Thesis Proposal

GATEWAY COMMONS
ITHACA, NEW YORK

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STRUCTURAL OPTION
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AE 481W
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Executive Summary

The Gateway Commons building in Ithaca, New York is a mixed-use development building being used for retail and residential apartments. It has a basement floor below grade and six floors above grade at a height of 62 feet. CMU walls supporting precast concrete hollow core planks make up the building structure. The building façade uses a combination of brick, an Exterior Insulation Finish System (EIFS), and metal panels.

This report starts off by describing the foundation, walls, floor system, roof system and lateral system. However, the main purpose of this report is to discuss the problem of not being able to create an effective redesign of the interior spaces due to the layout of the load bearing CMU walls. The owner might want to redesign the building as smaller student apartments or change the use to an office building due to future demands.

A more open floor plan will make these redesigns possible. Changing the structure to a pan joist system is the proposed solution. This system is supported by columns instead of walls and will allow for more of an open floor plan. The structure is laterally supported by concrete shear walls but these walls are located around the elevator and stair towers so that they do not interfere with the open floor plan. ETABS, SAP2000, and PCA programs will aid in the design of this structure.

This report also discusses the architecture and cost/schedule breadth topics. Architectural plans for office spaces will be developed to show that the new structure allows for versatility in design. The cost of the current structure and the proposed structure will be determined. Profitability of housing compared to office spaces will be studied and analyzed along with the cost of the structures to determine if the increase in price for the new structure is worth having the ability to redesign the interior. Schedules for the construction of both structures will be used to determine how the cost will be affected by the time of construction.

This report concludes with a list of tasks to be accomplished in order to complete the project along with a schedule breaking down the tasks to be accomplished on a weekly basis. The project should be completed and finalized by April 11th in order to be ready to present during April 14th -18th.

Introduction

Gateway Commons located in Ithaca, New York is a mixed use project containing retail and residential spaces. It has a basement floor below grade and six floors above grade at a height of 62 feet. The basement has a floor to floor height of 11'-4" and the floors above grade have height of 10' except for the first floor which has a height of 12'. The total building area is 43,000 square feet. The ground floor is retail spaces and the others contain residential apartments. Construction for this project was completed in April of 2007. A typical floor plan of the building is shown in Figure 1.

The building has a basement space between grid lines A and D. The floor for this space is a 5" thick slab on grade. Between grid lines D and E there is a compacted structural fill instead of basement space. The slab on grade that lies on that compacted structural fill is the first floor's floor system between grid lines D and E. Between grid lines A and D hollow core planks are supported by concrete foundation walls that transfer the loads from above onto strip footings.

Located above the concrete foundations walls are CMU walls. Some of the walls are part of the gravity framing system and only support the gravity loads bearing on them. Other walls are part of the lateral system and are designed to resist lateral forces from wind and seismic.

The walls that are part of the lateral system are considered intermediate reinforced masonry shear walls. These walls span in both the N-S and E-W directions. These shear walls are classified as wall types MW2 and MW3. These shear walls are highlighted in green on the plan in Figure 1.

The walls that are part of the gravity framing system are considered wall type MW1. These are all of the other walls on the plan that are not highlighted in green. These walls support the precast concrete hollow core floor planks that act as the flooring system. The roof is constructed out of the same hollow core planks and is also supported by CMU walls as well as two different steel shapes that support the roof planks at their 2'-8" overhang. The building sections in Figures 3 and 4 should also help describe the structure of the Gateway Commons building.

This report discusses the problem of not being able to create an effective redesign of the interior spaces due to the layout of the load bearing CMU walls. A new structure with columns instead of walls is proposed to allow for more of an open floor plan. This report also discusses the architecture and cost/schedule breadth topics. It concludes with a list of tasks to be accomplished in order to complete the project along with a schedule breaking down the tasks to be accomplished on a weekly basis.

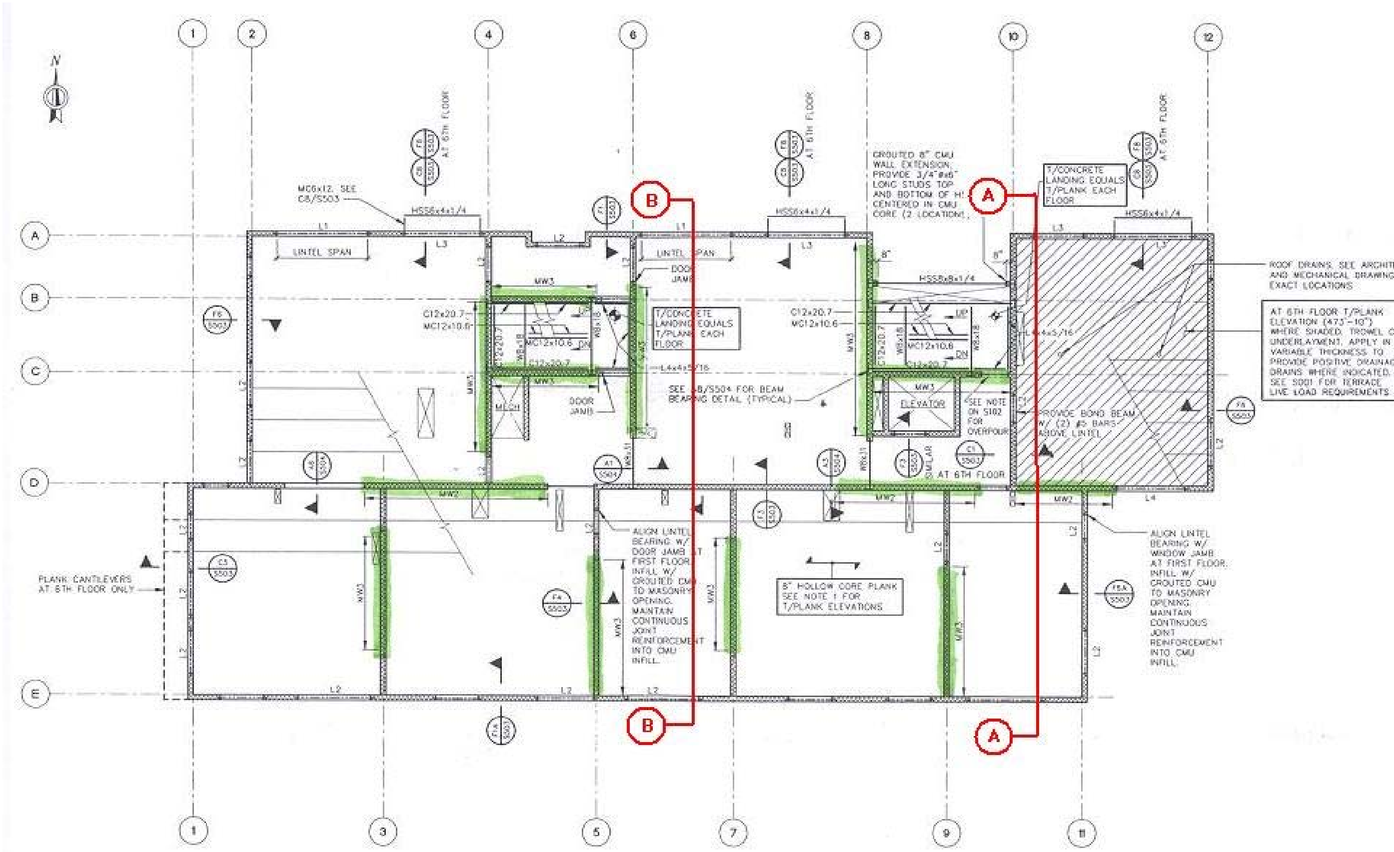


Figure 1 – Typical Framing Plan

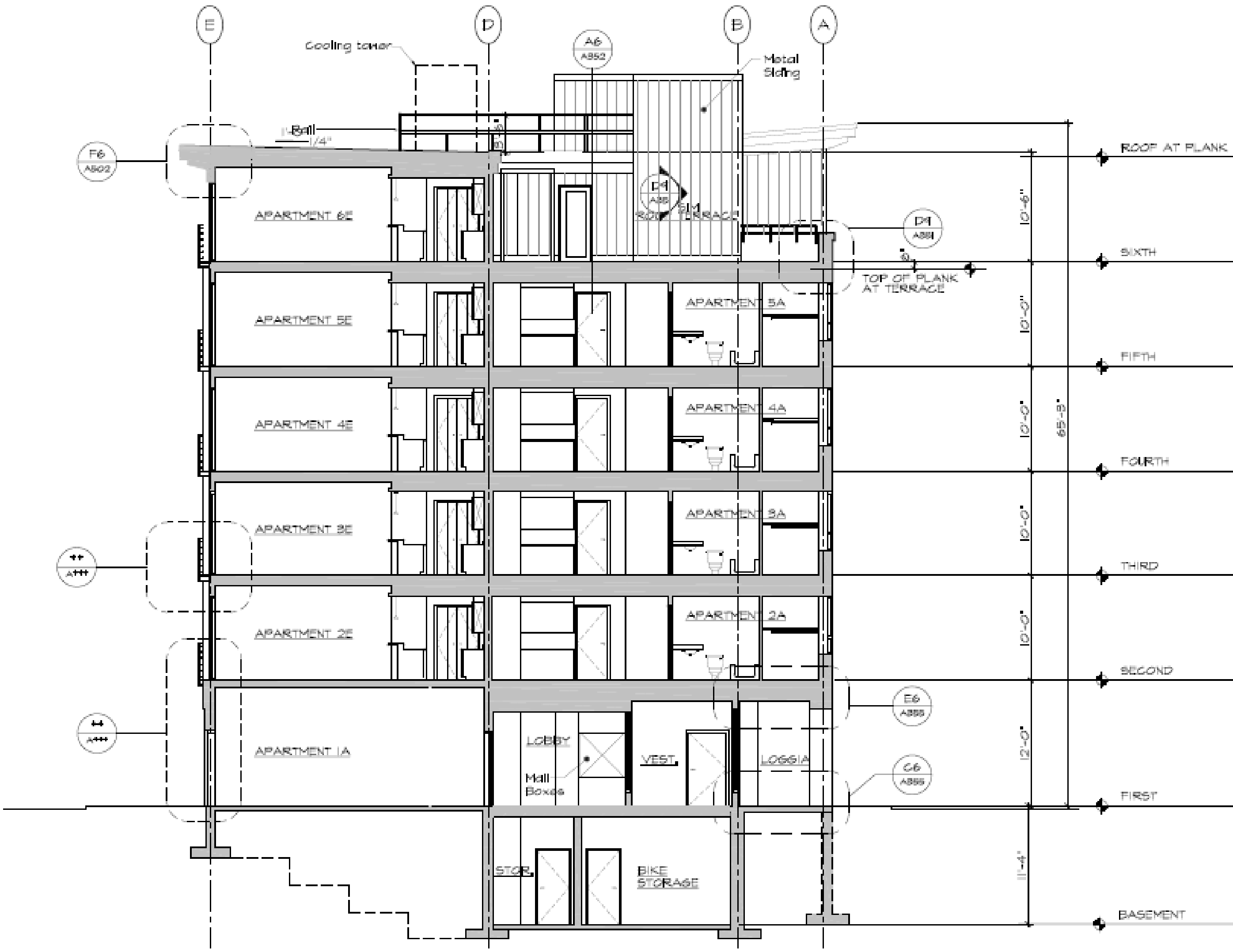


Figure 2 – Section A

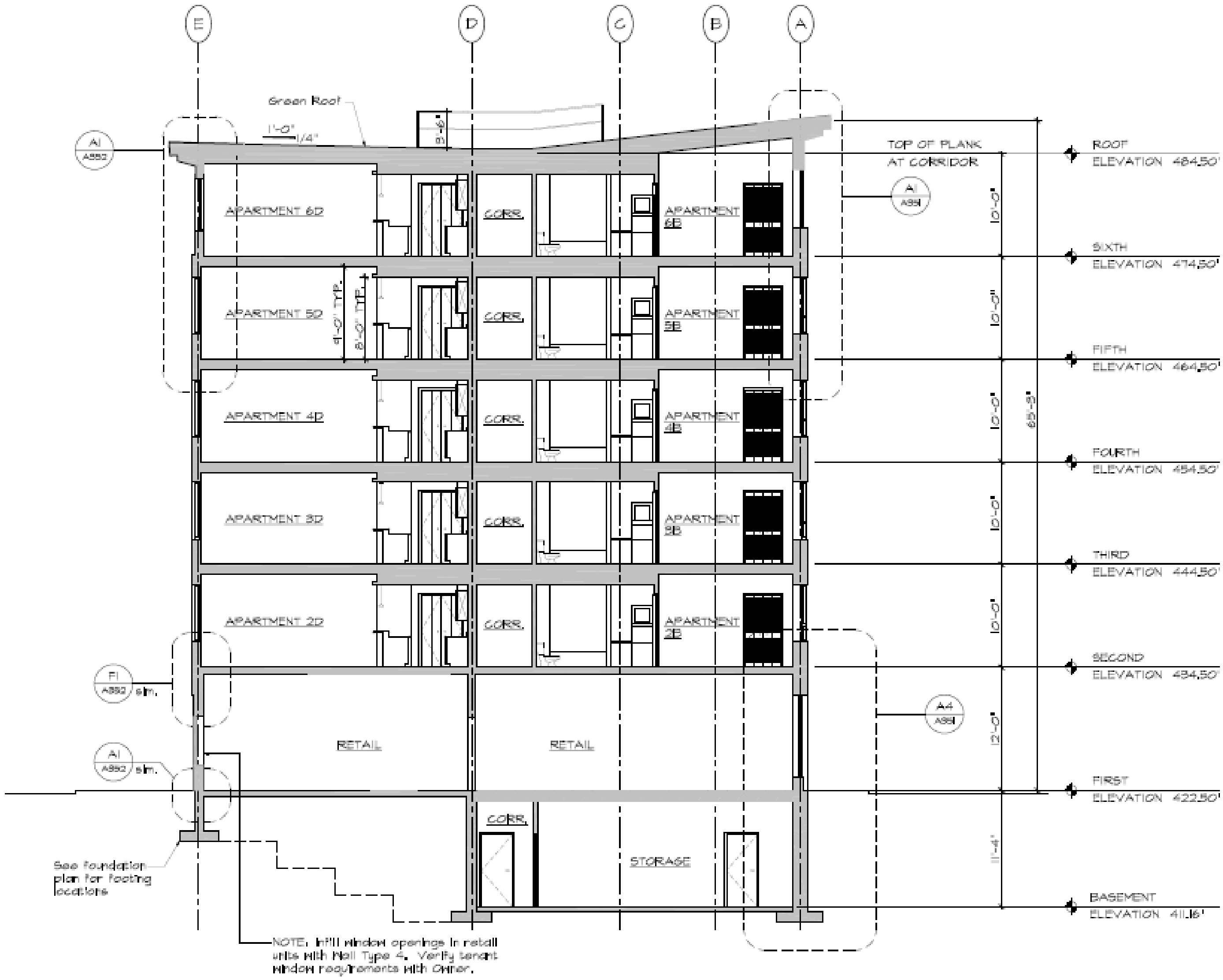


Figure3 – Section B

Structural System

Foundation

Between grid lines A and D, the basement floor slab-on-grade and loads from the concrete foundations walls are transferred onto strip footings with a 28-day strength of f'c = 3,000 psi. These strip footings sit on undisturbed indigenous soils composed of sand and gravel with an allowable bearing capacity of 5,000 psf . The slab-on-grade is 5" thick and reinforced with #4 bars at 16" on center spanning in both directions. The slab-on-grade has a concrete strength of f'c = 3,500 psi. The foundations walls will have a concrete strength of f'c = 3,000 psi or 4,000 psi depending on the type of wall. Between grid lines D and E the footings sit on a compacted structural fill that has an allowable bearing capacity of 5,000 psf. The slab on grade in this section is supported by the compacted structural fill and the foundation walls on grid lines D and E. It has the same thickness and reinforcing as the other slab on grade. The slab on grade in this section is 11'-4" higher than slab on grade between grid lines A and D.

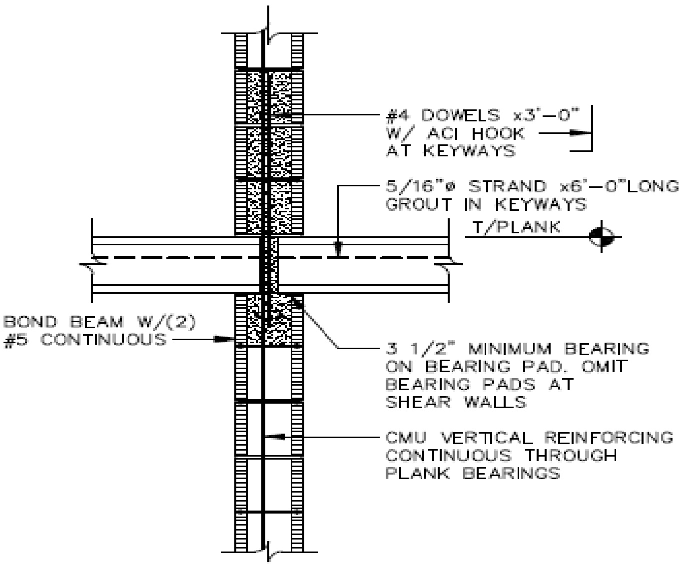
There are also five concrete piers that are supported by spot footings on the north east corner of the building. The reason for these piers is to create the loggia. At the second floor a concrete beam spans across the piers to pick up the gravity loads and distribute them onto the piers.

Masonry Walls

The walls that are not considered part of the lateral system are wall type MW1. Unlike the concrete foundations walls these walls are constructed out of 8" thick concrete masonry units (CMU). These walls act as the gravity framing system and support the precast concrete hollow core floor planks that act as the flooring system. Between the first and second floors the walls are grouted solid. Between the second and third floors the walls are grouted at 2' on center. For the rest of the floors, wall type MW1 has vertical reinforcing of #5 at 4' on center. The walls are horizontally reinforced at 16" on center. A wall schedule describing this reinforcing can be found in Figure 8. The exterior walls on the north and part of the east and west sides have a brick façade that is supported by shelf angles at each floor. The exterior walls on the south and other part of the east and west sides carry an Exterior Insulation Finish System (EIFS) façade.

Floor System

The primary flooring system for the elevated floors of the building is precast concrete hollow core planks. The planks span in the east/west direction. On the first floor the planks have a thickness of 10", but on floors two through six the plank thickness is 8". The planks on the first floor have a 2" thick concrete topping. All planks have a maximum width of 4' and are allowed to have a minimum width of 1'-6". Planks located at interior bearing partitions must be connected with a 6' long #3 bar or 5/16" diameter strand grouted into the keyway, as shown in Figure 5. Planks are often connected to exterior CMU walls with #4 dowels that are bent into the keyways, as shown in Figure 6. On the first floor, half of the floor is planks while the other half is a 5" thick slab on grade. The slab on grade described in the foundations section is the floor system for the basement.



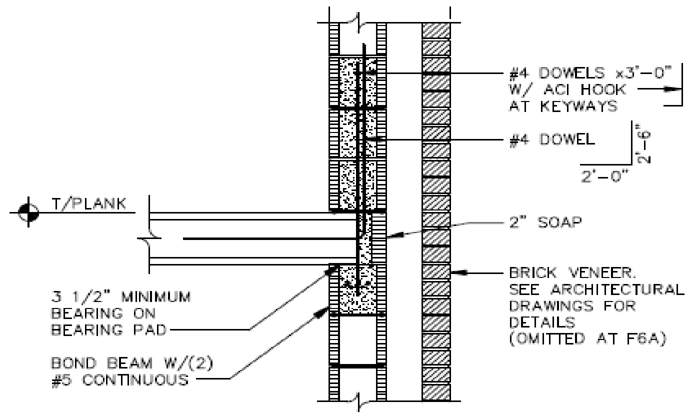


Figure 5 – Floor Planks at Interior Walls **Figure 6** – Floor Planks at Exterior
Walls

Roof

The roof structure uses the same 8" thick, precast, hollow core, concrete planks as used on the floors. At gridline D the roof begins to slope up toward the building's south end at ¼"/foot. Between gridline D and C the roof begins to slope up toward the building's north end at slightly larger slope. The building section in Figure 7 shows how the roof is sloped. The roof planks have a 2'-8" roof overhang. Two different steel shapes are used to support the planks at the overhang, a WT6x43.5 and an L6x6x1/2. There is also a roof terrace on the sixth floor that uses the same planks system as used by the typical floor system. There is no roof overhang on the sixth floor roof terrace.

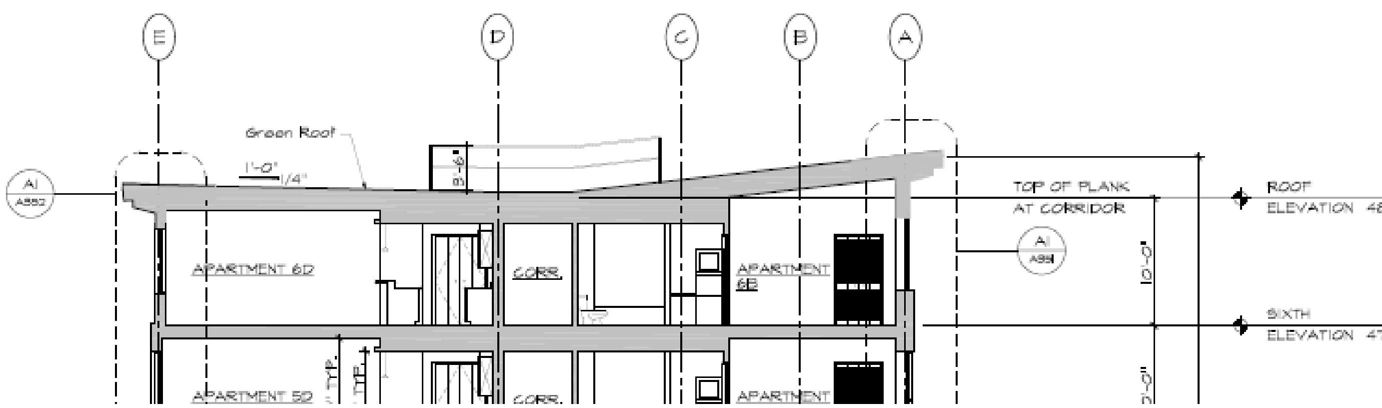


Figure 7 – Building Section for Roof

Lateral System

The structure is laterally supported by intermediate reinforced masonry shear walls in the N-S and E-W directions. Like the load bearing walls for the gravity framing system the shear walls are also 8" thick CMU walls. However, the shear walls are designed to resist the lateral loads due to seismic and wind forces. These lateral forces are distributed onto the shear walls through the rigid floor system of hollow core planks. There are two different shear wall types, MW2 and MW3. The shear walls are highlighted in green on the floor plan in Figure 1. The wall schedule in Figure 8 describes the reinforcing for both shear wall types.

WALL ~~LINTEL~~ SCHEDULE

MARK	VERTICAL REINFORCING	HORIZONTAL REINFORCING	REMARKS
MW1	#5 AT 4'-0"OC	STANDARD JOINT REINFORCING AT 16"OC	GROUT WALL SOLID 1ST-2ND FLOORS GROUT WALL AT 2'-0"OC 2ND-3RD FLOORS
MW2	#5 AT 4'-0"OC (TYPICAL) (6)#6 EACH END (1ST-2ND) (4)#6 EACH END (2ND-4TH) (2)#5 EACH END (4TH-ROOF)	STANDARD JOINT REINFORCING 1ST-2ND AND 6TH-ROOF, HEAVY DUTY JOINT REINFORCING AT 8"OC 2ND-6TH	GROUT WALL SOLID 1ST-2ND FLOORS
MW3	#5 AT 4'-0"OC (TYPICAL) (2)#5 EACH END	STANDARD JOINT REINFORCING 1ST-2ND AND 6TH-ROOF, HEAVY DUTY JOINT REINFORCING AT 8"OC 2ND-6TH	GROUT WALL SOLID 1ST-2ND FLOOR

NOTES:
1. UNLESS NOTED OTHERWISE ON PLAN, ALL WALLS ARE TYPE MW1.
2. MINIMUM REINFORCING REQUIREMENTS SHOWN ON A3/S506 APPLY TO ALL WALLS.
3. SEE F6/S506 FOR PLACEMENT OF VERTICAL BARS AT ENDS OF WALLS.

Figure 8 – Wall Schedule

Problem Statement

The hollow core floor plank on CMU walls structure of Gateway Commons is an excellent design for the building's use. It is a durable material and relatively inexpensive compared steel and concrete structural systems. However, this is a very custom structure. Spaces are separated by load bearing walls and openings in the walls have to be coordinated with the architecture. This becomes a problem when a change to the buildings architecture becomes an issue. The interior load bearing walls would make it difficult to produce an effective redesign of the interior spaces.

If the owner felt that the Gateway Commons building could serve a better function than the current residential apartment design it would be almost impossible to redesign the interior for spaces that are different than the ones currently provided. Due to conditions that occur down the road the owner may want the building to be used to an office building or student housing. With the way the interior load bearing walls are laid out it would be impossible to come up with a logical design for these spaces.

An alternate structure would allow for a more versatile design if the changes described above were to be considered. It should be determined if the added cost is worth the versatility in design.

Proposed Solution/Methods

A pan joist floor system supported by concrete girders and columns proved to be the best structure to fit in with the existing architecture and allow for an effective redesign of the architecture. Columns will have to be located to coincide with the existing architecture. The use of columns instead of walls creates an open floor plan with possibilities for a creative redesign of the architecture.

The lateral system in this design will be concrete shear walls. This design will allow for less shear walls than the current system. They will be placed around the stair towers so that they do not interfere with the open floor plan. Floor to floor height will also have to be taken into consideration due to the 65 feet above grade building height limitation. Edge beams will also have to be designed to support the brick façade.

PCAcolumn, PCAslab, SAP2000, and hand calculations will be used to design the structure for gravity loads. ETABS will be used to obtain the design values for the shear walls and the reinforcement for the walls will be designed by hand calculations and PCAcolumn. I hope to achieve the following goals by redesigning the structure of Gateway Commons:

- To better understand the design of concrete structures and the engineering design process in general
- To create a complete and economical structural design of Gateway Commons
- To compare the new structure to the existing hollow core floor plank on CMU walls structure
- To determine the cost and schedule of the new structure and determine if this redesign is economically feasible.
- To architecturally design the new structure for an office building to show that the new structure allows for versatility in architectural redesign.

Breadth Options

Along with the main study of redesigning the structure two breadth studies will also be completed. They will include a study on the architectural layout of the interior spaces and corresponding changes to the façade due to the new floor layouts. Also a cost study will be done to determine if the increase in cost of the new structure is worth the versatility of the interior spaces.

The architecture study will focus on an office building redesign. These changes to the building's interior layout will also greatly affect exterior architecture. The first floor will stay retail spaces but the spaces will have to be adapted to the new structure. Floor plans and exterior elevations will be created to show the changes made to the architecture.

The second breadth topic will examine cost analysis and the schedule impact between the new and existing structures. The cost study will use any available information that can be obtained from the project engineer. This information will be used along with RS Means to determine the overall cost of the current building structure. RS Means will be used again to determine the cost of the new concrete structure. Profitability of the office spaces will be studied and analyzed along with the cost of the structures to determine if the increase in price for the new structure is worth having the ability to redesign the interior. The schedule created in Microsoft Project will be used to determine how the cost will be affected by the time of construction.

Tasks

1. Plan Redesign
   a. Use PCA slab to determine column locations.
   b. Brainstorm the architecture breadth topic to create column locations that will allow for an effective redesign.

2. Column gravity load analysis and takedown
   a. Determine the loads acting on each column per PCA results and hand tributary area calculations.
   b. Design the columns using PCA column.

3. Lateral Loading
   a. Determine wind and seismic loads acting on the building.
   b. Use ETABS model to determine force distribution to each shear wall.
   c. Design the shear walls using PCA column and hand calculations.

4. Design Foundation
   a. Use the loads determined from task 2 to design the footings.
   b. Design the spread footings by use of hand calculations

5. Breadth Topic: Architecture
   a. Layout the building for office spaces.
   b. Create building elevations according to the floor plans.

6. Breadth Topic: Cost and schedule
   a. Determine the schedule the new and original structure
   b. Determine cost of new and original structure
   c. Research the profitability of office spaces
   d. Determine if the cost increase is worth the ability to redesign the interior

7. Finalization
   a. Create final report
   b. Create final presentation
   c. Finalize the CPEP website

Time Table

Week	Dates	Tasks
1	Jan. 14-18	1a, 1b
2	Jan. 21-25	1a, 2a
3	Jan. 28-Feb 1	2a
4	Feb. 4-8	2b,3a
5	Feb. 11-15	3a,3b
6	Feb. 18-22	3b,3c
7	Feb. 25-29	4a
8	Mar. 3-7	5a,5b
9	Mar. 10-14	spring break
10	Mar. 17-21	6a
11	Mar. 24-28	6b,6c
12	Mar. 31-Apr. 4	6d, 6e,7a
13	Apr. 7-11	7b,7c