Point Pleasant Apartments
Point Pleasant, NJ

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Structural Option
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Thesis Proposal

Table of Contents

Executive Summary

Point Pleasant is a 5-building apartment complex located at the New Jersey Shore. This report will focus on building 1, which is 64,000 square feet and has four stories over a partially exposed parking garage. There are sixteen luxury apartments in the building, four on each floor. The apartments are approximately 2,500 square feet and each has a front balcony facing the central courtyard and a rear balcony overlooking the Manasquan River. The exterior of the building is a combination of stone, stucco, and hardshingle siding. This change in material along with the bump out balconies creates an interesting façade and effectively masks its basic box shape. The roof is a simple hip accented with multiple dormers, a dome feature on one side, and steeple at the center.

Based on previous research, it has been determined that the current structural system of open-web steel joists with metal deck and concrete slab may not be the most economical or efficient choice for Point Pleasant Apartments. In the upcoming semester, an alternate system using wood floor trusses will be designed and compared to the existing structure. The wood trusses will be supported by PSL’s, wood bearing walls and W shapes, replacing the current W and HSS shapes.

A wood system will drastically change the weight of the building, therefore, the seismic loads will be recalculated and the lateral forces will be redistributed. An ETABS model will be created to calculate this distribution of forces as well as displacements and story drift. With the switch to a wood truss floor system, wood shearwalls will be utilized to resist lateral load as opposed to the braced frames of the existing system. The shearwalls will be design based on the distribution calculated by the ETABS model.

After the loads have been recalculated and shearwalls have been designed, the members will be rechecked to ensure adequacy and the results will be compared to those of the existing structural system. The members will be checked for both strength and deflection.

In addition to the structural changes made to Point Pleasant Apartments, two breadth topics will be explored. The first of these breadths is construction management. Changing from steel to wood will create drastic changes in both scheduling and cost of construction. A detailed schedule will be created for the new structural system and then compared to the schedule of the existing building. An in depth cost analysis will also be performed and compared to the existing cost to ensure that switching from steel to wood will be beneficial.

The second breadth option that will be explored is acoustical performance. Wood is more susceptible to vibration than steel. With the new structural system, the noise barrier created by the 3.5” of concrete is lost and replaced with a subfloor. In the upcoming semester, a vibration analysis will be performed and research will be performed to provide an adequate sound barrier from apartment to apartment.

Introduction

Point Pleasant is a 5-building apartment complex located at the New Jersey Shore. This report will focus on building 1, which is 64,000 square feet and has four stories over a partially exposed parking garage. There are sixteen luxury apartments in the building, four on each floor. The apartments are approximately 2,500 square feet and each has a front balcony facing the central courtyard and a rear balcony overlooking the Manasquan River. The exterior of the building is a combination of stone, stucco, and hardshingle siding. This change in material along with the bump out balconies creates an interesting façade and effectively masks its basic box shape. The roof is a simple hip accented with multiple dormers, a dome feature on one side, and steeple at the center.

Building Background

Foundation

For Point Pleasant Apartments, a traditional shallow foundation with spread footings was used. The building was designed based on a 3,000 PSF soil bearing capacity. The exterior foundation walls are 12" thick concrete over either a 2'-6"x12" thick footing with #5 @ 24" o.c. S.W.B. and (3) #4 L.W.B. or a 3'-0"x12" thick footing with #5 @ 16" o.c. S.W.B. and (3) # 5 L.W.B. There is a 5" concrete slab on grade with 6.0x6.0 – W2.0x2.0 welded wire fabric over 4" of crushed stone and a 6 Mil vapor barrier. The main columns at this level are 16"x24", 18"x26", or 24"x24" reinforced concrete columns. Beneath these columns are 11'-0"x11'-0"x26" deep concrete spread footings which are reinforced with (12) #7 bars each way.

Floor System

The framing for floors 2, 3, and 4 is all basically the same. These stories are supported by 16" deep Vescom composite joists with a 3 1/2"reinforced concrete slab. The slab is supported by a 1 5/16", 22 gage UFX 36 metal form deck. The joists are spaced at 48" o.c. and are designed to carry a total load of about 380 plf. The typical span for these joists is approximately 20', with a maximum span of about 24'. Spans run front to back. This composite system is supported by a series of steel girder trusses, wide flange beams, and HSS columns.

Each of the apartments throughout the building features front and rear balconies. The balconies are supported by a shallower composite joist of 12". HSS shapes are used as both edge beams and columns for the balconies.

The first floor is framed very differently from the floors above. Instead of a composite joist system, the first floor is a 12" thick, reinforced two-way slab. In addition to the 12" thick slab, there are slab beams in the outer apartments for additional support. Above the concrete columns below, are 12'-0"x12'-0"x20" deep (20"-12"=8" below slab depth) drop panels.

Roof Sytem

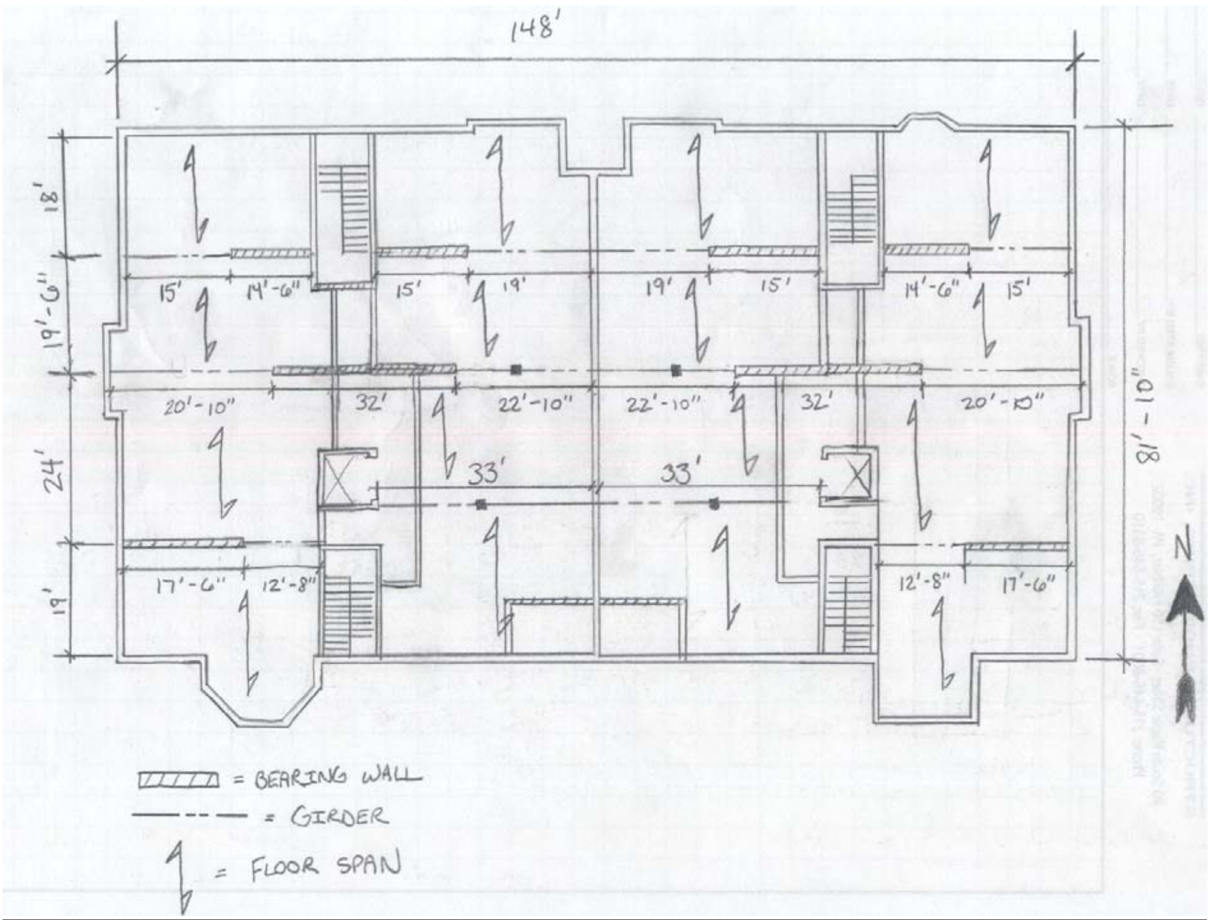
The roof system is a simple hip with two large dormers in the rear and two smaller dormers, a tower, and a dome feature in the front. The roof is made up of light gage metal roof trusses spaced at 48” o.c.

Lateral Framing

The walls of the building are comprised of metal studs, therefore, light gage shearpanels and are utilized to resist lateral load. The shearwalls, which actually act as braced frames, typically consist of 4”x14 gage flat strap bracing with 3 1/2”x3 1/2”x1/2” HSS shapes. The flat straps can either be screwed or welded to the HSS’s. All of the panels are 9’ 6” in length.

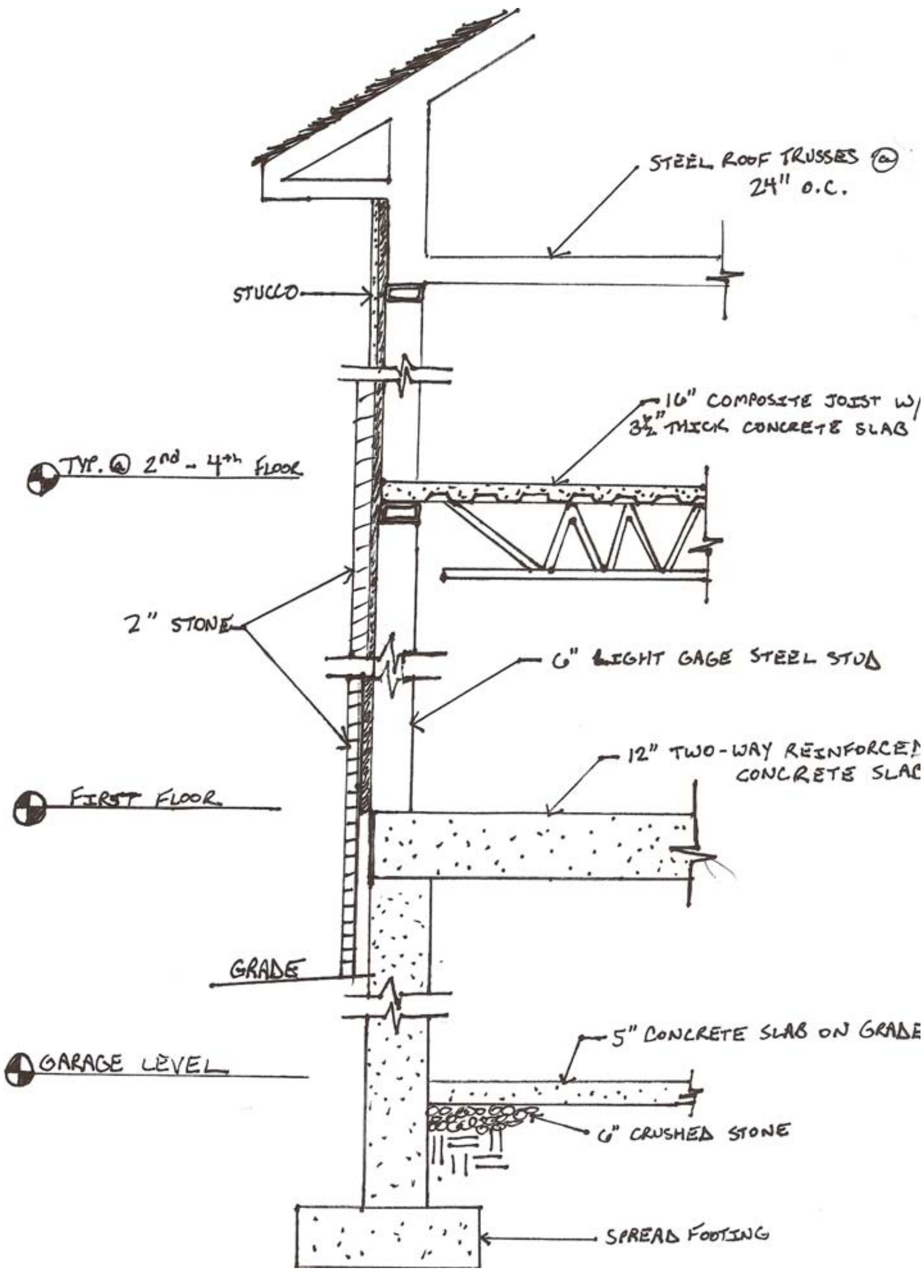
Typical Floor Plan (Structural Layout)

The floor plan below illustrates the typical framing for floors 2-4. The span arrows represent the composite joist system used for these floors. The outline of the building is the same for first floor and parking garage level as well.



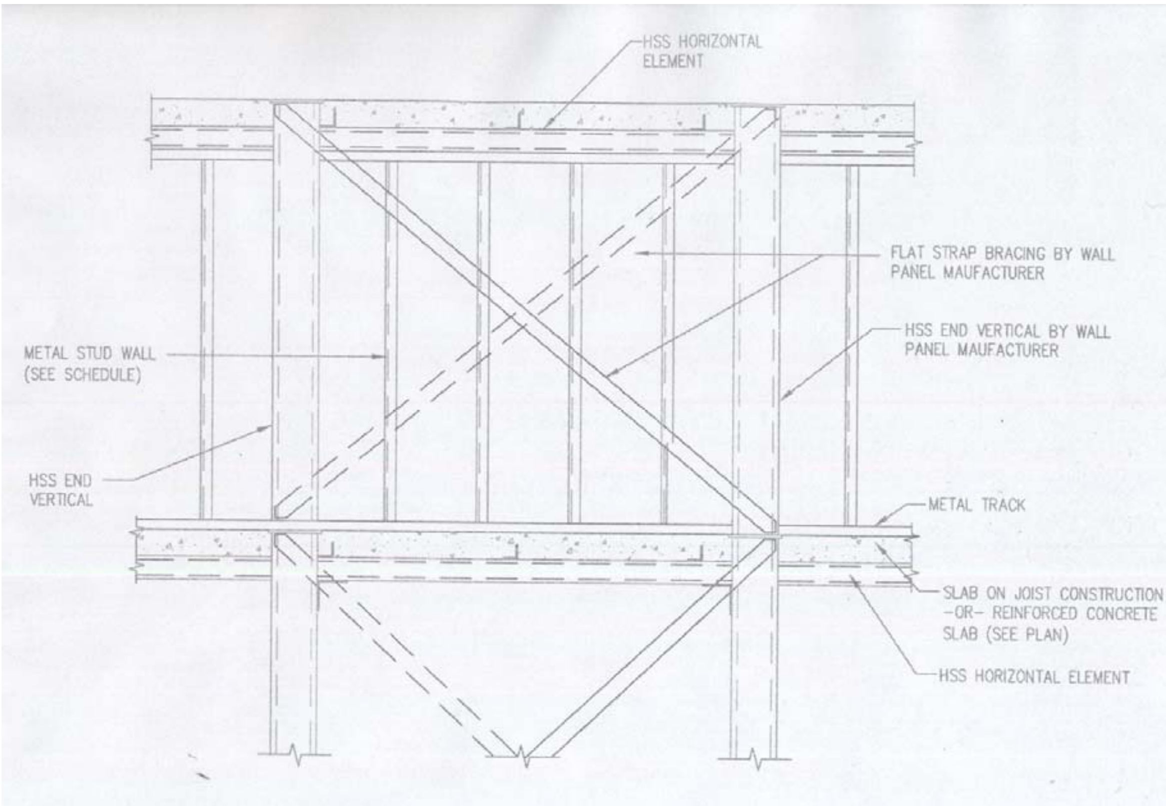
Typical Exterior Wall Section

The section below shows the basic structural framing from the foundation up to the roof. Floors 2-4 were generalized with one section because they use the same composite joist system. At different areas of the building the façade material may change to include hardshingle siding but this image gives a typical snapshot of the framing. How much of the garage that is above grade also changes around the building. For example, at the rear of the building, the full height of the garage is exposed so that cars can enter and exit.



Braced Frame Details

The image below illustrates the braced frames used for lateral resistance in the building. The HSS shapes at each end of the panel act as restraining points for the 4”x14 gage metal cross-braced straps. The story force is distributed among the braced frames, with the forces being transferred into tension in the straps. The manufacturer of the straps is Marinoware. Their design manual was consulted during the spot checks of the straps.



Problem Statement

The results from all the analyses performed in the first three Technical Reports show the current structural system is sufficiently designed to support forces due to gravity, wind, and seismic loading. However, because Point Pleasant Apartments is only four stories above grade and typical spans are not especially long, the building lends itself to a simpler and less expensive structural system. An advantage of the existing open-web steel joists is that the mechanical equipment can be run through them as opposed to having to be dropped below. However, the use of wood floor trusses is a possible alternative that could achieve this same goal and may in fact reduce the overall depth of the floor system. With the use of a wood floor system, steel studs will be replaced with wood walls and the braced frames will be replaced with shearwalls. The research performed in the next semester will determine the feasibility of a wood structural system and compare its advantages and disadvantages to those of the existing system.

Problem Solution

A wood truss floor will be designed in place of the existing open-web steel joists with metal deck and concrete slab. The wood trusses will be supported by a combination of PSL's, W shapes, and wood bearing walls. The wood bearing walls will replace the steel studs with HSS displacement tubes as well. The wood trusses will allow the mechanical equipment to run through the web, similar to the open-web steel joists. In an attempt to minimize floor depth, a top chord bearing condition will be explored for the floor trusses.

Based on preliminary research, the floor trusses will be approximately 18" deep. The live load will remain unchanged at 40psf, but the dead load will be significantly reduced resulting in a lower base shear. Because of this change, the seismic loads will need to be recalculated using ASCE-7 '05. The existing braced frames will also be replaced with shearwalls. An ETABS model will be created using the new system to determine the distribution of lateral forces, displacements, and story drifts. The shearwalls will then be designed based on this lateral distribution.

After performing a lateral analysis and reworking the gravity loads, the structural system will be rechecked for strength and deflection. These results will be compared to those of the existing structural system to ensure wood floor trusses make a viable alternative.

Breadth Options

In addition to the proposed structural revisions, two other breadth topics will be investigated. Switching from steel to a wood structural system will cause a significant difference from a construction standpoint in terms of cost and scheduling. Another area of concern that will be addressed is acoustical performance.

With a wood structural system, construction time could be greatly reduced. There is less lead time necessary for wood trusses than the steel system and the constructability is easier. In general, wood is inexpensive when compared to steel and the less labor intensive system would also in turn reduce the cost of construction. The research performed in the next semester will compare both the construction schedule and construction cost to determine if a wood structural system would be a favorable alternative to open-web steel joists supporting a metal deck and concrete slab.

One concern when using wood construction, particularly in a multi-family facility consisting of luxury apartments, is acoustical performance. Wood is more susceptible to vibration than steel. With the new structural system, the noise barrier created by the 3.5” of concrete is lost and replaced with a subfloor. In the upcoming semester, a vibration analysis will be performed and research will be performed to provide an adequate sound barrier from apartment to apartment.

Schedule of Tasks

Structural

1A. Determine new gravity loads using ASCE-7 '05.
1B. Analyze bearing wall layout and get trial sizes for floor trusses using ALPINE span tables.
1C. Size girders as LVL, PSL, and W shapes using iLevel publications and the 13th Edition AISC Steel Manual.
1D. Size bearing and exterior wood walls
1E. Lateral analysis
- a. Calculate new seismic and wind loads using ASCE-7 '05.
- b. Create ETABS model and distribute lateral load.
- c. Design shearwalls
- d. Check displacement story drift

1F. Recheck structural system and analyze changes to foundation.

Construction

2A. Research lead times and construction schedule for existing and new systems.
2B. Develop detailed schedules for both systems and compare.
2C. Research cost of materials and labor for both systems.
2D. Perform detailed cost analysis for both systems and compare.

Acoustic Performance

3A. Research acoustic properties of materials.
3B. Research vibration performance for both systems.
3C. Perform in depth vibration analysis for both systems.
3D. Design sound barrier from floor to floor and for common walls.
3E. Recheck adequacy of all acoustic systems.

Final Report

4A. Prepare final report.
4B. Prepare final presentation.

Schedule of Tasks

Week	Dates	Tasks
1	Jan. 14-18	1A, 1B
2	Jan. 21-25	1B, 1C
3	Jan. 28-Feb. 1	1C, 1D
4	Feb. 4-8	1E
5	Feb. 11-15	1E, 1F
6	Feb. 18-22	2A, 2B
7	Feb. 25-29	2B, 2C
8	Mar. 3-7	2D, 3A, 3B
9	Mar. 10-14	Spring Break
10	Mar. 17-21	3A, 3B, 3C
11	Mar. 24-28	3D, 3E
12	Mar. 31-Apr. 4	4A
13	Apr. 7-18	4A, 4B
14	Apr. 14-18	Final Presentations