Technical Note 15

Wood-Frame Construction—Do It Right!

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ABSTRACT

Information is available on how to build wood-frame houses that will last many years with a minimum of maintenance and repair. Unfortunately, much of this information is not used, so errors frequently occur. Field observations by the staff of the Forest Products Laboratory of the U. S. Department of Agriculture and of the Small Homes Council-Building Research Council of the University of Illinois have shown that certain problems occur frequently. This publication shows examples of common errors and explains acceptable principles and practices aimed at reducing future occurrences. It should be of use to building designers, builders, and homeowners.

Introduction

Considerable information is available to help one build a house that can be expected to last many years with a minimum of maintenance and repair. However, this information on “good” construction principles is often unread, misunderstood, or ignored, thereby leading to conditions that eventually require costly repairs and represent unnecessary waste of materials. Further, new sets of problems can occur because of unfamiliarity with changes in techniques and materials.

Field observations and personal contacts by staff of the Forest Products Laboratory of the U. S. Department of Agriculture, the Small Homes Council-Building Research Council of the University of Illinois at Urbana-Champaign, and other research agencies have shown that certain problems occur frequently and result in a large portion of the repair and replacement costs for the wood parts of the house.

Preservative-Treated Wood

Because wood is an organic material, it can readily absorb water from contact with the soil, entrapment through faulty detailing in construction, exposure to high humidities in a crawl space or attic, cold weather condensation, water leaks from plumbing, and recurring water flow over unprotected elements of the house. When the moisture content of wood exceeds 20%, it becomes susceptible to mold, stain, or early stages of decay, and may eventually cause discoloration or loss of strength, requiring replacement. Wood preservatives, which prevent fungal growth, have been used for years to allow the use of wood in areas subject to frequent wetting.
The most effective method of preserving wood is by commercial pressure treatment. The treating industry defines the degree of treatment for the various preservatives used by identifying the treatment chemical and to what standard it was treated. Preservative-treated wood should be stamped with an identifying mark. Only preservative-treated wood should be buried in the ground or used in contact with concrete below the gradeline.

Brushing, soaking, and dipping are less satisfactory methods of applying preservatives. They are recommended only for on-site treatment of field-cut ends of pressure-treated wood.

Figure 1. These are examples of preservative-treatment stamps which attest that certain treatment specifications have been met. Figure 1a indicates the wood has been treated with a water-borne salt preservative for above-ground use. In Figure 1b, the same water-borne salt was used to treat wood for ground contact. Figure 1c, FDN, indicates the wood has been specially treated for wood foundations for light frame construction.

Figure 2. This field-cut 6x6 timber shows shallow penetration of treatment, which would eventually allow decay spores to enter the untreated wood portions through checks and splits. It is essential that the wood be treated according to industry standards, especially for ground contact.
Figure 4. This plywood, used for aesthetic purposes to cover a concrete perimeter foundation, has decayed at the ground line because the purchaser did not require that the material meet the treatment specifications for in-ground use.

Figure 5. This sill plate, in direct contact with the block foundation wall, may become wet from moisture wicked up from the soil. In areas of high soil moisture, sill plates should be preservative-treated to prevent decay. Installing a sill sealer is also recommended to reduce air infiltration.
Figure 6. The wood sheathing has been placed too near the soil, creating a high potential for moisture absorption and eventual decay. In addition, buried wood debris can provide a source of food for termites, which then can move up into the structure as the colony searches for more food. Removing the debris from the construction site is recommended.

Figure 7. Backfilling over the foundation vents not only reduces ventilation but also creates an opportunity for water to enter the crawl space. In this case, 4 inches of water had collected on the crawl-space soil cover.

Figure 8. Backfill should be used against walls only where the wood parts have been preservative-treated for below-grade use and provisions have been made for moisture protection.
Foundations

Soil moisture is a major concern in considering the durability of wood materials in contact with foundations. Unvented crawl spaces with no soil cover can be excessively humid. Soil moisture may also be wicked up through concrete or concrete block to enter wood which is in direct contact with the foundation. Siding and sheathing materials are sometimes installed so close to the soil that they are affected by soil moisture from back splashing of rain and snow. In some cases, backfill soil above the foundation threatens not only the siding but also the floor framing. Poor drainage of rain water away from the foundation increases the amount of moisture and thus the potential for moisture-related problems.

Figure 9. The concrete floor slab of this porch was placed in direct contact with an unprotected band joist, creating a natural trap for water. This practice can eventually lead to expensive repairs.

Figure 10. Excessive amounts of moisture in the crawl space of a structure can cause the floor framing members to mold and decay, leading to possible structural failure. The decay in these two examples could have been prevented with proper exterior drainage, effective soil cover, and sufficient ventilation.

Figure 11. The use of a soil cover is a good practice to prevent moisture from migrating into the floor and house above. Six-mil polyethylene film is recommended. Soil covers should be laid flat over smoothed soil, overlapped at least 4 inches along the edges, and turned up at least 4 inches along the perimeter foundation.
Floors

Floor framing must be of the correct grade and size to assure the desired degree of stiffness and strength. Joists and beams should bear directly on supporting members or on ledgers or posts. Toenailing by itself is not adequate; joists must be end-nailed. Cutouts for plumbing should not be made in floor framing. Proper planning can avoid the necessity of cutting floor framing. A dry crawl space is critical to performance of the floor above. A ground cover and ventilation are required, as shown in the foundations section.

Figure 12. Toenailing is not satisfactory for supporting the end of this second-floor girder. A ledger strip or beam hanger should have been used to support the girder.

Walls

The structural aspects of walls are usually standard, but the incorrect application of the exterior covering material and trim often results in maintenance problems. Good drainage of rain water is essential. Water does not drain from flat surfaces and often soaks into the wood, creating a potential decay problem. Joints are particularly susceptible. Moisture from inside a house with an inadequate vapor retarder may cause cold-weather condensation and consequent siding and finish problems.

Figure 14. Paint discoloration and wood extractives bleeding through the paint are the result of moisture moving up around the foundation from the crawl space soil or through a wall not protected by a vapor barrier.
Figure 15. Cold weather condensation can cause paint peeling on wood siding. Moisture generated inside the house should be kept from moving through the wall by the installation of a warm-side vapor retarder. The potential for high relative humidity indoors should also be reduced by installation of exhaust fans in bathrooms and kitchens, and vents for clothes dryers.

Figure 16. A continuous vapor barrier or retarder on the warm side of the wall will reduce the rate of water vapor moving from inside the house out through the walls to the cold surfaces of the siding or sheathing. A soil cover prevents soil moisture from rising into wall cavities, decreasing the potential for condensation.

Figure 17. Water allowed to stand on flat surfaces can soak or wick into the ends of the wood, especially vertical members, resulting in decay. All "horizontal" surfaces should be sloped to ensure drainage, and end joints should be saturated with a clear, water-repellent preservative prior to painting.
Roofs

Whether insulation is applied to a cathedral ceiling or to a ceiling with an attic space above, ventilation is required between the roof and the insulation to vent moisture from the living space to the outdoors. Ventilation is particularly critical in cold climates to prevent the formation of ice dams and the consequent water damage to ceilings and walls.

Roof slopes should be steep enough for the type of roofing used. Flashing is essential at all joints as well as at the roof edge.

Care should be taken to avoid overloading engineered trusses, particularly where rafters frame into them, such as in hip roofs. Trusses cannot be used to carry the load from more of the roof area than they are designed to support.

Figure 18. Wood shingle or shake roofs with a low slope will not shed water properly, causing decay and early deterioration. Proper flashing is also essential.

Figure 19. Ice dams such as this result from snow melting over a warm attic area and refreezing at the overhang. Ice dams can back liquid water under the shingles, thus inviting decay or paint deterioration, or can cause structural damage to gutters and eaves because of the weight of the ice. Correct installation of the ceiling insulation and proper attic ventilation keep attics cool enough that thawing and the resultant ice damming is avoided.
Engineered Components

Current construction practices include the widespread use of engineered structural components, such as floor and roof trusses. These units are elements of the house that have been made in a factory or shop, using specific engineering design applications, specific lumber and materials, prescribed fastening methods, and appropriate levels of quality control. Construction modifications from the basic engineering requirements for a component should not be accepted unless approved by the design engineer or architect.

Figure 22. The builder of this hip roof should have used a specially fabricated hip-roof girder instead of a single standard truss. The standard truss is designed to support only a 2-foot width of roof, not the hip framing and the large area of possible snow load.
Figure 23. This field-built truss does not have the correct size connector plate; thus, the structural integrity of the truss is in question.

Figure 24. The web members of these roof trusses have been cut and portions removed to support a beam, which in turn is supporting the upper ends of 20-foot-long 2×10 rafters. This field modification has overloaded the trusses, raising the possibility of further problems from accumulation of snow on the roof.

Figure 25. This standard floor truss was not designed to be used in this application — to support the ends of 18-foot roof rafters. Structural problems could develop with any appreciable accumulation of snow on the roof. For special applications, engineering calculations are necessary to verify structural adequacy.
Protection of Materials at the Site

Wood and wood components delivered to the construction site prior to use should be protected from the weather. If they must be stored outdoors, they should be elevated above the ground on sleepers to prevent absorption of soil moisture. Some type of cover should be used for protection from rain. Kiln-drying of lumber serves little purpose if the lumber is allowed to get wet again. Protection of trusses and other factory-built units is particularly critical because connectors and fasteners can be affected by wetting and drying.

Figure 26. These unprotected trusses stacked directly on the ground are subject to absorption of soil moisture and rain or snow. They should be supported off the ground, stacked flat, and covered.

Additional Reading


Truss Plate Institute. Design Specifications for Light Metal Plate Connected Wood Trusses. TPI, 100 W. Church St., Frederick, MD 21701.


Additional Sources of Information

American Wood Preservers' Institute, 1651 Old Meadow Road, McLean, VA 22101.

California Redwood Association, 617 Montgomery Street, San Francisco, CA 94111.

Forest Products Research Society, 2801 Marshall Court, Madison, WI 53705.

Small Homes Council-Building Research Council, University of Illinois at Urbana-Champaign, One East Saint Mary’s Road, Champaign, IL 61820.

West Coast Lumber Inspection Bureau, P. O. Box 23145, Portland, OR 97223.

Western Wood Products Association, 1500 Yeon Bldg., Portland, OR 97204.

Wood Research Laboratory, Department of Forestry and Conservation, Purdue University, Lafayette, IN 47907.