Designing Tiered Retaining Walls

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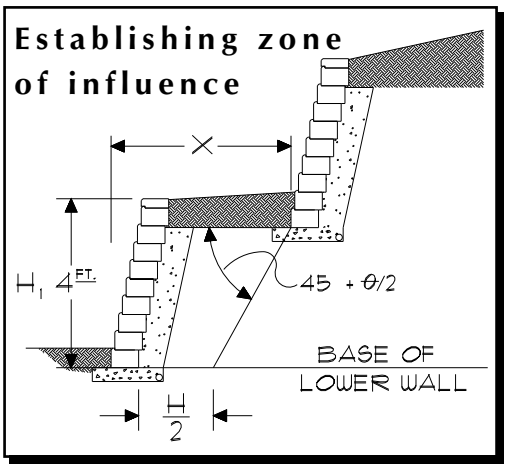
The need for tiered retaining walls is a common place occurrence. The reasons vary from:

1. **Aesthetics** - A single retaining wall 15 ft (4.6 m) high may be too overpowering for the setting of your wall. In this situation breaking the wall into three - 5 ft. (1.5 m) tall walls, or four - 4 ft. (1.2 m) tall walls can be designed to include terraces providing planting areas to break up the mass of designing around a grade change of 15 ft (4.6 m).
2. **Safety** - Depending on the setting of your wall project, designing with a single wall to handle the elevation changes may be prohibited by local safety ordinances. Fences placed at the bottom and top a tall wall structure to keep pedestrians away from the wall may produce a situation undesirable to the owner and outside of the scope of the overall project.
3. **Economics** - In order to construct a tall wall you normally are faced with additional excavation that was not accounted for in the original budget. Site constraints may offer more than enough area to break up the walls into smaller gravity wall that more closely conform to the existing landscape and will not require additional excavation for reinforcement.

Regardless of the driving force for why tiered walls are required, what items must be addressed to ensure that the final product will perform as desired? As a general rule, we have written that the required distance between two walls for them to act independently must be greater than or equal to twice the height of the lower wall. This approach is very conservative and will afford the designer or wall builder with an assurance that the walls will stand by themselves and have no impact on adjacent walls.

Many situations will not allow for terraced walls to be constructed with distances that exceed this general rule. A more detailed approach can be utilized to determine how close walls can be built to each other and not affect each other. Small terraced wall projects, each wall is less than 5 ft (1.5 m) with no more than two walls and a level slope below the bottom wall, may be analyzed to determine if the load from the upper wall will influence the stability of the lower wall. By drawing a line from the base of the upper wall at an angle equal to 45+Ø/2 toward the base of the lower wall you can visualize if the surcharge load from the upper wall will affect the lower wall. If the load path falls outside of a distance which is greater than fifty percent of the lower wall height (H1/2), as measured from the base of the lower wall at grade, you can safely assume that the upper terraced wall falls outside of the *zone of influence* for the lower wall.

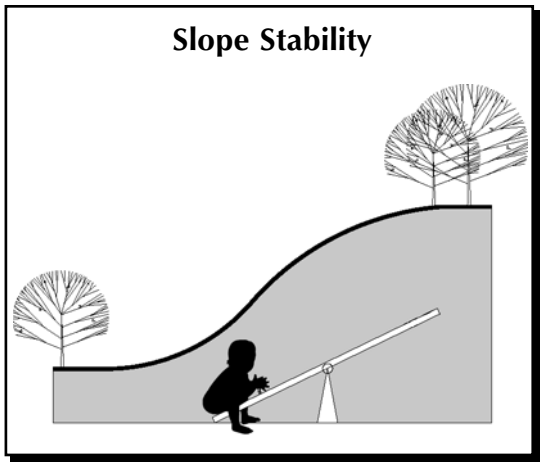


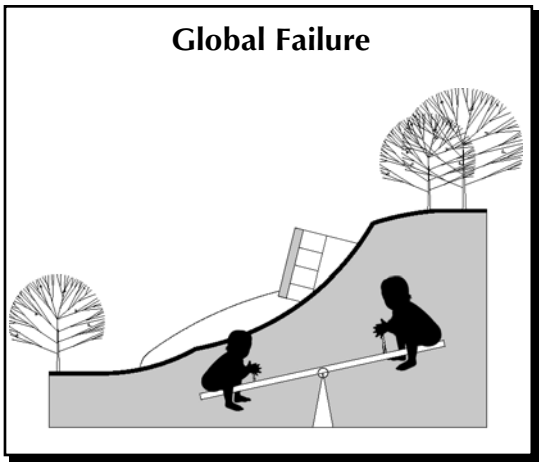
Many terraced walls have more than two terraces and potentially much larger individual walls. Additionally we will be presented with extensive slopes above and below walls that seem to run as far as the eye can see. These applications require a more comprehensive review, that includes a global stability analysis.

Global Stability & Tiered Retaining Walls

A global stability analysis is generally not included in standard design software, but without question, becomes essential.

Global stability is the ability of the entire earth mass to retain its shape, not just the wall. It is quite common during extremely wet conditions, such as those that have been experienced during the most recent El Nino, for hills that have stood for ages to come sliding down. The slopes of these failed hillsides existed in a state that was greater than the friction angle of the soil that made up the hillsides. The obvious question is why did these slopes not fail before now, and what held them together for all these years. In addition to shear strength some soils have another characteristic or property that gives the appearance that a soil mass is stronger and more stable than it really is. This property is called cohesion and describes the ability of a material to stick together.





Cohesion is typically found in clay soils and provides most people not intimately familiar with soil a sense of false security. This sense of security and apparent strength is greatly reduced when the soil becomes saturated as evidenced by the numerous landslides attributed to the heavy rains of the past year. To provide a very safe design it is customary to assume that no cohesion exists for the purpose of internal and external analysis while, a small amount of cohesion is utilized in most global stability analysis.

Typical Soil Properties

Soil Groups	Cohesion Compacted	Cohesion Saturated	Soil Friction Angle
Clean Gravel-Sand Mix	0	0	36°
Sand-Silt Clay Mix	1050 PSF (50 KPA)	300 PSF (14 KPA)	32°
Inorganic Clays	1800 PSF (86 KPA)	270 PSF (13 KPA)	27°

Now you may be wondering how this all ties into our discussion of tiered retaining walls. When tiered walls fall outside of the conditions outlined previously, there is a great likelihood that global stability will play a factor in the overall design. By introducing retaining walls on a hillside we have adjusted the natural balance of what may have stood for years. This change in balance must be evaluated to check the overall stability of the hillside. Refer your project to a qualified local geotechnical engineer or contact the Allan Block Engineering Dept. for help on your project. There are many software programs on the market that are quite helpful in analyzing the overall stability of your project. These programs will allow the designer to determine the location of the potential failure surface and allow you to determine if this becomes the controlling feature in your design. If you see more retaining wall work in the future of your firm you may want to invest in a program now to become familiar with it in advance of your next big project. Again contact the Allan Block Engineering department for a complete list of what programs are available and what level would be appropriate for your level of involvement.

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