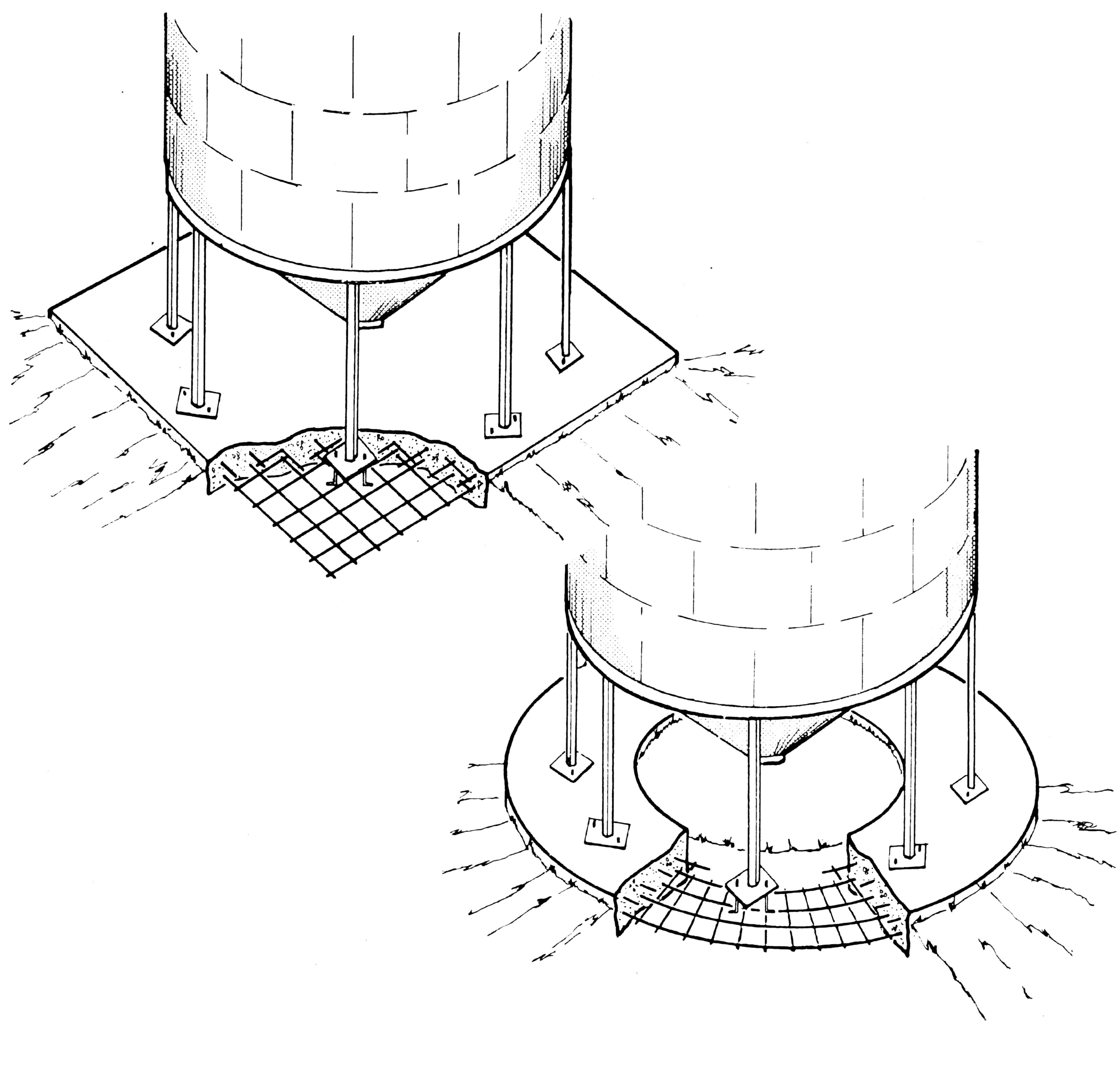
CONCRETE FOOTINGS
FOR STEEL HOPPER-BOTTOM BINS



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CPS
PLAN Q-7114

For many farm bins, the foundation details in this leaflet along with a good estimate of soil strength should suffice. If soil conditions are in doubt, or where very large loads and expensive structures are involved, test the soil to determine both its strength and the most suitable foundation for the job.

You can use three types of footings for steel hopper-bottom bins – slab, ring and pile. Each type best suits a specific application. The slab and ring footings are subject to frost heave; do not use them for soils that heave.

SLAB FOOTING

A slab footing is easy to form and the steel is easy to place. The low pressure it exerts makes it suitable for almost any soil. A large slab allows flexibility in placing the bin and makes clean-up around the bin very easy. However, the steel and concrete add considerably to the cost.

RING FOOTING

The ring footing usually requires the least material, although it may take somewhat more labor to build than the other two types.

TABLE 1 SIZING FOR SLAB FOOTING

Diameter **A** through center of legs (ft)	Maximum bin wall height (ft)	Maximum weight (tons)	Maximum capacity (bu)	Width **B** (ft)	Depth **C** (in)	Rebar spacing (both ways) (in)	Rebar size (both ways)	Volume of concrete (yd^3)
12	20.0	60	2000	15.5	10	12	10M	7.4
14	15.0	66	2200	17.5	10	12	10M	9.5
	22.5	90	3000	18.0	10	12	15M	10.0
16	17.5	100	3300	20.5	10	12	15M	13.0
	20.0	111	3700	21.0	10	12	15M	13.6
	22.5	126	4200	21.0	10	12	20M	13.6
18	22.5	150	5000	23.5	12	12	20M	20.5
20	15.0	150	5000	25.0	12	12	20M	23.1
	17.5	165	5500	25.5	12	12	20M	24.1
	20.0	180	6000	26.0	12	9	20M	25.0

TABLE 2 SIZING FOR RING FOOTING

Diameter **A** through center of legs (ft)	Maximum bin wall height (ft)	Maximum weight (tons)	Maximum capacity (bu)	Width **D** (ft)	Depth **E** (in)	Rebar Size (12” o.c. both ways)	Volume of concrete (yd^3)
12	20.0	60	2000	3.5	10	15M	4.0
14	15.0	66	2200	3.5	10	15M	4.8
	22.5	90	3000	3.5	10	15M	4.8
16	17.5	100	3300	3.5	10	15M	5.4
	20.0	111	3700	4.5	10	20M	7.0
	22.5	126	4200	4.5	10	20M	7.0
18	22.5	150	5000	4.5	12	25M	9.4
20	15.0	150	5000	4.5	12	25M	10.5
	17.5	165	5500	5.5	12	25M	12.8
	20.0	180	6000	5.5	12	25M	12.8

PILES

Deep pile foundations are recommended for two common soil conditions:

- deep clay soils that either have poor bearing capacity or are subject to frost heave; and
- situations where a dense hard soil or bedrock underlies an otherwise poor construction soil.

Pile foundations for large loads are typically of reinforced concrete cast in a bore hole that is 12 to 18 in. in diameter by 15 to 30 ft deep.

Piles derive most of their load-carrying capacity from what engineers call 'skin friction', the adhesion of the concrete pile to the wall of the bore hole. The end area of the pile carries relatively little load unless it sits on rock or exceptionally hard soil.

A safe design load for cast-in-place piles set in firm clay is 400 lb/ft^2 of shaft area. This does not count the top 6-8 ft of the pile, where frost disrupts the adhesion between the shaft and the soil.

Table 3 gives estimated design loads for typical concrete piles based on the above criteria (400 lb/ft^2) and disregarding end-area capacity. For example, a pile carry a 10 ton (20 000 lb) bin support would be 16 in. in diameter by nearly 20 ft deep.

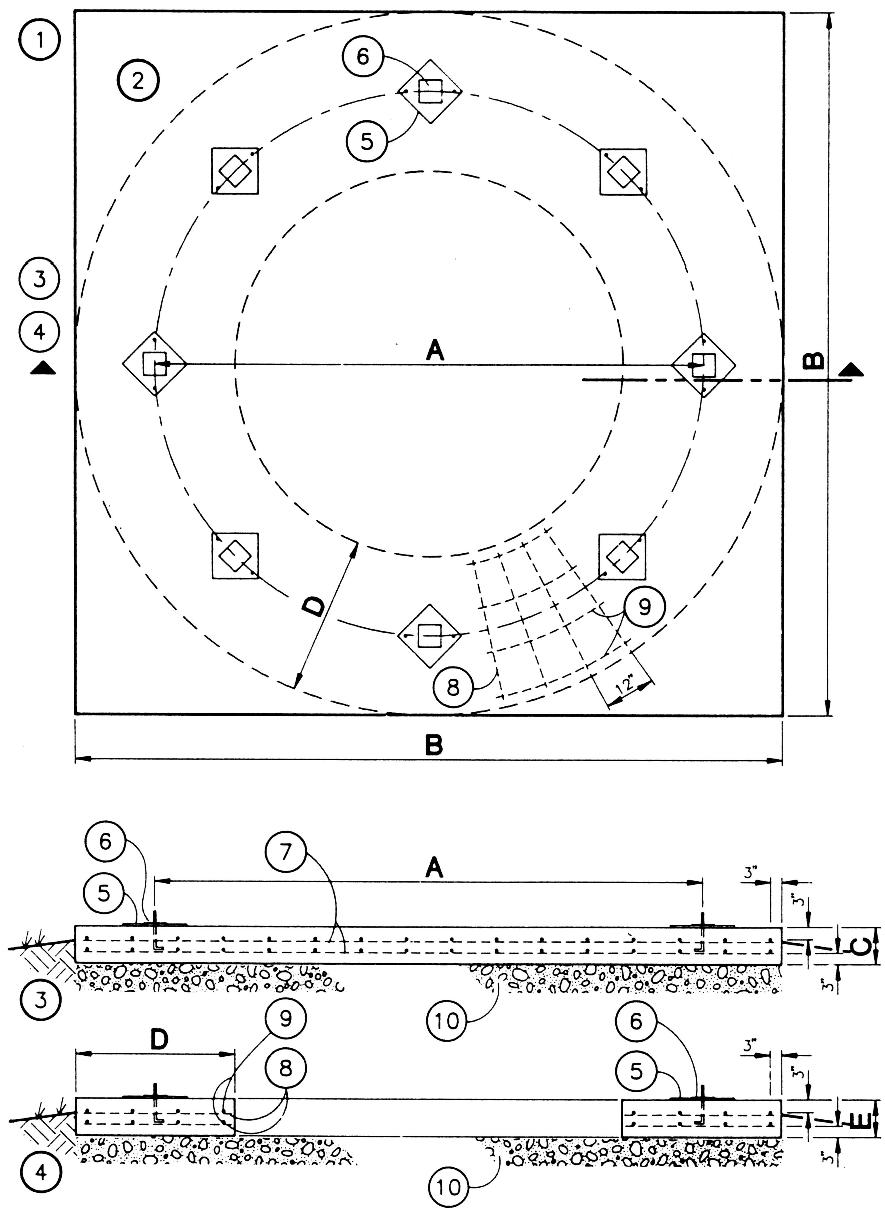
CONSTRUCTION

When building a slab or ring footing, pay careful attention to limits of soil strength, concrete strength, leg pad size, and number of legs. Note the details of slab or ring footing depth, footing width, rebar spacing and number and size of rebars as noted in the tables. You *must* remove the topsoil to expose firm subsoil and add compacted gravel up to the level of the footing base.

TABLE 3 CAPACITY OF CAST-IN-PLACE CONCRETE PILES (lb)*

Pile depth (ft)	Diameter of pile (in.)		
	12	16	18
12	7 500	10 100	11 300
15	11 300	15 100	17 000
20	17 800	23 500	28 400
25	23 900	31 800	35 800
30	30 200	40 200	45 200

* Based on skin friction of 400 psf and no end-bearing allowance (assume end bearing accounts for weight of pile)



1. Plan view of slab footing (solid lines) – see Table 1 for dimensions
2. Plan view of ring footing (dotted lines) – see Table 2 for dimensions
3. Section through slab footing
4. Section through ring footing
5. 12” x 12” x 1/2” steel plate complete with two 5/8” x 10” anchor bolts embedded in concrete
6. 6” x 6” x 1/4” steel plate welded to bottom of bin leg and welded to **5**
7. rebars both ways – see Table 1
8. rebars across ring footing; 12” o.c. at outside of footing
9. rebars @ 12” o.c. bent to curvature of ring footing
10. 6” well-compacted gravel

Notes:

Footings are designed for a minimum of six legs per bin.
Use 4000 psi (30 MPa) concrete, minimum.
Use 50 000 psi (300 MPa) deformed steel rebars, minimum.
Design soil strength for slab footing is 1000 lb/ft^2 (silt or loam).
Design soil strength for ring footing is 2000 lb/ft^2 (soft clay or sandy loam).
If diameter **A** at center of legs falls between values on tables, use design for next higher diameter. For ring footings adjust **A** so that bin legs are centered on footing.
Footing designs are based on storing grain (wheat) at a maximum density of 48 lb/ft^3.
Other anchor systems may be substituted for anchor bolts (consult manufacturer’s technical literature for equivalent-strength anchors).
This plan gives structural choices to be selected to meet local conditions. You must ensure that these conditions are met; consult an engineer if you are not familiar with the details.