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Hansen, A. T.

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Please note

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A.T. Hansen

Canada pioneered the use of wood frame house foundations in the early 1960's when they were featured in the Mark III and IV experimental houses erected by the National House Builders Association (now the Canadian House Builders Association). By 1974 Canada Mortgage and Housing Corporation accepted the system for use under the National Housing Act, and in 1975 provisions were included in the National Building Code to permit its use. From less than 100 units per year in 1974, the rate of construction increased to an estimated 8000 to 10 000 units a year by 1983.[1]

Industry-sponsored construction manuals promoted their use by house builders,[1, 2] and later formed the basis of a national standard prepared by the Canadian Standards Association.[3] Although the basic system can be compared to frame construction above ground, the hostile environment encountered by wood in contact with soil and the sustained forces caused by earth pressures require unique design features to accommodate these conditions.

Wood Preservation

Although the durability of wood in contact with the ground varies from specie to specie, untreated wood generally has a relatively short service life if it is located above the water table or if it is not permanently frozen. Effective treatment is, therefore, of paramount importance in the successful use of wood foundations.

Some experts claim the treatment specified for wood foundations should ensure a useful life of at least 50 years.[4] Others claim that extrapolation of data from buried stakes at exposure sites indicate an even longer life. Although a variety of wood preservative treatments exist, only amonical-copper-arsenite (ACA) and chromated-copper-arsenate (CCA) are currently considered appropriate for wood-frame foundations. The latter treatment is by far the most commonly used in Canada for foundations. These water-borne systems are essentially non-leachable, non-bleeding and odourless. Requirements for their use are specified in standards specially developed for this application.[5]

The degree of preservative retention required for wood to achieve a desired service life depends on the severity of exposure conditions. The minimum acceptable service life of wood in turn is dependent on the cost and convenience of its replacement and the consequences of failure. Because the exposure condition of wood in contact with the ground is severe, and the replacement of foundations is expensive and inconvenient, the preservative retention required for wood for such a use is high compared with the retention requirements for many other applications.

Since the amount of preservative retention cannot be verified visually, there is a danger that preserved wood intended for applications that do not require high retention may be inadvertently used in foundations. In addition, some species of wood such as spruce are more difficult to treat than others and will not accept the amount of preservative necessary to ensure the desired service life. Pacific coast Douglas fir, amabilis fir, grand fir, lodgepole pine, jack pine, alpine fir, balsam fir, ponderosa pine, red pine, white pine and eastern and western hemlock can all be effectively treated with preservatives, however.

To avoid the use of insufficient preservation, only lumber or plywood identified by appropriate certification marks should be used. The use of these marks is regulated by the certifying agency, who take precautions to ensure that the mark is only used by wood preservers qualified to treat wood to the accepted standards. The mark must show the name of the certifying agency, the letters PWF (or FBT) to indicate it is for use in foundations, and the designation, 0322, which indicates the CSA Standard that regulates the certification procedure.[6] The mark also shows a 4 digit number; the first two digits identify the treatment plant and the last two, the year of treatment. Figure 1 shows a typical certifying mark used by the Canadian Standards Association.

Figure 1. Typical certifying mark for preserved wood for foundation

Since most preservative treatments do not penetrate to the centre of a member, any cutting or drilling subsequent to treatment exposes the wood to potential decay. Where on-site cutting of studs is necessary, therefore, the cut ends should be placed upward. Any cutting, drilling or notching after treatment requires a liberal field application of a good preservative to protect the affected area (standards specify a 17% solution of copper naphthenate) which may be obtained from the supplier of the preserved wood.

Although some preservatives are toxic to varying degrees, those in CCA and ACA treated wood have not been demonstrated to be of risk to occupants through normal physical contact.[7] Interior finish is required in any event to protect the insulation normally installed between the studs. Field application of preservatives to wood cut on site, however, should carefully follow manufacturers instructions and waste ends and sawdust should not be disposed of by burning.

There is limited evidence to show that biological action on preserved wood as a result of certain fungi or mold growth can produce trimethylarsine gas. Although this gas which has a characteristic garlic odour has been produced experimentally under elevated moisture conditions and warm temperatures, field reports of such odours are rare.[8] Test on laboratory animals indicate that the gas is not likely to present a short term health risk at concentrations up to the level of odour detection. No long term tests, however, have been reported.

Control of moisture within basement stud spaces should reduce the possibility of such action. Effective subsurface drainage and damp proofing of the exterior walls together with an effective continuous vapour barrier on the room side of the studs all contribute to the control of moisture within the basement stud spaces. This vapour barrier will also resist the passage of airborn pollutants from the stud spaces into the basement.

Earth Pressures

Foundations walls must resist horizontal loads due to earth pressure as well as vertical loads from the superstructure. For smaller buildings such as houses, it can be assumed that earth pressures against foundations in ordinary, well drained soils act as if the backfill were liquid with a density slightly less than half that of water (480 kg/ m^3).[9]

The studs normally bear against the basement floor slab to resist the inward pressure but where this is not the case, the connections must be designed to transfer the forces to the slab. When a suspended wood basement floor is used, construction details must be designed to transfer loads from the studs to the floor system effectively.

The inward forces at the top of the wall, while less than those at the bottom, are sufficiently high to require special details at these locations to transfer the horizontal forces to the floor framing.

Sufficient nailing can resist the inward forces when the backfill height is 1500 mm or less,[3] but beyond this height, additional sheet metal ties are normally required to transfer the forces from the studs to the floor framing.

Stair openings framed into the first floor near the perimeter of the building reduce the floor framing's resistance to earth pressures. If an opening is too close to the perimeter, the sub-flooring will not be able to bridge the opening properly and transfer the horizontal forces to the floor framing on either side. Additional framing members may be required at the opening to carry these forces to the framing adjacent to the opening, in the same manner as wall lintels transfer superimposed loads to adjacent studs.

Window openings in foundation walls are other potential points of weakness in walls designed to resist earth pressures. At backfill depths less than 1200 mm, details used for conventional superstructure framing are normally adequate to transfer horizontal loads to adjacent studs but beyond this, additional nailing and metal ties are necessary.

Extensive tables have been developed that provide the size and spacing of the framing and the thickness of plywood required to withstand soil pressures from various heights of backfill.[1, 2, 3] These tables, together with numerous other details designed to resist earth pressure loads, greatly simplify the design process and enable walls to be designed without professional assistance. While these details have been standardized for smaller buildings, preserved wood foundations can be engineered for larger buildings also,[10] provided they are of a size permitted for combustible construction.

Since walls that resist earth pressures are required to have a number of specialized details, close supervision is warranted when the system is introduced into a new area until tradesmen become familiar with them.

Dampproofing and Drainage

Walls buried in the ground are exposed not only to natural dampness of the soil but to free water due to rain, melting snow and in some cases elevated water tables. Joints between plywood sheets therefore, should be caulked with a sealant known to have a long service life and that is compatible with the preservative.[2] As an additional precaution to reduce the risk of ground moisture entering the basement, it is normal practice to cover the exterior plywood sheathing with polyethylene film below ground. The caulking, therefore, should be of a type that will not damage the film.

It is important that backfilling be done in a manner that will not damage the polyethylene film. If there are tears in the film, water will by-pass it and collect against the plywood sheathing.

Footing drainage for preserved wood foundations is normally provided by a 125 mm layer of screened crushed rock (or any other coarse granular material that does not contain more than 10% of fine material that will pass a 4 mm sieve) extending under the entire building to beyond the outside edges of the footings. The granular layer drains any water at the base of the wall to a sump for subsequent disposal (Figure 2). Conventional footing tiles can be used in lieu of the granular drainage layer but these are usually restricted to walls with conventional concrete footings. Those experienced in the construction of wood basements prefer a granular drainage system beneath the footings, however, as a more dependable system.

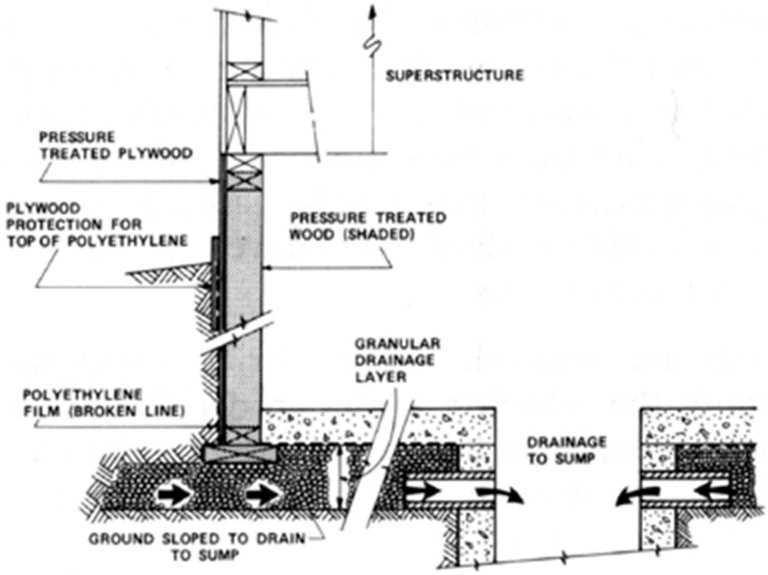

Figure 2. Typical wood frame foundation

Footings

Either concrete or preserved wood footings may be used with wood foundation walls.

The minimum widths required for footings beneath foundation walls depend on the characteristics of the soil on which they rest as well as the superimposed load. In the design of houses and small buildings, the bearing pressure for soil is assumed to vary from 40 kPa for soft clay to 300 kPa for clay shale.[6] Selecting the appropriate value is important to avoid excessive building settlements, and this is dependent on proper soil identification. Since most houses and small buildings are built without geotechnical expertise, specific soil identification is not normally carried out. Instead, rule-of-thumb footing sizes are generally specified, based on a fairly conservative soil bearing pressure. This permits the specified sizes to be used with a wide range of soil types without the risk of excessive settlements.

Foundations for wood basement walls can be significantly smaller than for concrete walls due to the difference in weight between the two. in addition, since the granular layer is assumed to spread the load over a larger area than the area of the footing, the footing width can be further reduced. The result is that lumber footings in widths between 140 and 235 mm can be used beneath such walls.

Column footings are somewhat more complicated to construct than wall footings because of the area over which the load must be distributed. These footings normally consist of two layers of 38 mm thick lumber on edge, with the layers at right angles to one another.

Summary

Although preserved wood frame foundation systems have been accepted for only a relatively short period of time, their use has increased steadily and now represents a significant portion of the market.

Since the success of this system depends on the effectiveness of the preservative treatment, it is important that only wood that has the required preservative retention be used and that any portions affected by field cutting or drilling be treated with preservatives. The system's adequacy to resist both earth pressure loads and loads from the superstructure can only be assured by paying strict attention to details that have been developed to resist such forces.

Aids are available for smaller buildings which simplify the selection of design details and these should be followed faithfully if the foundation is to perform as intended.[1, 2, 3]

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