

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 area 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