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Vertical movement in wood platform frame structures : basics

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Abstract: Movement in structures due to environmental condition changes and loads must be considered in design. Temperature changes will cause movement in concrete, steel and masonry structures. For wood materials, movement is primarily related to shrinkage or swelling caused by moisture loss or gain when the moisture content is below 28% (wood fiber saturation point). Other movement in wood structures may also include: settlement (bedding-in movement) due to closing of gaps between members and deformation due to compression loads, including instantaneous elastic deformation and creep. Differential movement can occur where wood frame is connected to rigid components such as masonry cladding, concrete elevator shafts, mechanical services and plumbing, and where mixed wood products such as lumber, timbers, and engineered wood products are used.
Evidence from long-term wood frame construction practices shows that for typical light frame construction up to three storeys high, differential movement can be relatively easily accommodated such as through specifying “S-Dry” lumber. However, differential movement over the height of wood-frame buildings becomes a very important consideration for taller buildings due to its cumulative effect. The APEGBC Technical and Practice Bulletin provides general design guidance and recommends the use of engineered wood products and dimension lumber with 12% moisture content for floor joists to reduce and accommodate differential movement in 5 and 6-storey wood frame buildings. Examples of differential movement concerns and solutions in wood-frame buildings can also be found in the Best Practice Guide published by the Canadian Mortgage and Housing Corporation and the Building Enclosure Design Guide –Wood Frame Multi-Unit Residential Buildings published by the Homeowner Protection Office of BC Housing. This document illustrates the causes and other basic information related to vertical movement in wood platform frame buildings and recommendations on material handling and construction sequencing to protect wood from rain and reduce the vertical movement.

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Vertical movement in wood platform frame structures : design and detailing solutions

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Abstract: Most buildings are designed to accommodate a certain range of movement. In design, it is important for designers to identify locations where potential differential movement could affect structural integrity and serviceability, predict the amount of differential movement and develop proper detailing to accommodate it. To allow non-structural materials to be appropriately constructed, an estimate of anticipated differential movement should be provided in the design drawings.
Simply specifying wood materials with lower MC at time of delivery does not guarantee that the wood will not get wet on construction sites and will deliver lower shrinkage amounts as anticipated. It is therefore important to ensure that wood does not experience unexpected wetting during storage, transportation and construction. Good construction sequencing also plays an important role in reducing wetting, the consequent wood shrinkage and other moisture-related issues.
Existing documents such as the APEGBC Technical and Practice Bulletin on 5- and 6-Storey Wood Frame Residential Building Projects, the Best Practice Guide published by the Canadian Mortgage and Housing Corporation (CMHC), the Building Enclosure Design Guide – Wood Frame Multi-Unit Residential Buildings published by the BC Housing- Homeowner Protection Office (HPO) provide general design guidance on how to reduce and accommodate differential movement in platform frame construction.

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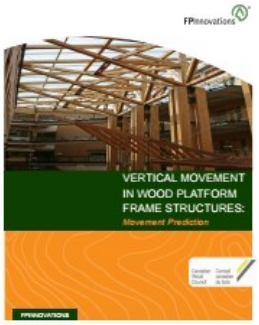

Vertical movement in wood platform frame structures : movement prediction

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Abstract: It is not possible or practical to precisely predict the vertical movement of wood structures due to the many factors involved in construction. It is, however, possible to obtain a good estimate of the vertical movement to avoid structural, serviceability, and building envelope problems over the life of the structure.
Typically “S-Dry” and “S-Grn” lumber will continue to lose moisture during storage, transportation and construction as the wood is kept away from liquid water sources and adapts to different atmospheric conditions. For the purpose of shrinkage prediction, it is usually customary to assume an initial moisture content (MC) of 28% for “S-Green” lumber and 19% for “S-Dry” lumber. “KD” lumber is assumed to have an initial MC of 15% in this series of fact sheets.
Different from solid sawn wood products, Engineered Wood Products (EWP) are usually manufactured with MC levels close to or even lower than the equilibrium moisture content (EMC) in service. Plywood, Oriented Strand Board (OSB), Laminated Veneer Lumber (LVL), Laminated Strand Lumber (LSL), and Parallel Strand Lumber (PSL) are usually manufactured at MC levels ranging from 6% to 12%. Engineered wood I-joists are made using kiln dried lumber (usually with moisture content below 15%) or structural composite lumber (such as LVL) flanges and plywood or OSB webs, therefore they are usually drier and have lower shrinkage than typical “S-Dry” lumber floor joists. Glued-laminated timbers (Glulam) are manufactured at MC levels from 11% to 15%, so are the recently-developed Cross-laminated Timbers (CLT). For all these products, low shrinkage can be achieved and sometimes small amounts of swelling can be expected in service if their MC at manufacturing is lower than the service EMC. In order to fully benefit from using these dried products including “S-Dry” lumber and EWP products, care must be taken to prevent them from wetting such as by rain during shipment, storage and construction. EWPs may also have lower shrinkage coefficients than solid wood due to the adhesives used during manufacturing and the more mixed grain orientations in the products, including the use of cross-lamination of veneers (plywood) or lumber (CLT). The APEGBC Technical and Practice Bulletin emphasizes the use of EWP and dimension lumber with 12% moisture content for the critical horizontal members to reduce differential movement in 5 and 6-storey wood frame buildings.

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