Prefabrication on the Farm

by JOHN A. SCHOLTEN

IN RECENT YEARS prefabricated brooder and poultry houses, hog houses, granaries, corn cribs, and other farm buildings have been manufactured and used in increasing numbers. Those manufactured at centrally located plants are usually of the panel type, which can be readily transported and assembled on the site. Those made at local shops are frequently built in the conventional manner, mounted on skids, and delivered to the site intact and ready for use. Because these small prefabricated buildings can be erected in a short time with little or no labor at the building site, they meet the demands for rapid expansion and fulfill a useful purpose by furnishing housing or storage facilities when regular structures are lacking or inadequate. An appealing feature of these smaller structures has been that they can be obtained in successive units without a large outlay of cash at any one time, and because they are small and portable they can be adapted to a changing farm program. Another factor that has contributed to their expanded use is the increasing difficulty of obtaining the needed skilled and semiskilled labor on the farm.

These small prefabricated units have, however, frequently been built to fill immediate needs without adequate consideration of their permanence or future usefulness. Their portable features, whether or not the building is ever moved after it is once erected, have led some farmers to overlook the need for adequate foundations and suitable anchorage. The framework is sometimes too flimsy to withstand the wear and tear of continuous service in structures that are hastily manufactured and inadequate in design. Furthermore, the material used for coverage has frequently been selected without consideration of the service condition to which it will be exposed and as a result has not proved suitable for the purpose. Certain wallboards, for example, manufactured for use as sheathing or as a plaster base have been used for subflooring, for roof boards, and in other ways not recommended by the manufacturers. That has been due partly to the wartime necessity of using anything that could be obtained, but it has also been due to a failure to consider the suitability of various materials for specific parts.

Factors that must be considered in evaluating a prefabricated farm structure are structural stability, permanence, and functional utility. These are important in any structure but must be reevaluated for prefabricated structures, which incorporate newer sheet materials and unusual structural and design features. Besides resisting the loads ordinarily imposed in use, such as pressures exerted by grains or external loads from the wind, such structures must be strong enough to meet the unusual racking strains imposed in transit and at the same time must be as light as possible to facilitate movement. In order to accomplish this the designer must have a knowledge of the properties of the materials, the mechanics of construction, and the techniques required to put the materials together so that the most satisfactory results can be obtained.

The new trend in prefabrication of farm structures is as much the result of the development of improved materials intended primarily for conventional construction, particularly the various sheet materials such as plywood and the fiberboards, as it is of jig-assembly and other factory methods. Possibly the most spectacular development along this line has been the improvement in plywood and its increased use in farm structures. The development of synthetic-resin adhesives, particularly the phenols, has made possible glue bonds that are waterproof and do not come apart in service even when exposed to severe moisture conditions.

Engineers have been working on a plywood or wood impregnated with highly moisture-resistant synthetic resins to reduce grain raising and checking and to provide a sheet which does not require paint or other protective coating. Another development in the experimental stage is plywood faced with sheets of impregnated cloth or paper. Exposure tests have shown satisfactory results with plywood surfaced with a three-sheet impregnated paper cover.

The new synthetic resins have also accelerated the development of "sandwich" structures of various kinds. Active experimentation is going on with cores of light material such as insulating board, balsa wood, and cellulose acetate plastics faced with hard, durable surface materials like metals, fabric, or paper laminates, and plywood. The resulting combination of light weight, high insulating value, and strength is reportedly suitable for use as the complete wall. Some sandwich panels would be capable of carrying the loads on the structures; others would have to be inserted into load-carrying frames of timber or other material.

Many of the new wall materials, except the sandwich panels, are now in production. In general, the costs of these materials run higher than traditional clapboard and their application to farm structures still requires considerable development.

In housing, considerable progress has also been made in prefabrication. Estimates of the number of prefabricated houses built during the war vary from 100,000 to 125,000; 133 manufacturers were listed by the National Housing Agency as builders of such houses. Most of these houses were erected in urban centers, but the principles incorporated in their construction can readily be adapted to farm homes.

Prefabricators of houses follow generally pioneer work by the Forest Products Laboratory and aircraft designers in building floor and wall panels employing the stressed-skin principle. In these panels the covering sheets, generally plywood, are firmly glued to a skeleton of structural ribs to form a strong rigid panel. The ribs and covering act together to withstand stresses imposed by weights and loads encountered in service. The interior of the panels can be filled with insulating material. Windows and doors are generally built in at the factory. Such construction eliminates to a large extent the need for a structural framework. It also makes possible quick assembly of all the component parts of a house. The coverings of the stressed-skin panel form both the exterior and interior surfaces of the wall.

Apart from the fully prefabricated units, more and more of the material used in farm buildings will be precut and at least partly assembled into units before delivery. Barn and house rafters and other members can be notched and cut to length at shops where power equipment is available instead of on the building site where slower hand methods are required.

One system of partial prefabrication that has been used extensively in many new barns and other farm structures involves the use of glued laminated members. Such members in the form of laminated beams, arches, or other structural units are used in conjunction with standard construction. In a building these members form continuous framing members running from foundation to roof ridge. They are made by gluing together laminations or boards, usually not more than an inch thick. In gluing, the laminations are bent to the required curvature, which is retained in the member when the glue sets. The curvature of the rafters provides a pleasing appearance and their continuity facilitates erection by eliminating some of the joints and supporting members required in structures erected with straight members.

Laminated rafters for farm use may be glued with casein glue. Resorcinol and phenol glues can be used where moisture conditions are severe. Joints properly made with casein glue will last as long as the rafters if the wood remains dry. If the wood becomes wet or damp, however, even for relatively short periods, the glue will gradually deteriorate and the joints will weaken. The kinds of wood used in laminated rafters are generally

703830°—47——57

the same as in solid rafters. Some kinds used for rafters are more easily glued than others, but all can be satisfactorily glued.

Improved casein glues containing preservatives have recently been developed. The chief advantage of a casein glue containing a preservative lies in its ability to resist deterioration caused by molds and other microorganisms when exposed to damp conditions. Intermediate-temperature-setting phenol and resorcinol resin glues have higher water resistance than casein glues and will give greater permanence under prolonged exposure to severe moisture conditions. It should be pointed out, however, that conditions unfavorable to casein glue joints in barn rafters, if maintained for long periods, are also harmful to untreated wood either in solid members or in laminations, regardless of the type of glue employed.

Casein glue resists moisture, but should not be used in wood members that stay damp or wet for a long time. Where such conditions are likely to occur, the use of a phenol or resorcinol glue is required to assure durable glue joints. The important fact to remember is that conditions that cause the moisture content of the wood to remain high for long periods favor decay of untreated wood as well as deterioration of casein glue, just as contact with the ground prohibits the successful use, in a permanent structure, of most woods without thorough preservative treatment.

In the Northern States safeguards should be made in the modern dairy or stock barn against moisture sweating within or on the wall or roof structure in cold weather. Studies at our laboratory on various types of wall sections have shown that, apart from ventilation, the most positive and least expensive method of preventing condensation of moisture within the walls is to provide vapor-resistant barriers at or near the inner face of exterior walls, or at or on the under face of stable ceilings. Among the materials that have been tested and found to be highly resistant to the passage of water vapor and hence suitable for these purposes are: Asphalt-impregnated and glossy surface-coated sheathing paper, weighing 35 to 50 pounds per roll of 500 square feet; the better grades of laminated sheathing paper made of two or more sheets of heavy paper cemented together with asphalt; and double-faced reflective insulation mounted on paper.

THE AUTHOR

John A. Scholten, as a staff member of the Forest Products Laboratory, has devoted the past 16 years to research to establish engineering design requirements for wood buildings, aircraft, and other structures. In 1943 he went to Costa Rica as a structural consultant to the Engineer Corps of the Army, and in 1946 he was an adviser to the Supreme Commander of the Allied Powers in Japan.