

JUNE 21, 1967

# slotted floors for swine

---

cooPerative  
extension  
service

•

university  
of  
hawaii

circular no. 413



## TABLE OF CONTENTS

	<u>Page</u>
Advantages of Slotted Floors.....	3
Disadvantages of Slotted Floors.....	3
Construction of Slats.....	5
Wood Slats.....	5
Concrete Slats.....	7
Steel Slats--Expanded Metal.....	11
Design and Layout of Slotted Floors....	15
Slat Width and Spacing.....	15
Partially Slotted Floor.....	15
Pen Size and Shape.....	19
Waste Receptacle—Manure Disposal..	19

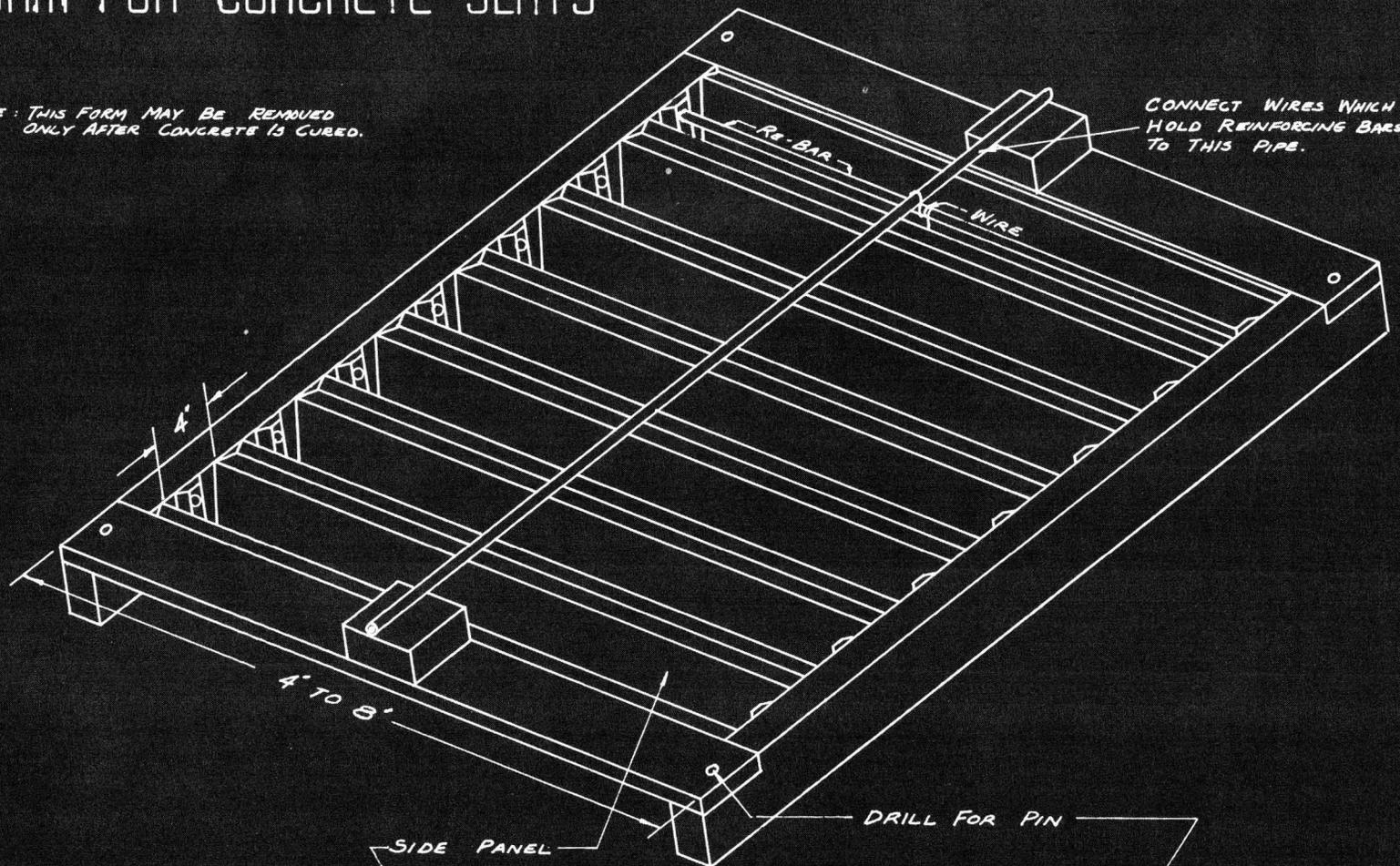
## LIST OF FIGURES

Fig. 1. Form for Concrete Slats.....	2
Fig. 2. Form for Concrete Slats.....	4
Fig. 3. Form for Double Slats.....	6
Fig. 4. Form for Double Slotted Floor..	8
Fig. 5. Form for Double Slats.....	9
Fig. 6. Single and Double Concrete Slats.....	10
Fig. 7. Farrowing Stall—Partial Slotted.....	12
Fig. 8. Farrowing Layout—Partial Slotted.....	13
Fig. 9. Farrowing Layout—Complete Slotted.....	14
Fig. 10. Nursery Pens.....	16
Fig. 11. Market Hog Unit—Partial Slotted.....	17
Fig. 12. Market Hog Unit—Complete Slotted.....	18
Fig. 13. Slotted Floor and Gutter.....	20

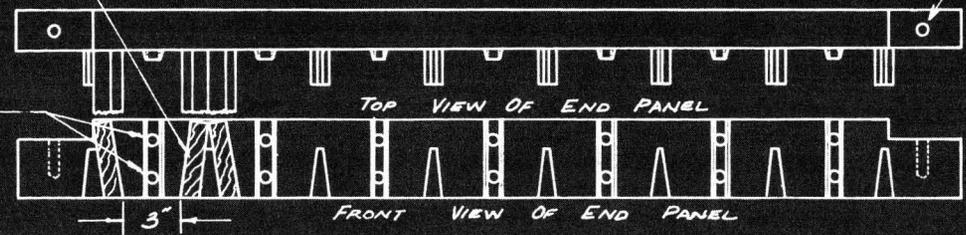
FIGURE 1

# FORM FOR CONCRETE SLATS

NOTE: THIS FORM MAY BE REMOVED ONLY AFTER CONCRETE IS CURED.



DRILL FOR REINFORCING BARS



DRAWN BY B.C.M.C.

# SLOTTED FLOORS FOR SWINE

**WILLIAMS I. HUGH**

*Extension State and Area Swine Specialist*

**HARRIS M. GITLIN**

*Assistant Extension Agricultural Engineer*

Hog producers who confine pigs have a continual labor problem of cleaning the floors daily and disposing of the waste products. Field observations in Hawaii indicate that, depending on the size of the operation, 2 to 4 hours per day is normally spent in pen cleaning. In areas of high rainfall and humidity, this practice, combined with other factors such as completely roofed units and garbage feeding, results in floors that never dry completely. This situation can result in less desirable performance, particularly in small pigs. In areas of the State where city water must be used, or in dry areas where water availability is inconsistent due to periodic drought conditions, it is desirable to use a limited quantity of water for clean-up.

Using slotted floors in swine units is a way to help the clean-up problem. Slotted floors have uniform openings in the floors, allowing manure and urine to pass through into some type of collection receptacle or lagoon underneath. Two basic floors designs are usually considered:

1. A completely slotted floor in which the entire floor area has openings for the waste material to drop through.

2. A partially slotted floor in which a portion of the floor area has openings and

the remainder of the floor surface is solid.

The use of slotted floors should be considered an aid to good management and feeding practices, not a substitute.

## **ADVANTAGES OF SLOTTED FLOORS**

1. Reduced labor in cleaning. This is the main advantage. Completely slotted floors are more self-cleaning than partially slotted floors.

2. Improved sanitation. Since the hog's wastes drop through the slot, the pig has less direct contact with waste products that may contain disease organisms or parasites.

3. Drier and cleaner pigs. This is most important in the farrowing and nursery area where damp, dirty floors can cause scouring in young pigs.

4. Possible saving in floor space. Reasonable crowding of pigs is necessary to help keep the manure working through the openings.

## **DISADVANTAGES OF SLOTTED FLOORS**

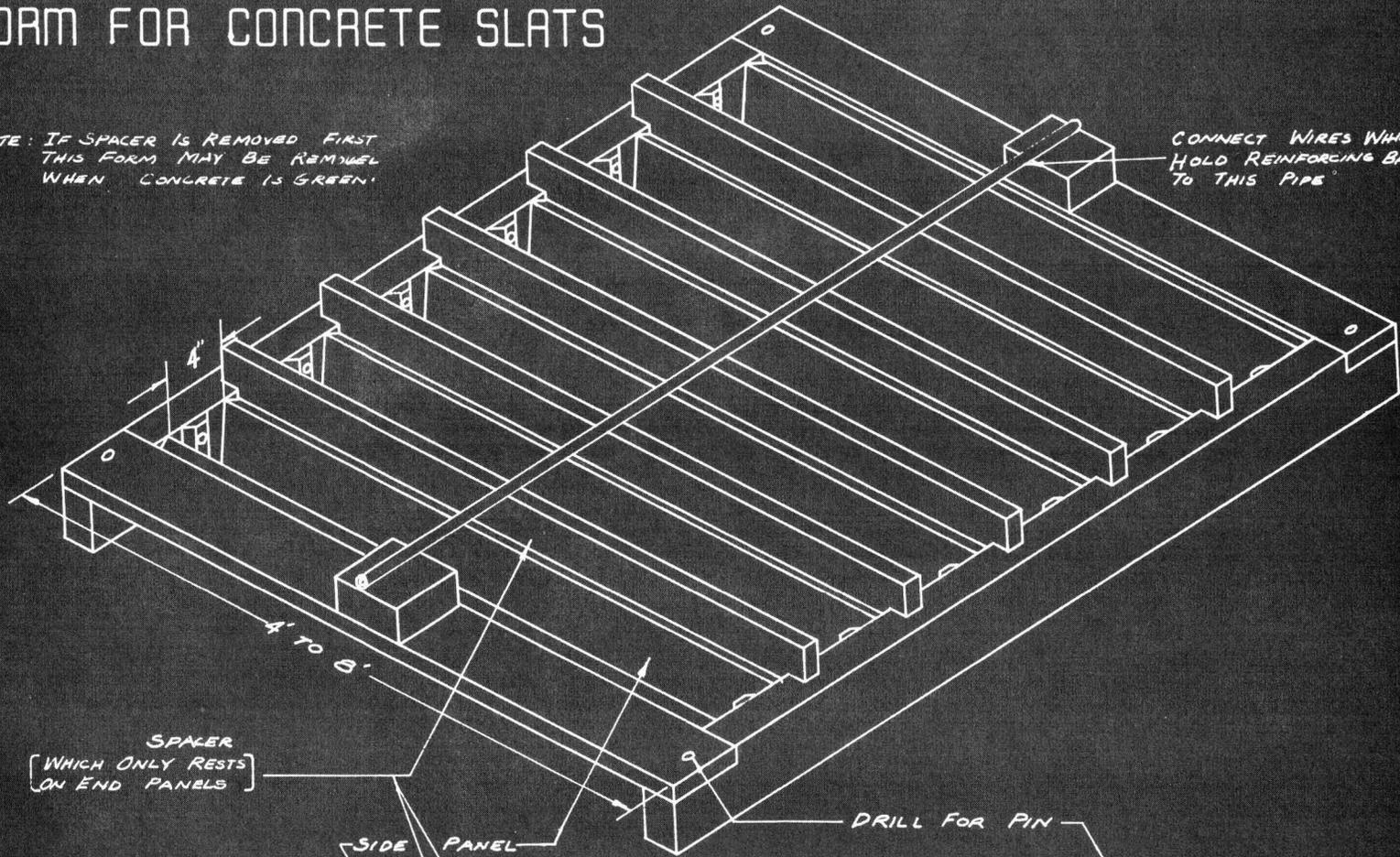
1. High initial cost. Compared with solid floors, the initial cost of slotted floors is higher. With slotted floors, two floor surfaces are required—one for the pig to stand on and the second one beneath the slotted portion to catch the waste ma-

FIGURE 2

# FORM FOR CONCRETE SLATS

NOTE: IF SPACER IS REMOVED FIRST  
THIS FORM MAY BE REMOVED  
WHEN CONCRETE IS GREEN

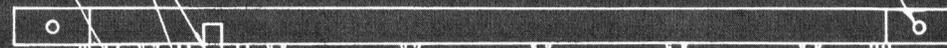
CONNECT WIRES WHICH  
HOLD REINFORCING BARS  
TO THIS PIPE



SPACER  
[WHICH ONLY RESTS  
ON END PANELS]

SIDE PANEL

DRILL FOR PIN



TOP VIEW OF END PANEL

DRILL FOR REIN-  
FORCING BARS



FRONT VIEW OF END PANEL

DRAWN BY  
B.C.M.C.

terial. Depending on whether the floor is partially slotted (1/4 of the floor surface) or completely slotted, initial cost of materials per square foot is roughly 1-1/2 to 3 times more for wood and steel slats and 1-1/3 to 2-1/3 times more for concrete slats than for a solid concrete floor. Materials cost for a solid concrete floor is around 30 to 35 cents per square foot.

2. Slotted floors in a building tend to make the building less flexible for change if it is to be used in a different way at a later date.

3. Feed spilled from a self-feeder or trough is lost through the slots on a completely slotted floor. Feeding equipment must be adjusted. The use of a combination slotted and solid floor eliminates this problem.

4. Pigs raised on completely slotted floors tend to resist being driven along a solid floor. In addition, slightly more trouble and injury to the hog's feet and legs can result. These problems are usually not met in partially slotted floors.

5. Environmental conditions must be considered when raising pigs on slotted floors. On completely slotted floors, pigs tend to suffer more from heat, since the floor remains drier than solid floors. When using completely slotted floors, precaution should be taken to avoid drafts—particularly critical with baby pigs. In enclosed buildings, it is important to have adequate ventilation to prevent gas build-up from the waste receptacle. These problems are reduced with the use of partially slotted floors.

Generally, the use of combination slotted and solid floor offers most of the advantages of completely slotted floors and considerably less of the disadvantages.



### CONSTRUCTION OF SLATS

Slats are usually made from one of three types of materials: wood, concrete, or steel—rolled expanded metal or T-bar and channel beams.

#### WOOD SLATS

Construct wood slats only out of hardwood to give the floor durability. Mainland experience indicates that hardwood slats wear out in 2 to 5 years. Wood slats tend to wear out quickly around feeders and waterers where there is more pig traffic. They become slippery when wet. Rough-cut the lumber to give the pig better footing. Pigs tend to chew wood slats, thus resulting in more maintenance. Do not use preservative-treated wood to avoid possible skin irritation to the pig.

All slats should be the same height, and they should be straight. To keep the openings uniform, nail 1 x 3 or 1 x 4 spacers across the slats, 3 to 4 feet apart. For easy handling and replacing of worn pieces, make the wood slats in sections. Support these sections at least every 5 to 6 feet.

Slat sections and dimensions are given below.

#### Sections



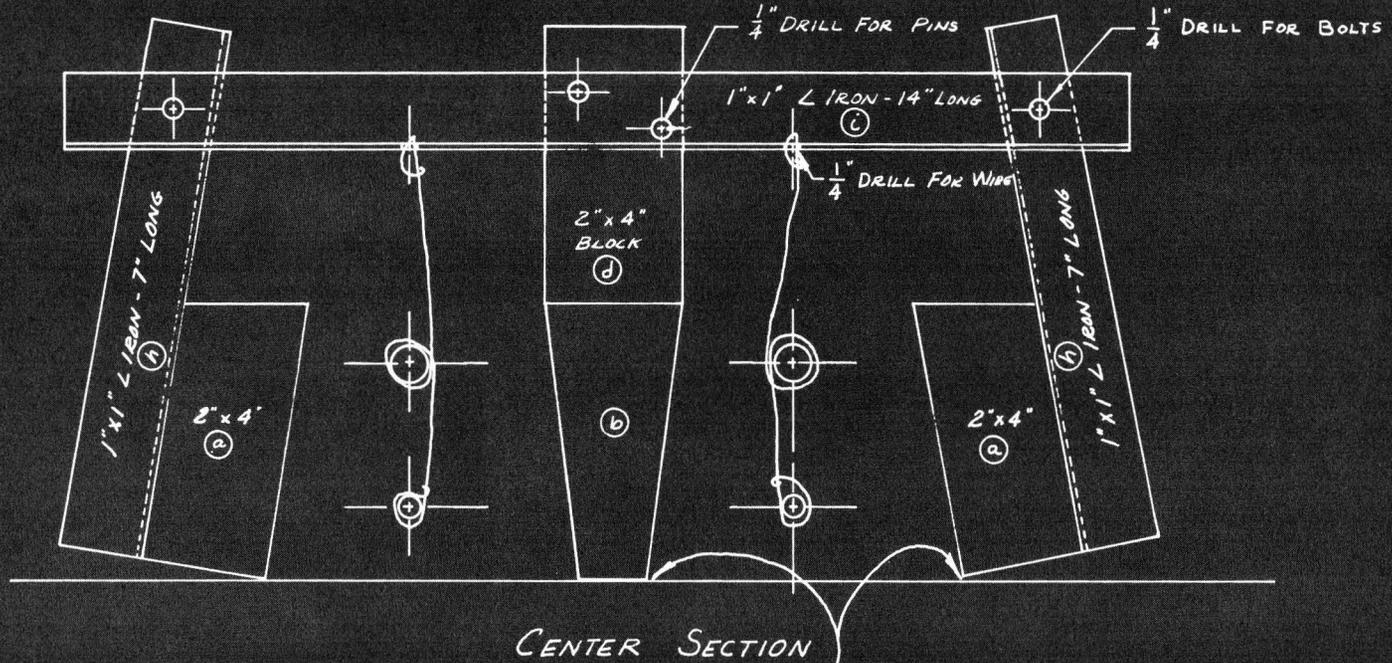
#### Dimensions of Wood Slats

Slat length (Feet)	Dimensions (Inches)		
	A	B	C
4	2	2-1/2	1-3/4
6	2-1/2	3	2
8	3	3-1/2	2-1/4
10	3-1/2	4	2-1/2

FIGURE 3

# FORM FOR DOUBLE SLATS

(CAN BE REMOVED AS SOON AS CONCRETE HAS SET)



TOTAL BILL OF MATERIALS

- Ⓒ 2 - 2 x 4 - 4'
- Ⓓ 1 - 2 x 4 - 40"
- Ⓔ 2 - 2 x 4 - 14 1/2"
- Ⓕ 1 - 2 x 4 - 4"
- Ⓖ 2 - 1 x 2 - 8"
- Ⓗ 2 - 1" x 1" x 1/2" L 3 3/8"
- Ⓘ 2 - 1" x 1" x 1/2" L 6"
- Ⓛ 2 - 1" x 1" x 1/2" L 7"
- Ⓜ 1 - 1" x 1" x 1/2" L 14"

NOTE:

REMOVE FORMS WHEN GREEN.  
TRIM EDGES WITH SPECIAL TOOL.  
OIL 2" x 4" BEFORE USING AGAIN.

FORM FOR 4' TWIN SLOTTED FLOOR  
CENTER SECTION  
1"-2"

DRAWN BY  
B.C.M.C.

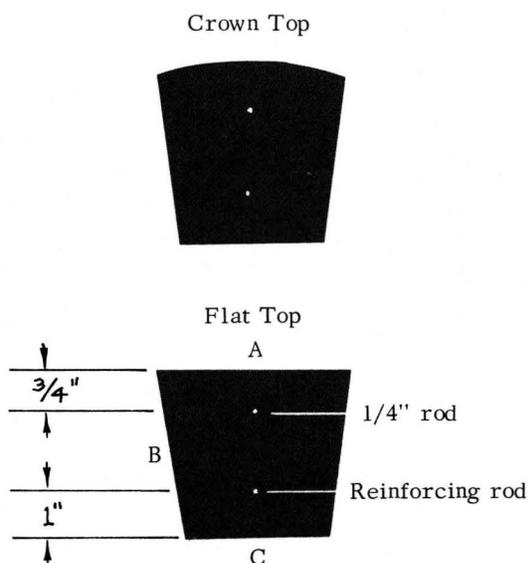
If slats are fastened together with steel rods or wooden dowels, dimensions A and C are reduced 1/2 inch for 4- and 6-foot lengths and 5/8 inch for 8- and 10-foot lengths.

The 4-foot slats can be taken from either a 2 x 3 or 2 x 6 diagonal cut. The 6-, 8-, and 10-foot slats can be obtained from a 4 x 6 diagonal cut.

#### CONCRETE SLATS

Slats made out of concrete, although they cost more initially, are longer lasting, require less maintenance, and tend to stay drier and cleaner than wood. Dimensions for concrete slats are given below.

#### Dimensions for Concrete Slats



Length	A	B	C	Reinforcing Rod
4'	4"	3-1/2"	3"	3/8"
6'	4"	4"	3"	3/8"
8'	5"	4-1/2"	3"	1/2"
10'	5"	4-1/2"	3"	5/8"

In constructing concrete slats, it is important to form them carefully and avoid chipping off the edges so as to maintain an even width. This even width is needed to avoid possible injury to the pig's legs and feet. As an aid to constructing concrete slats, the following suggestions are given.

1. Concrete mixture. When mixing concrete on the farm for slat construction, use the following proportions: 1 part cement, 2 parts sand, 2-1/2 parts gravel or crushed rock, and 5 gallons of water per sack of cement. (Sand and gravel usually contain some water.) The recommended amount of water results in a "stiff" mix to give strength. When more water is used, the strength of the slats decreases.

If ready-mix concrete is used, specify a 7-1/2-bag mix with a slump test value of 2 to 3 inches, a 3/4-inch maximum aggregate size, and a 28-day strength of 3500 psi (pounds per square inch).

2. Reinforcing rods. Two rods are used in each slat—an upper rod to prevent cracking during handling and a bottom rod to carry the load after the slat has been put in place. Take care that these rods are not displaced during pouring and working. Figures 1 and 2 show the provisions made for locating and supporting the reinforcing rods. Slats are weakest when lying on their sides and should always be handled in their normal, vertical positions.

3. The strength of concrete keeps increasing with age. However, the pour is not up to design strength for about 28 days. The slats should not be used in less time than that.

4. The poured slat should not be disturbed during the first week. That is, in the first week after pouring, no force or movement usually associated with the removal of forms should be applied. There are, however, special designs for forms that can be removed in 1 to 2 hours and in 24 hours (Figure 2). In these cases, make

FIGURE 4

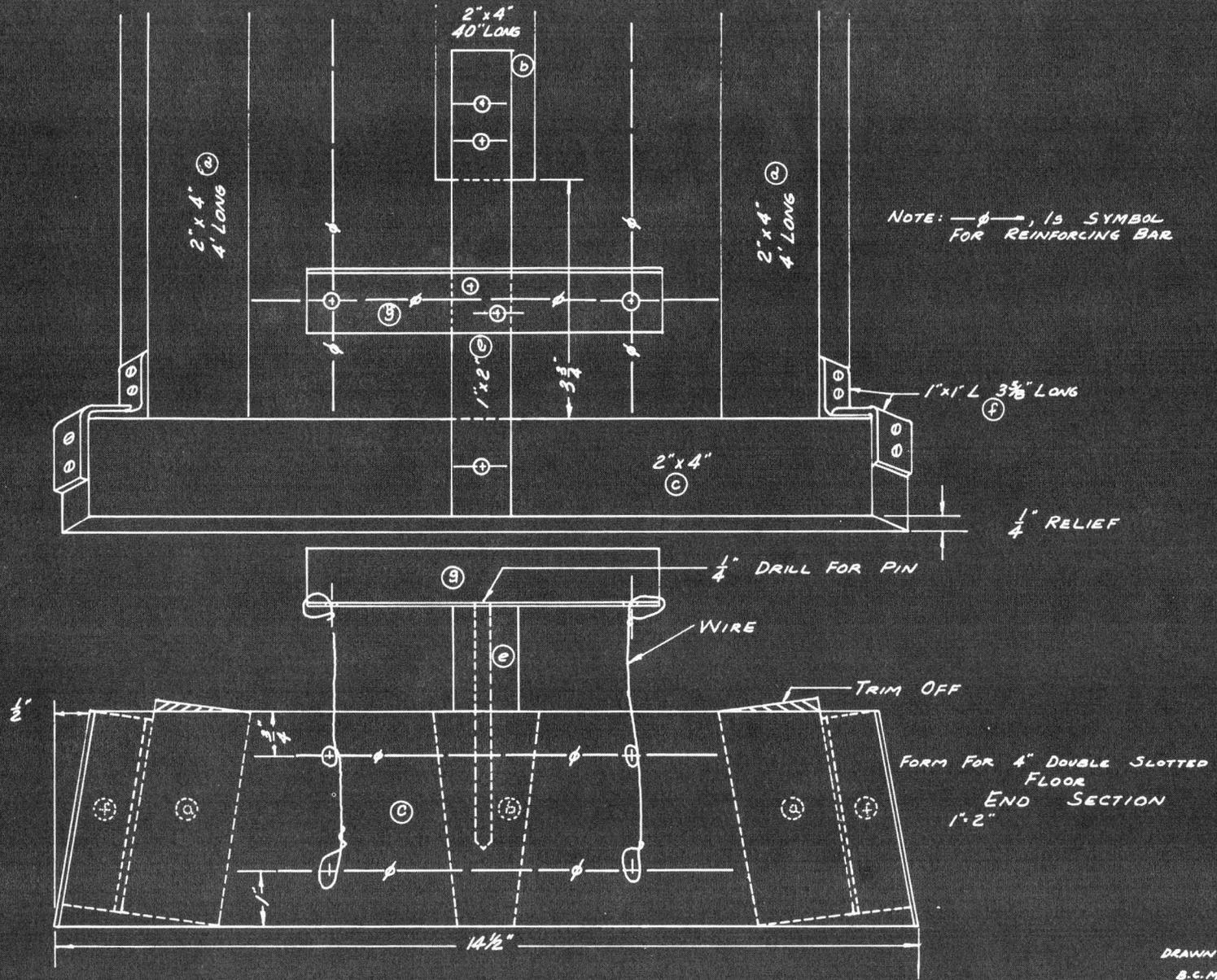
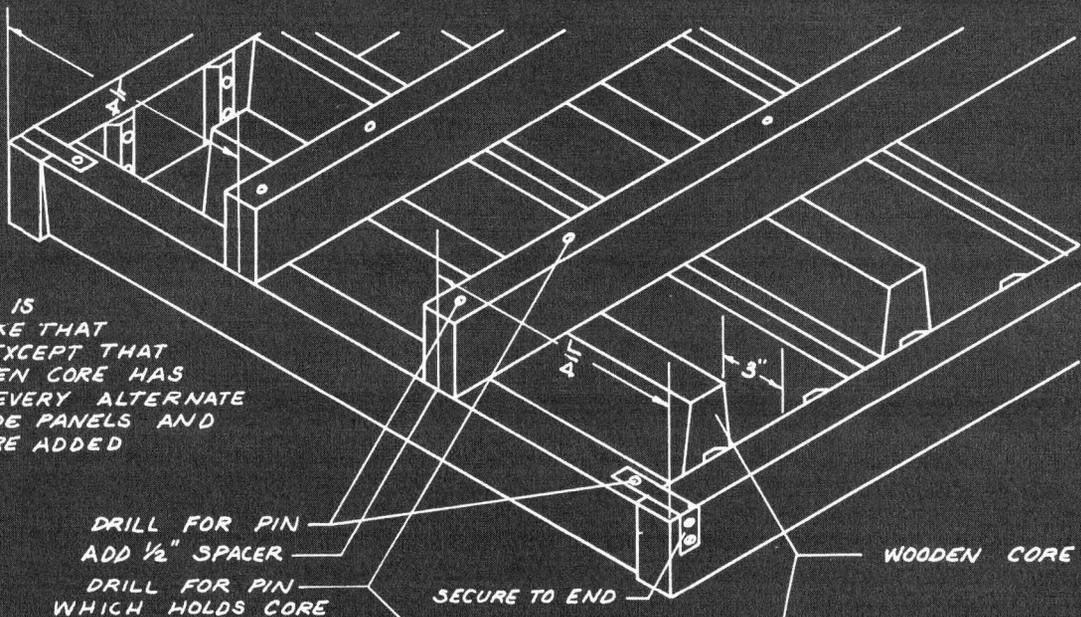


FIGURE 5

# FORM FOR DOUBLE SLATS

(REMOVE FORM AFTER ONE WEEK)

NOTE: THIS FORM IS EXACTLY LIKE THAT OF FIG. 1 EXCEPT THAT THE WOODEN CORE HAS REPLACED EVERY ALTERNATE SET OF SIDE PANELS AND SPACERS ARE ADDED

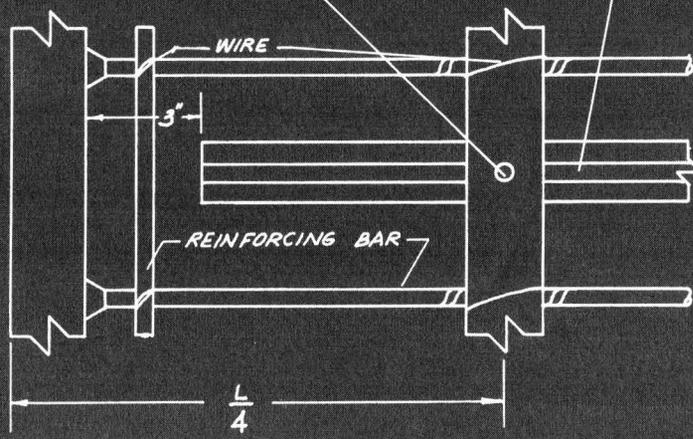


DRILL FOR PIN  
ADD 1/2" SPACER

DRILL FOR PIN  
WHICH HOLDS CORE

SECURE TO END

WOODEN CORE



WIRE

3"

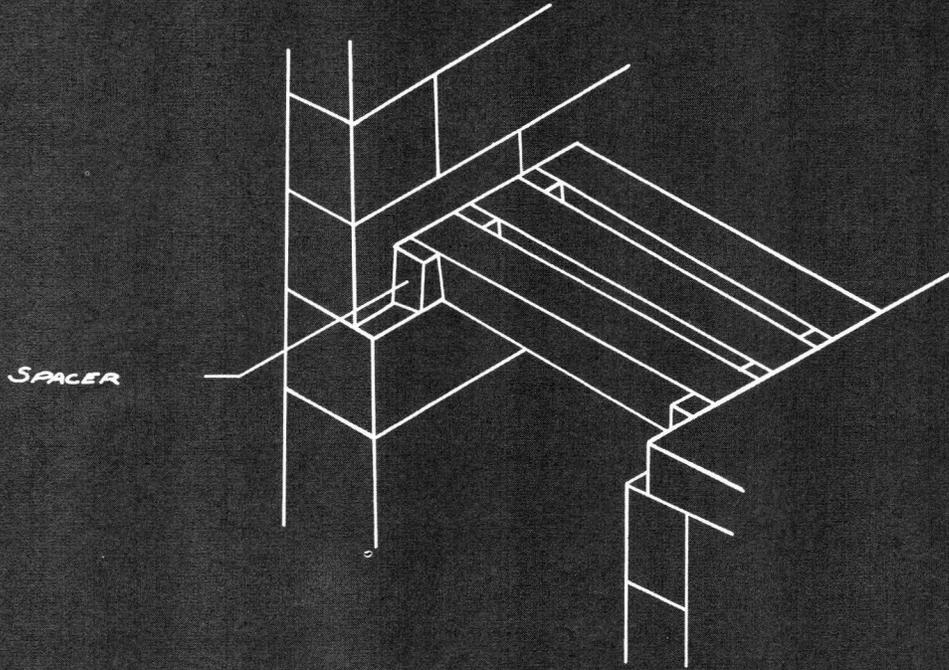
REINFORCING BAR

$\frac{L}{4}$

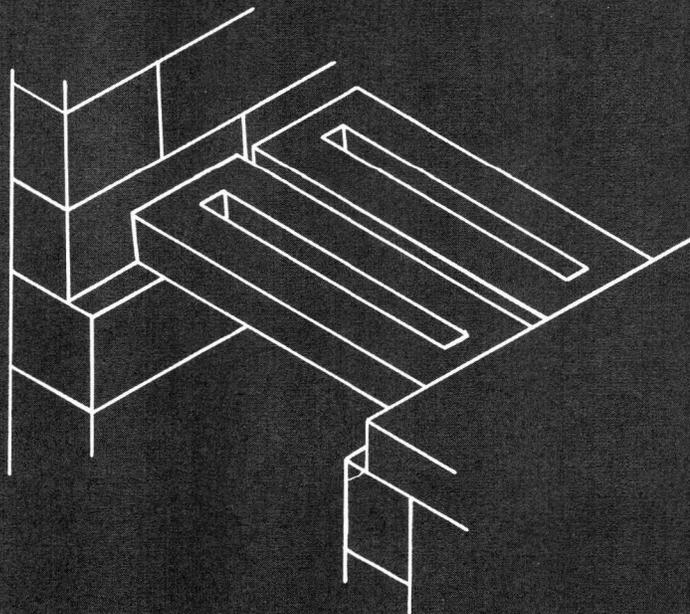
DRAWN BY  
B.C.M.C.

FIGURE 6

*SINGLE CONCRETE SLAT*



*DOUBLE CONCRETE SLAT*



*DRAWN BY  
B.C.M.C.*

sure that the slats are not disturbed in the process of removing the form.

5. Two conditions frequently occur and these should be avoided. They are (a) pits or bubbles along the forms and (b) sticking of concrete to the form.

In pouring the slats, the lower surface is actually formed by the base on which the pour is made. To obtain a good-quality slat, as the mix is poured, work it well, using some tool, such as a piece of reinforcing rod or trowel. The poured mix should be poked down so it is smooth on the bottom and sides, as well as filled in around the installed reinforcing rods. The more the concrete is worked when first poured, the more solid and uniform it will be. Vibrating the form also helps in producing a higher-quality slat.

Trowelling or float-finishing the top surface of the slat should be done after the pour has been worked and when the concrete has just started to jell or set. Trowelled earlier than this, the mix is soft; later and it is too hard to flow. Experience at working with the concrete will determine the optimum time.

To prevent the concrete from sticking, the forms should be well oiled so that they do not absorb any water. Before pouring, wait until the oil is absorbed into the wood. After each use, knock the forms clean of all material and oil again. To eliminate sticking, place a plastic sheet in each slat form so that it covers both the bottom and sides. A solid fill can be obtained by pulling and working the plastic.

6. Curing. Concrete has its highest strength when cured under water. During the first week of curing, the surface of the concrete should always be kept moist. Burlap bags or canvas may be draped over the slats and kept wet. Plastic sheets may be used to cover the slats if the concrete surface underneath is kept moist. Keep exposed slat surfaces away from direct

sunlight to prevent surfaces from drying quickly and from cracking later.

7. Forms. Figures 1 and 2 show a simple form to use for multiple pouring. The side forms are mutually supporting. This form should remain on the cast for about a week, since the cast will be disturbed when the side forms are removed. An alternate form that uses a 1/2-inch spacer board can be removed in about one day if done carefully (Figure 2). Remove the spacer boards first and then the ends, allowing the side boards to come off without disturbing the cast.

Figures 3, 4, and 5 show a form for casting double slats. Because of weight, these forms should be limited to 4-foot lengths. Remove this form about 1 or 2 hours after the concrete starts to set. Take the form off carefully. It should be noted that "relief" is allowed so that no disturbance of the delicate concrete cast is likely. Lining the form with plastic sheet will help remove it more easily. By using several of these forms, it is possible to continuously cast slats.

The double slat is stable and does not need a spacer at each end. However, single slats need a wood or concrete spacer at each end to maintain spacing and stability.

#### **STEEL SLATS -- EXPANDED METAL**

T-bars, channel bars, or 9-11 gauge flattened expanded metal (1/8 inch thick expanded metal rolled flat on both sides with a diamond-shaped hole 5/8 inch x 1-1/2 inches) can be used. When using T-bars, minimum 2-inch T size is recommended for spans up to 6 feet and minimum 3-inch T size for spans from 6 to 10 feet.

Stamped channel sections with strength proportionate to their length are available commercially.

Expanded metal is best used in the farrowing and nursery area for young pigs

FIGURE 7

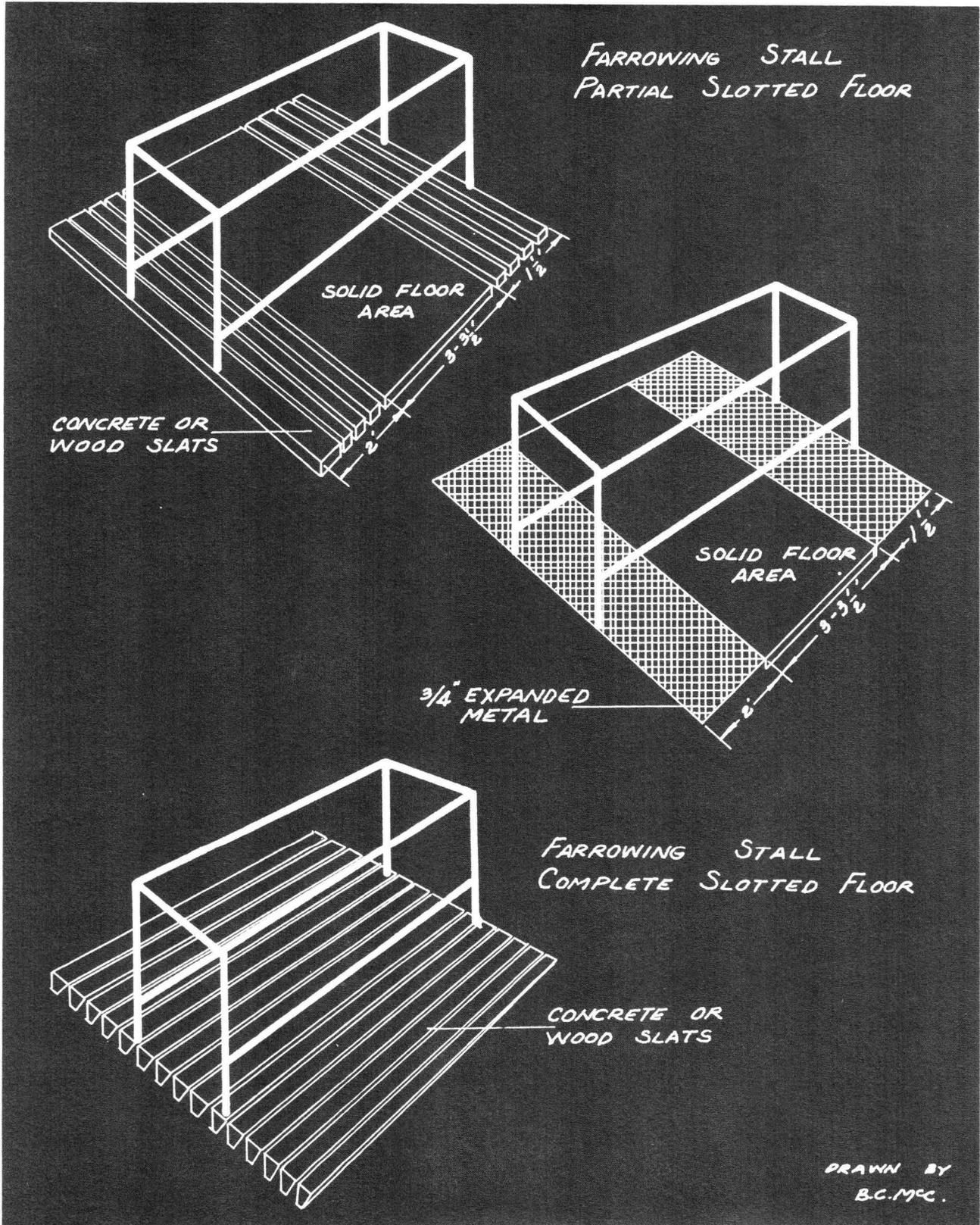
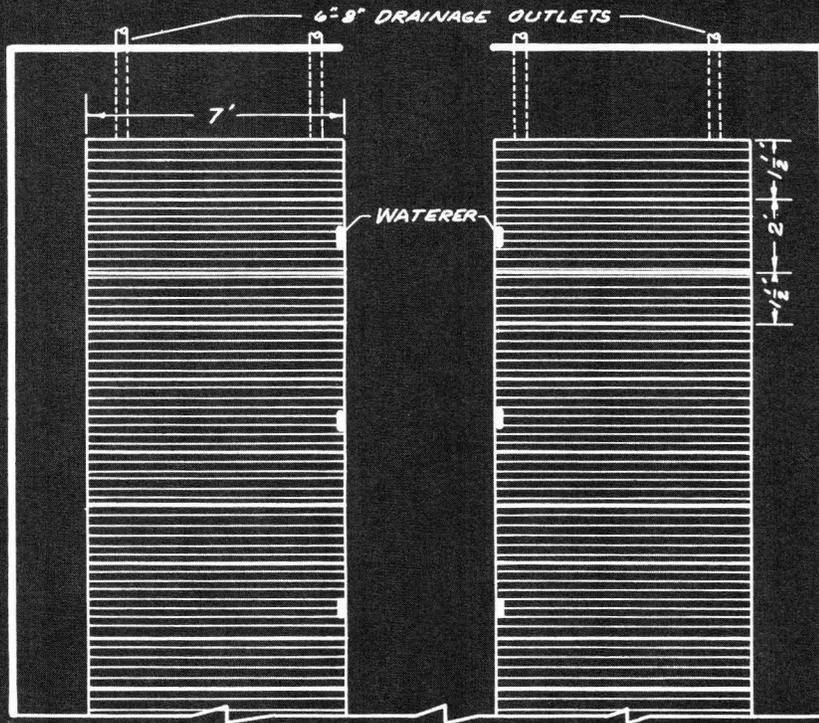
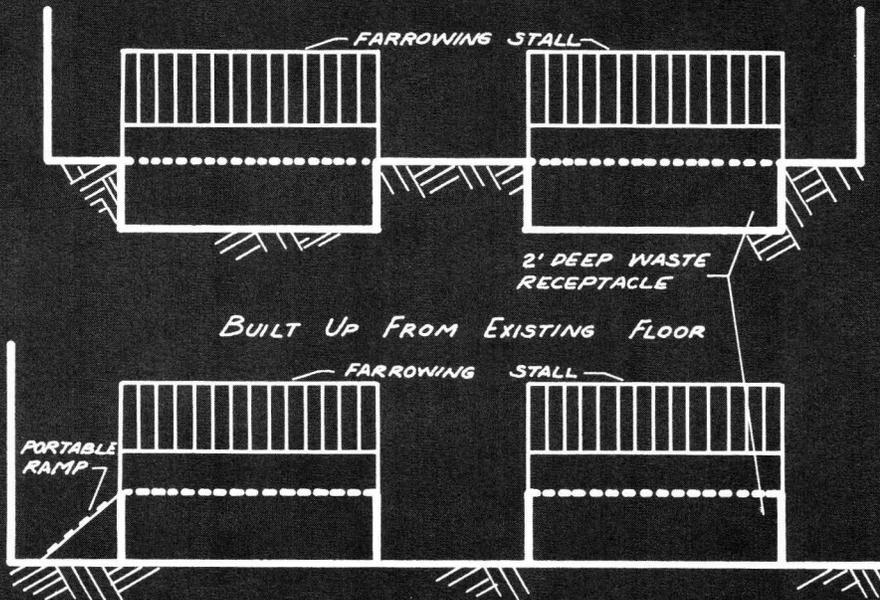


FIGURE 8

FARROWING LAYOUT  
COMPLETE SLOTTED FLOOR  
FLOOR PLAN

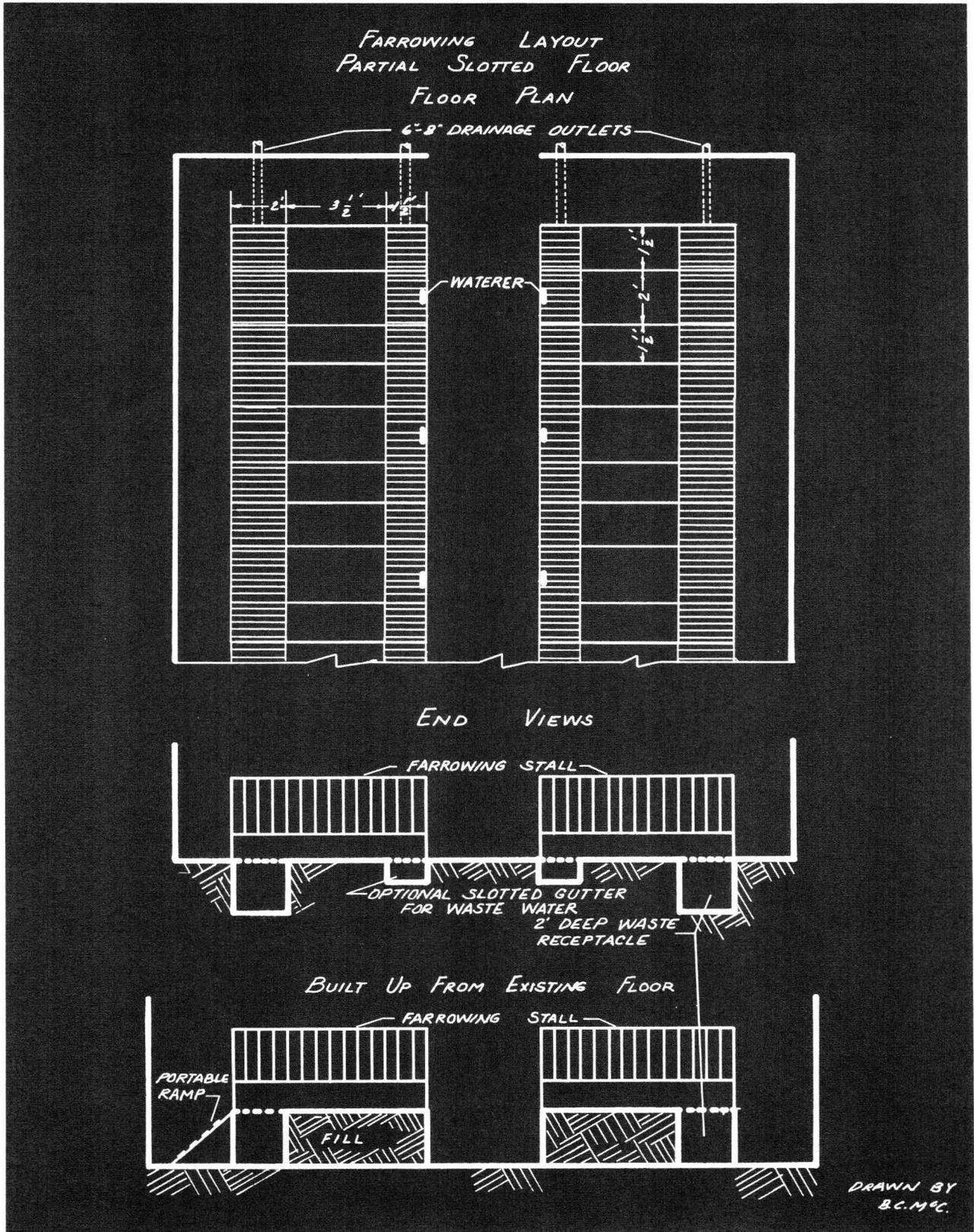


END VIEWS



DRAWN BY  
B.C.M.C.

FIGURE 9



up to 50 pounds. There have been occasional complaints of the sow's teats and baby pig's umbilical cord getting caught. Compared with wood and concrete, expanded metal stays cleaner. For bridging gutters, angle iron can be used to frame the expanded metal. Supports spaced about 1 foot apart are normally recommended. Recommended size of angle iron for framing expanded metal is given below.

Size of Angle Iron

Span	Angle Size	Thickness
2'	1-3/4" x 2-3/4"	1/8"
4'	1-3/4" x 1-3/4"	1/4"
6'	2" x 2"	3/8"
8'	2-1/2" x 2-1/2"	3/8"

**DESIGN AND LAYOUT OF SLOTTED FLOORS**

**SLAT WIDTH AND SPACING**

Narrow slats are usually more effective in farrowing and nursery units. The larger the animal, the wider the slat can be without sacrificing cleaning efficiency. Narrow slats and wide spacings can cause injury to the feet and legs of finishing hogs. On the other hand, wide slats and narrow openings result in floors that are not completely self-cleaning. To prevent manure build-up, allow a 1- to 2-inch space between the wall and slat, or use a baffle.

Slats tend to stay cleaner if they run at right angles to the pigs' major traffic pattern. Traffic can be increased by placing waterers and feeders at opposite corners. This practice may regulate the dunging area, since corners tend to be a place for dunging.

For the farrowing area and area for small pigs under 40 pounds, spacings should be either narrow enough (3/8 to 7/16 inch) to prevent the pig's feet from slipping through, or wide enough apart (3/4 to 1 inch) to prevent the pig's feet from getting caught. Slat width may vary from 1-1/2 to 3-1/2 inches. Figures 7, 8, and 9 indicate several slotted floor arrangements for farrowing stalls.

Figures 10, 11, and 12 show examples of nursery and market hog layouts. For pigs over 40 pounds, slot spacing can be 3/4 inch to 1-1/4 inches. The recommended slat-slot relationship is given below.

Slat-slot Relationship

Slat Width	Slot Width
2-1/2"	5/8"
3"	3/4"
4"	1"
5"	1"
6"	1-1/4"

Floor Space Requirements

- Pigs up to 100 lbs. weight =  
4 square feet per pig
- Pigs from 100 lbs. to market =  
8 to 9 square feet per pig

**PARTIALLY SLOTTED FLOOR**

Ratio of slotted to solid floor area should be 3 to 1 or 4 to 1. The slotted floor area should be within 16 feet of all parts of the pen; longer floor areas tend to get dirty. The slope on the solid floor should be 1/2 to 3/4 inch per foot. Some problems may occur when pigs dung on the solid floor portion. The normal behavior of the pig is to use the dunging area during

FIGURE 10

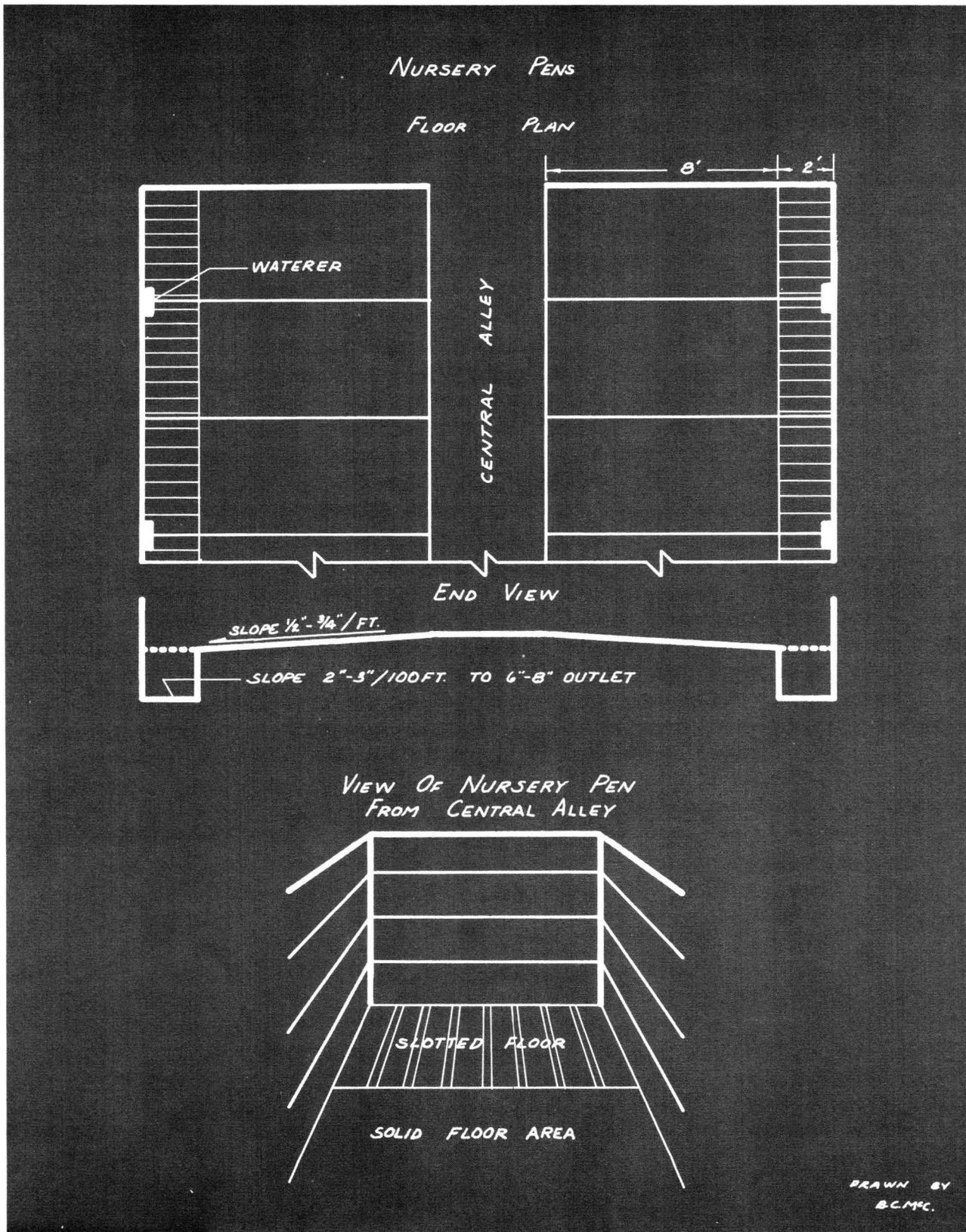
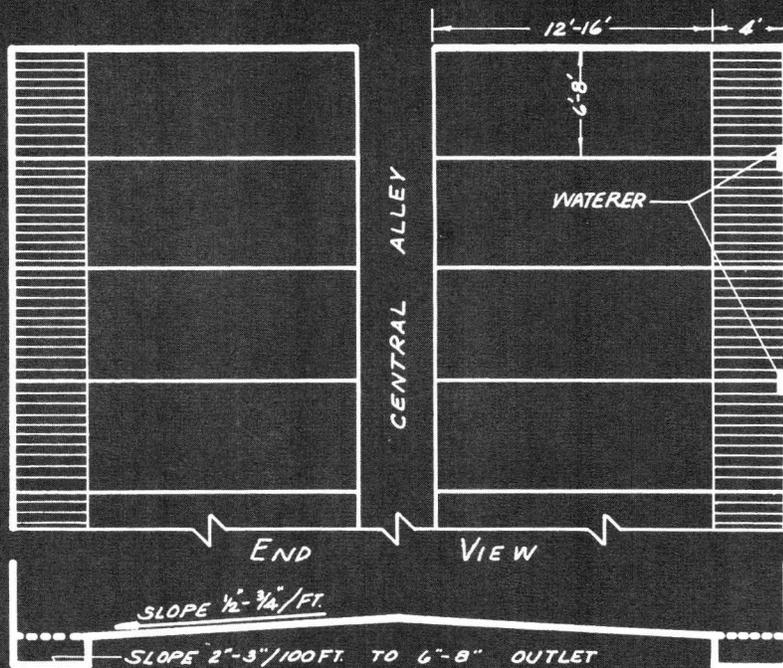
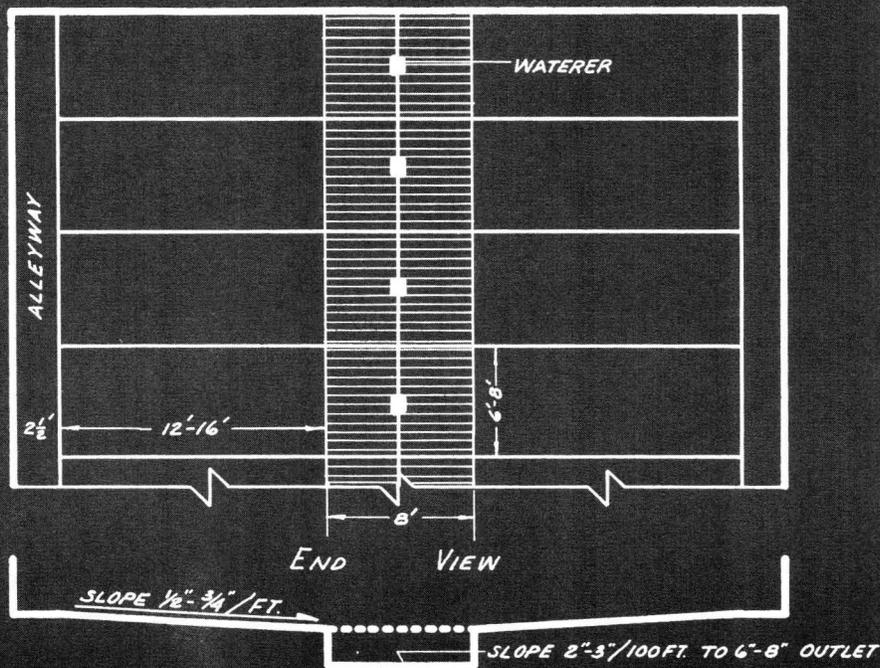


FIGURE 11

MARKET HOG UNIT  
PARTIAL SLOTTED FLOOR  
FLOOR PLAN



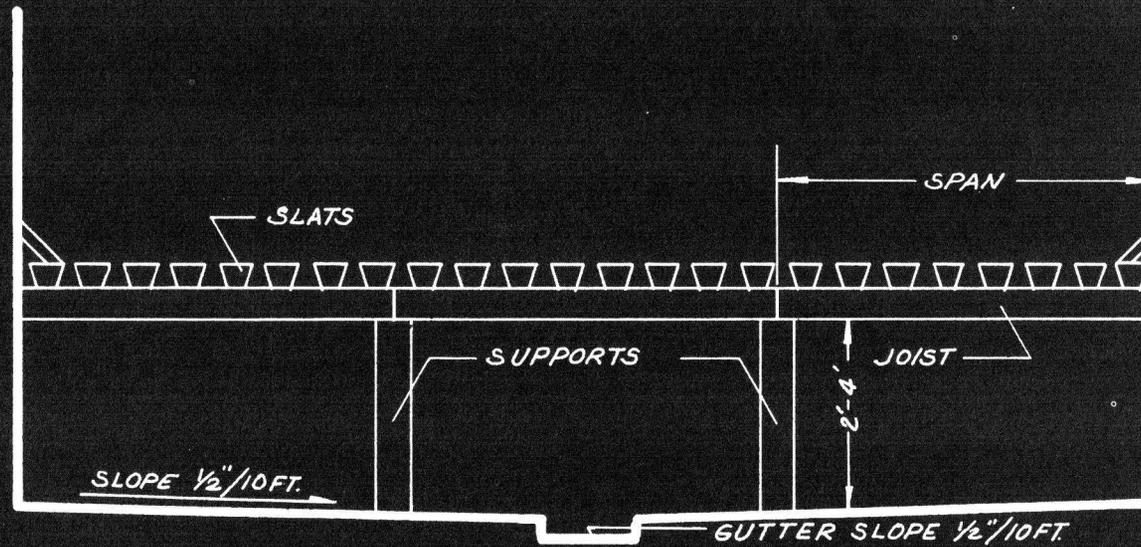
FLOOR PLAN



DRAWN BY  
B.C.M.C.

FIGURE 12

MARKET HOG UNIT  
COMPLETE SLOTTED FLOOR



SLAT LENGTH  
BETWEEN JOISTS

4 Ft.  
5 Ft.  
6 Ft.  
8 Ft.  
10 Ft.

JOIST SIZES FOR SPANS OF

8 Ft.	10 Ft.	12 Ft.
2" x 8"	2" x 10"	2" x 12"
2" x 8"	2" x 10"	2" x 12"
2" x 10"	2" x 12"	3" x 12"
2" x 10"	2" x 12"	3" x 12"
2" x 12"	2" x 12"	4" x 12"

DRAWN BY  
B.C. McC.

cool weather and to dung and urinate on the concrete during hot weather. To help prevent dunging on the solid concrete floor, the following practices can be used:

1. Limit the space on the solid concrete floor so there is just enough space for the pigs to lie down. This means either breaking groups of pigs into smaller groups as they grow older or using a movable pen wall.
2. Feed on the floor will tend to eliminate dunging.
3. Place waterer in the dunging area.
4. Keep dunging area at the same temperature as the sleeping area during warm weather.
5. Some authorities feel that the level of the dunging alley should be slightly lower than the solid concrete floor to aid in controlling dunging

#### PEN SIZE AND SHAPE

For nursery and finishing pens, a long, narrow type of pen appears to be the best. Pens 4 to 6 feet wide and 14 to 20 feet long with a 4-foot wide slotted section have been commonly used. For best performance, pen size should be limited to hold around 20 pigs.

#### WASTE RECEPTACLE--MANURE DISPOSAL

Depending on the desired capacity and frequency of emptying, the gutter under the slotted floor area should be at least 2 feet deep at the shallow end. This allows sufficient head for satisfactory flow at clean-

out time. Slope to the bottom of the gutter should be about 2 to 3 inches per 100 feet. Too much slope causes the liquids to run out, leaving the solids when the gutter is emptied. Baffles 4 to 8 inches above the gutter floor, spaced 8 to 16 feet apart, aid in cleaning the floor of the gutter when emptied. Outlet of the gutter should be 6 to 8 inches minimum and low enough so that the pit can be cleaned out when drained. It is advisable to have an overflow so that excess water due to rain or washing can get away and the desired level is still maintained. The space between the bottom of the slats and the manure mixture level should be not less than 1 foot, particularly if in an enclosed building. Air beneath the slotted floor has a high carbon dioxide (CO<sub>2</sub>) content. If the level of the manure is too close to the slats, CO<sub>2</sub> is likely to pass through with possible adverse effect on the pigs' performance. Odors intensify with length and quantity of storage of manure under the slats. In enclosed buildings, it is particularly important to have good ventilation to remove odors and gasses. Before turning pigs into the pens, it is advisable to fill the gutter with 10 to 12 inches of water. This aids in covering the solid material that drops through and helps disperse and decompose the material. Figure 13 diagrams a cross-section of a partially slotted floor and waste receptacle. Tables 1 and 2 can be used as guides for estimating required size and capacity of storage receptacle.

TABLE 1

Weight of pig	Daily manure production*	
	Solid	Total gals.**
lbs.	lbs.	
50	2.7	.53
100	4.3	1.06
150	5.8	1.59
200	7.3	2.12
250	7.8	2.65

\* Does not include wash or rainwater.

\*\* Assume 59 lbs./cu. ft. average density--liquids plus solids.

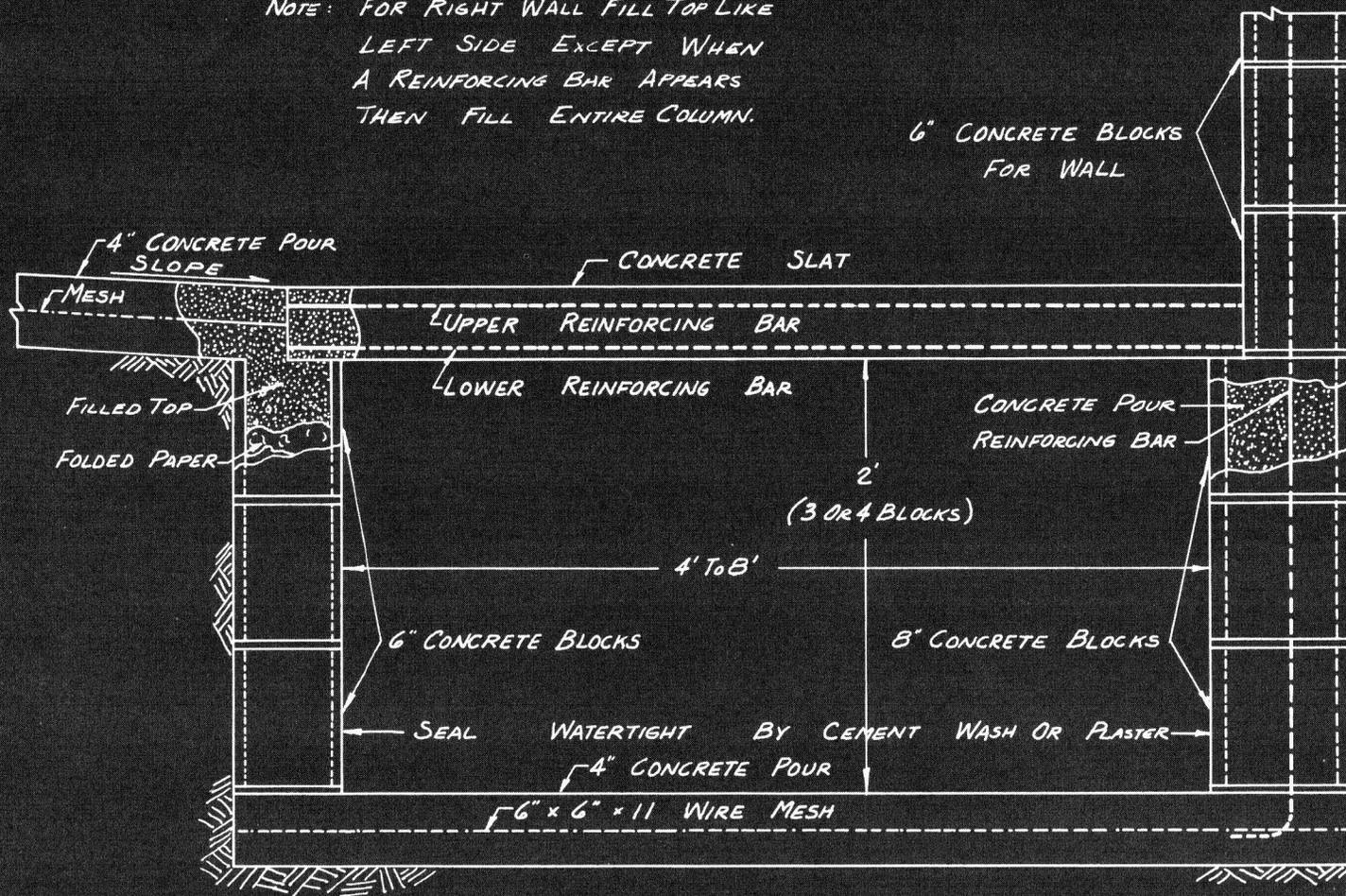
TABLE 2. MANURE STORAGE CONTAINER  
(Capacity, in gallons, per linear foot of container.)

Width	Depth of liquid fill				
	1	2	3	4	5
22	15	30	45	60	75
4	30	60	90	120	150
6	45	90	135	180	225
8	60	120	180	240	300

FIGURE 13

# SLOTTED FLOOR AND GUTTER (TYPICAL SECTION)

NOTE: FOR RIGHT WALL FILL TOP LIKE  
LEFT SIDE EXCEPT WHEN  
A REINFORCING BAR APPEARS  
THEN FILL ENTIRE COLUMN.



DRAWN BY  
D. C. M. C.

COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS  
COLLEGE OF TROPICAL AGRICULTURE, UNIVERSITY OF HAWAII, HONOLULU, HAWAII 96822  
UNITED STATES DEPARTMENT OF AGRICULTURE COOPERATING  
C. PEAIRS WILSON, DIRECTOR, HAWAII COOPERATIVE EXTENSION SERVICE  
DISTRIBUTED IN FURTHERANCE OF THE ACTS OF CONGRESS OF MAY 8 AND JUNE 30, 1914  
CIRCULAR 413--APRIL 1966