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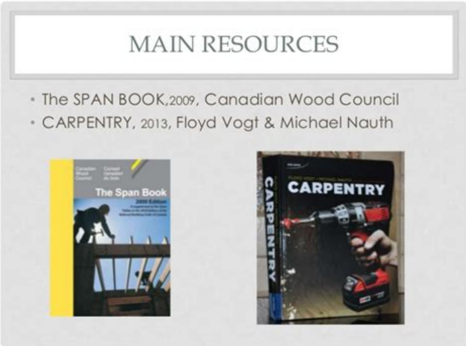

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If you are starting out and want an overview of a topic, look for Books and other background info here. If you are looking for the newest research on a very specific question, or your professor has told you to use peerreviewed articles, you can use a Research Article database. And we have Design Codes and Standards CSA available here. See the Books or the Research Article tabs for specific advice, and this guide. You can always contact me for advice. Its also important to organize the documents you find to save time later. You can use a citation manager Zotero or Mendeley to track what you find in your browser. It is normal to go back and refine your topic while you are researching, or to search some more while you are writing! But you can save time by thinking of a plan first. Here are a few suggestions Perhaps you are looking for something more specific effect of fly ash on freezethaw durability of concrete. If you are looking for the most recent research, you might want to look for conference papers or preprints, which are published more quickly than traditional journal papers. If you are looking for research on a very specific question, or your professor has told you to use peerreviewed articles, you can use a Research Article database. Or you may need to start with a professional document such as a standard or design code. Download Wood Design Manual, 2005.Ensuring that this information is in tune with technical change and users needs requires constant vigilance. The purpose of this fifth edition of the Wood Design Manual is to help the Canadian design community architects, engineers, specification writers, teachers and students of these disciplines to design wood structures with efficiency, economy and safety. It brings together, in a comprehensive but concise format, the essential information a designer needs for a wide range of wood structural elements and systems.

The information in the Wood Design Manual is based on the latest information available from the National Building Code of Canada 2005 and from CSA Standard 08601 2005 Engineering Design in Wood. Every effort has been made to ensure that the data and information in the Manual are accurate and complete. The CWC does not, however, assume any responsibility for errors or omissions in the Manual nor for engineering designs or plans prepared from it. The CWC would like to thank the individuals who were instrumental in the development of this manual Stephen J. Boyd, Quaile Engineering Ltd., and Gary C. Williams, President, Timber Systems Limited. LifeCycle Assessment Life Cycle Assessment is a performancebased approach to assessing the impacts that building products or systems have on the environment over their lifetime. This includes all activities from material extraction or harvesting through manufacturing, transportation, installation, use, maintenance, and final disposal or reuse. LCA is the best available tool to compare sustainability of building materials.Canadian law, as it now stands, has some of the most progressive legislation for forest management in the world. Public concerns focus on the highly visible effects of wood resource extraction. To address these concerns, Canadian wood product manufacturers are using certification by qualified, 3 rd party, independent bodies to attest that they meet the requirements of a rigorous and independent forest management standard. Canadian companies have achieved thirdparty certification on over 100 million hectares 250 million acres of forests, the largest area of certified forests in the world. The tabulated values have been calculated from CSA 086 using modification factors for conditions most often encountered in the design of wood structures. The designer must verify that the tabulated values are appropriate for a particular structure being designed by reviewing the checklist provided before each set of tables.

In most chapters, modification factors are provided so that the tabulated values may be adjusted for different conditions. Where a direct modification of the tabulated value is not possible, a simplified design equation is provided to calculate the resistance; however, the tables may be used to select a trial section. Chapters are arranged so that the lightest loadcarrying element is presented first and the heaviest last. For example, Chapter 2 Bending Members begins with sheathing and decking followed by joists and beams. This arrangement should assist the designer in making economical choices for an efficient deSign. Fastenings Design The design approach for fastenings is somewhat different since the resistance of a particular fastener often depends on a larger number of variables. For each fastener, a simplified formula for factored resistance is provided. The formula generally includes a number of modification factors which may be determined using a checklist. The checklist indicates the conditions where each factor is equal to unity, and where it is not. This enables the designer to quickly adjust the nominal resistance for the actual conditions and also ensures that all of the factors have been considered. Where applicable, diagrams are provided showing edge distance, end distance and spacings for different sizes of fasteners in order to assist the designer in detailing the connections. Reference Material Chapter 11 Reference Information provides background material on a variety of topics. Of particular importance to the design of members and fasteners is the description of duration of load and service conditions. In addition, information on species combinations, grades and sizes of lumber is included. Strength limit states refer to the maximum loadcarrying capacity of the structure. Serviceability limit states are those that restrict the normal use and occupancy of the structure such as excessive deflection or vibration.

The National Building Code of Canada NBCC applies factors of safety to both the resistance side and the load side of the design equation. The resistance factor takes into account the variability of dimensions and material properties, workmanship, type of failure, and uncertainty in the prediction of resistance. The factored load effect is calculated in accordance with the NBCC by multiplying the actual loads on the structure specified loads by load factors that account for the variability of the load. A summary of the NBCC loading is given below. Specified Loads and Combinations Revisions have been made to the limit states requirements in the 2005 edition of the NBCC These include Adoption of the companion action format for load combinations. Separation of load due to snow and rain from live load due to use and occupancy. Use of importance factors to determine the specified snow and rain, wind and earthquake loads. The importance factors are dependant on the type of load and the building use and occupancy. Separate importance factors are used to determine serviceability loads. Top right Double tongue and groove 64 mm and 89 mm thick decking is predrilled at 760 mm on centre for side nailing with 200 mm spikes. Middle left Structural Composite lumber SCl and glulam beams provide significantly higher design values than sawn lumber. Middle right Wood Ijoists are stocked in long lengths and a range of depths for use as secondary framing members. Bottom Nonresidential applications may be framed very competitively with glulam beams and a number of sheathing materials, including steel decking. Bending Members

Wood Design Manual Glulam beams and wood Ijoists are readily integrated with steel columns in this structure. Joists in the typical floor layout shown here are usually provided in No.1 or No.2 grade, both of which have the same specified strengths. 13 14 Glulam beams are commonly used as primary framing members and can be left exposed to form an architectural feature.

Bending Members 15 Wood Design Manual 2.1 General Information The following sections contain design information for members that are used in bending or flexure. These members include sheathing and decking, joists, beams and purlins. Additional design information is included for builtup beams, oblique purlins and cantilevered beams. While the tables in this chapter deal only with bending moment, shear resistance and stiffness, the designer must also be concerned with bearing of the bending members on their supports. Chapter 6 provides design information for bearing and compression loads perpendicular to the grain. The Sheathing Selection Tables provide the recommended thicknesses of waferboard, oriented strandboard and plywood for use on floors and roofs for various joist spacings. These thicknesses are recommended by Part 9 of the National Building Code of Canada NBCC, the Canadian Plywood Association Can Ply and the Structural Board Association SBA. Selection tables for joists, beams and purlins are arranged to provide moment and shear resistances, and bending stiffnesses Esl for given species, grades and size combinations. The design tables presented in this chapter are based upon conditions that are typical for most building structures. Checklists are also given before each set of tables.The designer should review these checklists to be sure that the tabulated resistance is appropriate for the actual conditions of use. For conditions outside the scope of the serviceability table, the designer should calculate a required Esl and compare it with the tabulated Esl values. Although CSA 086 provides no specific guidelines, the designer may refer to Appendix A9.23.4.2 of the NBCC. This article of the NBCC contains span tables for jOists in Part 9 buildings which incorporate vibration criteria see Chapter 11. Additional guidance on floor vibration can be found in the Commentaries to Part 4 of the NBCC and the CSA 086 Commentary.

Plywood, oriented strandboard OS8 and waferboard are the most commonly used panel products for structural roof, wall and floor sheathing. They are generally used on joists or light frame trusses spaced no more than 610 mm apart. Plank decking may be used to span farther and carry greater loads than panel products. Decking is generally used in combination with heavy timber or glulam structures and often where fire performance must meet the heavy timber construction requirements of Part 3 of the National Building Code of Canada. Plywood Sheathing Plywood panels are builtup from sheets of softwood veneer glued together with a waterproof resin adhesive. Typically the grain direction and thickness about the panel centreline is balanced. Douglas Fir Plywood DFP and Canadian Softwood Plywood CSP are the two most common softwood plywoods produced conforming respectively to CSA Standard 0121, Douglas Fir Plywood, and 0151, Canadian Softwood Plywood. These metric panel thicknesses are similar to the imperial sizes, which have been established through experience and traditional usage. Larger panel sizes may be available on a limited special order basis. 2. All thicknesses are metric. OSB is manufactured with the surface layer strands aligned in the long panel direction, while the inner layers have random or cross alignment. Waferboard on the other hand has all the wafers randomly aligned throughout the panel. The sizes shown in Table 2.3 are most common. The general product standard is GSA 0437, and Waferboard. The product standard contains three designations 01 and 02 indicate alignment of the strands as in OSB; while R1 indicates random alignment, and is less common. Another standard that applies to OSB and waferboard, as well as to plywood, is a performance standard GSA 0325, Construction Sheathing. This standard sets performance ratings Table 2.4 for specific end uses such as floor, roof and wall sheathing in lightframe construction.

It is referenced in Part 9 of the NaCC, and provides an alternative way of specifying products for these applications without referencing product standards. In addition to the Part 9 reference, design values for construction sheathing OSB conforming to GSA 0325 are listed in GSA 086 allowing engineering design of roof sheathing, wall sheathing and floor sheathing using GSA 0325 rated OSB. Designers should ensure the availability of designrated OSB before specifying. Values are listed for forces applied parallel and perpendicular to major axis or length of the panel. 7 ! 20 Bending Members Sheathing Selection Tables The roof and floor Sheathing Selection Tables provide the recommended panel thickness for the most common support spacings. These thicknesses conform to NBCC requirements for Part 9 buildings when applicable, reflecting past experience. The tables have been extended to meet the same criteria. The plywood, aSB and waferboard thickness for floors with live loads of up to 4.8 kPa are recommended by the Canadian Plywood Association and the Structural Board Association, respectively., 26 Bending Members Modification Factors The tabulated maximum uniform loads for plank decking are based upon the following formulae and modification factors. The factor is incorporated in the tables as noted. Ks is a service condition factor. However, most fire retardants will reduce strength. If the material is treated with a fire retardant or if it is incised prior to preservative treatment, multiply the tabulated values by the following factors Table 2.6 Treatment factor KT KT for Mr and Vr Treatment type Preservative treated, incised lumber Fireretardant treated lumber Kz Dry KT for Esl Dry service Wet service service Wet service 0.75 0.85 0.90 0.95 refer to Commentary is a size factor incorporated in the tables for given material dimensions. KL is a lateral stability factor. The maximum unsupported length is found to be 2.14 m at the ends of the interior span.

This occurs when full snow load extends over the centre span and half of full snow load on the outside spans. Maximum allowable deflection is governed by U180 based on total load. This occurs when full snow load is on the suspended beam and supporting cantilever, and half of full snow load on the other spans. Stud grade lumber is used together with plywood sheathing in bearing wall applications such as this gable wall. 93 94 Continuous columns form an integral part of this attractive glulam frame. Heavy loads are supported by this spaced glulam column. A unique architectural detail is used for the base shoe shown to transfer the loads to the foundation. Compression Members Wood Design Manual 3.1 95 General Information The following sections contain design information for members that are used in compression parallel to grain. These members include sawn lumber studs, posts, truss chords, single member glulam and sawn timber columns, and nailed builtup sawn lumber columns. The design information is for concentrically loaded members; however, the designer must consider eccentricity where it occurs. Chapter 5 provides design information for members subjected to bending due to eccentricity or lateral loading combined with compression. In addition, Chapter 6 provides design information for compression perpendicular to grain. Selection tables are arranged to provide compressive resistances, Pr for given species, grades and sizes. Checklists are given in each section. Sawn lumber used in stud wall systems has a common thickness of 38 mm and ranges in depth from 89 to 184 mm. Stud grade lumber, however, ranges in depth from 38 to 140 mm; the smaller sizes are used mainly in partitions. For depths greater than 140 mm, another grade must be specified. In stud walls, the members are spaced no farther apart than 610 mm to take advantage of loadsharing. Usually the spacing is 406 mm or less.

Stud wall systems are usually sheathed by plywood, waferboard, oriented strandboard or drywall. The sheathing is nailed to the narrow faces of the studs on at least one side along the entire length of the stud, thereby preventing buckling about the weak axis. Studs are susceptible to buckling if heavy loads are applied prior to installation of the sheathing. Members supporting stud walls or posts must provide adequate bearing resistance to prevent crushing. Bearing considerations are covered in Chapter 6. For walls with combined vertical and lateral loading, refer to Chapter 5. Shearwall design considerations are covered in Chapter 9 and fire resistance ratings for stud wall assemblies are discussed in Chapter 10. Lumber can usually be obtained kiln or airdried to a moisture content of 19% or less specify SDry in 38 mm thickness. Furthermore, the tabulated values cannot be adjusted by a factor that will apply throughout the entire unsupported length range. Therefore, Pr should be calculated from the following formula. This formula may also be used for lumber sizes not given in the selection tables. Wood Design Manual 101 Example 2 Stud Wall Systems Check the bearing wall in Example 1 for wet service conditions. For single members divide tabulated values by 1.1. 2. For fireretardant treated material, multiply by a treatment factor Kr. If the answer to any of these questions is no, the Post Selection Table may not be used. Instead, calculate Pr from the formulae given on page 98. The rules for the grading of timbers are outlined in the National Lumber Grades Authority Standard Grading Rules for Canadian Lumber. Generally, timber columns fall into the Post and Timber size and end use category. Gluedlaminated timber is an engineered wood product manufactured by gluing together 38 or 19 mm thick lumber laminations with a waterproof adhesive.

Glulam is manufactured to meet CSA Standard 0122 Structural GluedLaminated Timber and the manufacturers of glulam must be certified in accordance with CSA Standard 0177 Qualification Code for Manufacturers of Structural GluedLaminated Timber. Generally, the 16cE or 12cE stress grade is used for compression members. The 24fEX and 2OfEX grades are used for members subjected to combined axial and bending loads and design information is provided in Chapter 5. Availability Sawn Timber The Column Selection Tables for sawn timber provide resistance values for the following grades and sizes Table 3.4 Grades and sizes of sawn timber columns Grades Column sizes for all grades mm Select Structural, No.1, No.2 140 x 140 191 x 191 241 x 241 292 x 292 140x191 191 x 241 241 x 292 D.FirL and HemFir are the species groups most readily available in lumber yards, but SPF and Northern species may also be obtained. All the sizes listed above should be available; however, the availability of large sizes should be checked before specifying. Timbers may be obtained in lengths up to 9.1 m, but this should also be confirmed with local suppliers. The most readily available grades are No.1 and No.2 but Select Structural may be ordered. As a result, some amount of shrinkage and checking can be expected after dressing. These effects should be considered when detailing members and connections. The thicknesses shown in Table 3.5 are industry standards, but some fabricators can produce slightly different sizes. Most fabricators use 38 mm thick laminations for straight columns. The preliminary section can then be checked using the formula above note the difference between the estimated resistance and the actual resistance will not usually exceed 5%. 114 Compression Members Additional Design Considerations Where a column must be drilled or notched, the crosssectional area removed must not exceed 25% of the gross area of the member refer to Section 7.1 for information on net area.