# HOW TO BUILD A HOMEMADE WOOD STAVE SILO



Extension Circular 529

W. L. Griebeler
M. G. Huber

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# HOW TO BUILD A HOMEMADE WOOD STAVE SILO

W. L. Griebeler, Asst. Agricultural Engineer
M. G. Huber, Extension Agricultural Engineer

This circular contains plans and explains the construction of a homemade wood stave silo. This silo is easily erected without scaffolding, and with the tools usually found around the farm.

## SIZE TO BUILD

In order to preserve the silage on top, at least three inches should be fed daily. In warm weather this is important to prevent heating and spoilage. Many farmers are finding that it is a good practice not to build silos larger than 14 feet in diameter because of the work in unloading larger diameters. A 12-foot silo can be unloaded without much carrying of each fork full. Larger diameter silos require considerable carrying of the silage to pitch it down the chute.

Table 1 shows the proper diameter and height of silo for herds of different sizes to be fed different quantities when three inches are removed daily. To use Table 1 to figure the proper size of silo, you must know (1) the size of herd, (2) the amount of silage to be fed daily per animal, (3) the length of the feeding period. Feeding periods of 60, 90, and 120 days are given in the table. A 180-day silage feeding program will require two silos of the proper size to feed your herd for 90 days.

## STAVES

Douglas fir, pine, spruce, and hemlock are used for silo staves, the preference being in the order in which they are given. The most satisfactory wood silo stave is a 2" x 6" tongue and grooved, slightly beveled and as long as the height of the silo. Sometimes it is not possible to get full-length staves for a tall silo. If short staves are used, they should be of two different lengths so the end splice points will be staggered. With tongue and grooved staves, a butt joint splice in the upper 20 feet of a silo is sufficiently strong but may leak a little air if the joint is not perfectly square. Metal or wood splines may be used to make the joint tight. The number of staves required for different size silos is given in Table 2.

## HOOPS, TIE RODS AND STAPLES

Soft steel rods for hoops are preferred to iron. Table 3 gives the size and number of hoops required for different height silos. The length of the rods used for hoops for different diameter silos is given in Table 4. Both ends of each hoop rod should be threaded for 6 inches. Tie rods are 3'3" long and threaded 1½ inches on each end. Approximate number of staples needed for each diameter silo is given in Table 5.

## WASHERS

Large malleable or cast iron washers, commonly known as bridge washers, are used on hoops and tie rods for heights up to 24 feet. Larger washers should be placed under the malleable washers on every hoop and tie rod more than 24 feet down from the top of the silo to prevent the washers from pulling into the door frame and binding post. The taller a silo is, the greater the bursting pressure is near the bottom when the silo is filled. The larger washers should be 3 inches square and can be made from sections of ¼" x 3" steel bars drilled with a 11/16" hole.

## FOUNDATION

The foundation design shown in Figure 2 is for average conditions in western Oregon. Where the frost line is shallow, and solid, undisturbed earth can be found as little as twelve inches below the ground surface. In cases where the building site is poorly drained and there are soft soil conditions, the foundation size must be increased and additional reinforcement will be required. The plan shown is for a 12-foot inside diameter silo. For other size silos, the overall width of the foundation slab should be the inside diameter plus 1½ feet. The footing should be centered under the silo wall.

Concrete for a silo foundation must be of good quality. Use standard portland cement; clean, coarse sand; clean, coarse gravel graded from ½" to 1½" and water that is clean enough to drink. The usual mixture for this type of foundation is 1 part cement, 2½ parts sand, and 4 parts of gravel mixed with 4 to 5 gallons of water for each sack of cement used in a batch. If plant-mix concrete is used, specify that it be what is known as a 6-sack mix.

## DOOR FRAME

The door frame is built as a unit on the ground before erection, and is continuous from the bottom to the top of the silo. The frame is made of two full-length 4" x 6" door posts spaced 3'0" apart, outside to outside. The drawings in Figure 4 show the location of part of the holes for the hoops and tie rods for a 30' silo. All spacings are shown on Figure 1. Dimensions for hoop locations of other height silos are obtained from Table 3.

To build the door frame, lay the 4" x 6" door posts up on several sawhorses and mark the hoop and tie rod locations on both door posts at the same time. Notice that the dimensions are given in progression from the top of the silo down. A long, flexible tape will make this marking job easy and will avoid errors in location. After marking for the holes, spike on the 2" x 4" door stop, being careful not to nail where holes are to be bored.

Bore the holes for the hoops and tie rods with a No. 11 bit. The holes will be a little large which will permit easier assembly of the hoops to the frame. Notice that the tie rod holes are bored straight through the door frame. The hoop holes are bored at an angle to center the washer and nut location on the 2" x 4" door stop. A method of getting this angle bored correctly is as follows: Lay the door post on the sawhorses with the 2" x 4" door stop down. On both ends of the post carefully mark off the correct location and angle of the hoop holes. Nail a short piece of 1" x 2" on each end of the 4" x 6" carefully following the lines marked, with one end of the 1" x 2" sticking up in the air. While one man is boring the hoop holes, another can be sighting across the angled 1" x 2" and give corrections to him.

After the holes are all bored, assemble the door frame by bolting on the 2" x 6" pieces top and bottom. At frequent intervals, set in scraps of 2" x 4" across the frame to hold the door posts parallel during assembly and erection. Put in the tie rods and tighten the nuts. Remember to use larger washers near the bottom of the silo.

## BINDING POST

The binding post is a full-length 6" x 6" timber located on the opposite side of the silo from the door frame when the silo is erected. Figure 4 shows the location of the holes bored in this member to take the ends of the silo hoops. Use the system described previously to bore all holes in the binding post at the proper angle. To get the hoop holes marked in the proper position, lay the binding post alongside of the door frame and mark the holes 3" above and 3" below the hoop holes in the door frame.

## BENDING THE HOOPS

The hoops can be bent on a hay rake wheel or any wheel with a reasonably wide, concave rim. Such a wheel should be at least 4 feet or larger in diameter. Wrap a length of wire or chain to form a loop around a point on the rim of the wheel. Put one end of a hoop length under this loop and bend the hoop into the concave rim by turning the wheel. This job will require two men, one to turn the wheel and one to bend the hoop. If the wheel used is off the rake, lay it horizontally on sawhorses or the door frame. With one man holding the wheel, another can walk around the wheel bending the hoop into shape. After the hoop is bent to the wheel shape, one man on each end of the hoop can pull the hoop ends back out to approximately the diameter of the silo. If the wheel circumference is smaller than the length of the hoop, keep sliding the hoop through the loop on the rim while bending to keep the bend uniform and prevent sharp kinks.

## ERECTING THE SILO

Equipment needed:

- Brace and No. 11 bit or electric drill and bit
- Hand saws
- Claw hammers
- Sledge hammer
- Small jack that can be operated in a horizontal position
- Single pulley with clevis or hook
- Sufficient rope for three guy lines and a hoist line for pulling up staves
- Rope and pulley to erect door frame and binding post
- One ladder to reach top of staves--if staves are spliced, another ladder to reach splices
- Wrenches to fit hoop nuts
- Tractor or truck to pull up door frame and binding post
- Hay rake wheel for bending hoops

Materials other than the bill of materials:

- Miscellaneous lengths of lumber or small poles for bracing
- Spikes and nails for bracing
- One 2 x 4 about 4 feet longer than silo diameter for top bracing from binding post to door frame

Procedure:

The order of work in preparation of erecting the silo should be:

(1) Pour the concrete foundation
(2) Build the door frame
(3) Bore hoop holes in the binding post
(4) Bend the silo hoops

To begin the actual erection of the silo, mark off with crayon on the foundation the location of the door frame and binding post. Set up the door frame by means of block and tackle and truck or tractor power. Three guy ropes should be used in addition to the lifting line to hold the frame steady. Brace the door frame to adjacent buildings, if possible, or to ground anchors, making sure that it sets plumb. All braces must be fastened so as not to interfere with putting in hoops or setting in staves.

Securely fasten to the top of the binding post a length of 2" x 4" that will reach across to the top of the door frame when the post is upright in its proper position. This 2" x 4" should be well braced to the binding post by braces to the inside and outside surface of the post. Mark on the 2" x 4" the exact dimension for the diameter of the silo and start a spike in it that can later be driven in the top of the door frame. Fasten the three top hoops to the binding post and also secure the three guy ropes used on the door frame to the top of the post. Raise the binding post with one man on top of the door frame to position and nail the 2" x 4" crosspiece from the binding post. With the bottom of the post in position, tighten the guys, and leave them up as anchors until the silo is completed.

Place the hoops in position on one side of the silo only, beginning at the bottom and working up. Hoops in the binding post can be placed from the top down. To keep the hoops from sagging, place a narrow board vertically on the outside of the hoops midway between the door and binding post and drive a nail below each hoop position. Bend the nail up around the hoop. This board will not interfere with placing the staves if set on the outside and can be removed before final tightening of the hoops.

With a man at the top of the long ladder set inside the silo, start setting up the staves at the binding post, with the groove of the first stave toward the post. Staple each stave top and bottom, leaving just a little slack so the stave can move during final tightening. After 4 or 5 staves are in, drive a staple loosely in one stave and push this stave ahead of the work to hold the upper hoop in place. A pulley and rope fastened to the 2" x 4" across the top will be convenient to pull up the staves, especially full length ones.

Before the last two staves are set up, place a jack between the staves and the door frame. Jack the staves over tight and then nail several pieces of scrap board on the outside of the silo across the last stave and the door frame to hold them in place. Remove the jack and put in the remaining staves. Sometimes it will be necessary to rip a stave for the last one next to the door frame. When the last stave is in place, the hoops should be straightened up and tightened evenly.

Lean the remainder of the silo staves up in the finished portion of the silo, keeping them nearly vertical so they do not push the silo out of line. Fasten the hoops in place and set up the staves in the same manner the first half was built, again starting at the binding post.

Finally, tighten all hoops evenly and staple them in place. Every stave is stapled to the top and bottom hoop during erection. In addition, staple every third stave on each hoop. Stagger the staples so that each stave is stapled to every third hoop.

## DOORS

The doors fit across the door frame and inside of the 2" x 4" door stops. A simple type of door is made of lengths of 2" x 6" T & G cut about 1/8" shorter than the distance between the door posts. Set them in across the frame as the silo is filled. Alternate boards should be placed tight against the opposite door posts to stagger the air pockets at the end of each door board.

If you prefer to line the inside of the door with paper during filling, the paper should be a kraft type or good grade of roofing paper. This paper should run lengthwise up the silo and be held on each side of the door with lath battens placed vertically. If this system is not followed, the paper will usually buckle as the silage settles and form air pockets, a source of spoilage.

## ANCHORS

Figure 1 shows the method of anchoring this type of silo. The guy wires should be made of ½" galvanized steel wire strand which does not stretch as much as ordinary wire rope. If convenient to do so, the guy wires may be fastened 2/3 of the way to the top of the silo for a saving of material.

## CHUTE

Figure 5 shows a typical chute construction that was designed for ease in building. The framework is on the inside of the chute to permit application of vertical siding and prevent rain water damage to the supporting framework.

## ROOF

Figure 6 illustrates the method of framing a hexagonal roof with all of the layout dimensions given in Figure 7. By following the dimensions given in the table for a certain size silo, all cutting can be done on the ground and the roof assembled after the silo is filled so there is a platform of silage to work on. The 4 x 4 rafter plate that rests on the top of the silo should be tied to the silo staves by means of metal straps that can be looped over the plate and carried down the staves at the two points where each plate crosses the silo. The roof may be covered with 1-inch boards for sheathing and a choice of shingles, composition or metal sheets for roofing.

## PAINTING

Any painting should be done when the staves are dry. The best paint for a silo is one of the darker paints such as red barn paint which has iron oxide as a pigment. Black paints made with carbon black and similar pigments, yellow, red and brown paints made with natural earth pigments, in which the color is due principally to iron oxide, are very durable. A paint of high lead and oil percentage is also a good silo paint. The paints mentioned here are the type that will have a soft finish that will chalk with age and will not blister or crack. The harder paints made with lead and zinc do not give good results on a silo as they usually blister and crack as the staves absorb moisture from the silage.

Table 1

Relation of size of herd to diameter of silo for feeding on the basis of 40 pounds of silage per cubic foot and the removal of a minimum of three inches of silage daily to avoid spoilage

| No. Cows Fed 40# Daily | No. Cows Fed 50# Daily | No. Cows Fed 60# Daily | No. Cows Fed 70# Daily | FEED FOR 60 DAYS | | | FEED FOR 90 DAYS | | | FEED FOR 120 DAYS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Total Tons | Diam. Ft. | Ht. Ft. | Total Tons | Diam. Ft. | Ht. Ft. | Total Tons | Diam. Ft. | Ht. Ft. |
| 12 | 10 | 8 | 7 | 15 | 8 | 18 | 23 | 8 | 26 | 30 | 8 | 30 |
| 14 | 11 | 9 | 8 | 17 | 8 | 20 | 26 | 8 | 28 | 34 | 10 | 24 |
| 16 | 13 | 11 | 9 | 20 | 8 | 24 | 30 | 8 | 30 | 40 | 10 | 28 |
| 18 | 14 | 12 | 10 | 22 | 8 | 26 | 33 | 10 | 24 | 44 | 10 | 30 |
| 20 | 16 | 13 | 11 | 24 | 8 | 26 | 36 | 10 | 26 | 48 | 10 | 32 |
| 22 | 17 | 15 | 12 | 27 | 10 | 20 | 41 | 10 | 28 | 54 | 10 | 34 |
| 24 | 19 | 16 | 14 | 30 | 10 | 22 | 45 | 10 | 30 | 59 | 11 | 32 |
| 26 | 21 | 17 | 15 | 32 | 10 | 24 | 47 | 10 | 32 | 63 | 11 | 34 |
| 28 | 22 | 19 | 16 | 34 | 10 | 26 | 51 | 11 | 28 | 68 | 12 | 32 |
| 30 | 24 | 20 | 17 | 36 | 10 | 26 | 54 | 12 | 26 | 72 | 12 | 32 |
| 32 | 26 | 21 | 18 | 39 | 10 | 28 | 59 | 12 | 28 | 78 | 12 | 34 |
| 34 | 27 | 23 | 19 | 42 | 10 | 28 | 62 | 12 | 30 | 83 | 13 | 32 |
| 36 | 29 | 24 | 20 | 44 | 10 | 30 | 65 | 12 | 30 | 87 | 13 | 34 |
| 38 | 30 | 25 | 22 | 46 | 10 | 30 | 68 | 12 | 32 | 91 | 14 | 30 |
| 40 | 32 | 27 | 23 | 49 | 11 | 28 | 73 | 12 | 32 | 97 | 14 | 32 |

Table 2

| Inside Diameter of Silo | Number of Standard Silo Staves - 5-1/8" inside face |
|---|---|
| 8'0" | 53 |
| 9'0" | 61 |
| 10'0" | 69 |
| 11'0" | 76 |
| 12'0" | 83 |
| 12'6" | 87 |
| 13'0" | 91 |
| 14'0" | 98 |
| 16'0" | 112 |

Table 3

Hoop spacing for various heights of wood stave silos not exceeding 16 feet in diameter

| Rod Diameter | Distance in feet from top of silo |
|---|---|
| 1/2" | 1'6" |
| 1/2" | 5'0" |
| 1/2" | 8'6" |
| 5/8" | 11'6" |
| 5/8" | 14'0" |
| 5/8" | 16'6" |
| 5/8" | 18'6" |
| 5/8" | 20'6" |
| 5/8" | 22'0" |
| 5/8" | 23'6" |
| 5/8" | 25'0" |
| 5/8" | 26'6" |
| 5/8" | 28'0" |
| 5/8" | 29'6" |
| 5/8" | 30'6" |
| 5/8" | 31'6" |

Table 4

Length of Hoops Needed

| Diameter of silo | Length of each half hoop |
|---|---|
| 8' | 12'9" |
| 9' | 14'5" |
| 10' | 16'1" |
| 11' | 17'8" |
| 12' | 19'1" |
| 12'6" | 20'0" |
| 13' | 20'9" |
| 14' | 22'3" |
| 16' | 25'4" |

Table 5

Staples--5/8" diameter 2½ long

| Silo size | Number required |
|---|---|
| 8' x 28' | 2 gross |
| 9' x 30' | 2½ " |
| 10' x 30' | 3 " |
| 12' x 30' | 4 " |
| 14' x 30' | 5 " |
| 16' x 30' | 6 " |

# BILL OF MATERIALS

## 12' x 30' Wood Stave Silo
## (less roof or chute)

LUMBER:

| Item | Pcs. | Size | Length | BM |
|---|---|---|---|---|
| Silo staves (beveled) | 83 | 2 x 6 T&G | 30' | 2490 |
| Door post | 2 | 4 x 6 | 30' | 120 |
| Binding post | 1 | 6 x 6 | 30' | 90 |
| Door stop | | 2 x 4 | 60 lin. ft. | 40 |
| Wood hoop | 6 | ½" x 4" | 20' | 20 |
| Doors | 14 | 2 x 6 T&G | 12' | 168 |

HARDWARE:

| Item | Pcs. | Size | |
|---|---|---|---|
| Soft steel hoops | 6 | 1/2" dia. | 19'1" |
| Soft steel hoops | 22 | 5/8" dia. | 19'1" |
| Soft steel tie rods | 14 | 5/8" dia. | 3'3" |
| Large malleable washers | 12 | 1/2" hole | |
| (or cast iron) | 72 | 5/8" hole | |
| Steel washers | 24 | 1/4" x 3" square with 11/16" hole | |
| Nuts | 12 | 1/2" | |
| Nuts | 72 | 5/8" | |
| Staples | 4 gross | 5/8" dia. | 2¼" |
| Door frame bolts | 8 | 5/8" | 8" |
| Top anchor bolts | 6 | 5/8" | 3" |
| Top anchor bolts | 8 | 5/8" | 6½" |
| Steel wire strand | 8 | 1/2" dia. | 32' |
| Turnbuckles | 8 | 5/8" bolt | 20" |
| Guy clamps | 16 | 1/2" | 4" |
| Lateral anchors, steel | 4 | 1/2" x 2" | 14" |
| Top anchors, steel | 4 | 1/2" x 2" | 10" |
| Top anchors, steel | 2 | 1/2" x 2" | 20" |
| Guy anchor stirrups | 4 | 3/4" dia. | 30" |
| Floor drain | 1 | 6" dia. minimum | |

CONCRETE:

| Item | Pcs. | Size | |
|---|---|---|---|
| Reinforcing steel | 6 | 1/2" dia. | 15' |
| Concrete | 4½ cu. yds. | 1:2½:4 mix or 6-sack plant mix | |

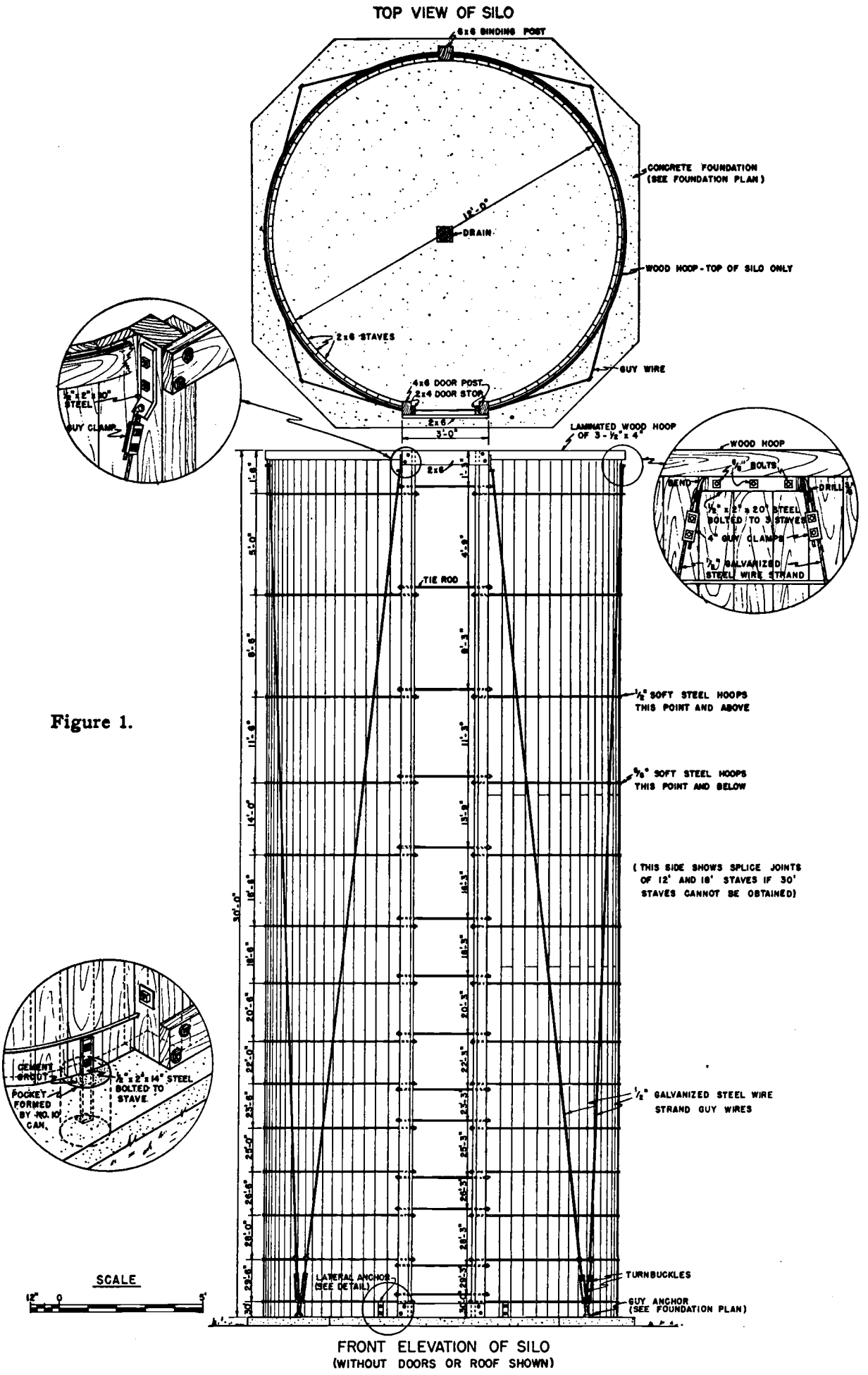

TOP VIEW OF SILO
6x6 BINDING POST
CONCRETE FOUNDATION (SEE FOUNDATION PLAN)
12'-0"
DRAIN
WOOD HOOP - TOP OF SILO ONLY
2x6 STAVES
GUY WIRE
4x6 DOOR POST
2x4 DOOR STOP
2x6
3'-0"
LAMINATED WOOD HOOP OF 3 - ½" x 4"
2x6
TIE ROD
½" SOFT STEEL HOOPS THIS POINT AND ABOVE
⅝" SOFT STEEL HOOPS THIS POINT AND BELOW
( THIS SIDE SHOWS SPLICE JOINTS OF 12' AND 18' STAVES IF 30' STAVES CANNOT BE OBTAINED)
½" GALVANIZED STEEL WIRE STRAND GUY WIRES
TURNBUCKLES
GUY ANCHOR (SEE FOUNDATION PLAN)
LATERAL ANCHOR (SEE DETAIL)
30'-0"
GUY CLAMP
WOOD HOOP
⅝" BOLTS
BEND
DRILL
½" x 2" x 20" STEEL BOLTED TO 3 STAVES
4" GUY CLAMPS
7/16" GALVANIZED STEEL WIRE STRAND
CEMENT GROUT
POCKET FORMED BY NO. 10 CAN.
⅜" x 2" x 14" STEEL BOLTED TO STAVE
SCALE
12" 0 5'
FRONT ELEVATION OF SILO
(WITHOUT DOORS OR ROOF SHOWN)

**Figure 1.**

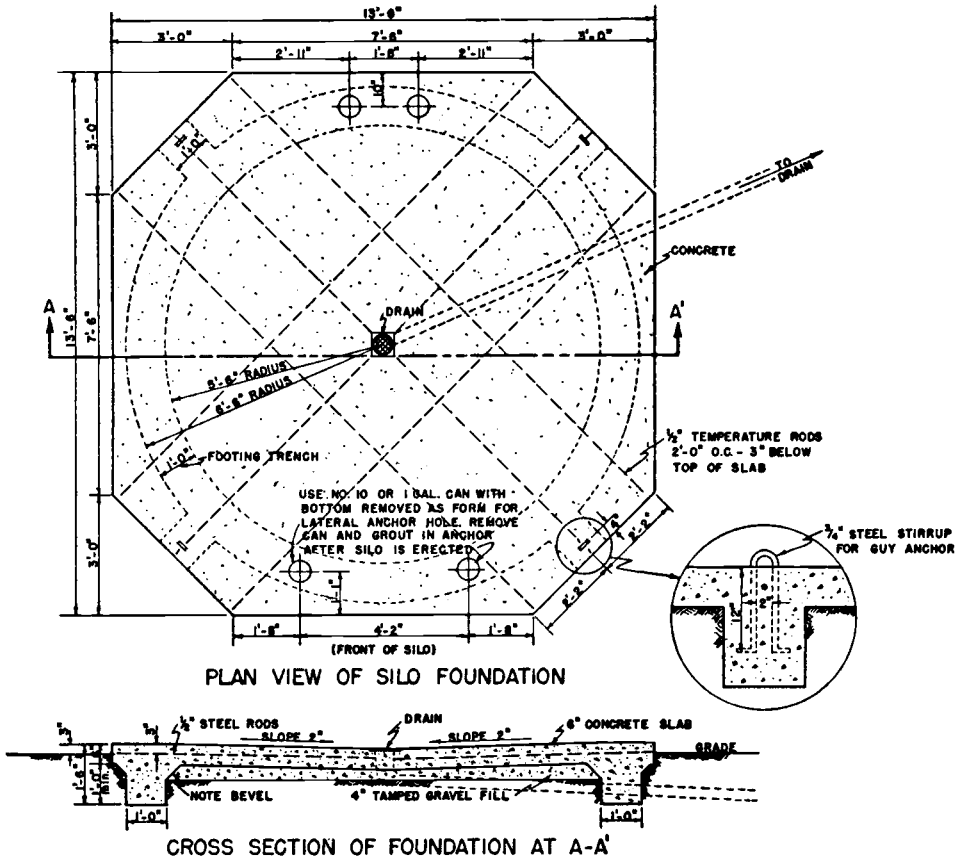



Figure 2.

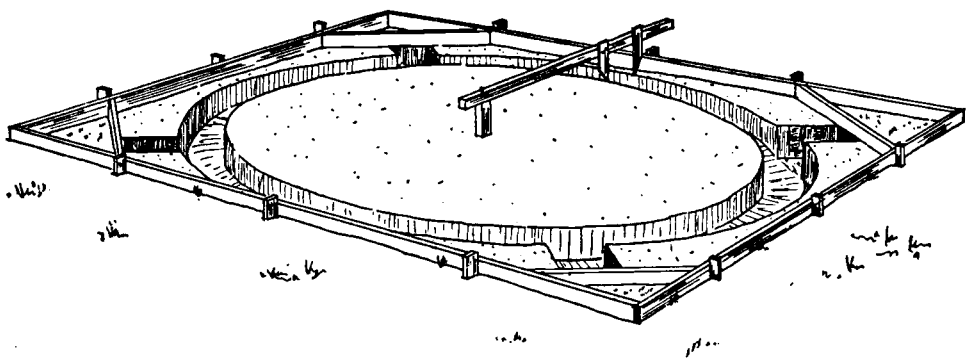
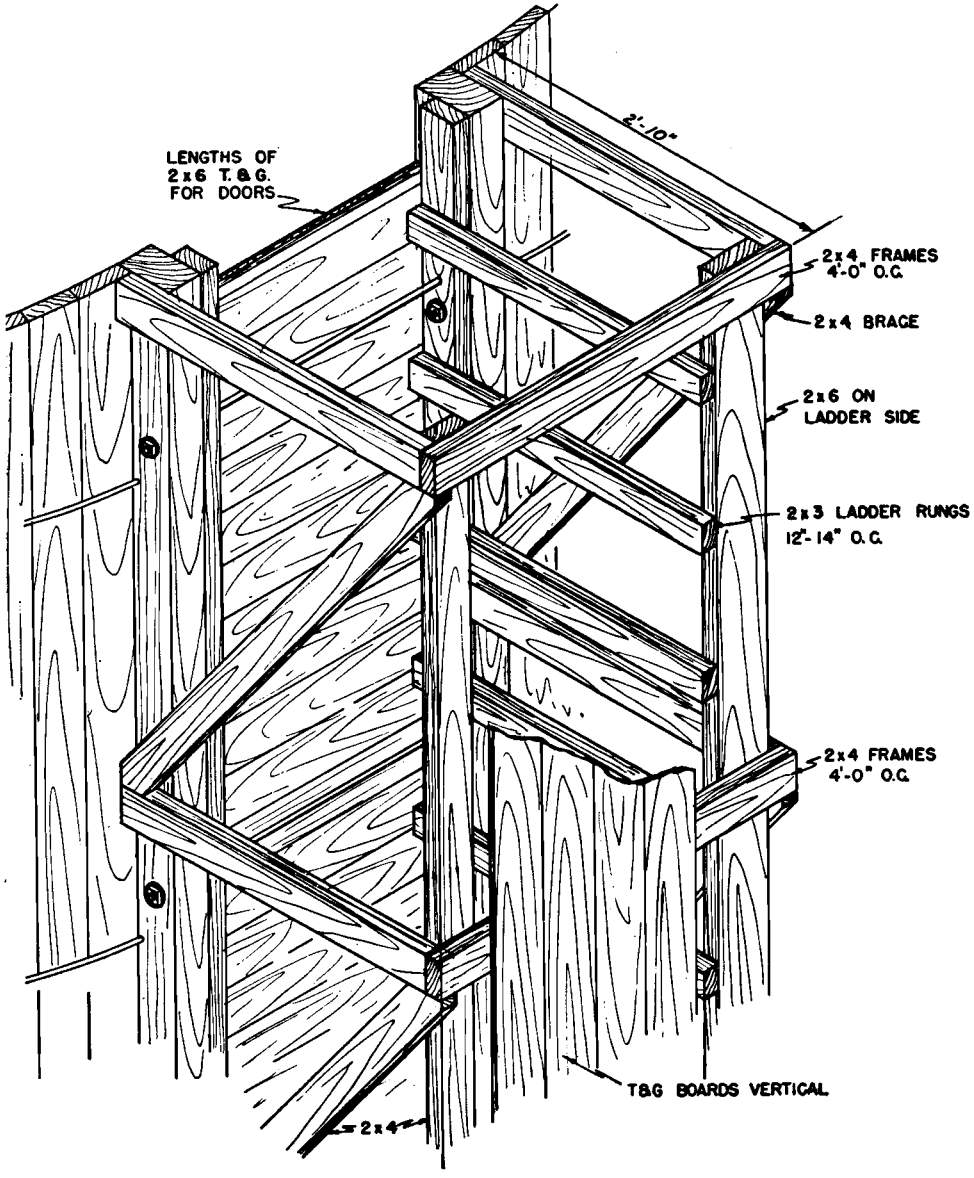


Figure 3. Method of laying out silo foundation.




TYPICAL CHUTE CONSTRUCTION

Figure 5.

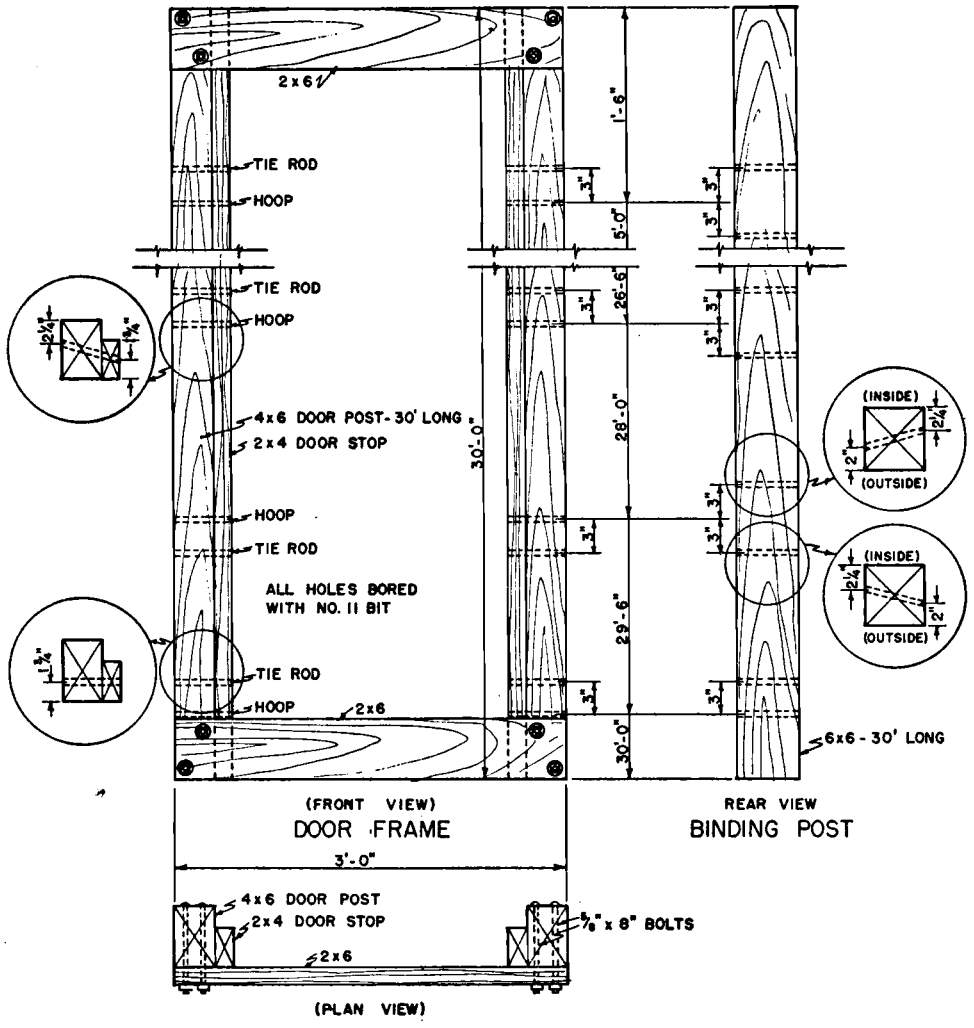
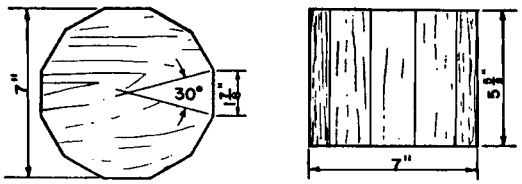
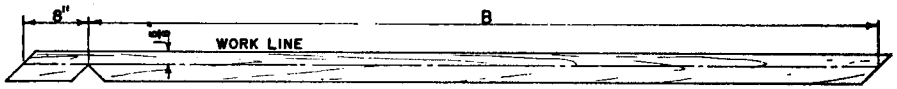



Figure 4.

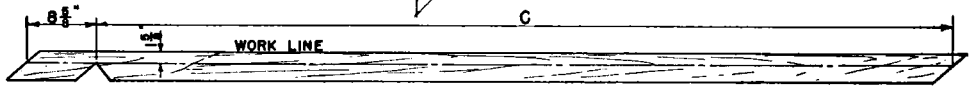



12-SIDE KEY BLOCK
(CUT FROM 6x8)


4X4 RAFTER PLATE
(USE $6\frac{15}{16}$ 12 ON END CUTS)



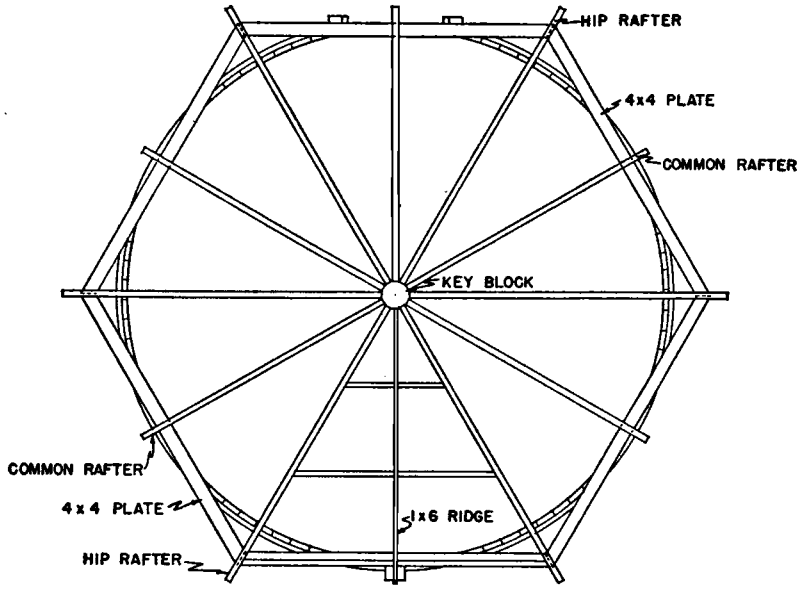

COMMON RAFTER
(USE 12 12 ON ALL CUTS).



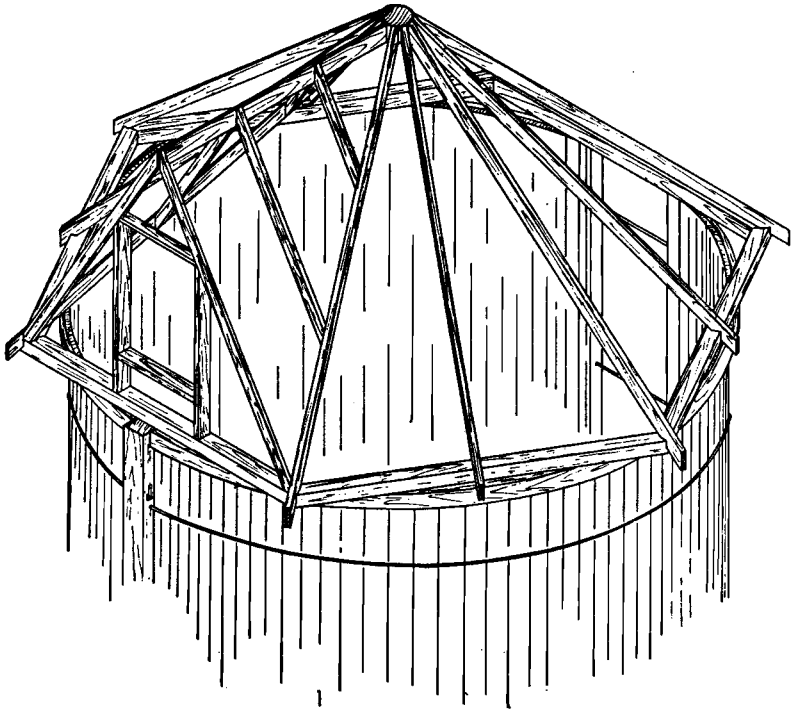

HIP RAFTER
(USE $10\frac{5}{16}$ 12 ON ALL CUTS)

| INSIDE SILO DIAMETER | 4x4 PLATE DIMENSION A | COMMON RAFTER DIMENSION B | HIP RAFTER DIMENSION C | RAFTER SIZE |
|---|---|---|---|---|
| 10'-0" | 6'-0" | $6'-11\frac{1}{4}"$ | $7'-6\frac{3}{8}"$ | 2x4 |
| 12'-0" | 7'-0" | $8'-1\frac{5}{8}"$ | $8'-10\frac{1}{16}"$ | 2x4 |
| 12'-6" | 7'-4" | $8'-7\frac{1}{8}"$ | $9'-3\frac{3}{8}"$ | 2x4 |
| 14'-0" | 8'-3" | $9'-8\frac{3}{8}"$ | 10'-6" | 2x6 |

Figure 7.




PLAN VIEW OF ROOF FRAMING



PICTORIAL VIEW OF ROOF FRAMING

Figure 6.