ARCH 631. Topic 1 Reading Notes

- A building structure is a device for channeling loads to the ground
- Text will provide insight into what IS the makeup and characteristics of the physical structure
- Structure must act as whole first, and have function of discrete elements secondly
- Must be designed to respond to specific set of loading conditions both vertically and horizontally
- Design is positioning of elements and determining interrelations to give the structure the desired character
- Characteristics can help classify elements and systems:
  - geometry – line and surface forming
  - stiffness (opposite of flexible) – rigid or flexible and based on material
  - one-way system: load transfer acts in one direction only
  - two-way system: load transfer is more complex and involves at least two directions
  - materials: wood, steel, etc. Deformations and construction are important
- Element types (don’t necessarily have different properties)
  - beams and columns – often called post and beam when put together
  - beams – carry load by bending; can be one span or continuous
  - columns – subject to axial load only (no bending)
  - frames – rigid joints between beams and columns and both see bending
  - trusses – short members in triangular pattern that see axial load and little bending
  - arches – curved span in compression and can have bending
  - walls and plates – rigid, can carry in plane loads (compression and shear); folded plates are narrow plates that are joined
  - cylindrical shells and vaults – singly-curved-plates and continuous arches
  - spherical shells and domes – doubly-curved surfaces that can span large distances
  - cables – flexible; shape is load dependent and described as catenary under distributed load; span long distances
  - membranes – thin flexible sheet
  - tents & nets – made of membrane surfaces; convex up or down needs supports; air-inflated have mechanism to maintain shape; nets are made from crossed curved cables
- Structural “unit” is volume-forming element or assembly (like four columns supporting a plate); useful for preliminary design;
  - can have single or multiple units to fill space;
  - needs a horizontal spanning system and a vertical support system;
  - top level picks up loads and distributes to lower level members
- Structure must resist applied forces to not slide or overturn or collapse internally; or break apart or deform badly
- Overall stability is resistance of whole structure to overturning, sliding or twisting
- Internal or relational stability is the arrangement of elements or interconnectedness to resist collapse internally
- Strength and stiffness is the resistance of parts to failure from loads or excessive deformations due to loads
· Design requirement: stable under loading with small deformations and no collapse
· Collapse mechanism – way it collapses due to lack of stability of collection of members
· Stabilizing – diagonal members, shear walls, rigid joint geometry (frames)
· External forces produce internal forces of tension, compression, bending, shear, torsion and bearing
· Stress is measure of force/unit area
· Strain is measure of length change / base length – unitless
· Tension pulls apart and stress = P/A
· Compression pushes and members crush or buckle which is inability to carry load based on length;
· Membranes can have stresses in the surface (both T & C)
· Bending is associated with bowing from loads perpendicular to the axis of the member; internal bending moments are rotational; resistance depends on distribution of are in the cross section and on material
· Shear is associated with opposite direction of forces and sliding; beam shear stresses are longitudinal and tangential
· Torsion is twisting
· Bearing is compressive stress at interface of two members
· Deflections must be limited
· Bending structures are less efficient when compared to tensile or compression structures
· Structural analysis process:
  determine external forces from live and dead loads;
  analyze system equilibrium for overturning, sliding or racking
  analyze member equilibrium
  (statics, reactions, free body diagrams, sum of forces, sum of moments)
  analyze internal forces (shear and bending moment diagrams)
  evaluate stresses
· Funicular structures are those primarily in tension or compression (cables, arches...) and can change shape under loading;
  thrust is an outward force on an arch
· Can classify based on loading resisted – concentrated or uniformly distributed