COOPERATIVE EXTENSION WORK
IN
AGRICULTURE AND HOME ECONOMICS
STATE OF OKLAHOMA

ERNEST E. SCHOLL, Director

OKLAHOMA AGRICULTURAL AND
MECHANICAL COLLEGE AND
UNITED STATES DEPARTMENT OF
AGRICULTURE, COOPERATING

EXTENSION SERVICE
COUNTY AGENT WORK
STILLWATER, OKLAHOMA

Distributed in Furtherance of the Acts of Congress of May 8 and June 30, 1914

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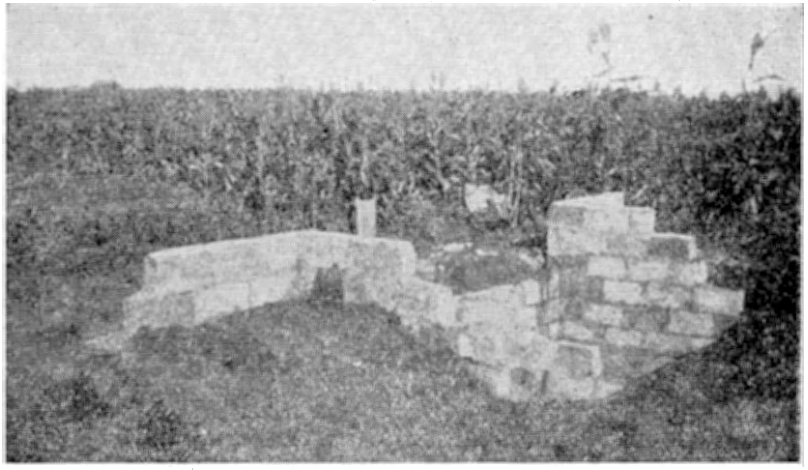
W. H. McPHETERS
Extension Agricultural Engineer



Baffles Made of Concrete Units

Circular No. 328 Reprint, 1937 General Series 103

BAFFLES FOR TERRACE OUTLET CONTROL

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When the water from one or more terraces is concentrated in an outlet ditch, its ability to wash away soil is increased because the volume of water is increased and the rate of movement down the slope is greater. Something is needed to protect the ditch from being washed out into a gorge.

A structure placed in the terrace outlet ditch for this purpose is referred to in this bulletin as a "baffle." The term "check" or "drop" might have been used instead; however, the term baffle has become familiar throughout the state and is generally used in the soil erosion control program.

Uses and Importance

The prinicpal use of the baffle is in the terrace outlet ditch to step the water down the hillside and reduce its velocity so it will not cut a deep gully. Water discharged from a number of terraces into a single ditch will soon cause the ditch to become a large gorge if it is not protected in the beginning. On very gradual slopes where the water can be spread over a wide area the ditch can often be protected by vegetation. The upper end of the ditch, where the first two or three terraces empty, may be protected by vegetation, and baffles used in the lower part of the ditch where water accumulates in such quantities that the vegetation will not protect the ditch. See Fig. 1.

The second, a special use of the baffle, is to let the water from the end of a terrace to a lower level, to keep the water from cutting a gully back into the field along the terrace channel.

WHERE TO PUT THE BAFFLES

The proper place to put the baffle in the outlet ditch is just below where the terrace discharges its water into the ditch. By this method the bottom of the outlet ditch is level with the terrace outlet. The water in the outlet ditch then drops over the baffle to about the level of the terrace below and flows slowly along the nearly level ditch to the next terrace, and so on down the hill.

A great deal of excavating can be saved by putting the baffle in the ditch at "A" one vertical foot lower down the hill than where the terrace line enters at "B," as shown in Fig. 1. By building the baffle one foot above ground, or to the level of the terrace outlet, one foot of excavation for the baffle is saved. A lot of excavation in the ditch below the baffle at "C," Fig. 1, is also saved. Since the top of the baffle wall extends a foot above the bottom of the ditch a space is available for part of the dirt removed from the ditch at "C," just below the baffle above. When this space is filled with dirt there is a portion of level ditch between the terrace outlet and the baffle. In many cases the terrace will curve down hill to the baffle and must necessarily be built a foot higher. This affords a place for more dirt that has to be removed from the ditch. By using the dirt removed from the ditch in this manner the ridges of dirt placed on the side of the ditch are eliminated. This is of great benefit, because a ridge of dirt along the side of a ditch interferes with contour farming.

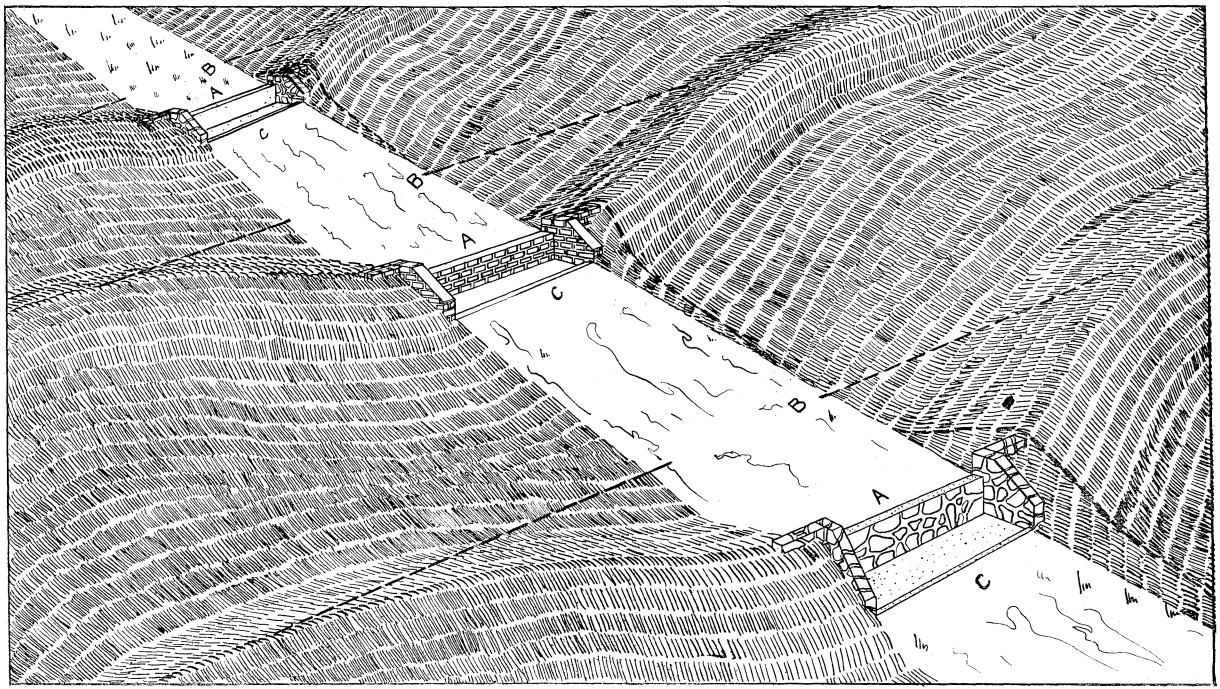


Fig. 1.—Showing how to locate the baffles in the terrace outlet ditch. The baffles, "A," are located one vertical foot below "B," where the terrace lines enter the ditch. The ends of the terraces are shown curved out of their natural course to connect with the baffles. The lower ends are built extra high to make up for the baffles being a foot low. The portion of the ditch above the top baffle is protected by vegetation.

KINDS OF BAFFLES

1. Baffles may be made of concrete units as shown in Fig. 2 and in the frontispiece. This is the only type that is discussed fully in this bulletin, because of its simplicity and low cash cost.

2. Where hard native rock is available baffles may be made of rock instead of the concrete units, using the same design. See the lowest baffle in Fig. 1.

3. Similar baffles may be made of monolithic concrete by the use of forms. The principal objection to this type is the high cost.

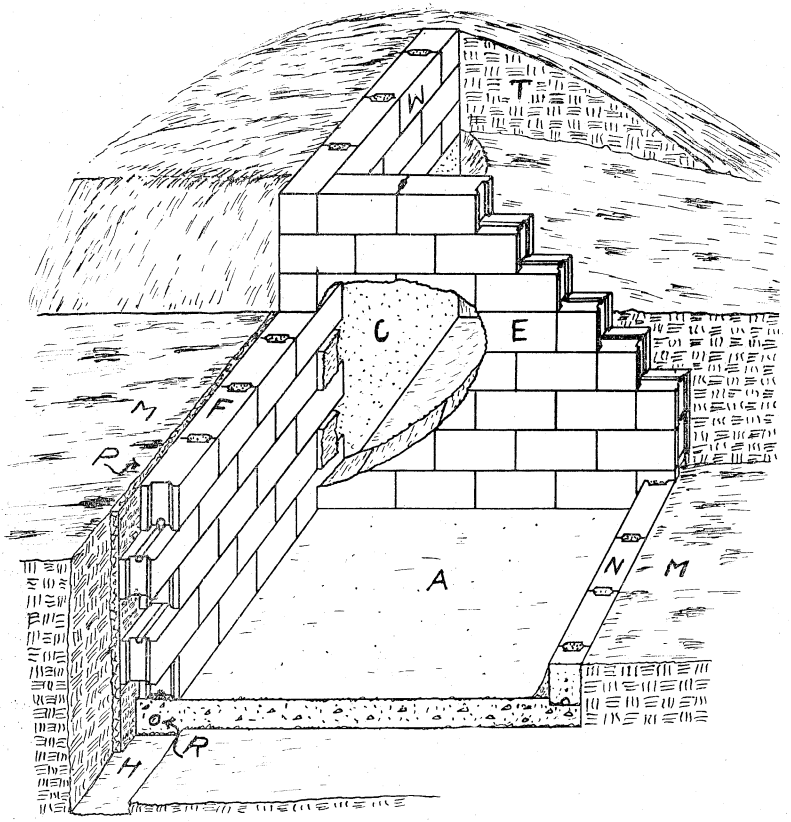


Fig. 2.—This is a section of a baffle showing the excavation and how the concrete units are put in. "W" is the upper part of the wing wall built of concrete units. "C" is the lower part of the wing wall, made by pouring concrete into the narrow excavated channel cut back into the bank. It should extend back 3 to 4 feet. "E" is the end or buttress wall. "M" is the bottom of the ditch. "A" is the concrete apron. "N" is the lip to create a basin of water on the apron. "P" is puddled clay poured back of the wall so no water can start undermining the wall. "R" is a reinforcing rod. "T" is a section of the terrace.

4. The back wall may be cast and the end and brace walls made of rock or concrete units. See upper structure Fig. 1.

5. Baffles may be made of concrete without the use of forms by sloping the abutment walls and reinforcing with hog wire. This type of baffle is satisfactory and can be built at a low cost, but the method of construction will not be taken up in this bulletin because of lack of space.

6. **Temporary methods** of ditch protection are: Loose rock dams, generally necessary to sod with grass; brush dams; log dams; hog wire and straw dams, which are probably the best of the temporary baffles.

7. **Spreader boards.** A spreader board is a board sunk into the ground about a foot deep, with its upper edge level and flush with the surface of the ground. The board should be placed squarely across the ditch. The purpose of the spreader board is to cause the water to spread evenly over a wide flat ditch and to hold the soil while grass sod is getting started. Planks may be used, or, better, use a narrow strip of concrete curb three inches thick and twelve inches deep. This is sufficient and will generally cost less than lumber, and is permanent. These spreaders should be placed at not over one foot vertical intervals or, better, at six or eight inch vertical intervals. They are not satisfactory for large quantities of water or on steep slopes.

FORMS FOR MAKING THE CONCRETE UNITS

The forms for making the concrete units are shown in the working plan in the center of this circular. (Pages 8 and 9.) A portion of the form is shown assembled, ready to place the concrete. Letters used in the following description refer to parts of the form thus designated in the working plan.

The base is made by nailing two 1″x6″ boards, "NN," or a 1″x12″ board to the 2″x4″ supports, "A." This base may be six feet long. There is a support, "P," at each end, made up of three 2″x4″ pieces and one 1″x4″ board bolted together. This base is really the pallet on which the bricks or units have to remain at least 12 hours before removing. The rest of the form may be removed within 20 to 30 minutes.

The four pieces of 1″x4″ boards, "B," are removable. They must be perfectly straight. These boards are held in place by the screw clamps "M." Their purpose is to hold the end partition "F" in a vertical position. The partitions "E" are made of 1″x6′ boards, two feet long with one end hewed off for a handle. They should be perfectly flat and straight. They are the partitions between the brick. The entire form should be well oiled. The partitions "E" and "F" should be soaked in oil. However, before using, they should be wiped off so no free oil is on the surface. When the forms are being used regularly, it is advisable to reoil occasionally.

The end partitions "F," may be any width, from 1¾ inches to 8 inches. Where the brick is to be used for baffles two to three feet high the partitions, "F," should be made of 1″x4″ boards. This makes the brick a little less than 4 inches thick. For a baffle wall that is higher, the blocks should be 6 inches thick, particularly for the lower half of the wall.

The partitions, "F," shown in the working plan have a ¼ inch board of less width nailed on the face to form a wide flat groove in the end of the brick or unit for an effective mortar joint. By leaving this ¼ inch piece off the partition, "F," regular smooth end bricks are made. This same type of form may therefore be used to make brick of any dimension to be used for constructing any farm building, as well as for baffles.

After all the partitions "E" and "F" are put in position and the support boards "B" clamped on, the partitions are tightened by means of two wedges "W." It is necessary that these be double wedges, as shown at the upper left corner of page 8. A single wedge would not tighten the partitions at the bottom, but the double wedge forms parallel sides and thus holds all the partitions vertical and tight. One half of each wedge may be nailed to the end support, if desired. Then it will be necessary to have one piece of the wedge as a removable part. When one desires to make quite a number of bricks in a day, it is advisable to make two sets of all movable parts of the form and as many of the base pallets as are desired to use for a day's work.

HOW TO PLACE THE CONCRETE AND REMOVE THE FORMS

After the forms are put together and tightened, as shown on pages 8 and 9, place the concrete in with a shovel. Do not fill more than half full before tamping. The mixture should be wet enough to stick to the hands, so that on tamping it will easily settle into place without excessive tamping. Be sure to tamp well at the ends of all the bricks. After all are filled about half full and tamped, fill to the top and tamp again. Strike off smooth with the tops of the partitions "E." In about 10 minutes tap the ends of the partitions "E" to break contact between the cement and partitions. After setting for about one-half hour, remove the wedges and pull all the partitions "E." If the bricks slump at all, a little longer period than a half hour may be necessary. After all the partitions are removed, loosen the screws "M," and remove the boards "B." Then carefully take off the end partitions "F," and leave the bricks on the pallets for at least 12 hours before removing. All the removable parts are now available to be used on another pallet.

THE PROPER MIX FOR THE CONCRETE

Where sand and crushed rock or gravel are available a mix of 1 part of cement, 3½ parts of sand, and 3 parts of crushed rock or gravel may be used. Where sand alone is available, use 1 part of cement to 4 or 4¾ parts of sand. Add sufficient water to make the mixture wet enough so that the concrete will not have to be pounded, as in making a complete tamped unit; yet, it should not be as plastic as concrete for regular uses. Where the mixture is too wet one has to wait too long before removing the partitions, "E." When the mixture is too dry too much labor is required in tamping. A few trials will teach one how much water to use.

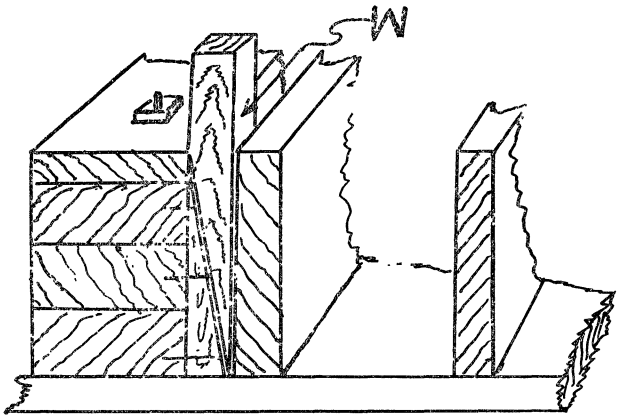
WORKING PLAN OF FORM FOR MAKING BRICKS (UNITS)

(See plan on pages 8 and 9)

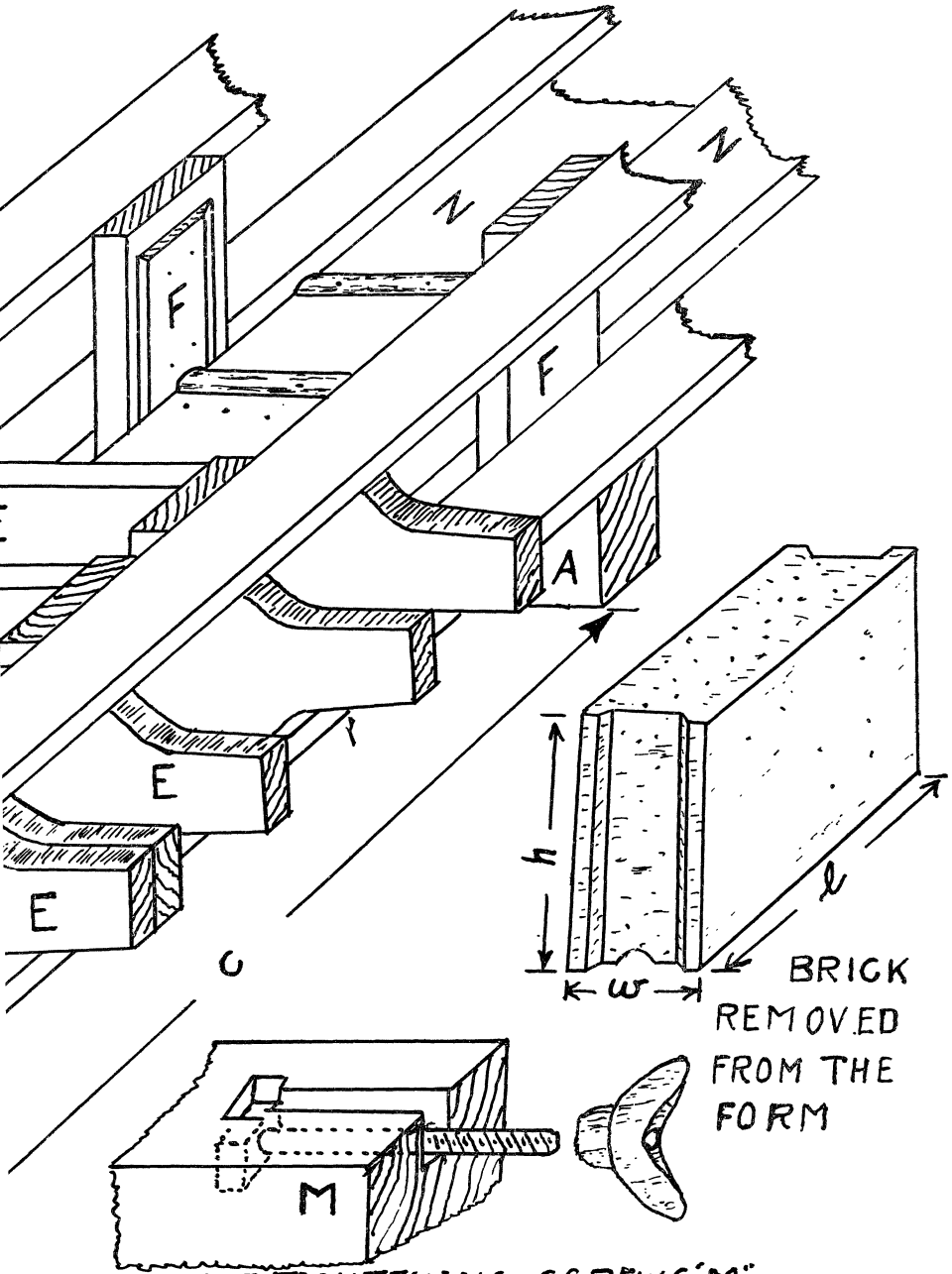
This plan shows portion of the forms for making the concrete brick. The base pallet is composed of two 1″x6″ boards, "NN," nailed to the 2″x4″ supports, "A." The distance, "c," between the supports should be about 16″. One 1″x12″ board may be used instead of the two pieces of 1″x6″ boards, if desired.

The removable parts of the form are: Four straight pieces of 1″x4″ boards, "B"; the end partitions, "F"; and the partition, "E." The wedges "W" are for the purpose of tightening the form; and the screws, "M," are for holding the boards, "B," tightly against the end partitions, "F."

A finished brick is shown removed from the form. The height, "h," should be 6″. The length, "l," is generally 12″, but may be longer if desired. The width, "w," may vary from 1¾″ to 6″ or 8″. For the average height baffle it is generally the width of a 1″x4″ board.



DETAIL DRAWING OF THE TIGHTENING WEDGES "W"



ETAIL OF THE TIGHTENING SCREWS 'M"

When the bricks have hardened sufficiently to remove from the base pallet, take them off and carefully stack them in a pile; then cover them with straw or hay, and wet them down every day or so for at least a week —the longer the better. They are then ready for use.

LAYING OUT THE BAFFLES

Locate the baffle in the outlet ditch at "A," Fig. 1, one vertical foot lower down the hill than where the terrace enters the ditch, at "B." This may be a fifth to a fourth of the distance down hill to the next terrace. Building the back wall of the baffle a foot above the level of the ground will then cause the ditch to fill up level with the terrace outlet. This pocket above the baffle, and the extra height of the end of the terraces that curve down to the baffle will furnish a place to put the dirt that it is necessary to remove from the ditch just below the baffle above at "C." Building the baffle a foot higher than the bottom of the ditch saves excavation, and also means that the ditch does not have to be dug so deep.

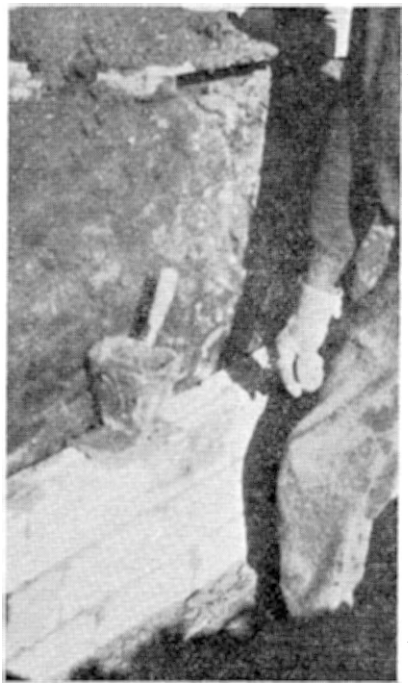


Fig. 3.—Shows the mortar being put in the vertical joints with the aid of a small mule.

EXCAVATING FOR THE BAFFLE

The height of the baffle is a few inches less than the vertical spacing between terraces. The width of the apron is determined by adding 1½ feet to the height of the baffle. For example, if the baffle is 3 feet high the width of the apron will be 1½+3, or 4½ feet wide, the 1½ feet being the

depth of the notch, that is, the end walls should be 1½ feet above the wall over which the water flows.

The length of the baffle is determined from Table I. Determine the approximate acres of land that drain through the baffle and look this acreage up in the column "acres drained." The length of the baffle in feet will be given opposite it under the column "length of baffle." Remember that each baffle must carry the water from all the field above it. For example, the baffle just below the fifth terrace must be made large enough to take care of all acreage above the fifth terrace.

With these dimensions, lay out the baffle and excavate, allowing for thickness of walls and floor. The back wall and ends should be kept nearly vertical. The wing walls should be dug back at least three feet, keeping them as narrow as possible as shown at "W" and "C," Fig. 2. By using a grubbing hoe they may be kept down to three inches wide. Fig. 2, assuming the wall is not laid, shows the excavation. A footing 6 or 8 inches wide and 4 to 6 inches deep should then be dug in the bottom of the excavation around the wall. See "H," Fig. 2.

SIZES OF BAFFLES

The dimensions in Table I are based on C. E. Ramser's curves for hilly cultivated land, with a depth of notch in the baffle of 18 inches, and for a maximum rain once in 10 years. In most of the table the acres are grouped and the approximate average lengths given rather than a length for each added acre.

The cost of a small baffle is proportionately more than for a larger baffle, because the wing and end walls are the same, regardless of the length of the baffle. See Table II and cost data.

TABLE I.—Length of baffles for various drainage areas.

Drainage Area Acres	Width of Baffle Feet	Drainage Area Acres	Width of Baffle Feet
3	3	35- 40	24
4	4	40- 45	26
5	5	46- 50	28
6	6	51- 55	31
7	7	56- 60	33
8	8	61- 65	36
9	9	66- 70	39
10-12	10	71- 75	41
13-15	13	76- 80	44
16-19	15	81- 85	46
20-23	17	86- 90	48
24-27	19	91- 95	50
28-31	20	96-100	52
32-35	22		

LAYING THE WALLS AND APRON

Make the apron of concrete about 4 inches thick. This may be reinforced with hog wire. Where hard rock is plentiful the apron may be made by pressing rock into the concrete. This saves sand and cement. The back wall and end walls are then laid up with the concrete units. Fig. 2 shows how the end walls tie into the back wall. When all the walls are built up to the level of the back wall, pour concrete into the wing wall nearly to ground level, then finish the wing and end walls with the brick to 18 inches above the back wall as shown in Fig. 2. Figs. 3, 4, 5, and 6 show the steps in laying the wall.

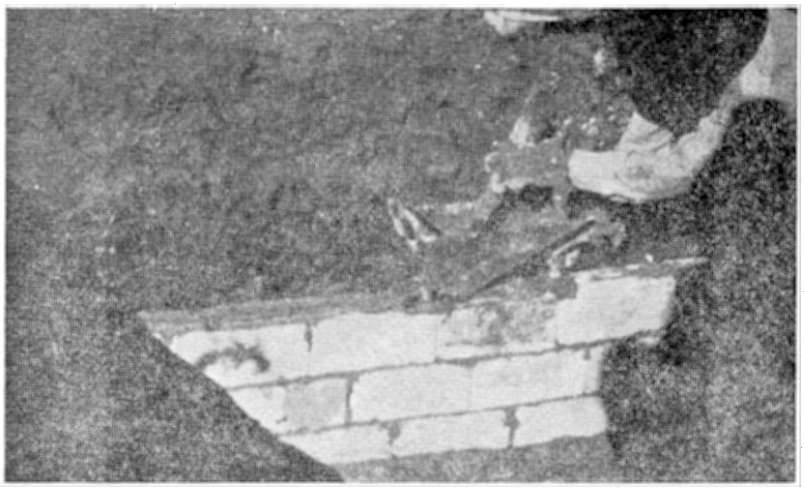


Fig. 4.—Shows the mortar being spread on the wall with the aid of a large mule.

Fig. 5.—Shows the brick being laid in place following the spreading of the mortar. After pressing the brick in place the mortar is cut off with the trowel.

A brace wall should be put in about every four feet. (Fig. 6.) A lip 4 or 5 inches high should be made on the front of the apron (Fig. 2), the top of the lip "N" being level with the bottom of the ditch "M." This gives a basin of water 4 or 5 inches deep in the apron to destroy the energy of the water falling over the baffle. This means that the pit must be excavated 8 inches below the level of the bottom of the ditch.

The mortar for laying the concrete brick should be made of a mixture of 1 part of cement to 3 parts of sand. One-fifth as much lime as cement may be added to make it work well if a trowel is used. By making the mortar very thin it may be poured in the vertical joints and tamped in with a piece of lath, as shown in Fig. 3. Similar mortar may be placed on the wall with a contrivance called a "mule," as shown in Fig. 4. Where only a few baffles are being built all mortar may be put on with a trowel.

Fig. 6.—Shows a brace wall being laid after the main part of the baffle is completed.

A few hours or a day after the baffle is complete, mix up on the ground nearby a puddle of water and soil and pour it between the brick wall and the earth wall, also back of the end walls. This will cause the concrete

wall to make contact with the earth wall just the same as if the wall had been poured of concrete. Thus there will be no crevices left for water to start running back of the wall. See "P," Fig. 2.

COST OF MATERIALS

One sack of cement and 4 cubic feet of sand will make 24 of these concrete units 12 inches long, 6 inches high, and 4 inches thick. This will lay 12 square feet of wall. In other words, it will lay the back wall of a baffle 6 feet long and 2 feet high. If one has his own sand and rock and does his own labor, the cash cost is not very much. The cost of baffles made of these units is about as cheap as where they are made of rock, even if the rock is convenient, for the entire wall does not require but very little more cement and sand than the mortar for a rock wall; however, where hard rock is available it is probably wise to use the rock.

To determine the total number of units in the back wall, multiply the length of the back wall in feet by the number of units per foot length, as found in Table II, for the desired height of baffle. (Example: The number of units for the back wall of a baffle 3 feet high and 10 feet long are: $10 \times 7 = 70$ units.)

TABLE II.—Number of units and cubic feet of concrete for various size baffles

1. Height in feet	2	2.5	3	3.5	4	5	6
2. No. units for the two end and wing walls	64	72	80	90	100	120	144
3. No. units for each ft. length of back wall	5	6	7	8	9	11	13
4. No. cu. ft. concrete for lower part of wing walls	4	5	6	7	8	10	12
5. No. cu. ft. concrete for each foot length of apron	1.3	1.5	1.6	2	2.3	3	3.5
6. No. units for each brace wall (brace walls to be placed every 4 feet)	10	13	19	25	30	35	40

To find the total cubic feet of concrete for the apron, multiply the amount of concrete per foot length (found in Table II) for the desired height of baffle by the length of the baffle. (For example: The cubic feet of concrete for the apron of a baffle 3 feet high and 10 feet long are $10 \times 1.6 = 16$ cubic feet.)

The size of units for baffles up to 3 feet high is 4″x6″x12″. For baffles higher, the units should be thicker than 4 inches. They should be 6 or 8 inches thick, depending on the height of the wall.

A cubic foot of concrete will make 6 units 4″x6″x12″

A cubic foot of concrete will make 4 units 6″x6″12″

A cubic foot of concrete will make 3 units 8″x6″x12″

One sack of cement will make 4 to 5 cubic feet of concrete, depending on whether sand or sand and crushed rock or gravel is used. Since the end walls are an expensive part of the baffle, and are the same regardless of length, it is easy to see from Table II that an extra few feet in length will not increase the cost very much and may save much trouble later by having the baffle large enough. Table I gives the size of baffle to use for various areas.

The material in the two ends and wing walls for baffles up to 5 feet high is approximately the same as needed for 16 feet of the back wall. The back wall is the part over which the water flows.

The amount of material needed for the apron varies somewhat, but for baffles up to 4 feet high it is about 1½ times as much as needed for the back wall. This is assuming the apron to be the same thickness as the wall, 4 inches. This is not true for higher baffles.