How Global Stability Analysis Can Make a World of Difference on Your Next Project

When a retaining wall goes up, of utmost concern to every developer, engineer and installer is the integrity of the wall. You can best serve your clients by taking time to analyze the global stability of the system and incorporate the design modifications resulting from the analysis.

WHAT IS A GLOBAL STABILITY ANALYSIS?

Global stability is essentially an assessment of a wall's ability to withstand the balance of earth pressures. Typically, a global stability analysis is performed using a special computer program that evaluates potential slip surfaces or failure planes that can go behind or through the reinforced soil mass. The analysis takes into consideration the following measures:

1) The overall geometry of the system including the wall and slopes either above or below the system

2) Loading or surcharge conditions (for example, 250 pounds per square foot (3.65kPa) for highway loading)

3) Soil parameters (shear strength and unit weight of the soil) determined by the site geotechnical engineer based on laboratory tests of the soil

4) Subsurface and surface water conditions (groundwater can have a negative effect on slope stability)

HOW THE ANALYSIS CAN HELP IMPROVE A WALL DESIGN

The end result of a global stability analysis is a calculation of the system's factor of safety. The NCMA (National Concrete Masonry Association) or FHWA (Federal Highway Administration) requires a minimum factor of safety of 1.3. For critical structures such as bridge abutments, the factor of safety may be 1.5 or higher. Frequently the results of a global stability analysis show that the reinforcement lengths determined in the external and internal analyses of the wall are too short to meet the needed factor of safety for global stability. In order to increase the factor of safety to satisfy global stability, reinforcement lengths may need to be lengthened and layers of reinforcement may need to be added.

COMPOUND INTERNAL STABILITY IS ANOTHER ANALYSIS

In addition to overall global stability, which is an analysis of slip surfaces occurring behind and below the reinforced soil mass, the design engineer should perform a compound internal stability analysis. This analysis looks at slip surfaces that pass through the reinforced soil mass. For example, if reinforcement layers are spaced too far apart, the risk of compound internal failure increases. With vertical spacing of reinforcement at two feet (600mm) or less, compound internal failures are less likely to occur.

Global stability analysis helped ensure that this massive two-tiered wall on a golf course in Alabama was built with the appropriate number and lengths of geogrid.

WHY GLOBAL STABILITY IS A WORTHWHILE MEASURE EVERY TIME

Blaise Fitzpatrick, of Fitzpatrick Engineering Associates, has designed hundreds of retaining wall structures. In his experience, there's no question about the value of global stability analysis in retaining wall design. Says Fitzpatrick, "When there are slopes above or below a wall, a global stability analysis is an absolute requirement, and should be conducted by the wall design engineer."

While Fitzpatrick asserts that global stability analysis is a prudent measure for just about every retaining wall project, he recognizes that some designers will only make the extra effort in the presence of an obvious need.

TERRACED WALLS ALWAYS BENEFIT FROM A CLOSER LOOK

Most wall designers realize the benefit of a global stability analysis when a wall involves toe (below the wall) slopes or crest (above the wall) slopes and weak foundation soils. On the other hand, terraced walls are frequently overlooked as far as global stability is concerned.

Explains Fitzpatrick, "In terraced wall systems, a common mistake is to design each tier as a separate wall, rather than considering the influence of an upper tier on the lower tier. As a general example, consider a 10-foot-high (3.0m) wall, stepped back 10 feet (3.0m) and rising another 10 feet (3.0m). Assuming no slopes (a flat surface above, below and between the walls) and relatively good soil conditions, a properly reinforced lower wall will require approximately 14-foot-long (4.2m) layers of reinforcement (as opposed to 7-foot-long (2.2m) layers of reinforcement in the upper wall). Increased reinforcement is needed to compensate for the load from the upper wall, which essentially mimics the load of a 10-foot (3.0m) high structure on the lower wall. A global stability analysis provides this type of essential information for the proper design of terraced, weight-bearing walls."

AN EASY WAY TO BUILD MORE STABLE WALLS

The message is simple: walls that go up without the benefit of global stability analysis are basically on shaky ground — and the results can be catastrophic. The good news is that global stability analysis is easy to perform for qualified geotechnical engineers. An engineer with a an understanding of segmental wall design, soil mechanics and computer software should be capable of performing the analysis. The following are just a few of the global stability analysis programs commercially available to wall designers: STABGM, XSTABL, PCSTABL6, G-SLOPE, UTEXAS3.

Blaise Fitzpatrick is an engineer with Fitzpatrick Engineering Associates, Atlanta, Georgia. His company specializes in the design of reinforced walls and slopes.