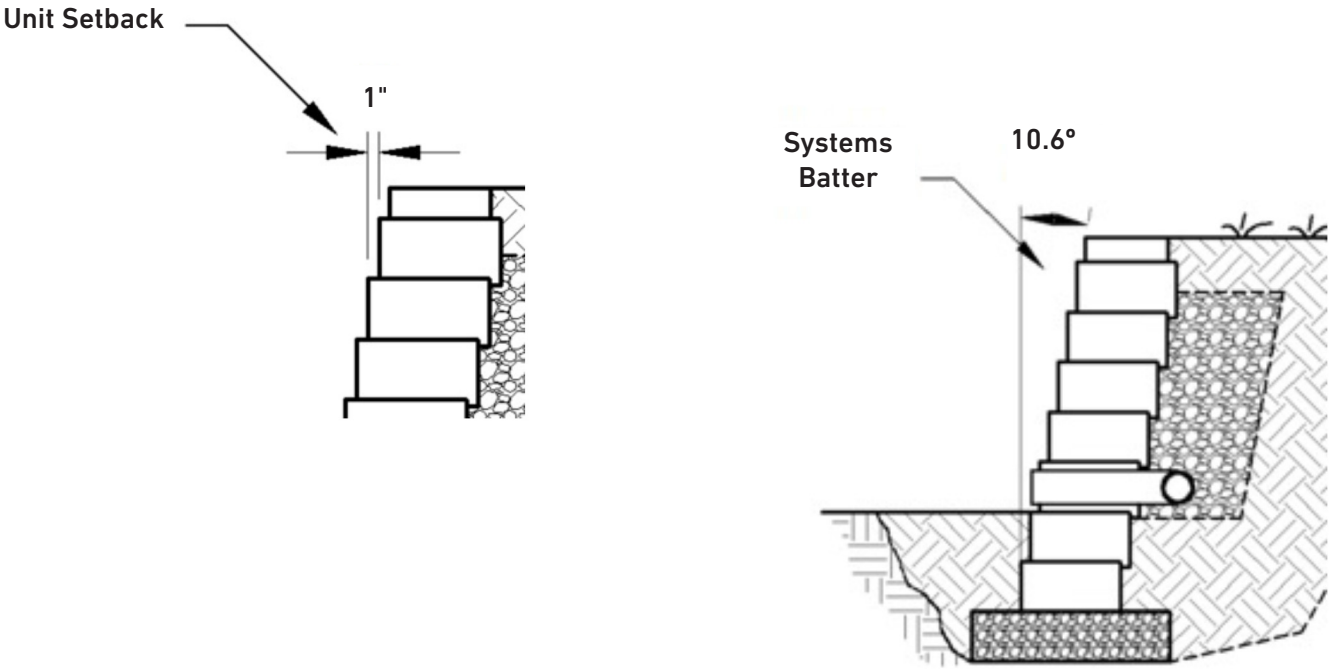
BELGARD COMMERCIAL

WALL ROTATION, ACTIVE EARTH PRESSURE, AND VERTICAL WALLS

When a licensor or manufacturer develops a segmental retaining wall (SRW) unit, they typically include a setback per unit, which provides an overall batter to the retaining wall system.



The importance of producing an SRW unit with setback/batter is to account for active earth pressure forces. The two nationally recognized design methodologies, published by the National Concrete Masonry Association (NCMA) and by the American Association of State Highway Transportation Officials (AASHTO), both use active earth pressure theory to develop the loads/forces acting on the retaining wall

This Technical Note explains the importance of wall batter in earth retaining wall applications and includes Belgard Commercial guidelines. Free-standing walls, which are installed vertically, have other structural design issues and are not addressed here.

Active Earth Pressure

Active earth pressure is the minimum value of lateral earth pressure exerted by soil on a structure. This occurs when the soil yields sufficiently to cause its internal shear resistance along a potential failure surface to be completely mobilized.

Simply put, the soil moves which mobilizes the frictional forces within the system. This soil movement results in lateral displacement. If the initial benchmark is vertical, the result will be a retaining wall that develops a negative batter as the wall rotates outward. The purpose of the initial retaining wall batter is to ensure the wall does not rotate past vertical during construction or within the wall's service life (75 to 100 years). Although walls that rotate slightly past vertical are often structurally stable, most people feel uncomfortable with walls that appear to be leaning over. It gives the appearance the wall may collapse at any time.

SRWs are flexible structures that are designed to accommodate some movement including differential settlement. Research has shown that the amount of horizontal wall movement needed to develop the active state of stress varies from about 0.5% to 2.0% of the wall height. The amount of movement required is dependent on soil type. The better the soils used for construction, the less movement needed.

Understanding soil behavior is essential to the design and construction of segmental retaining walls. This is especially true when attempting to predict or control wall movement. The preferred soils for wall design and construction are clean sand and gravel, or what is commonly referred to as "select," soils. Select soils require the least amount of movement to reach the active state of stress. These soils are also easier to place and require less compaction effort to achieve specified densities. As the soils become "less select," meaning the soil contains a higher percentage of silts and clay, more movement is required to reach the active state. In addition, these soils become more difficult to place and require significantly more compaction effort.

Construction Movement

It is important to remember that retaining walls also move during construction. This movement not only comes from the development of the "active" state of stress but is also affected by the wall components (geosynthetic reinforcement, drainage aggregate, and structural backfill soil) chosen for a project.

Proper installation procedures are essential to reducing horizontal movement of the retaining wall during construction. The variability in geogrid tensioning, the frequency (lift thickness) of compaction, the size and type of compaction equipment used, and the quality of the backfill material being compacted, all contribute to the amount of SRW movement. Based on Belgard's and Anchor Engineering's experience and available research, horizontal movements during construction range from about 0.5% to 1.3% of the wall height. Taller walls (over 25 feet) show a bit more movement, as much as 1.5% to 1.7% of wall height.

Long-term Movement

Retaining walls also move after construction. Post-construction, long-term wall face deformation data shows that properly designed retaining walls may have 1" to 1 ¼" of additional deformation during the first year of service and an additional 1.5" over the design life of the structure (75 – 100 years). This additional movement assumes select backfill (clean sand and/or gravel) has been used for the construction of the retaining wall. Research has also shown that this additional movement is relatively independent of wall height. Unfortunately using less select material adds an unknown to the equation since it is difficult to accurately predict the long-term behavior of cohesive (clay) soils.

Wall Rotation and Recommended Batter

Based on the above variables affecting SRW movement, choosing a wall system with the proper batter will assist in satisfying long-term performance objectives since many of the construction variables are difficult to control.

If the SRW is both designed and installed correctly, wall rotation of roughly 1.5 to 2.0 degrees would be expected when using high-quality (select) backfill. Where less select soils are used (such as clay), as much as 3.5 to 5 degrees of rotation might be expected.

As a general rule, Oldcastle/Belgard SRW products that are designed to be 'near vertical," (1.7 – 2 degrees), should only be used with high-quality backfill and experienced contractors. In situations where the soils are less select or you are working with less experienced wall installers, it is always better to use an Oldcastle/Belgard product with more setback or batter (greater than 4 degrees).

Referrences

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