Tiered Walls

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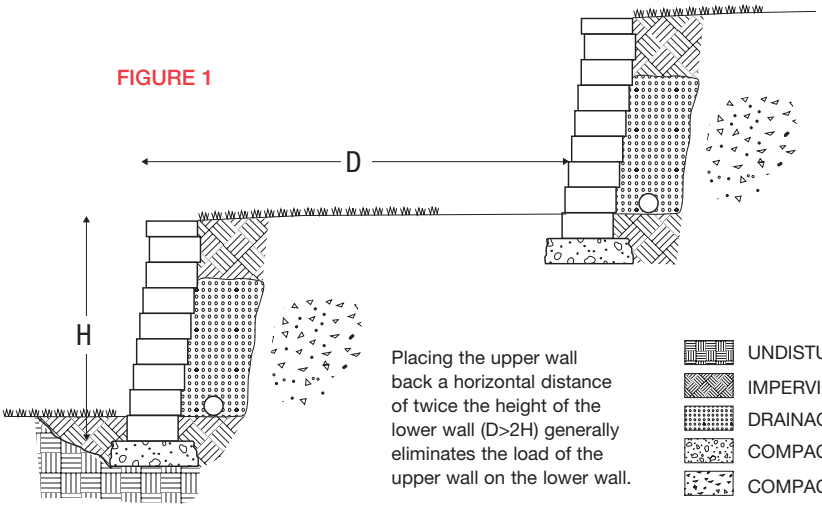
VERSA-LOK retaining walls create beautiful tiered (terraced) walls. Tiered retaining walls comprise two or more walls, each higher wall set back horizontally from the underlying wall. When designed properly, they not only retain soil and support loads, but also deliver an attractive appearance and provide room for plantings. When segmental retaining walls are tiered, the upper walls may exert extra loading on the underlying wall(s), necessitating special designs. When an upper-tier wall is placed within a horizontal distance less than twice the height of the underlying wall, the upper wall will apply a surcharge load on the lower wall (Figure 1). The wall design engineer must carefully analyze the site soil conditions and spacing between walls to determine overall stability of the entire tiered-wall system.

FIGURE 1



Placing the upper wall back a horizontal distance of twice the height of the lower wall (D>2H) generally eliminates the load of the upper wall on the lower wall.

UNDISTURBED SOIL
IMPERVIOUS FILL
DRAINAGE AGGREGATE
COMPACTED LEVELING PAD
COMPACTED BACKFILL

TECHNICAL BULLETIN

This Technical Bulletin is the seventh in a series of informational papers that provide specific application ideas and installation tips for VERSA-LOK® Retaining Wall Systems. Additional information is available in our *Design & Installation Guidelines.*

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ENGINEERING TIERED WALLS

Tiered walls are often more difficult to estimate and design than conventional single walls. Most single walls less than 4 feet high do not require geogrid reinforcement or engineering. In contrast, geogrid for tiered walls cannot be estimated using standard design charts, and tiers are more complicated to engineer. Even short tiered walls (less than 4 feet high) may require geogrid and engineering.

If the setback between tiered walls is at least twice the height of the underlying wall, with level grades between walls, each tiered wall can be treated as a separate entity during planning and engineering. When the setback distance between tiers is less than 2:1 (horizontal:vertical), the wall design must account for additional loads applied by upper walls (Figure 1).

As with any retaining wall project, a final engineered design must be prepared by a qualified, registered civil engineer when required. In addition, tiered walls often require an analysis of the slope stability (discussion below).

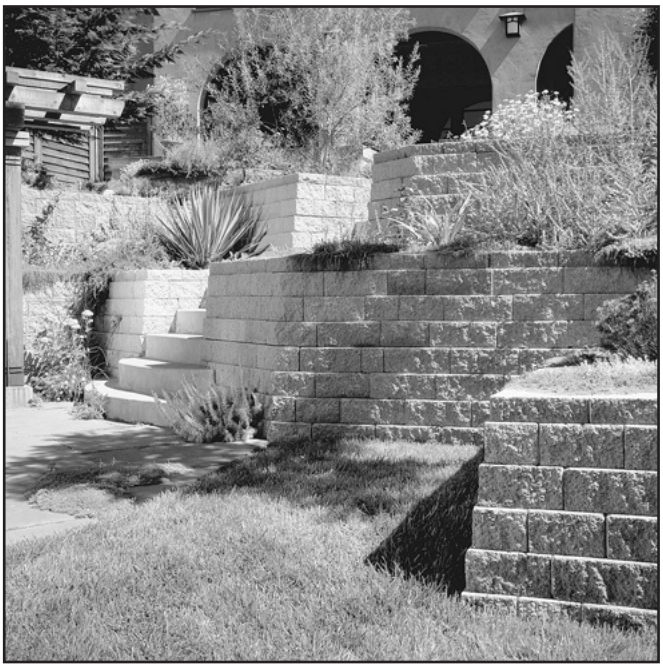
SLOPE STABILITY

Slope stability is a particular concern when designing tiered walls. A slope (global) stability failure is the mass movement of retaining wall structures and adjoining soil mass. Although an individual tier may be locally stable, there is a potential for deep-seated failure extending below the bottom of tiered walls (Figures 2A and 2B) that should be addressed in wall design.

Most unreinforced soils are not stable at slopes steeper than 2:1 (horizontal:vertical). If multiple tiered walls create a grade change steeper than 2:1, there is a slope stability concern that may require additional geogrid reinforcement. A qualified engineer should review the global stability of tiered walls that are steeper than 2:1, or that have slopes at the top or bottom of the walls.

FOUNDATIONS AND COMPACTION

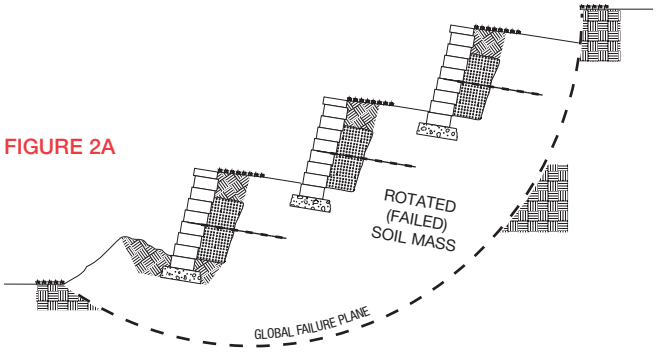
When building tiered walls, upper walls are often supported on the backfill behind lower walls. It is critical to carefully compact the lower-wall backfill to ensure the upper walls do not settle or overturn. Wherever upper walls rest on lower-wall backfill, well-graded granular soil is the preferred backfill material. Granular soils are easier to compact properly and settle less after construction.



Tiers may cost more to install, but they deliver an added aesthetic appeal.

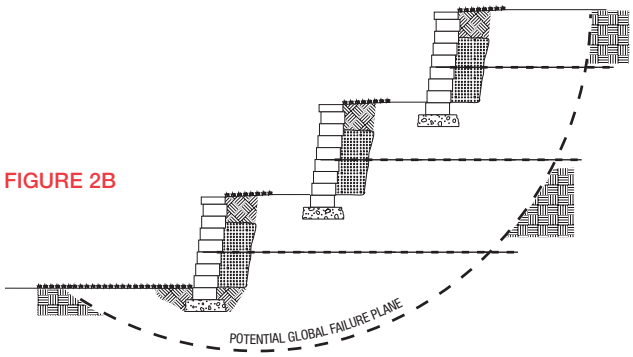
SLOPE STABILITY ANALYSIS

FIGURE 2A



Placing multiple tiers steeper than 2:1 can cause a deep-seated slope failure (Figure 2A).

FIGURE 2B



Lengthening geogrid can address slope stability concerns (Figure 2B).

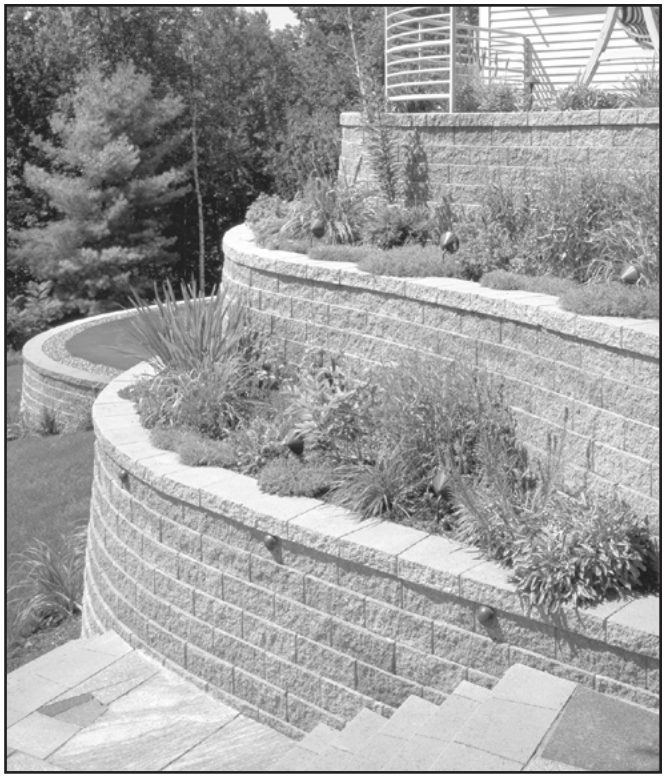
DRAINAGE

Providing proper drainage is especially important when building tiers. Any drainage problem in the upper wall(s) can compound in the lower walls. Surface drainage should be directed away from the walls by properly grading the area between the tiers and at the top of the tiers. Avoid any concentration of water behind the walls. Tiered walls should have a standard drain system that includes drainage aggregate behind all tiers. Drain pipes in upper tiers should not outlet onto lower walls, but instead should carry water away from walls.

COST EFFECTIVENESS VS. AESTHETICS

Tiers can improve aesthetics by visually breaking up a large monolithic wall. Tiered walls also create additional space for planting beds. However, more room is required and additional labor is needed to install tiered walls. The most labor-intensive part of installing any segmental wall is base preparation.

Tiered walls with setbacks of less than 2:1 (horizontal: vertical) usually require longer geogrid lengths at the bottom than single walls. This increases required excavation if the walls are cut into the existing soils. If there is room, spacing the tiers apart by more than twice the height of the lower walls minimizes the reinforcement needed, but still requires additional base preparation.



Tiered walls with plantings provide an attractive alternative to a single tall wall.

Alternatively, placing one short, unreinforced wall in front of one taller, reinforced wall provides the aesthetic advantage of tiers while reducing base preparation costs and the amount of space used when compared to a multiple-tiered wall.

FIGURE 3

SINGLE CONVENTIONAL WALL

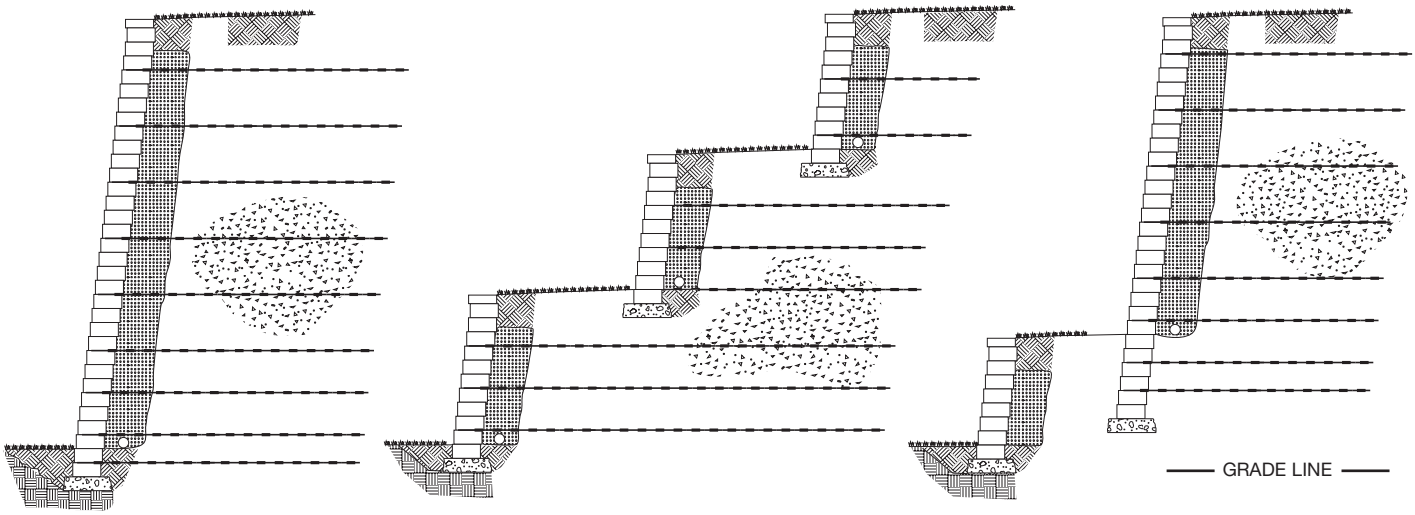
- LEAST SPACE TO MAKE GRADE CHANGE
- LEAST ADAPTABLE TO LANDSCAPING
- LOWEST COST (SITE WORK, BASE PREPARATION)

MULTIPLE TIERS

- MOST SPACE NEEDED
- MOST ATTRACTIVE LANDSCAPING
- HIGHEST COST

ALTERNATIVE TIERED WALL

- MEDIUM SPACE NEEDS
- GOOD AESTHETICS
- MEDIUM COST



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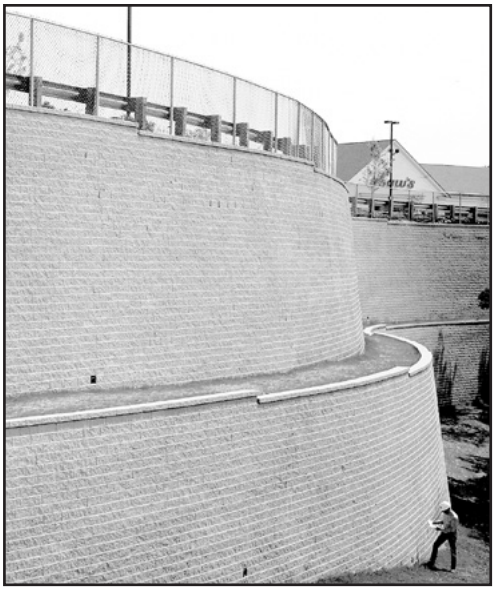
TIERED TALL WALLS

The two-tiered VERSA-LOK retaining wall shown on the right is more than 40 feet in overall height. It is set back approximately 4 feet at its midpoint to create an aesthetic "break." Both tiers were engineered with up to 25-foot lengths of geogrid reinforcement. The design of this wall is similar to that of a single 40-foot-high wall. Because setback between tiers is small, no additional length of geogrid is required. However, when an upper tier is set further back, but still not reaching the point of "no influence" (twice the height of lower wall), the walls are more prone to sliding at the base. Then the bottom wall would require longer geogrid layers than a single tall wall.

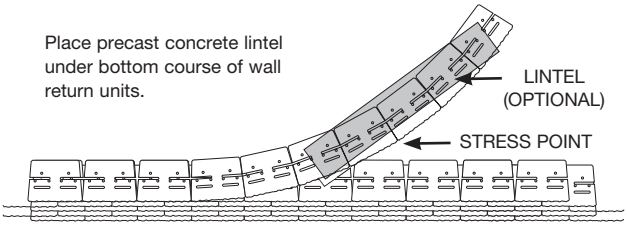


Geosynthetics and compacted soil combine to create a reinforced soil structure behind each tier.

TIERED RETURNS

Often, grade changes at the top or end of a wall can be accommodated by splitting a single wall into tiered sections and turning the tier into the slope behind the main wall.
At the beginning of the return, as units in the upper portion of the wall "leave" the main wall, stress is created when these units are no longer supported by the underlying wall. Settlement and/or gapping may occur at this point. This can be minimized by thoroughly compacting the fill below the return wall, and increasing the thickness of the return wall granular leveling pad. A lintel (concrete beam), extending from the main wall and placed under the units in the return wall, can also be used.

FIGURE 4 Return Wall Detail



Return walls create a terraced appearance instead of a series of short steps at the top of the wall.