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Structural Option
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Wellington at Hershey's Mill
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Thesis Proposal

Executive Summary

Wellington at Hershey's Mill is a retirement community located in West Chester, Pennsylvania. Consisting of 370,000 square feet and a total of 5 stories, Wellington offers 197 independent living apartments on the top three levels, a garage level directly below them, and a section with a lobby and offices for businesses within the building.

Wellington's foundation is slab on grade with strip footings in the exterior, spread footings in the interior, and a cmu foundation wall. The lobby floor and roof and first floor framing consists of steel joists bearing on girders in the interior and masonry bearing walls in the exterior. The girders are supported by interior steel columns. The second and third floors are 2x6 wood framing with open web wood trusses bearing on the walls. The roof framing is similar to the second and third floor except for slightly sloped wood roof trusses. Wood framed gypsum shear walls and masonry towers located at the elevator shafts and stairwells make up the lateral load resisting system.

The intent of this thesis is to design two alternate structural systems, perform an analysis of their impact on the interior acoustics and overall building envelope, and then choose the best system after a comparison.

The following is a summary of what is included in this proposal:

- Background information on Wellington at Hershey's Mill
- Description of the existing structural system
- Descriptions of two proposed alternate systems
- Intended methods of design and research sources
- Description of two breadth topics resulting from the redesign of the structure
- Tasks required for thesis completion and intended schedule

Background

Wellington at Hershey's Mill is a 370,000 square foot retirement community in West Chester, Pennsylvania. Wellington includes 3 levels of independent living apartments, a garage level below the residential levels with a lobby alongside it, and a lower level , directly below the lobby, which contains the medical suite that houses two doctors' offices, exams rooms, and nurses' stations. For entertainment, a lounge, auditorium, beauty salon, pool and courtyard were included. The kitchen, laundry room, and exercise and fitness center round out this level.

Construction began on Wellington in December of 2003 and consisted of three phases. The first phase was to be finished within 8 months of the start date and the second and third phases were scheduled for 20 months after the start date. Due to miscommunications mainly between the architect and the CM, the first phase was not finished in the allotted time. After coming to an agreement, the contractors worked well together and completed the next two phases by August 15, 2005, just two weeks later than the goal of August 1, 2005.

The structure of Wellington is a combination of systems. The garage level required the design of a platform consisting of masonry retaining walls and a non-composite steel floor framing system for the first level. The lobby level, which is on the same elevation as the garage level, also has a non-composite steel framing system for the floor and steel framing roof system. Directly below the lobby is the lower level which has masonry retaining walls supporting the lobby floor framing system.

The foundation is composed of 12" CMU foundation walls with 2' wide strip footings and 4" slab on grade with 6x6-W2.0xW2.0 WWF over 2-4" porous fill. The interior bay is 18 feet wide to allow for easy maneuverability for cars and has steel columns as the interior supports for the floor system. The load path travels from the steel joists to steel girders in the interior and CMU bearing walls in the exterior and from the girders to the steel columns in the interior. See figure 2 below.

Wood 2x6 stud framed bearing walls and open web wood trusses are the structural system for the second and third floors and roof. The trusses for the second and third floors are 18 inch TJL trusses, manufactured by Trus Joist. For the roof, slightly sloped, 24 inch trusses were used.

The following figures show the chosen section with the current floor system.

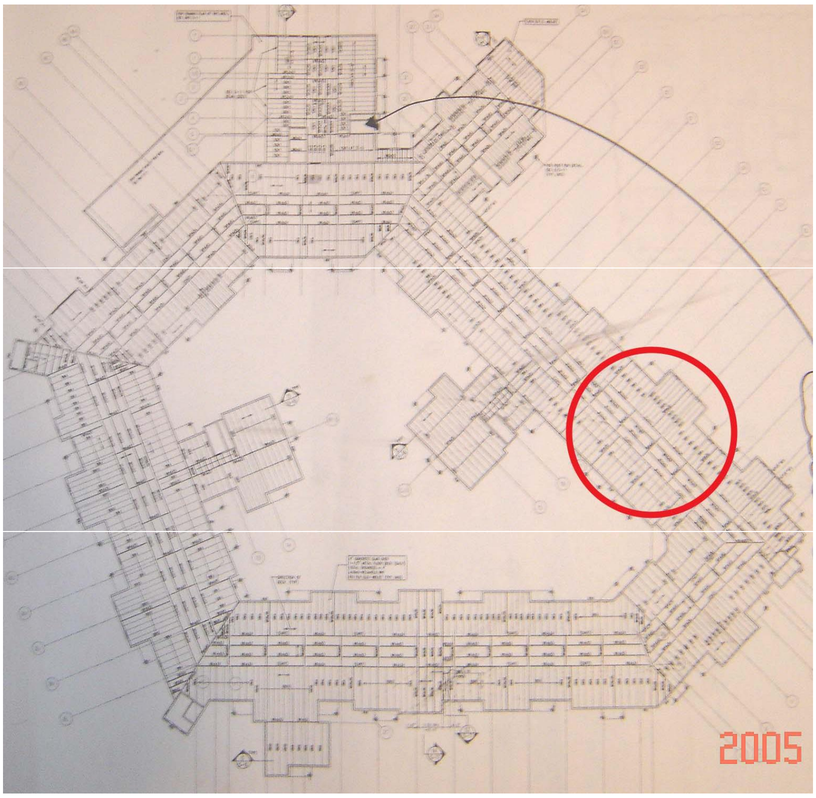
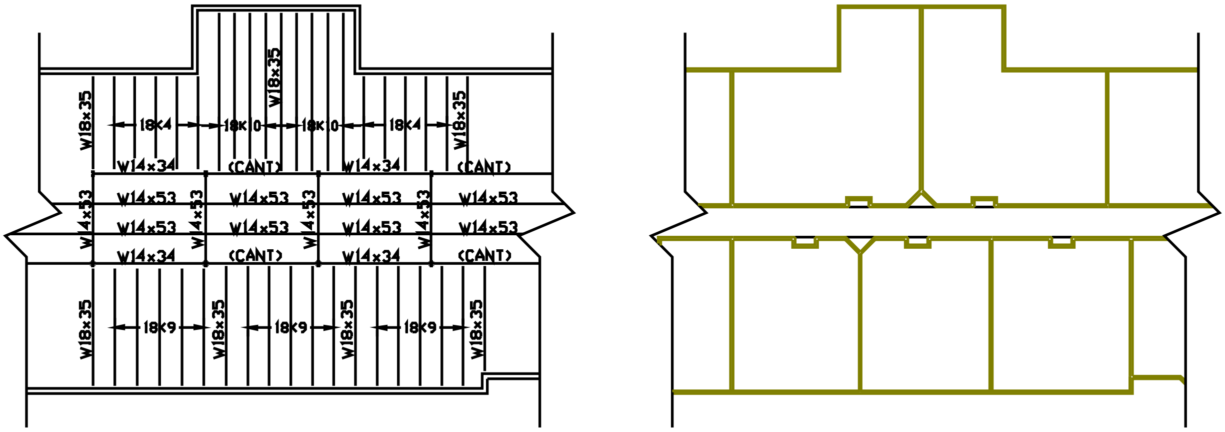


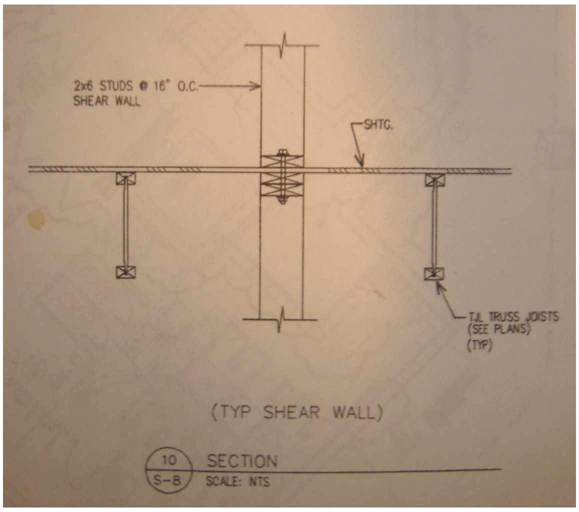
Figure 1



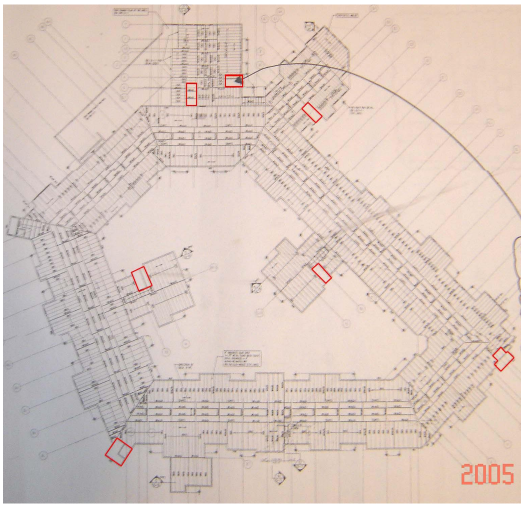
First Level   2nd & 3rd Levels

Figure 2

Wood framed gypsum shear walls and masonry towers located at the elevator shafts and stairwells (see plan below) make up the lateral load resisting system.



Typical Shear Wall



Masonry Tower locations

The exterior walls of the lower and lobby levels as well as the garage level are cmu block with a conventional red stucco finish for the parts of the wall above grade. The first through third floors' exterior walls are 2x6 wood studs framing with two layers of white stucco finish over wood sheathing.

Existing Structural System

The existing system is made up of many materials and a combination of systems. The wood section of the structure is the main reason for the consideration of designing alternate structural systems. Wood is a combustible material and, as such, is not suitable material for a retirement community. Two alternatives for the existing system will be explored, allowing for a different layout and materials more appropriate for the intended use of Wellington. It will not be determined, until further research is conducted, whether or not the masonry towers will remain as the lateral load resisting system.

Proposed Alternate Structural Systems

Alternate #1 – Light Gauge Steel Framing with CIP Concrete Platform for Garage

The first alternate system to be considered is a light gauge steel framing system on the residential levels of Wellington along with a cast in place concrete platform for the garage.

An alternate layout may also be considered, but the current layout will work with this system because of the similarity in members between light gauge steel and wood. The intention of the concrete platform is to provide sufficient sound barriers between the garage and residential levels, retaining structures for the below grade sections, and space for maneuvering of automobiles.

Alternate #2 – Masonry Walls and Hollowcore Plank floor system

Design of this system will take into consideration the residential layout from the architectural plans. All bearing and partition components of this system will be made up of masonry and designed in their current locations. Distances will be changed if necessary. The floor system will be concrete hollowcore planks, possibly with a topping.

Intended Methods and Research Sources

The CIP concrete platform will be designed using ACI 318-02. After the appropriate slab system is selected, it will be designed according to the information in the ACI. Walls and columns will then be designed and the garage platform will be complete.

The light gauge steel members will be chosen from the Marino Ware Lightweight Framing catalogue. Using calculated service loads and allowable load tables from the catalogue, members will be chosen to design the framing system of the residential floors.

For the second alternative, the masonry will be designed using the Empirical Design Method and resources from Beavertown Block Company's website. Empirical Design is a procedure in which unreinforced masonry elements are designed based on the historical performance of the masonry in the intended application. The Beavertown Block Company's website provides an abundance of information on this method as well as many other resources for masonry design.

For the design of the masonry walls, a design gravity load will be divided by the gross cross-sectional area of the wall, excluding areas of openings, and result in a compressive stress that will be compared to allowable stress values for empirically designed masonry. These allowable stress values are provided in a table from the Beavertown Block Company's website.

The floor system will be designed using the Nitterhouse Concrete Hollowcore plank loading tables. The tables are based on plank span and allowable superimposed load and will be compared to the calculated values.

Breadth Topics

Included in the proposed thesis are two breadth topics related to the change of the structural system materials. The two breadth topics that are to be studied are analyses of the interior acoustics and the overall building envelope.

Breadth Topic #1 – Interior Acoustic Analysis

The change in materials from both alternate systems will affect the acoustics of the interior. The purpose of this analysis is to establish if there is a significant acoustical advantage to changing the materials of the structure. The most interesting area of investigation will concern the barrier between the garage and first floor. The noise generated by cars will have to be isolated from the first floor residential units.

Breadth Topic #2 – Building Envelope Analysis

The effectiveness of the building envelope will also be altered with the change in materials. An analysis on the thermal, acoustic and waterproofing barriers will be performed using resources from previous classes and discussions with appropriate consultants.

Tasks and Schedule for Completion

The gravity loads will first be rechecked and verified for accuracy before applying them to the redesign of the structure. Member checks in previous technical reports proved there to be a discrepancy in the assumptions for the preliminary analysis and the original design. After the gravity loads are confirmed, they will be translated into the appropriate allowable loads used in tables for manufactured products, the Empirical Design of the masonry walls and the design of the concrete retaining walls and slab in the garage of the first alternate system.

The two alternate systems will be designed with hand calculations and using a spreadsheet for simplicity. After the members are chosen and checked, it will be determined if the current masonry towers will be the most appropriate lateral load resisting elements for these structures.

A good deal of research will be required for the interior acoustical and building envelope analyses due to a limited amount of study in these fields. At the completion of these studies, the two systems will be compared using the results along with other information on the appropriateness of the systems for the intended use of the building.

The following is the intended schedule for completion of this thesis:

Tasks	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Gravity Loads verified	ae	ae					
Alternate systems designed			ae	ae	ae	ae	
Breadth topic research						ae	ae
Breadth topic analysis							ae
Comparison of alternate systems & decision							
Final report							
Preparation for presentation							
Presentation							
Reflection							

Tasks	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15
Gravity Loads verified	S							
Alternate systems designed	P							
Breadth topic research	R							
Breadth topic analysis		ae	ae					
Comparison of alternate systems & decision	B		ae	ae				
Final report	R			ae	ae			
Preparation for presentation	E				ae	ae		
Presentation	A						ae	
Reflection	K							ae