RECON
Wall Systems™

// DOCUMENTS

Design Overview Guide

A Note from Recon to our Specifiers, Engineers, Wall Installers, and Customers:

When we first started Recon Retaining Walls, we set out do more than just supply a product … we made it our mission to provide ***SOLUTIONS and ADD VALUE****. With this idea in mind, we carefully engineered and crafted each one of our blocks to serve a specific purpose. So, whether your project focuses on scale and aesthetics, durability, site constraints, or construction efficiencies, we are confident that we have a product that will solve your site-specific challenges.*

As you know, the proper design and construction of a retaining wall is essential. Recon recognizes the important role that YOU; our specifiers, engineers, and installers, play in delivering a site solution that provides long lasting value for your customers. Recon wants to assist you when working on grade separation projects by providing tools that explain the special characteristics of Recon and how they can be used to address the challenges at hand. Recon's Design Overview Guide includes general information for you to get started on your next project design. We recommend using this information in combination with the additional material available on our website, ***reconwalls.com****. Armed with these resources, we believe that you will have a successful project and a Recon retaining wall that will perform as designed and remain attractive for years to come.*

If you require any additional information or there is anything that we can help you with, please feel free to contact us.

Sincerely,

The Recon Team

Recon Wall Systems — Design Overview Guide

Recon Wall Systems retaining walls are classified as Precast Modular Block Walls or PMBWs. When designing a PMBW, it is critical that all of the appropriate information be gathered so that a proper design can be completed. At a minimum, the following information needs to be obtained:

- Wall Geometry – Including length, height, corners, curves, etc.
- Site Geometry – Wall surcharges, toeslopes, and backslopes and whether the wall is a cut or fill application.
- Soils Information – Retained soils, foundation soils, reinforced soils, etc.
- Project Specification – Design and project information and requirements.

Once this information has been collected, the designer can begin the design process. Recon walls can be designed as either gravity retaining walls, which use the mass of the block to retain the soil, or as geogrid reinforced walls. ***The ability to construct tall gravity walls is one of the key advantages of a Recon retaining wall system.*** Geogrid reinforced walls, also referred to as mechanically stabilized earth (MSE) walls, utilize layers of soil reinforcement between the block and in the area directly behind the retaining wall.

Recon has several design tools to assist engineers in the analysis process. ***ReconWall***, which is Recon's proprietary analysis software, is a fully comprehensive retaining wall analysis tool available to industry engineers. In addition, Recon has Wall Charts for both gravity and geogrid reinforced walls that demonstrate the general capabilities of the system. More information can be found on these and other tools later in this manual.

Finally, in many cases, special design considerations will arise that a designer will need to account for. Some of these considerations include, but are not limited to:

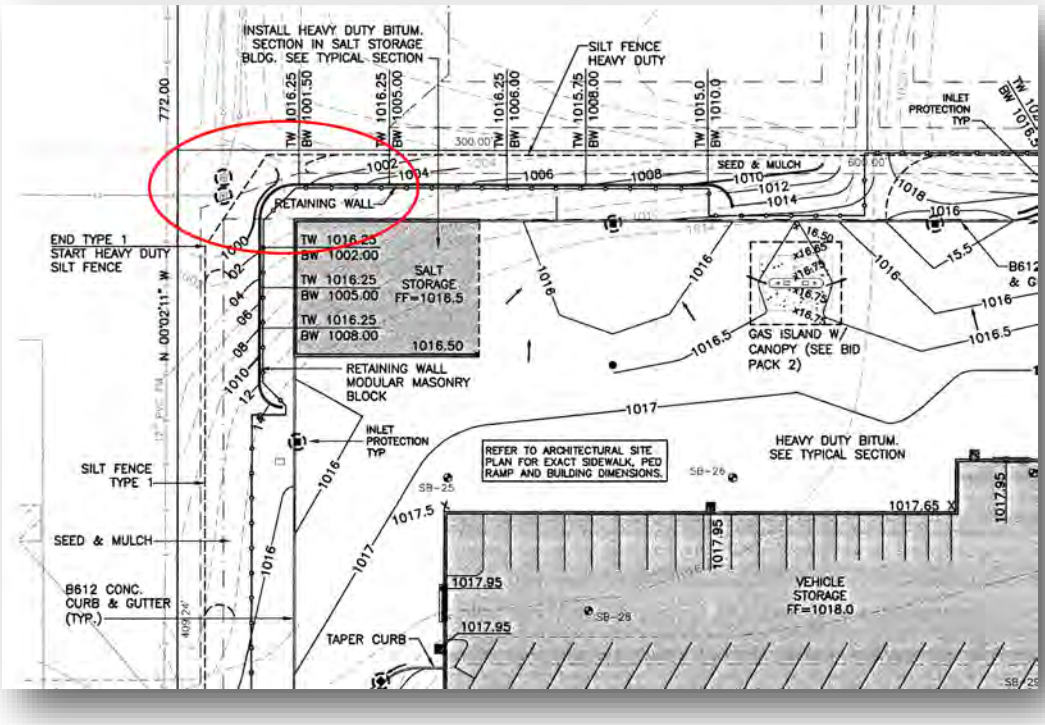
- Increased Wall Setback Options
- Retaining Walls in Water Applications
- Retaining Wall Drainage and Water Management
- Terraced Walls
- Global Stability

Each of these special design cases will be discussed in further detail within this manual.

Wall Geometry

For each Recon retaining wall, the geometry will be dictated by the specifics of the project site and topography. Geometry for each wall generally consists of: wall length, wall height and the location of corners and curves. For most projects this information is found on the site-grading plan. A site-grading plan provides a tremendous amount of the information necessary to properly design a Recon retaining wall.

For projects that don't have a formal site-grading plan, wall geometry is still required, even if perhaps obtained in a less formal way. Regardless of the source, this information is critical to proper design, determination of unit types, and the formulation of accurate unit quantities.



Site Geometry

In addition to wall heights, lengths, and layout, site-plans (grading plans) offer additional information about adjacent structures, surcharges, site access, property lines, utility locations and site drainage. All of these factors influence the final design and construction of a Recon retaining wall.

Surcharges

When a retaining wall is exposed to additional loads, whether permanent or temporary, the overall wall design is affected and the loads will need to be accounted for. This is generally the case when the source of the load (building, roadway, sidewalk, etc.) is located within a distance from the face of the wall, that is less than twice the height of the wall. This is only a general rule based on the most common soil types. Wall design engineers must consider many other factors which may adjust this proximity formula.

Surcharges are usually classified as either temporary (live load) or permanent (dead load) and may stabilize or destabilize a wall, depending on their type and / or relative location with respect to the wall. An example of a live load might be a fully loaded semi-truck traveling along a roadway within close proximity to the top of the finished wall. Because this type of load is temporary, it only contributes to destabilizing forces and any stabilizing contribution of a live load is usually ignored.

A dead load, by contrast, is intended to be permanent. Although it will increase stresses on the wall, depending on its type and location, it can also contribute to certain aspects of wall stability. An example of a dead load may be a building constructed behind the wall which exerts additional weight through its foundation or footing.

Backslopes

A backslope is defined as an upward sloping grade at the top of a retaining wall. Backslopes are technically considered a soil dead load. Determining backslopes is completed during a review of the site-grading plan and inclusion of the backslope during the analysis process is critical.

Toeslopes

A toeslope is defined as a downward sloping grade at the face (or toe) of a retaining wall. Toeslopes are determined by examining the site-grading plan but in general do not increase or decrease the driving forces acting on the wall. They can, however, impact the overall Global Stability of the wall. Refer to the Global Stability section of this manual for additional information.

Cut or Fill Application

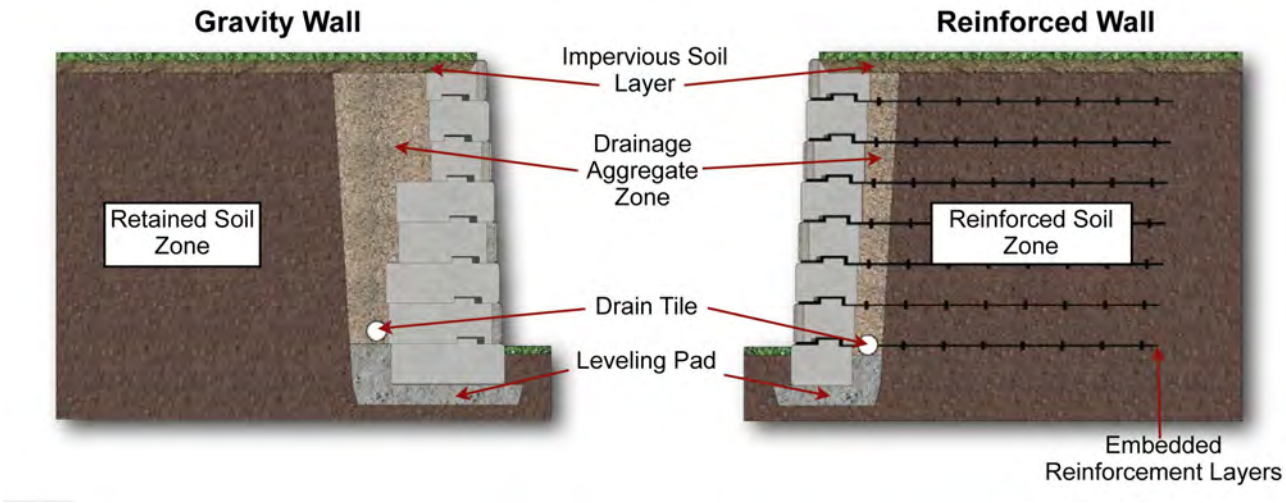
One of the final things determined regarding site geometry is whether the wall is a cut or fill application. Typically speaking, a cut wall is constructed to maximize the useable space at the bottom of the wall by cutting into an existing slope. By contrast, a fill wall maximizes the useable space at the top of the wall. Normally, a Recon gravity wall will be best suited for cut wall applications and a Recon geogrid reinforced wall will be best suited for fill wall applications. However, the use of wall type, gravity or geogrid reinforced, may vary depending on site conditions.

Soils Information

PMBWs, by definition, are a soil retention structures with a modular and mortar-less aesthetic facing. Since soil is one of the main components of the structure, it is necessary to know and understand the properties of these soils since they come in numerous types and compositions. For most projects, information regarding soil properties is obtained from a Geotechnical Report or Soil Boring Log. This information is then used in the wall analysis as well as to predict a wall's overall performance.

In the absence of detailed soils information, assumptions must be made about the soil properties in order to proceed. It is recommended that when assumptions are necessary, that they be generally conservative to preserve safety factors and wall integrity.

There are some soils that should never be used in the construction of a Recon retaining wall. A detailed discussion of all soil types and properties is beyond the scope of this manual. The determination of a particular soil's suitability for use rightfully belongs within the realm of a trained and experienced civil or geotechnical engineer.



The soils that are of critical interest to a wall designer are categorized into five basic zones with respect to their location in and around the finished wall.

The ***leveling pad*** is not technically a soil zone, but is an integral part of a well-designed, well-built retaining wall. The leveling pad, located directly beneath the base block, should consist of well-graded granular material that allows for drainage but has enough fines to allow for proper compaction. Some examples of leveling pad material (by regional name) include: road base, class 5, ¾-inch minus, and crush-and-run. The dimensions for the leveling pad vary and are discussed elsewhere in this manual.

The ***drainage zone,*** located within the voids between blocks and to a minimum depth of 1-foot behind the back of the units, is typically an imported, free-draining crushed rock material. This zone helps facilitate water flow to drainage collection pipes or dispersal areas. It is recommended that a generally self-compacting material, such as ¾-inch crushed stone, be used as it eliminates the need to operate compaction equipment directly behind the wall facing.

The ***foundation soil zone*** is the area located beneath the Recon blocks and drainage zone. This soil zone is responsible for providing adequate support for the weight of the retained wall above. In the case of a geogrid reinforced wall, the foundation soil zone extends beneath and behind the wall to a distance roughly equal to the depth of the embedded soil reinforcement.

The ***reinforced soil zone*** only applies to MSE walls and extends from the back of the drainage zone to the furthest extent of the geogrid soil reinforcement (tails of the grids). In some cases, this soil could be an on-site material. If this material is not suitable, then an imported, select fill material should be used. The properties of this material strongly influence the performance characteristics of the reinforced soil mass and, as such, have a significant effect on the strength, length and quantity of soil reinforcement in the design of the finished wall.

The ***retained soil zone*** is the material located behind the reinforced soil zone, in an MSE wall, or behind the drainage zone in a gravity retaining wall. Soil characteristics within this zone also have a significant effect on the design of the finished wall in the same way that the reinforced soil zone does.

Project Specification

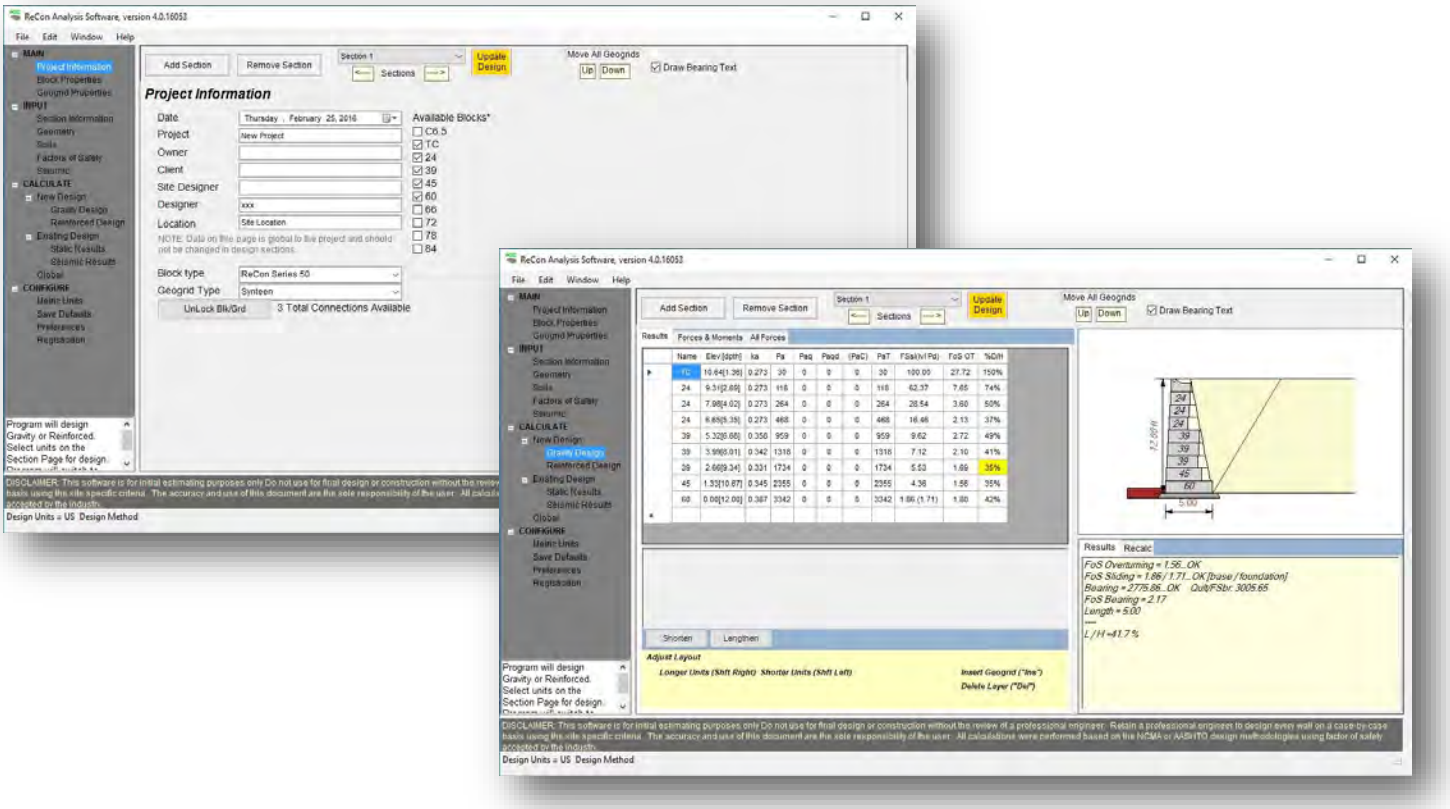
The purpose of a project specification is to outline specific requirements regarding materials, products, installation procedures, design guidelines and quality aspects. As a wall designer, this document should be used to determine required design methodologies, submittals, and other project specific requirements. For wall specifiers, an example of a project specification for Recon is located at the end of this manual and is available for use. Visit ***reconwalls.com*** to obtain a copy.

ReconWall Analysis Software

ReconWall is Recon's proprietary retaining wall analysis software that is available to industry professionals and wall design engineers. This powerful and easy to use software allows the user to analyze both gravity and geogrid reinforced wall sections. Here are just a few of the software's enhanced and comprehensive features:

- NCMA, AASHTO and CSA Design Methodologies
- Water Analysis – Buoyancy and Rapid Drawdown
- Global Stability Analysis
- Seismic Analysis
- Inputs for multiple soil zones
- Inputs for surcharge loading, backslopes and toeslopes
- Full calculation print-out
- Extensive User Help Manual

To obtain a copy of ReconWall, please visit ***reconwalls.com***.



Multiple Setback Options

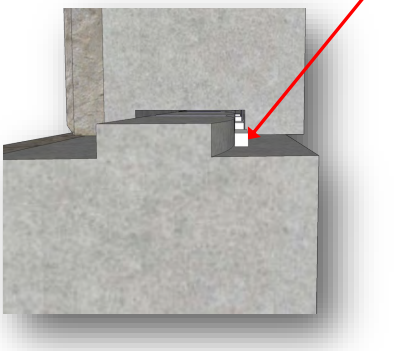
The ability to design a gravity wall to heights reaching 20-feet and beyond can help solve even the most complex site challenges and add significant value. This is especially true in cut wall applications when the objective is to maximize the useable space at the base of the wall. Recon gravity walls can be designed using a smaller footprint than geogrid reinforced walls, which require grids to be at least 60% of the height of the wall. Therefore, gravity walls maximize usable space and save on excavation and construction costs.

In design, the achievable height of a gravity wall can be increased by increasing the depth of the blocks, or increasing the batter / setback of the wall. Recon's retaining wall block lineup has a standard, industry leading, ***EIGHT*** block depths. Each of the blocks is produced with an integrated block-to-block tongue and groove system that creates 1-inch of setback per course. In addition, Recon offers two options for increasing the batter of the wall by modifying the setback between the individual blocks. These options include:

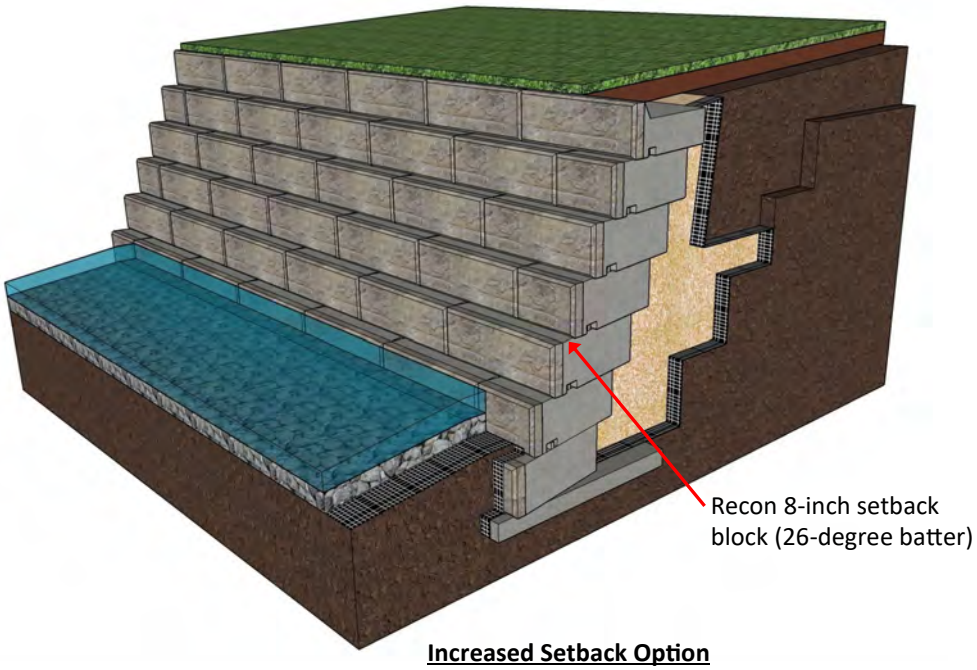
1. Adding a 1-inch fiberglass spacer bar (available from Recon) along the back of the tongue, effectively doubling the batter of the wall from 3.6 to 7.2-degrees. This quick modification is completed by the contractor in the field. Use of the spacer bar is recommended for walls 13-feet 4-inches in height or less.

2. Using Recon's increased setback Block, which modifies the setback between courses from 1-inch to 8-inches, resulting 26-degrees of wall batter. The additional setback is achieve by moving the location of the upper shear key. Additionally, a combination of 8-inch and 1-inch setback blocks can be used to create custom batter options.

Check with the local Recon Licensed Producer for availability of the 8-inch setback block in each particular market since it is not generally stocked as an inventory item.



Spacer Bar Option

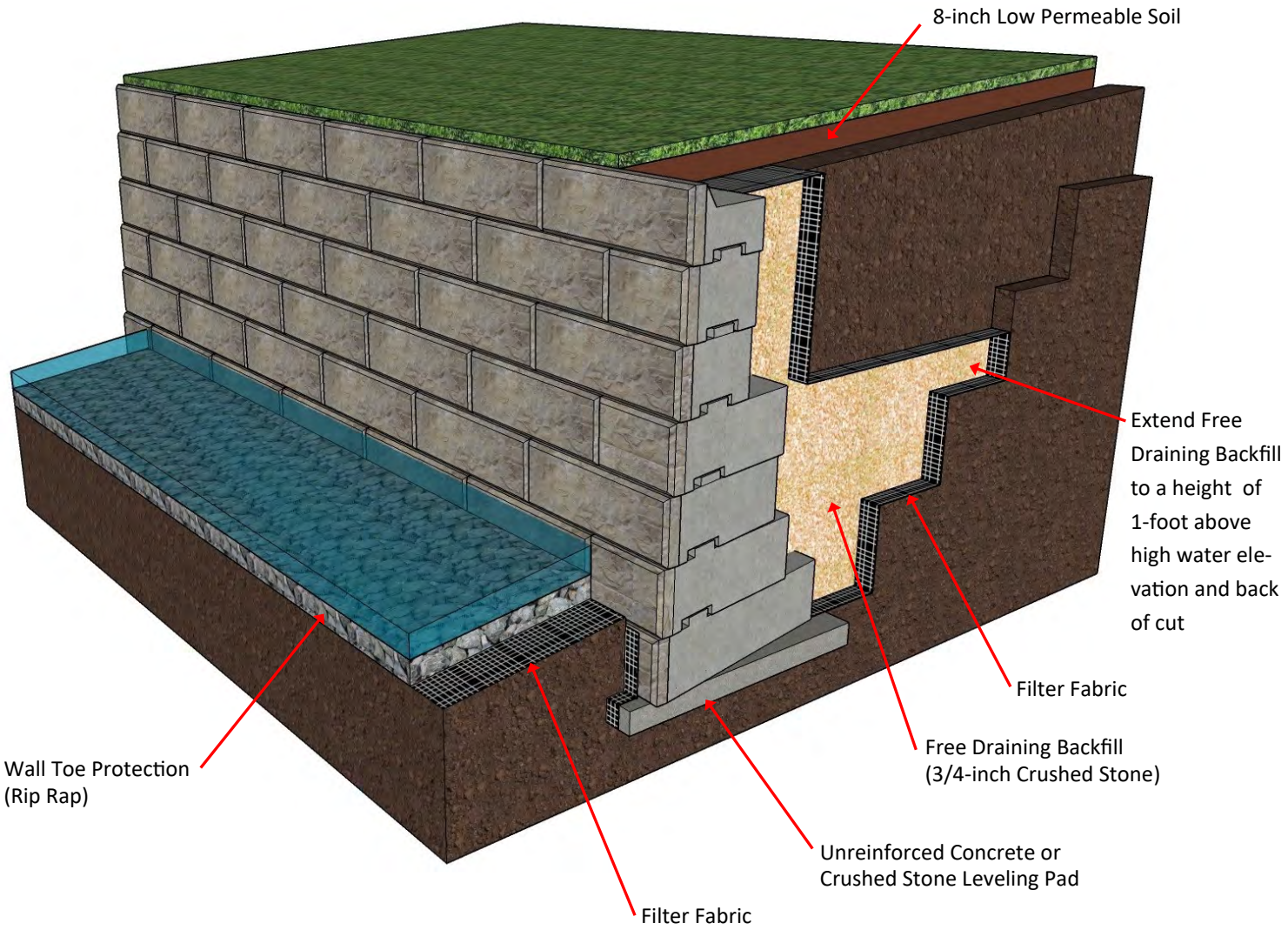


Increased Setback Option

Water Applications

Recon blocks have quickly become the product choice for retaining wall water applications because of their proven durability and ease of installation. By using wet-cast, air-entrained concrete, Recon blocks can perform in numerous harsh environments, including exposure to chlorides, exposure to repeated freeze thaw cycles, and water submerged applications. Since Recon blocks do not require steel reinforcement, they are not susceptible to the effects of corrosion. In addition, Recon blocks allow for rapid installation and reduce the footprint when constructed as a gravity wall.

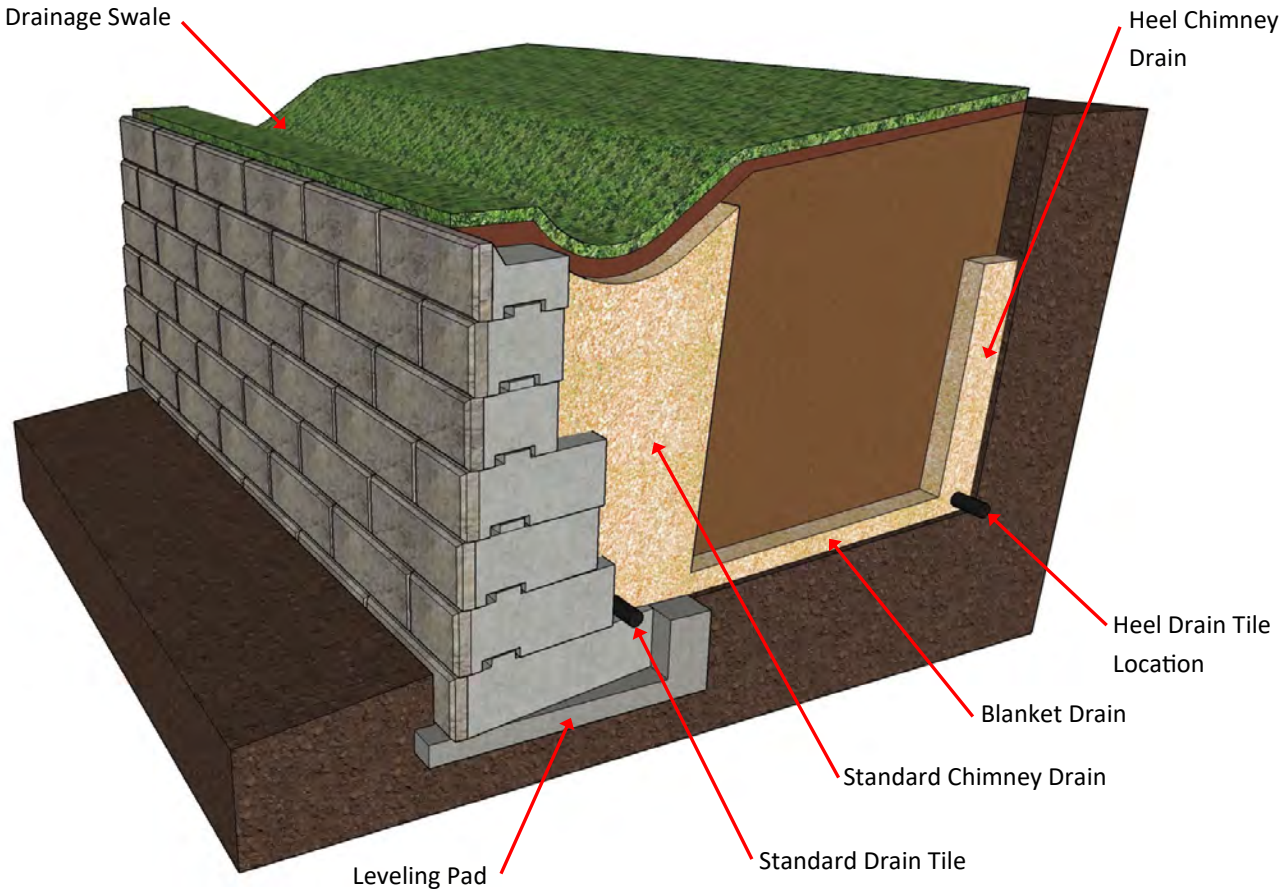
Special consideration should be taken when designing a retaining wall for a water application. Water has a significant impact on the bearing capacity of soils, the magnitude of driving forces and the calculation of resisting weights. It is recommended that wall designers utilize Recon's wall analysis software, ReconWall, when completing the design of a water application retaining wall. The figure below shows some of the specific construction requirements for water application walls. Additionally, designers should refer to Recon's Typical Construction Details regarding water application for specific construction recommendations and requirements. Visit ***reconwalls.com*** for additional information.



Drainage and Water Management

Most performance issues associated with PMBWs can be traced back, directly or indirectly, to water. The presence of water behind a retaining wall, whether it is anticipated or not, affects soil mechanics and increases wall stress. Additionally, a high-water table can weaken foundation soils to the point where they can no longer support the wall. Moving water over the top or along the bottom of a finished wall can erode the soil at the toe causing the wall to become unstable and needing to be rebuilt. For these reasons, it is critical that drainage and water management be consider prior to, during, and after a wall is constructed. In construction, the project site is continually changing. Consequently, drainage and water management techniques may change or need to be modified during the construction process.

Proper drainage and water management considers water from all directions. Where the water originates from will dictate the best method for moving or removing the water from the areas that may adversely affect wall performance. This may be completed through drainage columns, pipes, blankets or specifying a specific backfill material. A number of these features can be seen in the figure shown below. For more information please refer to Recon's Typical Construction Details regarding drainage and water management which can be found at ***reconwalls.com***.



Terraced Walls

Terraced walls are a common feature in retaining wall applications. From an engineering standpoint, these walls must be treated as a single composite structure if their proximity, in conjunction with other site and soil parameters, is such that an upper wall places additional load or stress on the wall (or walls) below.

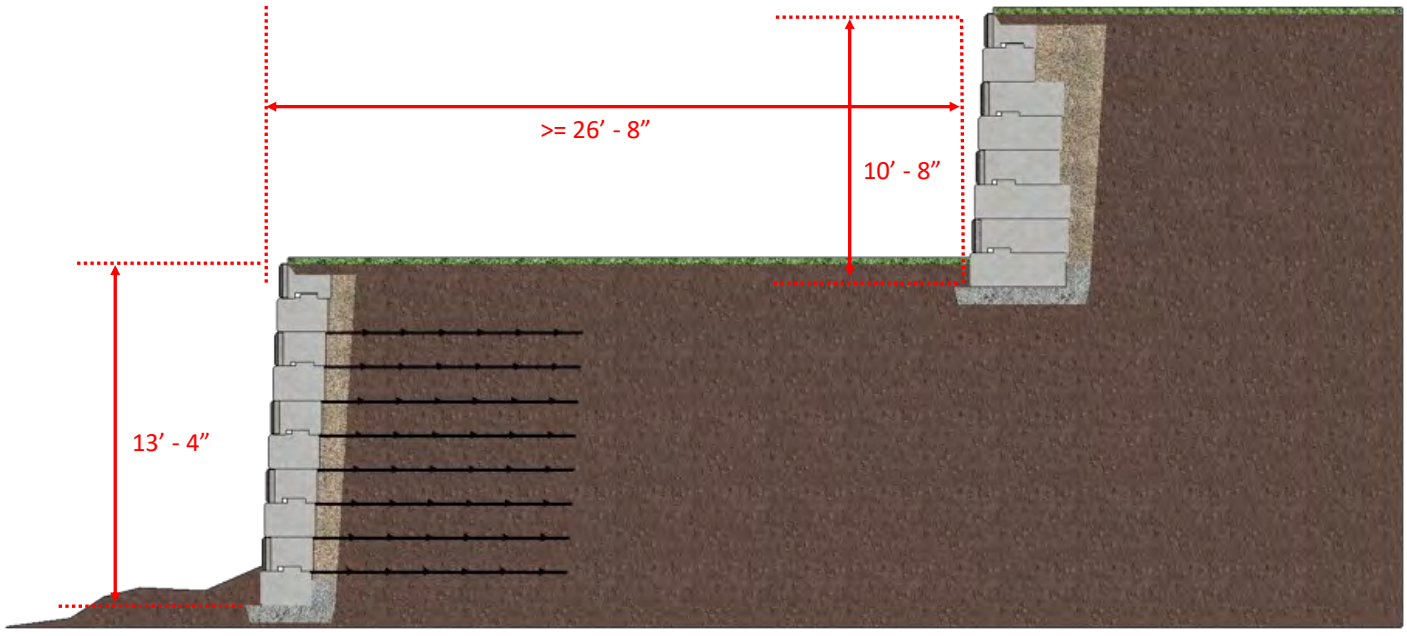
Most terraced walls may be considered independent of each other if they meet the requirements of the following general rule:

Terraced Wall "2:1" General Rule

"Terraced walls are generally considered independent of each other if… 1) the height of the upper wall is less than or equal to the height of the lower wall and … 2) the distance between the two walls is at least twice the height of the lower wall."

This general rule may not apply if soils are very poor, if toeslopes or backslopes are involved, or if there are additional surcharges present. Terraced walls that do not meet the "2:1" rule usually require additional mass and / or soil reinforcement incorporated into the lower wall design to resist the additional stress applied by the upper wall.

Regardless of whether terraced walls are determined to be independent, based upon the rule above, it is recommended that an overall global stability calculation be completed for the system of walls as this may control some of the design aspects.



Terraced Wall Example

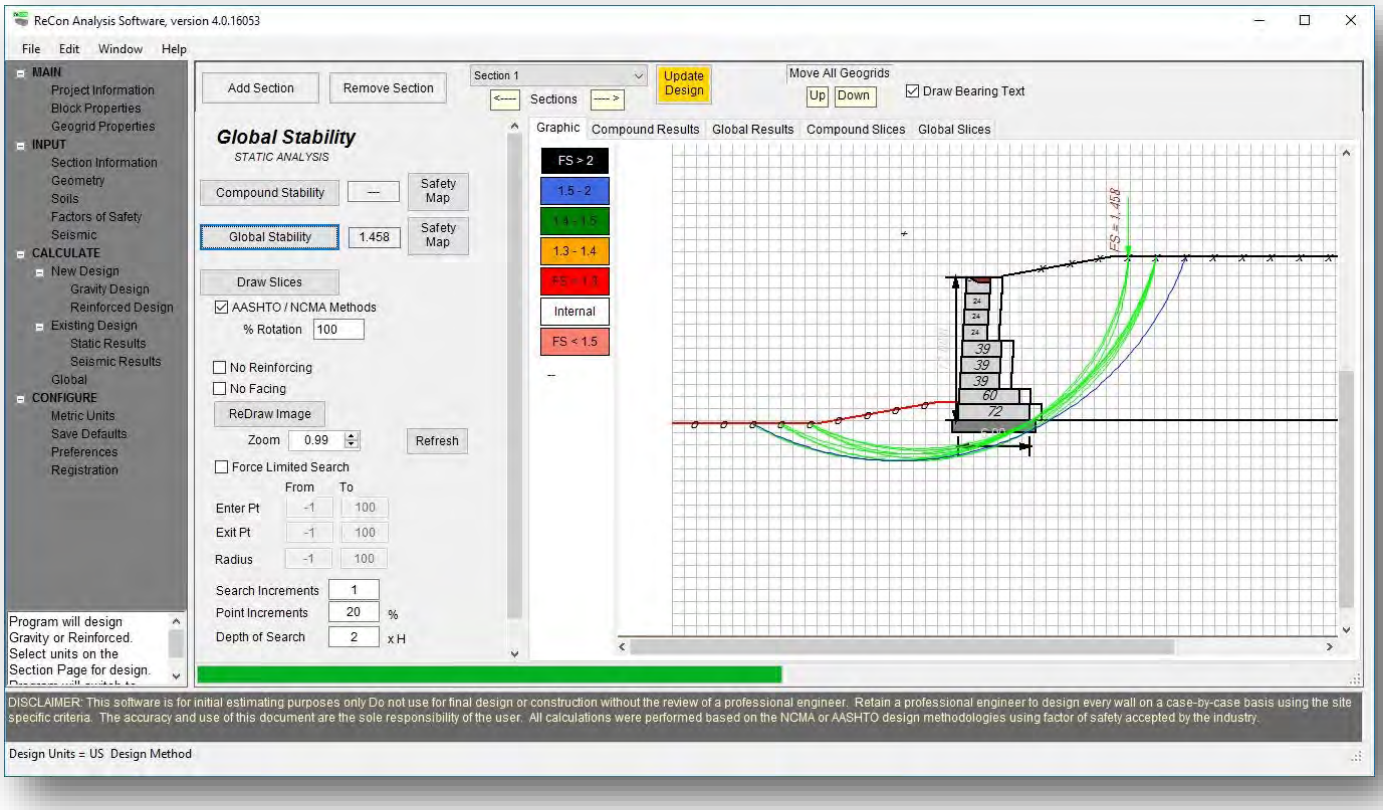
Global Stability

Global stability is defined as rotational, general mass movement of a retaining wall and the adjacent soils. Over the years, several analysis methods and tools have been developed for analyzing global stability. ReconWall, which is Recon's proprietary wall analysis software, is just one tool that designers have access to that can aid in the analysis process. In analysis, numerous soil failure planes, passing behind and beneath the wall, are considered to determine the most critical path. Based upon this critical path, a factor of safety is determined. To learn more about Recon-Wall's approach to global stability analysis, refer to the software's User Help Manual.

Global stability is an important component in retaining wall design and should always be considered during the analysis process. It becomes increasingly important in the presence of any of the following site conditions:

- Walls with toeslopes and/or backslopes
- Walls with significant surcharge loading
- Walls subjected to seismic loading
- Water application walls
- Walls constructed in poor soil conditions (soft soils, organics, high plasticity clays, etc.)
- Terraced walls
- Or any combination of the above

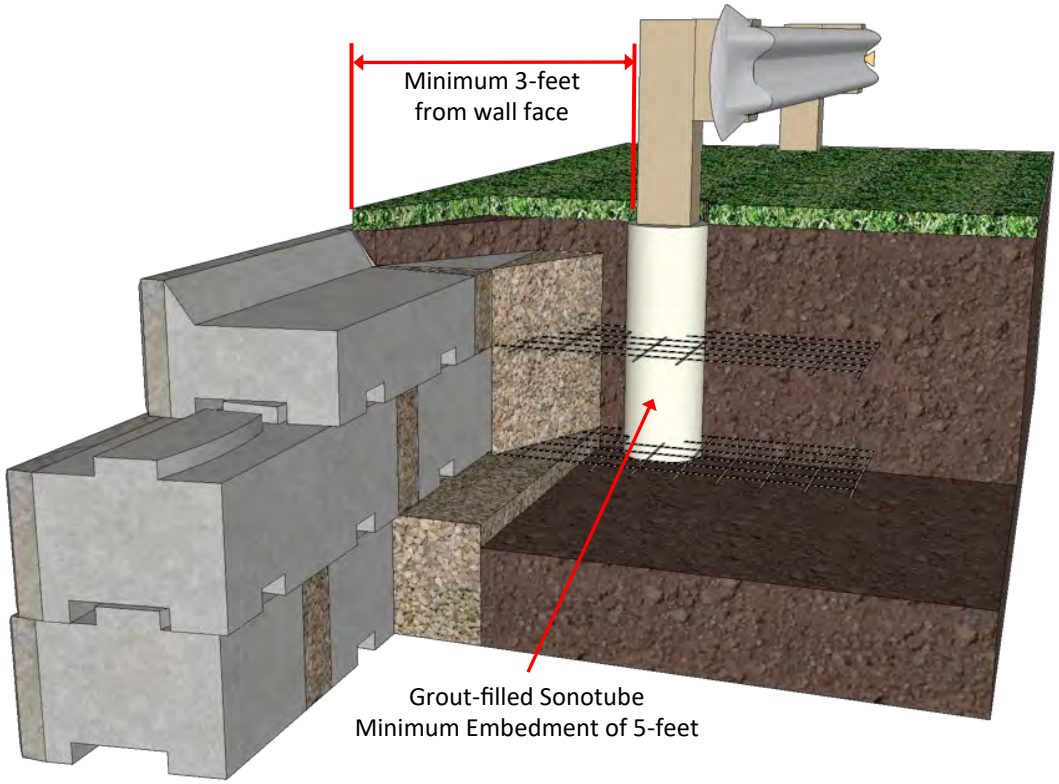
As previously mentioned, ReconWall is powerful tool for analyzing global stability for simple wall geometries, which includes many of the conditions noted above. For complex geometries though, such as terraced walls or multiple toe and back slopes, it is recommended that a third-party software be used that is capable of modeling these conditions.



Independent Pedestrian Railings, Fences and Traffic Barriers

Often, it is desired or required that an independent pedestrian railing, fence or traffic barrier be constructed behind the top of a finished retaining wall. Although they are technically independent from a construction perspective, it is possible that any load applied to these structures could influence the wall. For that reason, it is important that the wall design engineer and the railing/fence/traffic barrier engineer coordinate efforts to ensure that both designs are adequate.

Additional information regarding typical loading for pedestrian handrails, fences and traffic barriers is discussed in subsequent sections of this manual.



Notes:

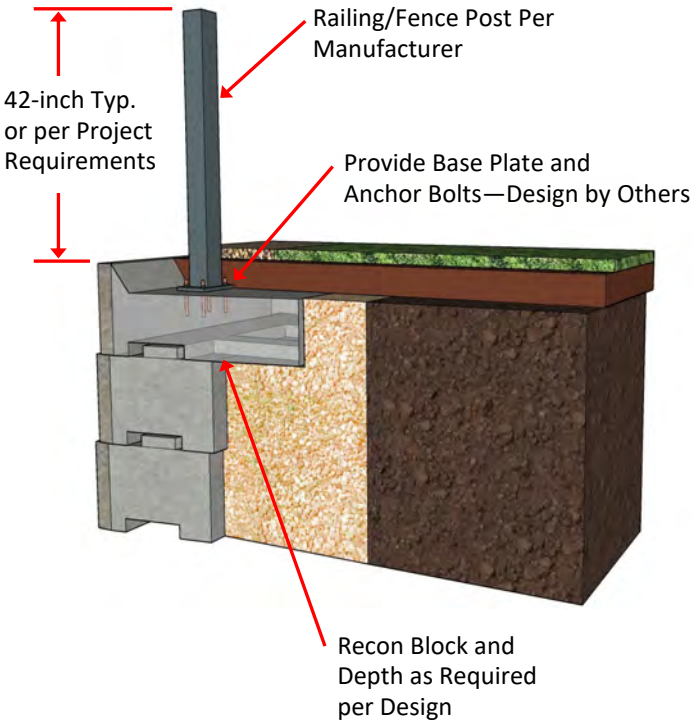
1. The figure above is intended to visually depict some of the minimum construction requirements for installing an independent post and beam traffic barrier. These minimums are based upon the requirements of the AASHTO LRFD Bridge Design Specification. Final design of the post and beam system, including the depth and diameter of the required Sonotube and the distance from face of wall is by others.
2. Once the final design of the post and beam system is determined, the wall design engineer should verify that the retaining wall design is capable of resisting any induced load from impact on the traffic barrier.
3. For Recon walls requiring geogrid reinforcement, refer to the Construction portion of this manual for additional guidance on the installation of the Sonotube.

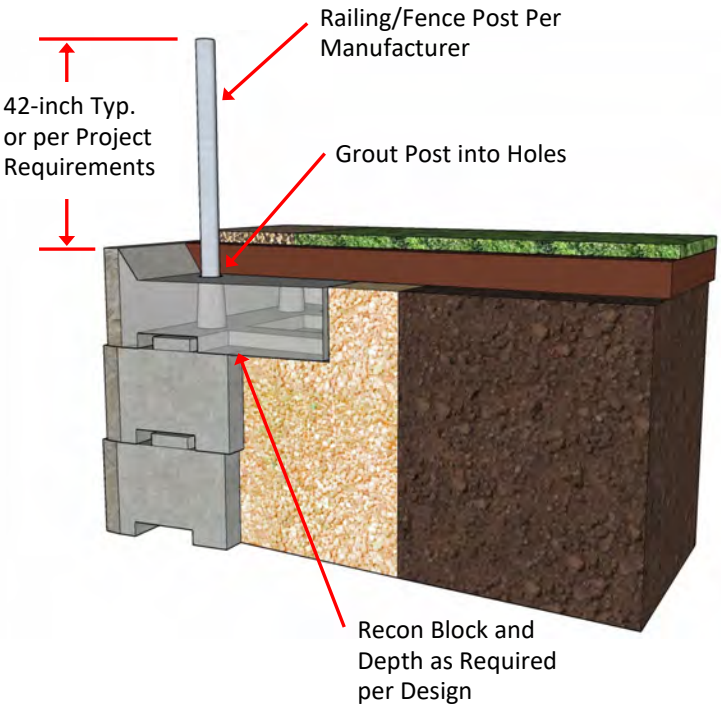
Integral Pedestrian Railings and Fences

One of the defining characteristics of Recon blocks is their substantial mass. Among many other advantages, the mass of the blocks presents an ideal condition for safely mounting pedestrian railings and fence posts directly to the top of the blocks.

When analyzing Recon blocks for the addition of handrailings or fences, there are several loads that need to be considered. These include pedestrian load, wind load, earth load or a combination of the three. The magnitude of these loads is typically determined in accordance with Code and project requirements. For more information regarding these loads, refer to the International Building Code (IBC), American Society of Civil Engineer (ASCE) 7, and the American Association of State Highway and Transportations Officials (AASHTO) Bridge Design Specification.

In some cases, the mass of a single block is adequate to resist the overturning forces from the applied loads. In other applications, the mass of more than one block is required. In these instances, a mechanical connection between blocks is required. Recon has a spreadsheet calculator that is setup to help determine the block configuration that is required based upon specific conditions. Block configurations may consist of Recon's Top Block, Full-High Cap, or Freestanding block with a Capstone. Additionally, the calculator provides some general guidance on the loading that the system must be designed for. Please contact Recon to obtain a copy of this calculator. The figures below illustrate two options for attaching a fence or railing post to a Recon Top Block. Refer to Recon's Typical Construction details for additional information on mechanically fastening multiple courses of block.





Freestanding and Parapet Walls

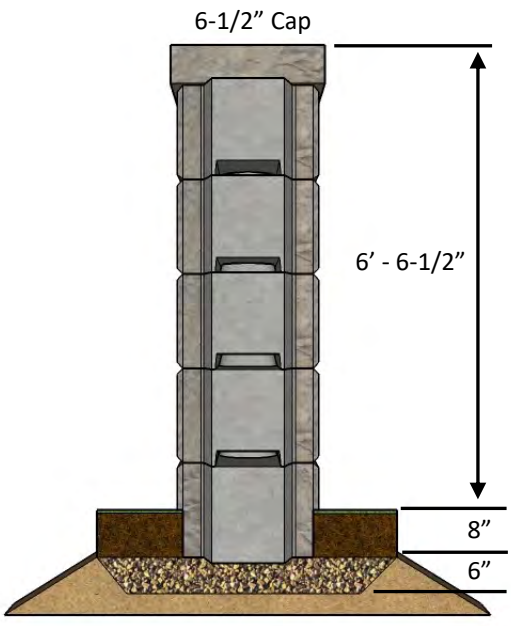
In addition to the full offering of retaining wall blocks, Recon offers a variety of freestanding blocks. Freestanding blocks are used in above grade applications and are textured on all exposed faces. So, whether your project needs an independent freestanding wall or an above grade option to complement our traditional retaining wall blocks, the Freestanding Wall System is an excellent solution.

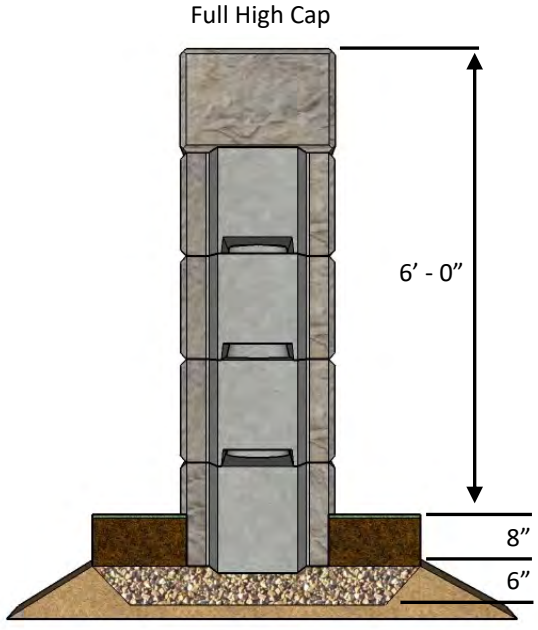
Whether completely independent, or constructed at the top of a retaining wall, Recon's Freestanding Wall System provides a unique solution when a project requires a privacy barrier with the look of natural stone.

Although each of Recon's freestanding blocks have considerable mass, there are limitations to the height in which they can be stacked without the need for reinforcement securing the block together. In a report dated December 2, 2005, Ericksen Roed & Associates summarizes the results of an engineering analysis that was completed for Recon's Freestanding Wall System. The purpose of the analysis was to determine the structural capacity of a freestanding wall with respect to lateral forces applied above grade. The wall was analyzed using the following loads:

1. A continuous pedestrian load of 50 pounds per linear foot, applied horizontally at a height of 42-inches above grade, per the International Building Code 2000 (IBC) 1607.7.1
2. A single pedestrian load of 200 pounds, applied at any point, per IBC 1607.7.1.1
3. A wind pressure of 15 pounds per square foot, per IBC 1609.1.2

The critical load combination was determined to be the continuous load (50 lb/ft) acting in conjunction with 80% of the prescribed wind pressure. The results of the analysis show that a freestanding wall can be stacked to a ***maximum height of 6-feet 8-inches above grade*** and still meet minimum factors of safety. Above this height, the need for reinforcement and a wider footing would be required. In cases where reinforcement is required, it is recommended that Recon's freestanding blocks be cast with a hole through them to help facilitate and ease installation. To obtain a copy of the full analysis and report, please contact Recon Wall Systems.





When inde- constructing pendent, an free-

standing wall it is important that the foundation soils be properly prepared and compacted to provide adequate support for the wall. When freestanding blocks are installed in combination with a retaining wall (as the top of wall finish), the wall and foundation soils should be analyzed for the addition of the freestanding block weight.

Integral Traffic Barrier

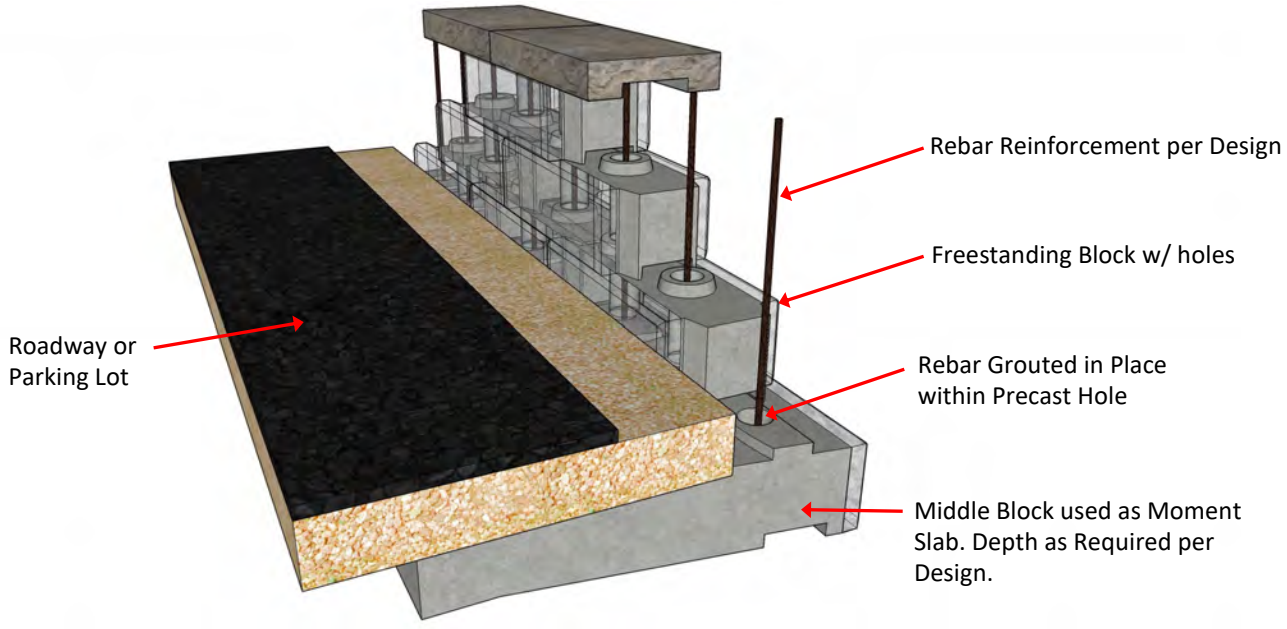
Often times, in the case of parking lots and along roadways, there is not enough space to install an independent traffic barrier system behind the top of wall. In these situations, a traffic barrier can be created at the top of a Recon retaining wall using the Freestanding Wall System with holes through the blocks.

There are many things that must be considered when designing a traffic barrier system. The most important piece of information though, is the magnitude of force that the barrier must be capable of resisting. This force is often referred to as an impact load, but in design it is common to use an equivalent static load. Both the International Building Code (IBC) and the American Association of State Highway and Transportation Officials (AASHTO) Bridge Design Specification provide guidance on determining applicable loads.

The IBC has a standard load, equal to 6,000 pounds, that is for vehicle barriers in parking structures or intended to protect building elements. This load is also generally accepted for parking lots, residential side streets or private drives where low vehicle speeds are anticipated.

By contrast, the AASHTO Standard has six load levels ranging from Test Level-1 (TL-1) through TL-6. Each of these load levels corresponds to a maximum vehicle mass, speed and angle of impact to the barrier. This information is then used to calculated an equivalent static load that can be used in design. For TL-1, that load is 13,500 pounds.

With proper reinforcing and block depths, Recon's Freestanding Wall System can be used to create a traffic barrier capable of resisting loads as high as AASHTO's TL-1. The figure below shows the general configuration of the block as well as the location of the rebar reinforcement. Please contact Recon Wall Systems to obtain a copy of the supporting calculations for both the IBC and the AASHTO TL-1 traffic barriers.

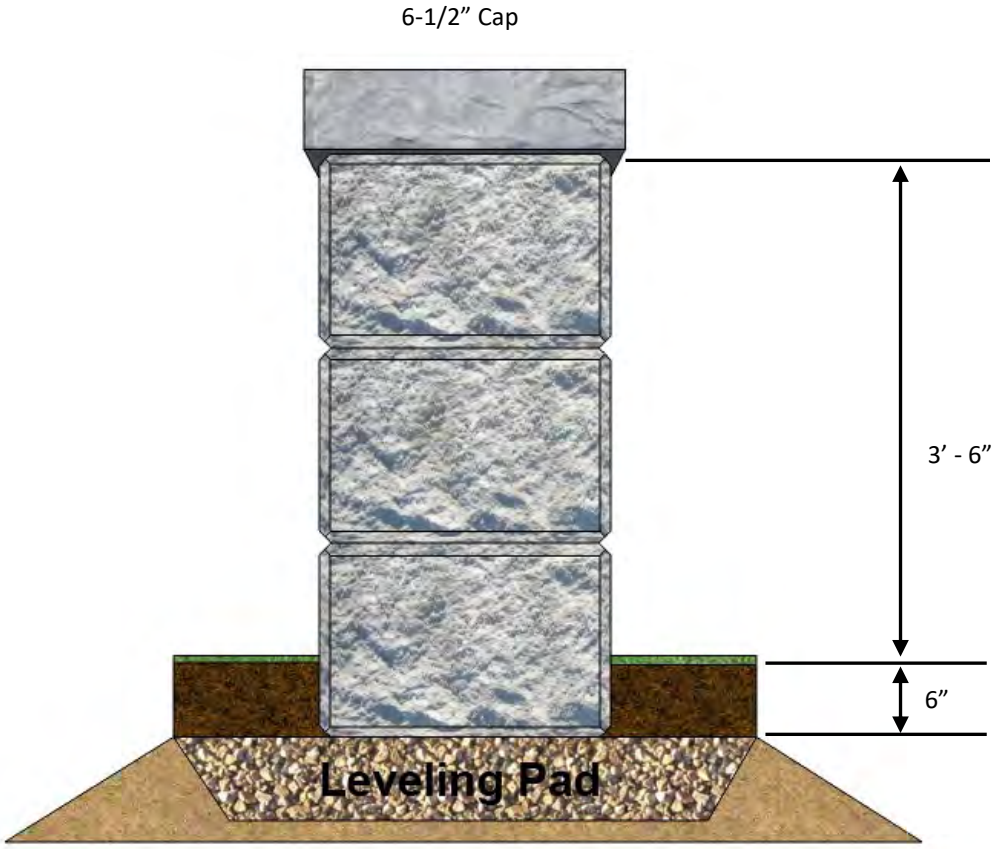


Column Blocks

The final block type in Recon's freestanding lineup is the Column block. Like the other freestanding blocks, the Column block is an above grade option that is textured on all exposed faces but is used to create freestanding columns.

Since the dimensions of the Column block are similar to that of the other freestanding blocks, the analysis completed regarding maximum height is applicable for Column block as well, provided the loading is the same. Adding reinforcement to the Column block core and adding a larger below grade footing would allow for additional height. Final determination of the maximum height should be completed based upon site conditions and anticipated loads.

Finally, it is important that the foundation soils beneath the Column block be properly prepared during construction and that they are adequate to support the loading from the column.



Note: This guide specification should not be included entirely "as-is". Specification writers must edit areas in red which may or may not be relevant to a specific project or where mutually exclusive choices are referenced.

SECTION 32 32 16
PRECAST MODULAR BLOCK RETAINING WALL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Furnishing materials and labor required for the design and construction of a Recon precast modular block retaining wall.

B. Related Sections:
   1. Section 312000 Earth Moving
   2. Section 099313.13 Exterior Staining
   3. Section 099723 Concrete and Masonry Coatings
   4. Section 099623 Graffiti-Resistance Coatings

1.2 REFERENCES

A. Precast Modular Block Units:
   1. ASTM C-33 Specification for Concrete Aggregates
   2. ASTM C-39 Test Method for Compressive Strength of Cylindrical Concrete Specimens
   3. ASTM C-94 Specification for Ready-Mixed Concrete
   4. ASTM C-138 Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
   5. ASTM C-143 Test Method for Slump of Hydraulic-Cement Concrete
   6. ASTM C-172 Standard Practice of Sampling Freshly Mixed Concrete
   6. ASTM C-260 Specification for Air-Entraining Admixtures for Concrete
   7. ASTM C-494 Specification for Chemical Admixtures for Concrete
   8. ASTM C1611 Test Method for Slump Flow of Self-Consolidating Concrete
   9. ASTM C-1776 Standard Specification for Wet-Cast Precast Modular Block Retaining Wall Units

B. Drain Pipe:
   1. ASTM D-3034 Standard Specification for Type PSM (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
   2. ASTM F-2648 Standard Specification for 2 to 60 inch [50 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications

C. Geosynthetics:
   1. ASTM D-4595 Tensile Properties of Geotextiles - Wide Width Strip
   2. ASTM D-4873 Standard Guide for Identification, Storage and Handling of Geosynthetics
   3. ASTM D-5262 Unconfined Tension Creep Behavior of Geosynthetics
   4. ASTM D-5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
   5. ASTM D-5818 Standard Practice for Obtaining Samples of Geosynthetics from a Test Section for Assessment of Installation Damage
   6. ASTM D-5970 Standard Test Method for Deterioration of Geotextiles from Outdoor Exposure
   7. ASTM D-6637 Standard Test Method for Determining Tensile Properties of Geogrids by the Single- or Multi-Rib Tensile Method
   8. ASTM D-6638 Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units
   9. ASTM D-6706 Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil

D. Engineering Design:
   1. NCMA Design Manual for Segmental Retaining Walls, Current Edition
   2. AASHTO LRFD Bridge Design Specifications, Current Edition
   3. International Building Code (IBC), Current Edition
   4. Minimum Design Loads for Buildings and Structures, ASCE 7, Current Edition

E. Soils:
   1. ASTM D-422 Standard Test Method for Particle-Size Analysis of Soils

2. ASTM D-448 Standard Classification for Sizes of Aggregates for Road and Bridge Construction
3. ASTM D-698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/f3) (600 kN-m/m3)
4. ASTM D-1241 Standard Specification for Materials for Soil-Aggregate Subbase, Base and Surface Courses
5. ASTM D-1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method
6. ASTM D-1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/f3) (2700 kN-m/m3)
7. ASTM D-2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
8. ASTM D-3080 Standard Test Method for Direct Shear Test of Soils Under Consolidated
9. Drained Conditions
10. ASTM D-4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
11. ASTM D-4767 Test Method for Consolidated-Undrained Triaxial Compression Test for Cohesive Soils
12. ASTM D-6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
13. ASTM D-G51 Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing

F. Recon Construction Detail Drawings: www.Reconwalls.com

1.3 DEFINITIONS

A. Recon Retaining Wall Unit: Concrete, modular facing block provided by an authorized manufacturer under license to Recon Wall Systems, Inc.
B. Geogrid: A geosynthetic material manufactured of high tensile materials specifically for the purpose of reinforcing and creating a structural soil mass.
C. Drainage Aggregate: Clean, crushed rock located within and immediately behind Recon units to facilitate drainage and avoid compaction in close proximity to Recon wall units.
D. Reinforced Soil: Soil zone extending from the Drainage aggregate zone to the back of the embedded geogrid.
E. Foundation Soil: Soil zone immediately beneath the retaining wall facing units, the wall leveling pad and the reinforced soil zone.
F. Retained Soil: Soil immediately behind retaining wall facing and drainage aggregate for modular gravity structures or behind the reinforced soil for wall that utilize geogrid.
G. Construction Drawings: Approved final plan for construction prepared and stamped by the wall design engineer licensed to practice in the state where the retaining wall is located.

1.4 Submittals

A. Contractor shall submit Manufacturer's product data and installation instructions for approval.
B. Contractor shall submit Manufacturer's test reports certifying that the Recon units manufactured at their production facility meet the requirements of this specification and the requirements of the Construction Drawings.
C. Unless provided within these project documents and/or the project drawings, contractor shall submit two sets of the Construction Drawings for all Recon retaining walls on the project.
    1. The design shall be prepared by a Professional Engineer licensed to practice in the state where the retaining wall is located.
    2. The design shall be per NCMA Design Guidelines for Segmental Retaining Walls, or the AASHTO Standard Specifications for Highway Bridges, whichever is applicable as determined by the retaining wall design engineer.
    3. Construction Drawings shall include:
        a. The retaining wall layout and retaining wall heights.
        b. Proper placement, lengths and types of geogrid reinforcement where necessary.
        c. Typical wall sections.
        d. Types, locations and properties of all drainage materials, appurtenances and special installation requirements not covered in this specification.
        e. Retaining wall elevation views.
        f. Any soils information or testing conducted in addition to that included within the project drawings and specifications.

g. Design assumptions.

D. If geogrid reinforcement is required in the final engineered construction drawings, submit manufacturer's product literature, product testing reports and a twelve inch or larger sample of each type to be used in wall construction.
E. Submit gradation reports for aggregates used for the wall leveling pad, unit / drainage fill and for select reinforced fill if required in the final engineered wall design.
F. All submittals must be provided and reviewed prior to the start of retaining wall construction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall inspect all products at delivery to determine that the proper materials have been delivered and are usable. Damaged material shall not be incorporated into the work.
B. Recon retaining wall units shall be stored in a location and manner that protects against excessive weathering and damage.
C. Contractor shall prevent Recon units from excessive soiling and coming in contact with substances which may stain or adhere to the finished visual surfaces of the unit.
D. Faces of the Recon Block shall be free of excessive chipping, cracking and stains.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Contractor shall have successfully installed at least three projects similar to that of this project within the last two years. Contractor shall maintain at least one mechanic on site at all times that worked on one or more of these previous installations.
B. Owner shall employ the services of an independent geotechnical or materials engineering firm to provide soil testing and quality assurance inspection for wall construction and soils work. Contractor shall provide any quality control testing or inspection not provided by the Owner.
C. Retaining Wall Design Engineer Qualifications: The Retaining Wall Design Engineer shall be licensed to practice in the state in which the project is located. Additionally, the Retaining Wall Design Engineer shall be independently capable of performing all retaining wall analysis calculations (internal and external stability, seismic analysis, water analysis, and global stability) and have designed at least three wall projects similar to that of this project.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Only licensed and authorized manufacturers of:
   1. Recon Wall Systems, Inc.
      7600 West 27th St., #229
      St Louis Park, MN 55426
      (952) 922-0027 Phone
      (952) 922-0028 Fax
      www.Reconwalls.com

2.2 MATERIALS

A. Recon retaining wall units.
   1. The block unit shall consist of concrete with the average 28-day compressive strength of no less than 4000 psi.
   2. Concrete shall have air entrainment by volume (as measured in the plastic state in accordance with ASTM C172) of:
      a. 5.5 – 8.5 percent, or
      b. In conformity with ASTM C94, latest revision.
   3. Exterior dimensions of the face shall be 48-inches by 16-inches for full and corner unit, and 24-inches by 16-inches for half unit.
   4. Depth of unit should be as per Construction Drawings and is available in depths from 24-inches up to 84-inches (dimensions in inches: 24, 39, 45, 60, 66, 72, 78, 84).
   5. Recon Units used shall maintain tolerances of:
      a. Height: +/- 3/16-inch
      b. Width: +/- 1/2-inch unless field cut for fitting purposes.
      c. Depth: No less than the unit design depth (i.e. 24-inch, 39-inch, etc.) with the textured face portion of the block being considered as 4-inches

6. Special shape units should be obtained and used where indicated on the final engineered construction drawings. Reference Recon Drawing #101 for overview of standard unit types.
7. Recon Unit Face Texture [Specify choice (or choices) as required. Check local availability]:
    a. Shall be “LeSueur County Limestone”
    <or>
    b. Shall be “North Shore Granite”
    <or>
    c. Shall be “Old World”
    <or>
    d. Shall be “Rustic”
    <or>
    e. Shall be “Weathered Edge”

B. Geogrid Reinforcement: Geosynthetic reinforcement shall be high tensile geogrid or geotextile manufactured specifically for soil reinforcement applications.
    1. Construction Drawings shall indicate the type, strength, location and lengths of reinforcement used.
    2. The geosynthetic manufacturer shall provide all relevant testing to the wall design engineer for incorporation in the wall design and shall be included in the submittal for the Construction Drawings.
    3. No substitutions of geosynthetic shall be allowed that was not evaluated in the Construction Drawings.
C. Base Leveling Pad: The wall base leveling pad material shall consist of a compacted crushed stone base or non-reinforced concrete as indicated in the Construction Drawings.
D. Drainage Aggregate: Drainage aggregate shall consist of clean 3/4” crushed stone or gravel meeting the requirements of the Construction Drawings.
E. Reinforced Soil: All reinforced soil, borrow or imported, shall meet all requirements of the Construction Drawings. Reinforced soils, by gradation, shall have no more than 35 percent passing the number 200 sieve for walls less than 20-feet in height and no more than 15 percent passing the number 200 sieve for walls greater than 20-feet in height.
F. Drainage Pipe: If required in Construction Drawings, drainage pipe shall be perforated, slotted or corrugated pipe manufactured in accordance with ASTM D-3034 or ASTM F-2648. Drainage pipe may also be covered with a geotextile filter fabric.
G. Unit Adhesive: Adhesive shall be a premium, construction grade suitable for concrete and exterior applications.

2.3 FINISHES

A. Recon retaining wall color [Specify choice (or color) as required]
    1. Finished wall shall be left in natural (as-cast) color.
    <or>
    2. Finished retaining wall shall be stained in accordance with Section 099313.13 “Exterior Staining”.
        a. Acceptable product stains:
            1. Sherwin Williams H & C SHIELD PLUS CONCRETE STAIN
            2. TK Products TRI-SHEEN PIGMENTED STAIN TK-5272
        b. Color shall match [Define reference or sample to match]
        <or>
        c. Color shall be [Designate existing color]
    3. Sealing [Optional, list here and specify in Section 099723 Concrete and Masonry Coatings or 099623 Graffiti Resistant Coatings]
        a. Acceptable sealers and anti-graffiti coatings
            1. TK Products TK-290 Tri-SILOXANE OTC (sealer)
            2. TK Products 1496 TK Prermaclean OTC (anti-graffiti)

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify locations of utilities and existing structures prior to excavation.
B. Examine the Project site and evaluate conditions where the Recon retaining wall will be constructed. Notify the proper supervising authority in writing of any conditions that may interfere with the proper construction of the Recon wall or delay completion.
C. Promptly notify the wall design engineer of site conditions which may affect wall performance, soil conditions observed other than those assumed, or other conditions that may require a reevaluation of the wall design.

3.2 EXCAVATION

A. Contractor shall excavate to the lines and grades shown on the construction drawings. The contractor shall be careful not to disturb the base beyond the lines indicated.
B. Foundation soils shall be excavated as required for footing base / leveling pad dimensions shown on the construction drawings, or as directed by the wall engineer.
C. Over-excavated areas shall be filled with suitable base or backfill material and compacted to 95 percent standard proctor.

3.3 FOUNDATION SOILS PREPARATION

A. Foundation soils shall be evaluated by a Geotechnical Engineer or Owners Representative to ensure that the bearing soils meet or exceed the design conditions or assumptions.
B. Compact foundation soil zone to 95 percent standard proctor prior to installing base / leveling pad.

3.4 BASE / LEVELING PAD

A. Base shall be located as indicated on the Construction Drawings and shall have a minimum thickness of 6-inches. Base materials are to be as specified by the wall engineer (generally crushed stone, 3/4-inch minus, or similar).
B. Width of the base pad must extend a minimum of 6-inches in front and 6-inches in back of the Recon Base Block footprint.
C. Base material shall be compacted so as to provide a smooth, hard surface on which to place the first course of units.
D. Compact base material to 95 percent of standard proctor.
E. Base shall be prepared to ensure full contact of the wall unit with base material. Spacing or gaps between units shall no exceed 1/2-inch.
F. Contractor may elect to substitute a portion of the specified granular base materials with a lean, unreinforced concrete topping.
G. When a reinforced footing is required by the Construction Drawings, it shall be located below the frost line.

3.5 UNIT INSTALLATION

A. First course of units shall be Base Block units and shall be placed in full contact with the base material.
B. Check units for level from side-to-side, front to back, and check to maintain unit batter front-to-back.
C. Place unit faces in contact side to side and avoid any gaps greater than 1/2-inch.
D. Fill and compact fill to grade in front of embedded units prior to compaction behind the wall units.
E. Fill voids between Recon units with 3/4-inch clean crushed rock to a distance of one foot behind the unit depth unless otherwise instructed in the Construction Drawings.
F. Sweep and clean the top of each course before setting additional courses.
G. Lay each successive course making sure that the bottom recess is in full contact with the unit locators of the course below. Pull unit forward as far as possible. Backfill and compact soil behind the units.
H. Check and maintain level and wall batter by use of shims when necessary.
I. Follow Recon recommended procedures to maintain acceptable running bond when constructing curved walls and / or corners. Build in accordance with Construction Drawings or Recon Construction Detail Drawings.

J. Handle units with proper lifting devices that have been certified for the loads associated with the weights of the units. Avoid applying forces to the lifting loops in excess of the normal force associated with the weight of the unit (i.e., avoid dynamic loads from bouncing or swinging of a unit). If the unit is to be transported over a significant distance in the field, it is recommended that a CABLE be used in lieu of a chain.

3.6 GEOGRID INSTALLATION

A. Install geosynthetic reinforcement in accordance with manufacturer's recommendations and the Construction Drawings.
B. Locate geosynthetic reinforcement at elevations and to the lengths shown on the Construction Drawings.
C. Prior to installation of geosynthetic reinforcement, level and compact backfill material to the level of the reinforcement layer.
D. Reinforcement design strength direction must be oriented perpendicular to wall face.
E. Position reinforcement on Recon units over the tongue and groove and to within 2-inches of the front exposed face. The next course of units shall be placed such that the geogrid is deformed over the tongue and groove. The next course of units must be slid forward such that the back edge of the groove on this unit is up against the back edge of the tongue on the lower unit with the geogrid pinched between the tongue and groove. Hold in place by installing the next course of units.
F. Remove all wrinkles or folds in reinforcement by pulling taut prior to backfill placement. Secure using soil staples, stakes or hand tension until reinforcement is covered with sufficient fill to maintain tensioned position.
G. Reinforcement shall be continuous throughout the embedment length. Splicing along reinforcement strength direction is not allowed.
H. Position reinforcement sections side-by-side to provide 100 percent coverage along wall face.
I. Where curved wall sections cause overlap areas in reinforcement, maintain at least 3-inches of soil between layers where overlap occurs.

3.7 REINFORCED BACKFILL PLACEMENT

A. Wall fill material shall be placed in lifts no greater than 8-inches in depth and shall be less if necessary to achieve necessary compaction.
B. Compact backfill material to 95 percent of standard proctor.
C. Only hand-operated compaction equipment shall be used within 3-feet of the back of the Recon unit. Heavy-duty compaction equipment should be kept a minimum of 5-feet from the back of the Recon unit to avoid wall rotation.
D. Wherever possible, backfill should be placed beginning at the face of the wall. Backfill shall be placed, spread, and compacted in a manner that minimizes the development of wrinkles, folds or movement of geogrid.
E. Tracked construction equipment shall not be operated directly on the geogrid. A minimum backfill thickness of 6-inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid.
F. Rubber tired equipment may pass over the geogrid reinforcement at slow speeds, (less than 10 MPH). Avoid sudden braking and sharp turning.
G. At the conclusion of each day's work, slope backfill at both the crest and bottom of wall away from wall face to prevent surface drainage from scouring or ponding.
H. During wall construction, the General Contractor shall be responsible for coordination of other project site operations so as to avoid adjacent construction site drainage from affecting wall construction area.
I. Upon completion of wall construction work, the General Contractor shall:
    1. Ensure finished grading directs normal drainage away from the finished wall.
    2. Ensure other trades do not operate heavy equipment or excavate near the wall and reinforced soil zone.

3.8 OTHER CONSTRUCTION DETAILS

A. Recon provides a number of Construction Detail Drawings (see Section 1.2F) which can be found on Recon's website (www.Reconwalls.com) and should be referred to for guidance on wall specific applications.

3.9 SITE TOLERANCES

A. Straight walls
    1. Vertical Alignment: +/- 1.5-inches over any 12-feet distance and no more than +/- 3-inches over the entire length of wall.
B. Horizontal Alignment Control:
    1. Corners and radius location: +/- 1-foot to theoretical location indicated on the Grading Plan.
    2. Radii: +/- 2-feet from theoretical lines indicated on the Grading Plan.
C. Wall Batter at Completion of Work: +/- 2-degrees from the design batter and no batter less than 2-degrees.

3.10 FIELD QUALITY CONTROL

A. Contractor shall be responsible for proper installation and quality control of all Recon wall components and appurtenant materials.
B. Owner shall, at their expense, retain a qualified professional to monitor and perform quality assurance checks of the installer's work.
C. Quality Assurance should include foundation soil inspection, frequent backfill compaction testing, verification of geotechnical design parameters and compliance with Construction Drawings and Project Specifications.

3.11 CLEANING

A. After completion of wall installation, remove construction debris and restore any adjacent finished areas affected by wall construction to their pre-construction state.
B. Wash wall face to remove soiling and stains. Do not use acid or detergents that my "burn" or discolor face.

3.12 STAINING / SEALING (Optional)

A. Provide samples of stained / sealed faces for approval prior to commencing application to Recon retaining wall units. Samples shall be large enough to demonstrate scope of color variation.
B. Install stain / sealer in accordance with manufacturers recommended procedures.