CHAPTER ONE

BRICKWORK

Foundations and Basement Walls

In Vol. I a study was made of the arrangement of foundations suitable for small buildings erected on ordinary dry soils and requiring little excavation.

The term "standard foundation" was used to denote the usual form and proportions adopted; such foundations are only suitable for favourable conditions and in structures of normal size.

Readers should observe that even the "standard" foundation, still required by most building regulations, is found unnecessary for many light buildings. Dwelling houses are commonly erected without brick footings to the walls, the latter being erected directly upon a concrete bed of the necessary width.

For buildings of the warehouse class, special consideration must be given to the problem of reducing the pressure on the foundation soil to a safe value per unit of area.

1. Function of a foundation. The purpose of a foundation is to receive the loads from walls and pillars and to transmit these to the earth without undue or unequal settlement.

Ordinary clay soils or confined sand may safely bear 2 tons per sq. ft. of foundation area and a building of two or three storeys in height may generally be erected thereon with perfect safety, if the standard foundation be adopted.

For taller buildings an estimate must be made of the total load likely to be borne, and the breadth of the concrete bed increased if necessary to reduce the pressure to the allowable value prescribed by local regulations, or where these do not exist to such value as experience has shown to be safe and economical.

2. Spread foundations. In many cases it will be found necessary to spread the foundation concrete beyond a width of $2T+12''$, where T is the thickness of the wall in inches at the base. In such instances the concrete may be kept of an economical depth and made to resist bending on the projecting arm by embedding steel beams transversely, at intervals of 1′ 6″ to 2′, across the full breadth of the base, or may be reinforced by embedding $\frac{5}{8}''$ to $\frac{3}{4}''$ round bars with hooked ends in a similar way near the base of the concrete, and overlaying these with $\frac{1}{2}''$ bars longitudinally at the overhanging parts only. The former bars convert the foundation into two reinforced cantilevers with the steel taking tension on the under side, while the upper layer of bars distributes the pressure over the length. According to size and conditions the transverse bars will be placed at 4″ to 8″ centres and the longitudinal bars at 6″ to 12″ centres.

3. Essential points in foundation and basement construction. The following are essential matters in the practical preparation for foundation and basement work:

(*a*) Seek a natural foundation which will satisfactorily support the load with the least artificial preparation and not unduly subject to disturbance. This may mean that layers of unsatisfactory earth must be cut through and the foundation bed made deeper in order to gain the desired result.

(*b*) See that the natural foundation is dry or take measures to maintain dryness, at least of the interior. Wet soils may need to be drained, or if this is impracticable, temporary dryness may be obtained by pumping, and some permanent means adopted for damp proofing the walls and floors in contact with the earth (see clause *d*).

(*c*) Proportion the size of the foundation to the bearing power of the soil if an increase of size beyond the standard foundation is necessary. Otherwise adopt the "standard".

(*d*) If a basement is required and ground water cannot be eliminated from the site, or, if the ground slopes downwards towards the walls and tends to absorb and pass surface water thereto, provide adequate damp-resisting construction throughout the basement floor and walling; see paragraphs 13 and 14.

4. Ground water. In Vol. I and also in the last clause a reference has been made to "ground water". This is water which exists in soils due to the following causes:

(1) Most soils are porous and water percolates through them until arrested by a bed of clay. Suppose a cup-like depression exists in this bed, then water may collect until full, when it overflows and spreads into the surrounding soil. Such a depression may be of large extent and retain considerable quantities of water and if a building foundation penetrates the depression it is difficult to get rid of this ground water. Drainage of the site at a low level is the proper procedure if means exist for disposing of the drainage.

(2) If near to a river and the banks of the stream are of porous soil, water spreads through the pores to the level of the water on each side and, by capillary attraction, rises to a higher level and saturates the soil. In addition, the water level fluctuates with the rise and fall of the river. Buildings on or near banks of streams are liable to damp basements and foundations due to this cause.

Other examples could be quoted, but the above will suffice for the present purpose.

5. Ground air and moisture. The pores or voids in soil, above the level of any ground water, are filled with air containing quantities of carbon dioxide and other gases, in some degree injurious to health. Water vapour is also enclosed with this air where it lies over damp soils, rendering the earth moist and cold.

Such ground air and water vapour is not stationary, but is expelled from the ground by rises in the level of the ground water and by the expansion of the air due to increase in temperature. When the ground water falls or the temperature decreases, air above the ground is drawn into the soil, becomes charged with gases and vapour and would be again expelled under suitable conditions.

Air and water vapour thus expelled quickly disperses if discharged into the open air, but if allowed to enter unventilated enclosures under ground or basement floors, it accumulates, the atmosphere becomes suited to the development of a decay in the floor timbers, known as dry rot, while if the air can leak into habitable rooms it may cause injury to health.

6. Cold sites. Wherever water is retained in the ground, unless at a considerable depth below the foundation, the temperature of the site is liable to be kept low, the atmosphere surrounding it damp, and the building cold.

Where such sites are used for the erection of dwellings they need careful treatment with the object of removing the cause or, as an alternative, of preventing ground air, ground moisture and water, or surface drainage from penetrating to the interior of such buildings.

In exposed and cold situations moderately thick walls are necessary for healthy buildings, whatever material or method of construction is adopted. The studies included in this volume are intended to be suitable for a first class building of each of the types under consideration.

7. Basement. A basement room is one which has its floor level below that of the ground immediately adjoining. The term is sometimes used to describe the lowest storey of a building but this is only justifiable when dwellings have some of their habitable rooms with their floors below the ground level. Many modern dwellings have no such rooms and the lowest storey is then named the ground floor storey.

Basements are adopted in each of the buildings selected for study and provision for damp-resistance suited to the conditions is considered in paragraphs 13 to 16.

8. Basement walling. This term refers to walling above the foundations and below the ground floor; much of it may be in contact with the soil and may thus require special treatment to prevent the absorption of moisture.

The moisture may be due to percolating rain water or to soil in contact with ground water.

9. Foundations to warehouse. The warehouse under consideration is a four storey building, and because of its height and weight will require larger foundations than those employed in previous studies. On good soils it may happen that the standard proportions still serve, but the width of the concrete should be checked, because its increase in breadth is not directly proportional to the thickness of the wall which it supports.

Most building regulations require a minimum thickness of walls for various stages in the height of a building, offsets being provided at floor levels, and the walls increasing in thickness inwards towards the base. The footings are twice the thickness of the wall at the base, but the concrete does not project in proportion, 6″ being usually adopted for all cases. Thus, if an 18″ wall supports a load of 16 tons per foot of length, the standard concrete base will be 4 ft. wide and thus provide 4 sq. ft. of base area per ft. run. The pressure on the earth would then be $\frac{W}{A}=\frac{16}{4}=4$ tons per sq. ft.

If a 36″ wall supports 32 tons, the base will be 7 ft. wide and the stress on the earth $\frac{32}{7}=4\frac{4}{7}$ tons per sq. ft.

Thus the pressure per sq. ft. becomes greater as the wall increases in thickness, assuming that the increase is proportionate to the load.

10. Thickness and projection of concrete. If the projection of the concrete were proportionately increased in order to keep the pressure per sq. ft. constant for one class of wall, a greater depth would become necessary to resist the upthrust from the ground, or some reinforcement would be provided to accomplish the same purpose.

The minimum depth of plain concrete may be determined by the following method, based on the graphical procedure adopted in Vol. I. In detail No. 1 let

T = thickness of wall at base,

D_F = depth of footings,

D_C = depth of concrete.

Each step of the footings projects $2\frac{1}{4}$″ and is 3″ deep, hence the total projection and depth of footings are proportionate. By similar triangles

$$\frac{D_F}{\frac{T}{2}}=\frac{3}{2\frac{1}{4}},$$

$$\therefore\ D_F=\tfrac{2}{3}T.$$

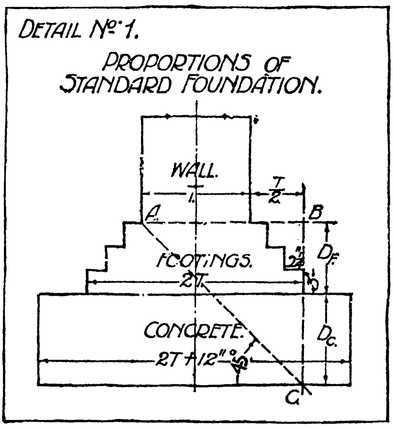
Employing the 45° line for determining depth, $AB = BC$.

$$\therefore\ D_C + D_F = T + \frac{T}{2}.$$

But $$D_F = \tfrac{2}{3}T,$$

$$\therefore\ D_C + \tfrac{2}{3}T = \tfrac{3}{2}T,$$

and $$D_C = \tfrac{5}{6}T.$$



It is proposed to employ this proportion for walls up to 2′ 3″ thick; the concrete then requires to be $\frac{5}{6} \times 27 = 22\frac{1}{2}''$ deep. Beyond this dimension, roughly 2 ft., the thickness may be kept constant.

If calculations show that a greater width of concrete is required than would be provided by a standard foundation one of the methods of strengthening already referred to in paragraph 2 should be adopted; it may then be possible to decrease the thickness.

Walls and Foundations to Warehouse

11. Warehouse walls. On reference to the general plans of the warehouse it will be seen that this building is exposed on three sides while the fourth might adjoin another building and become a party wall.

A "party wall" is a wall dividing two buildings adapted for use by different occupiers and jointly belonging to the respective owners of the two buildings.[1]

The front, back and party walls are joined to others at their angles only, but the external wall parallel to the party wall receives

[1] The student should consult the complete definition of "party wall" given in the Model Bye-laws of the Local Government Board and in the London Building Acts.

support by being bonded to the return wall of the staircase and hoist enclosure.

The building regulations of the London County Council are too extensive to quote here, but taking these as a guide for determining the thicknesses of the walls,[1] the three external walls should be 1′ 10½″ thick at the basement floor, while the party wall should be 2′ 3″ thick. This difference is due to the greater unsupported length of the party wall as compared with those of the three external walls.

On examination of the sections of the building, shown on the general plans, it will be seen that these thicknesses are diminished at each floor level until a minimum of 13½″ is reached for the top storey.

The front wall of the warehouse is of greater thickness than the regulations require, because of the architectural treatment adopted; see Chapter on Masonry.

12. Site of warehouse. The site is on sloping ground, which rises 3′ 9″ from the pavement level in the front street to the pavement level in the back street.

To avoid undue excavation, and to utilise the site economically, a front basement room is provided across the breadth of the building and half the depth of the site.

In some instances the material excavated to provide space for the basement might be used for filling in some of the space between the ground floor and the natural surface where no basement is required.

In this case it is scarcely feasible, the slope and available space being small; further, it is not desirable to construct the back portion of the ground floor on filled ground, because, although the material might be of a satisfactory nature, adequate consolidation during the period of building is not readily obtained. The foundation treatment due to the sloping site is given in Vol. III.

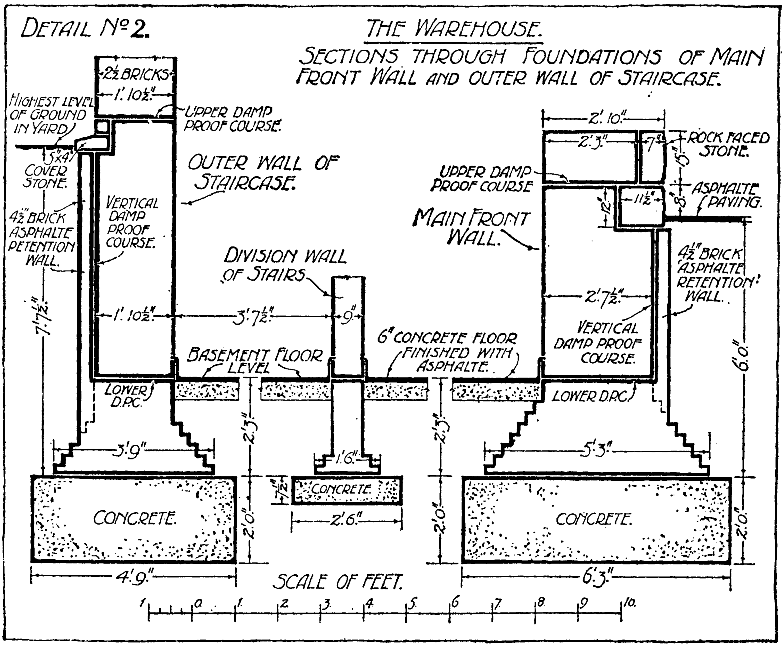
13. Damp proofing arrangements to warehouse walls. To exclude damp where no basement exists, the usual horizontal damp proof course is inserted in the external and internal walls, at least 6″ above the ground level.

If the adjoining property has no basement or the wall is an external one, *e.g.* the external staircase wall, two damp proof courses are necessary, one being inserted at the basement floor level to prevent absorption from the foundation and another 6″ above the ground level to prevent absorption from surface soil

[1] See also L.G.B. Model Bye-laws.

or surface drainage, as shown on detail No. 2. These horizontal courses are connected by a vertical damp proof course—see next paragraph.

In the case of very damp soil—unless the concrete floor to the basement is specially damp-resisting—the lower damp proof course is wisely carried right across the floor in the form of a ½″ surface covering, gritted with coarse sand to provide a non-slippery, while impervious, floor.



14. Vertical damp proof sheeting and retention walls. It would be useless to provide two horizontal damp proof courses, as described in the previous paragraph, if damp earth were left in contact with the intervening wall without protection. Hence a vertical sheet of asphalte or other suitable material[1] is inserted near the outer face of each exposed wall. An efficient method of doing this is to build a 4½″ wall in stretching bond against the main wall, leaving a ½″ space or cavity between the two and open horizontal joints ½″ deep on each side of the cavity. As the walls are erected, either molten asphalte, or Hygeian rock,[1] is poured in at intervals of three to four courses—see sketch on detail No. 3; the asphalte

[1] See Chapter on Materials.

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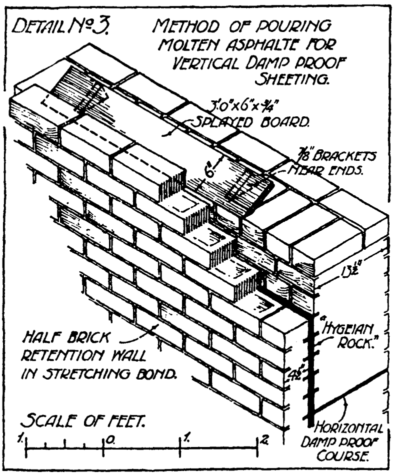
quickly solidifies and provides an effective bond between the facing and main wall.

The half brick wall used in such a manner is named a "retention" wall.



15. Basement of the house. The house selected for study is provided with a basement placed under the hall—see general plans.

This basement is lighted by two windows opening into an "area" in front, which is an open space formed by excavating to a suitable depth below the basement floor level and wide enough to admit adequate light on each side of the flight of entrance steps.

16. Damp proofing of basement to the house. The basement is protected against damp on the three vertical walls in contact with the earth in a similar manner to that described for the warehouse, a ½″ sheeting of Hygeian rock being poured between the 13½″ basement walls and a 4½″ retention wall; see detail No. 4. At the bases of these walls this sheeting is connected to a ½″ horizontal layer of similar material placed between the brick courses at the floor level, and projecting slightly over the 6″ concrete floor. The floor surface is formed by a ⅝″ coating of waterproofed cement mortar consisting of one part of Portland cement to 1½ parts of sand, and 2 per cent. of Pudlo[1] measured by volume. A skirting of the same material is carried 6″ up the wall and finished with rounded angles, the two intervening brick joints being raked out to a depth of ⅝″ to form a key for this skirting.

17. Hollow basement walls. Detail No. 4 also shows that the front wall of the basement is constructed in two sections with a space or cavity between them.

The purposes of hollow walls, their construction and the methods of ventilating are explained in the next chapter, commencing at paragraph 35.

18. Foundations to external walls of house. Apart from the basement the main walls of the house have their foundations carried to a depth of 4′ 6″ below the natural ground level.

[1] See Chapter on Materials.

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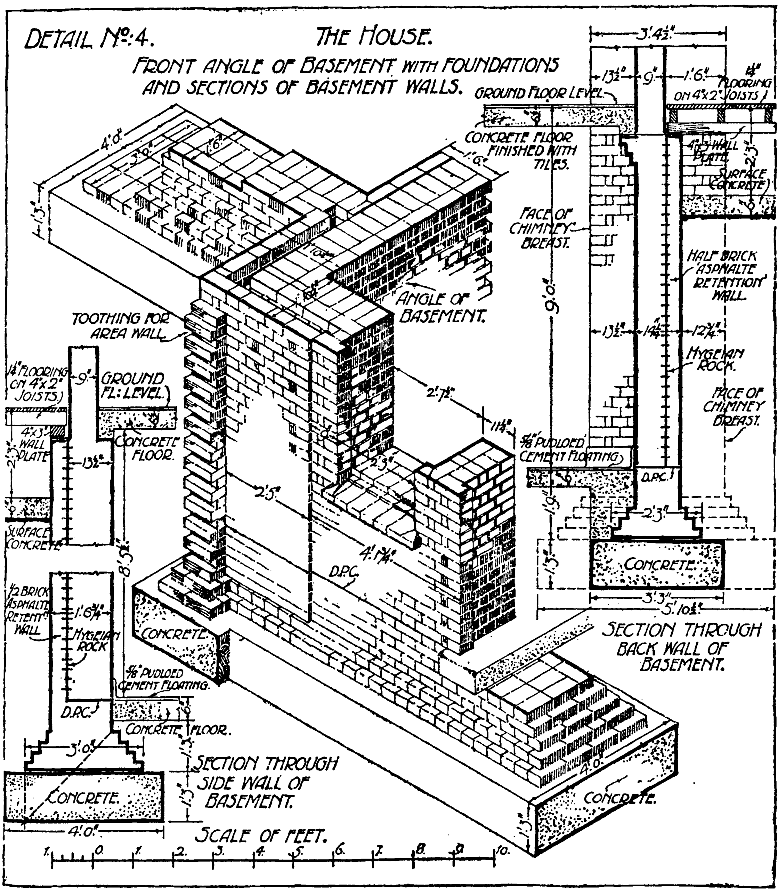
The walls vary from $13\frac{1}{2}''$ to $18''$ thick and have foundations of standard width, but the depth of concrete is $15''$ throughout to allow footings to commence at one level.



The sections of these walls are shown in detail No. 5. In the external wall at A the cavity is continued 1′ 3″ below the ground, and the foundation walling between this and the footings is solid. The damp proof course is inserted in the inner portion of the hollow wall immediately below the wall plate level and the space between the joists and the surface concrete ventilated by an air inlet through both portions of the wall. The outer opening is guarded by a $9'' \times 6''$ cast iron air grating while the inner one is unobstructed and spanned by two $2'' \times \frac{1}{4}''$ wrought iron bars to support the brickwork.

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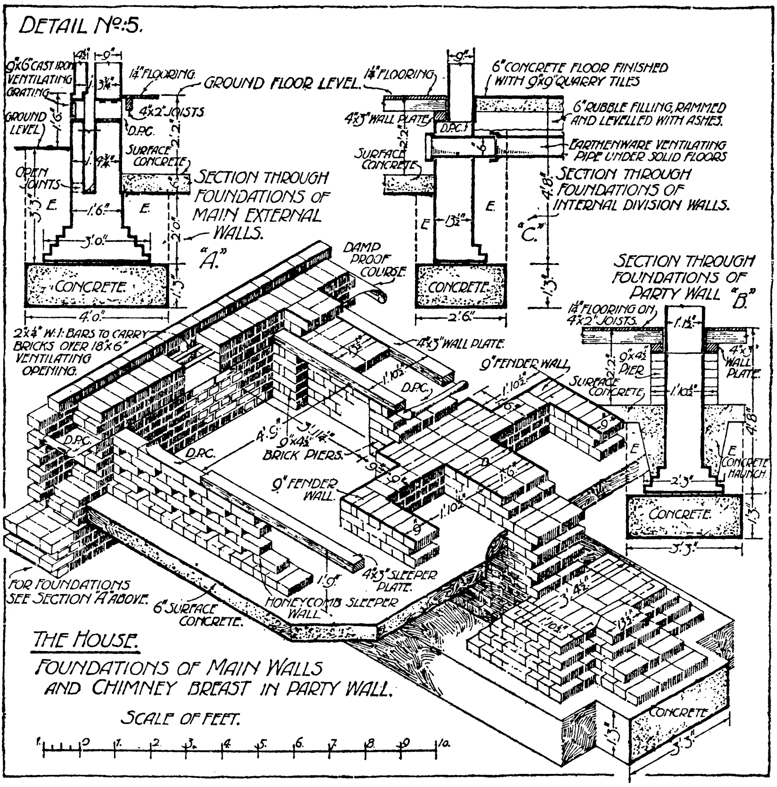
19. Foundations to party walls. The party wall at B is $13\frac{1}{2}''$ thick, but to support the wall plates which carry the floor joists at the recesses on each side of the fireplaces, pairs of brick piers are erected upon the surface concrete and bonded to toothings in the party wall. This construction is also shown in isometric projection on the same detail.



The damp proof course shown below the wall plate must be arranged to cover the piers in addition to the wall. Building regulations require that no openings be made through party walls.

20. Foundations to internal walls. The section at C is through the internal wall between kitchen and scullery. The floor of the latter is of concrete laid upon "hard core", while the kitchen floor is of timber, hence an offset of $4\frac{1}{2}''$ is provided to support the wall plate on the kitchen side and embodies the footings on that side;