2001. The report was prepared by William Farley and Christopher Rea to report on the feasibility of using T-Wall® systems as an approved earth retaining system by the State of Vermont.

We appreciate your business and look forward to working with you in the future. Please feel free to call me at (802) 828-2561 if you have any questions or concerns.

Sincerely,

Christopher C. Benda, P.E.
Soils and Foundations Engineer

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(See Page 2)

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Introduction

In 2001 the Vermont Agency of Transportation constructed its first T-Wall[®] precast concrete retaining wall system on the Hartford Transportation Path Project. The transportation path begins near the intersection of Gillette Street and U.S. Route 5 in Wilder and extends westerly along U.S. Route 5 approximately 1.75 kilometers (1.09 miles) ending at the playground area of the Dothan Brook School on Christian Street (*see fig. 1*). The town of Hartford was granted funding to establish a transportation path along U.S. Route 5 to help improve safety along the roadway as well as improve the aesthetics of the area. The project required several hundred meters of retaining wall along the project, which was quite visible from the roadway as well as from the residential neighborhood. Thus, such high, public visibility required the Agency to find a retaining wall system that would not only be structurally proficient, but would blend in well with the surrounding area. The State of Vermont prior to this project had not built the T-Wall[®] system, prefabricated modular gravity wall. Based on the performance of this wall system in other states it was decided that the T-Wall[®] system may be a useful design tool for the construction of fill walls in the state of Vermont. Due to the desire by the Agency and the manufacturer to approve this type of wall system for regular State use, the T-Wall[®] system was designated a Category II Experimental Project.

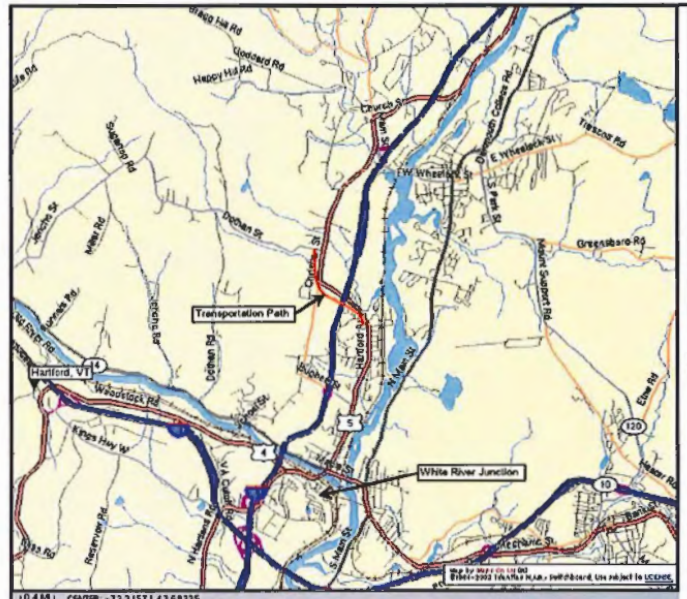


Figure 1. Location Plan of Transportation Path

The T-Wall[®] precast concrete retaining wall system is an economical and aesthetically customizable product that worked very well for this project. Overall the path required roughly 1043 square meters (11226 square feet) of retaining wall of which approximately 607 square meters (6538 square feet) of wall was constructed in a fill application and 436 square meters (4688 square feet) of wall was constructed in a cut application.

The T-Wall[®] system was determined to be beneficial for several reasons:

- Complete details of the wall were provided prior to bidding to allow contractors to become more acquainted with the construction requirements and procedures.
- The design could be reviewed in advance to allow the Agency to resolve any problems it had with stresses, loads, construction details, and specifications before bid letting.

- The T-Wall[®] system was expected to be more tolerant of differential movement than conventional reinforced concrete walls. Details of modular unit placement, connectors, and fabrication procedures are specific and would be provided by the proprietary wall company during early stages of the project, further reducing uncertainties. Since units are cast in a controlled plant environment, finish, section uniformity, and overall quality can be monitored more closely.
- T-Wall[®] systems should be significantly less costly to construct than a conventionally reinforced concrete retaining wall. The geometric flexibility, durability and ease of construction should be equal to or better than cast-in-place reinforced concrete.

Product Description

The T-Wall[®] is a pre-cast reinforced concrete retaining wall system. A cast in place reinforced concrete leveling pad provides the proper alignment for the first course of wall units. The wall consists of prefabricated modular blocks. Concrete shear keys hold the sections true, and filter fabric placed on the back of the units help keep the backfill material from seeping through the joints. As the wall units are stacked, each level is backfilled with an approved backfill material (see fig. 2).

Leveling Pad

The leveling pad is the base for the T-Wall[®] system. It is constructed of reinforced concrete and when on ledge dowels are typically used to prevent any lateral movement. The front of the first level of wall units rests on the leveling pad and the stem is adjusted with shims. If the wall is designed to have a batter, then the leveling pad is finished with the same batter.

Wall Units

Each unit has a face dimension of 750 mm (2.5 feet) high and 1500 mm (5 feet) wide and weighs 900 kilograms (2000 pounds). The stem length varies in 600 mm (2 foot) increments according to the height of the wall and various surcharge loads.

Backfill Material

A wide range of backfill materials can be used with the T-Wall[®] system due to the mass of the sections and its interaction with the backfill material. The pre-cast "one piece" concrete units eliminate most soil chemistry (corrosion) concerns. The VT Agency of Transportation specified a standard granular backfill for structures to be used.

Shear Keys

Shear keys are typically wrapped in cork and placed between the teeth of joining wall unit stems. The keys serve to prevent lateral movement of the wall units during backfill operations.

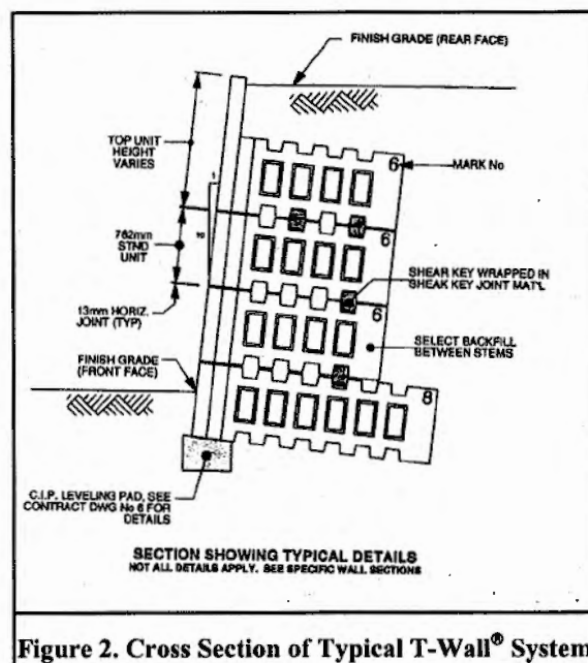


Figure 2. Cross Section of Typical T-Wall[®] System

Design Considerations

Battered walls were designed to save money enabling shorter stem lengths. If a battered T-Wall® system is to match up to an existing structure i.e. a bridge abutment, care must be taken to transition the batter to a vertical orientation.

The construction cost for a T-wall® system is considerably less than other forms of retaining wall designs. The T-Wall® system installed on the bike path costs \$225 per square meter (\$21 per square foot) excluding the leveling pad, backfill, and excavation. The temporary shoring for the project was \$85 per square meter (\$8 per square foot) compared to an average cost of \$215 per square meter (\$20 per square foot). A soil nail wall built in 2001 in Middlesex, Vermont cost approximately \$750 per square meter (\$70 per square foot). A cast in place reinforced concrete retaining wall comparable in size to the T-Wall® costs roughly \$605 per square meter (\$56 per square foot).

Construction

The T-Wall® retaining wall system was designed by The Neel Company out of Springfield, Virginia and the sections were pre-cast by the Fort Miller Co. in Schuylerville, New York. The Morrill Construction company of North Haverhill, New Hampshire assembled the wall.

Cut Area

A large cut area with limited right of way behind the proposed wall, exists between Stations 0+290.24 and 0+345.32. Temporary sheet piling (*see fig. 3*) was driven as well as anchors installed to provide slope stability during the wall assembly. The existing material was cleared down to ledge and the leveling pad was poured 500 mm (20 inches) wide by 300 mm (12 inches) thick and finished to a 1:10 (horizontal: vertical) batter. The first row of concrete units was placed, aligned, leveled, and plumbed. Filter fabric was placed in the vertical joints between each unit before backfill material was placed. The backfill was then compacted before the next lift of wall units was placed. As the wall height increased and backfill was placed the corresponding row of anchors in the sheet piling was cut to allow the sheet piles to be removed once the wall was completed.



Figure 3. STA 0+320 Fill Wall Constructed in a Cut Slope Retained by Sheet Piling

Fill Area

Another T-Wall[®] was constructed in a fill area located between Station 0+700.00 and 0+802.62. At Station 0+802.62 the wall connected to a wingwall for the pedestrian bridge on the path (*see fig. 4*). This portion of the wall connects into the pedestrian bridge wingwall, which has a vertical face. The T-Wall[®] system allowed each concrete unit to be incrementally adjusted so the batter transitioned from 1:10 to vertical matching the abutment face. The leveling pad dimensions were also 500 mm (20 inches) wide by 300 mm (12 inches) thick and poured on compacted soil.



Figure 4. STA 0+800 Fill Application Next to Bridge Abutment

Summary

The T-Wall[®] retaining wall system constructed for the Hartford Transportation Path Project along U.S. Route 5 has shown how economical and aesthetically pleasing this type of retaining wall can be (*see fig. 5*). The Vermont Agency of Transportation is planning on further use of the T-Wall[®] system on future projects. For constructing retaining walls in fill applications up to 20 feet in height the T-Wall[®] system seems to be a viable answer in the age of rising costs.

As of the date of this report the T-Wall[®] retaining wall system has performed as calculated. An inclinometer installed at Station 0+320 (*see fig. 5. red pole at top of wall*) has shown no movement. The wall has been well received by the residents of the surrounding area. This path was so well received that the residents would like the path to be maintained for year round use. The path is utilized by commuting students as well people of all ages for exercise and leisure allowing them safe passage along U.S. Route 5.



Figure 5. Finished Wall at STA 0+320

Recommendations

Future applications of the T-Wall[®] system should address and be designed to include:

- Monitoring instrumentation should be installed for a more accurate picture of the before and after effects of the T-Wall[®] system. Instruments such as tilt-meters and inclinometers to monitor any lateral wall movement should be used. Settlement platforms under the leveling pads, if placed on compacted soil, should be utilized to monitor any vertical movement.
- If the T-Wall[®] system is connected to other structures, such as in this case a wingwall for the pedestrian bridge, there should be further coordination in the design phase to alleviate any compatibility issues between the two structures. For example going from a battered wall to a vertical face, plans should indicate which structure will be built first and how those structures will interact. Finally coordinate the final elevations between the wing walls and T-Wall[®].
- Care should be taken when compacting the backfill behind the T-Wall[®] units to prevent lateral movement.
- In fill situations, design plans should anticipate the elevation of the stem of each concrete unit of the top lift making sure they are not left exposed.
- Drainage should be addressed in the design phase to prevent pooling of surface water. For this project it was essential that the finished grade of the pathway be higher than the highest T-Wall[®] units to allow for drainage (in the fill situations).
- When ledge is present on the project it is essential to know the elevations of the ledge to prevent an excessive concrete sub-footing.
- The cut applications required stone fill at the finished grade. It was evident that if too much fill was used it could fall from the top of the wall and onto the path. The fencing utilized at the tops of the T-Wall[®] left gaps between the top of the wall and bottom of the fence increasing the chances of rock fall (see fig. 6).



Figure 6. Fence Profile at STA 0+330

In conclusion it is recommended that the T-Wall[®] retaining wall system be approved for use on Agency projects and be added to the Vermont Agency of Transportation Earth Retaining System Selection Chart.

It is also recommended that this project be monitored into the future for any adverse changes and that these changes are reported in future updates.