13 FOUNDATION AND RETAINING WALLS

Masonry walls may be used to retain earth in landscape applications, belowgrade building structures, and even swimming pools.

13.1 GENERAL CONSIDERATIONS

Basement and retaining wall design must be concerned with allowable soil bearing pressures, lateral earth pressures, surcharge loads occurring during construction and in service, overturning moments, and sliding.

13.1.1 Soil Bearing Pressures

Building codes typically prescribe allowable soil bearing pressures for footing and foundation design according to the Unified Soil Classification System (see Fig. 13-1). International Building Code requirements for presumptive loadbearing values are shown in Fig. 13-2. Mud, organic silt, organic clay, peat, or unprepared fill must be sampled and tested to determine its bearing capacity, if any.

13.1.2 Lateral Earth Pressure

The magnitude and direction of soil pressure on the wall is dependent on the height and shape of the surface, and on the nature and physical properties of the backfill. The simplest way of determining lateral earth pressure is the *equivalent fluid method*. This method assumes that the retained earth will act as a fluid, and the wall is designed to withstand the pressure of a liquid assumed to exert the same pressure as the actual backfill material. Assumed equivalent-fluid unit weights vary with the nature of the soil in the backfill. Most building codes specify fluid pressures for various types of soil.

| Properties of Soils Classified According to the Unified Soil Classification System | | | | | | | | |
|--|--|---|----------------------------|-----------------------------|--|--|--|--|
| Soil Group | Unified Soil Classification Symbol | Soil Description | Drainage Properties§ | Frost Heave Potential | Volume Change Potential Expansion† | | | |
| Group 1 | GW | Well-graded gravels, gravel-sand mixtures, little or no fines | Good | Low | Low | | | |
| | GP | Poorly graded gravels or gravel-sand mixtures, little or no fines | Good | Low | Low | | | |
| | SW SP | Well-graded sands, gravelly sands, little or no fines Poorly graded sands or gravelly sands, little or no fines | Good Good | Low Low | Low Low | | | |
| | GM SM | Silty gravels, gravel-sand-silt mixtures Silty sand, sand-silt mixtures | Good Good | Medium Medium | Low Low | | | |
| Group II | GC SC ML | Clayey gravels, gravel-sand-clay mixtures Clayey sands, sand-clay mixtures Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plas- ticity | Medium Medium Medium | Medium Medium High | Low Low Low | | | |
| | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, and lean clays | Medium | Medium | Medium to Low | | | |
| Group III | СН МН | Inorganic clays of high plasticity Inorganic silts, micorcaceous or diatomaceous fine sandy or silty soils, elastic silts | Poor Poor | Medium High | High High | | | |
| Group IV | OH OH | Organic silts and organic silty clays of low plasticity Organic clays of medium to high plasticity, and organic silts | Poor Unsatisfactory | Medium Medium | Medium High | | | |
| | Pt | Peat and other highly organic soils | Unsatisfactory | Medium | High | | | |

The percolation rate for good drainage is over 4 in. per hour. Medium drainage is 2-4 in. per hour. Poor drainage is less than 2 in. per hour.

 $\textbf{Figure 13-1} \quad \text{Soil classification typically used in building codes}.$

| Allowable Footing and Foundation Pressures | | | | | | | |
|--|--|---------------------------------------|--------------------------|----------------------|--|--|--|
| | Allowable Bearing Pressure (psf) | Lateral Bearing | Lateral Sliding | | | | |
| Class of Material | | (psf per foot below natural grade) | Coefficient of Friction§ | Resistance (psf)† | | | |
| Crystalline bedrock | 12,000 | 1200 | 0.70 | _ | | | |
| Sedimentary rock | 4,000 | 400 | 0.35 | _ | | | |
| Sandy gravel and/or gravel (GW and GP) | 3,000 | 200 | 0.35 | _ | | | |
| Sand, silty sand, clayey sand, silty gravel, and clayey gravel (SW, SP, SM, SC, GM and GC) | 2,000 | 150 | 0.25 | _ | | | |
| Clay, sandy clay, silty clay, clayey silt and sandy silt (CL, ML, MH and CH) | 1,500 | 100 | | 130 | | | |

[§] Coefficient to be multiplied by the dead load.

Figure 13-2 Allowable soil pressures. (From International Building Code 2003.)

[†] Soils with a low potential expansion have a plasticity index (PI) of 0 to 15. Soils with a medium potential expansion have a PI of 10 to 35. Soils with a high potential expansion have a PI greater than 20.

t Lateral sliding resistance value to be multiplied by the contact area.