Breadth Topic 1 – Structural Slab and the Concrete Encasement of the Steel Beams

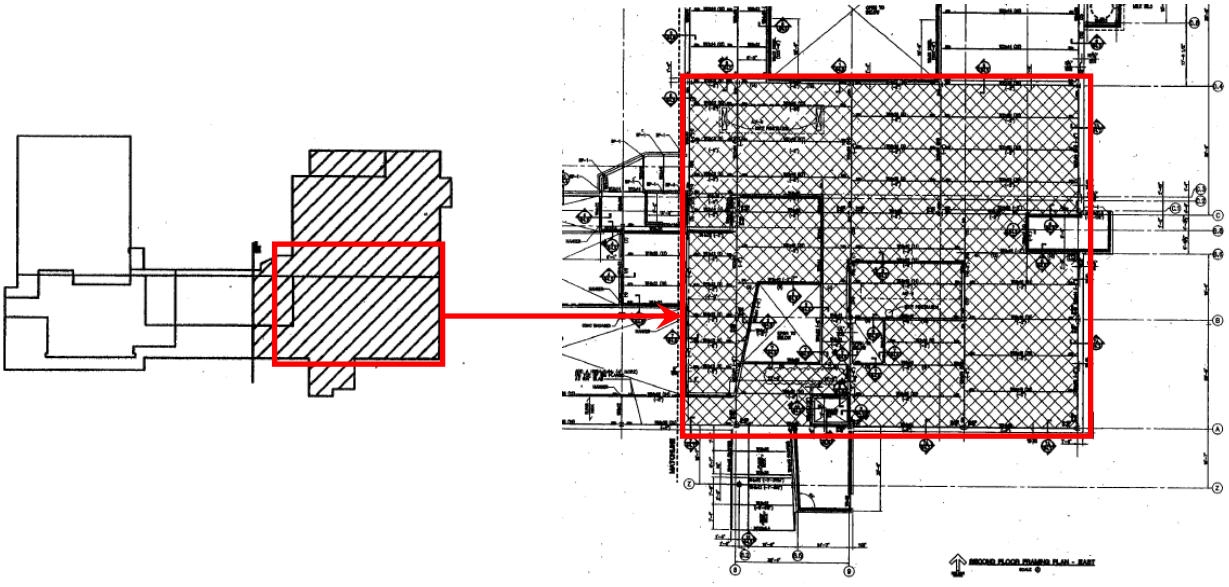
Background

The main Production Area is located in the east part of the Food Science Building on the first floor level. The ceiling of this area (the second floor) is currently designed and installed as an 8" thick structural slab vs. the rest of the buildings' typical 6" concrete slab-on-deck. Additionally, each structural steel beam, girder, and column in this area had to be encased with concrete which held no structural integrity; it was done simply for sanitation and cleaning purposes. This was the solution that was decided upon by the architect, engineer, and owner to solve the issues of sanitation requirements for a food processing facility. The other requirement that this solution maintained was that there was no exposed carbon steel in the area. The chemicals used weekly to clean and sanitize the area are so powerful that they would eventually corrode and eat through carbon-based structural steel.

Problem

The problem with this design was the difficult constructability and immense schedule impact that it has had to the project. The start-up and useable operation of the Production facility in the Food Science Building is by far the driving task on the schedule. The sequence of the trades that has to take place and the continuous irregular and complex details of the area made management and coordination almost infeasible at times. The extensive amount of mechanical and electrical rough-in that had to take place in the slab-on-grade below before it could be poured was key. This had to be done before the shoring and scaffolding in the area could begin for the structural slab above, which was also waiting on structural steel completion in this area before it could begin. Add in that once they got to this point, no two beam encasements were the same and that after all shoring, forming, and decking was complete another sizeable amount of mechanical and electrical rough-in had to be installed before the structural slab could be poured. These delays and problems continuously pushed back the schedule as well as creating daily headaches for everyone involved.

Refer to the figures below for structural layout showing the location of the structural slab in the building.



Proposed solutions

The proposed solution to the structural slab and steel beam encasement problem is a redesign to another structural system to be used in the area. There are two systems I feel could be utilized in its' place.

Alternative #1: The elimination of the structural slab and steel beams and the utilization of structural precast double tee's bearing on steel girders.

Proposed Benefit: The precast double tees will give a more finished, professional look to the area while maintaining all of the owners' requirements. They will provide a factory "steel plated" finish on the concrete ceiling which will be much more smooth and aesthetically pleasing than you can get with cast-in-place concrete. If able to coordinate around the erection of the building's structural steel I feel that the installation of the double tees will be significantly quicker than the original design and expedite the schedule and progress of the project in this area. On the other hand, another study must be done reviewing all the relocating of the mechanical and electrical rough-ins that are to be installed in the structural slab.

Alternative #2: The elimination of the use of structural steel in this area and the redesign using structural cast-in-place concrete columns, beams, and slab. *Benefit:* This would enable a more efficient schedule letting the concrete contractor begin work in this area with out the steel erector having his steel in place. Thus, the steel erector could begin at the west end of the building while simultaneously the concrete contractor can begin with his work in the Production Area on the east end. By the time the steel erector works his way around to the building's east side the concrete contractor should be done with this work. Hence, steel erection can continue and further trades can begin work in the Production Area. Consequently, this will allow the work in the Production Area to begin separately, without depending upon the rest of the building's progress.

These alternative value-engineering solutions will aid constructability and schedule. They will improve the overall quality of the Production Area while saving money and significant time in the schedule. Additionally, during the construction process the flow of job-site coordination, staging, and sequencing amongst trades will be notably improved.

Solution Method – Tasks and Tools

The design of these alternative systems will be based upon the necessary structural loads and requirements above and below the Production Area with regards to the remainder of the building. Below the Production Area is merely a slab-on-grade, but above is a small mechanical room with an air handling unit and an additional 3 stories of building.

I will utilize the project engineers and professionals in the field of concrete and precast design to aid my analysis. Also, I will recall my skills learned in concrete design class with some help from qualified AE faculty if necessary. A preliminary list of tasks necessary to redesign these alternative systems is as follows:

Alternative #1 – Precast Double Tee's:

a) Determine required live and dead load requirements for the floor.
b) Determine span distances for the precast double tees in between steel girders.
c) Size steel girders.
d) Size steel columns.
e) Determine how to make all necessary connections.

Alternative #2 – Complete Cast-in-Place Structural Floor System and Columns

a) Determine required live and dead load requirements for the floor.
b) Choose structural c-i-p floor system that would be best to use: 2-way slab, waffle slab, etc.
c) Design structural slab floor system chosen: thickness, reinforcing, etc.
d) Design c-i-p concrete beams and girders: size, reinforcing, and connections.
e) Design c-i-p concrete columns: size, reinforcing, and connections.
f) Determine how to connect c-i-p structural concrete portion of the building back to the remainder of the structural steel building.