Breadth: Mechanical

There are many mechanical systems which are including in building design and construction. Important systems designed by the mechanical engineering firm include HVAC, plumbing, fire suppression, transportation, and acoustics. For my breadth work I will briefly discuss how some of these systems can be integrated into a composite floor and steel frame structural design.

HVAC:

Fresh air requirements in the original design were provided by working windows in all apartment units. The new column layout will require some window placement be moved. Although the bay spacing is irregular, it is symmetrical about the geometric center of the residential levels forming a 13’, 16’, 20’, 16’, 13’ pattern. This allows for the windows to be moved while maintaining a symmetric grid. No move is significant enough as too eliminate large working windows from each living space.

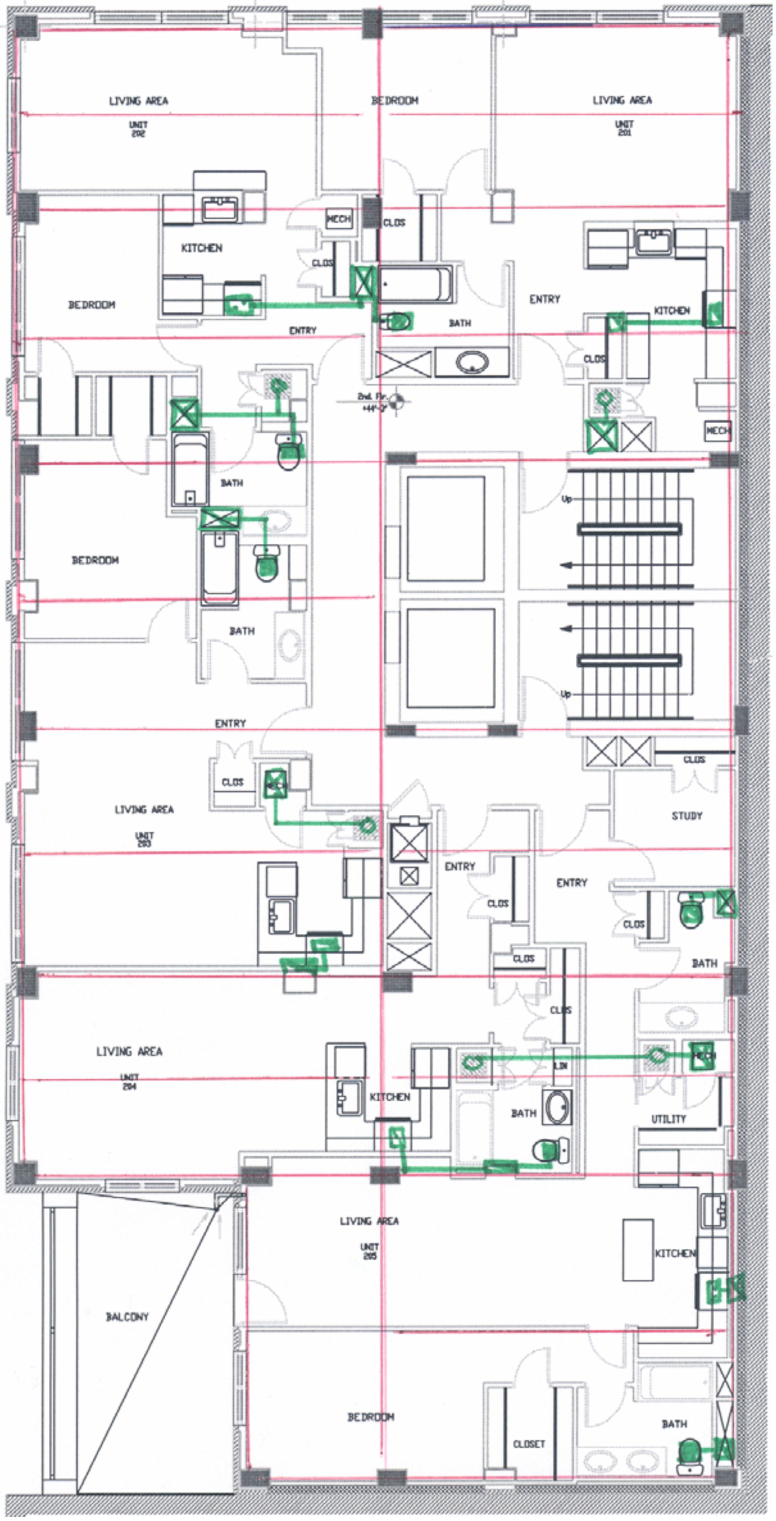
Existing Window Grid　　　　Adjusted Window Grid

Figure 35

To minimize the floor depth of Lexington II, the HVAC system was run through soffits along the top of interior partitions. Since the steel alternative design was developed around the existing architecture, no partitions were moved and the use of soffits can be maintained in the exact same manner as previously designed.

However, one advantage of a deeper floor sandwich is the ability to conceal the mechanical systems within the ceiling. Concealing the mechanical systems is usually more aesthetically pleasing to the tenant. The ductwork can be placed anywhere within the floor sandwich as long as it does not intersect a beam. If any ductwork intersects a beam, a hole cut into the beam would be necessary and the beam’s structural integrity would be compromised.

I have mapped out a brief example of an alternative ductwork design to verify that there are possible routes for which the ductwork can be concealed within the ceiling (Figures 36 and 37). This design provides exhaust to each toilet room, utility (washer/dryer unit), and oven range. Supply ducts are routed into every room and were designed to maintain the same supply quantities and number of diffusers to each space as in the original design. The numerous spaces from which concrete columns in the original design were removed provided additional space for risers in the new duct layout.



Red lines represent beams which cannot be crossed.

Green represents duct work

Figure 36
Possible Exhaust Plenum Layout

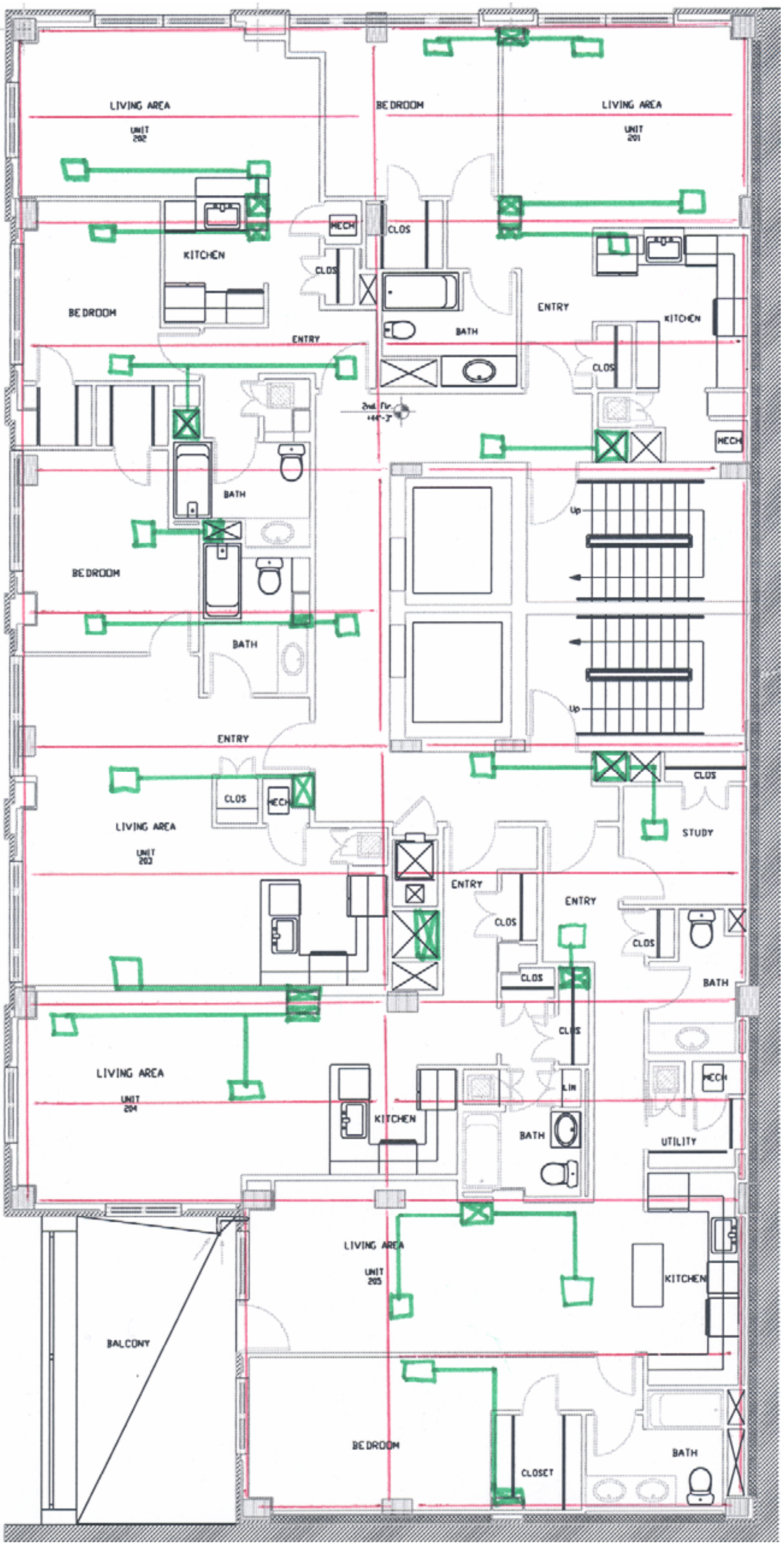


Figure 37
Possible Supply Diffuser Layout

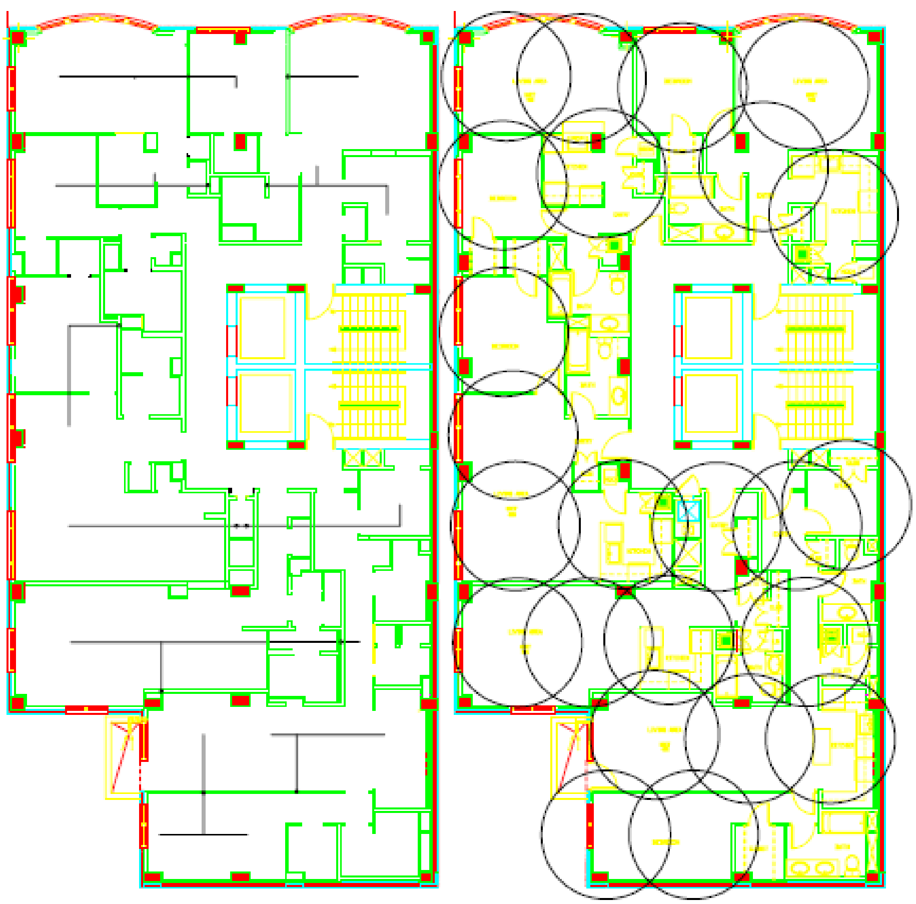
Plumbing:

All plumbing is concealed in existing walls. The steel design of Lexington II is sensitive to the existing architecture and wall partitions. Therefore no changes to the plumbing layout are necessary.

Fire Suppression[1]:

Currently Lexington II is 100% fully sprinklered. Although I do not have a copy of the sprinkler layout, I believe the current system will still work with the new structural design. Like the other MEP systems, in the original design of Lexington II the sprinkler system would have been run through soffits. All soffits are still possible to construct since none of the interior architecture has been altered. However, like the HVAC system it is safe to assume that a new layout may be completed upon investigation and that standpipes may be run in the areas previously occupied by concrete columns.

Lexington II would be classified as a Light Hazard Occupancy. Using upright or pendant sprinklers, this means that each sprinkler has a protection area of 225 square feet and the maximum spacing for sprinklers is 15'. Sprinklers are normally not required for bathrooms 55 square feet or less and closest with the least dimension 3' or less.



Piping Layout (with stand pipes) Sprinkler coverage area

Figure 38

[1] All fire protection requirements are as listed in *Mechanical and Electrical Equipment for Buildings* 9th Edition by Benjamin Stein, final design should be checked and complete with the Washington DC codes.

Figure 38 shows a possible sprinkler layout, all stand pipes have been run through walls and are concealed. There is no piping which intersects a ceiling beam.

Additionally, fire proofing must be added to all steel components. The most commonly used fireproofing is cementitious spray on fireproofing. This popcorn like fire retardant material must be applied to the underside of the steel decking as well as all beams and columns. Other fireproofing may include using fire retardant materials as finishes such as suspended ceilings and wall boards.

Means of egress is also an important issue with fire protection. In residential sprinklered buildings 35 feet is the common path limit for means of egress from a suite exit. As seen in figure 38, all apartment units open to the same hall and have very short egress paths. Fire resistance construction should be applied to the stairwells to create enclosed means of egress paths.

Additional precautions should also be taken. Smoke and fire detectors will be placed through out the building as prescribed in local code requirements. Smoke management should also be considered. Some ideas for smoke management may be automatic controls of the HVAC system once an alarm has been activated, or opening the top of the elevator shafts to create a natural chimney for the smoke to escape from.

Transportation:

No changes are necessary to the vertical transportation elements in Lexington II. The elevators and stairwells are located as before. Although braced framing now surrounds the stairwells, using the inverted chevron braced frame, the door to the stairwell is uninterrupted by the framing members.

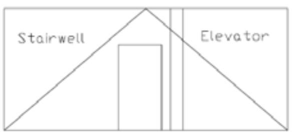


Figure 39

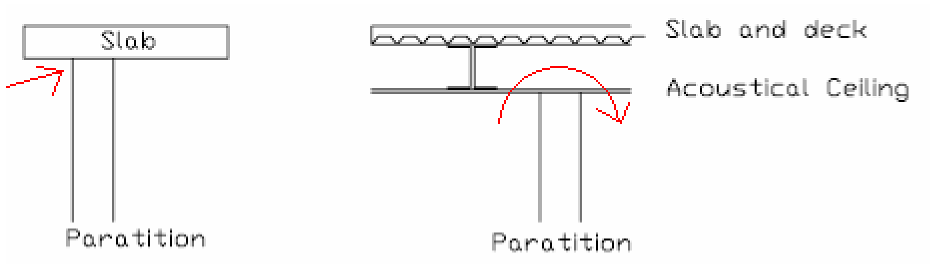
Acoustics:

Acoustics may be the mechanical system which differs the most between a steel and concrete building. Many items which affect the acoustic properties of each room will remain unchanged from one structural system to the next. Items in each room that are not altered by the structural system include interior partition materials and floor finishing materials. The greatest change to the acoustics will be reverberation and absorption associated with each room’s ceiling.

Concrete flat plate slab is a very hard and dense material. In the original design of Lexington II there was exposed concrete slab with sprayed acoustical sealant on it. Sprayed cellulose fibers can provide a noise reduction coefficient (NRC) of .75. The NRC is a single number rating of the sound absorption of a material averaged over the entire range of auditable sound frequencies.

For a composite steel decking system, it is possible to leave the decking and beams exposed as part of the ceiling system. In this case, there is also fireproofing exposed. Exposed sprayed fireproofing can provide a noise reduction coefficient (NRC) ranging from 0 to .75 depending on the product chosen. While this would cause little change from the concrete structural system, it is unlikely that a residential building would choose to leave such a system exposed. To be aesthetically pleasing, typically a suspended ceiling would be hung. This suspended ceiling is even more critical to hide the other MEP systems which have been moved from soffits to the floor sandwiches. Many suspended ceilings are designed to be acoustically sensitive and almost any required NRC can be specified. It is common for the NRC of acoustical tile to range from .5 to .95.

Noise infiltration can also differ between structural systems. Sound leaks are possible anywhere there is an interception of building partitions or materials. Although no specifics are known of the assembles existing between the concrete slab and wall partitions, it can be assumed that the partitions run the entire height of the room and connect to the concrete ceiling. For many reasons; aesthetical, thermal, etc, the owner and engineers will want to ensure that there is a solid connection at the ceiling and floor. When steel beams and a suspended ceiling are used, there is a much greater chance that the partition will not extend as far into the floor sandwich as needed to control noise leaks. Special attention should be paid to the design and construction of this detail.



Concrete Construction Steel Construction

Figure 40

Solutions to prevent noise infiltration are to continue the partition all the way to the ceiling or to use continuous gypsum in additional to the acoustic ceiling, Figure 41.

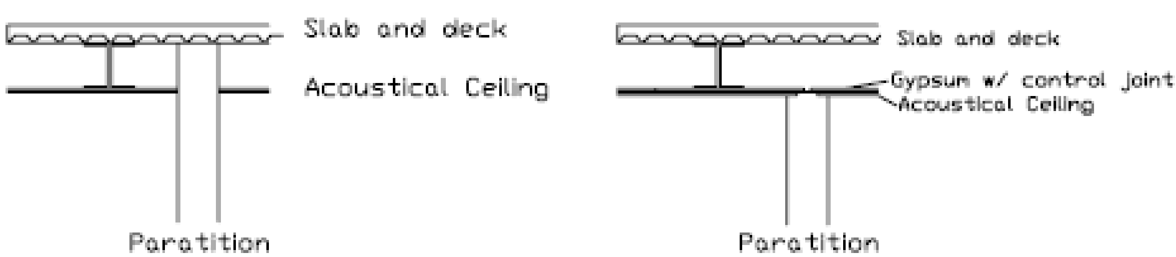


Figure 41