# ARCH 631. Topic 15 Reading Notes

- Lateral resistance is important to any height and shape building with the vertical AND horizontal elements; basic deformations are horizontal, twisting or torsion and possibly resulting in collapse
- Shear plane is the method or mechanism used to describe providing in-plane stiffness and in-plane force transmittal capabilities (vertically); horizontal shear planes or diaphragms are the same mechanisms in the floor or roof plane
- The horizontal shear plane (normally located anywhere in the overall plane) must be able to receive the lateral loads AND transmit the loads to the vertical shear planes; loads must be resisted from any lateral direction
- Good practice to make entire roofs or floors into diaphragms when possible; when not possible, converting the external edges of a roof or floor plane into a band of rigid planes is good practice
- With a floor diaphragm, the wind loads are carried through the tributary area to the floor diaphragm and the base; shear walls resist a portion of the shear from the diaphragm as a function of their stiffness (or deflection as a function of 1/EI)
- Use of three walls in a rectalinear structure results in twisting; twisting also results if the shear walls or diagonal bracing are not placed symmetrically such that the center of mass does not coincide with the center of rigidity
- Low-medium rise building lateral stability choices include rigid frame with two-way floor system, lateral bracing at perimeter only, symmetrically placed shear walls, end bracing, cross bracing
- Frames tend to be less efficient than shear walls or diagonal bracing
- Taller buildings must have lateral-load resistance mechanisms that are clearly defined; cores are frequent locations for those mechanicsm
- Frame action:
  - less efficient that either shear walls or cross bracing
  - more flexible than walls or braces
  - induce bending in columns and beams for larger member sizes than pinned frames
  - spatially more open
  - joint construction more involved (except for reinforced concrete)
- Shear walls and diagonal bracing:
  - member may be pin-connected (easier to construct)
  - floor diaphragms are necessary
  - diagonal bracing common for steel systems
  - shear walls appropriate for cast-in-place reinforced concrete systems
- Member orientation should be such that maximum bending resistance (bigger I) corresponds to the axes about which maximum bending occurs; narrow dimension buildings suggests orienting member deep dimension parallel with the narrow direction; frame action in long direction (with bracing in the short direction) requires the strong axis in the long direction beams and columns; extremely narrow width to large height with bracing in long direction indicates a “combination” frame (short direction) and bracing
- With long spans, the lateral system may be decided after horizontal spanning system choice; frame action is not as easy with long spans; load bearing walls can act as shear walls

- Frame action best for low-medium rise (10 stories max) because of inefficiency; concrete flat plate floor systems are not great at resisting moments from lateral loads because of transfer of load a columns (high shear) so that some other mechanism is needed (like shear walls); deeper two way systems like waffle slabs are better
- Tall structures:
  - act like vertical cantilever members because they are tall and slender
  - lateral loads produce an overturning moment with forces resisting in the vertical members
  - common to have a stiff exterior ring or tube which primarily carry forces from lateral loads with interior columns carrying gravity loads
  - stiffening the plan is useful
  - wind effect is pronounced with sway and vibration
  - tuned mass dampers dampen the effect by inducing side sway in large buildings
  - rule of thumb: limit deflections to h/500