Relation between Bracedwall for excavation

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Abstract: It is a legal necessity when new construction is begun in a developed area to provide protection to the adjacent existing buildings when excavation in the new site is to any depth which may cause loss of bearing capacity, settlements, or lateral movements to existing property. New construction may include cut-and-cover work when public transportation or public utility systems are installed below ground and the depth is not sufficient to utilize tunneling operations. The new construction may include excavation from depths of 1 to perhaps 15 m or more below existing ground surface for placing a "shallow" foundation or a mat, or to allow placing of one to three or more basements and subbasements. This type of work requires installation of some kind of system of retaining structure termed a cofferdam, braced sheeting, or slurry wall together with a means of holding the retaining structure in position. The retaining structure may be constructed of one of the following: I. Sheetpiling (steel, concrete, or wood). 2. Soldier beams (or piles) with or without lagging 3. Drilled-in-place concrete piles (or piers). 4. Concrete poured in a cavity retained with slurry.
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Introduction

Sheetpiling is commonly used for retaining excavations because it has the highest strength/weight ratio, and much of the piling is reusable and can generally be easily installed either with sheet-pile hammers or with vibratory driving devices. It is not usable, however, where the subsoil contains many boulders or is dense and the excavation is deep. Where the soil is rocky or quite dense and where sheetpiling will be excessively, damaged in driving, a system of soldier beams and lagging is often used. This system consists in a series of H piles (soldier beams) driven on a convenient spacing (often approximately 2 to 3 m for using standard-length timber). As excavation proceeds, 50- to 100-mm-thick boards are inserted behind the front flanges, or (as is becoming common because of the accurate excavation required) the boards are placed against the pile and clipped to the front flange using patented fasteners. Where pile-driving vibrations (using both pile hammers and vibratory drivers) may cause damage to adjacent structures or the noise is objectionable, drilled-in-place piles may be used. The piles (or caissons if 760 mm or more in diameter) are drilled on as close centers as practical, and cast-in-place concrete is used.

Review of study

Where earth is retained and water is not a factor, the soldier-beam spacing or drilled-in-place piles spacing may be such that lagging or other wall supplement is not required, as "arching" or bridging action of the soil from the lateral pressure developed by the pile will retain the soil across the open space. This zone width may be estimated roughly as the intersection of 45° lines.

The piles will, of course, have to be adequately braced to provide the necessary lateral soil resistance.

Where earth and water must be retained, the system will have to be reasonably watertight below the water table and be capable of resisting both soil and hydrostatic pressures. It will seldom be practical to lower the water table, as this will also lower the surrounding soil and/or structures. Sheetpiling joints may allow enough water to pass into the excavation to effectively lower the water table. For these conditions the solutions may be limited to cast-in-place concrete walls or the use of grout around the perimeter of the sheetpiling or clay cutoff walls to reduce the soil permeability. The concrete and clay walls would probably utilize slurry trench construction.

It is evident that uplift or buoyancy will be a factor for structures whose basements are below the water table. If uplift is approximately equal to the weight of the structure, or larger, it will be necessary to anchor the building to the soil. This can be done using some kind of anchor system such as anchor piles to bedrock, if in close proximity, or perhaps belled piles or vertical "tiebacks." The sequence of operations is to place the piling (sheet, soldier beams, or cast-in-place) and make any initial waterproofing operations via grouting. During this period a sufficient number of photographs of the surrounding structures should be taken to establish their condition and a select number of ground elevations and control stations established so that ground loss (subsidence accompanying lateral movements into the excavation) can be detected and/or monitored.

The excavation then proceeds, and at selected depths based on both monitoring and prediction of ground loss, wales and bracing are installed. A strut or raker system creates obstructions in the excavation area which are undesirable. The alternative is to use tiebacks, but this involves bringing a drilling machine to drill in the tieback anchorage, obtaining permission to trespass into the adjacent property owner's subsoil, and the problem of encountering public utilities. In spite of this, the tieback is the generally preferable solution where the adjacent property can be trespassed to the extent of installing the tieback anchors. The tieback anchors are left in place after construction is completed, as it would be excessively costly if not physically impossible to remove them.

Ground loss is a very serious problem around excavations in built-up areas. It has not been solved so far with any reliability; where the ground loss has been negligible, it has been a combination of overdesign and luck rather than rational analysis. The finite-element method presented in this chapter is one of the first methods to the author's knowledge of a semirational method of controlling the ground loss.

Soil Pressures on Braced Sheeting or Cofferdams

The braced cofferdam is subjected to the same earth-pressure forces as other retaining structures which may be calculated using the Rankine or Coulomb methods. The design pressures, however, are different from those computed from the methods because of the manner in which the pressures are developed as idealized the wall is subjected to an active earth pressure, and wall yield takes place. The lateral deformation depends on cantilever soil-wall interaction as would be obtained by the finite-element program. Next a strut force is applied to Obtain stage 2. No matter how large the strut force (within practical limitations) the wall and earth is not pushed back to its original position but the strut force, being larger than the active pressure, causes an increase in the wall pressure. The integration of the pressure diagram at the end of stage 2 would be approximately the strut force – not exact because of some uncertainty of how the pressures act at, and below, the excavation line. The excavation as shown for the end causes a new lateral displacement between b and c and probably some loss of strut force as soil moves out of the zone behind the first strut into the displacement between b and c as well as soil creep. The application of the second strut force and/or tightening up of the first strut results in the qualitative diagram of stage 3 beginning and the excavation and additional ground loss due to lateral movement at the end of stage 3 when excavation proceeds from c to d. Thus it is evident that if one measures pressure in back of this wall the pressures measured will be directly related to the strut forces and will have little relation to the actual soil pressures involved in moving the wall into the excavation.

Peck (1943) and later Terzaghi and Peck (1967) proposed empirical pressure diagrams for wall and strut design using measured soil pressures obtained as from the preceding paragraph. Pressures reported by Krey in Berlin for sands were incorporated into the pressure diagrams. These pressure diagrams were obtained as the envelope of the maximum pressures found and plotted for the several projects. The pressure envelope was given a maximum -ordinate based on a portion of the active earth pressure using the Coulomb (or Rankine) pressure coefficient.[1] These diagrams with the latest modifications. These diagrams are decidedly conservative, as one would expect. Certainly if one designs a strut force based on this pressure diagram and used simply supported beams for the sheeting as proposed by Terzaghi and Peck, the strut force will produce not more than that pressure diagram owing to creep and ground loss and the sheeting will be certainly overdesigned owing to both pre'ssure-diagram discrepancies and sheeting continuity. This was verified by Lambe et al. (1970) and by Golder et al. (1970) wherein predicted and measured strut loads varied by as much as 100 percent. Swatek et al. (1972), however, found reasonable agreement with the Tschebotarioff pressures in designing the bracing system on a Chicago, III., excavation 21.3 m deep. Swatek, however, used a "stage-construction" concept similar to along with the

TschebotarioH' pressure diagram. In general, the Tschebotarioff method may be more correct when the excavation depth exceeds about 16 m.[2]

Conclusion

Soil parameters using triaxial tests with decreasing lateral pressure may be more appropriate than standard triaxial tests. Often, however, the designer must extrapolate lateral pressures and make some estimate of the ϕ angle from penetration-test data.

Reference

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2. Brooker, E. W., and H. O. Ireland (1965), Earth Pressures at Rest Related to Stress History, CGJ, vol. 2, no. 1, February, pp. 1-15.

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