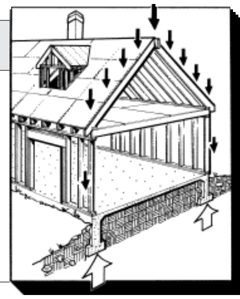
Interlocking Block Retaining Walls

by Harris Hyman, P.E.



A typical new house site in Portland, Ore., where I work, is about 60x60 feet. Within this 60-foot square, the builder has to squeeze the footprint of the house plus find room to maneuver construction equipment. Building would be a whole lot easier if the site were flat, but most of the easy sites were grabbed up years ago. So now we either get into difficult construction, or flatten the site by grading.

Grading nice stable slopes that won't slide or erode takes *space*, lots of it. A nice comfortable slope for the area immediately surrounding the house is anything no steeper than 5:1 (5 horizontal feet for every 1 foot of rise). Still, this means that a 5-foot change in elevation eats up 25 feet of often very valuable land. A steeper grade, such as 2:1, will save space, but it isn't very comfortable when it comes to stabilizing the slope.

One answer is retaining walls, which can give you an immediate change in grade. You may not have used them much in the past for a variety of reasons. For one, the height limit for dry-set stone or masonry blocks is about 2 to 3 feet. Concrete walls, which don't really have a height limit, are difficult and expensive to build and are often ugly. Also, concrete work is usually subbed out and a very limited number of concrete subs have the ability and craftsmanship to build nice-looking exposed walls.

New Option: Interlocking Blocks

There is another way. In the past 15 years, a number of manufacturers have started to make decorative interlocking concrete blocks that can be laid up into walls, without mortar, by any builder. Because they use plastic-grid geotextiles to help retain the slope, these dry-set walls can be quite high — 20 feet and more. The block manufacturers and the grid manufacturers have worked together to create an integrated construction system, and many suppliers carry both the plastic "geogrids" and the interlocking blocks, along with construction and design manuals.

Retaining wall basics. How does a retaining wall work? Figure 1 shows a section through a simple gravity wall. The earth behind the wall wants to slip from a vertical or steep slope into a much lower slope, called the *failure angle*. The slipping earth forms a sliding wedge that presses on the retaining wall to tip it over. The weight of the retaining wall resists this overturning.

If the height of the wall is doubled, the wedge is a *whole lot bigger*. In fact it is *four* times as large. Meanwhile, the wall is only *twice* as large, with only twice the weight and only twice the resistance to overturning. So we have problems. The gravity wall runs out of strength at about 3 to 4 feet high.

Geogrid reinforcement. Figure 2 on page 71 depicts a block wall with geogrids attached to the blocks. The geogrids tie the earth in back of the wall into a solid mass, and this forms an "effective wall" of earth. This earth wall is much larger and heavier than the block wall by itself and so much more resistant to overturning.

The geogrids themselves hook to the wall. Some of the stones in the gravel fill behind the wall poke partially through the holes in the geogrid and lock the layers of fill together. The wall is constructed by laying several courses of blocks, backfilling even with the top of the blocks, then laying the geogrid onto the fill and attaching it to the wall. Then come more courses of block, more backfill, and another layer of geogrid. It's a neat system. It looks good and doesn't show small errors. And you can do it yourself without subs if you choose to.

There are other ways retaining walls can fail besides getting pushed over. One is by slipping, where the sliding wedge causes the whole wall to creep outward without overturning. Geogrid-stabilized walls are more likely to fail by slipping than by overturn-

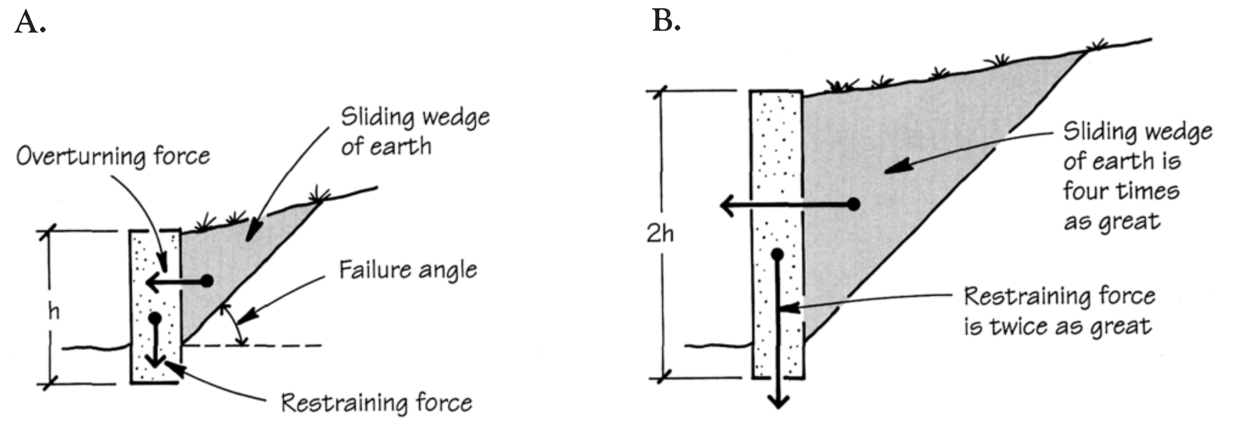


Figure 1. *The retained soil behind a gravity wall wants to slide down the hill till it reaches the failure angle (A). It pushes against the wall to tip it over or slide it down the hill, but the weight of the wall itself prevents this from happening. As a retaining wall gets taller, the wedge of soil pressing against it multiplies quickly. A wall twice as tall (B) is only twice as heavy, but has four times the soil pushing against it.*

Interlocking Masonry Wall with Geogrid

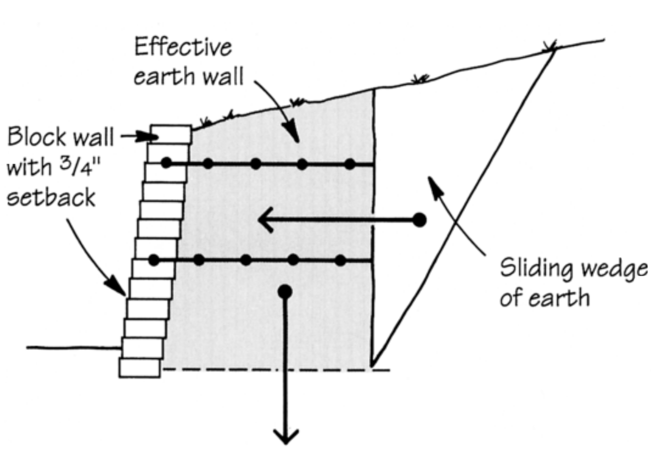


Figure 2. *With interlocking masonry walls 4 feet and higher, a geogrid fabric is used to reinforce the retained soil, creating an "effective" earth wall that reinforces the masonry wall.*

ing. These walls can also fail when the geogrid rips apart. Proper design analysis checks all these modes of failure.

Designing with Interlocking Blocks

There are four site conditions to consider for any retaining wall: the required height, the type of native soil behind the wall, the slope of the soil above the wall, and the *surcharge*. Surcharge means any particular load on the top of the retained earth, typically automobiles.

With these four factors, the wall designer uses the interlocking block manufacturer's technical data to get a geogrid schedule. This schedule gives the block courses at which to place the geogrids and the lengths of the grids. Some of the manufacturers also distribute computer software to assist in the calculations, such as *Tenswal*, from geogrid maker Tensar Earth Technologies (5775-B Glenridge Dr., Lakeside Center, Suite 450, Atlanta, GA 30328; 800/836-7271).

As an example, let's look at a retaining wall with level soil behind and no surcharge in two types of native soil: clayey silt and silty sand. Here is a sample geogrid schedule for various heights:

Sample Geogrid Schedule

Wall Height	Soil Type: Clayey silt	Soil Type: Silty sand
4'	no grid	no grid
6'	4' grids @ 16", 40"	3' grid @ 40"
10'	6' grids @ 24",48",80",112"	5' grids @ 32",64",96"

If there is a 250 pounds-per-square-foot (psf) surcharge on the surface above the wall, the "no-grid" or gravity wall height drops to 3 feet and the lengths of the grids increases by about 30%. (250 psf is the commonly accepted design load for automobiles on the top surface.) With a 2:1 slope above the wall, the gravity wall height drops to 2 feet 6 inches and the lengths of the geogrids is 60% greater than required for the level-top no-surcharge wall.

Remember that this table is only to give you some idea of geogrids. *It is not a design table*. For specific design information, *check the manufacturer's manual*.

I can give only one general rule of thumb for these walls: A gravity wall with no surcharge and a top slope no steeper than 4:1 should have a 3/4-inch setback each course (as shown in Figure 2, previous page), and should rise no higher than your belt buckle (call that 36 inches). For any other conditions, check the manufacturer's manuals. If the wall exceeds 5 feet in height, code calls for an engineer's stamp.

Soil Type and Drainage

A wall constructed in dry weather will look fine when you pack your tools and leave the site. But in late November, after the fall rains have soaked the site, the sliding wedge is a lot bigger and the wall may start to tip. While a low wall is rarely a safety hazard, it can be an expensive embarrassment when it deteriorates two years out, after all of the contract money has long been spent.

The most stable soil behind a retaining wall is clean river rock, followed by clean sand, silty sand, silt, silty clay, and firm clay. Clay is actually never too good but it will work if it remains dry and the design is conservative. Squishy, wet clay is just a disaster, so don't even think about it.

Drainage with block walls is helped by the fact that they leak. Effective drainage is achieved with a partial backfill of clean, graded crushed stone. More conventional perforated pipe systems can also be used. The critical point is that *some* sort of drainage system *must* be used to avoid extremely high hydrostatic pressures.

If you are not experienced, soil mechanics are a little tough to evaluate by eye and feel, so don't be afraid to call an engineer or geologist. The bill for a couple of hours may be quite small in comparison to the later corrective expense and effort. If you are building in a subdivision on the West Coast or in a major urban area, the developer probably has a complete geotechnical report on the site, so you might try that before you call the engineer. ■

Harris Hyman is a civil engineer in Portland, Ore.

Interlocking Block Wall Manufacturers

Allan Block
7400 Metro Blvd.
Suite 185
Edina, MN 55439
800/279-5309

Ideal Concrete Block Co.
232 Lexington St.
Waltham, MA 02154
617/894-3206

Keystone Retaining Wall Systems
4444 West 78th St.
Bloomington, MN 55435
800/747-8971

Unilock
287 Armstrong Ave.
Georgetown, ON L7G 4X6
Canada
416/453-1438

Versa-Lok Retaining Wall Systems
P.O. Box 9220
North St. Paul, MN 55109
612/770-3166