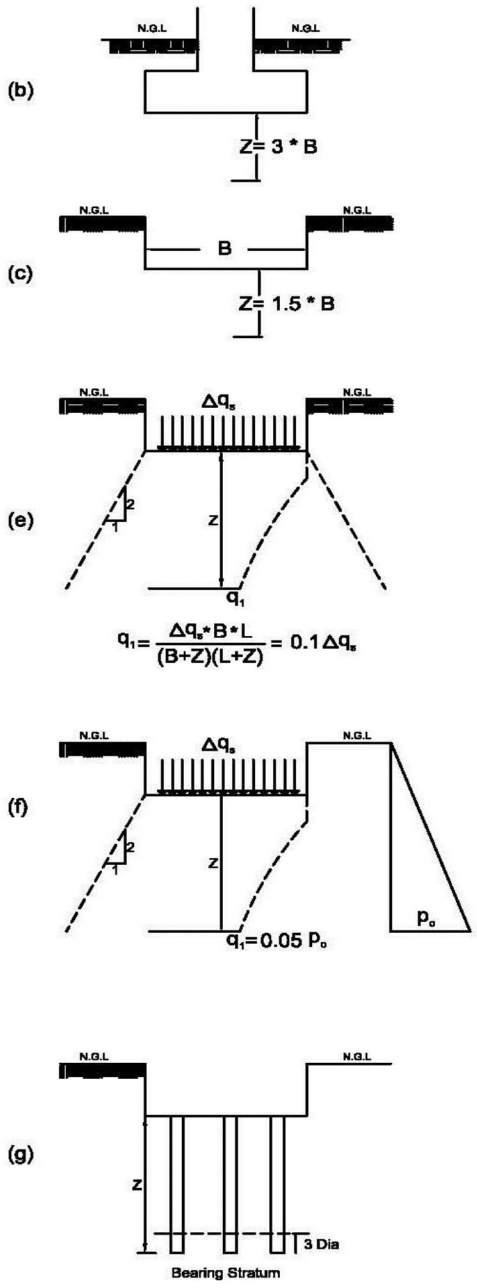
c. Group of overlapping footings or raft.
   - Depth = 1.5 x least width of the group or raft.

d. For heavy structures the depths of one of the boreholes should extend to 2 x width of footing (Heavy loads > 20 T/m^2=200 kPa).

e. The depth of boreholes should extend to the point where the net increase in stress due to the action of the load of the building is less than 10% of the total surface load.

f. The depth of the borehole should extend to the point where the net increase in stress due to building (Δq_s) is less than 5% of the overburden stress in soil.

g. For pile foundation, depth of boring should extend to the bearing strata + (3 x pile diameter).



Example – 1:

A four story building (20m x 30m) with a basement (depth = 4m below ground surface) is proposed. The net pressure (Δ qs) of the building at the basement level is 75 kPa. The soil is silty clay with a dry and submerged unit weight equal to 16 kN/m3 and 9 kN/m3 respectively. The water table was found at elevation 1

m below ground surface. Determine for a detailed soil investigation the number, layout and depth of the boreholes.

Solution:

1. No. of B.H : Area = 30 x 20 = 600 m2 > 300 m2 → use 5 boreholes.
2. Layout : 4 at corners and one at the center.
3. Depth : Using the criteria in Page
   a. No information.
   b. Not Valid.
   c. Depth (Z) = 1.5 x B = 1.5 x 20 = **30 m**
   d. One of the boreholes should extend to 40 m (= 2 x B) {Not necessary}.
   e. Assuming a 2:1 distribution

      $Q = \Delta qs \times B \times L = q1 (L+Z)(B+Z)$

      For $q1 = 0.1 \Delta qs$

      $\Delta qs \times 20 \times 30 = 0.1 \Delta qs (30 + Z) (20 + Z)$

      Solving to get **Z = 52.6 m**

   f. Effective stress at depth z (Po) = 1 x 16 + 9 x (Z+3) = 43 + 9Z

      0.05 x Po = q1 {where q1 is defined in item (e)}

      0.05 x (43 + 9Z)=75 x 20 x 30 /((30 + Z) x (20 + Z))

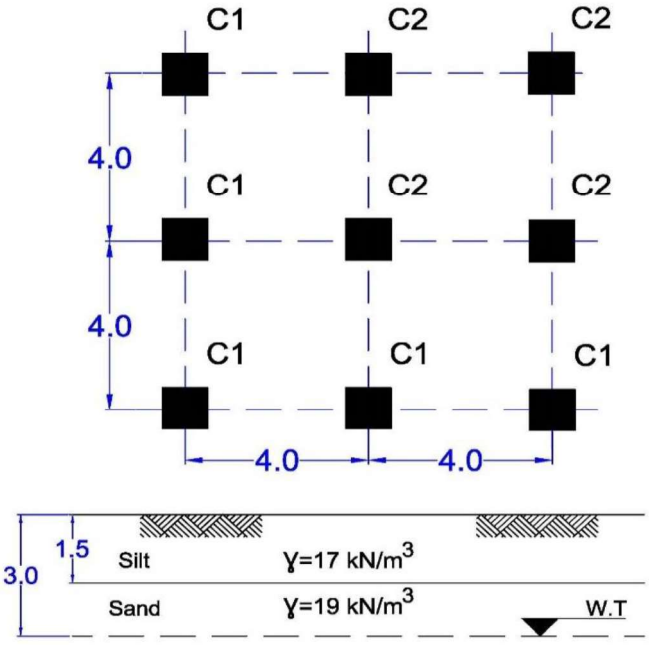
      Solving to get **Z = 29.4 m** which is the same as (c)
   g. Not valid (No Piles).

Therefore the final depth of boring = 30 m + 4 m = 34 m {choose minimum of (e) and (f)} {4 m is the depth of basement}.

ملاحظة : ملخص حساب قيمة (Z) من ثلاثة طرق نقوم بما يلي:

- من الفقرة (e) و(f) نأخذ اقل قيمة لـ (Z).
- نقارن قيمة (Z) مع قيمة (Z) المحسوبة من الفقرة (C) ونأخذ الاكبر.
- نجمع قيمة (Z) الاخيرة مع قيمة عمق قاعدة الاساس عن سطح الارض لاستخراج العمق الكلي للحفرة الاختبارية محسوبا من سطح الارض.

Example – 2



For the Building layout shown, find:

a) No. of Boring
b) Depth of boreholes

Given:

Col. No.	Load (kN)
C1	1500
C2	2500

Use Depth of Footing (1 m)

Solution:

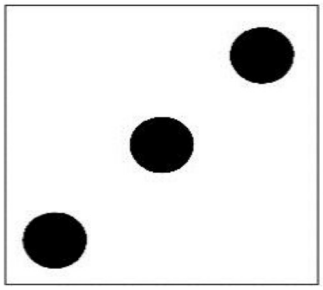
a) Area of Building = 8 * 8 = 64 m^2 < 300 m^2

Use 3 boreholes

b) $\Delta q_s = P_{Total} / Area = (5 * C1 + 4 * C2) / A = (5 * 1500 + 4 * 2500) / (8 * 8)$

$\Delta q_s = 273.43 \text{ kN/m}^2 = 27.343 \text{ T/m}^2 > 20 \text{ T/m}^2$

We have heavy structure, then to calculate the depth of boreholes:



Location of BH

1. $\Delta q_s > 20\ T/m^2$ → Depth = 2 * B = 2 * 8 = 16 m → **Z = 16 m**
2. (Δ qs x B x L) / (L+Z)(B+Z) = 0.1 Δ qs

   (8 * 8) / (8 + Z) (8 + Z) = 0.1 → **Z = 17.29 m**
3. (Δ qs x B x L) / (L+Z)(B+Z) = 0.05 ∑ ɣ'Z

(273.43 * 8 * 8) / (8 + Z) (8 + Z) = 0.05 [1.5 * 17 + 1.5 * 19 + (Z – 2) * (19 – 10)]

(273.43 * 8 * 8) / (8 + Z) (8 + Z) = 1.8 + 0.45 Z

Z = 27.26m

From 2 and 3 use min value of Z = 17.29 then compare it with 1 and choose the max value, then Z=17.29m

Then the total depth of borehole is = 17.29m + 1m = 18.29m ~ 19m