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George Read Hall – The University of Delaware
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Thesis Proposal
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<u>Executive Summary</u>:

George Read Hall is a five story dormitory on the University of Delaware's campus. emcompassing 129,000 square feet, it is the largest of three new buildings being constructed to replace the existing complex.

The floor system of George Read Hall is a Hambro composite system of 14" deep open web steel joists and a $2^{3}/_{4}$" concrete slab. The floor system is supported by 16 gauge, 50 ksi cold formed metal stud bearing walls. The lateral resisting system is comprised of x-braced shear walls. These shear walls are metal stud walls with 50 ksi metal straps.

In Technical Assignment #2, it was determined that alternate floor systems should be considered for use in this type of building. The most likely of those alternate systems to be used is precast hollow core planks. It was also previously determined that the existing lateral force resisting system is not adequately designed to resist the newly calculated seismic forces. Thus, an alternate system will be designed using reinforced masonry shear walls. However, strength is only one criteria of an engineer's design.

Another important aspect of the design is economy. In order to find the most economical overall building system, this proposal will examine an alternate bearing wall system, shear wall system, and floor system. The wall system being investigated is a load bearing masonry wall. Supplementing the masonry bearing wall will be reinforced masonry shear walls. These masonry walls will be designed in accordance with ASTM standard C90 and all other appropriate ASTM standards. As mentioned above, precast hollow core planks will be examined as a new floor system. The CRSI manual will be used as a design aid for the hollow core planks.

In order to determine if the new system is more economical, a cost analysis will be done on the original and alternate systems. The comparison will be done between the original light gauge metal stud bearing wall system and the newly designed masonry wall system. A comparison will also be done between the shear wall systems and floor systems.

BREADTH SUMMARY:

IN ADDITION TO THE STUDY OF THE LATERAL FORCE RESISTING SYSTEM, TWO BREADTH TOPICS WILL BE STUDIED. THIS WILL ALSO HELP TO EXPAND MY ENGINEERING KNOWLEDGE AND HELP ME TO BECOME A BETTER-ROUNDED ENGINEER.

BREADTH TOPIC #1: CONSTRUCTION MANAGEMENT

THE FIRST BREADTH TOPIC WILL BE A COMPLETE SCHEDULE OF THE CONSTRUCTION PROCESS FOR THE ALTERNATE SYSTEM. THIS SCHEDULE WILL BE COMPLETED IN PRIMAVERA PROJECT MANAGER. THIS SCHEDULE WILL BE COMPARED TO THE ACTUAL CONSTRUCTION TIMETABLE TO SEE IF THE NEW SYSTEM RESULTS IN LESS CONSTRUCTION TIME.

BREADTH TOPIC #2: LEED CERTIFICATION

THE SECOND BREADTH TOPIC WILL BE A STUDY OF LEED CERTIFICATION. A STUDY WILL BE DONE TO DETERMINE WHAT DESIGN CHANGES COULD BE INCORPORATED IN ORDER TO RECEIVE A LEED CERTIFICATION FOR THIS BUILDING. THIS REQUIRES 26 OUT OF A POSSIBLE 69 POINTS ON THE GREEN BUILDING RATING SYSTEM, VERSION 2.2. MOREOVER, ONE CATEGORY ON THE CHECKLIST WILL BE SELECTED AND THE SUBCATEGORIES WILL BE DESIGNED.

Introduction:

George Read Hall is a five story residential dormitory on the campus of The University of Delaware in Newark, Delaware. Construction completed in August 2005, and the building opened to residents for the Fall 2005 semester. George Read Hall is the largest of three new buildings being built to replace the former Pencader Housing Complex. At approximately 129,000 square feet, this building houses 1000 beds in double occupancy rooms, with some special single occupancy suites. In addition to the dorm rooms, the building has many lounge spaces, kitchen spaces, laundry rooms, and study rooms.

The building's "U" shape makes it unique architecturally. However, the shape also makes the design of the lateral force resisting system more complicated.

Existing Structure:

The existing floor system in George Read Hall is composed of a Hambro composite floor system. This system uses 14" deep steel 50 ksi steel joists working compositely with a $2^{3}/_{4}$" concrete slab. The joists are spaced at $4'$-$1^{1}/_{4}$" on center. The typical span for the joists is 23'-6" with an interior span of 6'-0" for the corridor. The typical bay is shown below.

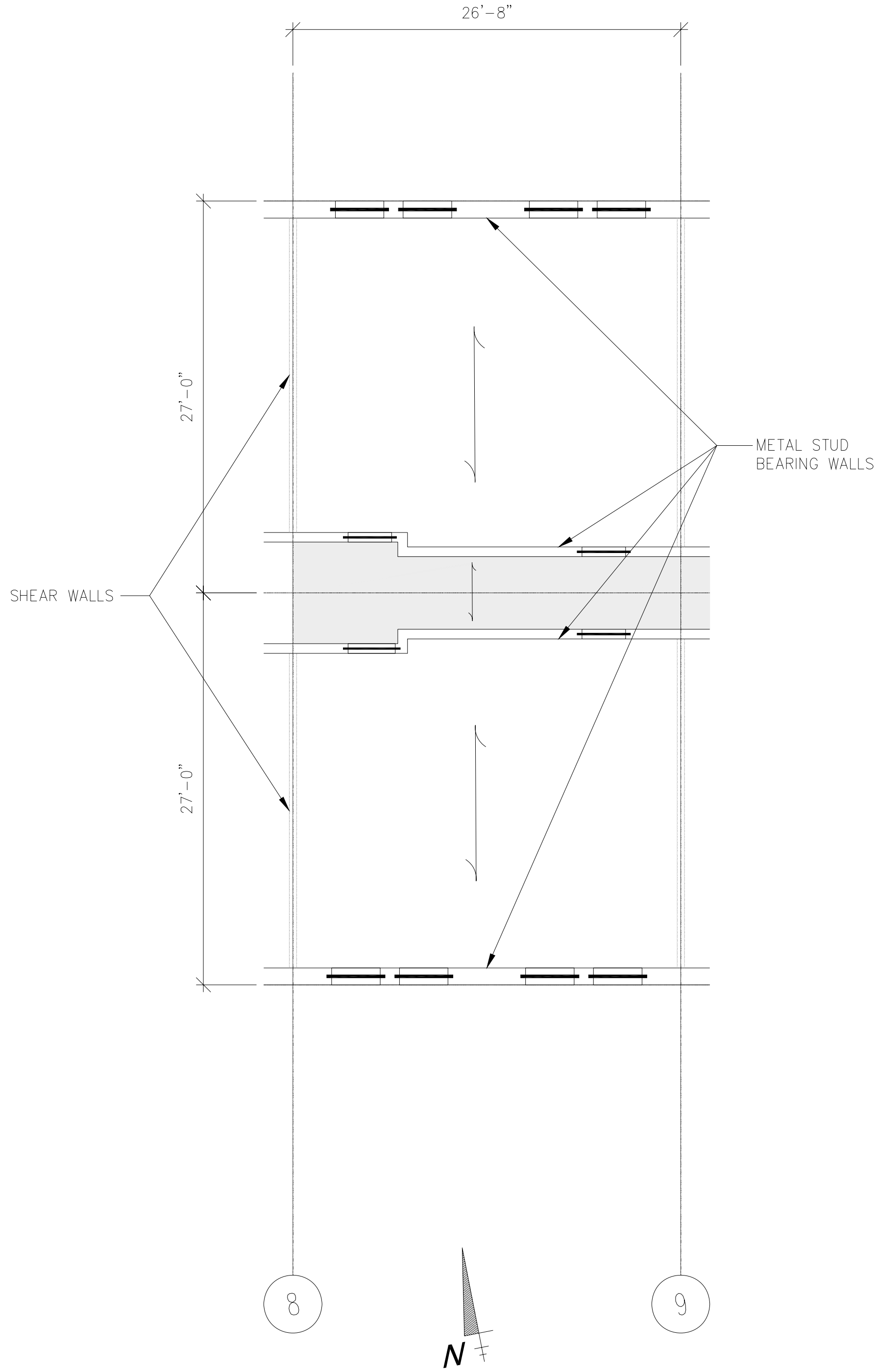
Bearing walls are 16 gauge, 50 ksi cold formed metal studs. The first floor is supported with 3-6" studs @ 16" on center. A typical bay is 26'-8" x 23'-6". Interior first floor framing consists of wide flange beams of various sizes. The second floor metal stud framing consists primarily of 3-6" studs @ 16" on center. Framing under the second floor hallway is wide flange beams, with the typical size being a W14x53. These interior hallway beams are located on each side of the 6'-0" wide hallway. The third through fifth floor framing is very similar. The third floor bearing walls consist mainly of 2-6" studs @ 16" on center. The fourth and fifth floor bearing walls are built with 1-6" stud @ 16" on center. The interior beams are replaced by metal stud bearing walls under the hallway in the third trhough fifth floor framing. Roof framing on George Read Hall consists of prefabricated light

gauge metal trusses at a maximum of 4’-0” on center with $1^{1}/_{2}$” 22 gauge galvanized metal deck. The roof trusses span 54’ with two intermediate supports located 23’-6” from each exterior wall.

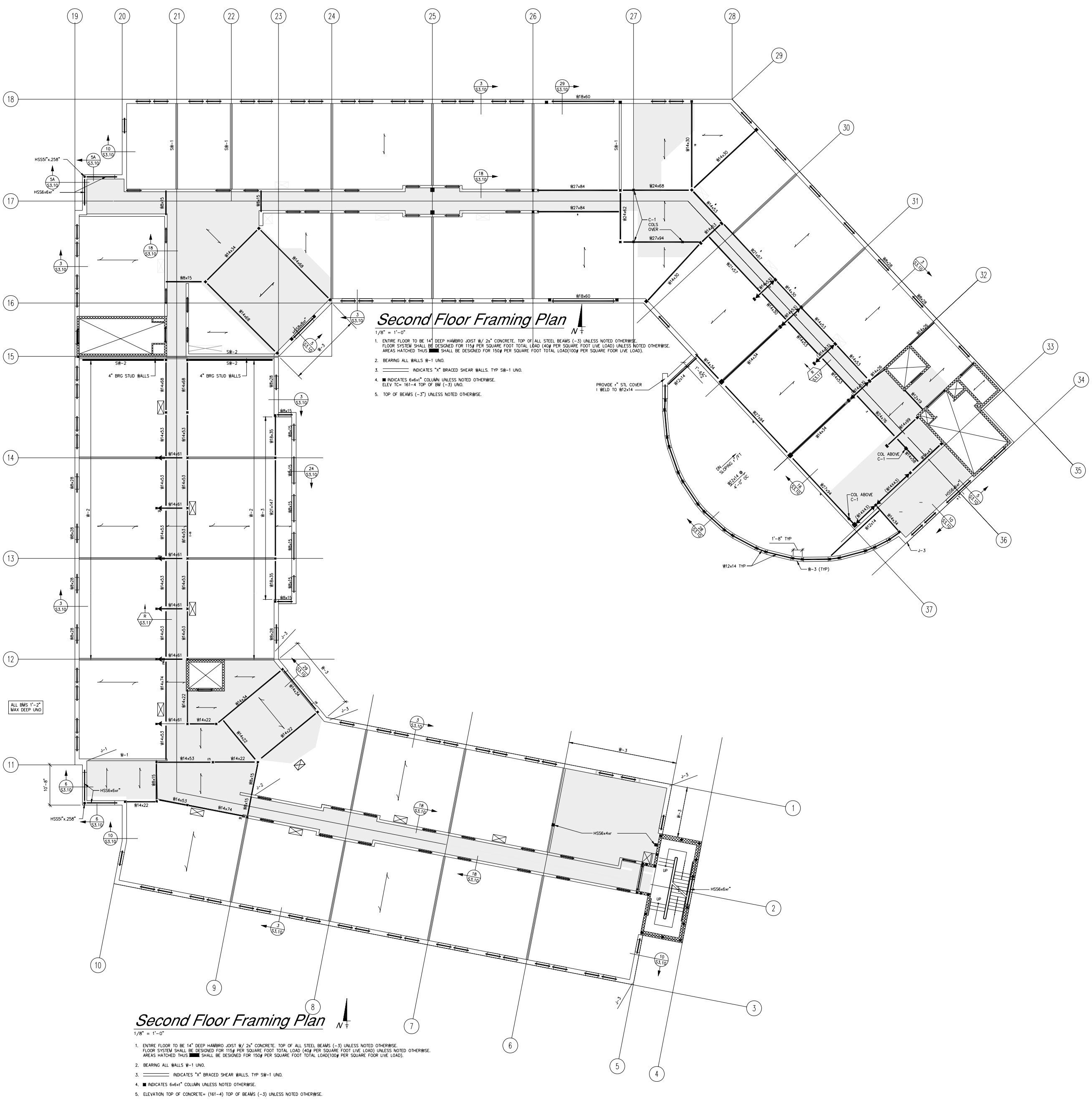
The foundation is comprised of a combination of continuous and spread footings. The continuous footings range from 3’-0” wide to 7’-0” wide and are 1’0” deep and are reinforced with continuous #5 bars. Fifteen different sizes of spread footings are used ranging in size from 3’-0” wide x 3’-0” wide x 1’-0” deep to 10’-0” wide x 10’-0” wide x 2’-3” deep. These spread footings carry the concentrated loads from the interior columns. Reinforcing bars for the spread footings consist of #5 bars or #6 bars. The footings were designed with a soil bearing capacity of 4000 psf. Basement walls are 1’-4” thick with #4@12 both ways in both faces. The basement floor of George Read Hall is a 5” thick slab on grade with 6x6-W1.4 x W1.4 welded wire mesh. Slab control joints are located so that there is a maximum of 40 feet in length along any one side with a maximum uninterrupted concrete area of 1200 square feet.

The lateral force resisting system of George Read Hall is x-braced shear walls. The shear walls are located along typical bay lines. first floor shear walls consist of x-bracing using 2-$4^{1}/_{2}$” metal straps. The second and third floor shear walls are x-braced walls of 2-4” metal straps. Fourth and fifth floor shear walls are 2-3” x-braced metal straps. The floor plans are shown below.

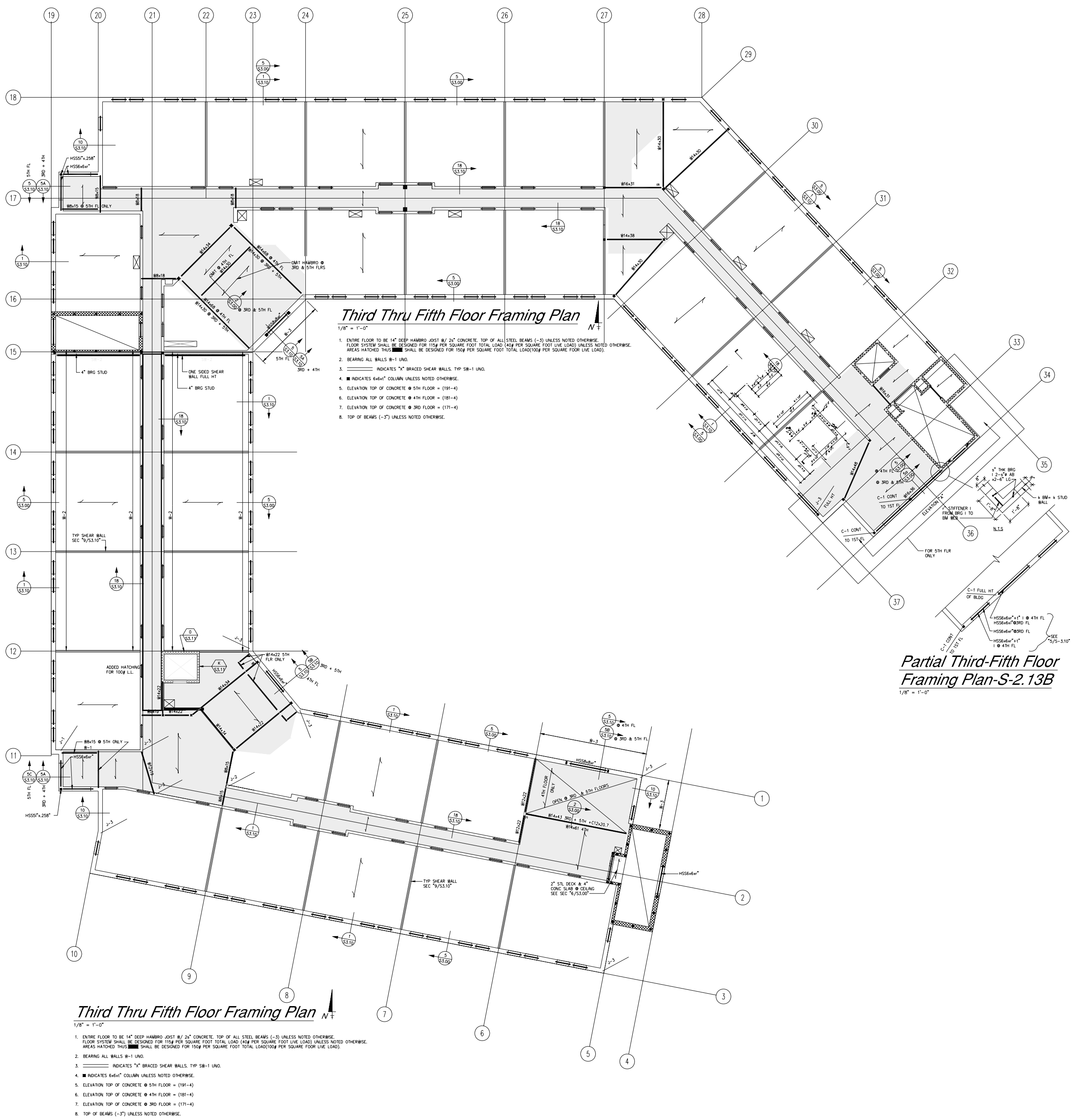
Typical Bay:



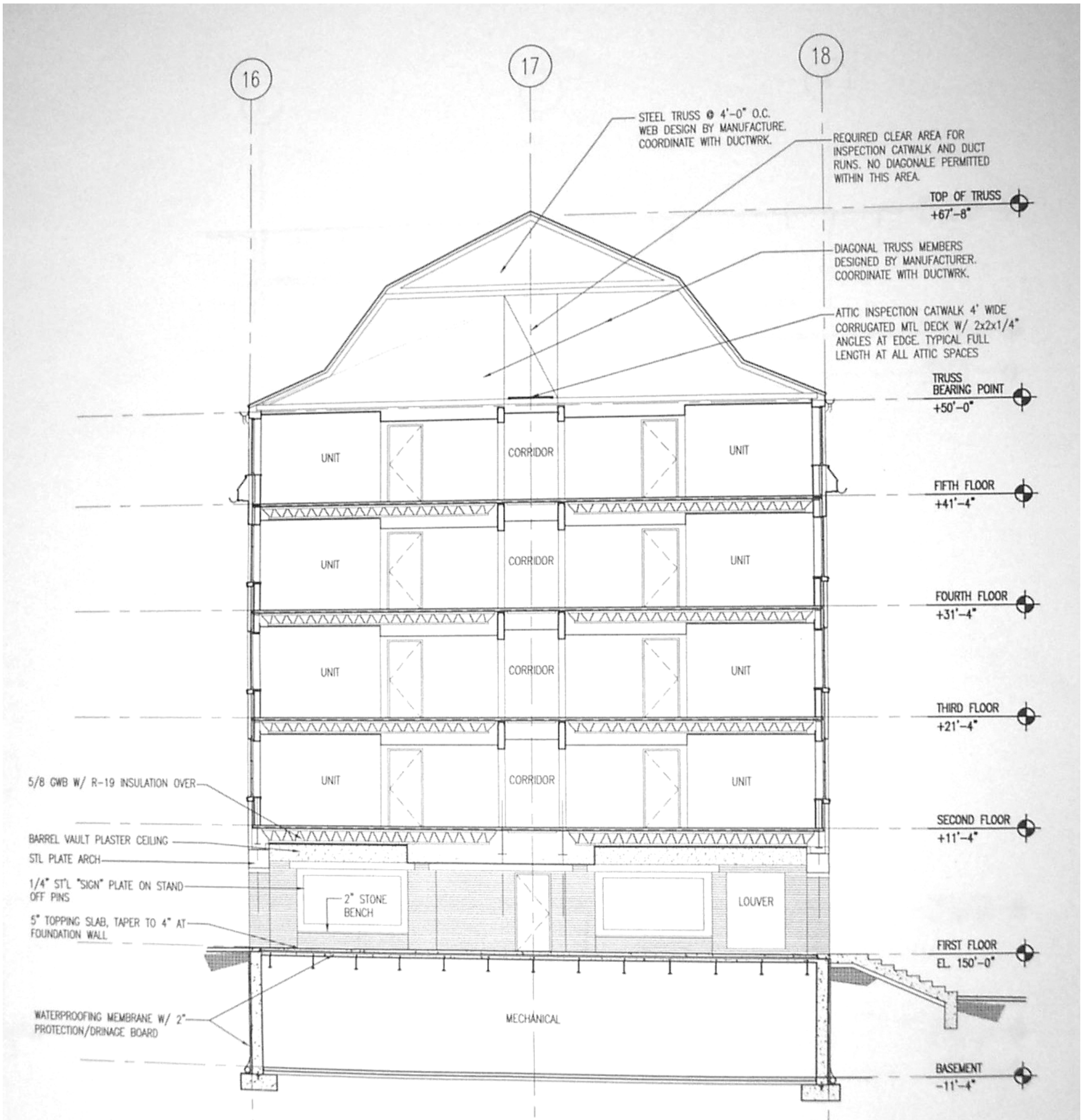
Second floor plan:



Third through fifth floor plan:



Building Section:



Problem Statement:

A building must be designed to resist all applied forces in accordance with the International Building Code. This includes gravity loads and lateral loads. The gravity loads are determined from the dead loads of the building and the live loads established in Table 1607.1 of IBC. The lateral forces take into account the effects of wind and seismic. These forces are also calculated in accordance with IBC with references to ASCE 7. Because of load combinations set forth in the IBC, the building does not have to resist both wind and seismic concurrently.

After a review of Technical Assignment #2 it was prevalant that several alternate floor systems were worth further investigation. the most viable alternative floor system is precast hollow core planks. This was determined because it has the most advantages. It was concluded in Technical Assignment #3 that the seismic forces control the design of the system. This differs from the original design in which the wind forces were determined to control the design. Because of this, it was also determined that the existing lateral system is not appropriately designed to resist these higher seismic forces. Therefore an alternate lateral force resisting system will be designed.

Although the system of x-braced shear walls is fairly simple in the scheme of lateral resisting systems, the irregular shape of the building requires an analysis beyond the scope of my educational experiences thus far. The determination of the direct and torsional shear forces are more complex than in a rectangular or more regularly shaped building. Therefore, the design of an alternate lateral force resisting system will expand my experiences in structural engineering. Additionally, introducing a new lateral system would not be appropriate with the existing gravity load resisting system. As a result, a redesign of the bearing walls system will also be done.

One of the most important things to consider when designing buildings is to make it as economical as possible. Because of this, it is very critical to investigate different systems.

Problem Solution:

The solution to this is to design an alternate system and compare it to the original design. The alternative system being considered in this proposal is a load bearing masonry system as well as masonry shear walls. Also, a new floor system of precast hollow core planks will be studied.

The alternate systems will then be compared to the original design to determine whether it is a considerable alternative.

<u>Solution Method</u>:

The first step in solving this problem is to accurately determine the loads on the building according to appropriate codes and references. The gravity loads must be applied to determine the necessary floor system requirements and bearing wall assembly. The floor system will be designed using the CRSI Manual in order to find an appropriate hollow core plank system. ASTM standard C90 will be used as a reference for the load bearing blocks. Other ASTM standards are required for the reinforcing steel depending on the grade of the steel. This includes wire and reinforcing bars.

The International Building Code and ASCE 7 will be used to determine whether the building acts as a rigid or flexible diaphragm. After determining the correct method, the lateral forces will be applied and distributed to determine the force in each shear wall. The forces will be distributed according to rigidities. This will allow the shear walls to be designed. The same ASTM standards will be used for the shear walls. The building will be modeled in the structural engineering computer program E-TABS if more in depth and complex design is required. After all of the design is completed, an economic analysis will be performed.

<u>Breadth Studies</u>:

Two breadth topics will be studied as part of this thesis. The first of which will be to determine the changes in materials and systems in order to obtain a LEED Certification for this building. In order to obtain this rating, 26 out of a possible 69 points must be attained on the LEED checklist. The checklist is from the Green Building Rating System, version 2.2. To determine the feasibility of this certification, one category will be selected and studied in depth.

The second breadth topic will be a complete schedule of the construction process for the alternate system. This schedule will be completed in Primavera project manager. This schedule will be compared to the actual construction timetable to see if the new system results in less construction time.

Tasks and Tools:

Task 1: Determine loads
- A. Determine gravity loads from dead loads and live load table 1607.1 in IBC.
- B. Determine wind and seismic forces in accordance with ASCE 7-98 chapters 6 & 9 respectively

Task 2: Apply loads and find critical design members
- A. Determine critical floor loads
- B. Determine critical bearing wall load
- C. Determine critical shear wall load

Task 3: Design of system
- A. Find required precast hollow core plank size from CRSI handbook
- B. Design load bearing masonry system according to ASTM standards
- C. Design masonry shear walls as required by the above calculations in accordance with the appropriate ASTM standards

Task 4: Breadth topics
- A. Research LEED certification
- B. Perform required work on chosen LEED topic
- C. Perform cost analysis using RS Means
- D. Create construction schedule using Primavera

Task 5: Report
- A. Compile final report
- B. Review
- C. Final presentation

Timetable:

	January			February				March					April	
	1/9 - 1/13	1/16 - 1/20	1/23 - 1/27	1/30 - 2/3	2/6 - 2/10	2/13 - 2/17	2/20 - 2/24	2/27 - 3/3	3/6 - 3/10	3/13 - 3/17	3/20 - 3/24	3/27 - 3/31	4/3 - 4/7	4/10 - 4/14
Task 1									B					
Task 2									R					
Task 3									E					
Task 4									A					
Task 5									K					