



RETAINING WALL DESIGN

This information bulletin establishes requirements for the design of retaining walls. L.A.B.C. Sections 1610.1 and 1807.2 cover the design of retaining walls as follows:

1610.1 General. Basement, foundation and retaining walls shall be designed to resist lateral soil loads. Soil loads specified in Table 1610.1 shall be used as the minimum design lateral soil loads unless specified otherwise in a soil investigation report approved by the building official. Basement walls and other walls in which horizontal movement is restricted at the top shall be designed for at-rest pressure. Retaining walls free to move and rotate at the top are permitted to be designed for active pressure. Design lateral pressure from surcharge loads shall be added to the lateral earth pressure load. Design lateral pressure shall be increased if soils with expansion potential are present at the site.

Exception: Basement walls extending not more than 8 feet (2438 mm) below grade and supporting flexible floor systems shall be permitted to be designed for active pressure.

1807.2 General. Retaining walls shall be designed to ensure stability against overturning, sliding, excessive foundation pressure and water uplift. Retaining walls shall be designed for a safety factor of 1.5 against sliding and overturning per 1807.2.3.

However, these sections of the code do not address the following three items:

1. Design fluid pressures for retaining walls supporting retained soil that is other than level backfill
2. Methods of determining surcharge loads on walls
3. Criteria for accepted engineering practice for design of retaining walls

Therefore, this information bulletin is written to address these items. Alternate design requirements may be approved in conjunction with a soil and/or geology report approved by the Department.

I. GENERAL REQUIREMENT

Retaining walls shall be designed to resist the lateral pressure of the retained material determined in accordance with accepted engineering principles.

The soil characteristics and design criteria necessary for such a determination shall be obtained through investigation, subsurface exploration, analyses and report by a soils engineer, subject to the department's approval.

EXCEPTION: Freestanding walls which are not over 12 feet (3660 mm) in height may be designed in accordance with the requirements stipulated in this information bulletin.

II. DESIGN FLUID PRESSURES FOR RETAINING WALLS SUPPORTING RETAINED SOIL THAT IS OTHER THAN LEVEL

Walls which retain drained earth and come within the limits of the exception above may be designed for an assumed earth pressure equivalent to that exerted by a fluid weighing not less than shown in Table No. I. A vertical component equal to one third of the horizontal force so obtained may be assumed at the plane of contact between the retained soil and wall surface when considering the total resisting moment taken at the toe of the wall. Such a vertical component will not be permitted when filter fabric is used behind retaining walls.

The depth of the retained earth shall be the vertical distance below the ground surface measured at the wall face for stem design or measured at the heel of the footing for overturning and sliding.

III. METHODS OF DETERMINING SURCHARGE LOADS ON WALLS

Any superimposed loading, except retained earth, shall be considered as surcharge and provided for in the design. Uniformly distributed loads may be considered as equivalent added depth of retained earth. Surcharge loading due to continuous or isolated footings shall be determined by the following formula or by an equivalent method approved by the Superintendent of Building.

Resultant lateral force:

$$R = \frac{0.3Ph^2}{x^2 + h^2} \tag{1}$$

Location lateral resultant:

$$d = x \left[\left(\frac{x^2}{h^2} + 1 \right) \left(\tan^{-1} \frac{h}{x} \right) - \left(\frac{x}{h} \right) \right] \tag{2}$$

WHERE:

R = resultant lateral force measured in pounds per foot (N/m) of wall width.

- P = resultant surcharge loads of continuous or isolated footings measured in pounds per foot (N/m) of length parallel to the wall.
- X = distance of resultant load from back face of wall measured in feet (mm).
- h = depth below point of application of surcharge loading to top of wall footing measured in feet (mm).
- d = depth of lateral resultant below point of application of surcharge loading measured in feet (mm).
- $\tan^{-1} h/x$ = The angle in radians whose tangent is equal to h/x .

Loads applied within a horizontal distance equal to the wall stem height, measured from the back face of the wall, shall be considered as surcharge.

For isolated footings having a width parallel to the wall less than 3 feet (914 mm), " R " may be reduced to one-sixth the calculated value.

The resultant lateral force " R " shall be assumed to be uniform for the length of footing parallel to the wall and to diminish uniformly to zero at the distance " x " beyond the ends of the footing.

Vertical pressure due to surcharge applied to the top of the wall footing may be considered to spread uniformly within the limits of the stem and planes making an angle of 45 degrees with the vertical.

IV. CRITERIA FOR ACCEPTED ENGINEERING PRACTICE FOR DESIGN OF RETAINING WALLS

a. Bearing Pressure and Overturning

The maximum vertical bearing pressure under any retaining wall shall not exceed that allowed by Division 18 except as provided for by a special soil investigation. The resultant of vertical loads and lateral pressures shall pass through the middle one third of the base.

b. Lateral Pressures

Retaining walls shall be restrained against sliding by lateral sliding resistance of the base against the earth, by lateral bearing against the soil, or by a combination of the two. Allowable lateral bearing and lateral sliding resistance values shall not exceed those allowed in Division 18 except as provided by a special soil investigation.

When used, keys shall be assumed to lower the plane of lateral sliding resistance and the depth of lateral bearing to the level of the bottom of the key. Lateral bearing pressures shall be assumed to act on a vertical plane located at the toe of the footing.

V. SPECIAL CONDITION

Whenever, in the opinion of the Superintendent of Building, the adequacy of the foundation material to support a wall is questionable, an unusual surcharge condition exists such as seepage pressure, or whenever the retained earth is so stratified or of such a character as to invalidate normal design assumptions, the Superintendent of Building may require a special soil investigation before approving any permit for such a wall.

Additionally, unless a soil report is submitted to and approved by the Department indicating that expansive soils do not exist, the footings for all retaining walls must extend a minimum of 24 inches below the natural and finish grades in accordance with the requirements contained in IB P/BC 2011-116 for expansive soil conditions.

**TABLE NO. I
EQUIVALENT FLUID WEIGHT OF EARTH
PRESSURE FOR RETAINING WALL DESIGN**

SURFACE SLOPE OF RETAINED MATERIAL ¹ HORIZONTAL TO VERTICAL	EQUIVALENT FLUID WEIGHT ² Pounds per cubic foot
LEVEL	30
5 to 1	32
4 to 1	35
3 to 1	38
2 to 1	43
1.5 to 1	55
1 to 1	80

For SI: 1 pound per cubic foot = 157 N/m³

¹ Where the surface slope of the retained earth varies, the design slope shall be obtained by connecting a line from the top of the wall to the highest point on the slope whose limits are within the horizontal distance from the stem equal to the stem height of the wall.

² The equivalent fluid weight shall not be less than that determined using table 1610.1 of the 2011 LABC.