8.0 – Structural Loads – Breadth 2

The building is supported by a steel structural system with concrete slabs on metal deck. Nothing jumps out immediately, but because a large lecture hall is located on the first floor of the building, a Vierendeel Truss was used to carry all the loads to the sides of this large clear-span room at the perimeter of the building, along the west wall.

The intent of this structural study was to adjust the concrete slab thickness and to check if any of the steel members could be reduced in size because of new mechanical equipment on the roof, and because of the lack of weight of slate shingles from the electrical breadth. The original design live loads are 70 psf for all non-public spaces (classrooms, offices, labs, etc.), and are 100psf for all other areas. Floor slabs are 4-1/2" Normal Weight Concrete on 2" composite deck, for a total slab thickness of 6-1/2". The roof slab is identical to all floor slabs except for thermal insulation board applied on top of the concrete slab.

The roof is designed for a 30psf snow load on flat sections, and a 28 psf snow load on the sloped sections of screen roof. The Vermont Slate shingles weigh 9.5 pounds per square foot, in the plane-of-roof dimensions. Replacing these shingles with PV panels saved a net of 7.1 psf on these surfaces, but the load is still dominated by snow loads, so no member sizes could be reduced. The 3" Type N metal roof deck could be reduced to 2-1/2" in this 3250 square foot area, and that would result in approximately a $1000 savings. However, the additional labor hours it would take to match the 2-1/2" and 3" roof deck sections together, in hips and valleys of a slate roof more than make up for the cost savings in materials, so for overall simplicity and costs it would be best to leave the roof a bit oversized in this area.

The chiller replacement will not save any structural costs in the Central Utilities Plant. The room for the chiller was originally built to have a chiller sit in that location. Placing the new chiller in the 800 square foot north mechanical room (M001) requires a slightly thicker slab-on-grade, 6-1/2" instead of the existing 5" SOG. This increases costs by roughly $250. A housekeeping slab will be necessary under the chiller, and will cost another additional (net, with removal of the full AHU-3) $540.

All the Water Loop Heat Pump units added to the building weigh a total dead load of 22.5k. When this load is distributed over the floor area, the increase is under 0.25 psf increase. The system can accommodate this increase in load due to the reduced weight of lighter ductwork. The net results of removed ductwork (0.11 psf) and the additional WLHP units is a net increase of 0.14 psf. The only stipulation with these unit is that they be hung from anchors embedded in the concrete slab, not just attached to the metal deck. If possible, they could be attached to the steel above, but since the average beams are 7' apart, and most of these units "long" dimension is less than half that distance, it would be best to hang them from the embedded anchors. Since each floor system is designed to hold up to 8psf of mechanical equipment, plus all other plumbing, electrical, etc., and the mechanical equipment (ductwork, WLHPs, piping) still only comes in at 6.3 psf, the system is slightly over designed, but again could not be reduced in size. See Appendix B for WLHP Data and weights.

The roof has seen more significant weight reductions. Removing the old summer boiler (6.2k) and all the AHUs and EAHUs (total of 50k), as well as the reduction in ductwork has reduced the penthouse dead load by just over 3psf. The entire penthouse/roof is designed to accommodate all the mechanical equipment as distributed loads, with the only concentrated loads being the four chimneys and the dunnage steel for cooling towers.

The additional cooling tower only adds 12k net during operation, and since the towers sit directly on steel connected to the column matrix at the building core, and this steel is designed for 5 more 700 ton (70k) cooling towers, this small increase does not require any steel increases.

Adding the WLHP Condensing Boiler in the penthouse mechanical room, even with the pumps, still only increases the area loading by 2k. The roof finally nets a 2.1 psf decrease in dead load from mechanical equipment. None of the roof or penthouse elements can be reduced in size because the load reductions are not as significant as was expected, and because these slabs are still dominated by a 70 psf design live load and 30 psf snow load. This requires the 6-1/2" slab in 2" composite deck, with insulation for the roof.

The intent was to reduce structural loads on the roof/penthouse enough to remove ½" or 1" of concrete from the slab, which would have reduced the slab weight by ~9 psf, 175k total dead load. Unfortunately this was not able to occur due to other loading constraints that were overlooked at the beginning of the process.

The structural system is completely sound, and well-designed to maximize the structural dollars. I am not able to offer a better suggestion than what they have already done.