Concrete Block Construction
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CONCRETE BLOCK CONSTRUCTION

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Concrete Block Construction*

*By C. H. JEFFERSON***

Concrete masonry units, such as concrete block, cinder block, building tile and concrete brick, are widely used in farm building construction. The economy, durability, and fire safety of concrete masonry for farm structures are advantages largely responsible for its growing popularity. Purpose of this bulletin is to present information that will be helpful to those persons considering or doing concrete masonry.

SIZES AND SHAPES

A full-sized concrete block actually measures 7¾ inches high, 8 inches wide and 15¾ inches long. When these blocks are laid in a wall with a ¼-inch mortar joint the distance from center to center of the mortar joints or from center to center of the blocks is 8 inches in height

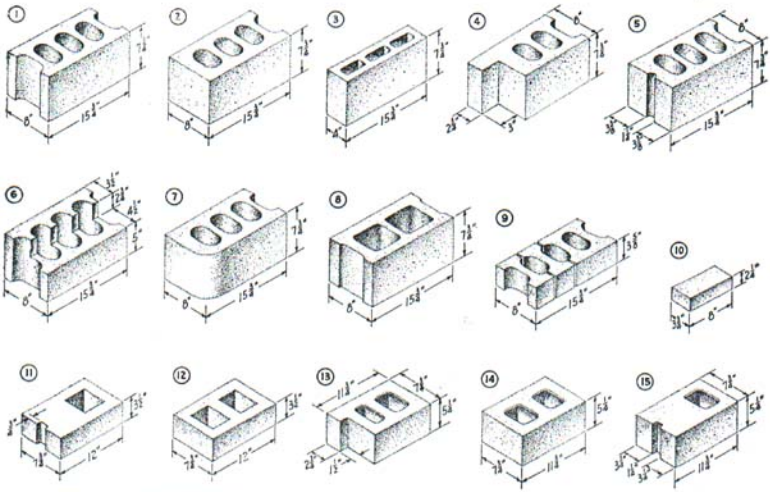

Fig. 1. Various types of concrete blocks are available for various special purposes.

*The assistance of the Portland Cement Association in furnishing illustrations and checking this bulletin is gratefully acknowledged.

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and 16 inches in length. Therefore these blocks are referred to as standard 8 x 8 x 16-inch units, which are comparable in frame construction to standard size 2" x 4"s that actually measure 1⅝ x 3⅝ inches. Concrete masonry units are made in several convenient shapes and sizes (Fig. 1). The standard 8 x 8 x 16-inch unit referred to as a concrete block is the size most widely used, although the standard 5 x 8 x 12-inch unit called a building tile, is another popular size. In addition to the standard full- and half-length units, there are many special ones used for corner returns, door and window jambs and joist supports which enable the mason to construct rapidly a neat, attractive wall. Uses of several special units are illustrated by the sketches in Fig. 5.

TYPE OF AGGREGATE USED

Two general types of blocks are available. One, commonly known as a "concrete block" is made of cement, sand and gravel. The other, commonly referred to as a "light-weight block" is made of light-weight material such as cinders, ordinary slag, or burned clay and cement. The "cinder block" made from specially prepared and carefully graded cinders is the most common light-weight block.

Both types are strong. Recent specifications require them to withstand 125,000 pounds vertical load per block for "A" quality and 90,000 pounds for "B" quality.

Light-weight units have about 25 percent better insulation value than sand-gravel units of the same size. A light-weight block weighs from 28 to 34 pounds for a standard 8 x 8 x16-inch size, compared with about 54 pounds for a similar size sand-gravel unit.

The surface texture is relatively rough and porous and for all types of external construction, the block should be water proofed. Light-weight blocks usually cost from 2 to 5 cents more per unit than sand-gravel blocks, the difference depending on the type of light-weight aggregate used.

Sand-gravel blocks, owing to their greater density and water-resistant properties, are suggested for below-grade construction unless cast-in-place concrete is used. Sand-gravel units are also satisfactory for above-grade work where insulation is not so important, for interior partition walls, or where especially smooth walls are required without plastering.

In general, it is best practice to employ an experienced mason to build concrete masonry walls, especially for the more important structures. In small, less important work, any man handy with tools can soon acquire the necessary experience to lay concrete masonry units. Reference to the sketches shown in Fig. 5 will aid materially in obtaining good construction.

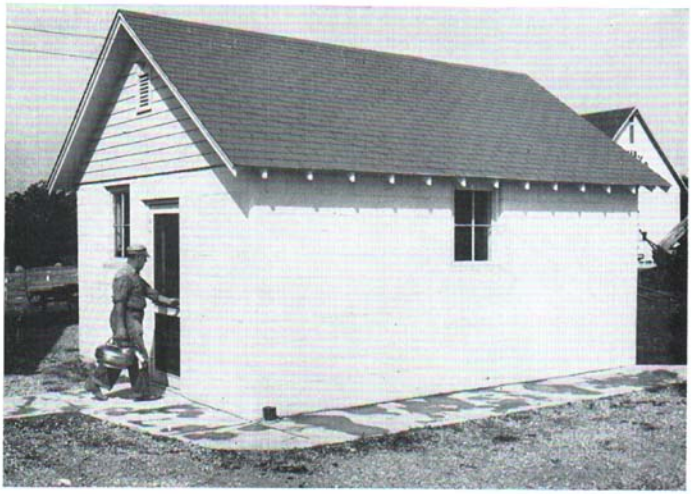

Fig. 2. Concrete block construction is widely used for milk houses.

COMMERCIAL VERSUS HOME-MADE BLOCK

Concrete blocks of good quality can be made at home when a supply of high grade sand is available. It is more difficult to make satisfactory cinder blocks at home owing to the fact that the proper type of cinders are not readily available. Even when good cinders are available they must be crushed, washed, carefully graded and sometimes treated to

Fig. 3. Concrete blocks make an excellent first-floor wall for remodeled barns.

remove sulfur residue. Therefore, it is usually impractical for an individual to make either type of block just for his own use. The cost of the necessary equipment to manufacture a quality product is often too great to allow economical production in small quantities.

TABLES OF MATERIAL REQUIREMENTS

The following tables will be useful in determining the number of blocks, the quantity of mortar to use, the amount of materials needed for various types of mortar, and the proper proportioning of materials for cast-in-place concrete to be used for floors and similar solid slabs.

TABLE 1—*Materials required for 100 square feet of concrete masonry wall above grade*

Standard block size (1) *H W L	H W L 8" x 8" x 16"	H W L 8" x 4" x 16"	H W L 5" x 8" x 12"	H W L 8" x 12" x 16"
Wall thickness	8"	4"	8"	12"
Number of blocks	110	110	220	110
Cubic feet of mortar (2)	3½	3½	5	3½

*H=height
L=length
W=width

(1) Actual size of block is 7¾" high, 8" wide and 15¾" long. Other sizes are also ¼" less in height and length than shown by standard sizes in this table.
(2) Mortar applied to face shells only (not on cross-webs). (See sketch 6 in Fig. 5.)

TABLE 2—*Materials required for different types of mortar*

Type of mortar	Sacks of cement*	Cubic feet of hydrated lime	Cubic feet of sand	Cubic feet of mortar
Cement and sand	1	—	3	3.1
Cement, lime and sand	1	1	3	3.2

*One sack of cement equals one cubic foot.

TABLE 3—*Approximate amounts of materials required per 100 square feet of cast-in-place concrete, using a 1:2¼:3 mix**

Thickness of concrete (inches)	Cement (sacks**)	Sand (cubic yard)	Gravel (cubic yard)	Concrete (cubic yard)
4	7¾	¾	1	1⅓
6	11⅗	1	1⅓	2
8	15½	1¾	1¾	2½
10	19⅓	1¾	2¼	3

*Amounts of sand and gravel required should be increased about 5 to 10 percent to allow for waste and other variables.
**One sack equals one cubic foot.

WALL SECTION	DESCRIPTION	INSULATING VALUE
① 	1" sheathing, studs	1.4
② 	8" concrete block	1.79
③ 	8" cinder block	2.43
④ 	8" concrete block, core loose filled with granular insulation	2.63
⑤ 	1" siding, paper, 1" sheathing, studs, and 1" sheathing	3.18
⑥ 	8" concrete block furred—1" air space and ½" insulation board	3.66
⑦ 	8" cinder block furred — 1" air space and ½" insulation board	4.28
⑧ 	8" concrete block, cores filled, and furred—1" air space and ½" insulation board	4.41
⑨ 	8" cinder block, cores loose filled	5.00
⑩ 	8" cinder block, cores filled, and furred —1" air space and ½" insulation board	6.78

Fig. 4. Insulating value of various types of walls commonly used in farm building construction. (Values from American Society of Heating and Ventilating Engineers.)

INSULATION OF CONCRETE MASONRY WALLS

Farm buildings housing livestock need good insulation to conserve animal heat in winter and to keep buildings cooler in summer. Insulation also helps to reduce interior condensation and thus prolongs the life of the building and equipment.

Three ways of providing greater insulation value in masonry are:

1. Using light-weight blocks.

2. Nailing insulation board on furring strips attached to the wall. This is the usual method in house construction. Plaster may be applied on insulating board if it is a plaster-base type of insulation.
3. Pouring a granular fill (crushed cinders, ground cork, expanded mica or mineral wool) into the cores of the block as they are laid in the wall.

Several typical masonry wall sections and the relative insulating value of each are shown in Fig. 4.

Heat is lost more rapidly through windows, doors, floors, and roof than through walls. Window openings in all livestock buildings should be reduced to a minimum consistent with livestock requirements. Roofs should be insulated with straw, hay, or other insulating material, and ground floors should be constructed as shown by sketches 18 and 19 in Fig. 5 to reduce moisture troubles.

Dampness owing to condensation on inside wall surfaces can be reduced by sufficient insulation plus adequate ventilation to remove excess moisture. Condensation may occur within the core of the wall unless a proper vapor seal is provided on the warm side. Asphalt aluminum paint can be applied on the inside surface of the blocks, or vapor-sealed insulating board may be used over a layer of vapor-resistant paper on furring strips.

SURFACE TREATMENT OF ABOVE-GRADE EXTERIOR WALLS

The exterior surface of masonry walls can be weather-proofed by a coating of any standard brand Portland cement base paint. Several commercial paints of this type are readily available in a wide range of colors. Instructions accompanying these paints usually state that two coats are recommended, the first coat being somewhat thinner than the second. The paint is scrubbed on a dampened wall with a short bristled brush (a scrub-brush is often used). The paint, after drying just enough to stay on, should be kept moist for two days after the application of each coat.

If such commercial paints are not available a satisfactory coating for the outside of cement or cinder block walls can be made by mixing white Portland cement with water to the consistency of thick cream. This cement paint can then be applied in the same manner as suggested for the commercial preparations.

WATER-TIGHT FLOORS AND BELOW-GRADE WALLS

Construction of water-tight walls below grade, and construction of dry floors are shown in sketches 17, 18, and 19 in Fig. 5. These methods should be followed whenever the water table is high or poor sub-soil drainage exists.

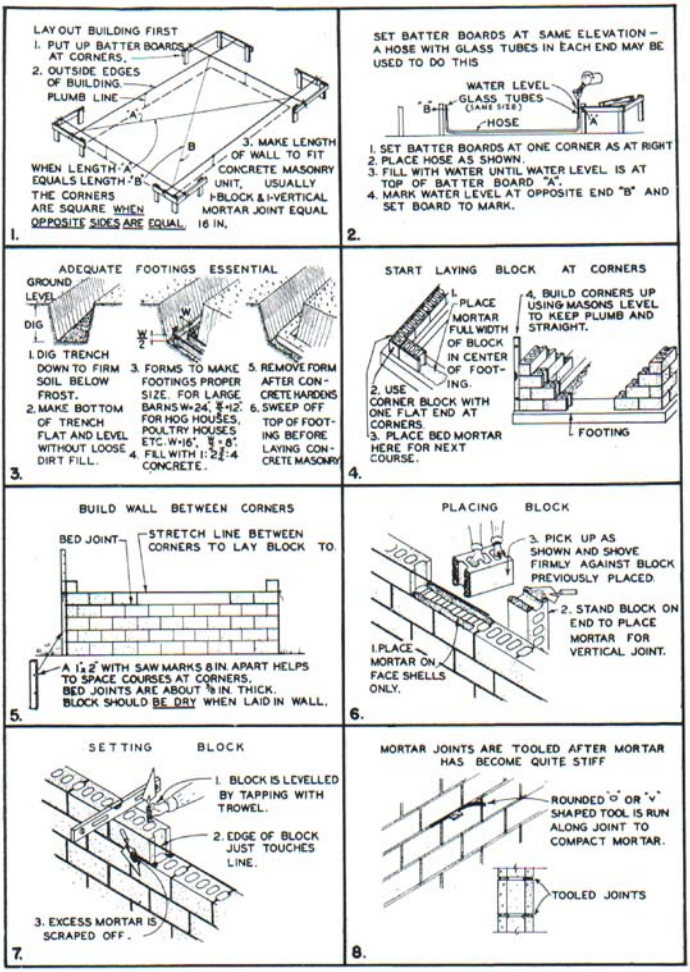

Fig. 5. Details of masonry wall construction.

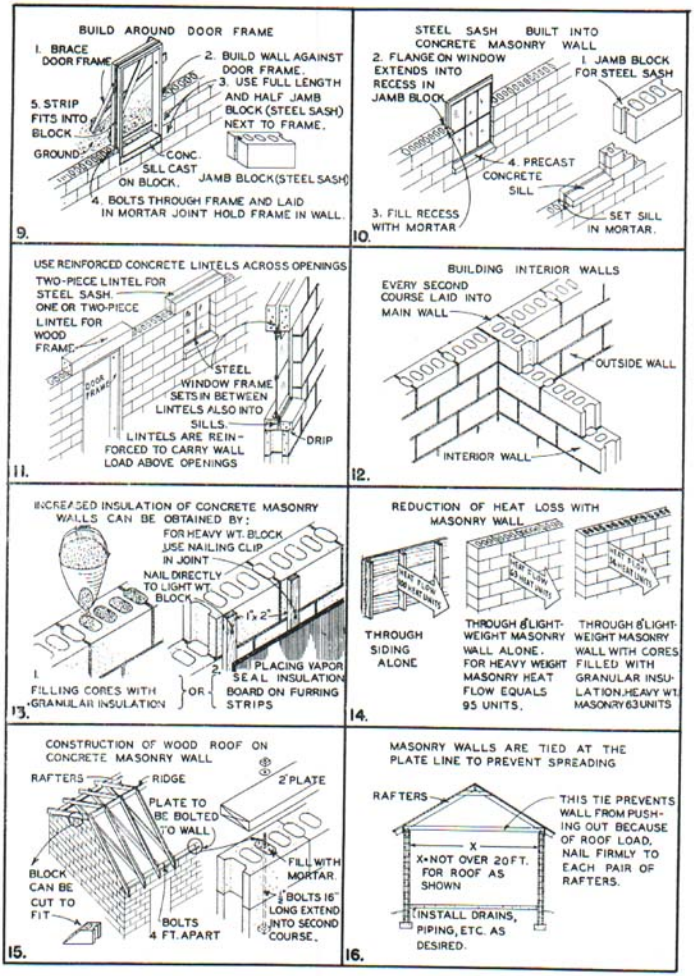

Fig. 5. Details of masonry wall construction—(Continued).

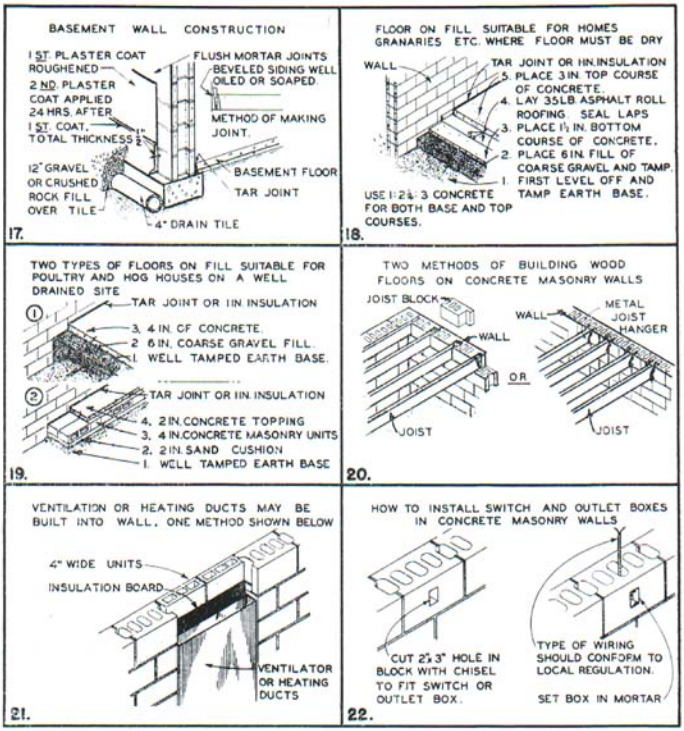

Fig. 5. Details of masonry wall construction—(Concluded).

SELECTING THE PROPER DIMENSIONS FOR MASONRY BUILDINGS

The most economical construction is based on the selection of wall heights and lengths to fit the dimensions of the blocks without cutting. In the same way, the location, width and height of rough openings should be planned to start and finish at even block heights. If the following tables showing the number of blocks required for any desired dimension are carefully observed such unnecessary cutting and fitting can be eliminated.

TABLE 4—*Number of standard length 16-inch (actual length 15¾) blocks required, using a ¼-inch mortar joint*

Outside length of wall	Number of blocks	Outside length of wall	Number of blocks
1′ 3¾″	1	13′ 4″	10
1′ 11¾″	1½	14′ 0″	10½
2′ 7¾″	2	14′ 8″	11
*3′ 4″	2½	15′ 4″	11½
4′ 0″	3	16′ 0″	12
4′ 8″	3½	16′ 8″	12½
5′ 4″	4	17′ 4″	13
6′ 0″	4½	18′ 0″	13½
6′ 8″	5	18′ 8″	14
7′ 4″	5½	19′ 4″	14½
8′ 0″	6	20′ 0″	15
8′ 8″	6½	26′ 8″	20
9′ 4″	7	33′ 4″	25
10′ 0″	7½	40′ 0″	30
10′ 8″	8	46′ 8″	35
11′ 4″	8½	53′ 4″	40
12′ 0″	9	60′ 0″	45
12′ 8″	9½	66′ 8″	50

*NOTE: By increasing the thickness of only two of the vertical joints by ⅛ inch each, the wall lengths from this point down are multiples of 8 inches, or half blocks.

TABLE 5—*Number of standard height 8-inch (actual height 7¾) blocks required, using ¼ and ⅜-inch mortar joints*

Number of blocks	Height of wall mortar joint ¼ inch	Height of wall mortar joint ⅜ inch
1	8″	8⅛″
2	1′ 4″	1′ 4¼″
3	2′ 0″	2′ 0⅜″
4	2′ 8″	2′ 8½″
5	3′ 4″	3′ 4⅝″
6	4′ 0″	4′ 0¾″
7	4′ 8″	4′ 8⅞″
8	5′ 4″	5′ 5″
9	6′ 0″	6′ 1⅛″
10	6′ 8″	6′ 9¼″
11	7′ 4″	7′ 5⅜″
12	8′ 0″	8′ 1½″
13	8′ 8″	8′ 9⅝″
14	9′ 4″	9′ 5¾″
15	10′ 0″	10′ 1⅞″
16	10′ 8″	10′ 10″
17	11′ 4″	11′ 6⅛″
18	12′ 0″	12′ 2¼″
19	12′ 8″	12′ 10⅜″
20	13′ 4″	13′ 6½″
25	16′ 8″	16′ 11⅛″
30	20′ 0″	20′ 3¾″
35	23′ 4″	23′ 8⅜″
40	26′ 8″	27′ 1″
45	30′ 0″	30′ 5⅝″
50	33′ 4″	33′ 10¾″

HOW TO USE THE TABLES

TABLE NO. 4: To find the number of standard 16-inch long blocks required for any length in half-block multiples, up to and including 20 feet, read the figure opposite the length in Table 4. To find the number of blocks in a 43'-4" building, for example, find the number required for a length of 40'—which is 30 blocks, then add the number required for a 3'-4" length, or 2½ blocks. The total blocks required then equals 30 plus 2½ or 32½ blocks.

TABLE NO. 5: To find the number of standard 8-inch high blocks in a wall of any multiple block height up to and including 13'-4" read direct from Table 5 the figure in the proper column, depending on the thickness of the mortar joints used. The number of blocks for higher walls can be obtained by adding the number required for several lower walls. For example, a building 16' high would require 9 blocks for a height of 6', plus 15 blocks for a height of 10' for a total of 22 blocks for a height of 16 feet.

It should be observed that all lengths are in multiples of 4" and all heights in multiples of 8" and that it is not always possible to have dimensions in even feet without cutting blocks.

Plans, further details, and instructions for building various types of concrete masonry farm buildings can be obtained from your county agricultural agent, or from the Agricultural Engineering Department, Michigan State College, East Lansing.

Fig. 6. Concrete blocks can be used to good advantage in the construction of farm houses.

Fig. 7. Single-story dairy barns of concrete block construction are fire-resistant and serviceable.

BUILDING TERMS APPLIED TO CONCRETE AND MASONRY CONSTRUCTION

AGGREGATE—Any material such as sand, gravel, cinders, crushed rock, etc., used together with cement and water to form concrete.

Coarse aggregate: Aggregate which is retained on a ¼" screen.

Fine aggregate: Aggregate which will pass a ¼" screen.

CEMENT PAINT—A mixture of specially prepared Portland cement in powder form to be mixed with water to desired consistency.

CONCRETE—A properly proportioned mixture of cement, aggregate and water.

Cast-in-place concrete: Concrete placed in formed sections in its permanent location.

Pre-cast concrete: Concrete building units cast in molds in advance of incorporation into a structure

CONCRETE MIX—(1 :2¼ :3) The proportion by volume of cement, fine aggregate and coarse aggregate, respectively. 1 cu. ft. (bag) of cement, 2¼ cu. ft. fine aggregate, 3 cu. ft. of coarse aggregate.

COPING—The top course of a wall so constructed as to shed water.

CURING—The retarded evaporation of water which facilitates proper hardening of concrete by the chemical reaction of Portland cement and water.

FLASHING—A lapped or flanged joint producing water tightness at joints.

FOOTING—Expanded base of any foundation or wall to provide bearing surface to support the weight of the superimposed load.

HEAVY-WEIGHT—A term usually applied to concrete masonry made from heavy-weight aggregate such as sand, gravel or crushed rock.

JAMB—The individual side or top member of a door frame.

LINTEL—A horizontal supporting member placed over window or door openings to carry the superimposed blocks. A split lintel is used for steel sash.

LIGHT-WEIGHT—A term usually applied to concrete masonry made from light-weight aggregate such as cinders, slag or burned clay.

MASONRY CONSTRUCTION—A term commonly used to denote an assembly of pre-cast concrete units in building construction.

MORTAR—A mixture of Portland cement, sand, and water. (A plasticising agent such as lime may be used.)

MORTAR JOINTS—

Face shells: A joint made by applying mortar to the surface of the interior and exterior shell only.

Full bedded: A joint made by applying mortar over the entire surface of the block.

Flush joint: A mortar joint flush with the face surfaces of the blocks.

Tooled joint: A mortar joint which has been finished with a shaping tool to provide a compact, indented joint.

PIER—A detached mass of concrete serving as a support.

PILASTER—A rectangular column with base forming part of a wall and employed as a supporting member.

PORTLAND CEMENT—A name given to a powder produced by calcining a mixture of limestone and clay. It was given this name because of the fact that it produced, when hardened, a yellowish grey mass resembling in appearance the stone found in various quarries on the Isle of Portland, England.

SILL—A horizontal member forming the foundation of a window or door frame.

STRETCHER—The over-all horizontal length of an individual concrete masonry block and one mortar joint.

STRETCHER COURSE—The horizontal extension of one layer of masonry units and joints.

STUCCO—A plaster or cement used for the heavy external coating of buildings.

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