ARCH 631. Topic 19 Reading Notes

- Timber construction commonly has linear one-way spanning elements, with 2 to 3 levels in the horizontal system
- Light framing construction is defined as floor systems with light occupancy loads and simply supported joists with transverse decking on a load bearing wall of masonry or studs sheathed in plywood; height restriction of 3-4 stories for fire safety
- Heavy timber construction is defined as large beams (commonly glue laminated) with transverse planking; larger spans; commonly simply supported on bearing walls or timber columns; shear walls provide lateral stability or knee braces with column; moment resistant joints possible, but not common
- Types of timber elements:

  stressed-skin member – plywood sheathing on one or both side of stringers; plates used for carrying bending loads; usually constructed off site and placed on site; can be used for folded plates

  box beams – built up with plywood and beams; good for long spans (more efficient than solid or laminated beams with less material)

  folded plates and arch panels – flat or curved that span one way; usually constructed with plywood

  arches – laminated (bent or curved) very common; good for long spans and useful as roofs with light uniform loads; most are two or three hinged (not fixed) at base supports

  lamellas – singly or doubly curved surfaces made from short pieces of wood; typically for roofs

- Approximate span ranges for timber chart is for TYPICAL lengths and corresponding depths for USUAL use (that means common loadings and tributary widths) – *use with care and THEN design using another method*; typical thickness to height (cross section dimension) for beams range from 1:25 to 1:10; typical slenderness ratios for walls are 1:30 to 1:15
- Appendix 17, Table A.17.2 lists common allowable stress ranges for douglas fir, southern pine and glued-laminated lumber made from these woods along with common load duration factors
- Design usually starts with finding tabulated values of stresses and multiplying by adjustment factors (shown in the second example with the shape facture and load duration factor); bending stress is used to determine $S_{req'd}$ or the size of b x d determined knowing $S = bd^2/6$ for a rectangle; shear stress is determined from 3V/2A (for a rectangle); bearing stress is found from P/A; deflection is determined using a formula and must be calculated for both the total and just the live load deflection which must not exceed limits described by the span (L) over a unit-less number (like L/240); **if at any time, the stress or deflection criteria is not satisfied, a new section must be chosen with larger S, A or I**
- Beams with constant rectangular cross section (prisms) are not structurally efficient because they provide extra cross section where it isn't needed for the maximum moment; because the part of the cross section seeing the maximum stress is at the top or bottom-most fibers, so the rest sees less stress

- Modulus of elasticity and allowable stress values are dependent upon the type and grade of wood and how it is used, if it is wet or dry – wet glulam needs the modulus of elasticity (E) reduced – what direction the loading is to the grain, the load duration, and many other adjustment factors ($C_{\text{sub something}}$)
- Laminated timber is made of gluing layers of wood to build up a composite whole; can be large with higher strength, usually with high strength layers on the exterior
- Timber column allowable stresses are derived from an adjusted compressive stress, f'_c; slenderness ratios (L/d) must be less than 50; allowable capacity is found from f'_c x area
- A simplified column design method is to determine allowable stress with the smaller of $0.27E/(L_e/d)^2$ and $0.6f_c$.
- ASD and LRFD determine limit stress with respect to buckling based on the column stability factor C_p. To find it, the critical buckling stress F_{CE} $(=0.822E'_{min}/(L_e/d)^2)$ and the adjusted compressive stress F_c^* must be determined (found from multiplying all the C factors by f_c). E'_m is the adjusted modulus of elasticity. The expression to calculate C_p depends on the material – either sawn timber or glulam.
- Appendix 14 shows that in design, the capacity is computed from the derived stress times the area and must be larger than the design load to be acceptable.