NOTE TO THE READER
This manual has been prepared as a guide to building T-WALL® Retaining Wall System structures within railroad right-of-ways. Its contents should be thoroughly reviewed by the contractor and the superintendent responsible for construction prior to the delivery of the T-WALL units to the job site. The Neel Company and/or its licensed project precaster will provide on-site technical assistance to the contractor so that he or she may implement correct T-WALL construction procedures. Compliance with this manual does not relieve the contractor of the responsibility to adhere to contract plans and specifications. The T-WALL Retaining Wall System should never be built without approved T-WALL drawings signed and sealed by a professional engineer or prior to completing a global stability analysis.

SAFETY INFORMATION
Individuals constructing the T-WALL System on railroad sites should have the following:
- e-Railsafe certification
- Completion and certification of an owner approved FRA 214, Roadway Worker Protection Course
- Understanding of safety briefing between the railroad and contractor prior to construction activity for each day or when conditions change
- Have the following personal protective equipment (PPE), including:
  - Hard hat
  - Steel toed boots
  - Reflective vest of the correct color for the project
  - Eye protection
  - Hearing protection
  - Approved gloves
  - Any other contractor specific requirements
- Appropriate check-in status with the flagman

In addition to the above, the employee in charge or flagman may request to employ additional PPE requirements or precautionary safety measures.
# T-WALL® RETAINING WALL SYSTEM

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The concrete T-WALL units are only half of the retaining wall structure—earth is the other half. It is the combination of T-WALL units and specified granular backfill that produces a successful wall structure.

**IMPORTANT EARTHWORK ITEMS**

**FOUNDATION**
The owner’s engineer must inspect and approve the foundation before the CIP or precast leveling pads are placed. If the foundation is soft the wall will settle.

**GRANULAR BACKFILL GRADATION**
Proper backfill gradation is critical to the stability of the T-WALL structure. Backfill requirements are listed on the shop drawings for each project. It is important that gradation tests be performed throughout construction to ensure the backfill meets project specifications. Granular backfill gradation affects stem friction, drainage, and settlement.

**COMPACTION**
Proper compaction of the backfill between and behind the stems is required to mitigate any settlement of tracks or sub-ballast placed at the top of the wall. Details for proper compaction are found in Part III.

* Failure to follow the specifications and notes in the approved T-WALL shop drawings for the project may result in wall movement.

**UNIT DIMENSIONS AND WEIGHT TABLE**

* Stem lengths continue to a max of 32'-0". Top units can extend up to 10'-0" high.

(see approved shop drawings for unit weights)
WORK TO BE PERFORMED
BY THE CONTRACTOR

- **Site preparation**, including excavation and compaction
- Forming and placing of the CIP or precast **leveling pads**
- **Wall construction**—including the process of placing and compacting backfill
- Installation of **fences, guardrails, and/or other necessary items**

CREW SIZE: 4–5 PEOPLE

A typical wall erection crew includes:
- One **excavator/crane operator** for setting units and placing backfill
- One **working foreman** to check alignment
- Two men for setting units, shear keys, and joint materials
- One **front-end loader** and **operator** to move backfill and T-WALL units

PRODUCTION RATES

- Construction rates for **T-WALL** depend entirely upon site access and the rate at which backfill can be delivered, placed and compacted—plus time to install/uninstall any necessary shoring. For more information consult the wall access chart on pages 18 and 19.

BASIC CONSTRUCTION PROCEDURES

- **Prepare** the site with any necessary excavation and compaction
- **Form** and **place** CIP or precast concrete leveling pads
- **Compact fill** between leveling pads
- Set **first course** of units
- Place vertical filter fabric
- Place and compact **granular backfill**
- Install **rubber blocks** and **wrapped shear keys**
- Set **second course** of units and repeat cycle
- Place horizontal filter fabric
- Repeat courses as specified

EQUIPMENT, MATERIALS, AND TOOLS
SUPPLIED BY THE CONTRACTOR

- **T-WALL** unit lifting equipment: **excavator** or **crane** and **correct lifting attachments**
- Equipment for hauling, dumping, and spreading backfill: **dump trucks**, **front-end loaders**, and **dozers**
- Compaction equipment suitable to project accessibility: **ride-on compactor**, small walk-behind **vibratory roller**, or **Rammax** type equipment

- **Tools:**
  - **Instrument level** to check the grade of the leveling pad
  - **Broom** to sweep the leveling pad
  - **Lifting beam**
  - **Lifting hooks** for connecting to inserts
  - **Chalk line**
  - **Shims**
  - **Pinch bar**
  - **Four foot level** *(minimum)*
  - Smooth, **18” long, ½” diameter steel rod** *(for gauging vertical joint widths)*
  - **Crow bar**
  - **Short ladder**
  - **Railroad approved construction adhesive** with cartridges and gun(s)
  - **Hammer drill** with 10”x ¾” carbide bit *(for drilling bolt holes in corner units—when required by design)*

MATERIALS AND SERVICES SUPPLIED
BY THE NEEL COMPANY AND/OR THE PRECAST MANUFACTURER

- **On-site technical assistance**
- **Engineering and design** of the structure
- **Delivery** of the following wall materials to the site:
  - Precast concrete **T-WALL units**
  - **Shear keys** and **shear key wrap material**
  - **Rubber blocks** for horizontal joints
  - **Filter fabric** for horizontal and vertical joints
  - **Connection hardware** *(when required by design)*

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SITE PREPARATION

- Excavate the site to the elevation shown on the contract plans for the entire footprint of the T-WALL structure (including the area covered by the granular backfill between the stems). Under special conditions the excavation may be done in increments to minimize the amount of open cut.

- All unsuitable materials below subgrade must be removed and replaced with compacted, granular backfill at the direction of the owner’s engineer or designated representative.

- Compact the subgrade to 95% standard proctor and proof roll the foundation in accordance with the project specifications.

- The foundation is to be inspected and approved (in writing) by the owner/owner’s engineer or designated representative for required bearing capacity as shown on the approved T-WALL drawings.

- Excavate for the leveling pads—5’-0” x 7’-6” units require both front and rear leveling pads.

- Where possible, the width of excavation should allow sufficient room to set the first course while still leaving access space behind the T-WALL stems for compaction equipment.

- Any under-drains, drainage piping, or drainage blankets should be installed at this time.

LEVELING PAD CONSTRUCTION

- The leveling pads are to be 15 inches wide and a minimum of 6 inches deep, unless otherwise shown on the approved shop drawings.

- Form the leveling pads similar to forming a sidewalk. The edge forms are the screed rail. They must be checked with a level to assure proper elevation and tolerance. Finished surface tolerance is ¼” in any 10’-0” length with no more than ¼” overall.
• **Check for alignment.** The leading edge of the front pad should be about $3\frac{3}{4}''$ outside the front face line of the wall.

• **Check the project drawings** for the location of the rear leveling pad.

• The leveling pads are for construction alignment only. The concrete may be **low strength, minimum 2,500 psi, without rebar in the leveling pads.**

• Check the leveling pad forms for line, grade, tolerances, and correct elevation with a level. If the forms are out of tolerance, **make corrections** at this time.

• **Place the CIP or precast concrete leveling pads.** The concrete surface finish must be smooth and flat. A steel trowel finish is desired. Leveling pads are to be checked with an instrument after removing forms. High spots must be corrected.

**STEPS IN THE LEVELING PADS**

• Construct the lower leveling pads. Leave an 8" gap before constructing the higher pads. The gap will assure that the higher pads do not interfere with the placement of the units on the lower pads.

• For a vertical wall, the typical step (change in elevation) is $2'\text{-}6\frac{1}{2}''$ or $5'\text{-}1\frac{1}{2}''$.  

• Bring the **subgrade to the top of the leveling pads** and compact before setting units.

**Units should not be placed for 24 hours after placing CIP concrete leveling pads.**

**PRECAST LEVELING PADS**

• Where necessary, **precast leveling pads** may be used if written approval is given by The Neel Company.

• Precast leveling pads are cast with rebar (which controls cracking) and lifting inserts for ease of placement. **Leveling pads must be of uniform thickness. Precast leveling pads must be 5,000psi.**

• **Compaction and grading** under precast leveling pads are extremely important because any settlement or tilting will result in an unacceptable joint pattern or spalling of the concrete units.
WALL ALIGNMENT

• To establish wall alignment, snap a chalk line on the surface of the front leveling pad approximately 3½" from the leading edge. This line marks the front face of the wall and will center the unit on the leveling pads.

• Fill material should already be graded level with the pads for the entire stem length/area between the pads.

T-WALL UNIT DELIVERY

• Prior to the start of construction, the contractor and the precast manufacturer should develop a schedule for material deliveries.

• This timetable will allow the producer to match unit production with the construction schedule.

UNLOADING THE UNITS

• Under normal circumstances a two-hour maximum unloading time is allowed for each delivery.
  - During this period of time the units may be unloaded and stacked on the ground using the appropriate equipment and lifting device. If permitting and time allows, the units may be placed directly into the wall structure.

• A typical truck load is 4 to 5 units.

• Care must be exercised during unloading to protect the units and joint materials from damage.

• Dunnage and plastic edge guards are the property of the precast manufacturer and must be collected and returned as soon as possible.
**ERECTION OF THE FIRST COURSE**

- Always begin erecting T-WALL at a fixed point such as a corner, step, or an existing structure tie-in point. If there is no fixed point, simply start on the lowest leveling pad. Using a smooth ½” diameter, 18” long steel rod, create a ½” vertical space between the units.

*Walls have a tendency to expand or shrink in length depending on the amount of care taken to properly layout and align the first course!*

- No joint material is required between the leveling pad and the precast units.
- Set the first units on the leveling pads, aligning the front faces to the chalk line guide.
- Plumb the front faces of the units by adjusting the rear elevation of the stems.
- After aligning the front faces, check the tops for correct level and height relative to the other units in the course. If the top of a unit is irregular, place the level on the line where the top of the front face is chamfered. Shim as necessary. Continually check alignment, level, and plumb as one unit may be disturbed while adjusting others.
- Finally, step back and sight down the tops of the units. This visual check allows you to fine tune the alignment.
- Every effort should be made to ensure that the first course of units is properly aligned and level.
- Construct the wall in horizontal lifts.
FILTER FABRIC & JOINT MATERIAL

VERTICAL FILTER FABRIC

• Prior to the initial backfilling, cut the 12” wide filter fabric into lengths equal to the height of each vertical joint.

• Center the cut strips over the ½” vertical joints on the interior faces between the units. This procedure prevents migration of the backfill material through the vertical joints.

• Throw any excess filter fabric over the front face of the units during backfilling, then pull it back over the backfill during setting operations.

HORIZONTAL FILTER FABRIC

• Cut 8’-6” lengths of fabric for each horizontal joint.

• Place a second strip of filter fabric over the horizontal joints between the stacked units on the interior face. Backfill material migration is now prevented through the horizontal joints as well.

• Adhesive may be placed in spots on the units to hold the fabric during backfilling.

HORIZONTAL JOINT MATERIAL

• Four rubber blocks act as a cushion to prevent concrete-to-concrete contact.

• Place two of the four rubber blocks on each end of the horizontal joint between the unit faces, flush with the rear edge.

• Place two rubber blocks on the top of the stem, one at the front where it meets the haunch and one at the rear.
PART III: CONSTRUCTION PROCEDURES for Single Sided Structures

BACKFILL

• **Shear keys**, wrapped twice with the provided shear key wrap, should be placed between stem notches where the unit above will meet the unit below.

• Approved, project specific T-WALL shop drawings show sections defining the required number and placement of keys per unit.

• The purpose of shear keys are to:
  – Provide an alignment guide
  – Prevent movement of the units during backfill placement and compaction
  – Provide additional pullout resistance at the top of the wall

• It may be necessary to plumb the units by placing shims between the rear stem ends. Shims may be pieces of standard asphalt shingles, plastic, or hardwood.

• If you encounter a unit that is out of square it is best to use the face as an alignment guide. Keep in mind that this is purely an aesthetic concern, not a structural problem. Difficulties with plumbing and alignment should be reported to The Neel Company.

• Dump the granular backfill material directly on top of the stems. Dumping in this manner will fill both sides equally and prevent lateral movement of the unit. It is mandatory that the backfill material meets the gradation specification shown on the approved project drawings.

• Backfill and compact each course of units completely before starting the next course. The loose lifts of backfill should not exceed 12” before compaction, or the maximum specified by the railroad or in project specifications. Each lift must be thoroughly compacted before more fill is placed. Failure to adequately compact the backfill can jeopardize the stability of the wall.

• Backfill and compact the fill in front of the wall as soon as possible. This procedure must be accomplished before the wall is 20'-0" high.
STAGED CONSTRUCTION

T-WALL should be constructed horizontally, one course at a time. However, there are some situations where staged construction may be necessary.

Be aware that if the vertical height difference between adjacent columns is greater than one unit, the vertical joints will open due to the unbalanced earth pressure. Backfilling, handling, and compaction techniques may vary for staged projects and are detailed in Part VI.

SUBSEQUENT COURSES

- **Do not stack the units more than one unit high** without backfilling. It is unlikely that the subgrade will support the point load of the stem, causing the front face to be out of plumb by the time backfill is placed.

- Repeat the same steps followed when installing the first course when installing subsequent courses. Use the faces as a sight line. Continue the use of filter fabric, joint material, and shear keys. Per project specifications, shear keys may or may not be used at the top of the wall.

- Place units on top of the previous course by aligning the vertical center line of the new unit with the one below. The left and right vertical edges of the T-WALL face may vary SLIGHTLY with those of the unit below it.

In order to avoid problems with the wall alignment when planning for staged construction, contact The Neel Company for specific instructions.
Construction procedures for back-to-back structures follow the same construction methodology as that defined for single-sided structures. Backfill, handling, and compaction techniques will vary from single-sided methods and are addressed in Part VI. The following are two examples of back-to-back and interlaced structures:

**EXAMPLE I: BACK-TO-BACK ELEVATED RAIL CORRIDOR**

Back-to-back structures can be constructed in several ways:

- **Phased:** one side at a time, working around/under or incorporating existing structures

- **Concurrently:** equipment works between the walls as both sides are constructed

- **Simultaneous:** course-by-course construction with equipment working on top of the stems
EXAMPLE II: INTERLACED BRIDGE APPROACH

The T-WALL® bridge approach for Tri-Rail New River Bridge, has a live track on one side and a major highway on the other.

A cantilevered walkway was built on the fieldside of the approach to provide maintenance crews safe access to the new tracks.

T-WALL® stems are interlaced to save space in this tight right-of-way situation. Generally these walls are constructed course by course with equipment working on top of the stems.
**Inverted T-WALL** is a structure in which the shortest possible T-WALL units are placed at the bottom of the retaining wall structure with successively longer units stacked on top.

By using the **Inverted T-WALL** configuration, the active wedge area behind the stems is reduced, thereby lowering the active lateral pressure coefficient.
CONSTRUCTING INVERTED T-WALL

Inverted T-WALL is constructed using the same steps as standard T-WALL. Refer to Part III for instructions, including:

- Site preparation
- Leveling pad installation
- Wall alignment
- T-WALL delivery
- Construction of the first course
- Filter fabric and joint material placement
- Backfilling and compaction
- Installing subsequent courses
- Staged construction details

Placing a precast leveling pad

Prepare site

Compacting the subgrade

Units delivered to site

First course of units on leveling pads
First course with steel plate shoring
(shoring requirements vary, if any)

Compaction testing

Setting second course on wrapped shear keys

Second course

Over 64,000 SF of T-WALL and Inverted T-WALL were used to support the new siding track
HAULING UNITS TO A PROJECT SITE

Large flat-bed or step deck semi-truck averaging 4 to 5 units per load

Small flat bed truck where access is restricted

Front end loader where access is very restricted
SETTING UNITS IN PLACE: LIFTING DETAIL

Excavator using lifting inserts and ring clutches to place unit

Lifting insert and ring clutch

Excavator with lifting beam working in front of the wall

Large excavator with lifting beam on top of back-to-back walls

*Note the large timbers used to protect the top of the stems from the excavator's tracks*
# Construction Alternatives by Access & Wall Type

## Setting Units

<table>
<thead>
<tr>
<th>Setting Units</th>
<th>Placing Backfill</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rear Only Access</strong></td>
<td><strong>Front-end Loader</strong></td>
</tr>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>Offload units directly into wall from truck using a tracked excavator</td>
<td></td>
</tr>
</tbody>
</table>

## Front Only Access

<table>
<thead>
<tr>
<th>Setting Units</th>
<th>Placing Backfill</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Front Only Access</strong></td>
<td><strong>Telebelt Trucks or Towed Conveyors</strong></td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>• Offload units into holding area</td>
<td>• Excavators supply backfill to telebelts</td>
</tr>
<tr>
<td>• Transport to excavator with front-end loader</td>
<td></td>
</tr>
<tr>
<td>• Set with excavator from in front of the wall</td>
<td></td>
</tr>
</tbody>
</table>

## Top/Side Only Access

<table>
<thead>
<tr>
<th>Setting Units</th>
<th>Placing Backfill</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Top/Side Only Access</strong></td>
<td><strong>Telebelt Trucks on Backfilled T-Wall Stems</strong></td>
</tr>
<tr>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td>• Offload units into holding area</td>
<td></td>
</tr>
<tr>
<td>• Transport to excavator with front-end loader</td>
<td></td>
</tr>
<tr>
<td>• Set with excavator from the side/end or top of the wall</td>
<td></td>
</tr>
</tbody>
</table>
Note: Equipment on top of stems should always be rolled over timbers or a layer of fill—never directly on unit stems.
COMPACTING Lifts of Backfill: Equipment & Methods

Articulated trench roller type compactor

A Rammax trench roller is very maneuverable and effective

Operator driven smooth drum vibrating compactor working between the stems

Compacting with vibrating plate compactors
Note: water truck and hose for moisture control

Small jumping-jack type compactor

Close-up of vibrating plate compactors working between stems

A nuclear density gauge is used to measure density and moisture of the compacted soil. Each lift should be tested.
PART VII: STRUCTURAL DETAILS

FENCES, RAILINGS, AND BARRIERS

FABRICATED FENCE

TYPICAL ANGLE AND CABLE RAILING

SET CHAIN LINK FENCE

BOLTED CHAIN LINK POSTS AND FENCE

TEMPORARY BALLAST RETAINER

HANDRAIL POST AND TEMPORARY TIMBER BALLAST RETAINER
CORNERS AND ANGLE POINTS

INTERLACED CORNER DETAIL

BOLTED CORNER

ANGLE POINT

LARGE PIPE PENETRATIONS