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 transmital capabilities (vertically); horizontal shear planes or diaphragms are the same mechanisms in the floor or roof plane
- Shear wall materials include masonry (low-mid rise), timber studs with sheathing; cast in place concrete walls. Diaphragm materials include timber beam-and-decking systems, cast-in-place concrete slabs
- Stiff shear or diaphragm planes can be obtained with diagonal or cross bracing (“triangulation”) – mostly for steel and timber systems, and for precast. Members can be pin connected (easier to construct)
- 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)
- 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 rectilinear 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
- Taller buildings must have lateral-load resistance mechanisms that are clearly defined; cores are frequent locations for those mechanisms
- 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, tube or diagrid 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