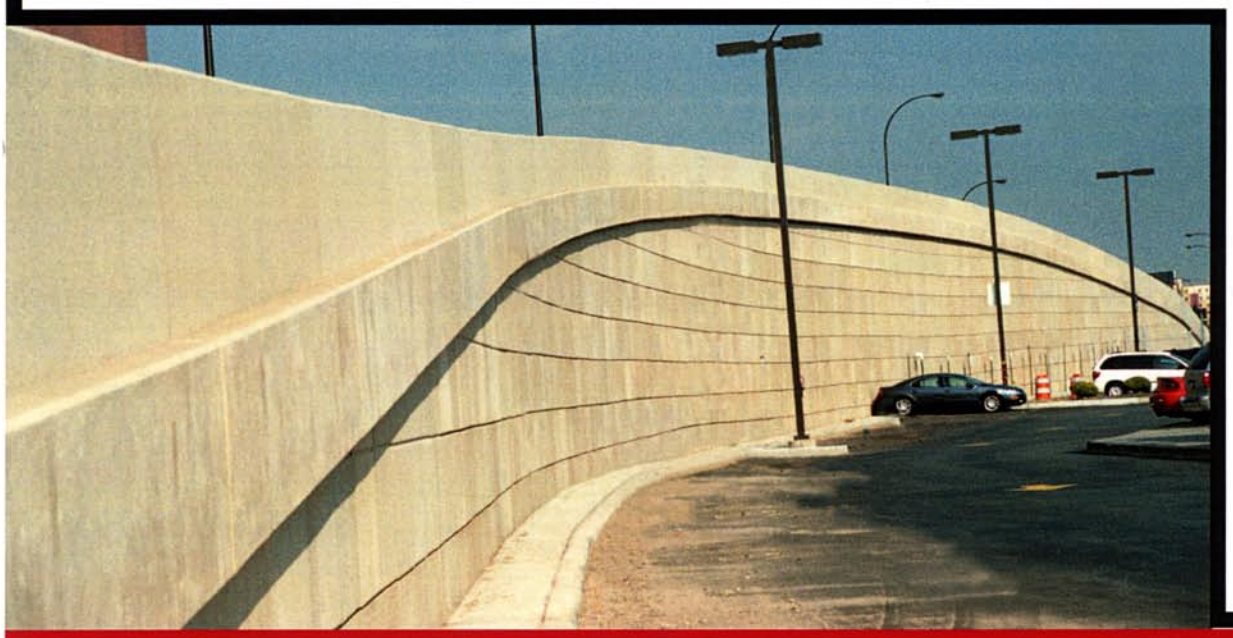
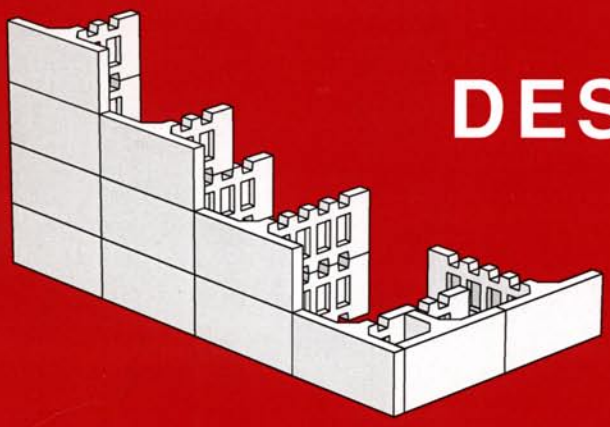
T-WALL® Retaining Wall System





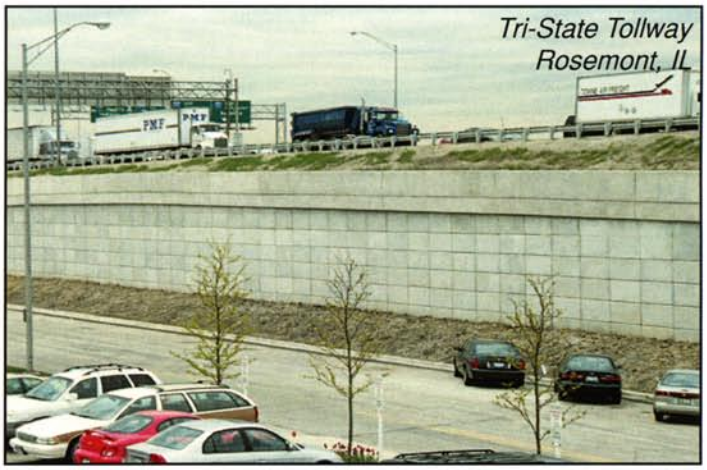
DESIGN GUIDE

& TECHNICAL INFORMATION

Revised 09/05

APPLICATIONS

- Highway and Roadways
- Railways
- Waterways, Bank Stabilization
- Bridge Approaches & Abutments
- Wingwalls
- Site Improvements
- Parking Facilities
- Trash Transfer & Dump Walls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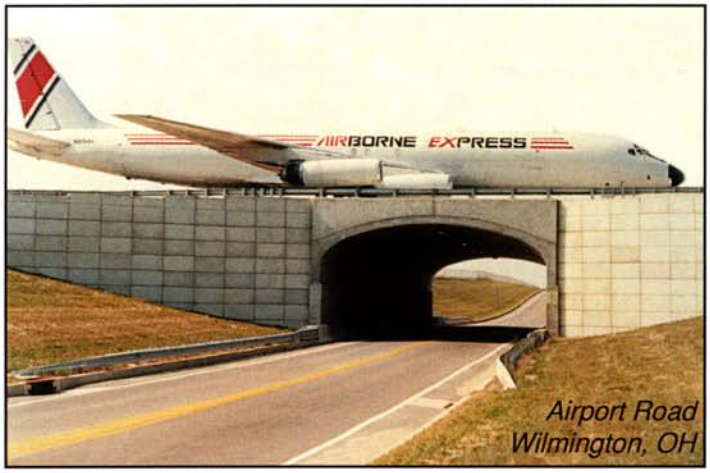
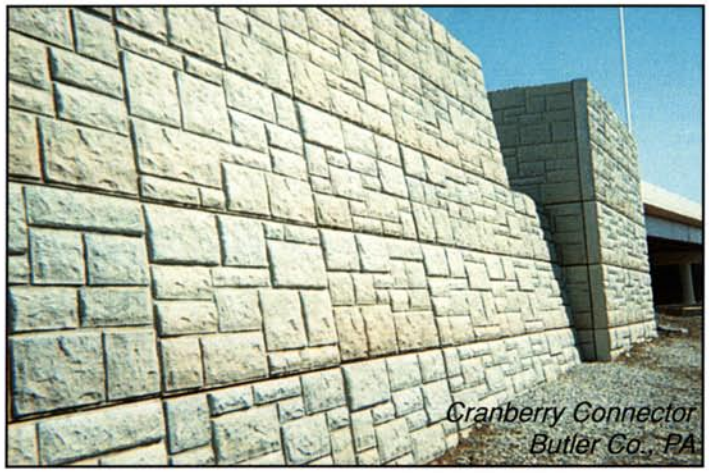
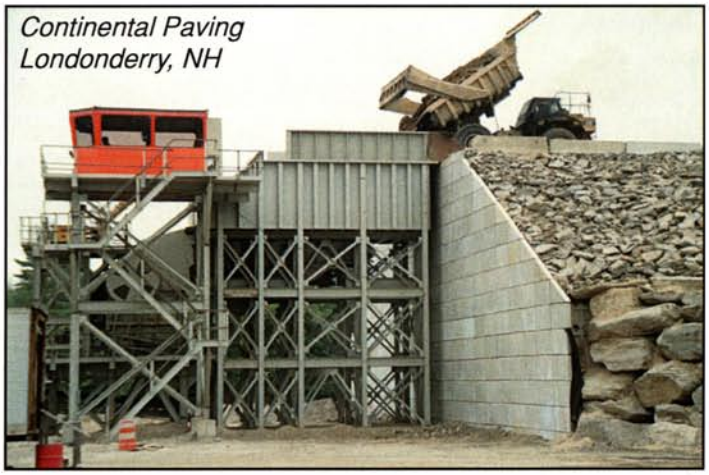
Rosemont, IL

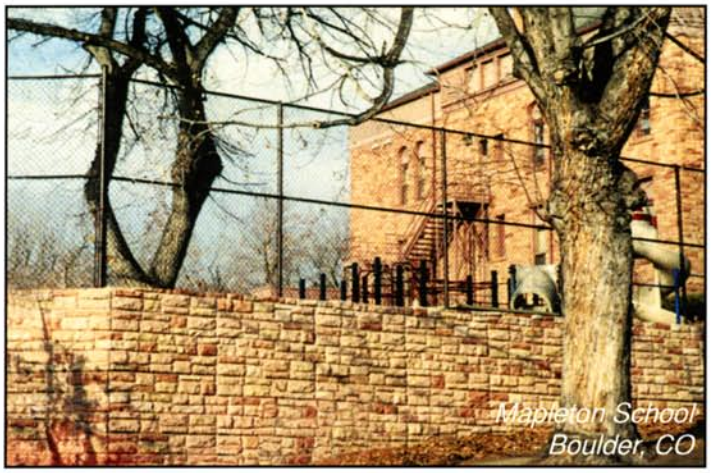


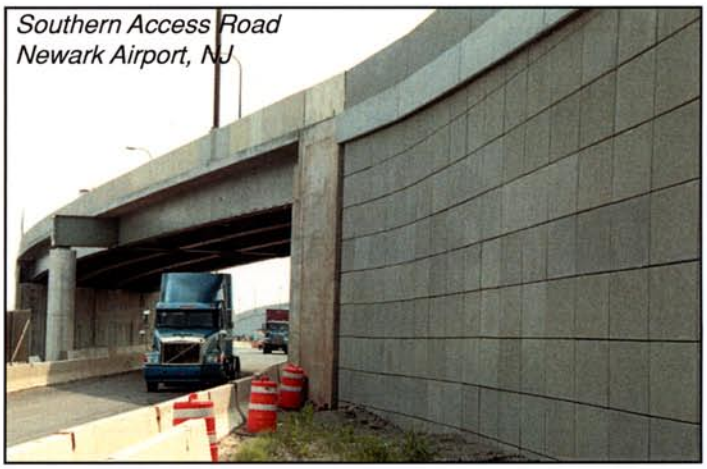
Airport Road
Wilmington, OH


Framingham College
Framingham, MA


Cranberry Connector
Butler Co., PA


Continental Paving
Londonderry, NH


Mapleton School
Boulder, CO


Southern Access Road
Newark Airport, NJ

T-WALL® Retaining Wall System

Design Guide and Technical Information

– CONTENTS –

– NOTE TO READER –

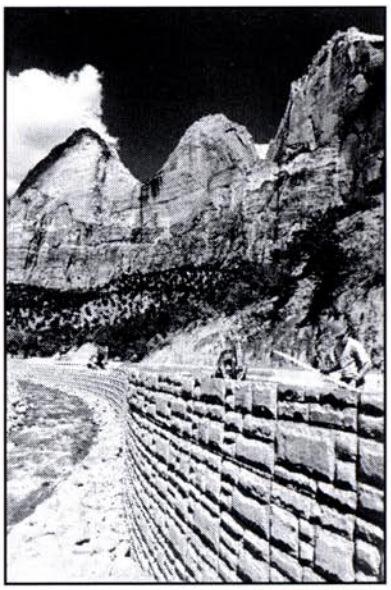
The information presented herein is provided solely as general information for the T-WALL® Retaining Wall System user. Specific projects are designed by The Neel Company.

The T-WALL® Retaining Wall System provides solutions to a number of earth retention problems commonly encountered on highway, railway, public works, commercial and industrial projects.

T-WALL is a gravity retaining wall structure that combines the design principles for externally stabilized retaining walls (concrete modular wall) with the frictional resistance of internally stabilized systems to create a structural mass that will resist the sliding and overturning forces.

The Neel Company has been actively involved in the design, manufacture and construction of the *T-WALL® Retaining Wall System* for over 20 years. Our experience allows us to offer a comprehensive design package from concept to completion, with exceptional technical assistance. Neel Company engineers thoroughly address issues of feasibility, geotechnical conditions, physical restraints, loading requirements, specifications, production schedules, and construction procedures.

Our goal is to provide an integrated retaining structure that meets your project requirements and exceeds your expectations for quality and customer service.



Sentinel Slide
Zion National Park, UT

US PATENT #4684294

FROM "CONCEPT TO COMPLETION"

Consulting and Design Engineering:

- Preliminary design and budgeting assistance.
- Sealed drawings and internal stability calculations.
- Shop drawings for fabrication.
- Geotechnical and structural review.
- Interface T-WALL with existing and proposed structures.
- Design of special units to accommodate utilities and drainage structures, headwalls, barriers, parapets, light standards, and guard railing as required.

Lisburn Road, Cumberland Co., PA

Material Supply:

- Manufacturers are pre-qualified and licensed by The Neel Company.
- Available throughout North America.
- Designed in accordance with AASHTO specifications.
- Complies with ACI, ASTM, and AREMA codes.

Construction Assistance and Coordination:

- Preconstruction advice and technical know-how to assure speed and efficiency.
- Construction sequencing assistance.
- On-site training at the start of the project.
- On-going communication throughout construction.

T-WALL SOLUTIONS FOR VARIOUS SITE CONDITIONS AND PROJECT REQUIREMENTS

Reduce Cut Excavation – For gravity walls requiring excavation for installation, the base-to-height ratio for T-WALL is equal to or less than other wall types. In addition, T-WALL may be built on a batter, further reducing the base-to-height ratio.

Space Restrictions – Where space is limited for the gravity structures by right-of-way or utilities, the shorter base width or stem lengths is an advantage.

Bearing Capacity and Settlement - The full-height vertical joints at five-foot intervals act as slip planes that can accommodate total and differential settlement without structural distress. This feature can minimize foundation improvement cost when additional bearing capacity is required.

Foundation Improvement - T-WALL may be used in conjunction with a variety of foundation improvement techniques to minimize settlement such as:

- Consolidation with the permanent structure by staged construction.
- Reinforced mats.
- Stone or vibro-compacted concrete columns.
- Over-excavation and replacement.

T-WALL SOLUTIONS – continued

Select Backfill - The backfill between the stems is an important part of the T-WALL structure. A wide range of backfill specifications is possible depending upon the loads on the structure, water conditions and available backfill. The precast concrete unit eliminates soil chemistry concerns and allows the use of the most economical backfill materials available, including crushed concrete and bottom ash. The stepped section design combined with a shorter base width greatly reduces the amount of select fill when compared to other wall types.

Corrosion – The all-concrete system provides excellent long-term service life wherever corrosion is a consideration. Corrosion is an important concern in projects where stray current, water, soil chemistry and hazardous materials are a factor.

Impact – The dense reinforced concrete wearing surface provides resistance to the erosive effects of water and ice. The weight and interlock of the units provide resistance to impact.

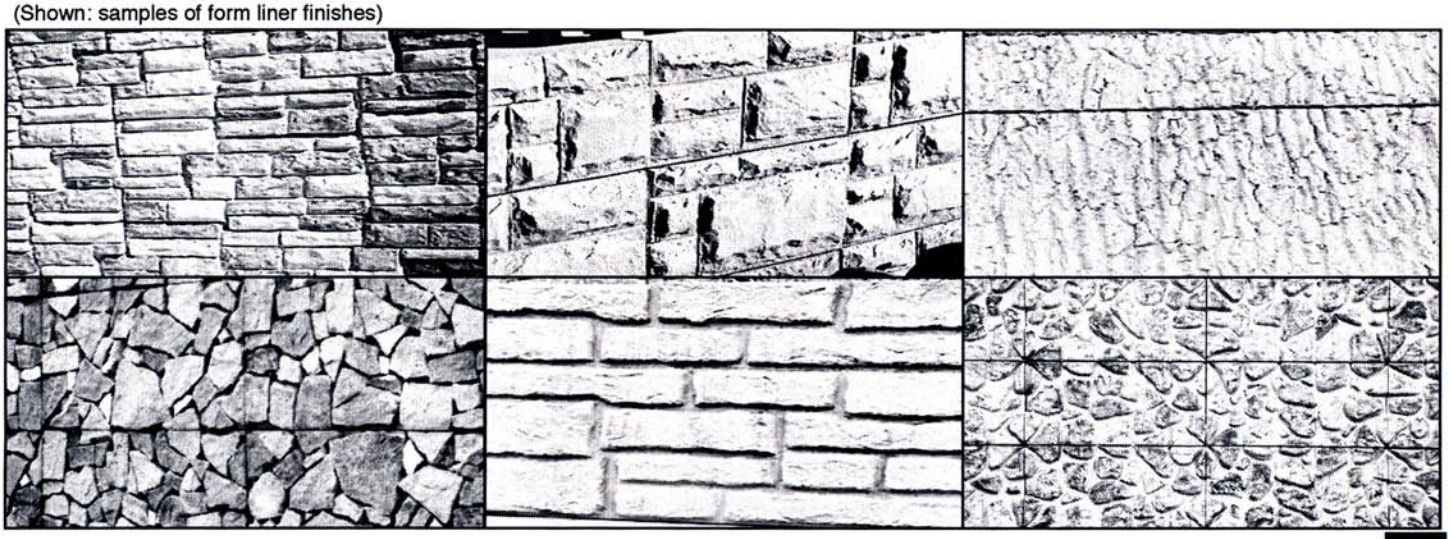
Geometry - There are no geometric restrictions. The units can be installed either vertically or on a batter. In general, vertical walls can more easily accommodate bends and curves. Battered and tiered walls permit shorter stem lengths, resulting in less excavation and backfill. T-WALL can even be constructed on a sloping grade (for grades up to 4 percent).

Utilities - T-WALL can accommodate roadway drainage structures. Signposts, fences, guardrails, drop inlets and curb drains can be located between the stems. The concrete units can be modified to handle pipes through the wall. See "*Typical Details*" (p. 12).

Composite Structures - T-WALL can be combined with other structural systems such as rock bolts and soil anchors to increase horizontal and/or vertical support. Composite walls are as varied as the site conditions. For example, they may be the solution where soil and rock are encountered or where space is limited due to right-of-way restrictions or utilities.

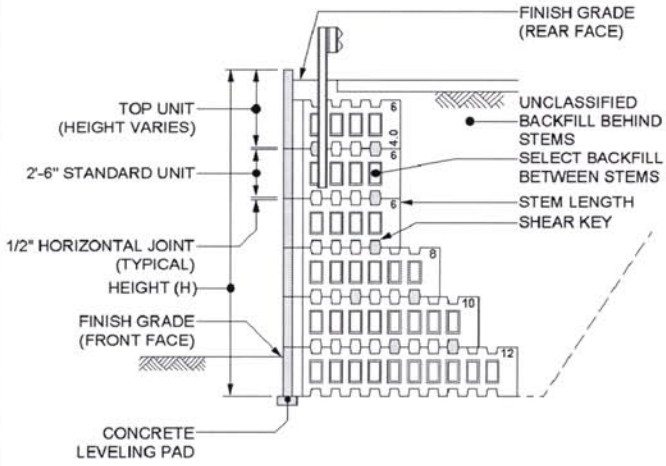
Aesthetics – A variety of architectural finishes are available.

(Shown: samples of form liner finishes)

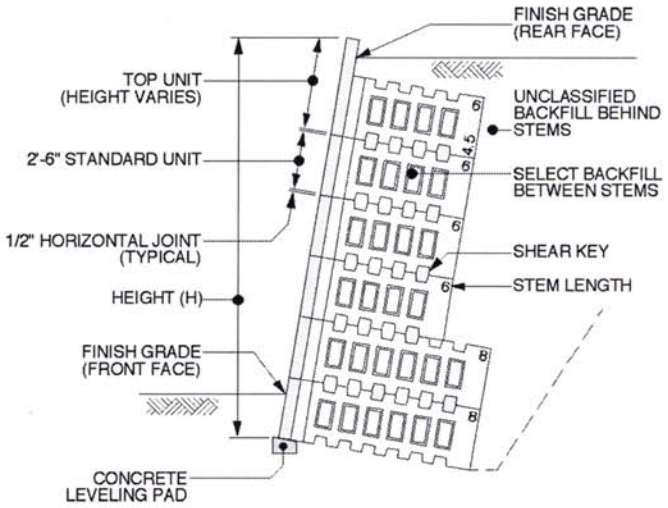


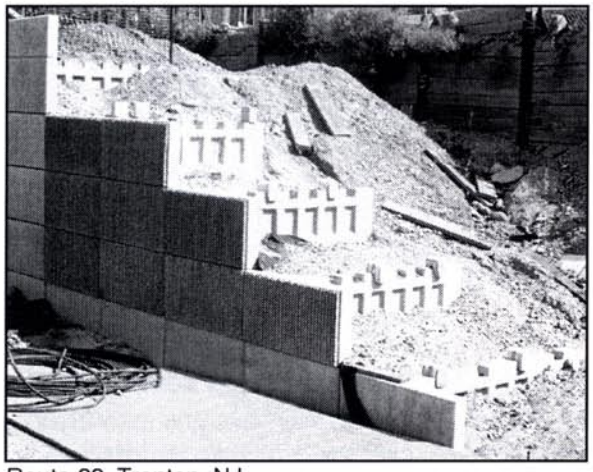
TYPICAL SECTIONS

VERTICAL WALL SECTION

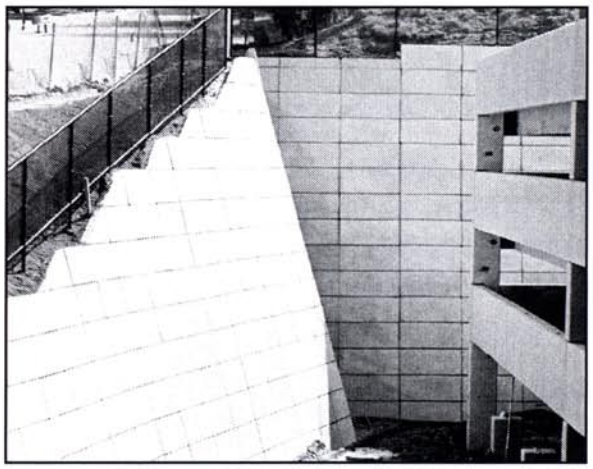


BATTERED WALL SECTION



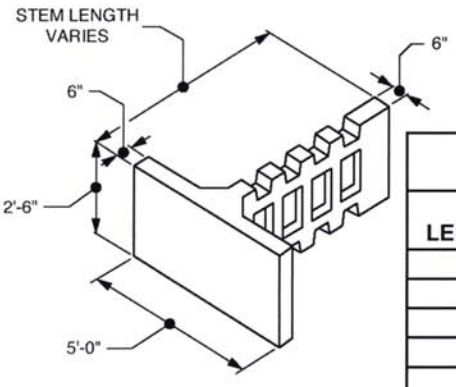


Route 29, Trenton, NJ



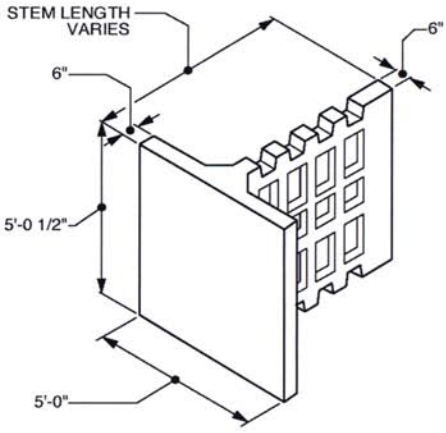
N. Shore University Hospital, Manhasset, NY

STANDARD UNIT DIMENSIONS



- The size of the T-WALL unit refers to the stem length.

T-WALL® UNIT WEIGHTS		
STEM LENGTH (FT)	SINGLE UNIT WEIGHT (#)	DOUBLE UNIT WEIGHT (#)
4	1600	3200
6	1850	3700
8	2100	4200
10	2350	4700
12	2600	5200
14	2900	5800
16	3150	6300
18	3400	6800
20	3650	7300



- The unit reinforcing steel meets AASHTO and ACI codes.

WALL HEIGHT TABLES

1. Design Parameters:

Weight of backfill	120 pcf
Angle of internal friction	
Select backfill	34°
Unclassified backfill	30°
Foundation	30°
Coefficient of active earth pressure (Ka)	
Level surcharge	0.33
Infinite surcharge	0.54

2. Safety Factors:

Overturning	Soil – 2.0
	Rock/piles – 1.5
Sliding	1.5
Pullout	1.5
Allowable Bearing Pressure	2.5

3. Drainage must be designed to control ground water and seepage at the site.

4. Embedment is based on bearing capacity, settlement and stability requirements. Other factors to consider include: scour, proximity to slopes, erosion and future excavation.

   Slopes - A minimum four feet wide horizontal bench shall be provided in front of walls founded on slopes.

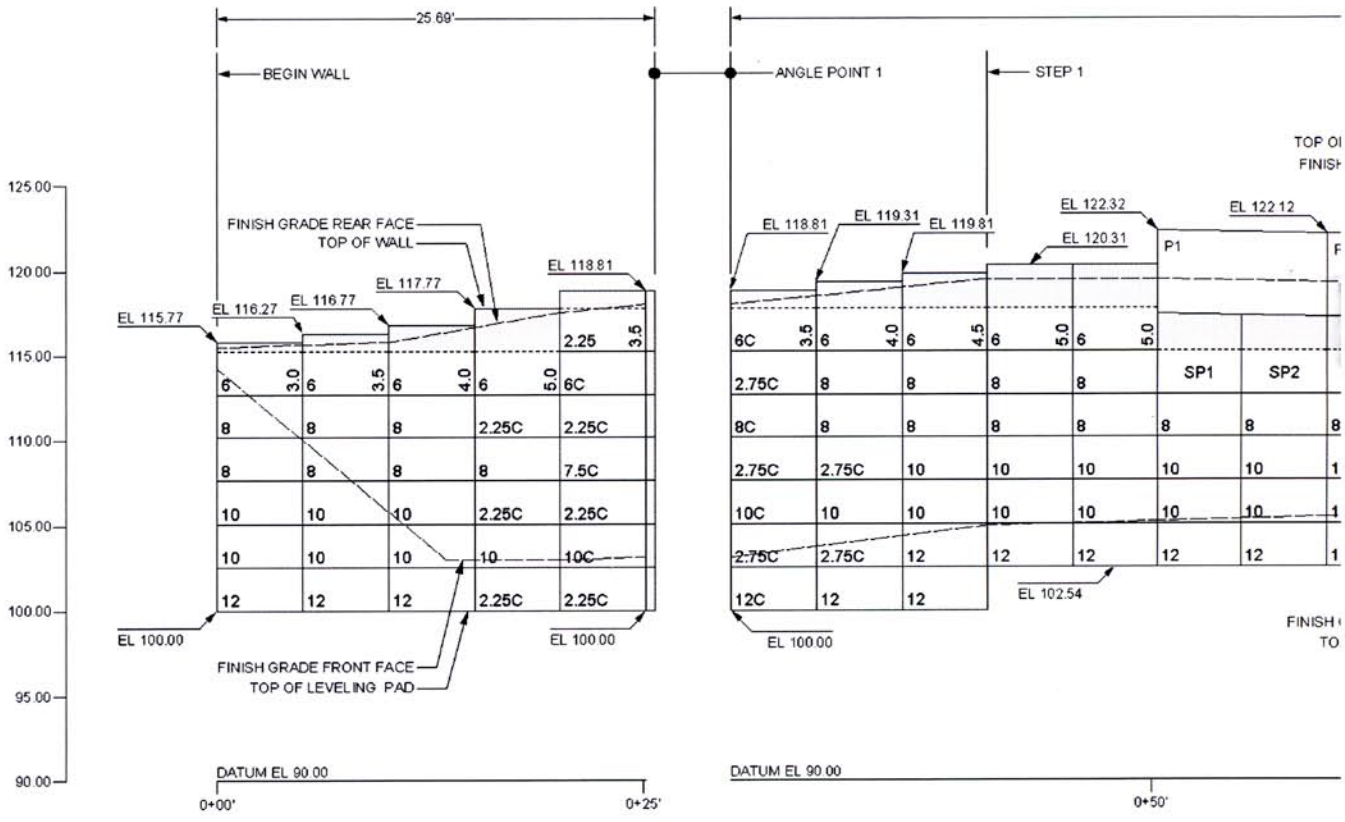
   Rivers and Streams - The embedment depths shall be established at a minimum of two feet below potential scour depth.

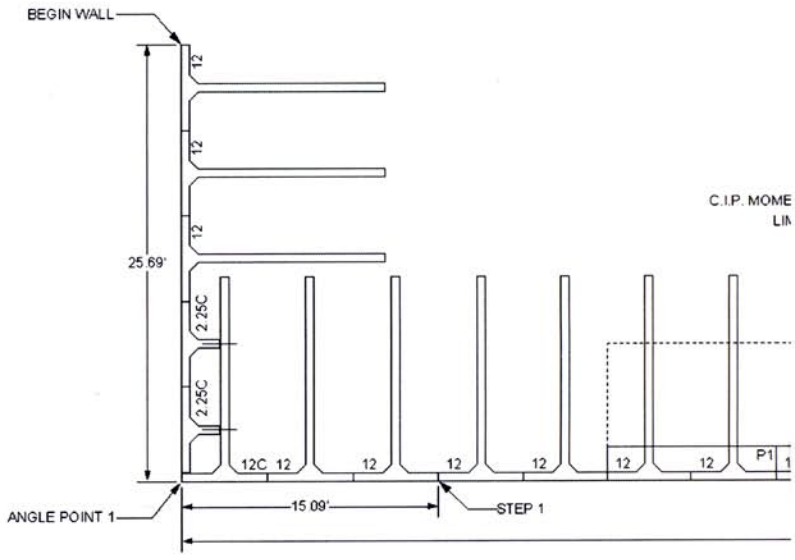
5. Analysis of the site is the responsibilty of the owner/engineer. This analysis should include bearing capacity, settlement and the overall stability of the slopes in the vicinity of the wall.

These tables are guidelines. Job specific designs will be provided by The Neel Company.

Wall Height from top (ft)	UNIT STEM LENGTHS FOR VERTICAL WALL		UNIT STEM LENGTHS FOR BATTERED WALL (6V:1H)	
	Level embankment w/ 2-ft traffic surcharge	Infinite 2H:1V surcharge	Level embankment w/ 2-ft traffic surcharge	Infinite 2H:1V surcharge
2.5	6	6	6	6
5.0	6	6	6	6
7.5	6	6	6	6
10.0	6	8	6	6
12.5	8	8	6	8
15.0	10	10	8	8
17.5	12	12	8	10
20.0	12	14	10	10
22.5	14	16	10	12
25.0	16	18	12	14
27.5	18	20	12	16
30.0	18	22	14	16
32.5	20	24	14	18
35.0	22	26	16	18
37.5	22	28	16	20
40.0	24	30	18	22

DRAWING EXAMPLE





TITLEBLOCK: BORDER-TNC 1:1 v3.0

PLOT DATE & TIME: Wednesday, September 21, 2005 2:40:23 PM
CAD FILE NAME: Sample Dwg v11.mod

DATE: 09-21-05
TW PROJECT:

The design contained on these drawings is based upon information provided by the owner. On the basis of this information, The Neel Company has designed, and is responsible for, the internal stability of the structure only. External stability, including foundation and slope stability, is the responsibility of the owner.

This drawing contains information proprietary to The Neel Company. The Neel Company is the exclusive licensee of the T-WALL patent.

PRECASTER:
PROJECT #:

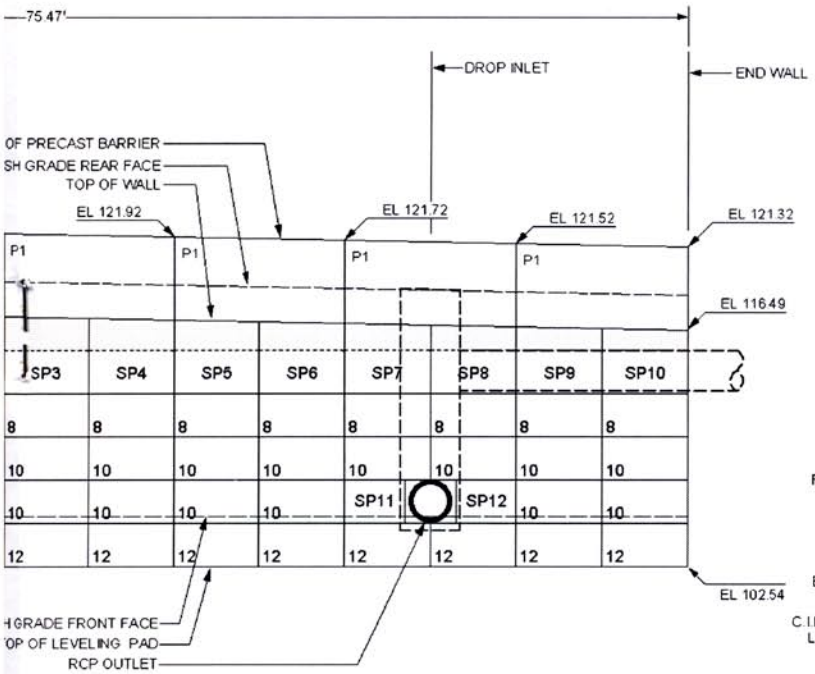
CONTRACTOR:
PROJECT #:

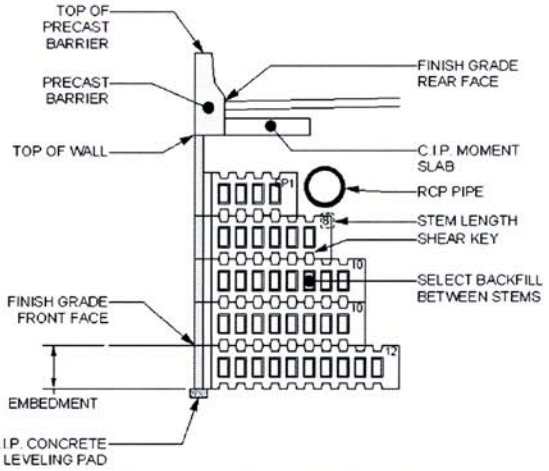
DESIGNER

THE NEEL COMPANY
8328-D TRAFORD LANE
SPRINGFIELD, VIRGINIA 22152
PH: (703) 913-7858
FX: (703) 913-7859
WEB: WWW.NEELCO.COM

PROJECT #:

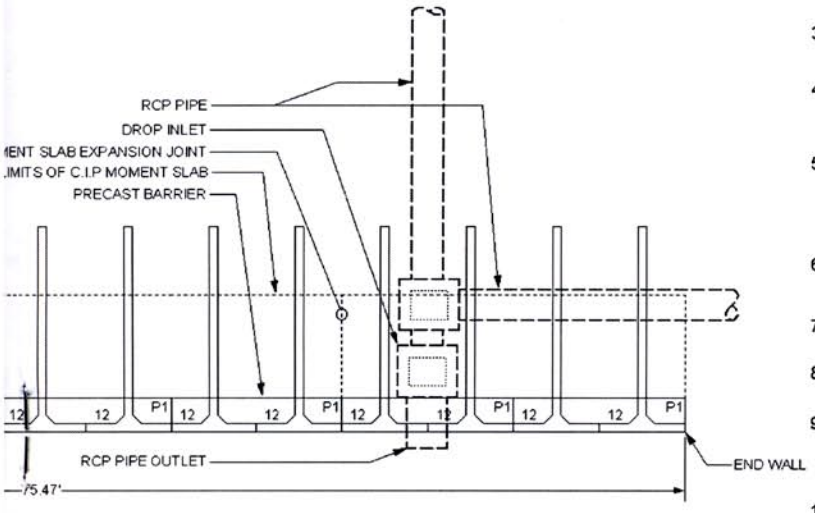
DRAWING EXAMPLE





TYPICAL SECTION AT MAXIMUM HEIGHT

EVATIO ONT FACE)



ERAL PLAN
N OF STEM SHOWN)

GENERAL NOTES:

1. SELECT BACKFILL BETWEEN STEMS:
   - ANGLE OF INTERNAL FRICTION - 34° (MIN)
   - DENSITY - 120 pcf (MIN)
   - 15% MAXIMUM PASSING #200 SIEVE
   - 100% PASSING 3" SIEVE
   - 95% STANDARD COMPACTION (ASTM D-698)
2. UNCLASSIFIED BACKFILL BEHIND STEMS:
   - ANGLE OF INTERNAL FRICTION - 30°
   - DENSITY - 120 pcf
   - 95% STANDARD COMPACTION (ASTM D-698)
3. HORIZONTAL JOINT:
   - 1/2" FIBER EXPANSION JOINT MATERIAL
4. VERTICAL JOINT:
   - 3/8" SPACE
   - 12" WIDE FILTER CLOTH BACKING CENTERED AT JOINT
5. CONCRETE LEVELING PAD:
   - 6" x 12"
   - 2500 psi CONCRETE
   - NO REBAR
   - GRADE TOLERANCE - 1/4" IN 10'-0"
6. T-WALL UNIT REBAR:
   - GRADE 60
   - BLACK
7. T-WALL UNIT CONCRETE STRENGTH:
   - 4000psi MIN @ 28 DAYS
8. TOLERANCES OF THE WALL:
   - VERTICAL AND HORIZONTAL PLANE - 3/4" IN 10'-0"
9. FOUNDATION:
   - UNSUITABLE MATERIALS TO BE REMOVED AND REPLACED WITH COMPACTED SELECT FILL PER ENGINEER DIRECTIONS.
10. CONSTRUCTION:
    - TO BE IN ACCORDANCE WITH T-WALL® CONSTRUCTION MANUAL

ITH RESPECT
STABILITY OF
UCTURES ONLY

REVISIONS

DRAWING EXAMPLE

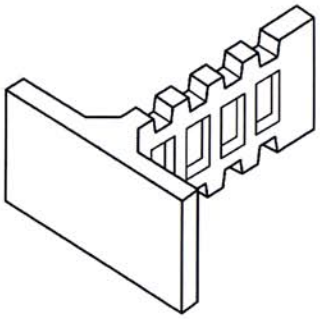
DRAWING

PLAN, ELEVATION AND SECTION

T-WALL® RETAINING WALL SYSTEM

SCALE:	NO SCALE
DATE:	09-21-05
DESIGNED BY:	KD
DRAWN BY:	CJW
CHECKED BY:	TNC
SHEET:	1 OF 1

DESIGN INFORMATION



DESCRIPTION – The T-WALL® Retaining Wall System is a gravity structure whose dimensions are bounded by a front plane formed by the facing panels and a back plane formed by the ends of the stems. The system stability is a function of the weight of the concrete units and the select backfill between the stems. The stems have to be long enough at each level to develop a cross section to resist overturning and sliding at that level and ensure soil/structure interaction.

The reinforced concrete module has a face height of 2.5 ft. or 5.0 ft, a face width of 5.0 ft and stem lengths ranging from 4 ft. to 30 ft. A 5 ft. high x 7.5 ft. wide unit is available for large projects.

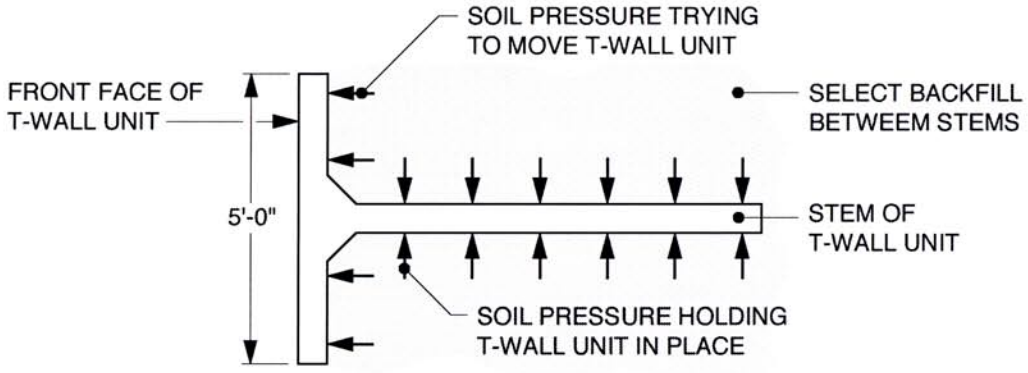
Argentine Connector, Kansas City, MO

APPLICABLE CODES – T-WALL is designed in accordance with the applicable sections of AASHTO and State DOT codes. Allowable stress design (ASD) or load resistance factor designs (LRFD) can be provided.

For Railroad projects, T-WALL is designed in accordance with applicable sections of AREMA. See the T-WALL Railway Design Guide.

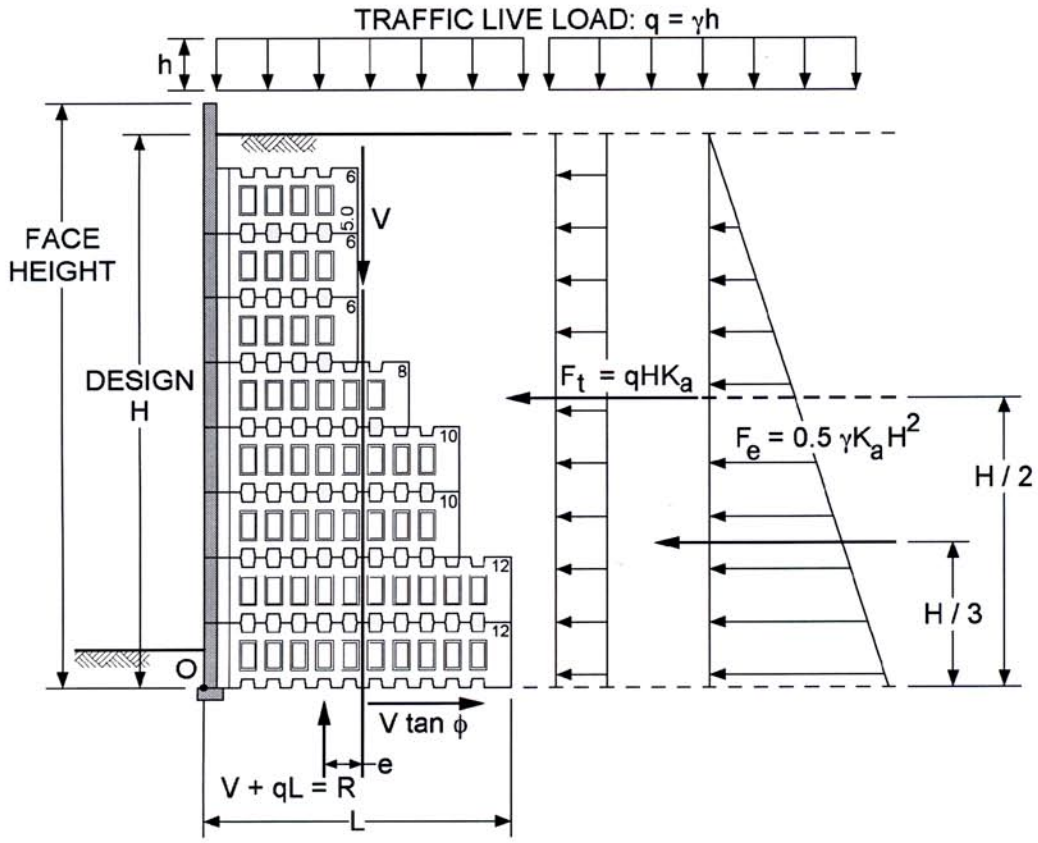
WALL DESIGN – External Stability computations are made by assuming that the system acts as a rigid body. Calculations are made for sliding, overturning, bearing pressure and eccentricity.

Internal Stability computations are made at each level to demonstrate that the frictional forces gripping the stem (caused by pressure of the compacted, confined soil between the stems) exceeds any horizontal force acting on the face of the unit. If the concrete units cannot be pulled out of the soil then the concrete and soil act together to form a composite gravity mass.



TOP VIEW OF T-WALL UNIT

DESIGN INFORMATION



EXTERNAL STABILITY CALCULATION:

Factor of Safety Against Overturning (moments about point 0):

$$FS_{OT} = \frac{\sum \text{Moments Resisting}}{\sum \text{Moments Overturning}} = \frac{V(L/2)}{F_e(H/3) + F_t(H/2)} \geq 2.0$$

Factor of Safety Against Sliding:

$$FS_{SL} = \frac{\sum \text{Horizontal Resisting Forces}}{\sum \text{Horizontal Driving Forces}} = \frac{V \tan\phi}{F_e + F_t} \geq 1.5$$

ϕ= friction angle of foundation

$\tan\phi$= coefficient of sliding friction

$$K_a = \cos\beta \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi'}}{\cos\beta + \sqrt{\cos^2\beta + \cos^2\phi'}}$$

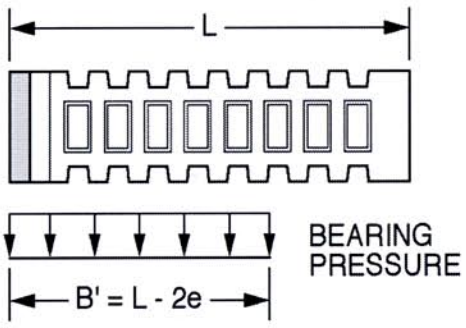
β = slope angle above the wall

ϕ' = friction angle of unclassified backfill

Bearing Pressure (Vertical Stress) Calculation:

$$\text{Bearing Pressure, } \sigma v = \frac{V + qL}{L - 2e}$$

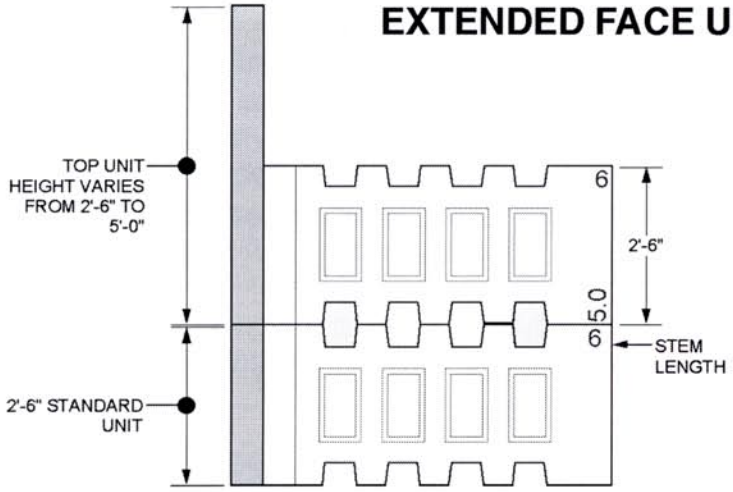
$$\text{Eccentricity } e = \frac{L}{2} - \frac{(V+qL)L/2 - \left[F_e(H/3) + F_t(H/2)\right]}{V + qL}$$

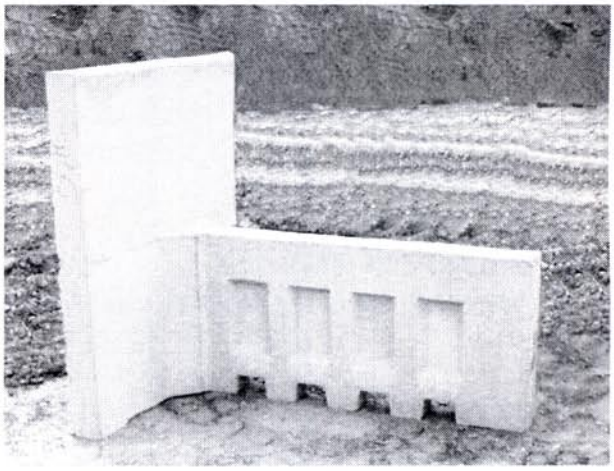


The bearing pressure is computed using the Meyerhof distribution, which considered a uniform base pressure distribution over an effective width of footing B ' = L - 2e.

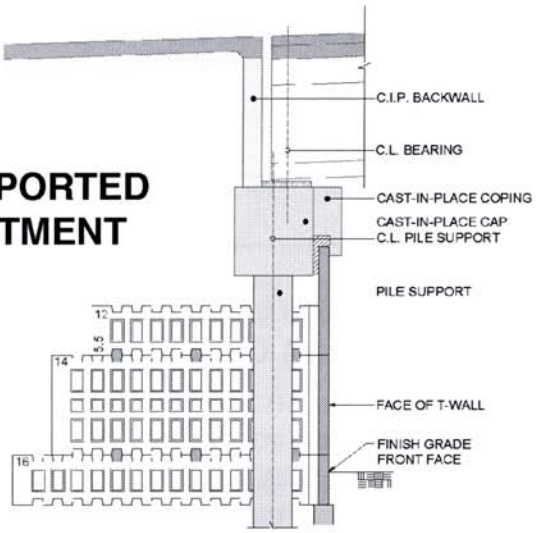
TYPICAL DETAILS

EXTENDED FACE UNIT



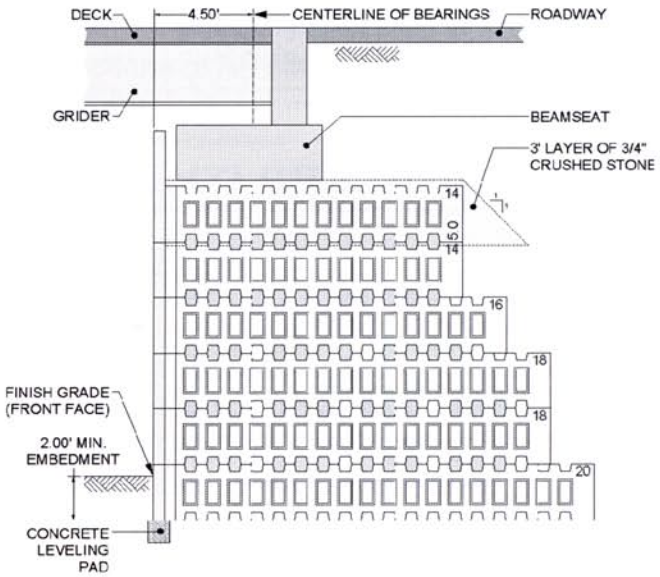


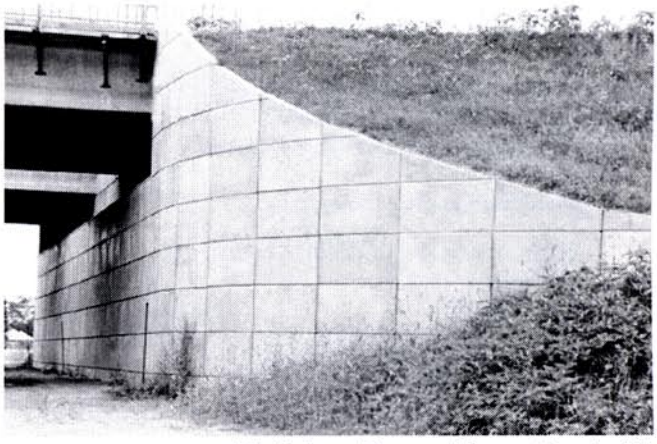
PILE SUPPORTED ABUTMENT



Hathaway Bridge, Panama City, FL

T-WALL ABUTMENT

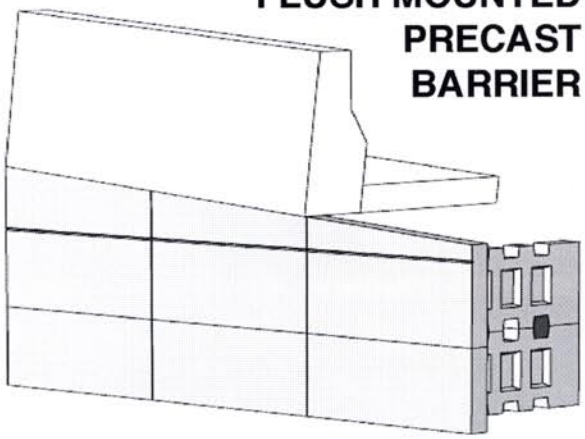




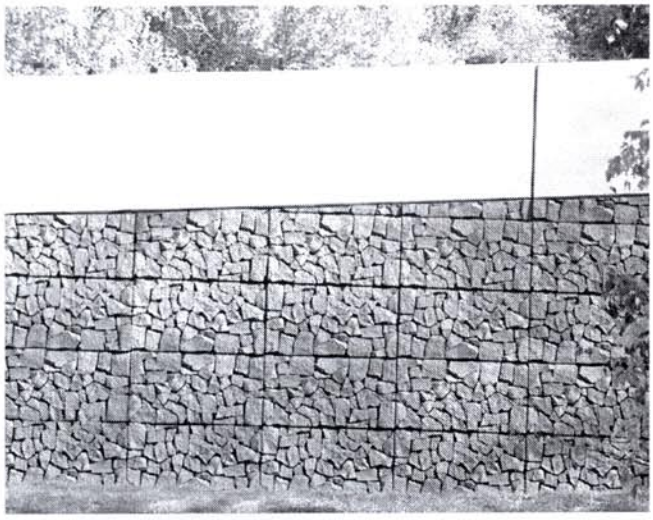
Hightstown Bypass, Mercer County, NJ

TYPICAL DETAILS

FLUSH MOUNTED PRECAST BARRIER



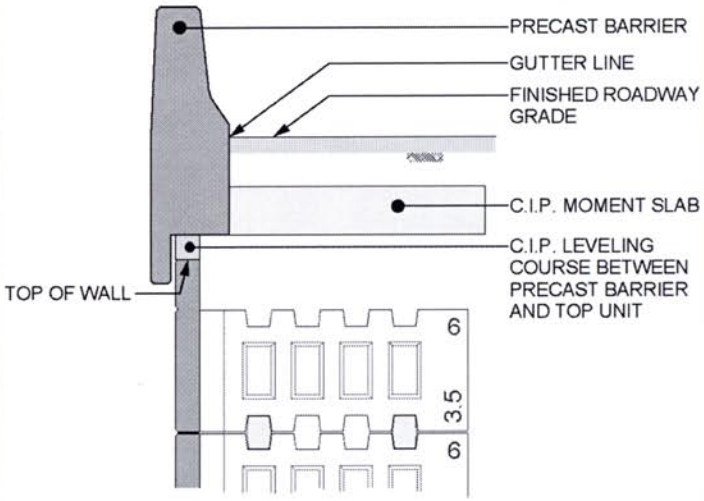
Top row of T-WALL units is sloped to follow grade.



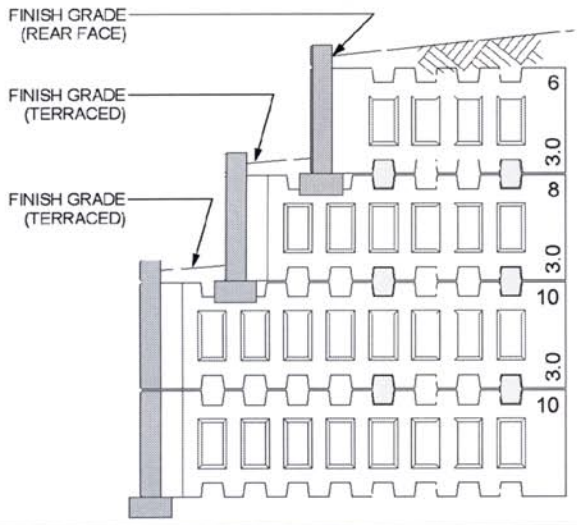
Route 183, Stanhope, NJ

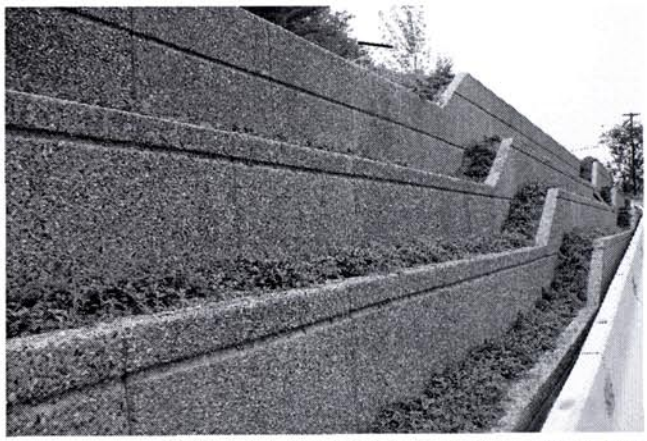
PRECAST BARRIER WITH OVERHANG

Barrier with lifting device still attached



TERRACED WALL



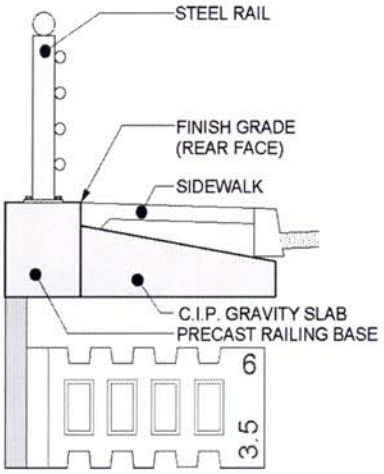


Maxon & Aqueduct Roads, Schenectady, NY

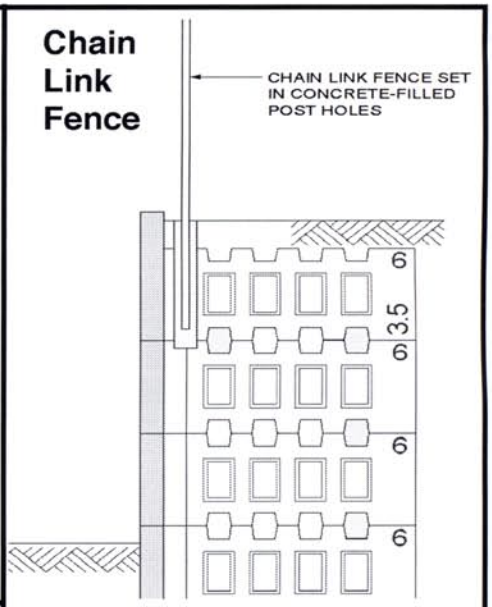
TYPICAL DETAILS

Memorial Bridge 310, Burrillville, RI

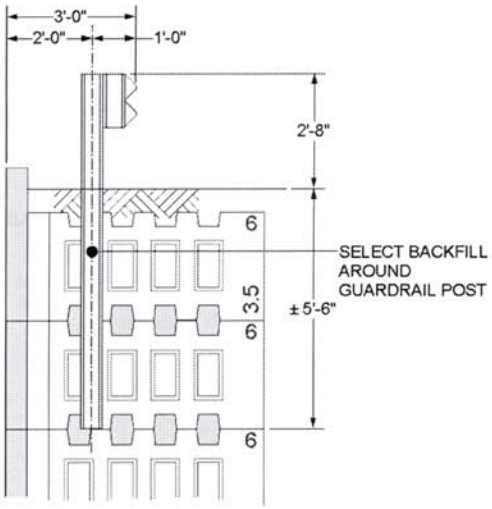
Railing Detail



Chain Link Fence



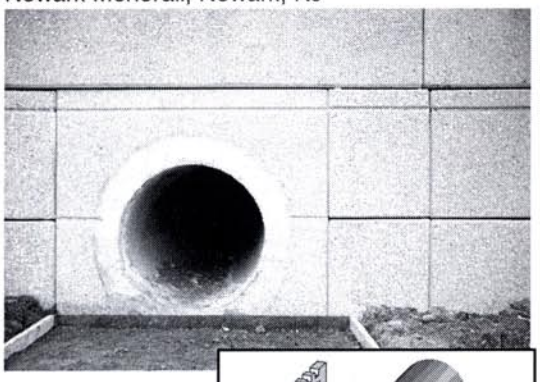
Guard Rail



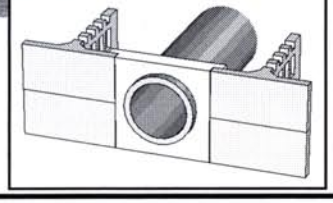
Ridge Road, Woodbury, NY

Rt. 59 Retail Center, Kent, OH

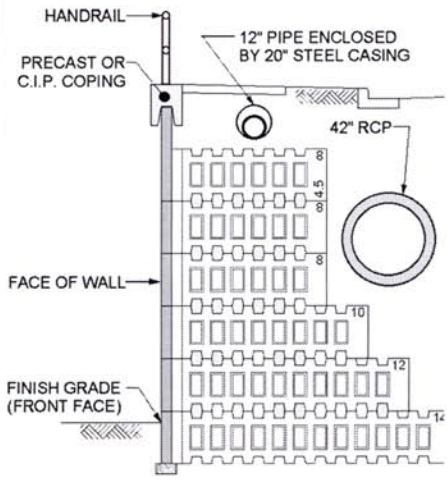
Newark Monorail, Newark, NJ



Pipe Penetration

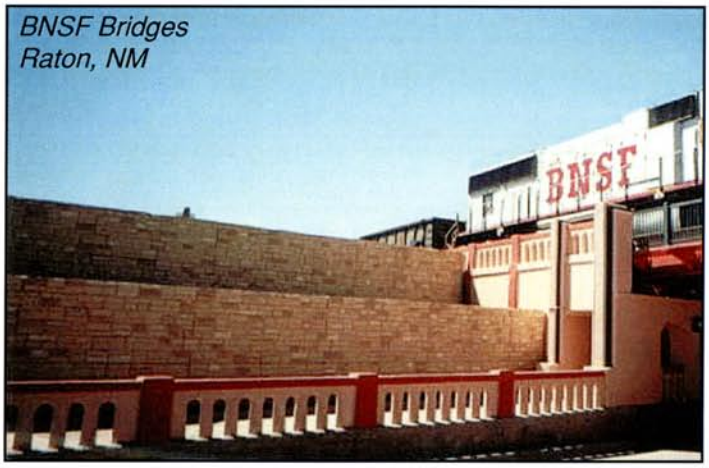


Pipe Parallel to Wall Face



SR 15/600, Seminole County, FL


Hathaway Bridge
Panama City, FL



BNSF Bridges
Raton, NM


ARE Research Center
Rockville, MD


Lake Howell Outfall
Orlando, FL


MBNA Bank
Camden, ME


Grand Lake Lodge
Grand Lake, CO


Southern NJ Light Rail
Riverton, NJ


Ridge Road
Woodbury, NY

DESIGN GUIDE & TECHNICAL INFORMATION

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