Determining Allowable Design Values for Wood

An Online Continuing Education Course for Engineers

Course Number: S-2001

Credit: 2 Hours / 2 PDH / 2 CPD

Determining Allowable Design Values for Wood

Richard Nolan, P.E.

I. Introduction

Wood is the most popular building material for residential homes and other smaller buildings. There are many types of wood products on the market used in the construction industry today. Some of the engineered wood products include I-joists, laminated veneer and glued laminated timber. However, the most familiar and well used is still sawn lumber. This course will provide the methodology for determining the allowable design values to use when designing sawn lumber components, such as beams, headers, trusses, floor joists, decking, etc. However, much of the same methodology and adjustment factors are also applicable to the other types of engineered lumber.

This course teaches the methodology used by the National Design Specification (NDS) for Wood Construction published by the American Forest & Paper Association and the American Wood Council. It is recommended but not essential that the student obtain a copy of this nationally recognized standard. Owning a copy of the NDS will not only increase the understanding of the course material but also be an invaluable source of information for anyone designing wood structures. The NDS contains reference design values for all types of sawn lumber and other engineered wood products. The copy of the NDS can be purchased from www.amc.org.

Lumber Types

Sawn Lumber
-Graded
-Standard Sizes
-Same visual appearance
-Spans 6-32'

- Glued Laminated Timber
- I-Joists
- Laminated Veneer
- Etc.

Sawn Lumber

Laminated Veneer

I-Joist

Glued Laminated Timber

II. Reference Vs. Allowed Design Values

There are a few readily available sources which tabulate reference design values for all types and grades of sawn lumber. Reference (a) and (b) are two good sources of sawn lumber design values. However, it is not appropriate to use the reference design values without first adjusting them for the size of the lumber, service condition, type of loading, and the way the lumber is to be supported. Once the reference design values have be adjusted for these factors, the wood member may be safely designed to handle to applied loads.

The reference design values found in various references are referred to in this course as either, reference, tabulated or baseline design values. Once the reference design values have been adjusted for all factors, it is termed the 'allowable' design value. The allowable design value is the value that should be used when sizing/designing wood structural components. This course teaches the methodology for adjusting the reference design values for all significant factors in order to arrive at the allowable design value.

Remember:

- Reference values are baseline values that you start with
- These values need to be adjusted (downward or upward) to account for different conditions which are discussed herein

Reference:

a) Nation Design Specification (NDS) for Wood Construction, American Forest & Paper Association and American Wood Council, www.amc.org
b) Timber Construction Manual, American Institute of Timber Construction, www.aitc-glulam.org

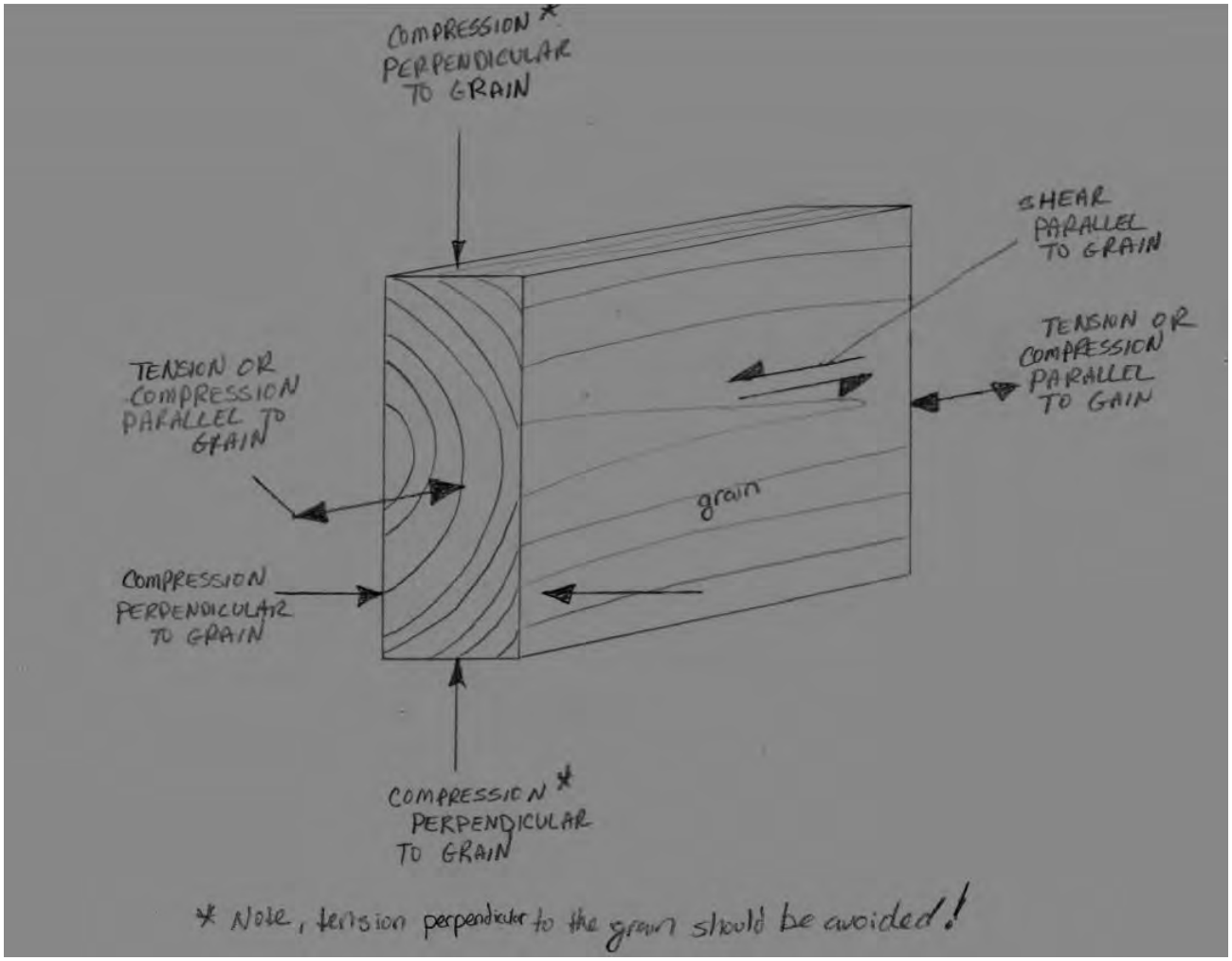
III. Types of Design Values

Below is a list of the design values which are typically needed to design wood components. The actual design value(s) that will be used when design a structural wood component will depend on what the wood component is being design to do. For example, if a beam is being design, the design values used will typically be bending, shear, compression perpendicular to the grain and modulus (to calculated deflection). Design values for a column would be compression parallel to the grain and modulus. For a chord in a truss under tension, the tension design value would be needed. The next section will illustrate the definition of perpendicular and parallel to the grain.

- $\mathbf{F_b}$ Bending (typical beam bending)
- $\mathbf{F_t}$ Tensions (hanging something from timber, truss member under tension)
- $\mathbf{F_v}$ Shear parallel to grain (Beam design)
- $\mathbf{F^{c_\perp}}$ Compression perpendicular to grain (Beam bearing)
- $\mathbf{F_c}$ Compression parallel to grain (header support, truss chord in compression, studs in a wall)
- **E** modulus of Elasticity (used for displacement calculations or column buckling calculations)

Remember:
F = Reference (Baseline) Design Value
F' = Allowable Design Value after all Adjustments have been made

IV. Wood Grain



This image illustrates the what is meant by 'parallel' and 'perpendicular' to the grain.

V. Factors that Affect Reference Design Values

Below is a list of the significant adjustment factors that are applied to the reference design values. Not all of the adjustment factor are used on every type of design value. For example, the bending reference design value is adjusted for all the factors below except for the column stability factor (C_P) and the buckling stiffness factor (C_T). The following section will explain and show you how to determine each adjustment.

- Temperature, C_t
- Moisture Content, C_M
- Load duration, C_D
- Beam Stability Factor, C_L
- Size Factor, C_F
- Repetitive Factor, C_r
- Incising Factor, C_i
- Column Stability Factor, C_P
- Buckling Stiffness Factor, C_T
- Bearing Area Factor, C_b

Below is a sample of ...actors listed above to arrive at the allowable ... in bending. Note not all of the factors are used ...ill be discussed in further detail.

$$F'_b = F_b C_D C_F \; C_L C_M$$

Load Duration Factor (C_D)

Most reference design va... ...he duration of load, that is how long the load ... Reference design values may be increased f... ... loads acting more than 10 years. Different c... ... used in order to determine the most limitin...

Frequently Used Load Durations Factors C_D[1]

Load Duration	C_D	Typical Design Loads
Permanent (>10 yrs)	0.9	Dead Load
Ten Years (Normal)	1.0	Occupancy Live Load
Two Months	1.15	Snow Load
Seven Days	1.25	Construction Load (Roof Included)
Ten Minutes	1.6	Wind/Earthquake Load
Impact[2]	2.0	Impact Load