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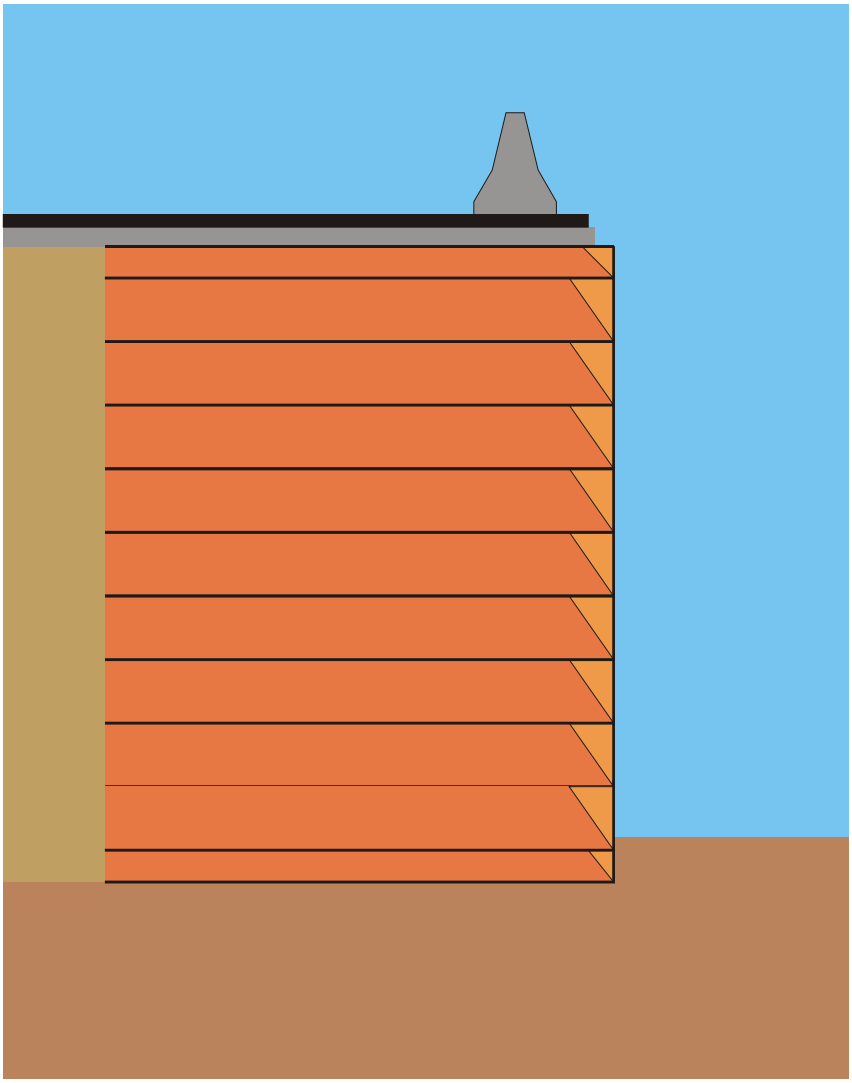
ENGINEERED STRUCTURES



MECHANICALLY STABILIZED EARTH STRUCTURES

WELDED WIRE WALL SYSTEM

INSTALLATION GUIDE

MECHANICALLY STABILIZED EARTH STRUCTURES

WELDED WIRE WALL SYSTEM

INSTALLATION GUIDELINES

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IT IS THE RESPONSIBILITY OF THE ENGINEER OF RECORD
TO REVIEW AND VERIFY THE ACCURACY OF THESE CALCULATIONS.
BY SIGNING AND SEALING THE ENGINEER OF RECORD ASSUMES
THE LEGAL RESPONSIBILITIES FOR THIS PROJECT.

LIST OF FIGURES

TBSS GABION WELDED WIRE WALL SYSTEM

1 INTRODUCTION

This manual is designed to provide a set of general guidelines and specifications for the Owner, Contractor, and Erector of the ***TBSS GABION WELDED WIRE*** retaining wall system (GWWW).

Mechanically Stabilized Earth (MSE) is a composite structure consisting of welded wire facing panels, steel soil reinforcing and compacted soil. The inclusion of tensile resisting steel soil reinforcing elements in the soil significantly improves the strength of the soil. This unique combination, when designed and installed properly, will create a cost effective integrated retaining structure.

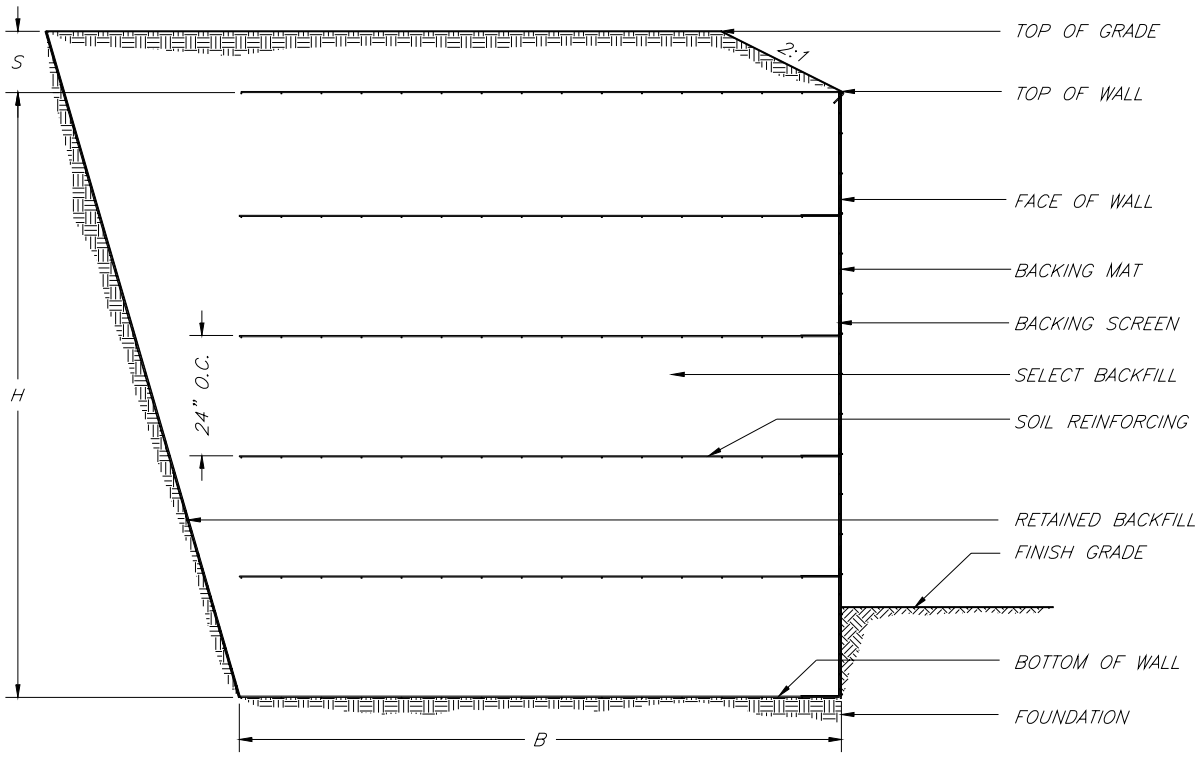


Figure 1 – Typical Wall Section

2 TERMINOLOGY

Backing Panel – A welded wire mesh panel that is placed at the back face of the facing panel. Typically spans between adjacent facing.

Connection Pin - A structural steel pin that joins the soil reinforcement to the welded wire element. Typically used to splice two soil-reinforcing elements together.

Coping – An element that is used as the top of wall treatment. Can be either pre-cast or cast-in-place concrete.

Face Panel - A special welded wire facing with variable, high density welded wire, that is connected to a variable, low density welded wire soil reinforcement, and that prevents the raveling of soil between the successive layers of soil reinforcement.

Face Of Wall - The front face of the wire face panel.

Filter Fabric - A geo-textile fabric that is placed behind the welded wire face panel in temporary wall systems that prevents the erosion of soil from the MSE mass.

Finish Grade - The material that is placed in front of the MSE wall that protects the bottom of the wall from erosion and undercutting.

Gabion – Literally means a basket full of rocks. A six-sided welded wire box that is joined at the edges with spiral ties or wire lacing and that is filled with a 4" to 6" clean rock.

Geogrid - A high-density polypropylene or woven polyester with an apparent opening of ¼" that is placed behind the welded wire face panel that prevents the erosion of soil from the MSE mass. Typically used in permanent wall applications.

Hardware Cloth - A woven steel mesh with an apparent opening of ¼" that is placed behind the welded wire face panel that prevents the erosion of soil from the MSE mass. Typically used in permanent wall applications.

Hog Ring - Special shaped opened wire ring that is crimped shut with special pliers. Used to tie the filter fabric to the face panel and to tie wire together.

Hog Ring Pliers - Pliers that are specifically manufactured for the application of hog rings.

Inclusion - Any steel or geo-textile element that is inserted into the soil mass so as to improve the structural properties of the soil.

Mechanically Stabilized Earth (MSE) - Engineering term for the stabilization of earth through the use of soil inclusions.

Prepared Foundation - The excavated and proofed rolled area that the MSE wall bears on.

Prong - The bottom and top vertical wires after the first or last horizontal wire located on the facing panel and backing panel. The top prong aids in the tying of face panels together with next lift of the soil reinforcement.

Reinforced Soil - A composite structure composed of soil and layers of inclusions inserted into the soil.

Retained Fill - The backfill material that is directly behind the reinforced soil volume. Usually consists of normal highway embankment material or in-situ material.

Select Fill - The volume of soil that is placed within the extent of the soil reinforcing.

Soil Reinforcement - A manufactured welded wire grid element.

Traffic Barrier - A structural element that retains traffic impact and directs the impact in a desired direction.

3 CONSTRUCTION SEQUENCE

The construction of the Mechanical Stabilized Earth structure is a repetitive process that requires successive placement of layers of soil reinforcing inclusions, compacted soil and facing panels. Each layer requires the same erection procedures and standard material. Typically, the difference between layers is the size, spacing, and configuration of the soil reinforcing inclusions.

In order to speed erection it is highly recommended that the erector be familiar with the location and type of each of the components in the wall, and where they are stored on the site. The shop drawings detail the proper orientation and combination of material contained within the structure.

The material that arrives to the site should be sorted and grouped by type, wire size and length. It is the responsibility of the contractor or erector to properly store the material so as to prevent damage.

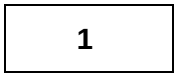
3.1 SITE PREPARATION

It is important to prepare the site properly before placement of any of the soil reinforcement. The foundation has to be capable of supporting the loads that are to be placed on it by the reinforced volume and all anticipated external loading. The foundation shall be grubbed and graded level for a width equal to the length of the soil reinforcement, plus 6 inches (150 mm). All foundation material that is suspected of being of poor quality shall be removed and replaced. The foundation preparation is the critical part of the wall construction. *Taking time to properly prepare the foundation will greatly decrease the chances of problems occurring during or after construction.*

3.2 SOIL REINFORCEMENT

The welded wire soil reinforcement grid is a continuous element that is defined by a horizontal soil reinforcing section and a vertical face section. The welded wire wall system is fabricated with a 90° bend at the interface of the soil reinforcing and facing panel.

The shop drawings detail the soil reinforcing type that is matched to a specific configuration. Typically a number is placed within the rectangular face area in the shop drawings such as follows:



The designator defines the soil reinforcing type. Each corresponding designator is coordinated with the appropriate soil-reinforcing schedule. The soil-reinforcing schedule dictates the size and spacing of each member. The minimum required length of the soil reinforcement is given in the elevation drawings, under the dimension line, and is identified with “B“ followed by the length (i.e. B=10.00’). This length is the minimum length that is required to be placed for the extent of the dimension.

It is important that the wall erector place the correct size, length, and configuration of soil reinforcement with the correct face panel. *Typically, heavier gauge wire with greater transverse spacing is used in the bottom of the structure, and a lighter gauge wire with a closer transverse spacing is used at the top of the structure*.

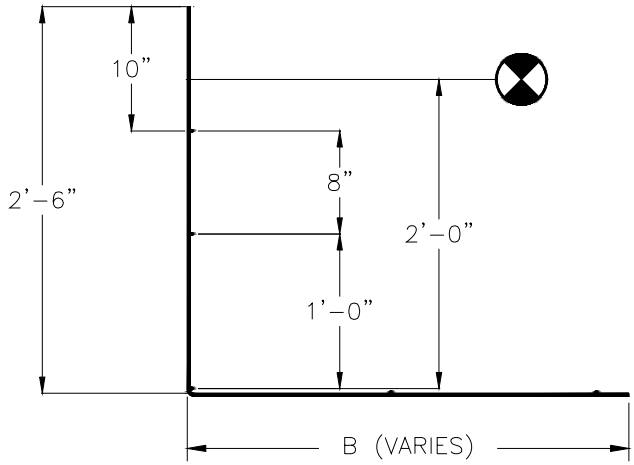


Figure 2 – Section Soil Reinforcing Element
(Shown for reference only may vary on final design)

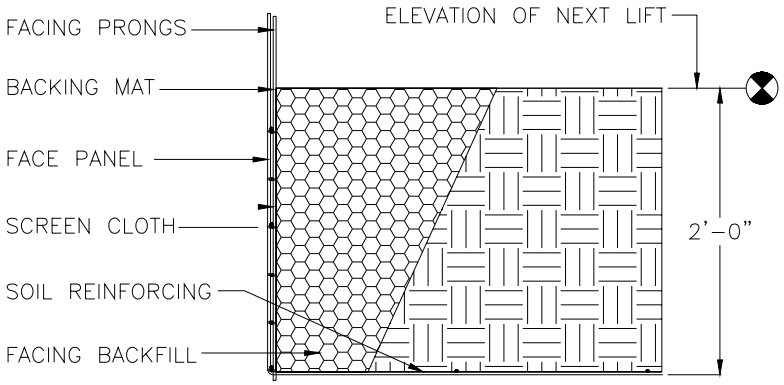


Figure 3 – Typical Lift Section
*Note: Wall face backfill may be same as select backfill shown for information only

3.3 REINFORCEMENT PLACEMENT

The soil reinforcing face panels are 4’-0” wide (1.220 m) and are designed to span a center-to-center spacing of 4’-8” (1.424 m). The soil reinforcing has a length equal to “B” which is detailed on the shop drawings and is typically given under the dimension line or in the elevation sheet general notes. The vertical dimension of the face panel and is 24” (610 mm) from the mid-point of the bottom horizontal wire to the location of the next soil-reinforcing element. Contained above the top vertical wire are 8”-10” (200 mm – 250 mm) prongs. These prongs help line up successive rows of soil reinforcing and tie the facing portions of each layer together. The soil reinforcing contains longitudinal wires that are spaced at 8” (203 mm) on center and transverse wires that are typically spaced a 12” (305 mm) but can vary from 8" to 48” (203 mm – 1200 mm) on center. The spacing of the transverse wire is dependent on the structural requirements of the system.

Adjacent soil reinforcing is spaced 8” (200 mm) apart. Once the soil reinforcement is placed and aligned accordingly, the backing panel is attached to the back face of the soil reinforcing face panel. The backing panel is fabricated with dimensions equal to 2’-0” x 9’-4” (610 mm x 1424 mm). The backing panel contains 4” (100 mm) spaced horizontal wires and 8” (200 mm) spaced vertical wires. The backing panel is placed so the lead end falls at the mid point of an adjacent face panel. The backing panel then spans between a full-face panel and the mid point of the adjacent face panel. The face panel and backing panel configuration provide a 4” x 4” (100 mm x 100 mm) grid opening in the face of the wall. The backing panel can be tied to the face panel with hog rings or with tie wire. The hog ring and tie wire is not intended to be a structural element and is used to temporarily hold the backing panel on the face panel in order to maintain alignment.

Once the backing panel is placed and secured in place the hardware cloth, filter fabric or geogrid is placed over the entire back face of the backing panel. The hardware cloth, filter fabric or geogrid is also temporarily held in place by hog rings. At the location of the 90° bends and at every 8” (203 mm) spaced longitudinal wire it is necessary to split the hardware-cloth, filter fabric or geogrid to prevent binding of the cloth, fabric, or geogrid, at the bend and to have complete continuity of fabric from top to bottom. It may be necessary to manually force it into the facing panel below. The hardware-cloth, filter fabric, or geogrid that is placed on the first layer of soil reinforcing at the foundation shall be lapped over and on the soil reinforcing.

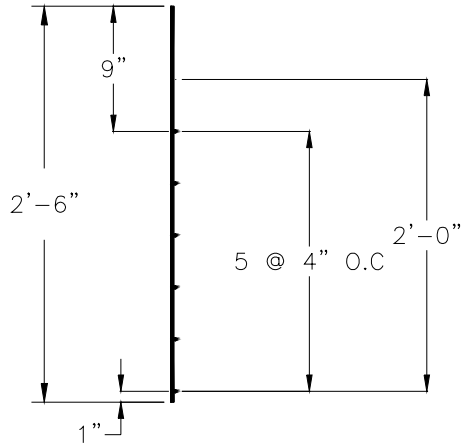


Figure 4 – Section Backing Panel

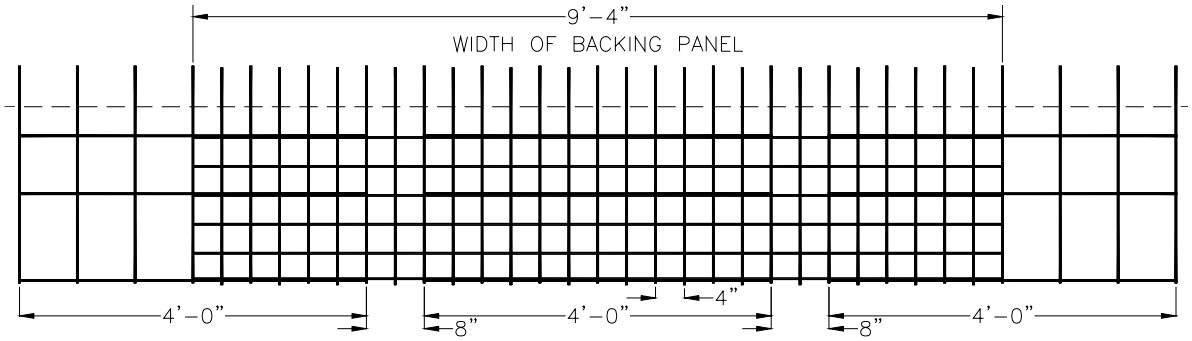


Figure 5 – Assembled Facing Element

3.4 BACKFILL PLACEMENT

The placement of the backfill should begin parallel to the wall face at a distance greater than or equal to 12" (305 mm) from the back face of the structure. The backfill should be placed in a maximum of 12"" (305 mm) compacted layers. The fill is leveled by machinery moving p*arallel* to the wall, fanning the material *toward the tail of the grid*. The placement of the backfill from the front of the soil reinforcement to the tail of the soil reinforcement will help keep the wall face aligned. Failure to place the backfill in a direction toward the tail, or by turning the compaction equipment sharply on the soil reinforcing during the placement, will force the wall face out of alignment.

A first layer of 12" (305 mm) compacted fill is placed on the soil-reinforcing element. The fill is manually placed at the face of the wall. It is imperative that during the compaction process that the face of wall alignment is maintained to project specifications. It may be necessary to force the wall face out toward vertical as fill is placed. Be careful not to force it past vertical or past the desired batter. Walking on or placing any type of vertical load on the backfill at or near the face before the top is connected to the next soil reinforcing element or the cap mat will cause the wall face to move out past vertical. If the wall face moves out past vertical it is imperative that the soil at the face be removed, the wall moved back to the specified vertical and horizontal alignment, and the soil replaced and compacted.

A second layer of 12" (305 mm) compacted fill is placed over the first lift of 12" (305 mm) compacted fill. The fill is sloped away from the face in order to leave a small 45°-void (approximate). The next layer of soil reinforcing is placed on the 24" (610 mm) compacted lift by placing the soil reinforcing – face panel combination and backing panel over the protruding vertical prongs of the lift below located at the face of the wall. (Note that the horizontal wire at the bend of the facing panel and soil reinforcing does not rest on the horizontal wire of the facing panel below but rather is spaced 4" above the wire. This will allow the wall to settle without bulging the face). The components are then pulled into alignment. Backfill is placed on the tail of soil-reinforcing element a distance of 3'-0" (1 m) from the face in order to anchor the soil reinforcing and keep it from moving out of alignment during filling and compacting of the void of the face below.

The 45° void at the face of the wall, which was left in the lift below, is then filled manually with the use of a shovel or come-along rack. The fill shall be placed through the grid opening and forced into the void by hand rodding. This area should be over filled and mounded on top of the soil reinforcing and compacted with a walk behind tamper weight approximately 1000 pounds (4 kN). After the placement and compaction of the fill at the face the wall, the facing element (face panel and backing panel combination) is manually pulled upward

approximately in order to maintain the 4” wire spacing and the 24” lift spacing. Pulling the soil reinforcing up at the interface of successive layers keeps the face panel above from bearing on the face panel below. This will reduce the tendency for the wall face to bulge outward and allows for the face panels to accommodate some settlement and consolidation of the fill material.

Compaction of the backfill a distance of 3’-0” (1 m) from the face of the wall shall be performed with an 8-10 ton (88 kN) roller. Smooth wheeled rollers or rubber tire rollers are acceptable. Compactors that employ grid type rollers shall be used with caution. Compaction must be ***parallel*** to the wall face working toward the tail of the soil reinforcement. Proper moisture content of the backfill material should be maintained uniformly within each layer. The material should be placed on the dry side of the optimum moisture content. Care should be used in adding water to the backfill material in order to get the proper compaction density.

The three-foot zone (1 m) of fill located at the back of the wall is placed with an end loader and spread manually. The material is then compacted with the use of a 1000-pound (4 kN) vibratory roller or plate. This face panel should be manually forced to vertical or the required batter during compaction. Care should be exercised within this area and during the compaction process so as not to force the alignment of the face panel past the required batter. Walking close to this area can cause the face panel to move outward. Do not disturb this 3-foot (1 m) area once compaction is achieved. Compaction should proceed from the back face of the panel to the end of the grid.

Compaction test and gradation tests shall be taken and recorded per the contract specifications. These reports shall be made part of the wall erectors log. Proper compaction will alleviate problems in the future. Improper compaction can cause the face panel to move outward past vertical. Not enough compaction can cause the face panel to not move out past vertical. The alignment should be monitored continuously during the compaction process.

3.5 FACE BACKFILL

The material directly behind the facing panel will dictate how the face of the wall performs under load. The better the quality of the material directly behind the facing panel the better the alignment and performance at the face of the wall. In permanent applications it is recommended that the facing material be well-graded gravel with a grain size distribution between 1” to ¼”. Well-graded gravel is easier to compact than select backfill material that can include 10%-20% of fines passing the #200 sieve. Better compaction will decrease the void size and possible settlement and bulging of the face of the wall. If bulging of the face does occur it is a sign of improper installation and compaction. Do not confuse face bulging with foundation settlement or with internal failure of the MSE system.

To fill the void left at the face of the wall it is extremely important that during the compaction process with the self-contained plate compactor that the soil-reinforcing element of the lift above be periodically pulled upward to disengage it from the cross wire of the facing panels below. This will keep the soil reinforcing element from bearing on the cross wires of the backing panel and face panel below decreasing the tendency to bulge outward.

3.6 OBSTRUCTIONS

During the design phase an attempt is made to detail special panels and connections at the locations of vertical and horizontal obstructions. If a vertical obstruction is encountered

where the proper number of soil reinforcements cannot be maintained, the retaining wall Engineer of Record (EOR) should be notified for solutions. It may be necessary to cut some of the transverse wires and bend the longitudinal wires by the obstruction. Horizontal obstructions can be passed by gradually skewing the soil reinforcement. If the soil reinforcement is skewed horizontally, care should be taken so as not to kink the reinforcement. A 4" to 6" (100 mm – 150 mm) buffer of soil shall be placed over the obstruction before the placement of the soil reinforcement.

Post for railings, barriers, or similar vertical penetrations can be driven after construction or they can be placed in a hollow vertical shaft that is placed in the soil during the erection and placement of the soil reinforcing. If the obstruction is driven into the reinforced mass some distortion of the face of wall may occur.

3.7 DRAINAGE

It is extremely important not to allow the reinforced volume to become saturated at any time during construction. At the end of each day of work proper precautions shall be taken in order to assure that the MSE volume does not become saturated. The wall erector shall slope the reinforced volume of soil away from the facing panel at the end of each days operation. Saturation of the reinforced volume can result in destabilizing forces that cause the structure to fail or deform excessively.

Heavy rainfall can cause erosion of the soil from within the layers of the reinforced volume. Further, heavy rain can cause the backfill to be transported to the face of wall and cause any soil reinforcing face panels that are not connected to a soil-reinforcing element above to completely bend over the face of the wall. If any erosion does occur, or if the wall moves past vertical, or if the backfill becomes saturated, the backfill and soil reinforcing elements shall be removed and replaced with material that conforms to the project specification. Care shall be taken during periods of heavy rain to assure proper drainage and to provide positive flow away from the facing.

3.8 FINISH GRADE PLACEMENT

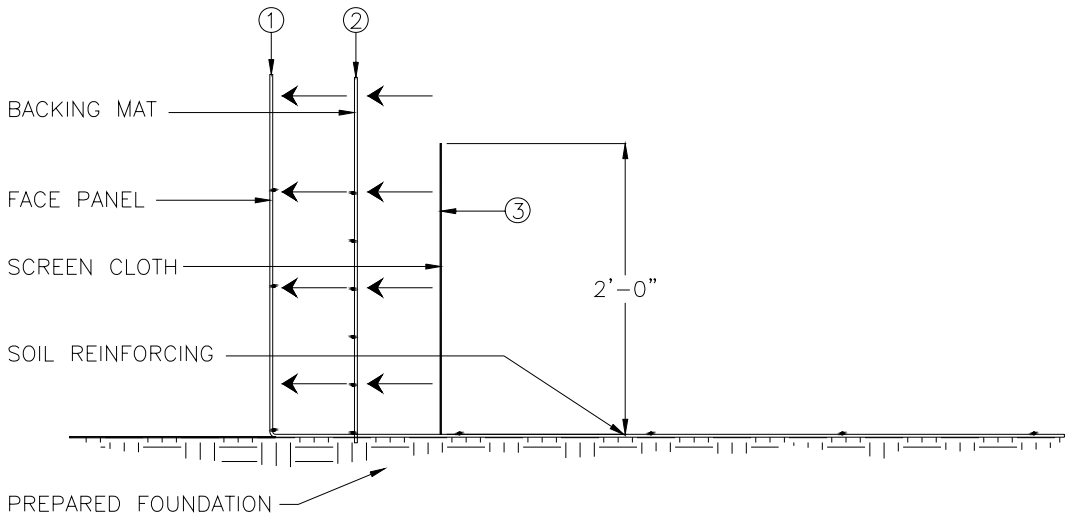
The placement of the finish grade fill material in front of the wall shall occur before the wall height exceeds 20 feet (6.10 m). Ideally, the finish grade fill should be placed as soon as possible to prevent undercutting of the base of the wall and possible foundation saturation and to prevent the base course from bulging outward. Although the fill in front of the wall is not considered in the stability calculations it should be understood that any excavation in front of the wall at depths below the base course could greatly affect the structural stability of the reinforced volume. No excavation will be allowed until written permission is received from the Engineer of Record and the wall supplier.

3.9 BARRIER PLACEMENT

The placement of the barrier requires that the top of wall be at the proper elevation and orientation as shown in the contract plans. If the barrier is to be placed directly at the face of the wall special design considerations will need to be incorporated in order to keep the wall facing from deforming or causing outward rotation. It is recommended that front face of all barriers be kept a minimum of three feet (1 m) from the wall face.

4 INSTALLATION SEQUENCE

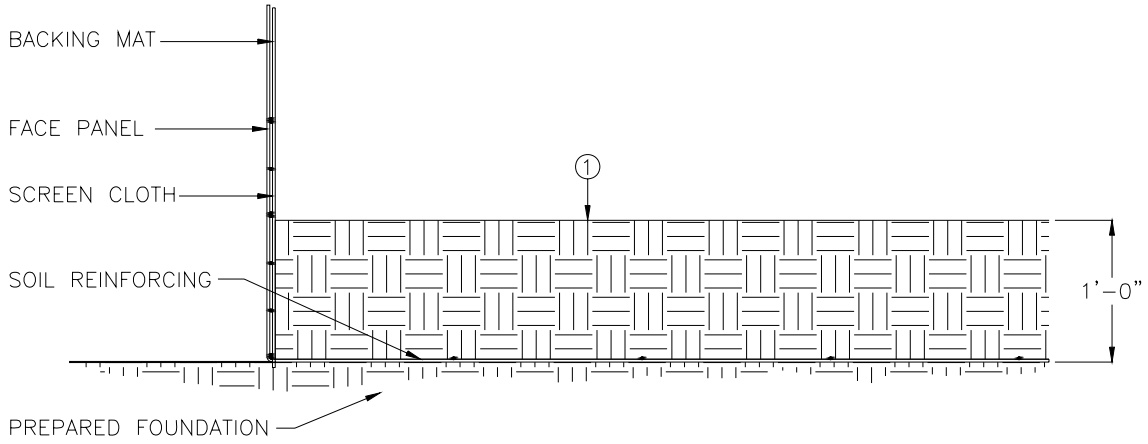
4.1 STEP ONE



Sequence 1

1. Place soil reinforcing and facing panel on prepared foundation. Place elements in proper orientation in both the vertical and horizontal direction.
2. Attach the backing panel to back face of facing panel. Place horizontal wires so they are on the same side. Attach hog-rings for temporary support. Place wires so there is a 4" x 4" opening in the grid.
3. Attach filter fabric, hardware cloth, or geogrid to back face of backing panel.

4.2 STEP TWO

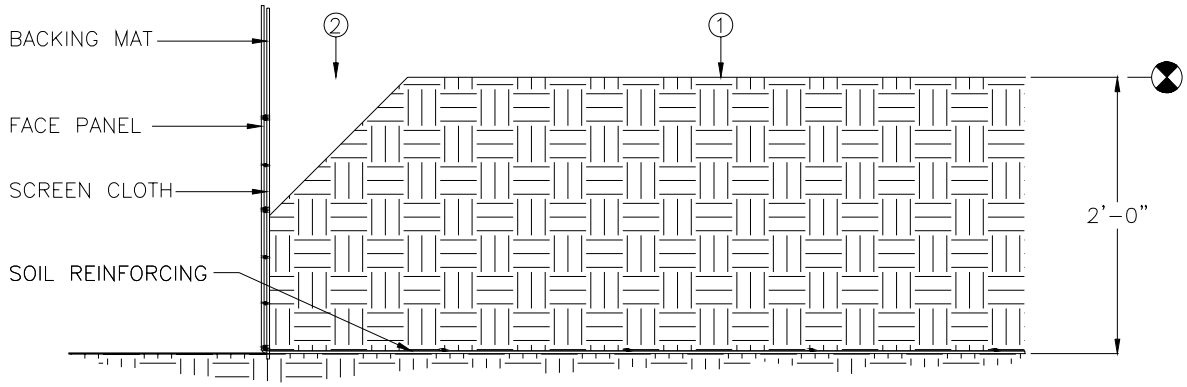


Sequence 2

1. Place and compact a maximum 12" of select backfill on top of soil reinforcing element.

2. Take care in placing backfill at face of wall. Pay particular attention to alignment of face in both the horizontal and vertical direction. Depending on conditions you may want to leave void at face.

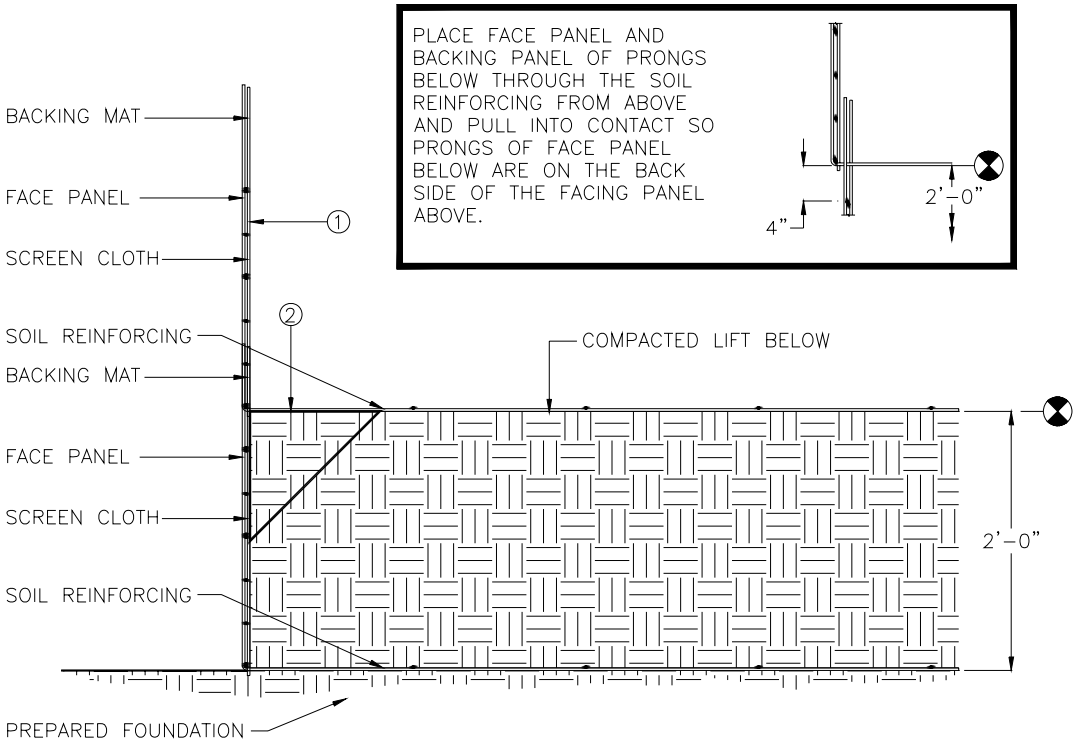
4.3 STEP THREE



Sequence 3

1. Place and compact a second 12" lift of select backfill to elevation of next sol reinforcing element.
2. Leave a void at face of wall. The void is to be filled after next soil reinforcing element is placed in wall.

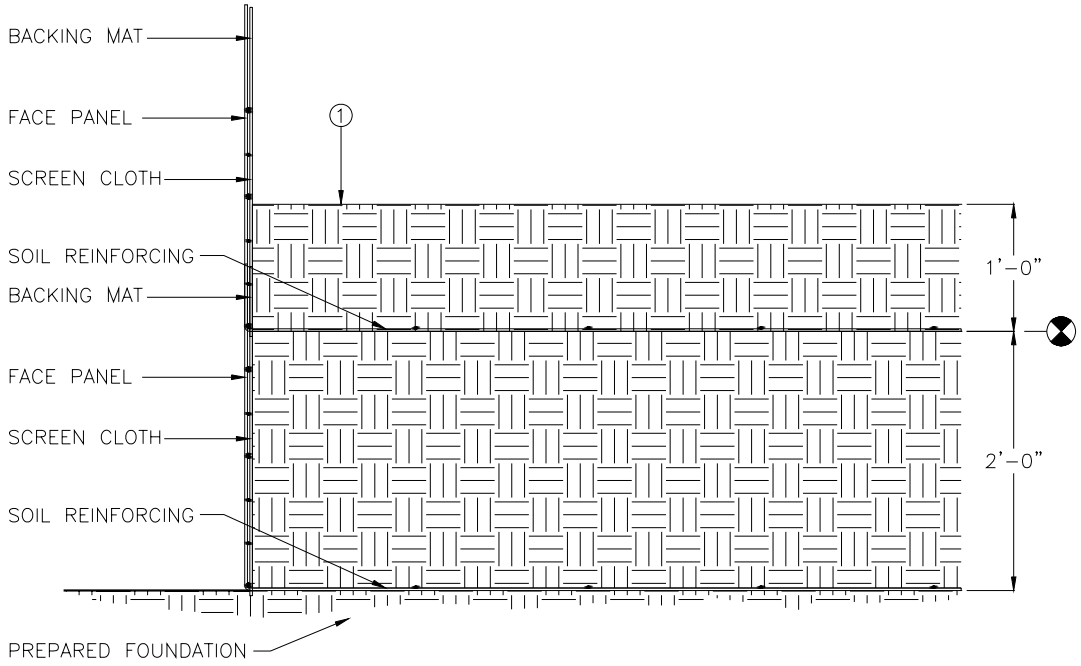
4.4 STEP FOUR



Sequence 4

1. Place next lift of soil reinforcing. Place soil reinforcing over prongs of facing panel below. Pull wall facing into alignment. Soil reinforcing grid shall be anchored with stake or by placing select backfill on tail of grid before backfilling void at face of wall.
2. Place and compact select backfill in void of lift below. Mound backfill over soil reinforcing grid and compact forcing backfill into void. It is very important to work this material fully into void. After compaction, pull the face panel upward 2" to decrease pressure on facing panel below.
3. Repeat steps 1-10 until top of wall elevation is achieved.

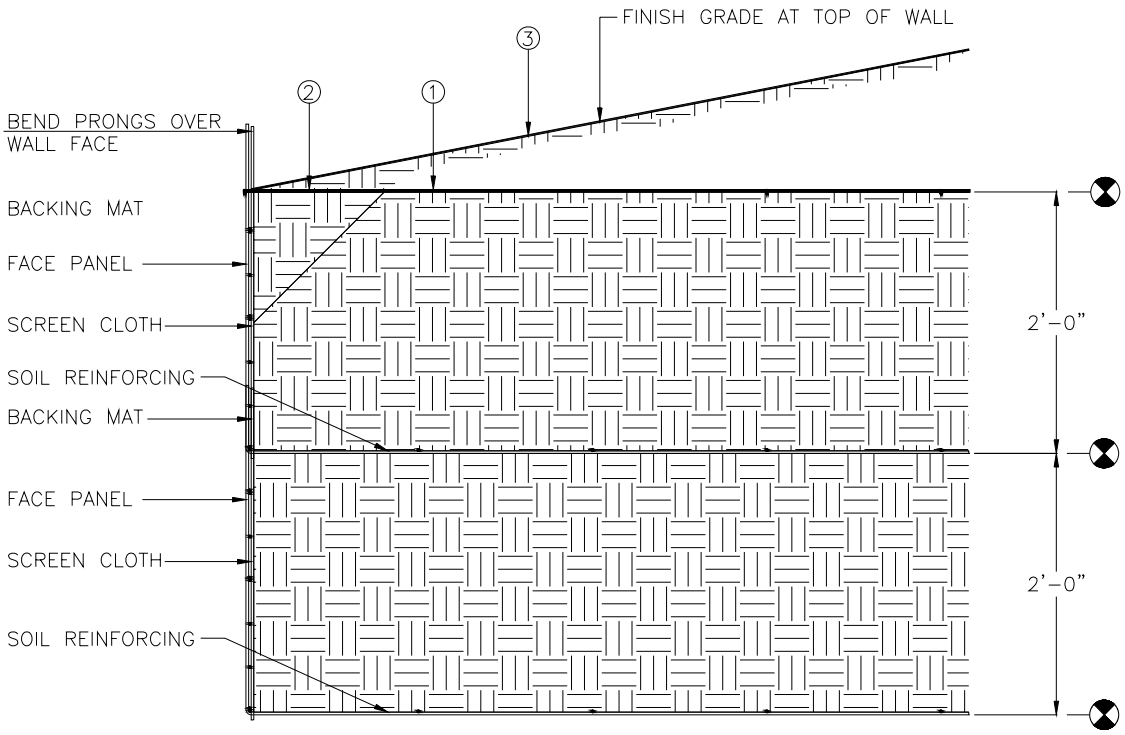
4.5 STEP FIVE



Sequence 5

1. Place and compact 12" lift of select backfill on sol reinforcing element. Maintain proper orientation of face panel.
2. Repeat steps 3 to 5 until top of wall elevation is reached.

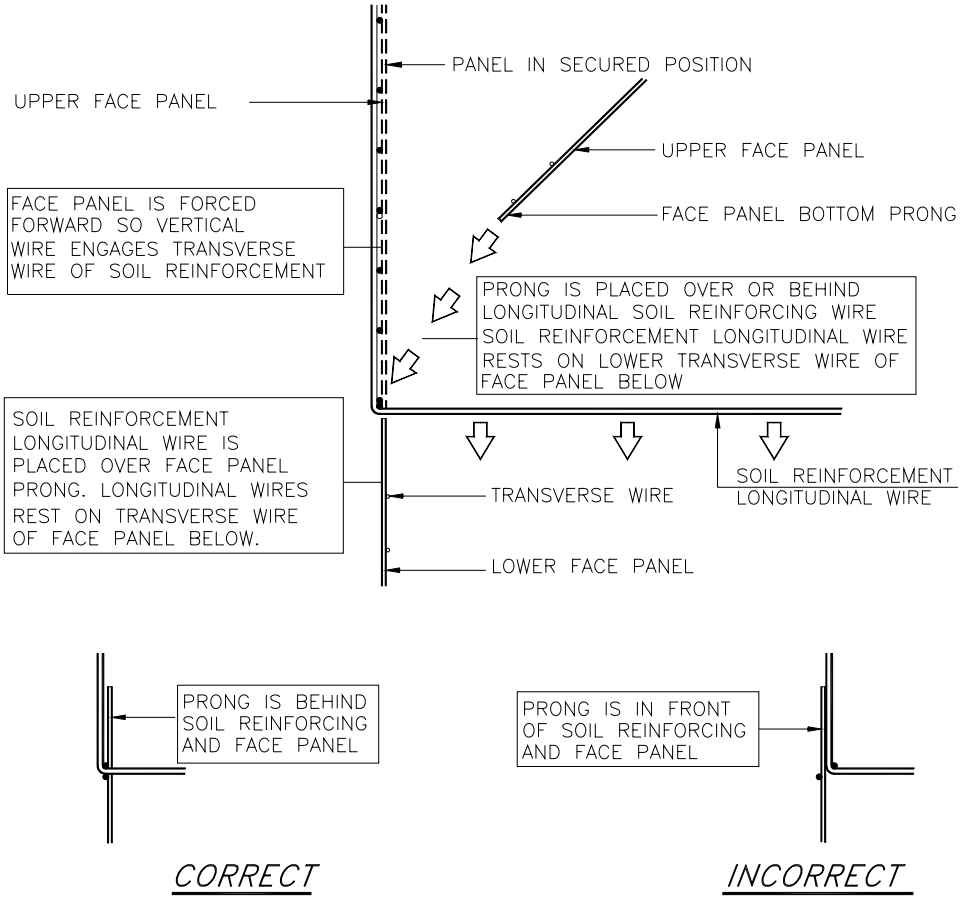
4.6 CAP MAT



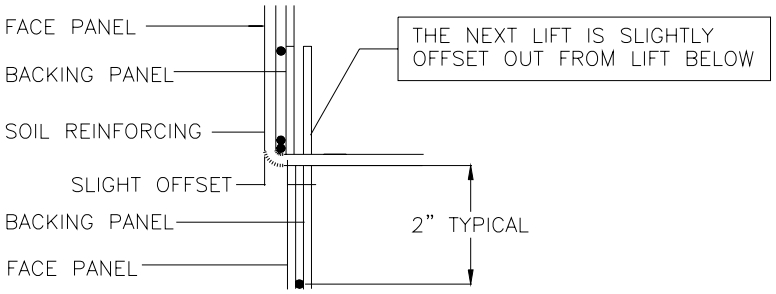
Sequence 4

1. Place cap mat at elevation of top of wall and connect with hog ring to horizontal wire or bend exposed prongs over horizontal wire of cap mat.
2. Place backfill in void at face of wall and compact. Mound backfill on top of cap mat and force through opening.
3. Place finish grade on top of cap mat and compact to required slope.

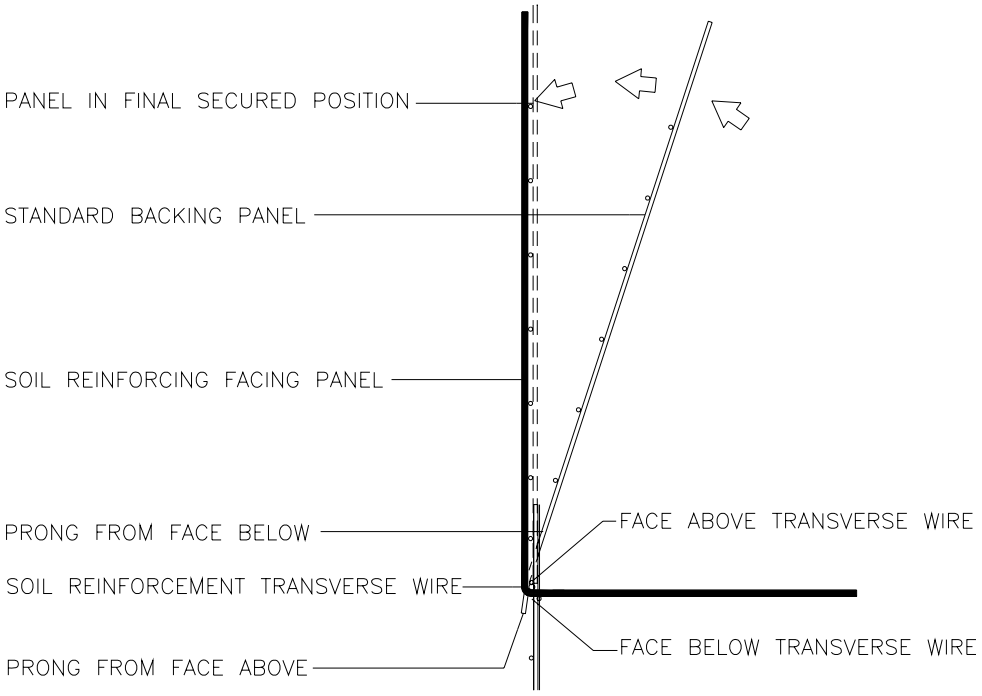
4.7 SOIL REINFORCING CONNECTION SEQUENCE



4.8 PRONG CONNECTION DETAIL



4.9 BACKING PANEL CONNECTION SEQUENCE



5 WALL ERECTION CHECK LIST

1.	Yes	No	Do you have an approved copy of shop drawings?
2.	Yes	No	Do you have backfill certifications?
3.	Yes	No	Do you have material certifications?
4.	Yes	No	Does the wire mill have material manufactured and inspection certifications?
5.	Yes	No	Is all material on site?
6.	Yes	No	Is material stored properly to prevent on site damage?
7.	Yes	No	Has damaged material been recorded and a copy of rejected material given to suppliers?
8.	Yes	No	Is the foundation excavated and proof rolled per the specifications and to the required width and elevation?
9.	Yes	No	Has unsuitable material been compacted or removed and replaced?
10.	Yes	No	Is the first row of soil reinforcing grids properly placed, aligned, and spaced.
11.	Yes	No	Are the proper face panels being installed?
12.	Yes	No	Are the required number of soil reinforcing grids and the correct type being used?
13.	Yes	No	After compaction are they pulling the face panel and backing panel upward to remove it from top horizontal wire??
14.	Yes	No	Is the filter fabric or screen cloth being properly placed and hog-ringed to the face panel?
15	Yes	No	Is the fill being properly placed? Are they using 12-inch lifts? Are they spreading backfill from one foot of back face of panel to tail of grid?
16.	Yes	No	Is the equipment being kept off of the grid until 6” of material is placed?
17.	Yes	No	Is proper compaction being met? A minimum 90% of maximum density for first one foot and 95% of maximum density for the remaining area.
18.	Yes	No	Are the grids properly aligned?
19.	Yes	No	Is the vertical and horizontal alignment of the structure being checked periodically?
20.	Yes	No	At the end of each days operation is the reinforced volume being protected from runoff and saturation?

Notes:

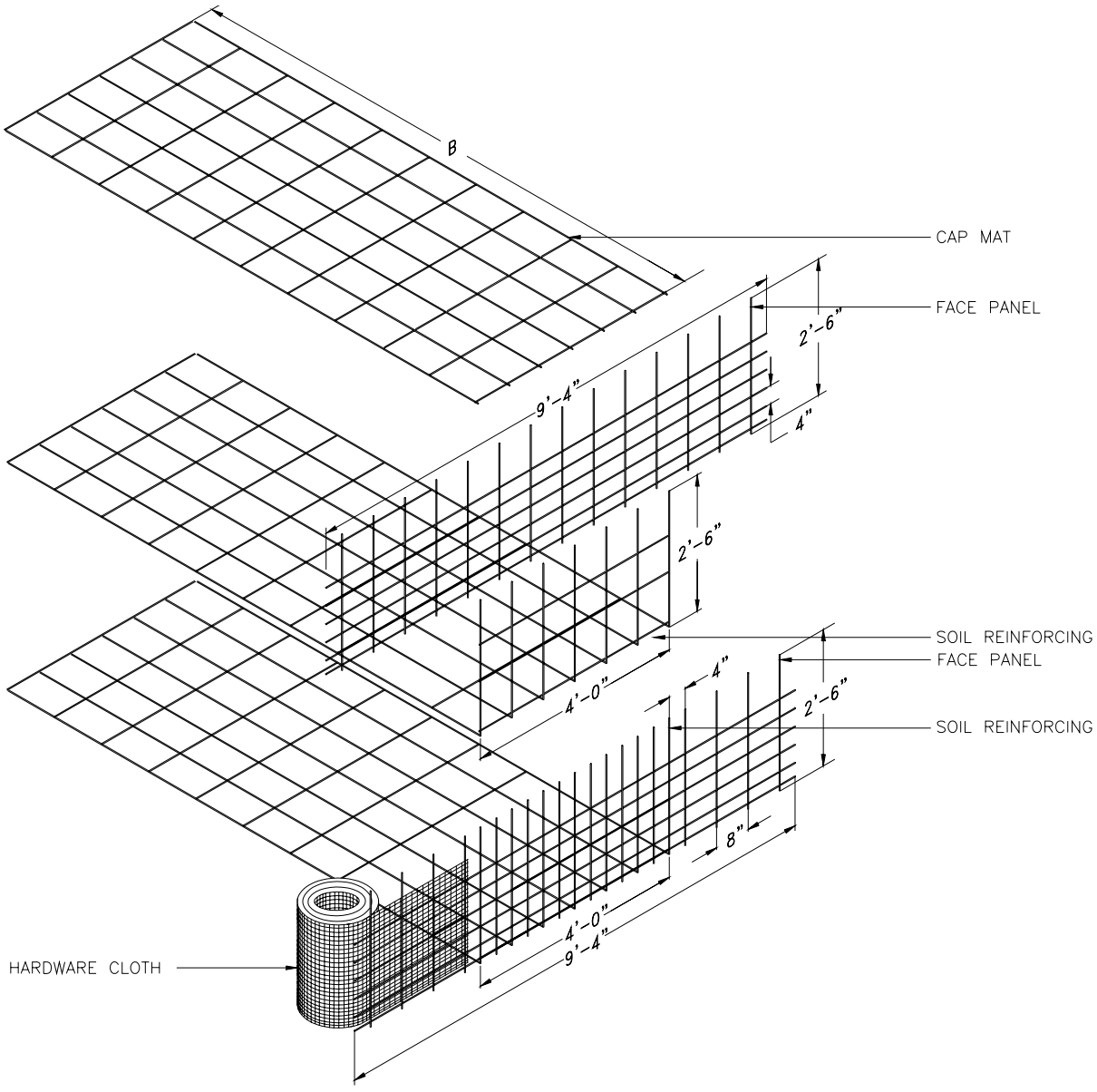


Figure 6 - Material Isometric