Existing Conditions & Thesis Proposal

AC Hotel Philadelphia

Philadelphia, Pennsylvania

Jesse C Bordeau

Heather Sustersic, Advisor

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Contents

Executive Summary

AC Hotel Philadelphia is a 15-story residential transient hotel (including penthouse) located in the heart of downtown Philadelphia. This new hotel, owned by Baywood Hotels, will be built on top of the previous NFL Films and Warner Bros distribution center, a historic two-story building located at the corner of Florist and North 13th Street in Philadelphia.

The original two-story, 31'-0" tall building is a load bearing masonry structure. In order to properly satisfy the proposed addition, a mat foundation of varying thickness (30-42") will be installed and the building will be gutted and restructured. The new construction will consist of composite steel at the bottom three levels, supporting a 12-story steel-frame structure atop, capped with a mechanical penthouse. The typical floor-to-floor height measures 10'6". Multiple 14" shear walls make up the lateral system until floor 1 (at grade) where concentric braced frames (chevron) are utilized for architectural/spatial purposes including door and window openings.

AC Hotel Philadelphia was designed using the 2009 edition of the International Building Code (IBC) and ASCE 7-05 was used to determine lateral loads on the building. The City of Philadelphia Building Code (with current amendments) and the 2014 version of "AC Hotels by Marriott Design Standards" were also used as references. The Philadelphia Historical Commission also influenced the project boundaries.

A new scenario has developed where a structural redesign of the hotel must take place. The structure will chance to concrete, and a coordination of the trades will be crucial in order to alter the location of floor openings to minimize excess materials being used.

Purpose and Scope

This report provides a detailed backround description on the existing conditions of 230 North 13th Street. Now that all of the Notebook Submissions reports have been completed, an alternative design must be executed based on information gathered from the reports. This design must involve a structural depth along with two breadth topics to explore during the Spring 2016 semester. At the conclusion of the Spring semester, a detailed report must be submitted and a capstone presentation will be given to a panel of Architectural Engineers, staff and other design professionals.

Building Description

Figure 1: Northeast Elevation (Courtesy Holbert Apple Associates)

230 North 13th Street is a high-rise residential hotel located in downtown Philadelphia. This upper class hotel will provide 150 luxurious guest rooms, a private dining area solely for guests, and underground valet parking accessible only by car elevator. There is also a rooftop penthouse with a small, intensive green roof along with extensive green roofs on the low roof areas at the second and third levels. The original two-story structure will be partially demolished and remodified in order to support the 192' superstructure. It is important to note that the existing structure will not support the new building, new steel and concrete columns will be erected to compensate for the proposed design. The building team and the Philadelphia Historical Commission came to an agreement that in order to historically preserve the existing facades, the building must step back 18ft on the southern and eastern sides. SPG3 architects contrasted the existing art deco facades (curved corners and large grid-windows) with a more modern-looking approach. They plan to achieve LEED Gold certification by including local materials, high-efficiency fixtures, a breathable facade and several green roof areas, both extensive and intensive.

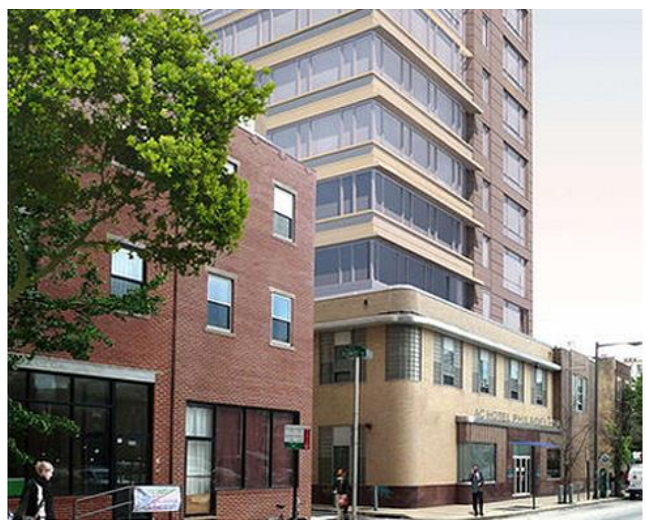


Figure 2: Rendering showing new hotel on top of existing, two-story building. (Courtesy Google Maps)

AC Philadelphia occupies 107,680 SF, with the typical floor occupying near 6,000 SF. The lower three levels have a slightly larger footprint than the typical level (levels 3-13). There are two small service rooms which stack vertically (to cut down on mechanical equipment) near the two main stairwells located at the northern two corners of the building. Two elevators sit in the center of the building, helping to keep the center of rigidity and center of mass towards the middle of the structure. The bottom floor (at grade level) contains a lobby, café, lounge and a kitchen. The second floor is occupied by an indoor pool, meeting rooms, and several guest rooms. Above this, the typical floor contains only guest rooms, and the penthouse at level 14 includes a fitness room, a green roof terrace and some of the mechanical equipment. The majority of the mechanical equipment is contained on the mechanical penthouse (level 15).

Building Elevations

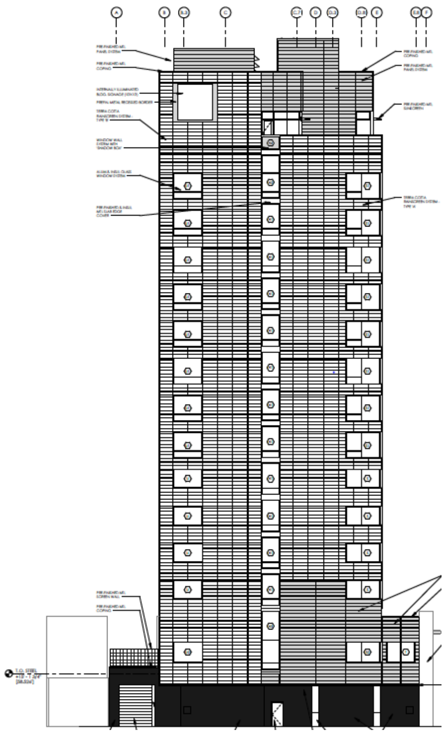


Figure 3: West Elevation

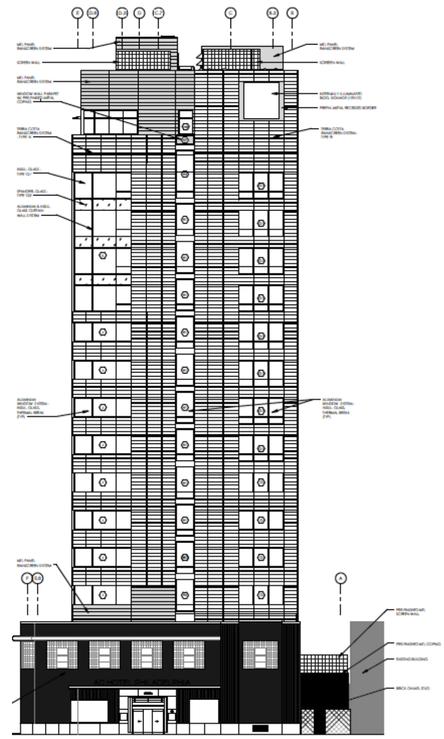


Figure 4: East Elevation

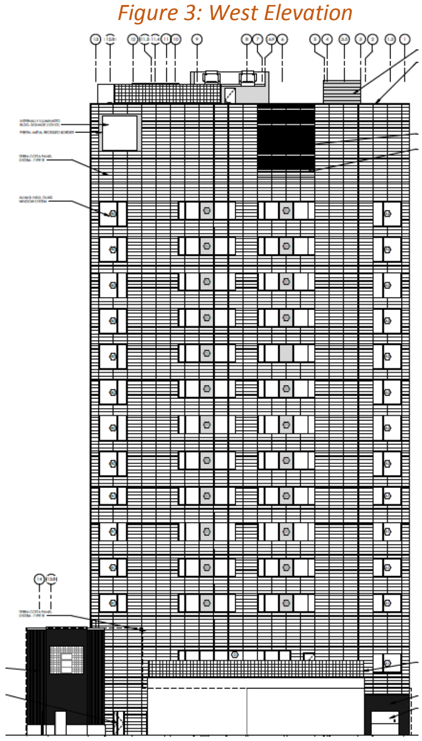


Figure 5: North Elevation

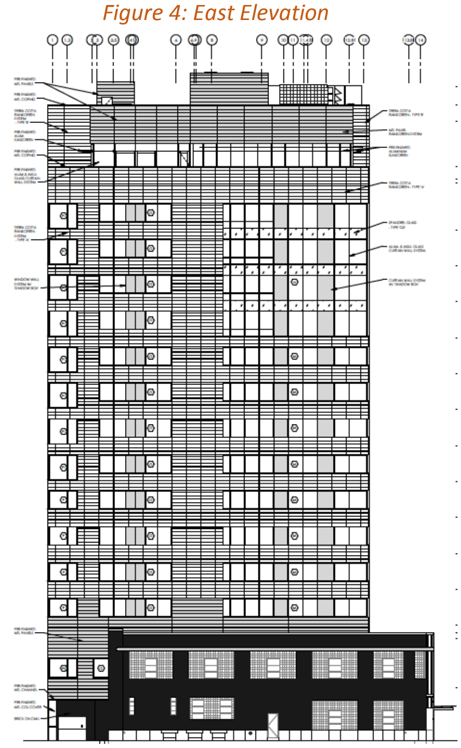


Figure 6: South Elevation

All Figures courtesy of Holbert Apple Associates

Design Codes and Standards

Relevant codes and standards used while designing AC Hotel Philadelphia are listed below:

- International Code Council
  - International Building Code 2009
  - Chapter 11 (IBC 2012) Accessibility Requirements
- American Society of Civil Engineers
  - ASCE 7-05
- AC Hotels By Marriott Design Standards 2014 edition
- AC Hotels By Marriott Module 14 FLS Design Standards January 2015 edition
- City of Philadelphia Building Code with Current Amendments
- AISC Steel Manual

Gravity Loads

This section focuses on the loads used for the structural design of AC Hotel Philadelphia. Loads were determined using IBC 2009.

Dead Loads

Dead loads for AC Hotel Philadelphia are found in the structural notes preceding the structural drawings. Listed below are the common dead loads used in design.

Table 1: Superimposed Dead Load Values

Superimposed Dead Loads (in addition to structure self-weight)	
Area	Loading [PSF]
Typical Roof	30
Floors	10
Intensive Green Roof	200
Extensive Green Roof	60

Live Loads

Live loads were determined using IBC-2009 and live loads on columns and beams are reducible in accordance with the IBC-2009, Section 1607.9.

Table 2: Gravity Live Loads

Permissible Gravity Live Loads		
Area	Loading (PSF)	Live Load Reduction Permitted
First Floor	100	Yes
Second Floor	100	Yes
Typical Floor	40+10 partitions	Yes
Loading Dock	250	No
Roof Live Load	30	No

Snow Loads

The ground snow load for Philadelphia, Pennsylvania, is 25PSF. As for the flat-roof snow load, 20PSF is to be used. However, unbalanced, drifting and sliding snow must be taken into account on the green roofs and on the mechanical penthouse level since snow can accumulate between large equipment.

Lateral Loads

Wind Loads

Wind loads are determined using ASCE 7-05, Chapter 6. Relevant wind load criteria is found in Table 3, below.

Table 3: Wind Load Criterion

Criteria	Value
Basic Wind Speed (3 sec gust)	90 mph
Occupancy Category	II
Site Exposure Category	B
Wind Importance Factor (I_w)	1.0
Internal Pressure Coefficient (GC_{pi})	+0.18, -0.18
External Pressure Coefficient (GC_p)	+0.88(windward), -0.50(leeward)

Seismic Loads

Although seismic design will not control over wind in Philadelphia, it is still due diligence to determine seismic loads on the building. According to the contract documents, AC Philadelphia falls into Seismic Design Category B. This will be confirmed in Notebook Submission B.

Soil Loads

Lateral soil loads acting on AC Philadelphia basement walls were determined by Whitestone Associates, Inc., and are outlined in the geotechnical report. The soil sliding resistance factor is 0.30. In the at-rest condition, the soil has an equivalent fluid pressure of 70 PSF/FT of depth.

Foundation System

A geotechnical report for AC Hotel Philadelphia was written in Spring, 2015, by Whitestone Associates, Inc. Based on the report, designers determined that a reinforced mat foundation of varying depth (30”-42”) would be most suitable and economical to distribute the building weight and loads into the ground. Located at the base of Figure 7, the mat foundation is designed with a maximum allowable bearing pressure of 5,000 PSF. Typical mat foundation reinforcing is displayed in Figure 8. In order to successfully install the mat foundation, temporary shoring and bracing will be required for adjacent buildings since the new excavation extends beyond site boundaries. Furthermore, the existing garage and three-story building at the North of the site will need to be underpinned to ensure proper support during construction.

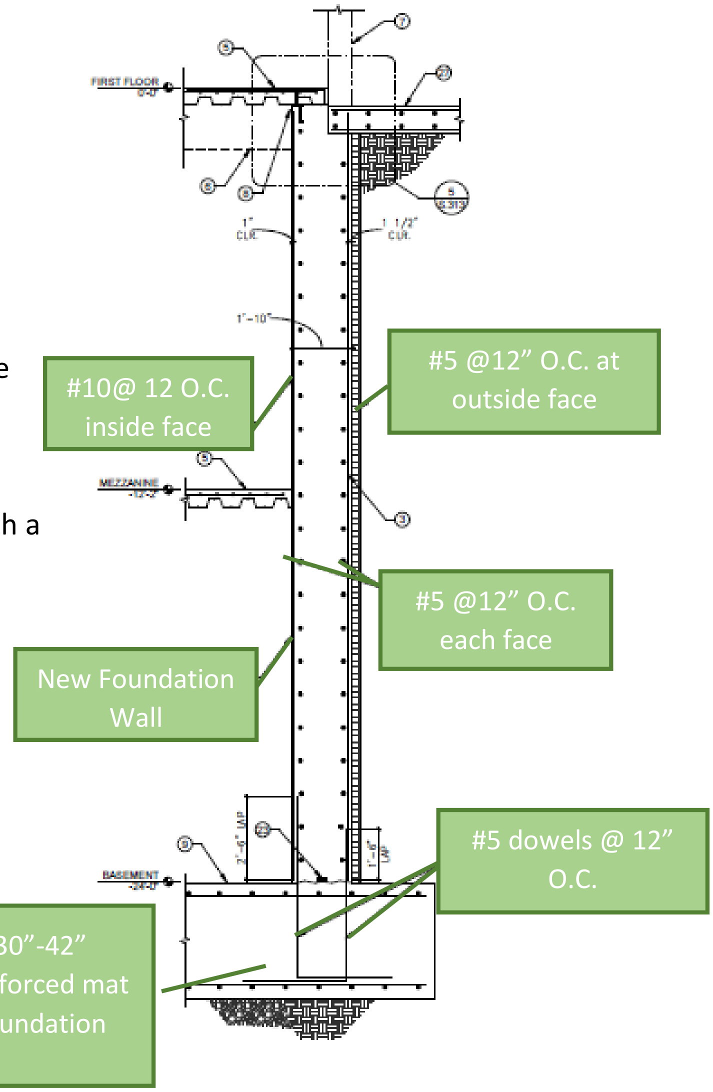


Figure 7: Foundation Wall Section Cut

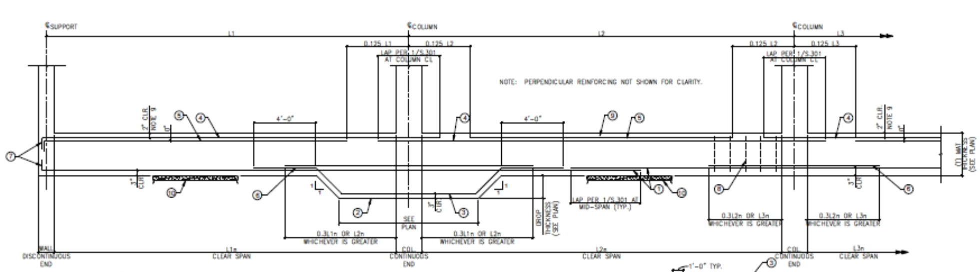


Figure 8: Typical Mat Foundation Reinforcing

Structural Framing System

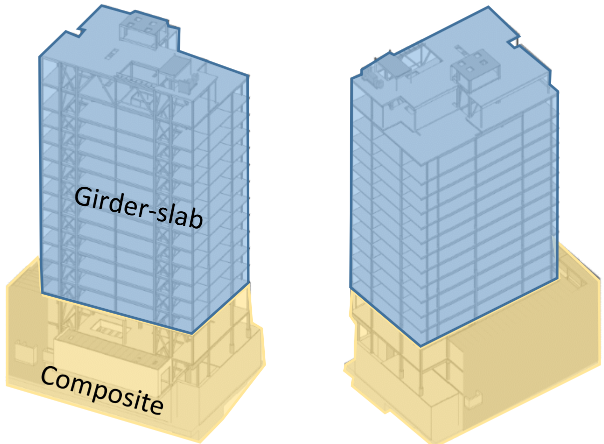


Figure 9: Structural skeleton of AC Marriott Philadelphia

Columns/Foundation

The existing building is supported primarily by steel (wide-flange) columns. At the base of the structure, the columns are supported by the mat slab foundation. Partial demolition will take place to allow for the construction of AC Hotel Philadelphia. Remaining foundation walls can be seen in Figure 10. Underpinning will be needed for the one-story garage to the North and for a portion of the three-story building to the North. The AC Hotel Philadelphia building will be supported on a varying 30”-42” mat foundation and micropiles needed to support existing structures on the northern side. Extra steel columns will complement the concrete columns at the basement level to support the

Figure 10: Existing exterior walls to remain after demolition (Courtesy Google Maps)

entire building load. At the basement level, a mix of concrete (30"x30", typ.) and steel columns (W10x54, W12x136 and W14x211 typ.) are used. Beginning at the first floor, steel columns (W10x54 and W14x211, typ.) are used. At the top level, W10x33 and W14x120 columns are used. As elevation increases, column weight per foot decreases; however, steel column depths remain the same full height to minimize splice connection detailing.

Lateral System

Laterally, multiple 14" concrete shear walls are utilized up to grade, with braced frames (HSS8x8 and HSS6x6) on all floors above grade (Figure 11). Braced frame beam sizes are W14x26 typ. Braced frames are utilized around the stair towers located on the northern façade and at the centralized elevator shaft.

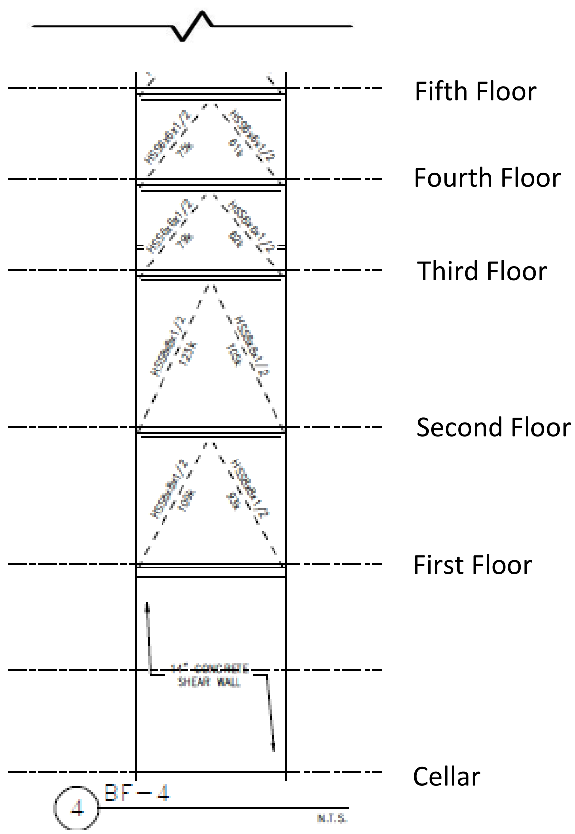


Figure 11: Elevation of Lateral Load Resisting Elements.
The brace configuration type is the chevron type.

Typical Floor Bay

Despite a rectangular structural grid, the bay sizes of AC Philadelphia are quite irregular. Bay sizes range anywhere from 14'-25' in width by 17'-30' in length. Highlighted in Figure 12 is the average bay size chosen for the AC Philadelphia building. Due to the bay irregularity, the loads on each girder vary, hence why girder (d-beam) sizes range from DB8x37 to DB 9x65. One can see the architects' intent to open up occupiable floor space in the building by creating much larger interior bays than exterior bays.

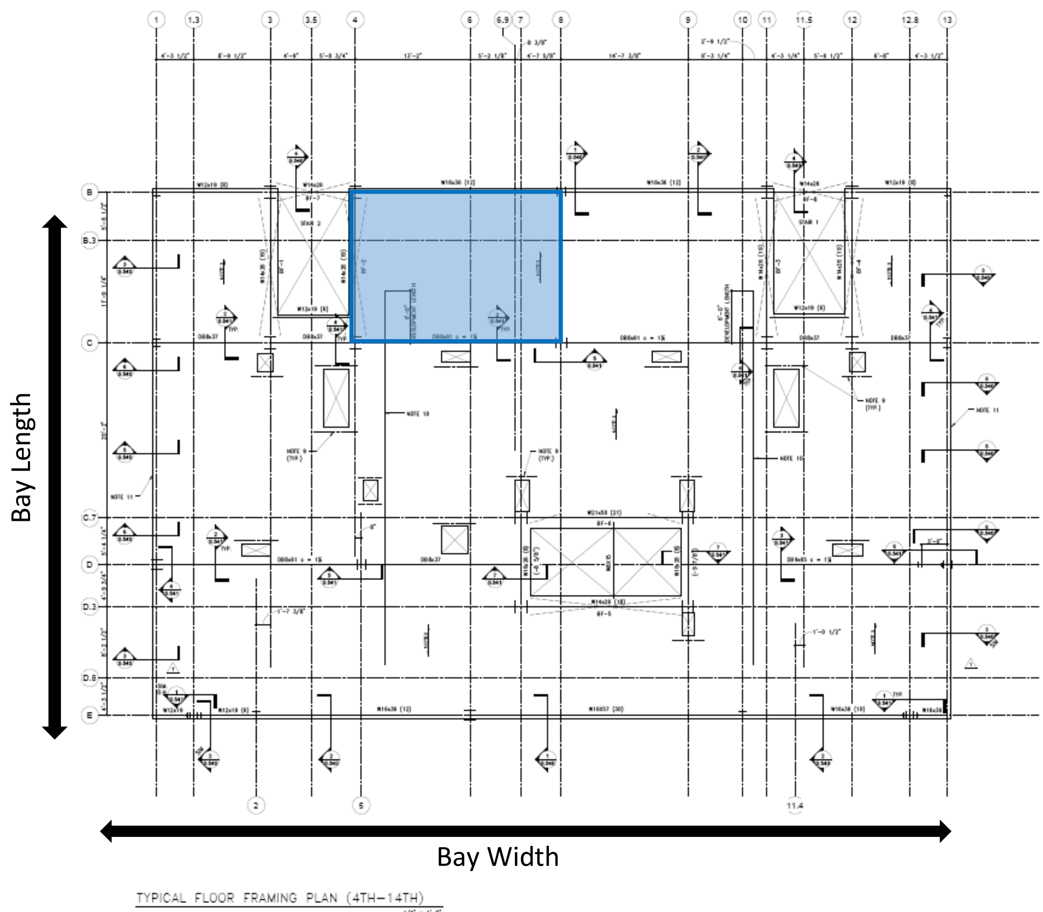


Figure 12: Typical Framing plan showing irregular structural grid. The average bay size (24'x17.5') is highlighted above.

Shown below is a section cut through the typical girder-slab construction. This configuration allows 8" thick, precast hollow core planks with 2" concrete topping to sit directly on the bottom flange of a structural steel beam, and protrude past the top flange, concealing the top of the beam. The bottom of the beam is exposed, however this issue can be solved by adding a drop-panel ceiling. Proper construction for inspection requires 2'0" width openings (minimum) at 24" O.C. in order to place #4 transverse rebar. Once all rebar is placed, the openings are backfilled with grout. The grouted transverse rebar helps transfer load between the concrete and steel, therefore, this floor system is assumed to be composite. Since concrete planks are being utilized, infill beams are not needed for the system, and as noted in the previous section, the typical dissymmetrical (D-beam) used for the project ranges from DB8x37 to DB 9x65. Since the floor is a girder-slab, shear studs are not needed. However, in other areas of the building, ¾" diameter, 5" long shear studs are used for composite sections. The D-beams are commonly cambered 1 ¼" to ensure allowable beam deflections.

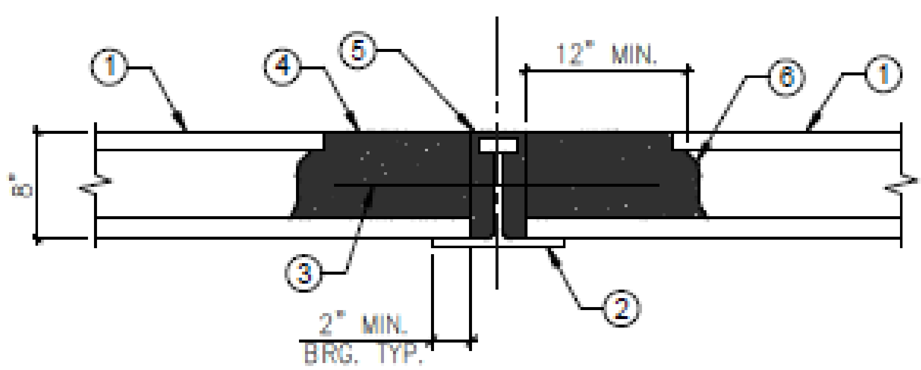


Figure 13: Typical Girder-slab Beam Section-Reinforced

Load Paths

Gravity

Starting from the rooftop penthouse, loads are applied from the penthouse green roof and transmit through the floor decking onto composite, girder slab floor system, and then into the columns (Figure 13). The building façade is primarily an ALPHATON Terracotta Panel Rainscreen system. The façade load is transferred into the aluminum substructure, through the panel clips and into the girder slab floor system. Loads are applied on girder and brought down through the columns (W10x33& W14x120) into the column footings, which sit on grade beams. The load is then dispersed onto the mat foundation which will evenly spread out the full load into the soil beneath. Loads from the lower floors will follow the same path except for loads will transfer from the composite floor into the girders and down through the columns.

Lateral

Lateral loads are absorbed by the diaphragm and transferred into the column lines where the concentric braced frames and shear walls will withstand the force. This bracing transfers the load down through the cross members and is

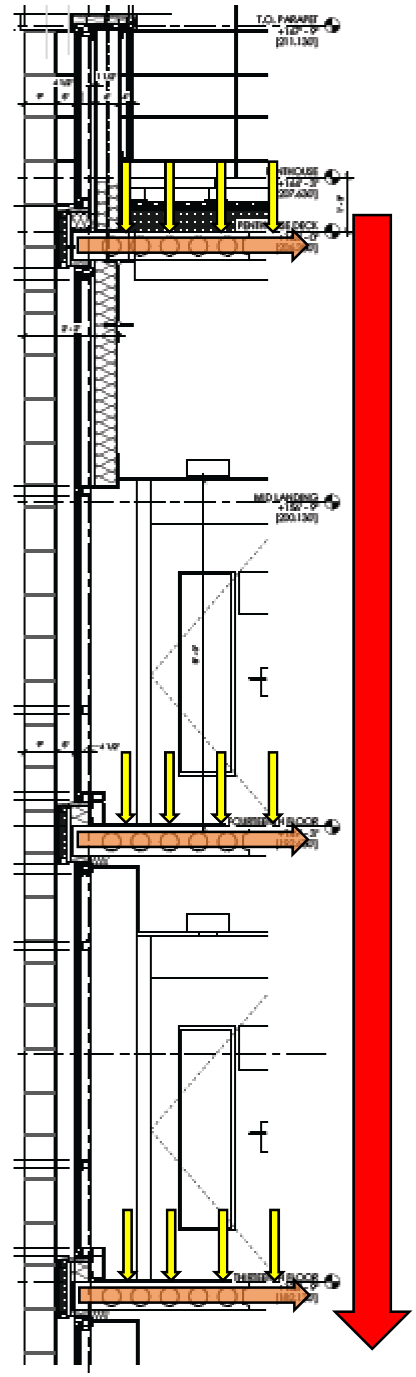


Figure 13: Gravity Load Path

collected at the base where the foundation walls distribute the load into the surrounding compact soil.

Based on the geotechnical report, the maximum anticipated factored design loads are as follows:

- Column Gravity Load- 1,200 kips
- Lateral Load- 70 kips

Joint Details

Gravity beam to column connections vary depending on whether the girder-slab system or composite steel system is installed at the level under investigation. Girder-slabs are used on the residential floors. The detail in Figure 14 below depicts the girder-slab to column shear connection wherein the girder-slab sits on a ¾"x6"x ½" wide stiffened seat which is fastened by (2) ¾" diam. A325 high strength bolts. Slotted holes are used to allow for easier installation; however, some connections may require slip critical (SC) bolts to negate movement. Slip critical bolts are less common, as for AC Hotel Philiadelphia, SC bolts are only needed braced framed-connections. Stiffened seat shear connections are welded to the column and underside of the angle.

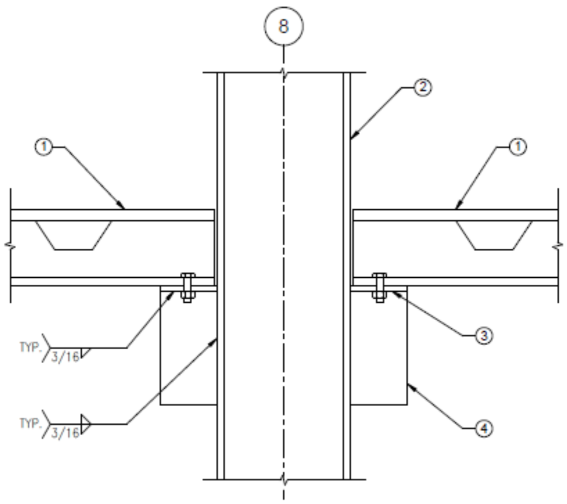


Figure 14: Girder-slab beam to column connection

Framed beam to column connections are also common (Figure 15). Table 4 shows the typical required number of bolts and their capacities for connection.

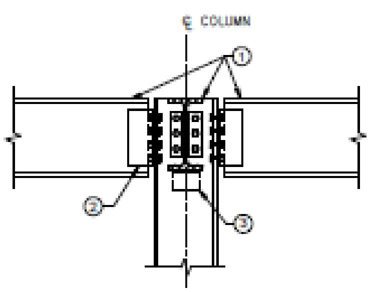
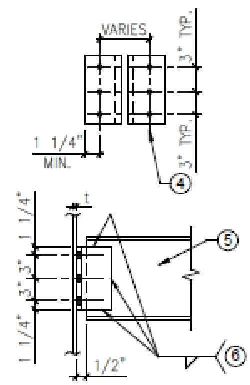


Table 4: Required # of bolts and their capacities.

TOTAL NUMBER OF BOLTS IN CONN. ANGLES	MINIMUM CONNECTION ON BEAM	MAXIMUM CONNECTION ON BEAM	3/4" DIA. BOLTS CAPACITY (KIPS)		E70xx WELD CAPACITY (KIPS) ①					
			A325–N ②	A325–X ②	3/16"	MIN. WEB	1/4"	MIN. WEB	5/16"	MIN. WEB
4	W8,W10,W12	W8,W10	37.2	42.1	37.1	.286	49.5	.381	61.8	.476
6	W14,W16,W18	W12,W14	55.8	65.9	55.3	.286	73.7	.381	92.1	.476
8	W21,W24	W16	74.4	89.7	72.7	.286	97.0	.381	121	.476
10	W27,W30	W18	93.0	113	88.7	.286	118	.381	148	.476
12	W33,W36	W21	112	136	104	.286	139	.381	174	.476



1) WHEN BEAM WEB THICKNESS (Fy = 50 KSI) IS LESS THAN MINIMUM REQUIRED MULTIPLY LISTED CAPACITY BY RATIO OF ACTUAL THICKNESS TO LISTED MINIMUM THICKNESS. WELD SIZE SHALL CONFORM TO MINIMUM SIZE PER DETAIL 8/S.502.
2) MINIMUM SUPPORT THICKNESS (t) TO DEVELOP BOLT CAPACITY IN BEARING:
   SINGLE SHEAR (BEAM ONE SIDE) A325–N = 0.159" A325–X = 0.227"
   DOUBLE SHEAR (BEAM BOTH SIDES) A325–N = 0.318" A325–X = 0.454"
   WHERE ACTUAL SUPPORT THICKNESS IS LESS THAN MINIMUM INDICATED MULTIPLY TABULATED BOLT CAPACITY BY RATIO OF ACTUAL TO MINIMUM SUPPORT THICKNESS.
3) DO NOT USE THIS DETAIL FOR COLUMNS LESS THAN 8"x8".
4) ALL CONNECTION ANGLES TO BE L3 1/2x3 1/2x5/16 (L3 1/2x3 1/2x3/8 FOR 5/16" WELDS) W/ STD. ROUND HOLES OR HORIZONTAL SHORT SLOTS (IF NEEDED TO ACCOMMODATE BOLT GAGE VARIATIONS).
5) BEAM WEB.
6) FOR WELD SIZE, SEE TABLE.
7) WHERE BEAMS FRAME ON BOTH SIDES OF COLUMN WEB, OR BOTH SIDES OF GIRDER WEB OVER COLUMN, COMPLY WITH OSHA ERECTION RULES REGARDING DOUBLE CONNECTIONS BY PROVIDING AN ERECTION SEAT, STAGGERED CLIP ANGLES, OR OTHER METHODS AS APPROVED BY STRUCTURAL ENGINEER OF RECORD.

Although not common in the structure, several transfer girders are utilized to distribute column loads above the public floors of the building (Floors 1 & 2), allowing larger open public spaces without column interruption. The typical connection for transfer girders is shown below in Figure 16. Columns will be attached to the girder using (4) ¾" dia. bolts and stiffener plates are attached from flange to flange on the girder. Transfer girders tend to be larger (W36x361 & W36x652 both on 2nd floor, W40x593 on 3rd floor) than other members due to increased moment on the span. The main transfer girders are highlighted in Figure 17 & 18.

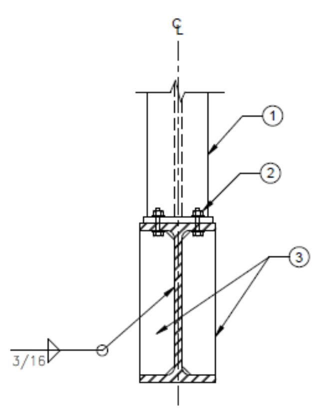


Figure 16: Typ. column to transfer girder connection

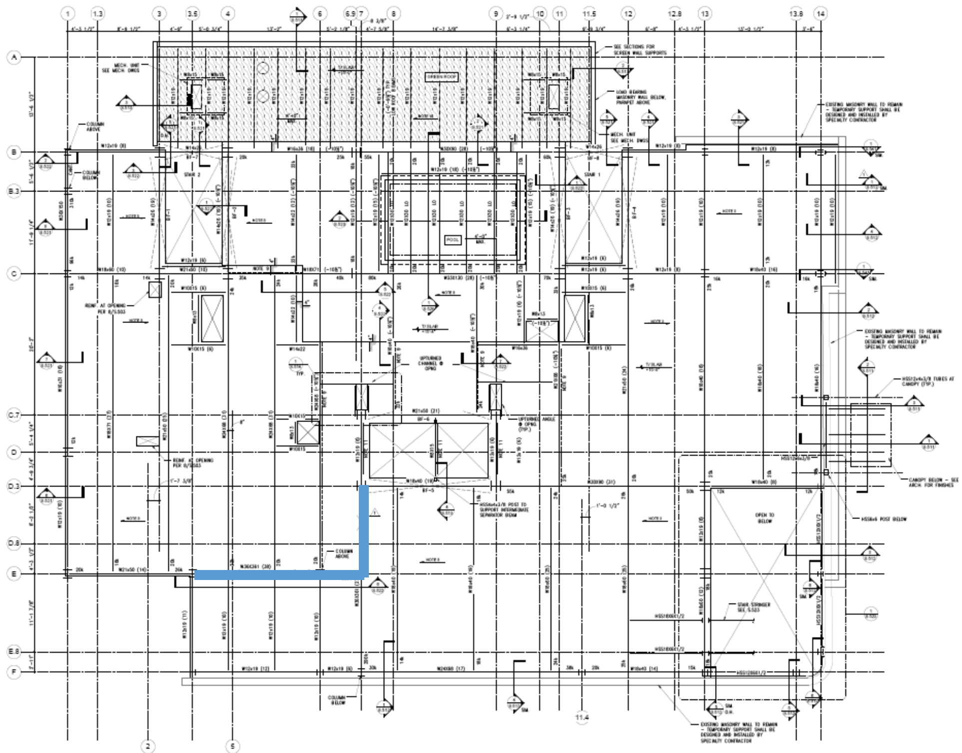


Figure 17: Transfer girder locations on 2nd level

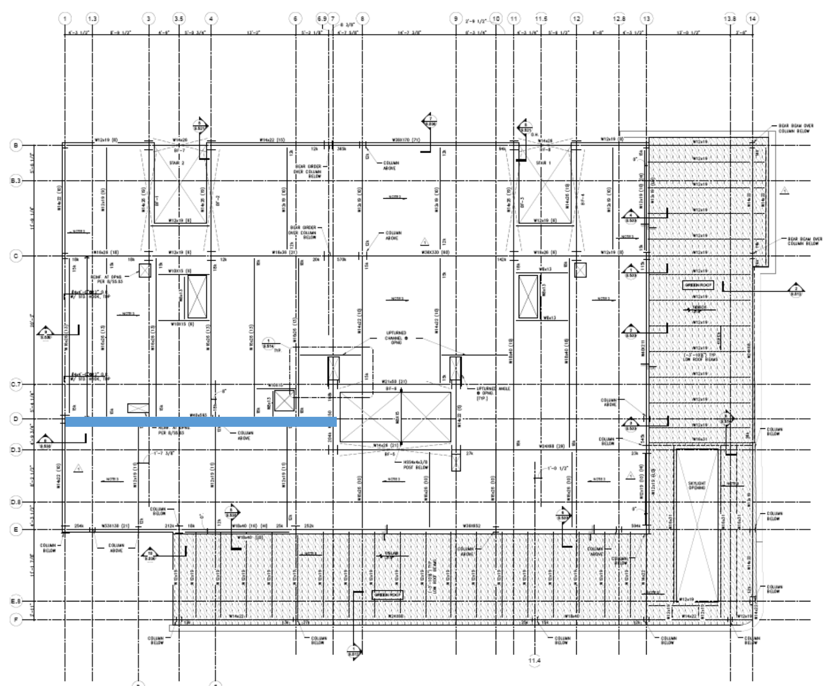


Figure 18: Transfer girder locations on 3rd level

Other Elements

Project designers of AC Philadelphia incorporated multiple green roofs (both intensive and extensive) in their design (Figure 19-21). On the second and third levels, smaller, extensive green roofs are utilized. On the upper penthouse level, a larger, intensive green roof was installed. Since intensive green roofs are designed to support dynamic activity, higher design loads must be accounted for.

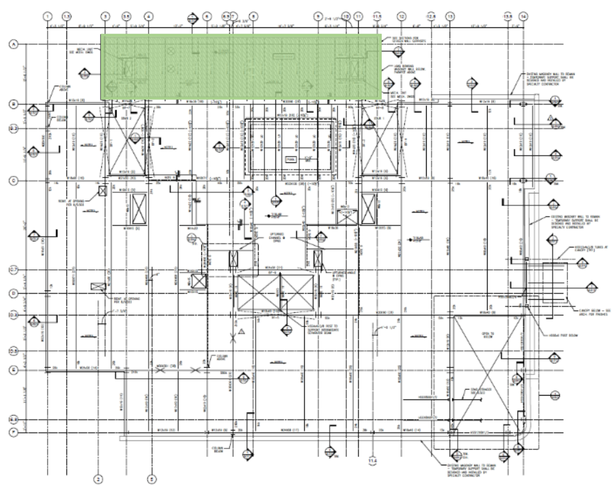


Figure 19: 2nd Level Green Roof

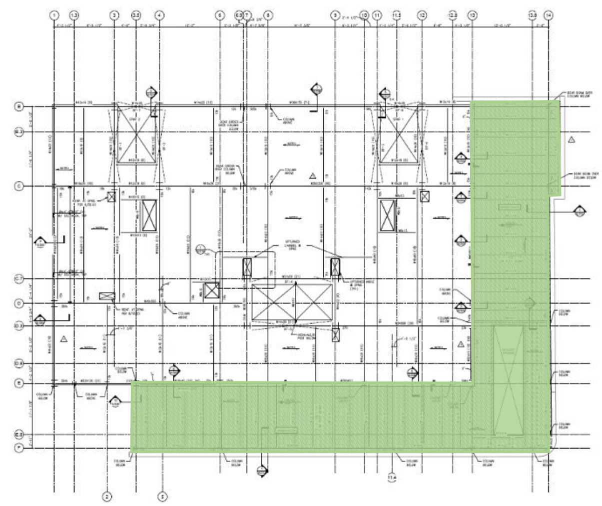


Figure 20: 3rd Level Green Roof

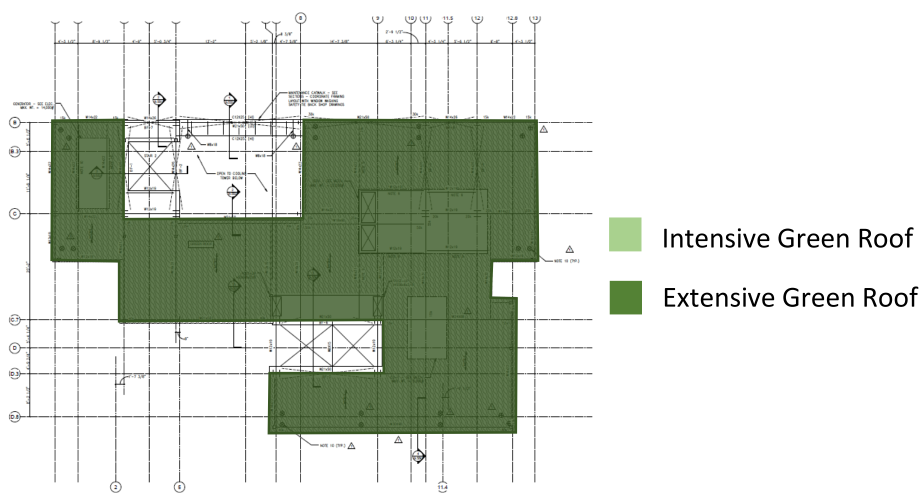


Figure 21: Penthouse Level Green Roof

Alternative Design Proposal

Proposal

The current gravity and lateral framing systems of 221 N. 13th Street have been determined to be satisfactory for strength and serviceability requirements based on the findings in Notebook Submission A, B & C. Although the design is sufficient, the owner and architect have decided to alter the structure, utilizing structural concrete instead of structural steel. The main reason behind this drastic decision is to modify the location of openings in the floor plans in an attempt to simplify floor plan layout and cut down on material costs. In the original design, several openings disrupt structural beam spans which requires extra steel framing in order to accommodate. With a careful floor plan layout, these openings will be relocated so that extra materials are minimized, and changes will be made to architectural features to keep the hotel as appealing as possible. Mechanical equipment will also be investigated relocated, and possibly altered if deemed necessary.

Design Alternative

The new design will incorporate a gravity system that will consist of a two-way concrete slab with and a lateral system supported by concrete shear walls at the interior of the building and concrete moment frames at the exterior. Floor openings vary on location and purpose, therefore extra steel reinforcing will be necessary in these areas. If steel reinforcing is not feasible (excess) for construction, slab beams will be utilized. The decision to use a two-way concrete slab was based on the fact that the current floor plan has an irregular grid. Compared to most other systems, a two-way slab works well for spans that vary within the floor plan. In Notebook Submission B, alternative floor systems were investigated, however, a two-way slab was not explored at the time. This will require extra work in the spring semester, but is necessary because of the possible advantages the system provides.

Breadth #1: Mechanical & Architectural Coordination

After analyzing the floor plans for AC Hotel Philadelphia, it is apparent that there are numerous openings serving multiple purposes including: mechanical equipment, electrical equipment and sanitary lines. All of these are necessary, therefore it has been decided to maintain all openings, however they will be altered to improve their locations. Due to these changes combined with a completely new structural material being introduced, architectural features will also be investigated in order to keep the aesthetic integrity SPG3 architects' have put in place.

Breadth #2: Construction Management

The two-way slab floor system will have an impact on both the critical path of construction and the overall cost of the hotel. The critical path of both structures will be investigated along with a cost comparison (materials and labor) of the existing girder-slab system to the proposed two-way slab. These two comparisons will help to determine the feasibility of the proposed system.

Methods (Research & Analysis)

The flat slab system will be designed based on specifications in American Concrete Institutes' (ACI) 318-11 chapter 13 using the Direct Design method. The redesign will begin with selecting a trial slab thickness (Table 9.5c) based on new structural loads which will be calculated. Although spSlab uses the Equivalent Frame Method, it will be still be utilized for spot checking and verifying that the values computed are viable. Once the slab is determined adequate, the layout for the lateral system (concrete shear walls and concrete moment frames) will be analyzed, selected and checked using spWall. After the slab, beams (if necessary) and columns have been determined, a 3D model will be created in ETABS to gain a better understanding of the design that has been put in place. Loads will be entered into ETABS and design member sizes will be compared with those determined by the ETABS gravity and lateral analyses.

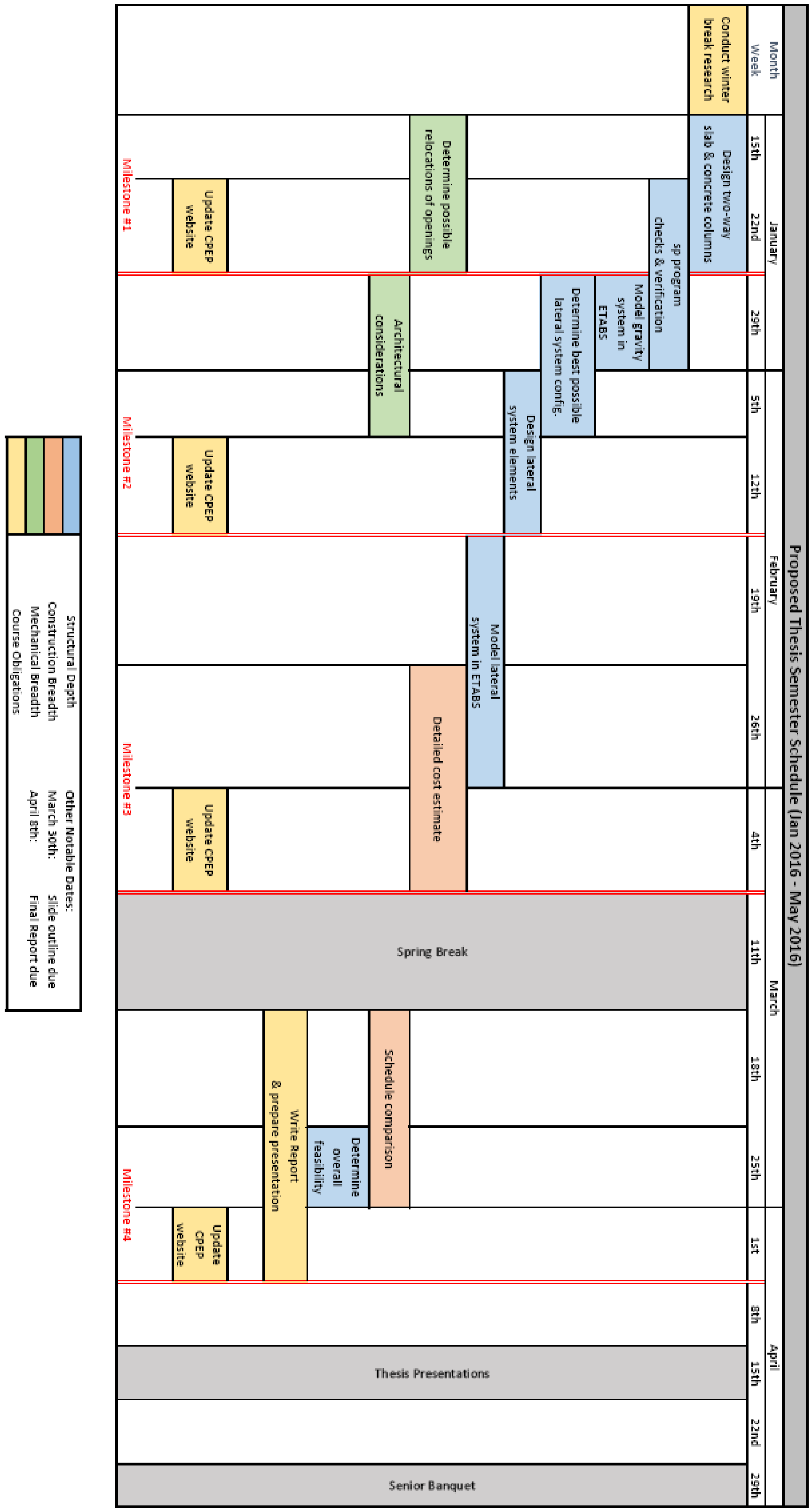
With coordination of the mechanical and architectural features being one of my priorities, research and careful integration will be executed to find the best solution for altering openings within the floor plans, while pursuing the goal of minimizing the overall change in aesthetics. ASHRAE standards 62.1 and 90.1 will be used to determine new ventilation and mechanical loads based on changes made to floor plans.

Tasks & Tools

1) Winter Break Research
    a. Contact Holbert Apple
        i. Obtain original construction schedule
        ii. Get updates on any changes made to construction documents
    b. Explore ETABS and SP (slab, column, beam) programs to become more familiar
    c. Study Mechanical drawings in CD's to become more familiar with layout and systems in place
    d. Visit site of building (221 N. 13th St, Philadelphia Pa) if possible to become more familiar with site surroundings
2) Structural Depth: Concrete Design
    a. Gravity System Design
        i. Design
            1. Estimate structural loads based on new material
            2. Determine appropriate two-way slab thickness
            3. Determine rebar needed for slab openings
            4. If too excessive, determine required slab beam size
        ii. Design Details
            1. If possible, create standard detailing for typical floor opening reinforcement based on size of opening
            2. Utilize SP programs to verify hand calculations, adjust slab thickness and reinforcing if needed
            3. Create a 3D model in ETABS to get a better overall understanding/appearance of the structure and to verify hand calculation results with a computer program
    b. Lateral System Design
        i. Design
            1. Determine seismic loads based on change in building mass
            2. Using ETABS, conduct a modal analysis to find building period
            3. Use ETABS to analyze proposed lateral system configuration
            4. Design concrete moment frame reinforcement to account for extra load
            5. Design concrete shear wall reinforcement to account for extra load
        ii. Design Details
            1. Using hand calculations, verify ETABS model
3) Mechanical & Architectural Breadth
    a. Alter mechanical equipment based on new location of openings
    b. Alter architectural aspects based on new location of openings
4) Construction Management Breadth
    a. Cost Analysis

        i. Perform a detailed cost analysis of the proposed concrete system using RS Means data
        ii. Compare proposed design cost with original (girder-slab) design cost
    b. Schedule Comparison
        i. Adjust schedule activities for concrete construction design
        ii. Analyze critical path timelines for both designs, commenting on any major changes
        iii. Determine if proposed concrete system is practical
5) Final Report/Presentation
        i. Write & format final report
        ii. Create/format/review final presentation
        iii. Finalize report & presentation
        iv. Practice presentation
        v. Update CPEP website

Schedule


Proposed Thesis Semester Schedule (Jan 2016 - May 2016)
Month
Week
January
February
March
April
15th
22nd
29th
5th
12th
19th
26th
4th
11th
18th
25th
1st
8th
15th
22nd
29th
Conduct winter break research
Design two-way slab & concrete columns
sp program checks & verification
Model gravity system in ETABS
Determine best possible lateral system config.
Design lateral system elements
Model lateral system in ETABS
Determine possible relocations of openings
Architectural considerations
Detailed cost estimate
Schedule comparison
Determine overall feasibility
Write Report & prepare presentation
Update CPEP website
Update CPEP website
Update CPEP website
Update CPEP website
Milestone #1
Milestone #2
Milestone #3
Milestone #4
Spring Break
Thesis Presentations
Senior Banquet
Structural Depth
Construction Breadth
Mechanical Breadth
Course Obligations
Other Notable Dates:
March 30th: Slide outline due
April 8th: Final Report due

Conclusion

AC Hotel Philadelphia is a 15 story (including penthouse) transient hotel occupying a little over 107,000SF. This report explored the existing conditions of 230 North 13th Street. Design codes and standards were introduced to first clarify which editions are being utilized. As noted before, the current girder-slab structural system has been deemed to be sufficient for strength and serviceability criteria. An imaginary scenario has been created in order to reanalyze a new system developed by a fifth year Architectural Engineering student. In the spring 2016 semester, a full structural redesign will take place and the building will be altered to concrete. To analyze the feasibility of this system, a cost and schedule comparison will be performed. Mechanical and architectural considerations will also take place in an attempt to improve the location of floor openings.

The existing gravity system in place is 8" thick concrete planks that sit on D-beams to create what is known as a composite girder-slab system. Concrete columns will take the place of wide-flange steel columns. Laterally, AC Hotel Philadelphia is supported by shear walls up to grade, and concentric braced frames from grade to the top of the structure. For the redesign, a flat slab will be introduced with mild steel reinforcement in both directions. Around openings, supplementary reinforcement will be added to account for extra stress within the concrete. If needed, slab beams will be introduced. After the redesign is completed, a reflection on the semester will be performed, determining whether or not the new design is feasible, and furthermore, compare it back to the original design and draw overall conclusions.