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CONCRETE AND CONCRETE MASONRY CONSTRUCTION ON THE FARM

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Concrete and Concrete Masonry Construction on the Farm

By T. J. BREVIK[1]

Proper use of concrete in its many forms – as poured concrete or in concrete masonry units – can help make farm operations pleasanter and more efficient. In recent years, masonry units (concrete blocks, etc.) have become available in a variety of forms to make their use more flexible. The economy, durability, fire-resistance, and the minimum maintenance required have contributed greatly to the expanded use of concrete construction. This bulletin will aid you in obtaining well-constructed concrete and concrete masonry farm buildings.

MAKING QUALITY CONCRETE

Today, as in the past, much of the farm concrete made is produced by hit-and-miss methods. The result is that the quality is not what it could have been, had the mix been properly proportioned. "Good" concrete is noted for strength, durability, water-tightness, and economy – with "proper proportions" depending partly upon the intended use. So before actually starting concrete work, determine what it is to be used for. The needs of the job should then govern the particular proportions of the materials.

These steps are considered important in contributing to the quality of concrete:

1. Selecting materials.
2. Proportioning.
3. Mixing.
4. Placing.
5. Finishing.
6. Curing.

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Selecting Materials

Materials generally used are sand, gravel, and Portland cement. Each of these listed materials must be of the best quality in order to obtain a good concrete. Cement should be dry, powdery, and free from lumps. Any lumps that appear which cannot be readily pulverized by squeezing them in the hand, or tapping them lightly with a shovel, should not be used.

The aggregates (sand and gravel) should be clean and sharp and vary in size from fine to coarse, as shown in Figs. 1 and 2. The water that is used should be clean. A good rule is to use only water fit for drinking in making concrete.

Proportioning the Materials

Combining the materials in various amounts is known as proportioning. The old method was to establish a proportion between the aggregates and the cement, and then add water freely until the mix looked about right. It has been found through research and experience that a better quality concrete can be made, and the mix more accurately controlled, if a proportion is established between the water and the cement. The aggregates are then added until the mix becomes stiff enough for the use desired.

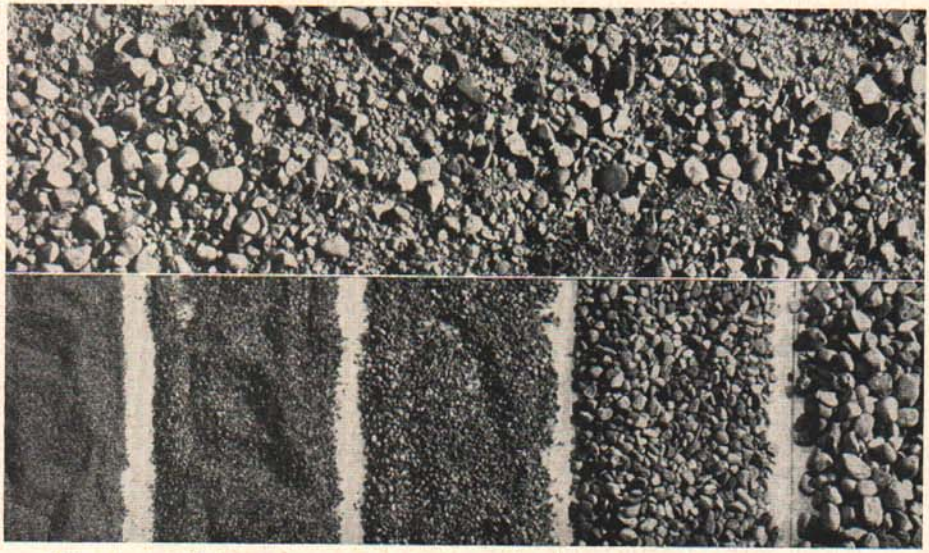

Fig. 1. Well-graded sand, before and after being separated into various sizes. Particles vary from fine to those that will just pass through a No. 4 sieve.

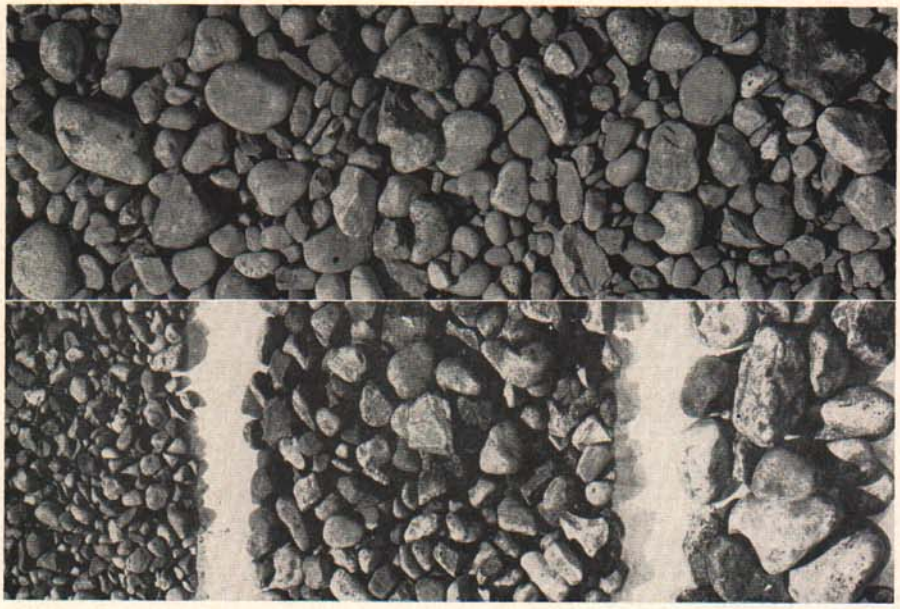

Fig. 2. Well-graded gravel. This is how the coarse aggregate looks before and after being separated, the three sizes running (left to right) ¼″ to ⅜″, ⅜″ to ¾″, and ¾″ to 1½″. Smaller pieces should fit in well among the larger ones in a good mixed aggregate.

For most jobs about 6 or 7 gallons of water per sack of cement are required to obtain required strength. In general, the less water used, the stronger the concrete. However, the less water used, the less aggregates the batch will hold; therefore, the expensive part, the cement, will not go as far. A mix that is too stiff will be difficult to handle.

A 5-GALLON MIX (5 gal. of water to a sack of cement) is recommended for fence posts, tanks, and concrete poured in thin sections.

A 6-GALLON MIX is recommended for watertight foundation walls, floors, and walks. A 7-GALLON MIX is recommended for thick foundation walls and footings.

The first batch of concrete should be a trial batch. The purpose is to establish the ratio between the different materials that go into making the concrete. The procedure is to select the water-cement ratio that will best fit the job. (See Fig. 3.) That is, how many gallons of water to use per sack of cement?

SIZE OF BATCH	Pints of mixing water to add to—		
	Dry Sand	Damp Sand	Wet Sand
6 gallons of water per sack of cement			
1/2 sack	24 pts.	22 pts.	20 pts.
1/4 sack	12	11	10
1/5 sack	9 3/5	8 4/5	8
1/10 sack	4 4/5	4 2/5	4
7 gallons of water per sack of cement			
1/2 sack	28 pts.	25 pts.	22 pts.
1/4 sack	14	12 1/2	11
1/5 sack	11 2/5	10	8 4/5
1/10 sack	5 3/5	5	4 2/5

Fig. 3. Concrete mixing chart. Pints of water to add to the mixer for batches of concrete using 1/2, 1/4, 1/5 or 1/10 of a sack of cement.

Determine the capacity of the mixer and in turn the amount of cement (in fractions of a sack) in each mixer full. The volume of cement can be measured accurately in an ordinary 12- or 14-quart pail, or an old paint pail (Fig. 4). Mark in the pail the amount of cement that is to be used, and use this pail for measuring the cement for each batch. Use another pail and apply the same principles in measuring the water (Fig. 5).

Sand and gravel can be measured by shovelfuls (Fig. 6); the amount of each determined in the first mixer full (the trial batch) by adding shovels of sand and shovels of gravel until the desired mix is obtained. Keep count of the number of each that are put in. A good rule to follow for most concrete work is to use approximately 4 parts sand and 6 parts gravel. This makes a water-tight concrete that will finish well and be economical. To increase finishing qualities use 5 parts sand and 5 parts gravel.

One way of determining the consistency of concrete is to pour a small amount of the mix into a wheelbarrow and work it with a wood float (Fig. 7). If the concrete is soupy, and water and cement appear around the edges, it indicates that more sand and gravel should be added. If the batch appears harsh and coarse, too much coarse aggregates have been added. If it seems fine and sandy, it may contain too much fine material.

Fig. 4. Measure cement and keep that pail separate for use as the cement measure.

Fig. 5. After establishing the water measure to be used, mark it on the inside of the pail with a heavy pencil. Then use only for water.

Fig. 6. Measure sand and gravel by the number of shovelfuls.

After the proportion has finally been established, use those quantities for all succeeding batches.

Mixing the Materials

Mixing should continue for approximately one minute after all materials are in the mixer, in order that all aggregates become well coated with the cement-water paste.

Fig. 7. A well-proportioned concrete mix.

Placing Concrete

When transporting concrete between the mixer and the forms, material should be carefully handled. If the concrete is transported over rough ground, the coarse material may settle to the bottom and the fine come to the top. This is "segregation", and the mass of concrete will not be uniform throughout. A rubber-tired wheelbarrow is recommended, or one with steel wheels and a plank runway. Concrete should not be dropped more than 4 feet. If the drop exceeds 4 feet, a chute should be used.

When pouring a continuous wall foundation, care should be taken to get a good bond between the old and new concrete. That is, when pouring concrete start at one corner, and time the pouring so that you return to this corner within one hour's time. In so doing, you will insure a good bond between the two layers of concrete.

Concrete obtains its initial set within one hour, and should not be disturbed after this time.

Finishing Concrete

The finish given to a concrete floor will depend upon its use. A basement floor or milkhouse floor might best be smooth or finished

with a steel trowel. Gritty, slip-proof finishes are needed for concrete floors in cow stalls, sidewalks, and the like. After the concrete has been struck off flush, wait until the water sheen has disappeared. The waiting time may vary from ½ hour to as much as ½ day, depending on temperature, humidity and water content of the concrete.

Wood-float the surface to bring some of the fine material to the top, and then finish it with either a steel trowel or wood float – or a broom if a rougher finish is desired. As little finishing as possible to obtain the desired surface is important. Overworking the surface tends to bring the fine materials to the top; this gives a dusty surface, and one that will not wear too well.

If water stands on the surface of a poured concrete floor, the finish should be delayed until the water disappears. Or excess water may be brushed off with a broom. It is not good practice to dust the surface with a dry, powdery cement to soak up the water. If this practice is followed, the surface will probably develop hair-line cracks and in later use be dusty.

Curing Concrete

Proper curing of new concrete has a great effect on its ultimate strength and durability. Concrete which is permitted to dry out rapidly after placing will not reach its maximum strength and durability. Tests have shown that concrete improves in quality with age, provided moisture is present to aid in the curing process. The gain in strength is most rapid during the first few days after pouring. A curing period of 7 days is recommended for most concrete work. A longer period is desirable if practical under the conditions applying to the particular piece of construction.

Successful curing is achieved by keeping concrete moist. Flat surfaces, such as walks and floors, can be covered with straw or sand as soon as the surface will not mar easily. The covering material can be kept wet by sprinkling. Foundation walls can be cured by leaving the forms on, or by frequent sprinkling, especially if the weather is hot and dry. Old burlap bags or tarpaulins may be draped over walls, or other vertical concrete work, and kept wet for the specified time.

Fig. 8. A well-constructed footing should be flat on the bottom.

Fig. 9. Good building footings should be true dimension and level on top.

POURED CONCRETE WORK

Footings and Foundations

One of the most important parts of a building is a well-constructed footing. A footing which is too small to support the weight of the building may crack and affect the rest of the structure. Footings should be of uniform depth, flat on the bottom, and placed level so that foundation work and framing are easily accomplished (Figs. 8 and 9). Footings should extend below the frost line and rest on firm, well-drained soil. The width of the footing will depend upon the supporting capacity of the soil, as well as the weight of the building. In general practice, footings that are twice as wide as the thickness of the foundation wall and equal in depth to the thickness of the wall will support the weight of most farm buildings (Figs. 8 and 9).

Fig. 10. Compacting the gravel fill for a dry, warm floor.

Building Warm, Dry Concrete Floors

A good method for pouring warm, dry concrete floors is shown in Figs. 10-13. A 4-to-6-inch layer of coarse gravel fill is necessary to prevent soil moisture from reaching the concrete floor. A vapor barrier should be installed between the mortar coat and the concrete floor to prevent any moisture which does come up from below from reaching the surface.

Barnyards and Walks

A good concrete barnyard, and walks leading between buildings, goes a long way in making farm chores easier. When constructing either be sure to place them on a firm, well-drained soil.

Fig. 11. Placing the mortar coat.

Fig. 12. Laying the vapor barrier for a moisture-proof floor.

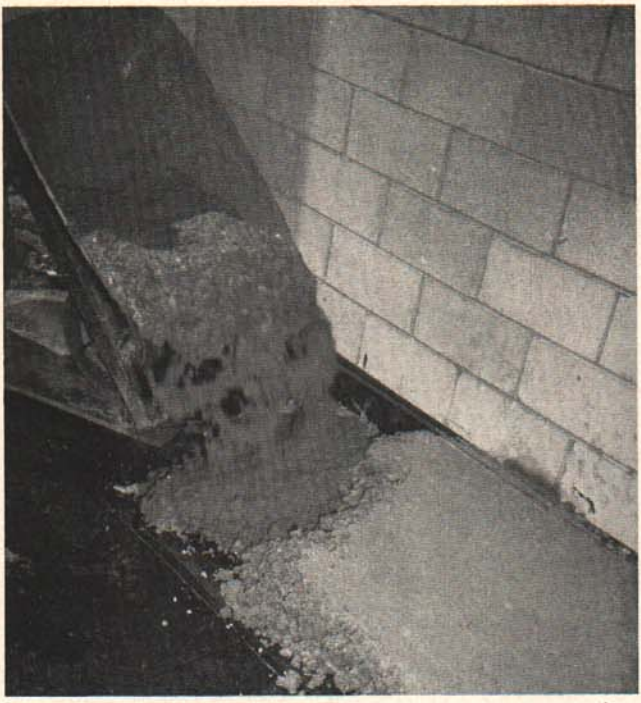

Fig. 13. Pouring the finish coat. Concrete should not be poured from a height greater than 4 feet without a chute.

If a barnyard has been severely trampled during wet weather, the top should be removed to firm ground and backfilled with gravel to build up the base so that the finished slab is above grade. The slab as well as the surrounding ground should have enough slope to carry surface water away.

Cold-Weather Concrete

Whenever possible concrete should be poured in above-freezing weather. (The best temperatures are between 50° F. to 70° F.). If it is necessary to pour concrete in below-freezing temperatures, certain precautions must be taken to prevent the fresh concrete from freezing. In near-freezing temperatures, heating the mixing water and the aggregates will usually do the job. When temperatures fall well below freezing, it may be necessary to provide some covering and heat for several days until the concrete has reached sufficient strength for the job intended.

Calcium chloride may be used to shorten the time the concrete needs to be protected against the cold. Calcium chloride causes the concrete to gain strength faster and is not considered to act as an anti-freeze, hence a shorter protection period is required. Not more than 2 pounds of chloride dissolved in the mixing water should be added for each sack of cement used.

CONCRETE MASONRY CONSTRUCTION

Sizes and Shapes

The most popular masonry unit is the so-called concrete block. Blocks are available in many different sizes, which in most cases are nominally 16 inches long and 8 inches high (Fig. 14). The widths vary from 2 inches to 12 inches, in 2-inch multiples. The actual size is ⅜″ less than nominal, so that a standard 8-inch concrete block measures 7⅝″ high, 7⅝″ wide, and 15⅝″ long.

When these blocks are laid in a wall, the mortar joints should average ⅜″ thick. They will then occupy a wall surface area 8 inches high and 16 inches long. These are sometimes referred to as modular blocks. They are designed to fit conveniently into the wall and reduce cutting to a minimum. A building with dimensions in multiples of 8 inches can be constructed with whole and half-blocks, which eliminates cutting.

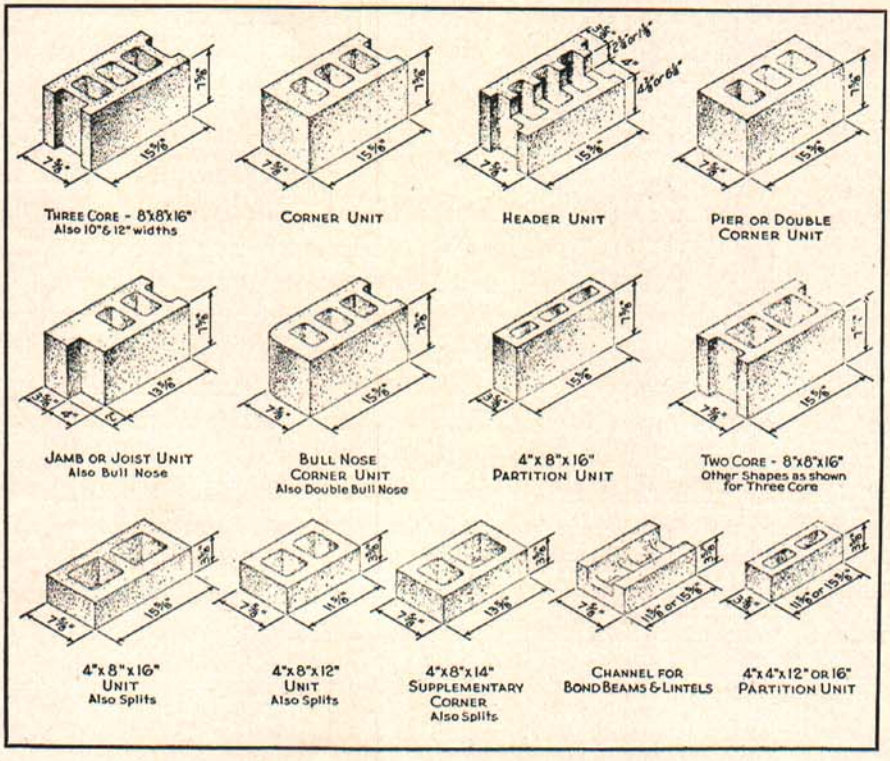

Fig. 14. Sizes and shapes of concrete masonry units.

Aggregates

Sand and gravel are the most common aggregates used in making concrete block. Other materials are used to obtain a unit which is light in weight and has greater insulating value. In certain sections of the country cinders, pumice, blast-furnace slag, and burned clay are used. Lightweight units have about 25 percent better insulating value than those of sand and gravel. A lightweight block weighs about 30 pounds; a standard 8″ x 8″ x 16″ about 45 pounds.

For certain uses, surface texture is important. The texture of various types of units vary. Lightweight units being relatively rough, when used for a room interior (houses) give a rather pleasing appearance.

Quality of Concrete Masonry Units

When buying concrete masonry products, it is well to purchase them from the manufacturer or retailer who is known to handle good merchandise. Units that are well manufactured will be square with straight edges and can easily be laid up into a neat-appearing wall.

The quality of concrete blocks is measured by compressive strength, water absorption, and the moisture content when blocks are placed in the wall. The strength, absorption, and the dryness of the units should meet the specifications of the American Society for Testing Materials. A block dealer who handles quality merchandise will most likely adhere to these requirements.

Mortar to Use

Concrete masonry walls subject to average loading and exposure are generally laid up with a mortar consisting of one part of masonry cement, and between two and three parts of mortar sand. The cement used should be free of lumps. The sand that is used should be sharp, clean mortar sand, varying in size from 1/16″ in diameter on down to very fine. A perfectly good mortar can be made using one volume of Portland cement and about one to one-and-a-quarter volumes of hydrated lime, adding to this four to six volumes of damp, loose mortar sand.

In cases where walls are subject to heavy loading or wind pressures, it may be necessary to increase the strength of the mortar used. This can be done by the addition of small quantities of Portland

cement. One recommended mixture is to use one volume of masonry cement plus one volume of Portland cement, and four to six volumes of damp, loose mortar sand. Or, if masonry cement is not available, a combination of hydrated lime and Portland cement can be used. A recommended mixture for this is one-quarter volume of hydrated lime, one volume of Portland cement, and two to three volumes of damp, loose mortar sand.

With the above-mentioned mixes, add enough clean water so the mix is plastic and workable and will stick well to the blocks.

Estimating Quantities of Block

The number of concrete masonry units required in a particular building can easily be determined. Multiply the number of blocks required in one row around the building by the number of rows. To find the number of standard 16-inch blocks required for one row, measure the lineal distance in feet around the top center of the wall, and multiply this number by ¾.

Or, determine the perimeter of the building in feet, subtract ⅓ foot for each corner, and then multiply this number by ¾. To determine the number of rows required for a given height, multiply the height in feet by 3/2. This method of estimating does not make any allowance for window or door openings or any allowance for waste. Figure 15 gives information on the number of blocks required for several conditions.

MATERIALS FOR 100 SQ. FT. OF MASONRY WALL

	*H W L	H W L	H W L	H W L
Standard block size†.....	8"x8"x16"	8"x4"x16"	4"x8"x16"	8"x12"x16"
Wall thickness	8 in.	4 in.	8 in.	12 in.
Number of blocks needed	113	113	226	113
Cubic feet of mortar‡	3½ cu. ft.	3½ cu. ft.	6 cu. ft.	3½ cu. ft.

*H = height W = width L = length

†Actual size of blocks is 7⅝" high, 7⅝" wide, and 15⅝" long on an 8 x 8 x 16 block. Other sizes are also ⅜" less in all actual dimensions than shown on the chart.

‡Mortar applied to the face shells only (not on the cross-webs).

Fig. 15. The materials required for 100 square feet of concrete masonry wall. The chart shows four of the most commonly used sizes in standard blocks.

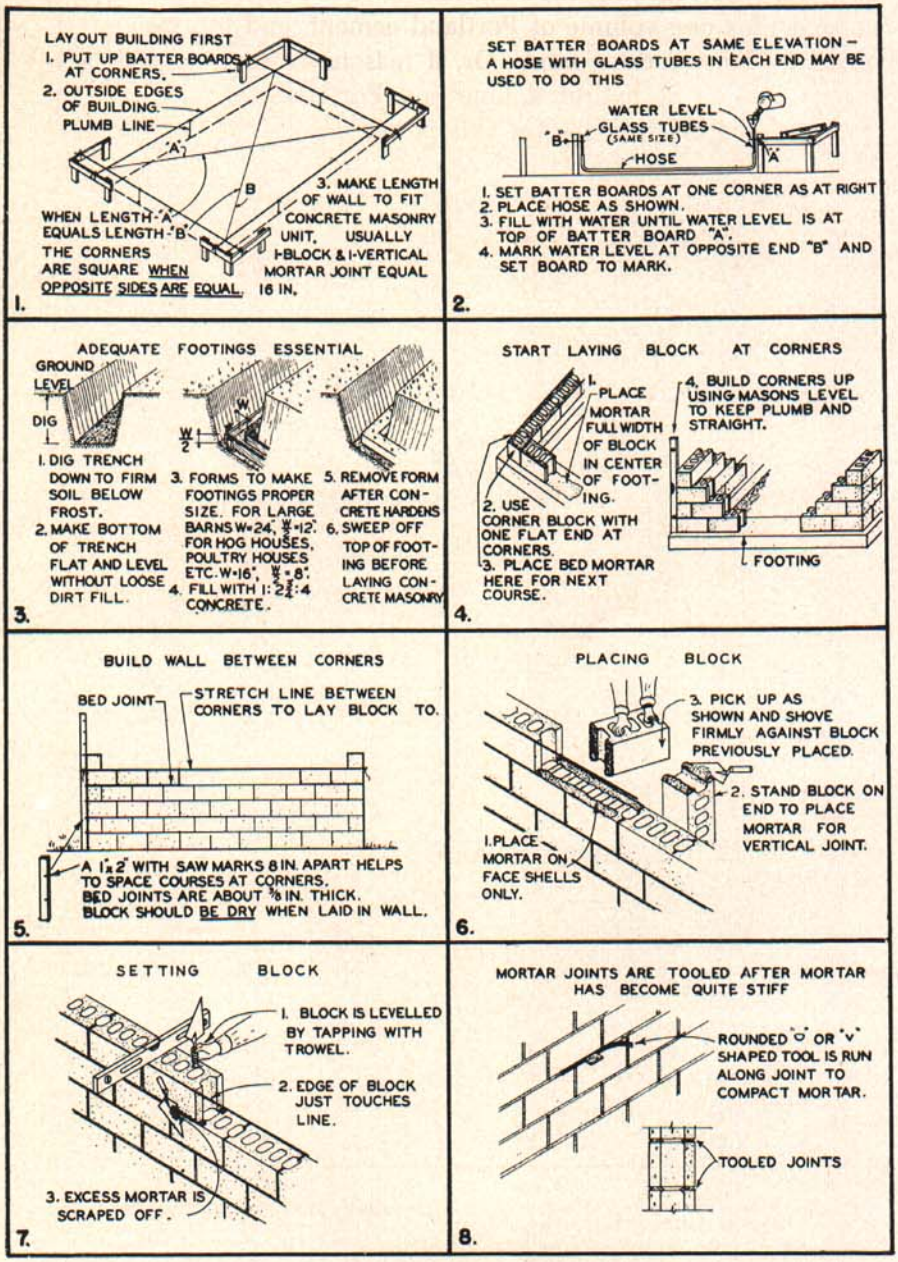

Fig. 16. Details of concrete masonry wall construction.

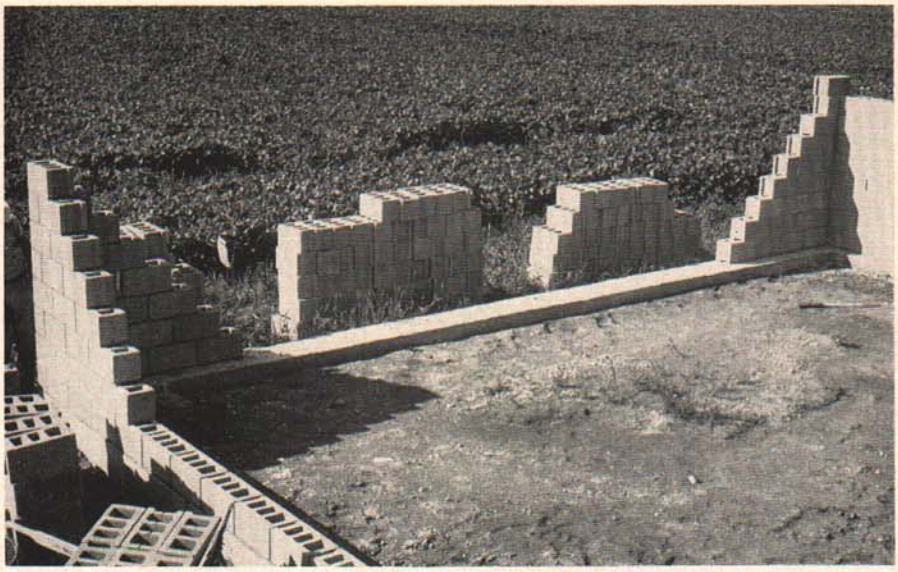

Fig. 17. Corners laid up, ready for filling in the wall.

Laying Block

Prior to laying block, it will be necessary to have an accurate and level layout of the building. The footings upon which the blocks rest should be flat and level. The procedure used for building layout, constructing footings, and laying block is outlined in Fig. 16.

The first step in actually laying block is to locate accurately all corners. Start by laying the corners four to five rows high, then fill in between (Fig. 17). Use a chalk line stretched between corners as a guide for lining up the rows of blocks (Fig. 18).

Fig. 18. Using a chalk line to line up the rows of blocks between the corners.

Whenever an experienced mason builds corners, notice that he frequently uses the level to make sure the structure is plumb and level, and that the height of the various corners are staying on a level line.

When several rows have been laid, the mortar joints should be tooled. This compacts the mortar, makes the joint more water tight, and gives a neat-appearing job. Tooling patterns are shown in Fig. 19.

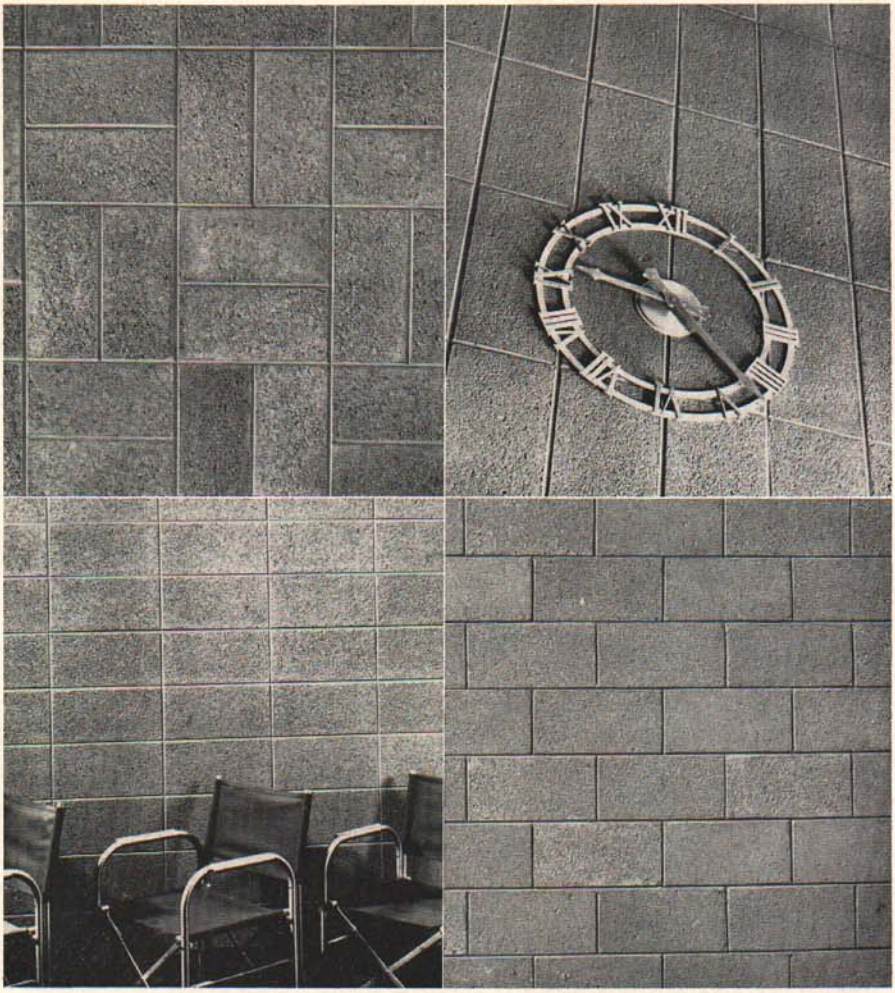

Fig. 19. How wall patterns can be obtained by different arrangements of concrete masonry units and by tooling the joints in various ways.

Insulating Masonry Walls

Farm buildings housing livestock and poultry may require additional insulation to conserve animal heat in the winter, and to help keep the buildings cool in the summer. Figure 20 illustrates methods

SECTION	DESCRIPTION	INSULATING VALUE
1 U=.70	8" solid concrete-plain wall.	1.43
2 U=.629	8" concrete block-plain wall.	1.89
3 U=.339	8" hollow cinder block-plain wall.	2.51
4 U=.173	8" cinder furred 25/32" rigid insulation.	5.78
5 U=.782	8" cinder block, 4" shavings, paper and 1/2" boards.	12.77
6 U=.195	8" cinder block, furred, 1/2" rigid insulation and 1/2" plaster.	5.13

Fig. 20. Insulating values for concrete masonry construction.

of insulating block walls and their comparative insulating values. For example, wall section No. 5 has 6 times more insulating value than wall section No. 2.

Before insulating sidewalls built of concrete masonry, other sources of heat loss should be checked. Quite often more heat may be lost through openings around poorly fitted doors and windows, and poorly insulated ceilings. If this is the case, the sources of heat loss around

windows and doors should first be corrected before attempting to insulate the sidewalls.

Almost any type of commercial insulation is satisfactory. However, in buildings where high humidity exists, it is well to make sure that a proper vapor barrier has been installed along with the insulation. A positive vapor barrier prevents moisture from entering the insulation and condensing, thus decreasing the effectiveness of insulation and damaging the building. A properly insulated building will be easier to heat, easier to ventilate, and will be much dryer.

Surface Treatment of Concrete Block Walls

Construction of a water-tight masonry wall below-grade is shown in Fig. 21. This method should be followed if there is a high moisture condition in the soil, and you desire a dry basement.

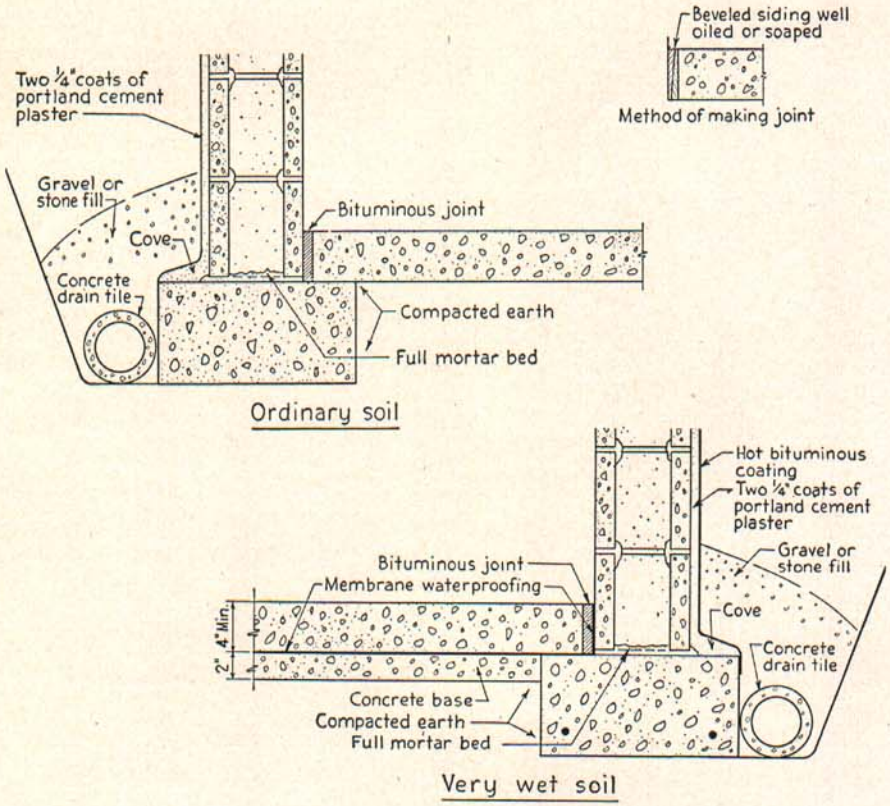

Fig. 21. Recommended construction for dry basements, in ordinary soil (above) and very wet soil (below).

Portland cement base paint is one of the more easily applied and satisfactory paints to be used on above-grade masonry surfaces. This paint, when mixed with water and properly applied, bonds directly to the concrete. The instructions for mixing usually are contained in the package.

The surface to be covered should be dampened just prior to application of the paint. A curing period during which the surface is kept damp should be allowed for at least 24 hours after applying the paint. The type of brush used for application is a long, coarse-bristled brush similar to a scrub brush.

Anchoring Buildings to Masonry Walls

One of the weak points in farm building construction is the anchorage between a concrete masonry wall and the framework. Common practice is to attach a 2″ x 6″ or a 2″ x 8″ plate to the tops of masonry walls (Fig. 22). The wood plates should be anchored to the wall with half-inch bolts 12 to 16 inches long. These bolts should extend well into the second row of blocks. They should be spaced about 4 feet apart, with the threaded end up.

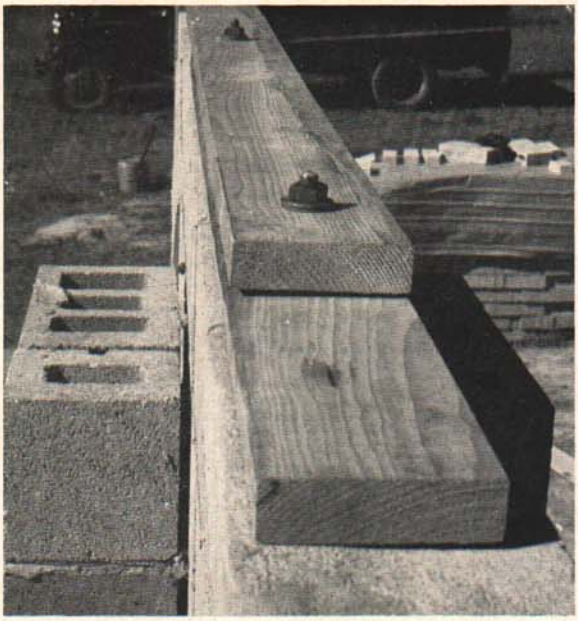

Fig. 22. Wooden plate in place on top of concrete masonry wall, anchored by ½-inch bolts.

Fig. 23. A two-story dairy barn with an attached milkhouse of concrete masonry.

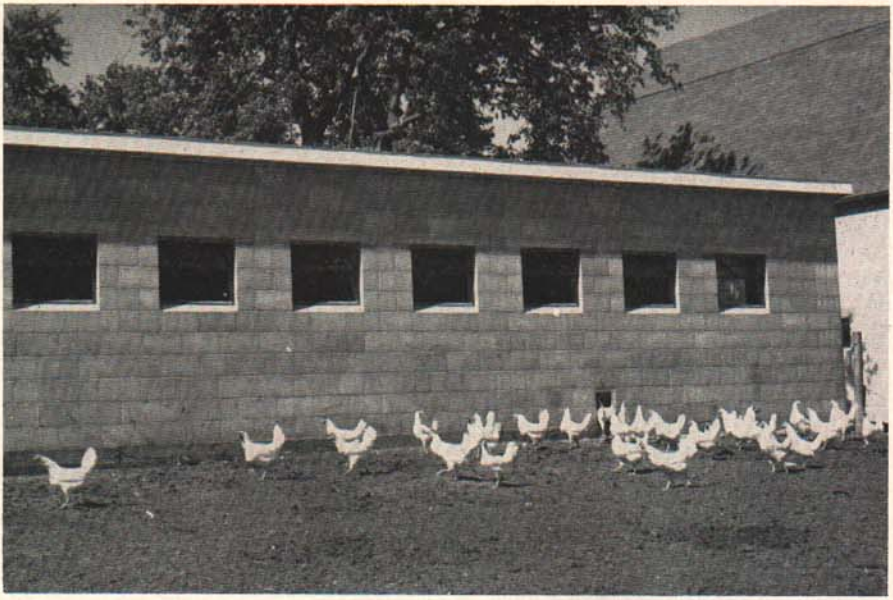

Fig. 24. A concrete masonry poultry house.

Fig. 25. Liberal and attractive use of concrete masonry around a one-story dairy barn.

In areas of high wind it may be desirable to extend the anchor bolt to the footing. The bolts are held in place by concrete poured in the core of the blocks. This can be done by padding the core of the block below 16″ with paper, and then filling the core with concrete and placing the bolt head down in the core. The thread end of the bolt should extend high enough above the wall so that it will project through the plate.

When securing the plate, the nut on the anchor bolt should not be tightened too tightly, as this might cause a crack in the wall.

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. Figures 23-25 show typical farm construction.

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