Upper Campus Housing Project

Thesis Proposal
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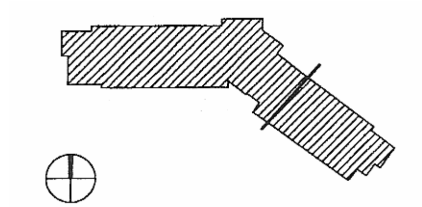
EXECUTIVE SUMMARY

The Upper Campus Housing Project, currently under construction on the campus of the University of Pittsburgh, is a nine-story, 161,600ft^2 structure that will house approximately 500 students. This 100ft tall building will have a brick façade encasing a structure of precast hollow-core concrete planks with reinforced masonry bearing and shear walls. The problem that may arise for the building owners in the future is the inability to change the structure's purpose. This is a problem because the plank will be insufficient to carry new, larger live loads and the masonry walls cannot be changed or moved because of their functions.

For the purposes of thesis, this structure will be examined as a two-way concrete system. ADOSS will be used to analyze the gravity and lateral loads that the structure will be exposed to. A choice between a flat plate system and a waffle slab system will be made within the first few weeks of the up-coming semester. Also, a new exterior curtain wall will be developed to provide the building with a different form of thermal and moisture protection and the interior walls will also be redesigned and examined. Construction management issues such as cost and schedule comparison will also be done.

BACKGROUND

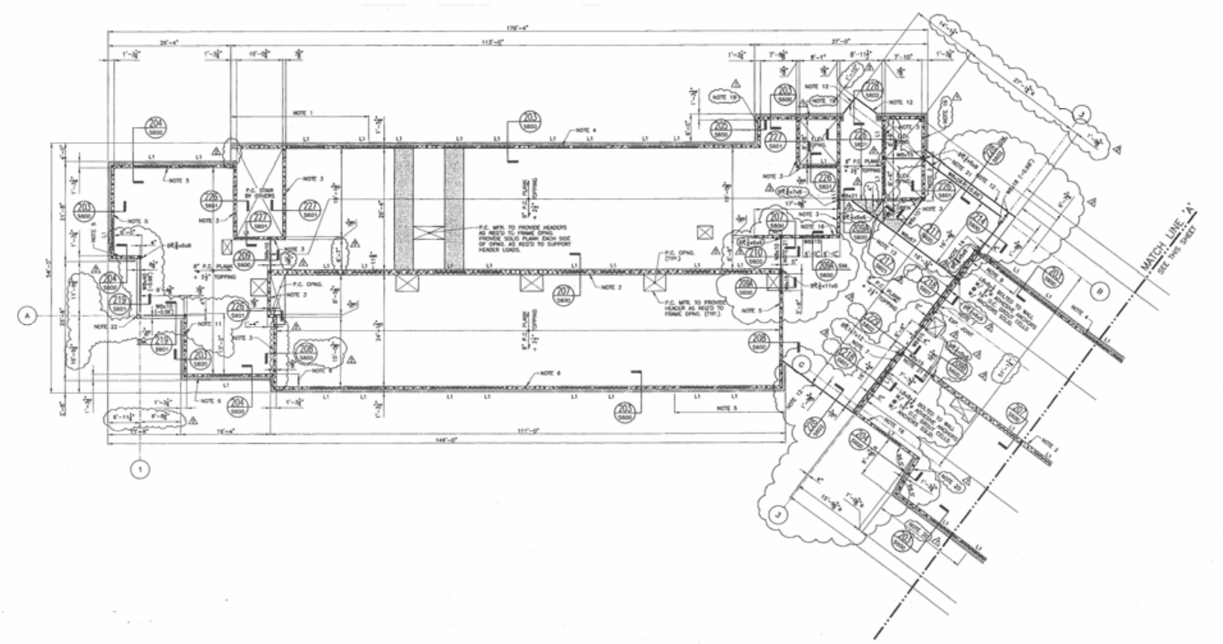
On stadium drive, on the campus of the University of Pittsburgh, the Upper Campus Housing Project is currently under construction. The Upper Campus Housing Project is a 161,600 ft^2, 9 story dormitory facility designed to house approximately 500 students. The structure will stand a little over 100ft tall.

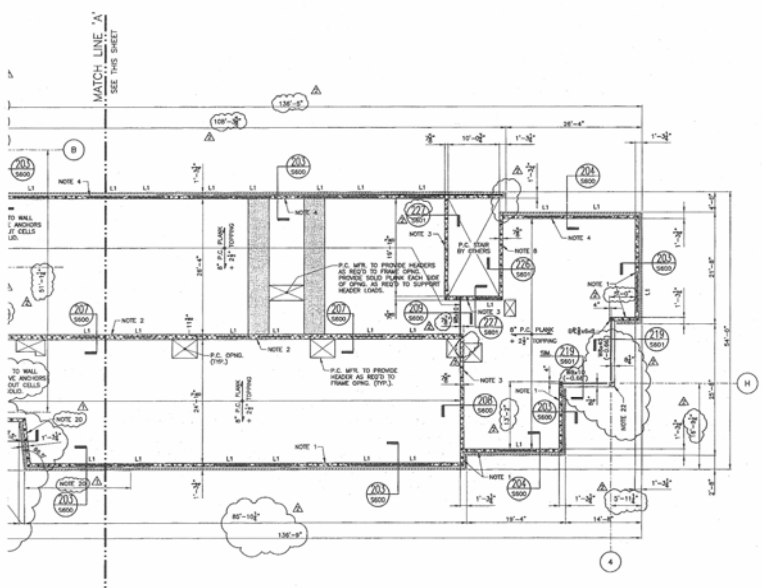


The building façade consists of brick curtain wall containing windows of tempered insulated spandrel and vision glass. The brick façade consists of different shades of light brown, complimenting surrounding structures. The key plan for the building is shown above. The main entrance to the building is on the south side. Here, a large staircase leads into the Lobby/Café area. Large retaining walls are located around the exterior of the building.

Construction on the Upper Campus Housing Project began in May of 2005 and is expected to end in July of 2006. The overall cost of the dormitory building is approximately 33 million dollars.

The structure of the building consists of concrete masonry bearing and shear walls of varying thicknesses. These walls act as both the lateral and gravity systems for this structure. The floor structure consists of concrete precise hollow-core plank. On floors one through nine the plank is 8" thick with a 2 ½" topping. On the roof the plank is 10" thick with a 2 ½" topping and is solid. Also located on the roof is a small steel structure to encase mechanical units. A typical floor plan is shown on the following page.





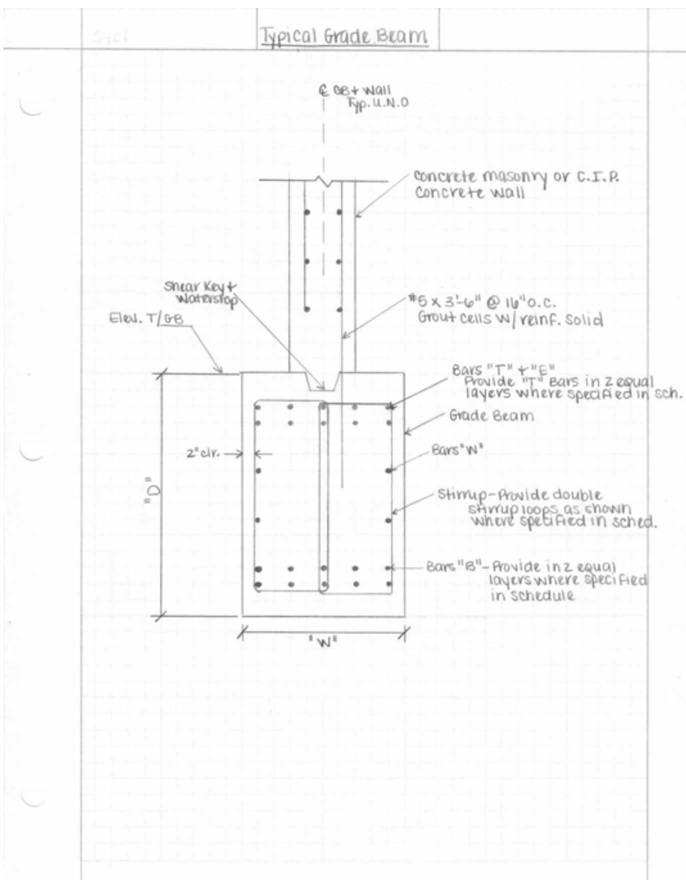
There are also five steel columns in this building. They are all HSS6.625x0.500. Two of these columns only span from the ground floor to the first floor (L=12'-6"). Two other columns span all the way to the ninth floor. Also, the last of the five columns spans the entire height of the building. Column 1A sits on a W8x31 transfer girder, which transfers the load from the column into the foundation. Columns 3B and 4H sit on concrete piers at the second floor level.

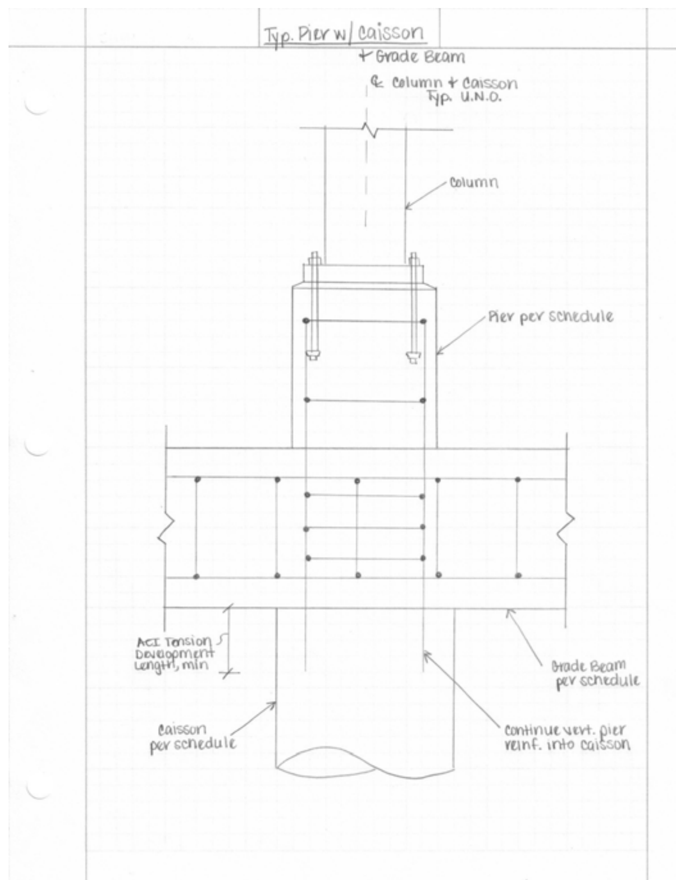
Also in this building there are four 20" diameter Concrete Piers located at column lines 3C, 3D, 3E, 3G. Each of these concrete piers spans from SOG to the second floor level.

The foundation system of this building begins with 71 drilled concrete caissons. As stated above, each concrete caisson has a concrete strength (f'c) = 3000psi. The diameters of these caissons range from 36"-66". All caissons are designed to bear on either limestone/sandstone bedrock or shale/sandstone bedrock per geotechnical report dated December of 2004.

The foundation system also includes 78 concrete grade beams, which sit on the concrete caissons. The concrete strength of this concrete is also specified at 3000psi. All grade beams have a width = 24", except for GB 67 which has a width = 30". The depths of the grade beams range from 36"-60". The concrete masonry walls then sit directly on the grade beams. At each connection between a concrete masonry wall and a grade beam there is a key and waterstop. The key is provided to prevent sliding between members. Reinforcement is also used to connect members and transfer load between.

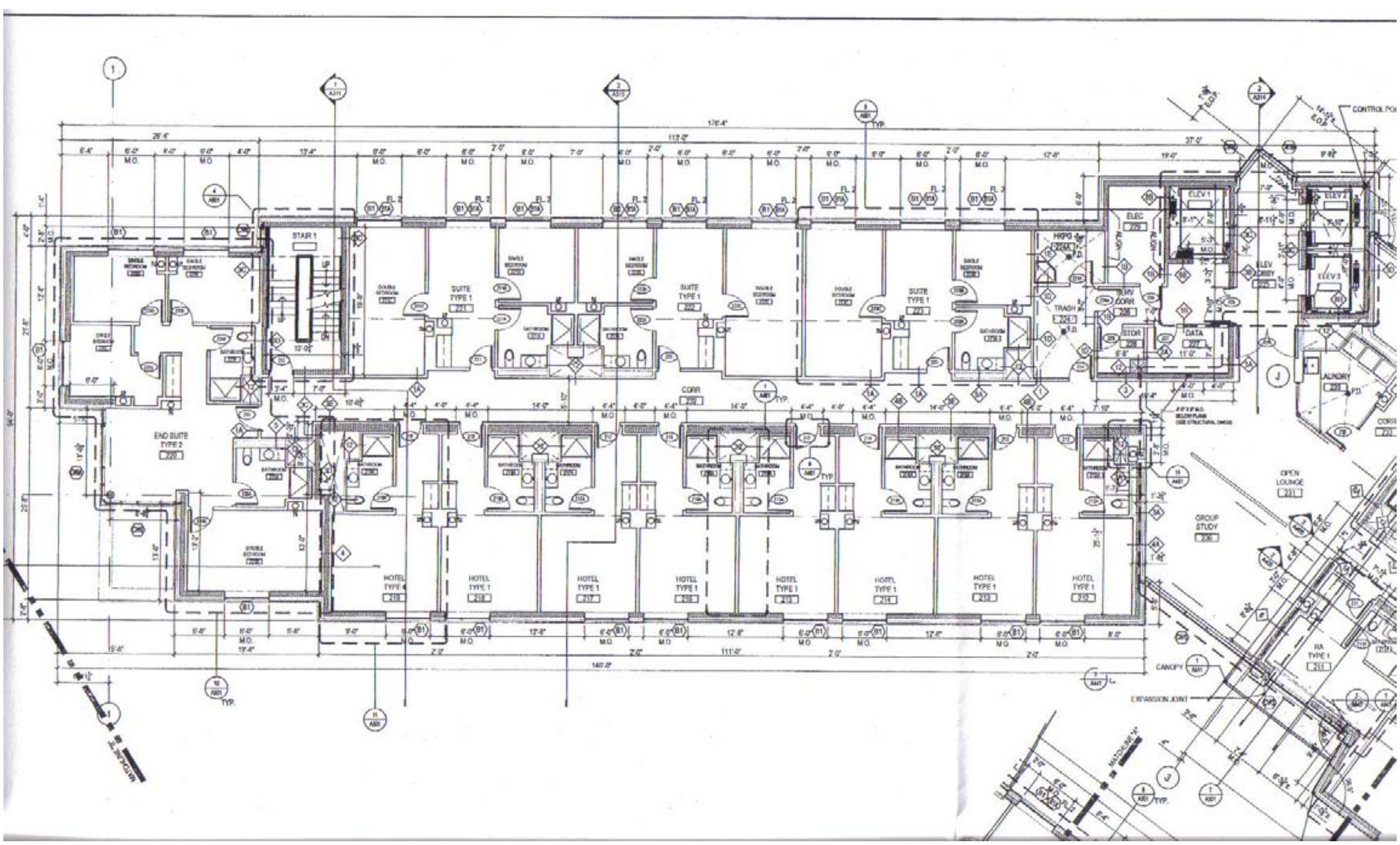
Below are typical foundation details.





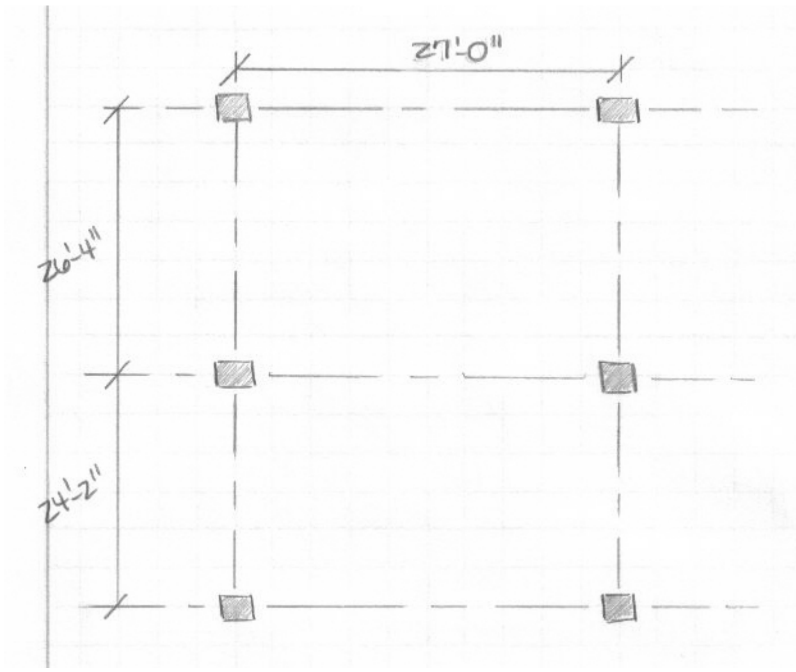
STATEMENT OF THE PROBLEM

Due to the nature of a one-way plank and bearing wall system, there is no flexibility to the architectural floor plan. For example, a hallway exists to one side of the center masonry wall running along approximately the centerline of the structure. This hallway must be designed at 100psf. The spaces to either side of this hallway are dorm rooms, which are designed to withstand only 40psf. Because of the nature of the plank, the main wall could not be moved if this building is ever converted for another use. Another problem is that the most common conversion that would be needed is office space. With office space loading equaling a minimum of 50psf, this would not be a possibility. On an ever-changing college campus, it is impossible to tell the university's needs for the structure down the road. Below is a typical architectural layout for the Upper Campus Housing Project.



PROPOSED SOLUTION

The proposed solution to this above-mentioned problem is a two-way system. Two alternative two way systems will be examined in the first few weeks of the spring semester, a two-way flat plate system and a two-way waffle slab. Using an ADOSS model, the two systems will be compared and one will be chosen for the remainder of my thesis work. Each of these systems will share a similar layout (shown below). The columns will be laid out to integrate with the current architectural stipulations. However, this layout will allow for a more flexible floor plan with interior walls that have a possibility of movement.



Alternative #1 (Flat Plate)

The two-way flat plate system is designed using square bays of 27ft. The design for this system according to CRSI is a slab thickness of 9 ½" with a minimum square column of 32". The reinforcement for this system is as follows for the column strip: top exterior (16 #5's), bottom (10 #7's), and top interior (14 #8's). For the middle strip, the reinforcement should be designed with 9 #6's in the bottom and 11 #5's in the top. This system can hold a load of 150psf. One advantage of this system is easy formwork framing.

Alternative #2 (Waffle Slab)

Waffle slab construction shares the same framing layout as shown above. However, this system allows for less dead load because it only has concrete in the moment region needed. Another advantage to a waffle slab is the geometric shape formed by the ribs. Architects, especially in dormitory structures, often desire this design. This system also works well with MEP accommodations.

The CRSI Design Handbook was also used for this design. 30" x 30" with 6" ribs would be used to make a total system of 36". The total load that this system can carry is 150psf. The reinforcement for the column strip is 20 #5's at the top edge, 1 #7's and 1 #8's at the bottom, and 24 #5's at the top interior. At the middle strip the bottom long bars should be #5's and the bottom short bars should be #6's. At the top interior middle strip 8 #5's should be used. In column strip regions the waffles will be filled in solid.

Changing the floor structure in the Upper Campus Housing Project will also change other systems for the building. Another system that will be changed is the lateral system. Concrete frames form natural moment frames. Therefore, the reinforced masonry shear walls will no longer be necessary or a smaller number of concrete walls could be used. These moment frames will be analyzed against wind and seismic loads. Unlike steel, concrete moment frames will not add extra cost to the structure because they occur from the way the building is constructed. However, like steel moment frames, concrete may not be able to handle the lateral loads applied to this structure. If this is the case, some shear walls may be used. The other building system that will change is the interior and exterior wall construction.

SOLUTION METHOD

The design of both two-way gravity systems will be based on three things: ADOSS, CRSI Design Handbook, and Chapter 13 of the ACI 318 code. These methods are based on the Equivalent Frame Method. The trials sizes for each two-way system are analysis from the CRSI Handbook. Live loading patterns such as full live loading on all spans, half live load with full live load on adjacent spans, and no live load with 75% live load on adjacent spans will be analyzed. Lateral loads and the effects on the structure will also be analyzed in ADOSS.

The removal of the masonry bearing and shear walls not only affects the lateral system, but it will also change the exterior wall system of the building. The exterior wall currently in place for this building is detailed and analyzed as a masonry wall. This exterior wall will be changed to a stud curtain wall system with a brick façade. Changing the construction of the exterior wall will change the thermal and moisture protection for this structure. Heat transfer and moisture protection will be analyzed and new curtain wall details will also be examined. The interior wall construction will also be affected by the removal of the masonry walls. A stud wall construction will also be used for interior walls. For these walls details will be developed. These interior walls will also provide the building owner with the possibility of a flexible floor plan in the future if needed.

TASKS

Design of Two-way system:

1. Determine Factored Floor Loads
2. Build ADOSS model and compare two-ways systems
3. Design two-way system
4. Design Columns
5. Analyze for lateral loading
6. Check Deflections
7. Check Drift

Breadth Work:

8. Create Curtain Wall Details
9. Create Interior Wall Sections and Details
10. Analyze Exterior Curtain Wall for Thermal and Moisture Protection
11. Develop Two-way system Construction Schedule

Comparison of Existing vs. Proposed Systems

12. Advantages and Disadvantages of Each System
13. Approximate Cost of Each System
14. Select System that is More Appropriate for Structure
15. Prepare Final Written Report
16. Prepare Final Presentation

PROPOSED SCHEDULE

Week Beginning With:	Goals:
JANUARY	
9	Task 1 and 2
16	Task 3
23	Task 4
30	Task 5
FEBRUARY	
6	Task 6 and 7
13	Task 8 and 9
20	Task 10
27	Task 11
MARCH	
6	SPRING BREAK
13	Task 12, 13, and 14
20	Task 15
27	Task 15
APRIL	
3	Task 16
10	Task 16