



Celtik Wall

Standardized Engineering Design Guideline



- Wall Heights up to 6'
- Pre-Engineered Designs



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INTRODUCTION

Segmental Retaining Walls (SRWs) are constructed using dry-stack modular concrete blocks as the facing elements, commonly called SRW units. This Celtik Wall Standard Engineering Design guideline provides pre-engineered design for construction of segmental block retaining walls using 5-1/4" (135mm) Celtik blocks manufactured by Belgard Hardscapes. This guideline is for walls less than 6' in total height with specific backfill and surcharge conditions. The design is consistent with the National Concrete Masonry Association (NCMA) "Design Manual for Segmental Retaining Walls, Third Edition".

CELTIK BLOCK DETAILS

Celtik block is one of the many block types available from Belgard Hardscapes, and has the following dimensions:

5 1/4" (H) x 6 3/4" (W) x 9" (D) minimum	
5 1/4" (H) x 10 1/2" (W) x 9" (D) minimum	
5 1/4" (H) x 13 3/4" (W) x 9" (D) minimum	
5 1/4" (H) x 17 1/4" (W) x 9" (D) minimum	

DEFINITIONS

The following definitions apply where for these terminologies used in this document:

Gravity SRWs: Retaining wall that resists external destabilizing forces through the self-weight and batter of the SRW. Figure 1 shows a typical detail of a gravity wall.

Geosynthetic-Reinforced SRWs: Retaining walls that require geosynthetic reinforcement to create a coherent gravity mass of reinforced soil that resists destabilizing forces. Figure 2 shows a typical detail of a geosynthetic reinforced wall.

Geosynthetic soil reinforcement or Geogrid: A structural element formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement.

APPLICABILITY

This design guideline can be used under following conditions:

Total height of Retaining Wall is less than 6 feet. The wall has level backfill or sloping backfill with no greater 14-degree slope or traffic load of 250 pounds per square foot. The soils are the site has internal angle of friction of 26° or 28° or 30°.

This design guideline shall not be used when one or more of the following conditions exist:

The user has no knowledge of strength parameters for soils. Total wall height is in excess of 6 feet. Back slope is steeper than 4 horizontal to 1 vertical (14 degrees). Special surcharge loading conditions exist such as buildings. Groundwater or drainage problems exist. A toe slope is present. The project has terraced or tiered walls.

BUILDING PERMIT

The user shall consult the local building authority for permit requirements for construction of retaining walls for specific conditions at the site. The user shall use experienced construction contractor or should have experience in construction of these walls and knowledge of soil compaction. The authority may require a report from a licensed soils engineer for soil type and its strength parameters applicable to use of this design guideline.

DESIGN SUMMARY

The design presented in this guidance meets minimum acceptable factors of safety of 1.5 against sliding, overturning and bearing capacity failures. For 135 mm Celtik blocks, the total height of **Gravity SRW** is limited to 3 blocks or 16". The charts that follow provide reinforcement schedule for **Geosynthetic-Reinforced SRWs**. For geogrids reinforcement Fortrac 35/20-20 as manufactured by Huesker Geosynthetics, Miragrid 2XT manufactured by Tencate, and Stratagrid 200 as manufactured by Strata Systems or equivalent can be used.

STEPS FOR DESIGN SELECTION

1. Determine if Celtik Wall Standard Engineering is applicable to your project: This design guideline can be used when acceptable to local building official and when the wall height, surcharge load, and soil type are consistent with those indicated in this guideline.

2. Determine total wall height including proposed embedment: The total wall height is defined as the exposed height plus the minimum embedment. The minimum wall embedment required is one block for walls eligible for Celtik Wall Standard Engineering.

3. Determine the type of soils that will be retained: Estimate the Friction angle of the soil based on soil classification or soil testing. Typically soil with 26° or 28° friction angle is UBC Class 4 or 5 and consists of sand, silty sand, clayey sand, and silty gravel (SW, SP, SM, SC, GM, GC), and soil with 30° friction angle consists of UBC Class 3 soils consisting of sandy gravel and/or gravel (GW and GP). Highly plastic clays, silts, and organic soils can cause performance and construction problems and should be evaluated by a soils engineer.

4. Determine loading condition on the wall: All cases apply for a near-level soil surface at the toe of the wall.

Case 1 depicts a near-level wall backfill with no surcharge load near the wall crest. Case 2 depicts a near-level wall crest with surcharge load applied by traffic, for example, along a driveway or a parking lot at the top of the wall. Case 3 depicts a 4:1 sloping surcharge (14 degrees maximum) above the wall.

6. Select proper wall design sections from the charts:

Based on loading condition determined in previous step select geogrids reinforcement schedule:

For soils with 26 degrees internal angle of friction use charts on Table 1

For soils with 28 degrees internal angle of friction use charts on Table 2

For soils with 30 degrees internal angle of friction use charts on Table 3

7. Determine if building permits are required for wall construction: Building permit requirements for segmental retaining walls are unique to each jurisdiction and can only be determined through direct contact with local building officials. If permits are required, submit this Standard Engineering Design Guideline along with other site drawings, survey plats, literature, etc. that may be required by the building department.

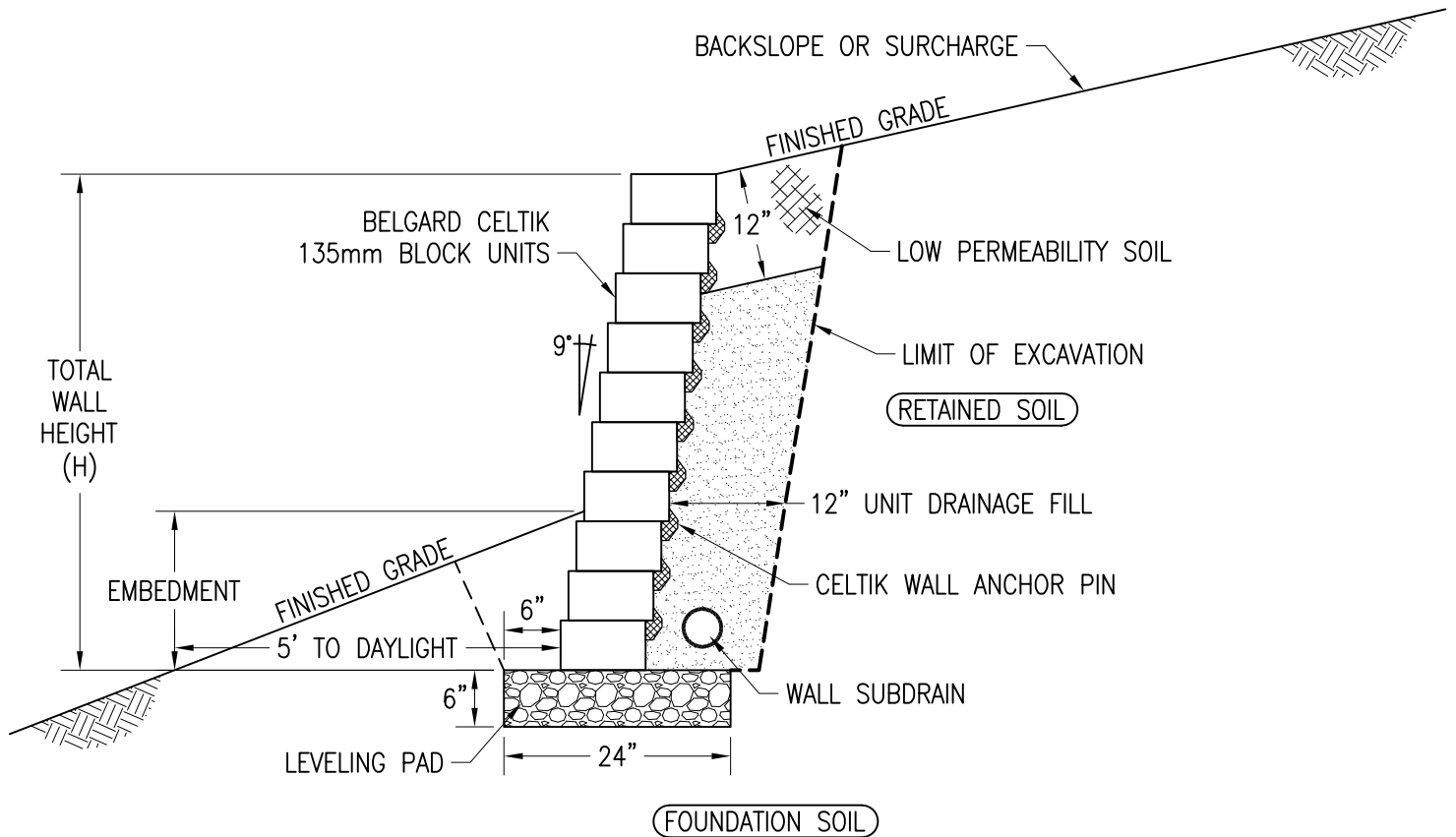
8. Wall Construction: Start wall construction only after you confirm that you do not need a permit or a permit is obtained. Construct wall by per details shown on Figures 1 and 2. Consult a Celtik Block Wall representative or hire a Licensed Engineer, as the case may be, to understand the construction details and methods.

Additional information is also available from www.belgard.biz.

LIMITATIONS

The design presented herein is based on the use of the specified product manufactured under license from Belgard Hardscapes and for specific soil conditions. It is the responsibility of the user of this design guideline to verify the actual site soil conditions, and to construct the wall in accordance with standard construction procedures and manufacturer's recommendations. A qualified geotechnical engineer may be retained to determine the soil type and any other geotechnical condition which may affect the design and stability of the wall and surrounding area, and to provide inspection and testing services during wall construction. The geotechnical engineer or his appointed representative shall observe and verify the installation of Celtik blocks, geosynthetic reinforcement, and compaction of fill soils. All fill soils should be compacted to at least 90% of maximum dry density determined using Modified Proctor Compaction Test (ASTM D 1557).

The user of this design manual or his representatives agree, to the fullest extent permitted by law, to limit the liability of Sierra Building Products and ABI Engineering Consultants, Inc. for any and all claims, losses, cost, damages of any nature whatsoever or claims expenses from any cause or causes, so that the total aggregate liability of Sierra Building Products and ABI Engineering Consultants, Inc shall not exceed \$1,000.00, or the cost of the wall materials, whichever is less. Such claims and causes include, but are not limited to negligence, professional errors or omissions, strict liability, breach of contract or warranty. The user of this design manual or his representatives also agree to fully protect, indemnify, hold harmless and defend Sierra Building Products and ABI Engineering Consultants, Inc., their principals, officers, employees, and agents from and against any and all loss, cost, damage, injury, liability claims, liens, demands, taxes, penalties, interest or causes of action of every nature whatsoever resulting from the use of this document.



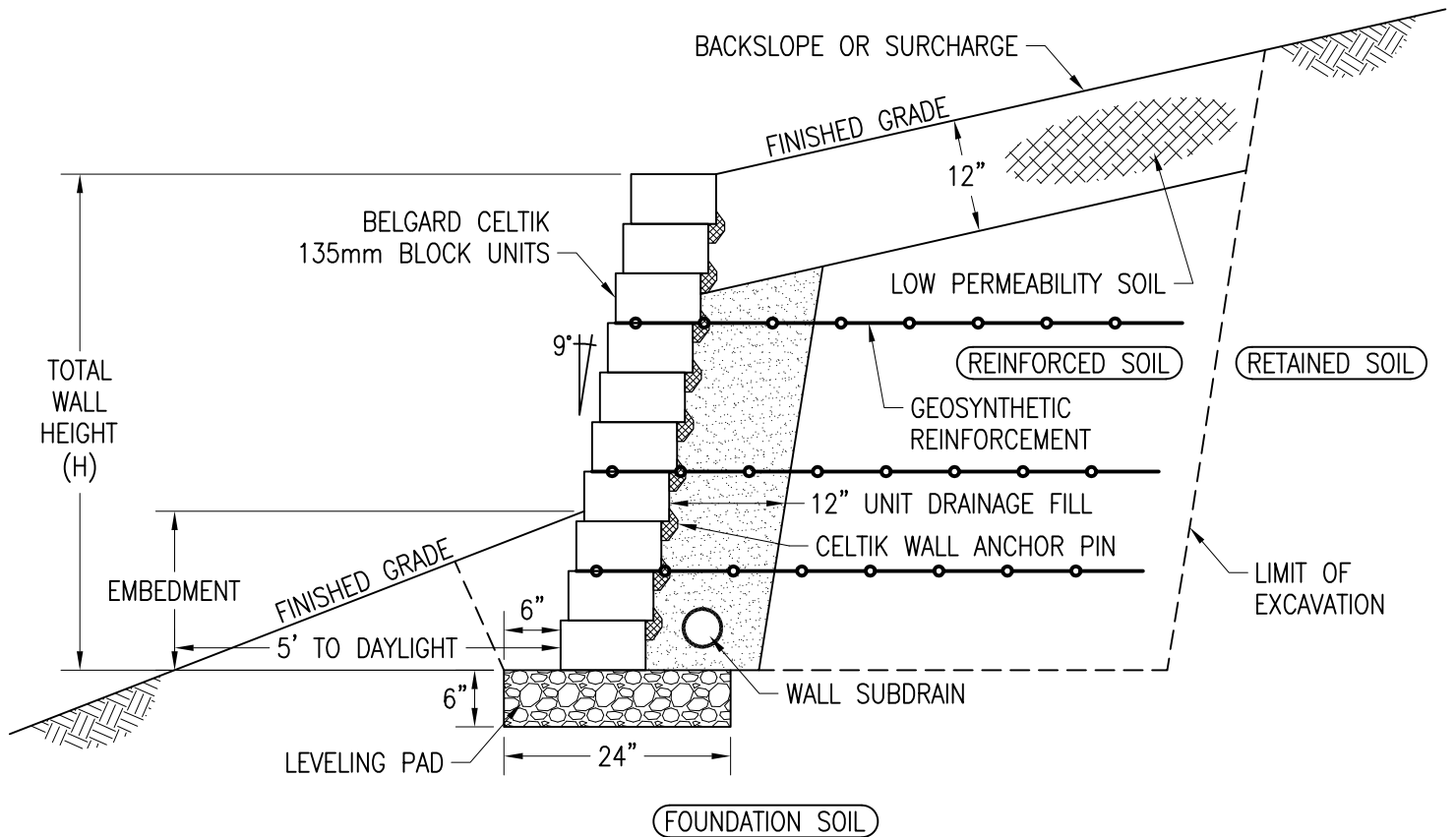
NOTES:

- WALL HEIGHT (H) IS THE TOTAL HEIGHT FROM TOP TO BOTTOM.
- MINIMUM WALL EMBEDMENT SHALL BE 6" FOR LEVEL TOE.
- MINIMUM WALL EMBEDMENT SHALL BE SUFFICIENT TO ACHIEVE 5' TO DAYLIGHT FOR SLOPE TOE.
- SUBSURFACE SOILS SHALL BE CAPABLE OF SUPPORTING WALL SYSTEM.
- UNIT DRAINAGE FILL SHALL BE 3/4" CLEAN CRUSHED STONE.
- LEVELING PAD SHALL BE 3/4" CLEAN CRUSHED STONE.
- ALL BACKFILL MATERIALS SHALL BE COMPACTED TO 90% MAXIMUM DRY DENSITY (ASTM D1557).
- GEOGRIDS SHALL BE APPROPRIATE TYPE AND LENGTH PER THE DESIGN.
- FINISHED GRADE SHALL PROVIDE POSITIVE DRAINAGE.
- WALL SUBDRAIN SHALL BE MIN. 4"Ø PERF. PVC PIPE WRAPPED WITH FILTER FABRIC INCASED IN 3/4" CRUSHED ROCKS 1 CU. FT./FT. LENGTH WITH HOLES DOWN SLOPE AT 1% MIN. WITH SOLID PVC OUTLET PIPES AT 40' MAX. SPACING.

BELGARD CELTIK SEGMENTAL BLOCK WALL
GRAVITY WALL TYPICAL SECTION



FIGURE
1



NOTES:

- WALL HEIGHT (H) IS THE TOTAL HEIGHT FROM TOP TO BOTTOM.
- MINIMUM WALL EMBEDMENT SHALL BE 6" FOR LEVEL TOE.
- MINIMUM WALL EMBEDMENT SHALL BE SUFFICIENT TO ACHIEVE 5' TO DAYLIGHT FOR SLOPE TOE.
- SUBSURFACE SOILS SHALL BE CAPABLE OF SUPPORTING WALL SYSTEM.
- UNIT DRAINAGE FILL SHALL BE 3/4" CLEAN CRUSHED STONE.
- LEVELING PAD SHALL BE 3/4" CLEAN CRUSHED STONE.
- ALL BACKFILL MATERIALS SHALL BE COMPACTED TO 90% MAXIMUM DRY DENSITY (ASTM D1557).
- GEOGRIDS SHALL BE APPROPRIATE TYPE AND LENGTH PER THE DESIGN.
- FINISHED GRADE SHALL PROVIDE POSITIVE DRAINAGE.
- THE SYMBOL $\text{---}(6.0')\text{---}$ INDICATES LOCATION AND LENGTH OF GEOGRIDS AS MEASURED FROM THE FACE OF THE WALL TO THE END OF THE GEOGRID.
- WALL SUBDRAIN SHALL BE MIN. 4"Ø PERF. PVC PIPE WRAPPED WITH FILTER FABRIC INCASED IN 3/4" CRUSHED ROCKS 1 CU. FT./FT. LENGTH WITH HOLES DOWN SLOPE AT 1% MIN. WITH SOLID PVC OUTLET PIPES AT 40' MAX. SPACING.

BELGARD CELTIK SEGMENTAL BLOCK WALL
REINFORCED WALL TYPICAL SECTION



FIGURE
 2

<p>NO SURCHARGE</p> <p>REINFORCED SOIL ZONE</p> <p>H</p>	<p>GEOGRID PLACEMENT</p> <p>NO REINFORCEMENT</p> <p>4.0'</p> <p>4.0'</p> <p>5.0'</p> <p>5.0'</p> <p>6.0'</p> <p>6.0'</p> <p>6.0'</p>
<p>CASE 1</p>	<p>HEIGHT (H) 1.31' 2.19' 3.06' 4.38' 5.69'</p>
<p>250PSF SURCHARGE</p> <p>REINFORCED SOIL ZONE</p> <p>H</p>	<p>GEOGRID PLACEMENT</p> <p>NO REINFORCEMENT</p> <p>5.0'</p> <p>5.0'</p> <p>6.0'</p> <p>6.0'</p> <p>7.0'</p> <p>7.0'</p> <p>7.0'</p>
<p>CASE 2</p>	<p>HEIGHT (H) 1.31' 2.19' 3.06' 4.38' 5.69'</p>
<p>1 4</p> <p>REINFORCED SOIL ZONE</p> <p>H</p>	<p>GEOGRID PLACEMENT</p> <p>NO REINFORCEMENT</p> <p>4.0'</p> <p>4.0'</p> <p>6.0'</p> <p>6.0'</p> <p>7.0'</p> <p>7.0'</p> <p>7.0'</p>
<p>CASE 3</p>	<p>HEIGHT (H) 1.31' 2.19' 3.06' 4.38' 5.69'</p>

BELGARD CELTIK SEGMENTAL BLOCK WALL
REINFORCED WALL DESIGN CHART

GEOGRID: MIRAFI 2XT
 SILT/LEAN CLAY SOIL: $\phi = 26^\circ$, $\gamma = 120$ PCF



TABLE
 1

<p>NO SURCHARGE</p> <p>REINFORCED SOIL ZONE</p> <p>H</p>	<p>GEOGRID PLACEMENT</p>
<p>CASE 1</p>	<p>HEIGHT (H) 1.31' 2.19' 3.06' 4.38' 5.69'</p>
<p>250PSF SURCHARGE</p> <p>REINFORCED SOIL ZONE</p> <p>H</p>	<p>GEOGRID PLACEMENT</p>
<p>CASE 2</p>	<p>HEIGHT (H) 1.31' 2.19' 3.06' 4.38' 5.69'</p>
<p>1:4</p> <p>REINFORCED SOIL ZONE</p> <p>H</p>	<p>GEOGRID PLACEMENT</p>
<p>CASE 3</p>	<p>HEIGHT (H) 1.31' 2.19' 3.06' 4.38' 5.69'</p>

BELGARD CELTIK SEGMENTAL BLOCK WALL
REINFORCED WALL DESIGN CHART

GEOGRID: MIRAFI 2XT
 SILTY SAND SOIL: $\Phi = 28^\circ$, $\gamma = 120$ PCF



<p>NO SURCHARGE</p> <p>REINFORCED SOIL ZONE</p> <p>H</p>	<p>GEOGRID PLACEMENT</p> <p>NO REINFORCEMENT</p> <p>4.0'</p> <p>4.0'</p> <p>4.0'</p> <p>4.0'</p> <p>5.0'</p>
<p>CASE 1</p>	<p>HEIGHT (H) 1.31' 2.19' 3.06' 4.38' 5.69'</p>
<p>250PSF SURCHARGE</p> <p>REINFORCED SOIL ZONE</p> <p>H</p>	<p>GEOGRID PLACEMENT</p> <p>NO REINFORCEMENT</p> <p>4.0'</p> <p>4.0'</p> <p>5.0'</p> <p>5.0'</p> <p>6.0'</p>
<p>CASE 2</p>	<p>HEIGHT (H) 1.31' 2.19' 3.06' 4.38' 5.69'</p>
<p>1 4</p> <p>REINFORCED SOIL ZONE</p> <p>H</p>	<p>GEOGRID PLACEMENT</p> <p>NO REINFORCEMENT</p> <p>4.0'</p> <p>4.0'</p> <p>5.0'</p> <p>5.0'</p> <p>6.0'</p>
<p>CASE 3</p>	<p>HEIGHT (H) 1.31' 2.19' 3.06' 4.38' 5.69'</p>

BELGARD CELTIK SEGMENTAL BLOCK WALL
REINFORCED WALL DESIGN CHART

GEOGRID: MIRAFI 2XT
 SAND SOIL: $\phi = 30^\circ$, $\gamma = 120$ PCF

