

Multicombination Farm Building Design

L. W. Bonnicksen

Assoc. Member ASAE

A PROJECT was initiated by the Oregon Agricultural Experiment Station in 1955 on the development of new types of farm-building construction, the objective was to develop types of farm-building construction featuring: (a) economy of construction (b) suitability for many farm uses, and (c) ease of alteration to meet changing farm requirements. It was the thought that buildings using types of construction incorporating these features would greatly aid the farmer in obtaining a larger net income. The following procedure for the project was employed:

- Develop preliminary designs of various types of construction
- Prepare detailed plans and analysis of the best preliminary designs
- Construct pilot buildings and individual building units for test purposes
- Analyze the test observations and alter plans where necessary
- Evaluate critically the feasibility of each type of construction.

One of the first steps in the developing of preliminary designs was to make the following hypothesis. In order for a type of construction to be economical, suitable for many uses, and easy to alter, it should consist of building parts from which many combinations of buildings can be assembled.

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1955, on a program arranged by the Farm Structures Division. Approved as Miscellaneous Paper No. 24, Oregon Agricultural Experiment Station.

The author—L. W. BONNICKSEN—is assistant professor of agricultural engineering, Oregon State College.

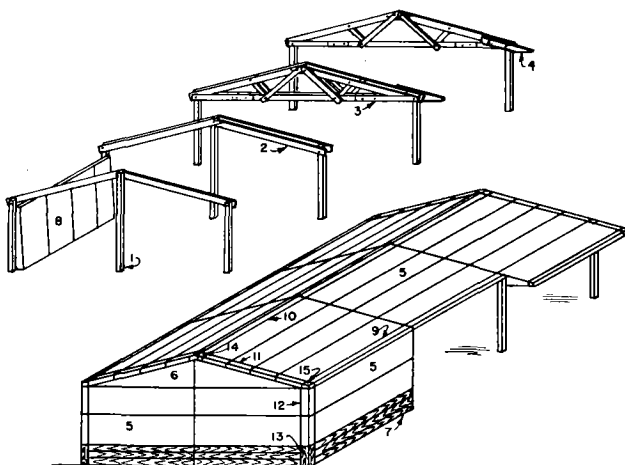


Fig. 1 Preliminary design (PD-1) consisting of panels supported on a rigid-pillar and rafter frame: (1) pillar, (2) shed rafter, (3) gable rafter, (4) cantilever rafter, (5) panel, (6) gable panel, (7) splatter panel, (8) silo and grain panel, (9) eave panel, (10) ridge panel, (11) rake panel, (12) corner panel, (13) splatter corner panel, (14) ridge cap, and (15) corner cap

Standardized, prefabricated panels for pole-type farm building construction provide variety in design combinations, together with expansibility and economy in assembly costs

The building parts should be:

- Prefabricated
- Interchangeable
- Standardized
- Kept to a minimum of different kinds of parts
- Made of low-cost readily available materials
- Easy to fabricate
- Easy to handle
- Easy to fasten and unfasten to other parts
- Durable
- Readily available for use

The buildings should be:

- Easy to assemble, alter, disassemble
- Have many combinations of size, shape, strength, support, and degrees of functioning, and be suitable for meeting the optimum requirements for a maximum number of farm uses
- Have a low original cost, low maintenance, high resistance to destructive forces
- Readily available and easily obtained for immediate use by the farmer.

The first preliminary design developed to any extent consists of panels supported on a rigid-pillar and rafter frame. Fig. 1 shows a sketch of this design, which is referred to as PD-1.

A unique feature of PD-1 is the panel scheme illustrated in Fig. 2. If $S=L$, $X=Z=Y$, and $N=a$ whole number, the number of types of panels can be reduced to three—right-hand and left-hand gable panels, and a standard panel that can be used on the roof, side wall, or end wall. The roof slope under these conditions would be:

$$Z/L = X/L = \sqrt{1/(N^2 - 1)}$$

This shows that the roof slope is dependent on N , the number of panels per L . X , the width of the panels, is dependent on N and L .

$$X = L \sqrt{1/(N^2 - 1)}$$

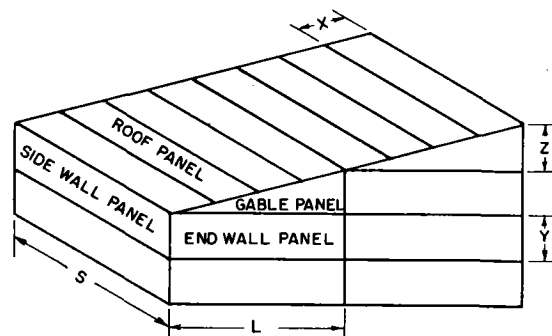


Fig. 2 Panel scheme for design PD-1. $N = (L)/\text{horizontal projection of } X = \text{number of roof panels per } L$

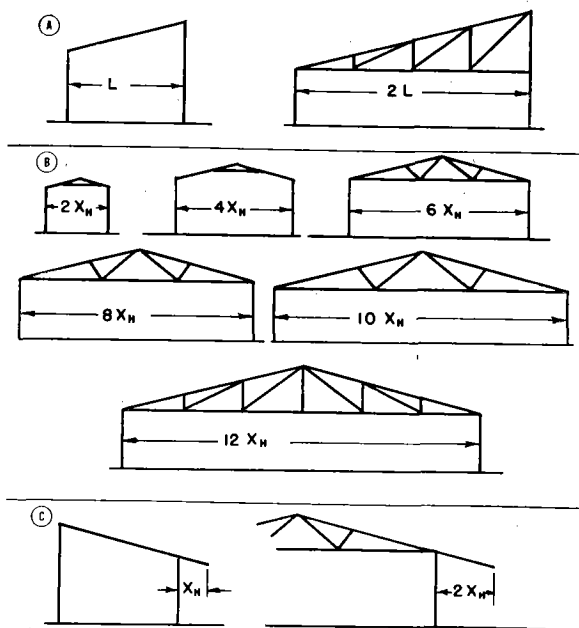


Fig. 3 Rafter types. X_H = horizontal width of roof panel: (A) shed type, (B) gable type, (C) cantilever type

The pillars are standardized as to height above ground level. The lowest pillar is established to give the desired door height, open wall height clearance, or wall height. Then the next pillar in the lateral direction is a distance Z higher.

The horizontal measurements of one pillar to another is from center to center including the side and end pillars. This is to allow for expansion of the building.

The rafters are hinged to the tops of the pillars. There is a rafter placed on each side of the pillar, except at the ends, where only the inside rafter is placed. There are three types of rafters: shed, gable, and cantilever (Fig. 3).

The roof and wall panels (a) support the roof and wall loads between the rafters and pillars, (b) are weathertight, and (c) have assembly joints which are weathertight.

The splatter panel is used for the lower part of the walls. These panels are able to withstand the extra conditions to which they are exposed.

The silo and grain panel is designed to withstand the lateral pressures of silage and grain. It has a vertical slope for silage, and the outside or vertical side is weather resistant.

Other panels that are used are partial panels and panels for windows, doors, and vents.

When the previously mentioned panels are assembled, they do not join at the intersections of the walls and roof.

Thus special panels are needed at these points. These special panels are shown in Fig. 1, numbered 9 through 15.

These various building parts can be assembled into many combinations of buildings. The possible shapes are shed, gable, off-center, butterfly, gambrel, full and half monitor, sawtooth or a combination of these shapes. There are many combinations of width, height and length. Many combinations can be made with the various wall panels and cantilever rafters. By using different grades of materials and several panel lengths, various combinations of strength can be made.

With PD-1 as a basis, the detailed plans for four types of construction are being developed. These are the OSC 141, 142, 161, and 162 Farm Building Constructions. Fig. 4 shows views of the panels for these types of construction.

For the 141 and 142 FBC, L , the lateral spacing, is 14 ft; and S , the longitudinal spacing, is 14 and 16 ft. N , the number of panels per L , is 4; therefore, the roof slope is approximately 3.1 to 12. The width of all panels, X , Y , and Z , is 3 ft, 7 $\frac{3}{8}$ in. The 14-ft long panels can be used on the roof, sidewall, or end wall. The 16-ft long panel can be used on the roof or sidewall.

For the 161 and 162 FBC, L , the lateral spacing, 16 ft; and S , the longitudinal spacing, is 16 ft. N , the number of panels, is 4; therefore, the roof slope is approximately 3.1 to 12. The width of all panels (X , Y , and Z), is 4 ft, 1 $\frac{1}{16}$ in. These panels can be used on the roof, sidewall, or end wall.

The pillars for all four types of construction are pressure-treated, wood-sawed posts or round poles. The rafters are made from structural timbers and are fastened to the top sides of the pillars by a $\frac{3}{4}$ -in bolt and a 4-in split-ring connector. The pillars are set into the ground to a depth of four or more feet on a gravel footing. The backfill material is gravel.

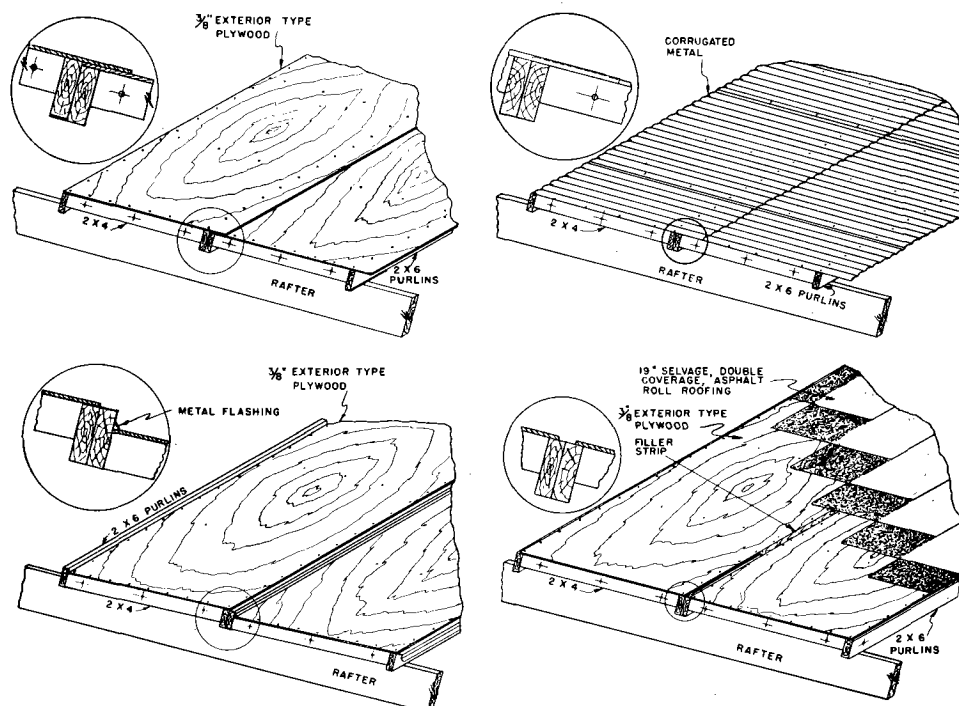


Fig. 4 Various types of roof panel construction. (Upper left) Plan OSC 141. (Upper right) Plan OSC 142. (Lower left) Plan OSC 161. (Lower right) Plan OSC 162

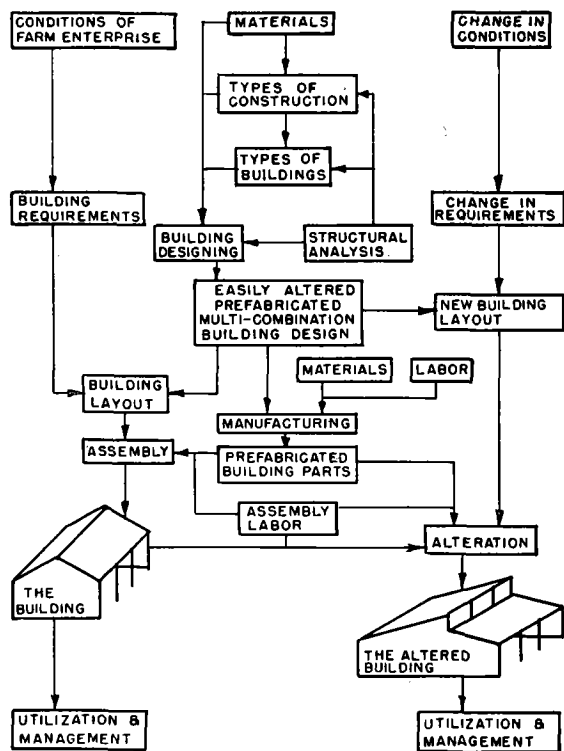


Fig. 5 Diagram showing how a prefabricated, multicomination building is designed, laid out for a specific set of requirements, manufactured, assembled, and utilized. It also shows the process of alteration when conditions change

The splatter panel is made of 2 x 12-in pressure-treated timbers.

The panels are fastened to the pillar and rafter frame by metal ties.

The panels can be insulated before or after assembly.

The parts of these types of construction are similar in many ways, and there is a degree of interchangeability among the four types.

A type of cantilever rafter which will hinge on the top of the outside pillar is being designed. One or two wall panels are fastened to this rafter. Then, by rotating the rafter, the panels can act as a cantilever roof or a sidewall.

These types of construction can be prefabricated by farmers; however, it could be more economically done by local manufacturers with a small investment in tooling. The assembly could be done by farmers, by local carpenters, or the manufacturers. These local manufacturers or carpenters could very well develop a business in the farm-building field similar to the business of a local farm-machinery dealer.

These types of construction are still in the development and testing stage. They have not as yet been evaluated for feasibility or approved.

Fig. 5 is a diagram of how an easily altered, prefabricated, multicomination building is designed, laid out for a specific set of requirements, manufactured, assembled, and utilized. It also shows the process of alteration when the conditions change.

The utilization of other materials and designs are still being developed. The prospects are good that other types of construction can be developed which will meet the objectives of this project.