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### Retaining Walls – Part II

*By Ronald Thornton, PE*

Developing the proper cross section for a retaining wall is more by analysis than design. In other words it is a process of trial and error, which begins by selecting a particular geometry then analyzing it to see if it will hold up under the given soil conditions. It may take several iterations to come up with an optimum design. Fortunately, computer programs are available for many types of walls that make the process much more efficient.

When analyzing a retaining wall, the selected cross section must be checked for various modes of possible failure. There are essentially four (4) external failure modes to consider including:

- Overturning
- Sliding
- Bearing
- Global Stability

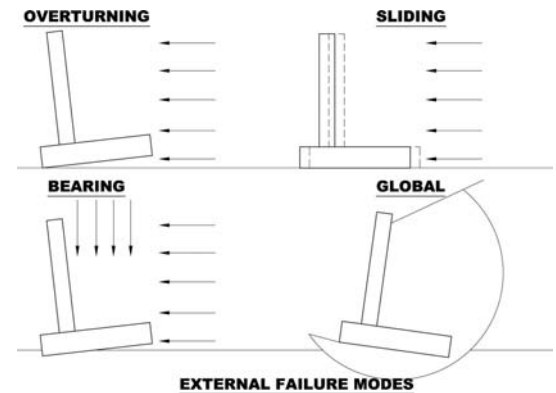
Mechanically Stabilized Earth (MSE) Walls must also consider internal failure modes such as grid pullout and overtensioning.

Overturning occurs when the wall topples forward over its toe. The analysis for this failure mode includes the summation of destabilizing moments resulting from active soil pressures and prevailing surcharge loads and comparing that total to the sum of stabilizing moments which include the self-weight of the wall plus the weight of soil resting above the heel. The safety factor against overturning failure should be at least 2.0.

Sliding is the result of soil pressure and surcharge loads acting perpendicular to the back face of the wall causing it to move forward along its base. Sliding resistance is computed by multiplying the weight of the structure plus the weight of soil acting on the heel times a coefficient of sliding friction. Sliding coefficient will vary depending on the type of soil (typically in the range of 0.35 – 0.55). The safety factor against sliding failure should be at least 1.5.

Bearing failure may occur if the foundation soil does not have sufficient bearing capacity to support the wall. Overturning forces tend to put more of the bearing pressure toward the toe of the wall and less on the heel. In order to balance these forces it is important to keep the resultant force location within the middle third of the base.

Global stability is the total failure of the system along a slope located somewhere behind the wall. The analysis is complicated and requires the services of a qualified geotechnical engineer who is familiar with the site soil and ground water conditions.



The design methods and failure modes described above apply to all types of retaining walls including cantilever, MSE, and modular block walls. As we mentioned in Part I, it is critically important to obtain as much information as possible about the site conditions and soil properties to be used in the design.

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## Featured Project

Trout Brook Storm Sewer Replacement Project

Owner: Metropolitan Council Environmental Services of Minn.

Produced by: Royal Concrete Pipe, Inc.

Structural Design by: Delta Engineers



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This project included the specialty design of 96" diameter reinforced concrete pipe spanning between precast pipe cradles. The precast cradles also act as pile caps and were designed using a strut-and-tie structural analysis method. The sewer line consisted of 208 lineal feet of pipe and 29 cradles.



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