Bulletin 874

Concrete Tilt-up Construction on the Farm

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R. D. LEWIS, DIRECTOR, COLLEGE STATION, TEXAS

SUMMARY

Tilt-up construction is a method of building erection which involves the casting of concrete panels on a carefully prepared sand bed or on a floor previously cast at the building site. These panels are tilted into a vertical position to form the building walls and, by means of concrete pilasters, are connected together to give the rigid construction necessary for a permanent farm service building.

Methods of tilt-up construction have been developed to a high degree in commercial buildings. These techniques require heavy equipment which is not available on the farm. Methods now have been developed which permit the techniques of tilt-up construction to be used on the farm by the utilization of common farm equipment. This publication gives the techniques used in the erection of two experimental tilt-up farm structures.

A study of 100 plans of implement storage sheds, dairy barns and poultry houses, which were collected from 23 land-grant colleges throughout the United States, showed that the walls of most farm buildings in these classifications can be constructed from 8 x 8 or 8 x 10-foot panel modules with thicknesses of 4 to 6 inches.

A sand bed covered with 4 mil polyethylene sheeting made a satisfactory casting bed. A minimum of two footing holes 8 or more inches in diameter and 30 inches deep were used to support line or end pilasters, while a minimum of three footing holes were used to support corner pilasters. Footing caps were 6 inches thick and long enough to provide a minimum of 10 linear inches of bearing surface for each panel end.

Finished 2 x 4 and 2 x 6-inch lumber was found to be convenient for panel form construction. Concrete used with satisfactory results contained a minimum of five sacks of cement per cubic yard of mix. Clean, hard and well-graded aggregate was used.

Reinforcing steel was placed in every panel to insure adequate strength and stability. The tilting bolts at the top of the panel were located one-quarter of the panel height down from the top and one-quarter of the panel width in from each side. The bottom tilting bolts were positioned for tilting the panel directly into place or for the use of panel-placement rollers.

Two or four-row, wheel-type tractors were used with a tilting frame to erect the panels. The largest available farm tractor is recommended. The lowest gear should be used to insure a slow, smooth and safe tilting operation.

Panels cast on a concrete floor were moved into position by the use of panel rollers. These rollers could not be used on an earth surface. Therefore, panels cast on a sand bed were tilted directly into position.

Pilasters 7 inches wide and 8 inches long with two rods of 3/8-inch reinforcing steel were used to support 3 5/8-inch panels carrying only a roofing load. One vertical edge of each panel, and all the 3/8-inch reinforcing steel which projected out of the panel, were wrapped with 4 mil polyethylene to prevent bonding of the concrete when the pilasters were poured. This procedure provides a flexible joint for expansion and contraction when temperature changes occur.

Tilt-up construction requires no skilled labor. Two men can handle any phase of the work. Form materials can be reused for other purposes, after the completion of a tilt-up structure.

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Concrete Tilt-up Construction on the Farm

OTTO R. KUNZE and PRICE HOBGOOD*

A FARM SERVICE BUILDING should be durable and low in cost, have a long, useful life and still be flexible enough to accommodate the changes in farm management, processing and storing as they are developed.

The walls of a structure alone may constitute 30 to 60 percent of the total building cost. Therefore, if the cost of the walls could be reduced appreciably, the total cost of the structure could be reduced.

Concrete wall panels have been developed which can be cast by unskilled labor on the farm. The panels provide a permanent wall which needs no further protection from wind or weather. The walls are water-tight, termite-proof and present no problems in regards to rust, rot or maintenance.

Concrete-panel buildings lend themselves to painting and are worked easily into the color scheme or pattern of other farm structures.

PANEL SIZES

Panels for tilt-up construction on the farm are limited in size to such dimensions and weights as can be handled readily with farm equipment. To determine these sizes, 100 plans of implement storage sheds, dairy barns and poultry houses were collected from 23 land-grant colleges throughout the United States. A thorough study of these plans showed that most farm buildings in these classifications could be constructed from 8 x 8 or 8 x 10-foot panel modules with thicknesses of 4 to 6 inches. These panels are of convenient size to be tilted with the common wheel-type farm tractor.

*Respectively, associate professor and professor, Department of Agricultural Engineering.

TABLE 1. PANEL SIZES AND WEIGHTS USING COMMON SAND AND GRAVEL AGGREGATE

Size	Cubic yards required	Weight, pounds
8'0" x 8'0" x 3⅝"	.75	2900
8'0" x 8'0" x 5½"	1.10	4400
8'0" x 10'0" x 3⅝"	.90	3625
8'0" x 10'0" x 5½"	1.40	5500
10'0" x 10'0" x 3⅝"	1.15	4530
10'0" x 10'0" x 5½"	1.70	6875

STRENGTH OF PANELS

It was thought originally that solid panels 3-5/8 or 5-1/2 inches in thickness would be too heavy and difficult to handle with common farm equipment. As a result, numerous thin section or web panels were cast with reinforced ribs. These light-weight panels were subjected to simulated impact, wind and racking loads. Further tests were run with a testing frame capable of imposing a horizontal load on a vertical panel until failure occurred.

Although the strength and durability of the web panels were satisfactory, construction of the panel forms was a tedious, costly and time-consuming job. This was especially true when only materials which are commonly available on the farm were used. This undesirable feature of the web panel forms caused simplicity to be set up as an objective in future research.

More work was done to develop the equipment necessary to handle solid panels having thicknesses of 3-5/8 and 5-1/2 inches. These are the common widths of finished 2 x 4 and 2 x 6-inch lumber as it is purchased on the market. It can be used without alteration for panel form construction.

Solid 3-5/8-inch panels have sufficient strength for implement storage buildings, animal shelters, dairy barns and poultry houses.

WEIGHT OF SOLID PANELS

Finished concrete with sand and gravel aggregate weighs approximately 150 pounds per cubic foot. The weights of panels most adaptable for use in farm building construction are shown in Table 1.

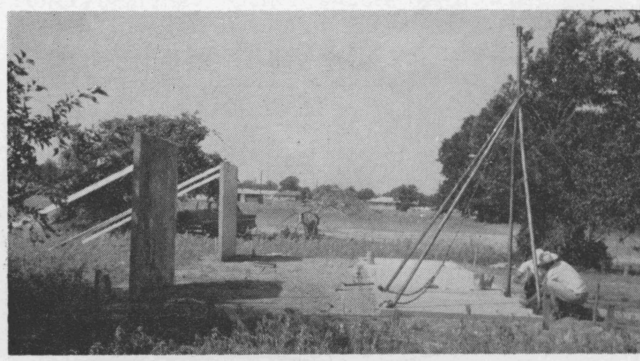

Figure 1. The tilting frame attached to a wall panel ready for tilting.

EQUIPMENT FOR HANDLING

Tilting Frame

A tilting frame is necessary to obtain the required leverage for erecting the wall panels. It consists of four legs which are constructed from 1-1/2 and 2-inch pipe. Each leg is attached to a tilting bolt which must be placed in the panel before it is cast. The frame attached to a panel is shown in Figure 1.

The four frame legs converge at a common point approximately 10 feet above the panel and are connected by a 1/2-inch bolt. One of the legs is extended 4 feet beyond the connection to provide a handhold and additional leverage for handling the panels. The tilting cable extends over the convergence point to produce a lever arm for tilting.

The two legs attached to the bottom of the panel should be at right angles with the lower

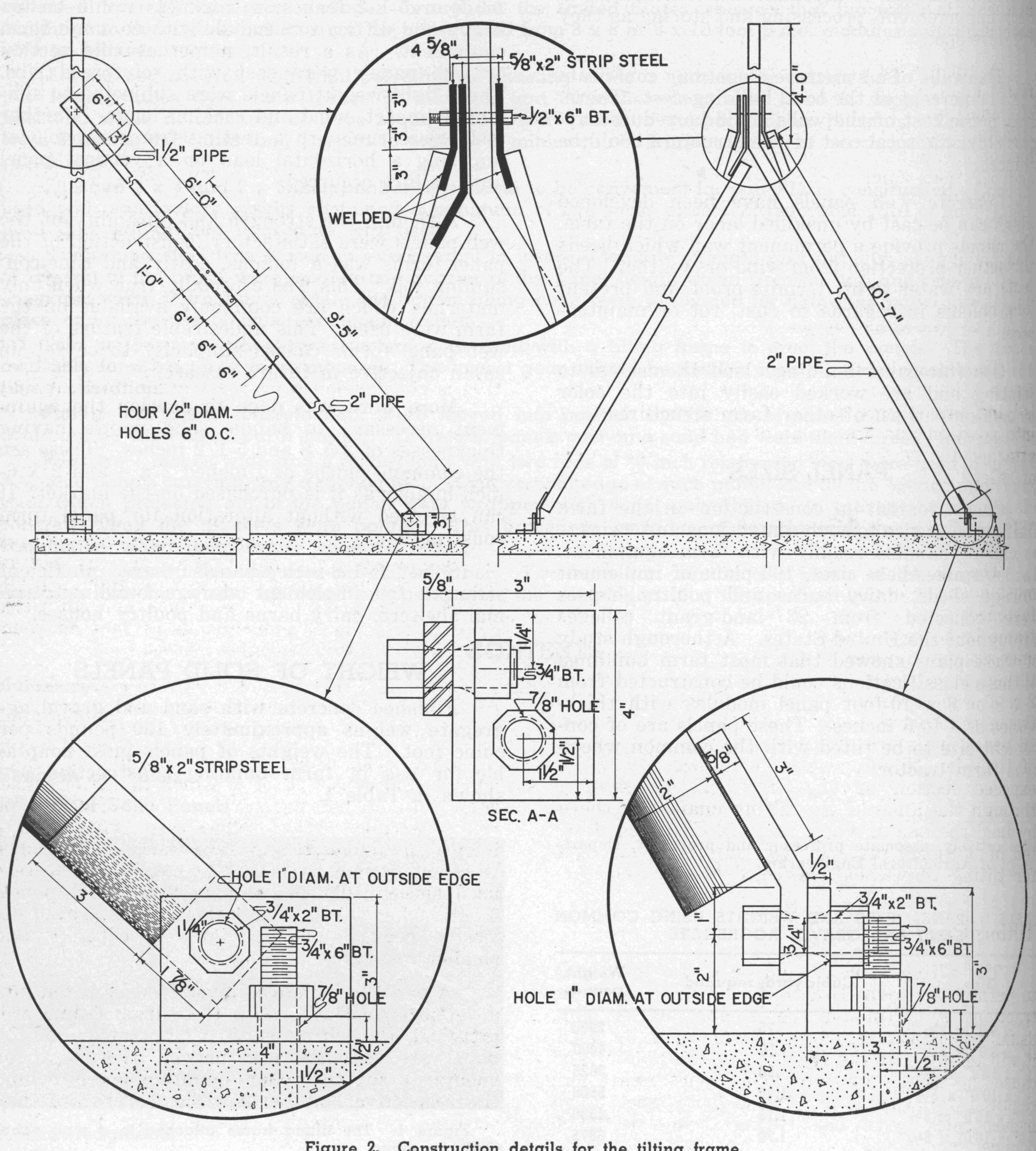

Figure 2. Construction details for the tilting frame.

edge of the panel. The tilting frame legs connecting to the bottom of the panel can be kept in the same relative position to the panel, regardless of its size, by adjusting the length of the tilting frame legs which connect to the top of the panel.

This adjustment is possible through the use of a 1-1/2-inch pipe which inserts into a 2-inch pipe. The length of the leg attaching to the top of the panel is adjusted by aligning a single 1/2-inch hole in the 1-1/2-inch pipe with any of a number of 1/2-inch holes which may be drilled in the 2-inch pipe. By use of a 1/2-inch bolt, each leg can be secured at its desirable length.

A hinge arrangement is used to connect the frame legs to the bottom of the panel. A strip of angle iron 3 x 3 x 4 inches and 1/2 inch thick is fastened to the 3/4-inch tilting bolt at the bottom of the panel. A metal strap 2 x 5 inches and 5/8 inch thick is bent to the proper angle and welded to the 2-inch pipe leg. A 3/4-inch hole reamed on the outside edge is drilled through the metal strap attached to the pipe and also through the portion of the angle iron which projects above the panel. A 3/4-inch bolt 2 inches long can be used to complete the connection. A sketch of the construction is shown in Figure 2.

The hinged connection permits the tilting frame to be attached to the panel while the frame is lying on the ground. The frame can be raised into position and the remaining two legs can be attached to the top panel bolts with a maximum of safety and a minimum of effort.

Tilting Chain and Spreader Bar

The tilting bolts in the top of the panel also must hold the chain to which the tilting cable is fastened. The chain is attached after the tilting frame legs are in place. To keep from exerting unnecessary stresses in the concrete panel while tilting, a spreader bar consisting of a wooden 2 x 4 with a length equal to the distance between the tilting bolts should be used. If two 16 penny nails are driven to within 1-1/2 inches of their length into each end of the 2 x 4, the exposed section of the nails can be inserted through the links of the tilting chain and thereby hold the bar in place. A steel chain constructed of 3/8-inch material has sufficient strength for tilting the panels discussed in this report.

Tilting Cable

The tilting cable should be sufficiently long to permit the farm tractor to develop maximum traction. A 1/2-inch diameter cable, 50 feet long, usually is adequate. If a shorter cable is used, it will tend to lift the rear end of the tractor and cause the wheels to spin. The approximate pull required for tilting an 8 x 8-foot panel 3-5/8 inches thick with the tilting frame is 2,000 pounds.

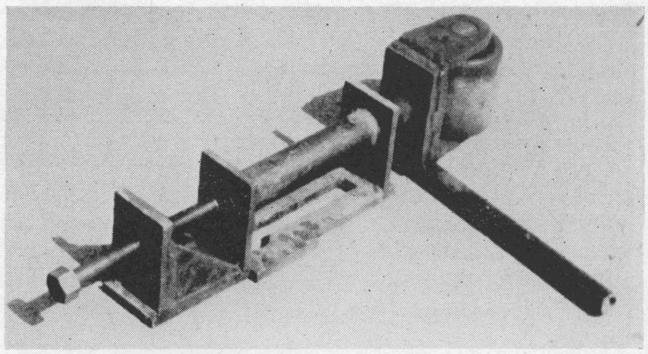

Figure 3. A steel roller used on concrete floors to transport the tilted panels into position. The tilting bolt in the bottom of the panel is slipped into the slot on the mounting plate. Two rollers are required to move a panel.

Tilting Power

A two-row tractor has been used successfully for tilting 8 x 10-foot panels with a thickness of 3-5/8 inches. For 5-1/2-inch panels, a four-row tractor should be used. To obtain maximum smoothness in the tilting operation, the lowest gear available is recommended. This is important where the panel is tilted directly into place. Sudden jerks in the tilting operation will cause the panel to slip and be out of position when the tilting operation is completed. If the needed traction is not developed by the tractor itself, it may be necessary to use additional wheel weights or ballasts.

Panel Placement Rollers

For some tilt-up construction, a concrete floor may be available on which the panels can be cast. In such a case, the panels may or may not be positioned while being cast so that they will tilt directly into place. If the panels are not tilted directly into place, some means of moving them into final position becomes necessary.

Figures 3 and 4 show a picture and a sketch, respectively, of the additions made to a purchased roller so that it could be used for this purpose.

The roller itself had a capacity of 4,000 pounds and consisted of a 4-inch diameter wheel with a 4-inch bearing surface and a Hyatt type roller bearing. Other rollers with wheels 2-1/2 inches in diameter and face surfaces 2 inches wide, but without any type of bearings also were used successfully for moving 8 x 8-foot panels 3-5/8 inches thick. The larger rollers proved desirable because of their greater capacity and smaller resistance to rolling.

A panel to be moved must first be tilted into a vertical position. With the tilting frame still attached, the tilting bolts in the bottom of the panel are loosened and driven back just far enough to slip the roller mounting plates behind the respective bolt heads. The rollers are then secured by tightening the nuts on the tilting bolts.

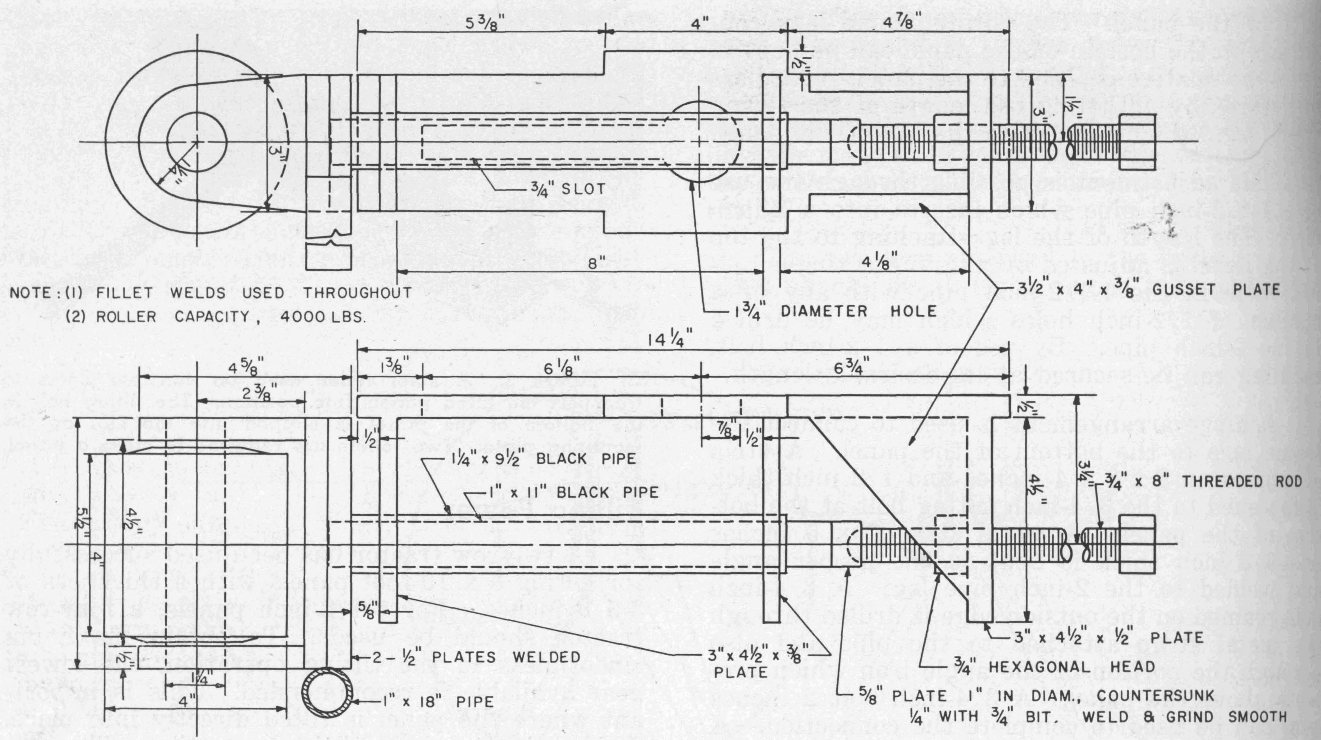

Figure 4. Construction details for panel rollers used to transport tilted wall panels into position.

The panel is raised clear of the floor by means of a jacking arrangement which consists of a 3/4-inch threaded rod passing vertically through a nut which is welded to the roller frame. The lower end of the threaded rod presses against the vertical pipe section attached to the roller. A bolt head is welded to the top end of the threaded rod which, when turned, raises or lowers the roller frame and the attached panel.

A vertical adjustment of 2-1/2 inches is provided to raise or lower the panel. This allows the panel to be set on a brick ledge below the floor level for ease in making a waterproof joint. A handle 18 inches long is provided on each roller to guide the direction in which the panel is to be moved.

CASTING PROCEDURE

Tilt-up construction, as every other type of construction, requires careful planning before the erecting work is started. The following discussion gives the general procedure used for erecting an implement shed and an animal shelter, and recommended improvements in procedure resulting from the experience gained in the construction of these buildings. The dimensions of the shed were approximately 20 x 40 feet, and those for the animal shelter were approximately 20 x 60 feet. The completed implement shed is shown in Figure 5. The animal shelter, after partial completion, is shown in Figure 6.

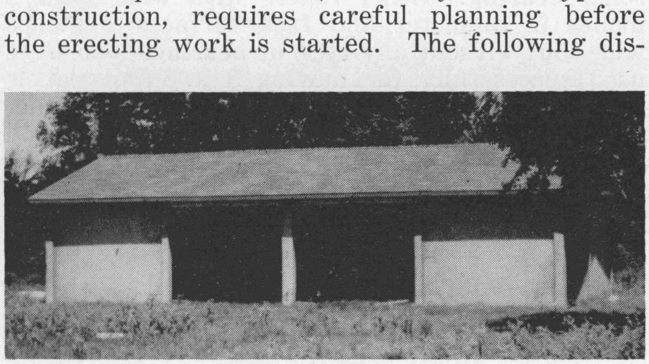

Figure 5. The implement shed complete with a solid deck roof and asphalt shingles.

The implement shed required ten panels 9 feet 4 inches x 8 feet in size and 3-5/8 inches thick. A two-panel opening was provided on the front of the structure to accommodate rolling doors.

The animal shelter consisted of an addition to an existing building and was designed with an open front. Therefore, it was necessary to construct only the back and one end wall. Concrete posts were used to support the roof in front. The eight panels cast for this structure were 9 feet 8 inches x 9 feet 3 inches and 3-5/8 inches thick. One panel had a 3-foot x 6-foot-8-inch opening for a door and three other panels had 20 x 30-inch window openings.

Actual construction of the buildings began by an even spreading of the sand necessary for the casting beds over the building site. The batter boards were set and the string lines were drawn at floor level to assist in establishing the elevation of the footings or foundation piers.

One 8-inch footing hole was drilled for each of the concrete posts across the front of the ani-

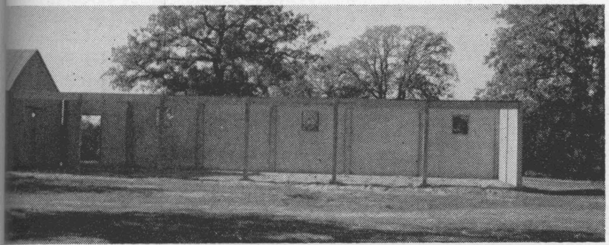

Figure 6. The animal shelter after the walls had been lted, the pilasters and posts poured, the lintels set and the p plates attached.

al shelter. Two holes were drilled adjacent to ach other for the pilaster footing along a wall r a wall end, and three holes were used for the orner pilaster foundations. All holes were drilld to a depth of 30 inches. The adjacent holes or the wall or corner pilaster footings were joind and made into a single oval or triangular hole y removing the remaining materials between he holes. In areas of sandy or sandy loam soils, r for the construction of a building with 5-1/2-nch panels, it may be desirable to drill three 12-nch holes for the wall footings and five similar ize holes for the corner foundations. The footng caps also should be extended to cover the oundation piers.

Footing caps 6 inches thick and approxinately 12 inches wide were provided for all pilsters and posts. The lengths of the caps were 2 inches for the concrete posts and 24 inches for he pilasters. The footing cap forms were held n place during placement of the concrete with stakes driven next to them. Each form was set to floor level. Each footing was reinforced with two bars of 3/8-inch reinforcing steel which extended the length of the footing and projected 18 inches above to provide ample room for fastening the pilaster or concrete post reinforcing steel.

The footings were cast with a mix containing five sacks of cement per cubic yard of concrete. The top surface was screeded, floated and given a final steel trowel finish to provide a uniform bearing area for the wall panels.

The sand floors were used for the panel casting beds. All the panels could not be cast in one operation since both panels adjoining any corner required the same area for casting. Figure 7 illustrates the panel form layout for the side walls in the implement shed, and Figure 8 shows the layout for the end panels after the side panels had been tilted into place.

The panel forms consisted of finished 2 x 4-inch lumber. The top and bottom forms were placed first, since they were utilized as supports for the screed which was used to level the sand. Figure 9 illustrates the screeding operation. The forms were set in exact position for tilting the completed panels into place. This required that the inside of the form at the bottom of the panels be set along the inside line of the finished wall.

Care was taken to keep from making unnecessary and undesirable imprints on the casting bed after the screeding process was completed. If a person accidentally stepped on the prepared

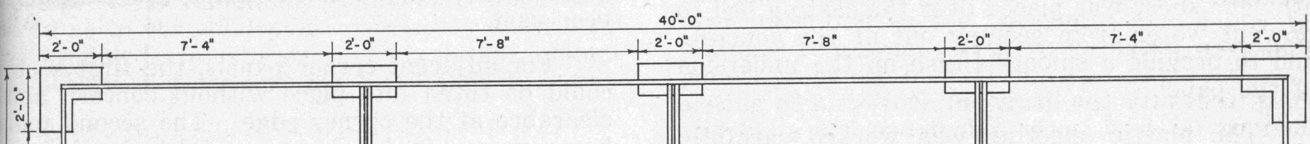

Figure 7. The panel form layout for casting all of the side panels in the implement shed.

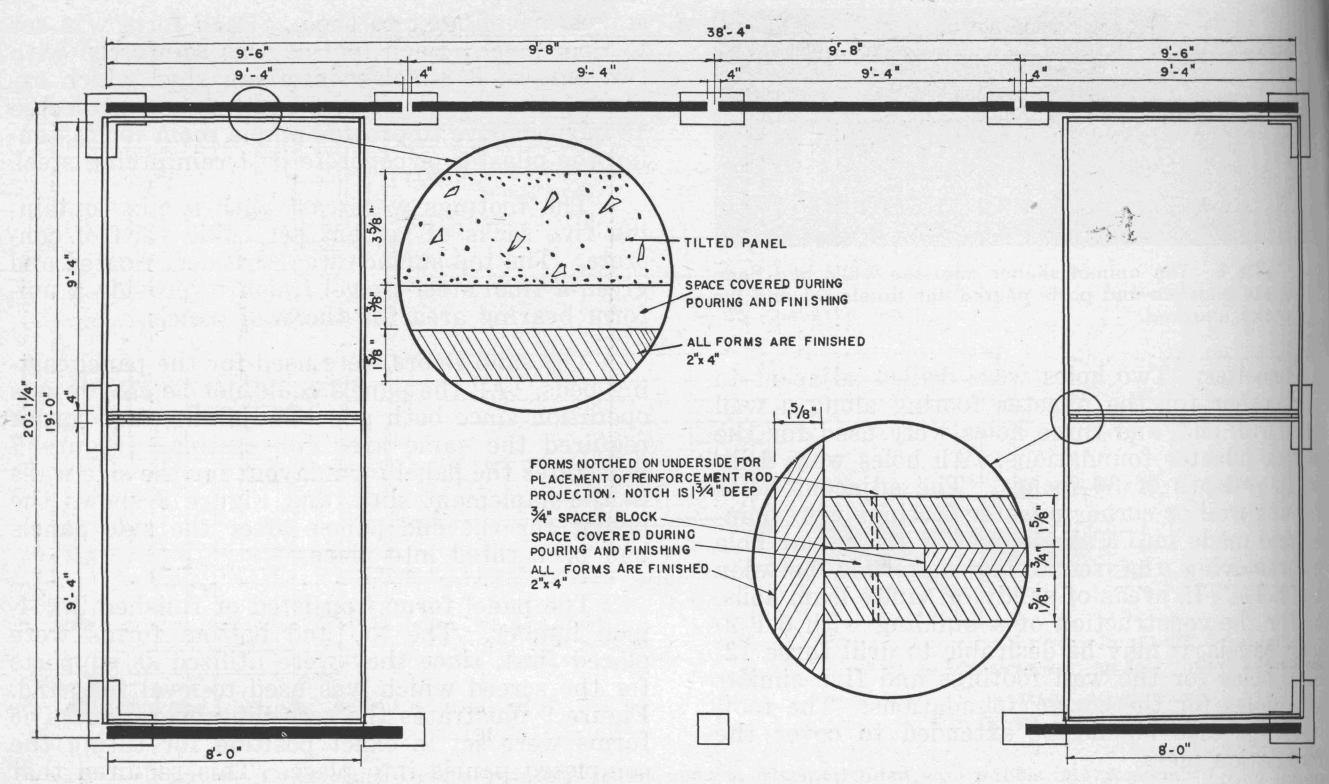

Figure 8. The panel form layout for the end panels as constructed for the implement shed after all of the side panels had been tilted into place.

sand bed, the resulting foot print appeared in the finished wall. Any other imprint in the sand bed also appeared in the finished product.

Following the screeding process, a 4 mil polyethylene sheet was placed over the casting bed to prevent water from seeping out of the concrete and to provide a smooth finish on the underside of the panel.

The plastic sheeting was worked carefully through under the panel forms and cut with sufficient extra length to pull on for smoothing and anchoring the sheets.

The side forms for the panels were set and spaced to provide adequate clearance between panels for the tilting process. A 3/4-inch opening between the two outside edges of the side forms gave a total clearance of 4 inches between panels when the forms were removed. This distance

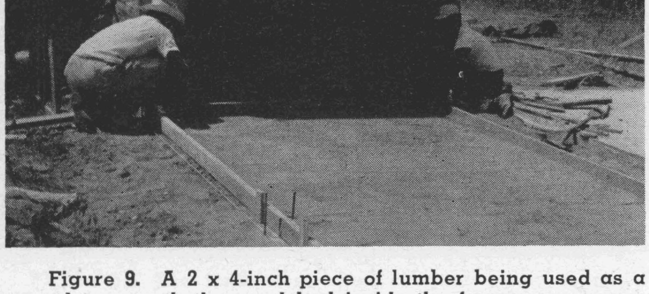

Figure 9. A 2 x 4-inch piece of lumber being used as a screed to smooth the sand bed inside the forms.

proved to be adequate. The 3/4-inch space had to be covered during the casting operation to prevent its being filled with concrete. Failure to keep this space clear caused severe binding during removal of the forms after the panels had been cast.

For adjacent corner panels, the first section could be tilted into place without concern about clearance at the corner edge. The second panel, however, required a clearance of 3 inches between the inside edge of the tilted panel and the panel being cast.

Figures 10, 11 and 12 show the 3/8-inch reinforcing steel which was used in a solid panel, a panel with a window and a panel with a door opening, respectively. The dimensions represent the size of panel used in the animal shelter.

All reinforcing steel in the solid panel was placed 1 inch above ground level and, consequently, was in tension during the tilting operation. Two horizontal bars extended 1-1/2 inches beyond the panel at either end to provide anchorage to the pilasters. The side forms were notched to accommodate these steel extensions and were placed with the openings facing down to facilitate removal after the panels were cast. This reinforcing steel is the minimum amount with which a successful tilting operation was obtained. Additional steel was desirable from a safety standpoint. Consequently two 3/8-inch compression bars and one tension bar were added and placed, as shown in Figure 11.

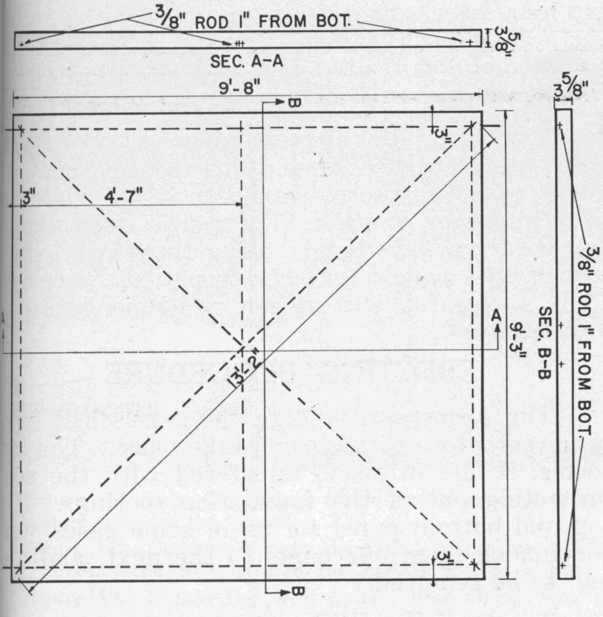

Figure 10. The minimum amount of steel which permitted successful tilting of a solid panel for the animal shelter.

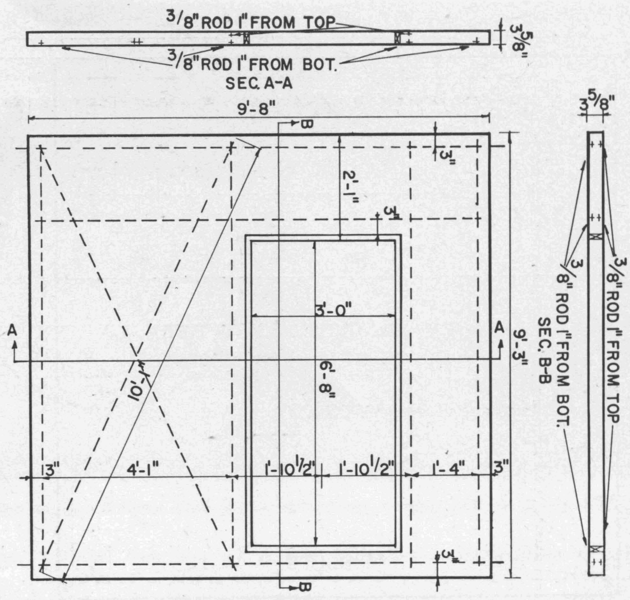

Figure 12. Location of steel reinforcing rods in a concrete wall panel containing a door opening.

Panels with window openings required a set of reinforcing bars at points one-quarter of the panel width from each vertical edge of the panel. The bars in each set were placed vertically above each other and were located 1 inch and 2-5/8 inches, respectively, above ground level. A horizontal reinforcing bar extending exactly the width of the panel was placed 3 inches from the top of the panel and 2-5/8 inches above ground level to strengthen the concrete beam above the window opening. The remaining reinforcing steel was placed as in the solid panel previously described. The window form consisting of 2 x 4-inch lumber was staked in place and a 3/8 x 6-inch bolt was inserted in each side to secure the form to the concrete panel.

The panel containing the door was reinforced. with three sets of bars running horizontally. These sets were placed at the same elevations as in the panel with the window opening. The same steel extensions as previously described were used to anchor the panel to the pilasters. Two sets of 3/8-inch steel bars also were placed in the panel 3 inches from each vertical edge of the door opening. The steel was placed at the same elevation as the horizontal bars. The remaining reinforcing bars were placed as in the panels previously described. The door form, consisting of 2 x 4-inch material, was staked in place and bolts 1/2 x 6 inches were used to secure it to the concrete panel.

The shanks of the 3/4 x 6-inch tilting bolts were wrapped with several layers of brown wrapping paper and positioned in the panel, as shown in Figure 13. Wrapping of the bolts permits their easy removal after the panels are tilted into place. If the panel is cast on a concrete floor with the thought of using panel rollers to move it into position, the lower tilting bolts should be tied to the diagonal bars a distance of 9-1/2 inches from the bottom edge of the panel.

Panels with door openings may or may not permit the tilting bolts at the top of the panel to be placed, as shown in Figure 13. If the bolts cannot be installed as recommended, they should be placed an equal distance in from the panel sides and along the set of horizontal reinforcing bars immediately above the door opening.

Holes were drilled in the form for the top of the panels and 1/2 x 8-inch bolts were inserted on 39-inch centers for securing the top plate to the finished wall. The same 2 x 4-inch lumber

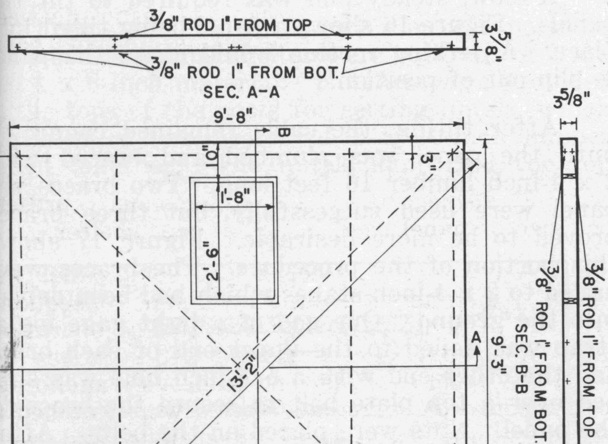

Figure 11. Placement of 3/8-inch steel in a panel with a window opening.

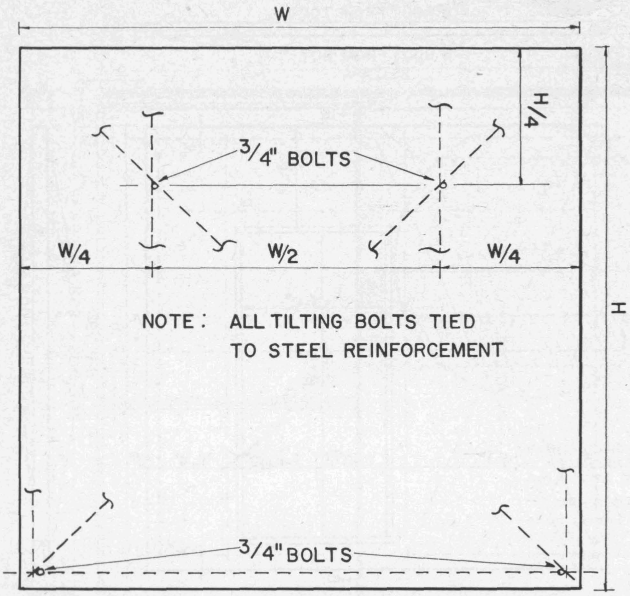

Figure 13. The recommended location of the tilting bolts in a wall panel to be tilted directly into place. The illustration shows steel intersections as they occurred in the panels.

used for the form was used later for the top plate of the erected walls.

Any additional bolt holes or openings required in the completed wall had to be provided at this time. In the animal shelter, two rows of 1/2-inch holes, 18 inches on center, were provided on the entire length of the back wall to attach a feed rack. One row was 22 inches above the floor and the other was 32 inches. Wooden dowels wrapped in paper were driven into the concrete panels prior to finishing to provide these openings. Figure 14 shows the wall in final position with some of the dowels still in place.

The panels were cast with a mix of five sacks of cement per cubic yard of concrete. The mixture was rodded thoroughly and carefully. Precautions were taken to insure a smooth bottom surface on each panel. The top surfaces were screeded, hand floated and given a final broom finish.

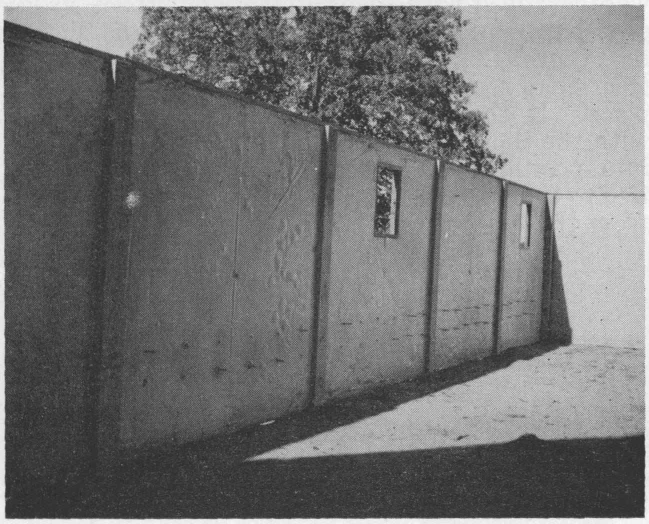

Figure 14. The rear wall of the animal shelter with ½-inch holes provided for the attachment of a feed rack.

The tilting, top plate, window and door frame bolts were checked during the casting and finishing of the respective panels to insure that they were in proper position. The panels were allowed to cure for 3 days before being tilted. Attempts to cure the panels for shorter periods were partially successful, but are not recommended.

ERECTING PROCEDURE

The forms surrounding the panels had to be removed before tilting could take place. The side forms, if left in place, interfered with the steel projecting out of the foundation footings. The top and bottom panel forms in some cases were continuous from one panel to the next, and also had to be removed.

To attach the tilting frame to a panel, two legs of the frame were connected to the lower tilting bolts. The frame then was erected into vertical position as shown in Figure 15. The other two legs were attached to the top tilting bolts by a slotted shoe at the end of each leg. A conection similar to the one used on the lower tilting bolts also may be used.

The tilting chain was attached to these same bolts and the spreader bar was hooked into the tilting chain. The tilting cable was attached to the chain and then placed over the intersection of the legs at the top of the tilting frame to provide a lever arm for tilting the panel. A sawhorse was placed in front of the panel to stop the tilting frame as the panel came into the vertical position.

A slow, steady pull was required to tilt the panels. Figure 16 shows a panel being tilted into place. A jerking motion would cause the panel to slip out of position.

After tilting, the cable remained connected until the panel was plumbed and braced with 2 x 4-inch lumber 16 feet long. Two braces per panel were used successfully, but three braces proved to be more desirable. Figure 17 shows this portion of the procedure. The braces were nailed to 2 x 4-inch stakes which had been driven into the ground. One end of a light gage metal strap was nailed to the upper end of each brace and the other end with a 5/8-inch hole was slipped over a top plate bolt to secure the brace to the panel. Nuts were placed on the bolts. After the tilting frame was removed, the metal straps were wired to the lower tilting bolts to make the panel more secure.

STABILIZING THE WALL PANELS

The panels were plumbed and aligned with each other before they were stabilized. The re-

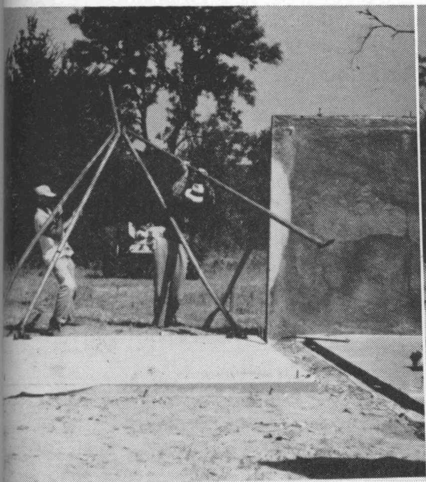
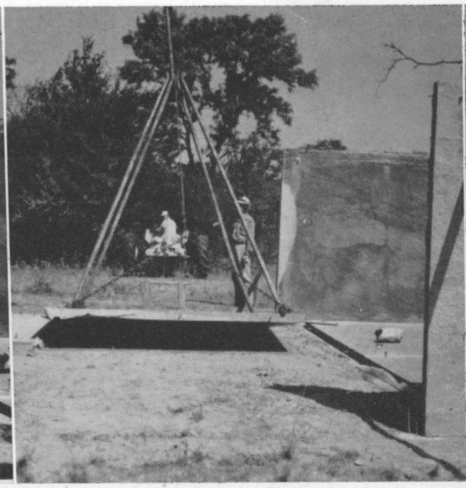


Figure 15. Left—The tilting frame being erected after two legs of the frame had been attached to the tilting bolts along he bottom edge of the panel.

Figure 16. Center—A concrete panel being tilted into position without the use of a spreader bar. Difficulties which vere encountered necessitated the installation of a bar.

Figure 17. Right—The wall panel, after tilting, was plumbed and braced in its final position.

nforcing steel projecting into the pilasters was vrapped with 4 mil polyethylene to prevent bonding, and thus allowed for expansion and contraction of the wall panel. This procedure proved atisfactory, but some bond still developed beween the panel wall and the pilaster. To insure n expansion joint, one vertical edge of every panel should be wrapped with polyethylene before he forms are set and the pilasters are cast.

Two bars of reinforcing steel were placed nd tied into each of the pilasters along the wall ections and in the posts in front of the animal helter. The pilaster forms were built of plywood and are sketched in Figures 18, 19 and 20. Ten gage aluminum wire was used at 12-inch intervals for tying the pilaster forms into place.

Forms for the 6 x 6-inch concrete posts in front of the animal shelter were built out of 1 x 8 nd 1 x 6-inch material. Notches were provided t the tops of the posts for setting lintels, which onsisted of two beams of 2 x 10-inch lumber nailed together. The lintels supported the top plate.

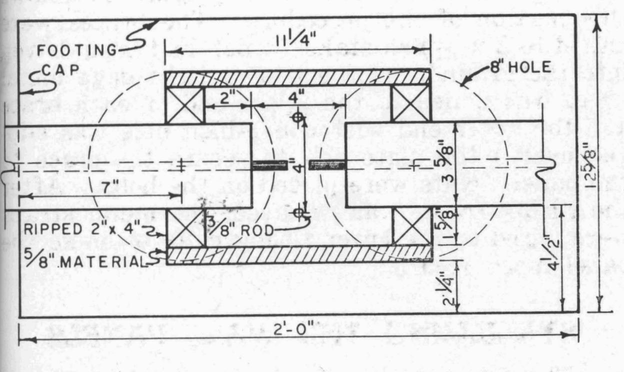

Figure 18. The pilaster form and footing used to connect djacent panels in a straight section of wall.

The pilasters and posts were cast with a mix in which six sacks of cement were used per cubic yard of concrete. Pea gravel was used to facilitate the placing of the mix. The forms were removed from the posts and pilasters after curing 1 day. The posts and pilasters were painted with a water and cement grout and smoothed with a mason's stone. The panel braces were removed, the lintels set and the top plates were bolted on.

The tilting bolts were driven out of the wall panels and the remaining bolt holes were filled with mortar. Each structure was then ready for its roof.

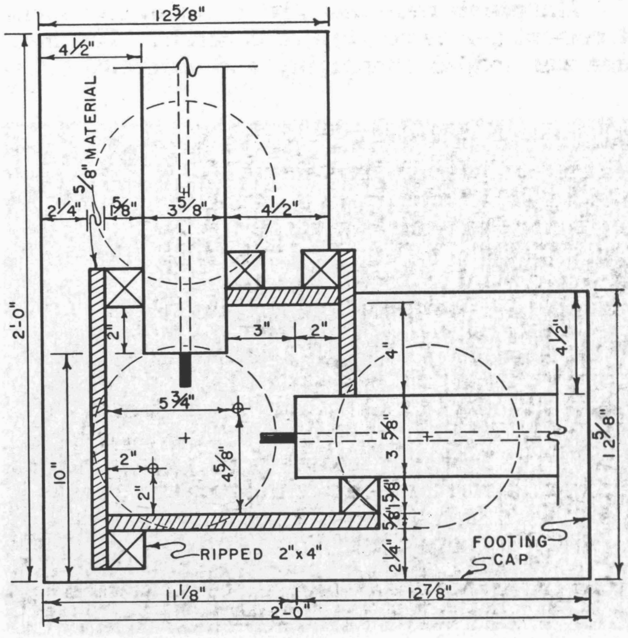

Figure 19. Construction details for the corner pilasters.

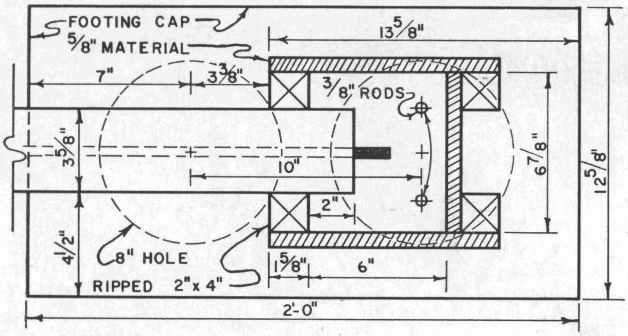

Figure 20. Foundation and pilaster form details for a pilaster at the end of a wall.

TIME, LABOR AND MATERIALS REQUIRED

Material and labor requirements for tilt-up construction were low. The construction costs consisting of both labor and materials for the two buildings, are summarized in Table 2. All labor was charged at $1.50 per hour since no skilled workmanship was required.

The 20 x 40-foot implement shed required 107 man-hours for construction of the footings and walls. The materials used in the concrete portion of the structure cost $350.20. After completion of the project, it was estimated that materials costing $108.50 were reusable. The total cost of the foundation and walls was $510.70, or 63.8 cents per square foot of floor area. Cost of labor and materials for roof construction would be the same as for any other structure of the same size.

TABLE 2. LABOR AND MATERIAL REQUIREMENTS FOR CONSTRUCTION OF FOOTINGS, WALLS AND POSTS IN EACH OF THE BUILDINGS.

Structure	Labor		Cost of materials	Total cost
	Hours	Cost		
Implement shed	107	$160.50	$350.20	$510.70
Animal shelter	213	$319.50	$435.92	$755.42

The 20 x 60-foot animal shelter required 213 man-hours for construction of the foundations, walls and concrete posts. The materials cost $435.92. When the structure was completed, materials costing $142.34 were reusable. The total cost of the foundations, walls and posts was $755.42, or 62.9 cents per square foot of floor area. This figure includes the cost of the reusable material.

The cost of the animal shelter could have been reduced approximately $70 by using 6-inch creosoted posts set in 4 feet of concrete instead of the cast-in-place concrete posts. This reduction would be possible because of the high labor requirements for construction of the post forms.

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