Theoretical Failure Surfaces

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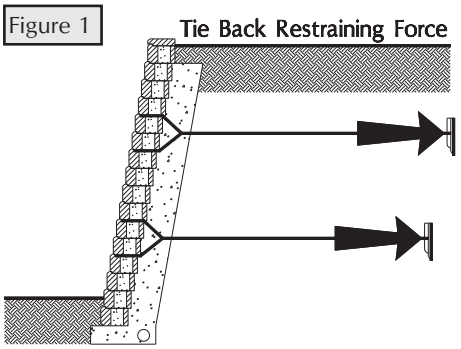
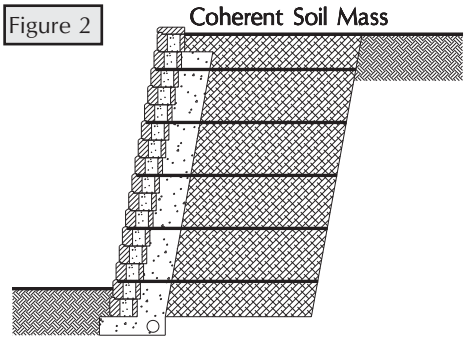
Allan Block Corporation has done more than evaluate and refine the configuration of our retaining wall blocks. We have worked hard to understand the fundamental principals of geogrid reinforced soil masses and how our products work with these giant soil retaining walls. Theories for geogrid reinforced retaining wall structures have assumed that a theoretical failure plane runs through the heart of the reinforced mass. Accepting the concept that a failure plane is present accounts for why many design theories run geogrid beyond this theoretical failure plane. The following will review the theory used by Allan Block to determine how large the reinforced mass should be to safely retain the soil behind it.

Figure 1



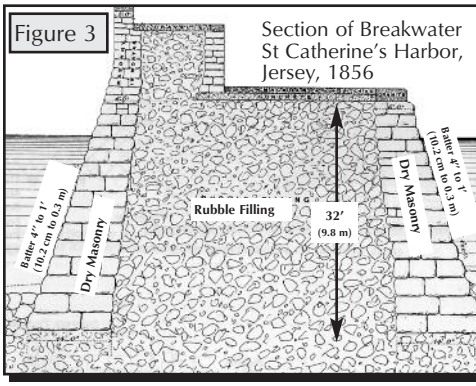
The first and most important question that must be answered is, "Does geogrid reinforcement act as a tie back (Figure 1) or does the reinforcement create a coherent reinforced mass (Figure 2)?" Sources such as the FHWA and the NCMA have written about how a geogrid reinforced soil mass behaves as a coherent gravity retaining wall.

Figure 2



The basic theory that the introduction of geogrid as an internal reinforcement into a soil mass creates a solidified mass has proven itself to be true. Man has evaluated nature and learned how to build many things. From basics of aerodynamic design revealed when the flight of birds are studied to how beavers build earth dams, engineers have derived fundamental elements that are used in present day design. Beaver dams are constructed to become coherent gravity masses by using branches, logs, stones and mud to stop the natural flow of streams and small rivers to create lakes. Man-made earth dams and breakwaters (Figure 3) also create a coherent mass that effectively resist the pressure from the water that is being held back. These common structures help to reinforce the concept that properly compacted and reinforced soil masses will act as independent coherent gravity walls and withstand the active forces behind them.

Figure 3



Allan Block has been used in over 30 million square feet (2.8 million square meters) of retaining wall projects and well over half of those projects have used geogrid to construct reinforced soil masses. Based on the performance of the geogrid reinforced retaining walls that Allan Block has been associated with and the research reports published to date, Allan Block has seen consistent proof that a coherent gravity mass does exist.

Allan Block is committed to implementing a design process to ensure that we are designing retaining walls that will not only last a lifetime but will be cost effective. The job of a good engineer is not only to develop a lasting design, but through a process of creative critical analysis, a design that is affordable to build. We recommend a five step process that evaluates the following.

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- **External Stability** - Analyze how big a reinforced mass is required to hold back the retained soil.
- **Internal Stability** - Analyze the proper spacing and strength of geogrid reinforcement to ensure that the reinforced soil mass will act as a coherent mass.
- **Bearing Capacity** - Analyze the strength of the soil beneath the wall and the reinforced soil mass.
- **Localized Stability** - Check for localized slip planes which may develop between grid layers.
- **Global Stability** - Check for the over all stability of the hillside.

Each of the five steps will be discussed to show how each topic pertains to wall design. For the purpose of this article we will focus on *External Stability*. The primary objective is to build a mass large enough to overcome forces trying to topple the mass (Figure 4) or slide the mass forward (Figure 5). The main elements of a retaining wall structure, to obtain a stable design, are the weight of the soil mass and the setback or batter of the mass. These two design features allow you to calculate the active forces resulting from the type of soil being retained and geometry of the site where a retaining wall is required.

When the reinforced soil mass is properly designed and a coherent gravity soil mass is in place, the potential failure plane moves behind the reinforced soil mass (Figure 6). Moving the theoretical failure plane behind the reinforced mass eliminates virtually all of the stress at the face of the wall, therefore, the grid to block connection only comes into play for localized stability.

Figure 7 illustrates the basic forces at work on a coherent gravity mass. In a manner similar to a properly designed and constructed earth dam we now have a structure that acts as a unit and resists the forces acting upon it. Allan Block retaining wall units perform their job as an integral facing for a reinforced soil mass. The geogrid reinforced soil mass is really doing most of the work for *External Stability* with Allan Block providing a form during construction, a surface to prevent erosion, and an aesthetic, maintenance free veneer that will last a lifetime. During our discussion of *Internal Stability* and *Localized Stability* we will show how the built-in design features of Allan Block provides the best retaining wall facing on the market.

Figure 4

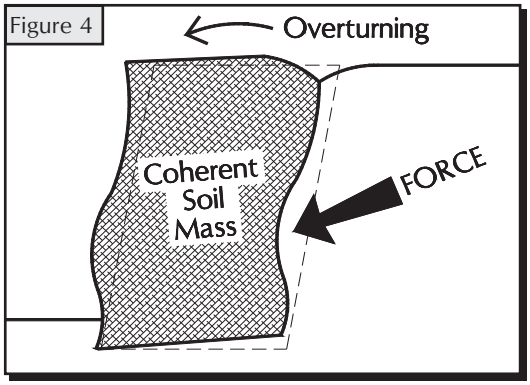


Figure 5

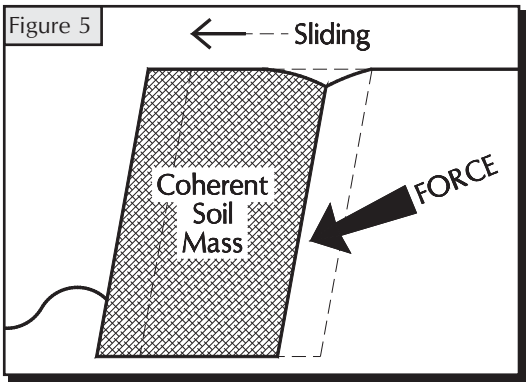


Figure 6

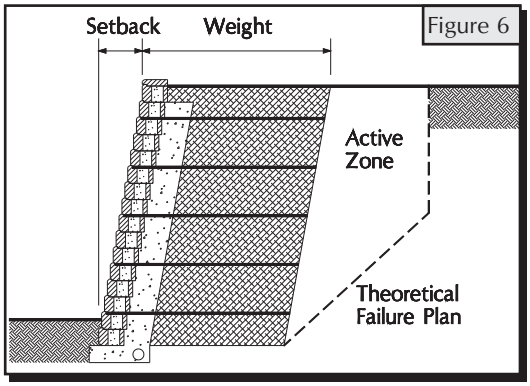
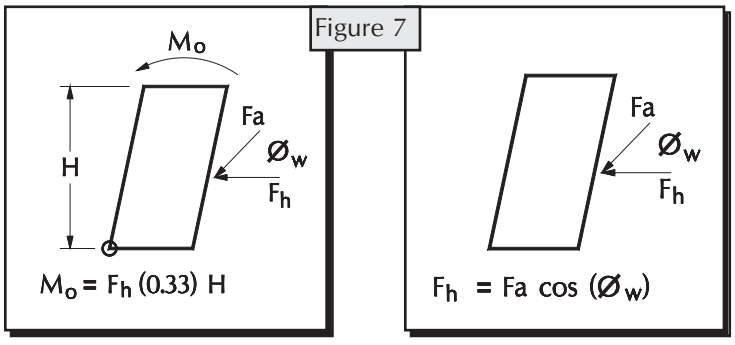


Figure 7



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