Does your site have excessive slopes? What to consider when developing land with steep slopes

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Continued from the June Hudson Valley section.

Of course, many people, and, in particular, planning boards, are not very happy with high concrete retaining walls because of their appearance. After all, a 15-ft. high concrete wall is not exactly the most attractive of man-made items. However, using dove-tail anchors and slots, concrete retaining walls can be designed such that they can have facing materials of railroad ties, stone, brick, or other materials. I have designed several gravity retaining walls which have a railroad tie facing. One of those walls is located along N. Chatsworth Ave. It supports the parking lot of the complex at 21 N. Chatsworth Ave. When the parking lot was created, a former engineer designed a railroad tie retaining wall (more on this type of wall, later) to support the parking lot. Unfortunately, within six months, that wall started to bow and fail. As a result, the town of Mamaroneck directed that a new, stronger wall be built to support the parking lot. However, both the planning board and the zoning board of that town did not want a wall which consisted of just exposed plain concrete. Some of the board members expressed a preference for a railroad tie look.

The solution was simple. My firm designed a concrete gravity wall with a railroad tie facing. Many people today think that the wall is a railroad tie wall. But, it is not. The railroad ties are merely a facing for a concrete gravity wall.

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Many designers, and certainly most builders, like railroad tie retaining walls because they are inexpensive. The Building Code of New York state does allow railroad ties to be used in the construction of retaining walls and crib walls (Section 2304.11.7). However, such walls still must meet the requirements of Section 1806 of the Building Code. It has been the experience of this firm that crib railroad tie walls can be designed in such a way that the requirements of Section 1806 are met. However, very few railroad tie walls are of the crib design. Rather, most of them consist of a single face of ties which are held-up by tie-back railroad ties which extend back into the retained soils. Unfortunately, as the tie-backs begin to decay, the wall will start to bow. Often, the tie-backs do not extend far enough into the soil to derive any resistance. In such instances, the railroad tie face will rapidly fail. This firm has investigated many such failed walls. You, the reader, probably see at least one such wall every week as you drive along the roadways of our fair state.

Another inexpensive wall type which has been commonly used in the state is masonry block walls. Masonry block can, under certain circumstances, be used as the stem of a cantilevered retaining wall. Unfortunately, to survive on any long term basis, such walls have to have a very large footing. They will also have to have internal steel bars to take the tensile forces which will develop in the wall stem (which would be composed of block and steel bars). However, because the cells of the blocks are small, it is difficult to properly place and grout steel bars in retaining wall stems which are made of block. So, to remain code-compliant, cantilevered retaining walls with masonry stems cannot be very high. Since different soil types will exert different loads against a retaining wall, it is impossible to provide a maximum height for a cantilevered retaining wall which has a masonry stem. That is, different soils will exert different pressures against a wall. So, each wall must be designed on a case-by-case basis.

The forces which a soil will exert on a wall are depended on the internal strength of the soil, the cubic weight of the soil, and the height of the wall. Soils such as sand exhibit an internal strength known as the internal friction. This is expressed as an "angle," and the property is often referred to as the internal angle of friction of the soil. Soils such as clay do not exert much of an internal friction angle (if any), and usually derive their internal strength from cohesion. This, of course, is a very generalized discussion of what is really a very complex issue. The weight of the soil will also play a part in the force which a soil will exert against a retaining wall.

Finally, the exposed (or, the revealed) height of the wall will be significant. The higher the wall, the greater will be the soil pressure against the wall. Unfortunately, the increase in pressure is not related lineally to the increase in height. Rather, it is exponentially related.

By way of an example, all other parameters being equal, the soils against a 10-ft. high wall will exert a force which will be four times greater than the force that they would exert against a 5-ft. high wall. So, even though the height of the wall only doubled, the force would increase by four times.

Part 3 of 3 will appear in the August Hudson Valley section.

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