13
FOUNDATION AND RETAINING WALLS

Masonry walls may be used to retain earth in landscape applications, below-grade 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 I	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	Well-graded sands, gravelly sands, little or no fines	Good	Low	Low
	SP	Poorly graded sands or gravelly sands, little or no fines	Good	Low	Low
	GM	Silty gravels, gravel-sand-silt mixtures	Good	Medium	Low
	SM	Silty sand, sand-silt mixtures	Good	Medium	Low
Group II	GC	Clayey gravels, gravel-sand-clay mixtures	Medium	Medium	Low
	SC	Clayey sands, sand-clay mixtures	Medium	Medium	Low
	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Medium	High	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	CH	Inorganic clays of high plasticity	Poor	Medium	High
	MH	Inorganic silts, micorcaceous or diatomaceous fine sandy or silty soils, elastic silts	Poor	High	High
Group IV	OL	Organic silts and organic silty clays of low plasticity	Poor	Medium	Medium
	OH	Organic clays of medium to high plasticity, and organic silts	Unsatisfactory	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.

† 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.

Figure 13-1 Soil classification typically used in building codes.

Allowable Footing and Foundation Pressures

Class of Material	Allowable Bearing Pressure (psf)	Lateral Bearing (psf per foot below natural grade)	Lateral Sliding	
			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.

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

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