ARCH 631. Topic 21 Reading Notes

- Most heavy steel systems are comprised of one way elements from a variety of structural (cross section) shapes; pin connections are preferred; rigid connections aren’t too difficult to construct.

- Beams are usually wide flange shapes; channels are sometimes used (tend to twist – so they are good anchored to masonry walls, as are angles, to support joists).

- Trusses have a variety of shapes and lengths and span ranges; open-web joists are an economical solution for light, uniformly distributed loads (like roofs) and for long spans; because open-web (or bar joists) are simply supported, they don’t contribute any lateral resistance; joist girders exist.

- Composite construction refers to two structural materials that act together; composite systems with steel are typically concrete (and not described as reinforced concrete or reinforced masonry); to act together in bending there are shear studs in a steel beam or deck to tie the concrete to the steel; “concrete-wearing” refers to having concrete on the steel deck to make a flat floor and it might as well be used structurally instead of as dead load.

- Plate girders are wide flange sections built of plates and are usually used for long spans like in bridges or as transfer girders.

- Rigid arches can be made into any shape and of solid sections or open web sections; pre-manufactured ones are common for short to moderate spans.

- Space frame structures are typically steel for long spans.

- Shells are possible with steel; it is tricky using straight line elements to establish double curvature; curved segments are possible by pressing (cold forming) steel sheets; domes can be ribbed or geodesic.

- Cables are extensively made of steel.

- Steel columns typically have t/h or (t/d) ratios from 1:24-1:9.

- Beams can be designed based on serviced loads and allowable stresses (though not as common any more); rolled sections are standard shapes; built-up section are custom shapes; because there are standard shapes, the section modulus can be put in tables for design aids; select a section, then evaluate for shear, deflection and other design issues.

- In wide flanges the number after the W is the nominal depth with the second number (after the x) being the weight per linear foot; C’s are channels; L’s are angles; section modulus and moment of inertia are listed for x-x and y-y axes in shape tables along with other geometry; built up section must have the moment of inertia calculated with the parallel axis theorem.

- Shear strength is a function of the area of the web (td).

- Compact section have the right proportion of geometry and do not have to be carefully examined for thin member (unbraced) behavior problems amongst others; flange buckling is possible under compression and must be designed for.

- Steel has a linear elastic behavior under stress-strain loading and then plastic behavior (very little increase in stress with significant strain) after yield and eventually rupture; plastic hinge is the effect of all the fibers in the cross section yielding and having no more resistance to an increase in bending moment; the “section modulus” corresponding to the yield moment is called the plastic section modulus (Z).
Plastic hinges in simply supported beams will cause an instability, but may not in an indeterminate structure where more hinges may be necessary for collapse;

LRFD stands for Load and Resistance Factor Design and is a design method based on limit states and amplification of service loads (like 1.4D); \( R_n \) stands for nominal resistance, \( \phi \) stands for resistance factor; \( R_u \) stands for the design quantity determined with the load factors; deflection are always determined from *unfactored* loads.

Allowable stress for high slenderness ratios (larger than \( C_c \) which is a function of \( E/F_y \)) has a similar form to the Euler equation: \( 12\pi^2 E/23(\ell L/r)^2 \); shorter columns buckle inelastically; \( kL/r \) is limited to 200.