Thesis Proposal

Seneca Allegany Casino Hotel Addition

Salamanca, NY

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Structural Option

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Executive Summary

The Seneca Allegany Hotel addition is an 11 story addition for the Seneca Allegany Casino complex in Salamanca, New York. The new addition ties into an existing hotel with a similar structural system of composite metal deck on steel framing. Lateral loads are resisted by braced frames in the short direction and moment frames in the long direction along the perimeter of the addition, while resting on steel piles driven to bedrock.

Previous technical reports analyzed the existing structure, and deemed that the system was adequate in carrying gravity and lateral loads. Through these analyses it was determined that some members were slightly larger than necessary based on strength, which brings up the possibility of reducing overall cost and building weight. This proposal states that implementing a staggered truss will potentially reduce the overall weight and cost while maintaining structural integrity and performance.

The staggered truss was previously researched in Technical Report 2 and found to be a possible solution, though the system required a much more in depth analysis to make a final judgment. This proposal explains the steps necessary to continue the analysis of the truss system through computer modeling and a redesign of the foundation. The trusses will be designed to resist both gravity loads and lateral loads in order to remove interior columns and the existing braced frames.

Since this is a hotel, the layout of the rooms themselves will be impacted by the trusses since they will span the width of the building. For the first breadth, a study of the interaction between truss location and room layout will be performed to ensure the best use of space while maintaining structural integrity. The floor system will be replaced with a precast concrete plank system, freeing up ceiling space within the hotel rooms. A look at room aesthetics as well as ventilation and lighting locations will also be investigated.

The second breadth will focus on the cost and schedule impacts of redesigning the foundation to adequately carry the new truss system. The use of trusses will reduce the overall weight of the building allowing the existing steel piles to be reduced in size. A comparison between the original cost and the redesign cost and an investigation of items affecting the critical path in the schedule will be conducted.

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Building Introduction

The Seneca Allegany Casino has undergone multiple construction phases over the years, 5 in total, with the first being a pre-engineered metal building housing the original casino floor, built in 2004 and shown on the far right of Figure 1. Phase 2 consisted of an 8 level parking garage, built from precast concrete in 2005. Next came the first 11-story, 200 room hotel tower with a 2 story casino/restaurant addition, built in 2006 with a typical steel framing system. In 2007, Phase 4 was a renovation of phase 1, converting the original casino floor into an event center, which required new steel truss supports for partitions and concert lighting.

Figure 1 - Seneca Allegany Casino
Satellite Photo Courtesy of Bing.com

This thesis will focus on Phase 5, which is another 11-story, 200 room hotel tower with a structural steel framing system bearing on steel pile foundations. This tower ties into an existing portion of the Phase 3 tower, which was originally built to withstand gravity loads from Phase 5. Construction started in 2008, but construction was halted until 2011, with a projected completion date of Fall 2012. Phase 5 is shown in yellow in Figure 1.

Figure 2 shows the hotel tower sheathed in an insulated glass façade, reflecting the same aesthetic of the original hotel tower. The casino is located within the Seneca Indian Reserve in Salamanca, NY, a mountainous region with an average elevation of 1400 ft. above sea level. This high elevation allows for plenty of natural light and there are no other surrounding structures to shade the casino complex. The lower 3 levels of the addition consist of insulated metal panels backed by metal framing studs.

Figure 2 - South Elevation
Photo Courtesy of Jim Boje, PE (Wendel)

Structural System

Foundation

Drawing 1 shows a plan view for the steel pile foundations, with the perimeter of the hotel addition outline in red. The piles are HP12x53's designed for a working capacity of 200 kips and driven between 30 - 100 ft to bedrock depending on location. The pile caps are designed for a compressive strength of 4000 psi, reinforced with #9 and #11 bars, and range 42" to 72" in thickness. The caps rest on piles and strip and spread footings rest on subgrade with an allowable bearing capacity of 2000 psf.

The perimeter foundation consists of strip and spread footings designed for a compressive strength of 3000 psi, ranging from 5' to 16' in width, reinforced with #5-#8 grade 60 steel bars. The perimeter uses concrete frost walls up to the ground floor slab on grade, while interior column footings make use of piers tied to columns with steel plates and Gr. 36 and Gr. 55 steel anchor bolts. A fixed connection was assumed for the E-W moment frames and a pinned connection for the N-S braced frames.

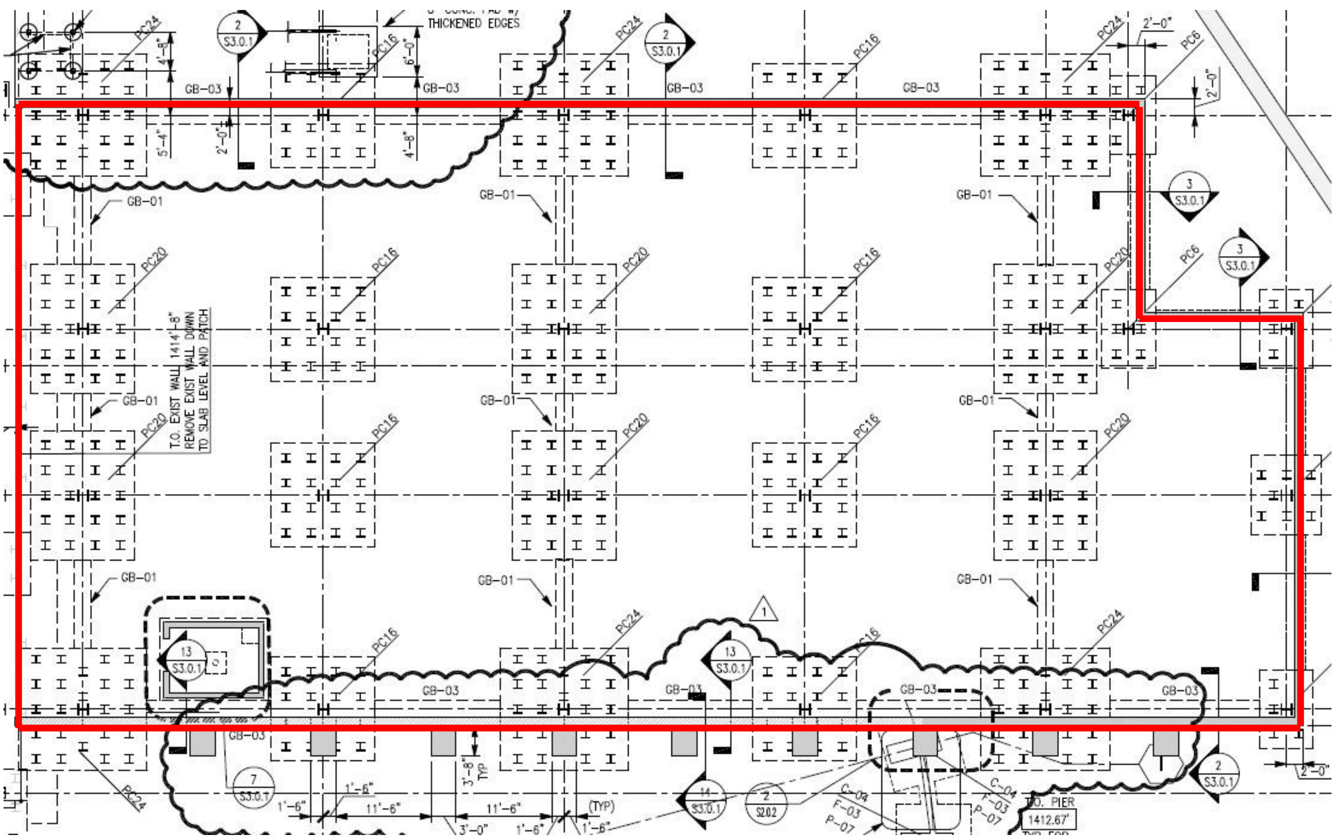


Figure 3 - Steel Pile/Pile Caps Plan
Drawings Courtesy of JCJ Architecture

Framing & Floors

Since this is a hotel tower, the bays are repetitive with the largest bay size a consistent 25’-9” by 29’ from the lobby up through the 11th floor. The hotel rooms are located along the outer edges, between column lines 6.6 - 7.3 and 8.4- 9, shown here in Drawing 2. The middle section is the corridor, with a slightly smaller bay size of 20’ by 29’.

The most significant change in member sizes occurs in the columns and girders as the elevation increases. All structural steel is 50 ksi. The majority of floor beams in the hotel rooms are W16x26, with the exception of the 3rd floor, where they are W16x31 and the mezzanine level, where they are W18x35. The corridor also is consistent with W12x16’s on the 3rd through 10th floors. The exception in sizes for the corridor is on the 2nd floor with W14x22’s and on the 11th floor with W12x19’s.

The floor system consists of concrete slabs on metal deck; 20 gage for hotel rooms and 18 gage for roof, with a 6.5” total depth, normal weight concrete (145 pcf) with compressive strength of 3500 psi and 6x6/W2.9xW2.9 wire mesh. At splices between deck and span changes, #4 rebar spaced at 12” is used. 3/4” diameter shear studs are spaced evenly along beams and girders, with the number shown in plan. Figure 5 shows a typical deck section.

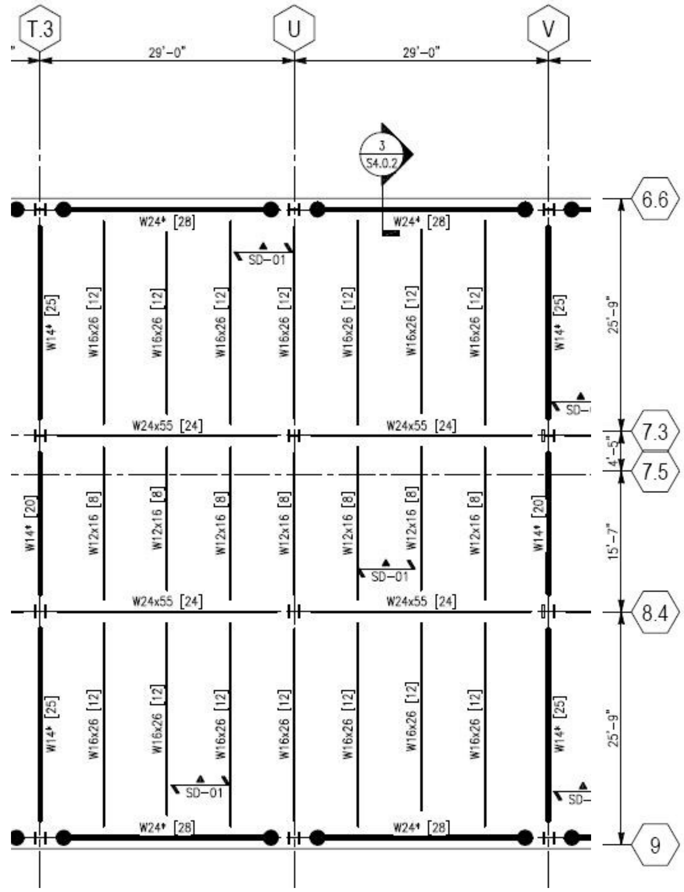


Figure 4 - Section of 4th—10th Floor Framing Plan
Drawings Courtesy of JCJ Architecture

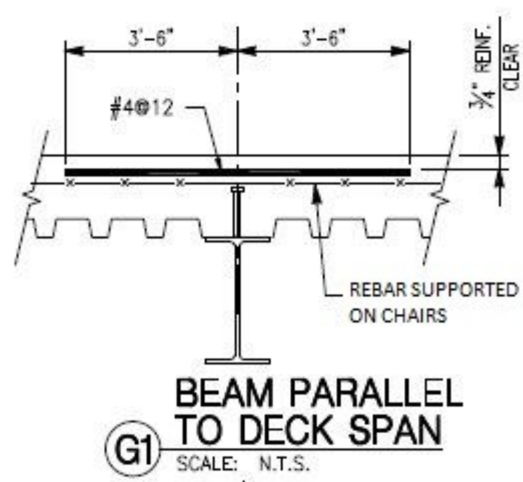


Figure 5 - Typical Composite Metal Deck Section
Drawings Courtesy of JCJ Architecture

Columns

The SAC Hotel addition uses wide flange columns throughout the entire addition. The weight of the columns decrease as the elevation increases, with a small range of sizes used. Figure 6 below shows the column schedule. All columns are in accordance with ASTM A992, 50 ksi steel.

Columns connect to the foundation by use of ASTM A572, 50 ksi base plates, and vary in attachments, whether it be with or without column piers, or directly to frost walls along the perimeter. Anchor bolts conform to ASTM F1554, 55 ksi.

STEEL COLUMN SCHEDULE								
COLUMN MARK	COL. SIZE	BASE PLATE			ANCHOR BOLTS			REMARKS
		T (in.)	W (in.)	L (Ft.–in.)	QTY	SIZE (DIA)	ASTM F1554	
C–01	16"øx0.50" PIPE	2"	24"	2'–0"	4	1 1/4"	GR55	.
C–02	W14x68	1"	22"	1'–10"	4	1"	GR36	·
C–03	W14x90	1 1/2"	22"	1'–10"	4	1"	GR36	·
C–04	W14x132	2"	28"	2'–4"	4	1 1/4"	GR55	20" WIDE BASE ℄ AT HOTEL LOBBY

Figure 6
Drawings Courtesy of JCJ Architecture

Lateral System

The lateral systems used in the SAC Hotel consist of moment frames in the long span (E-W) directions and diagonally braced frames in the short (N-S) directions. For the moment frames, moment connections occur at columns and girders, shown below in Figures 7 and 8.

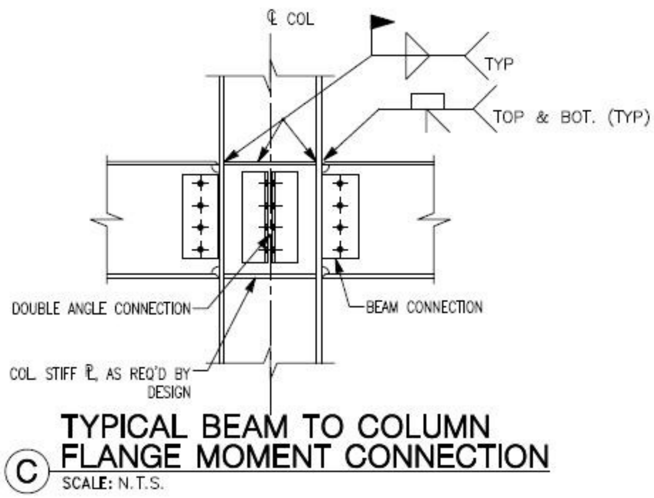


Figure 7 - Typical Moment Connection
Drawings Courtesy of JCJ Architecture

Figure 8 - Typical Moment Connection
Photo Courtesy of Jim Boje, PE (Wendel)

The diagonal bracing is used in specific column lines. Wide flange shapes are used, ranging in size from W14's at the lower floor levels to W10's for the 4th through 10th floor. Column line W has only one bay diagonally braced the entire height of the building to account for the stair-well. The bracing is tied into the frame by use of steel plates embedded in slab deck at beams and columns, shown by Figures 9 and 10.

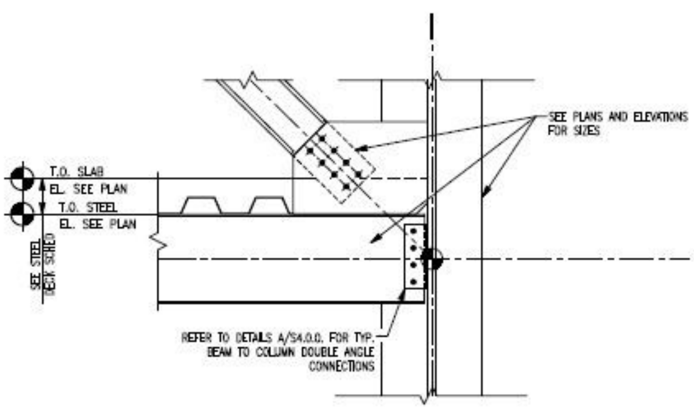


Figure 9 - Diagonal Brace Connection at Column
Drawings Courtesy of JCJ Architecture

Figure 10 - Diagonal Brace Connection at Column
Photo Courtesy of Jim Boje, PE (Wendel)

Roof

The roof structure is consistent with the hotel floor framing, with no change in bay sizes, or location of moment frames, and uses similar metal deck to the hotel floors, with a larger gauge of 18. Slightly larger W shapes are used to account for the extra roof snow load, (40 psf), with the majority of members being W18x35's. A 5' parapet surrounds the perimeter, framed with HSS 14x10x3/16 members embedded within. A detailed parapet section is shown in Figure 11, with the HSS outlined in red. The roof also supports window washing machines, with anchors embedded in the deck.

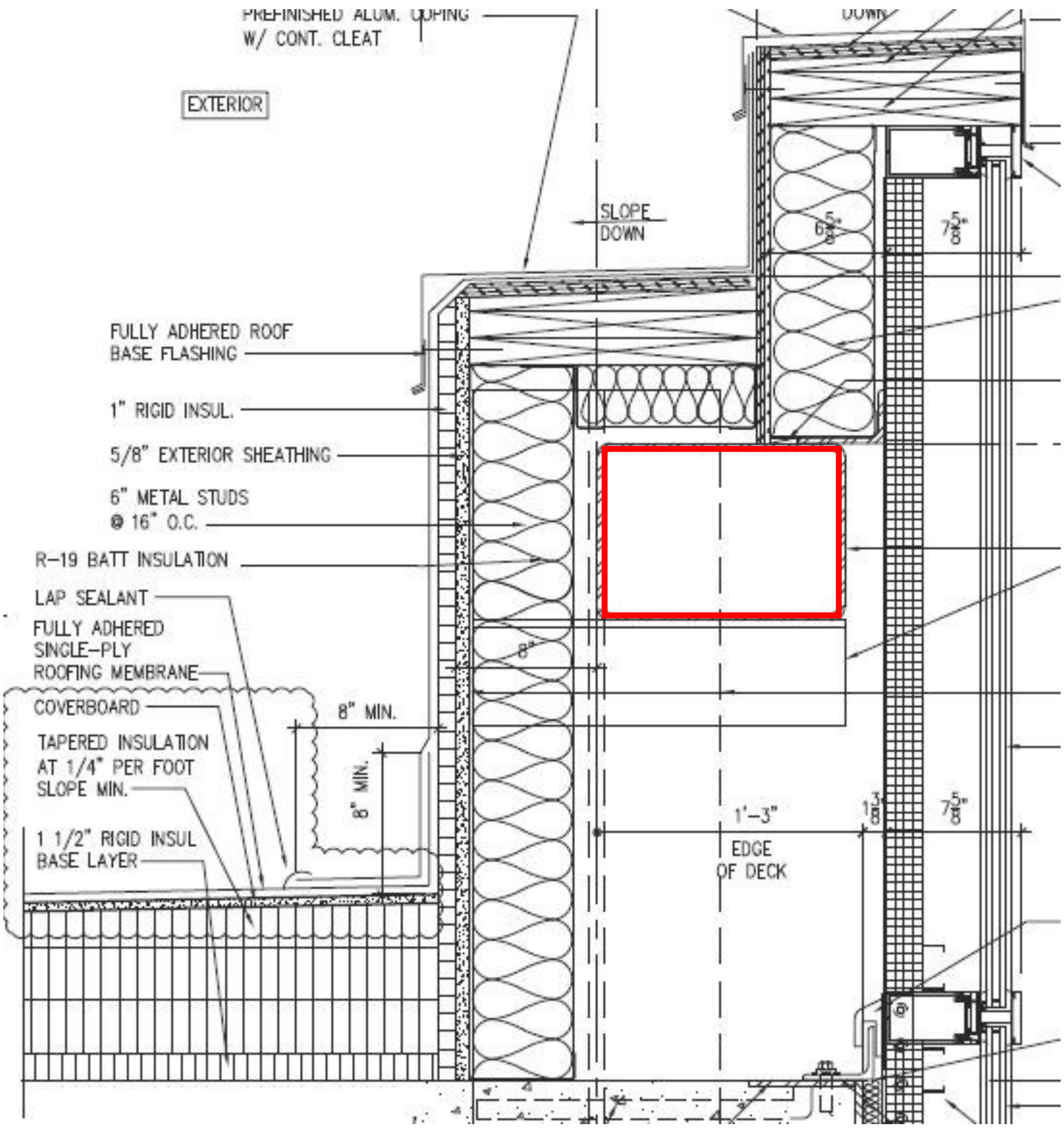


Figure 11 - Roof Parapet Section
Drawings Courtesy of JCJ Architecture

Expansion Joint

The addition to the SAC Hotel requires that the structure tie into the existing structure of the original 11-story hotel tower. This was accomplished using a 12" expansion joint beginning at the 4th floor and at each floor up through the roof level, shown below in Figure 12 and 13. The joint provides a flexible connection which allows the new addition to move independent of the existing tower, resisting wind and seismic loads through the moment and braced frames with no effect on the existing tower.

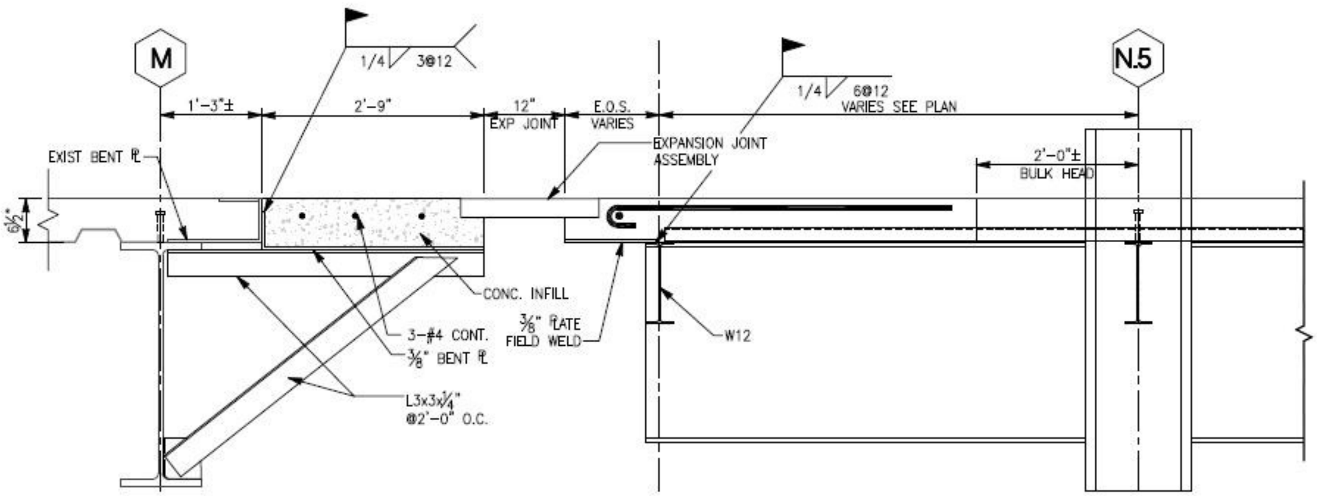


Figure 12 - Expansion Joint Section
Drawing Courtesy of JCJ Architecture

Figure 13 - Expansion Joint Section
Photo Courtesy Jim Boje, PE (Wendel)

Design Codes

Construction of the 2nd SAC Hotel tower began in 2008, and was put on hold until 2011. The following codes were used in the design process:

- 2006 International Building Code
- 2010 New York State Building Code
- ASCE 7-05
- ACI 318-08
- AISC, 13th edition
- Building code requirements for concrete masonry structures ACI-530 and ACI-530.1

For this technical report, the following code editions were used for calculation checks:

- 2009 IBC
- ASCE 7-05
- AISC, 14th edition
- AISC Design Guide 14 - Staggered Truss Design
- Vulcraft 2008 Decking Catalogue

Material Properties

Concrete

Pilecaps, Piers, and Grade Beams	4000 psi
Footings and Frost Walls	3000 psi
Interior Slabs	4000 psi
Concrete in Slabs on Metal Deck	3500 psi

Masonry

Hollow Masonry Units	ASTM C90, 1900 psi
Mortar	Type S, ASTM C270, 1800 psi
Grout	ASTM C476, 3000 psi

Metal Deck

Hotel Floors	2", 20 Gauge, NWC
Mezzanine and Roof	2", 18 Gauge, NWC

Reinforcement

Reinforcing Bars	ASTM 615, Grade 60
Welded Wire Fabric	ASTM A185
Lap Splices and Spacing	ACI 318

Structural Steel

Connections	Bolts, ASTM A325 or A490
Columns, Beams & Girders	50 ksi, ASTM A992
Tubular Shapes	46 ksi, ASTM A500, Grade B
Round Shapes	36 ksi, ASTM A53, Grade B
Plates	50 ksi, ASTM A572
All Other Steel	36 ksi, ASTM A36
Anchor Bolts	55 ksi, ASTM F1554 (U.O.N.)

Cold Formed Metal Framing

12, 14 and 16 Gage Studs	ASTM C955, Fy = 50 ksi
18 and 20 Gage Studs	ASTM C955, Fy = 33 ksi
Track, Bridging and Accessories	ASTM C955, Fy = 33 ksi

Gravity Loads

Below is an overview of the design loads used in this analysis of the SAC Hotel addition, including loads provided in the specifications and estimations used for calculations.

Dead Loads		
Superimposed	15 psf	Partitions/Façade Estimate
MEP	10 psf	Specs
Ceiling	5 psf	Specs
Metal Deck	69 psf	Vulcraft 2008 Deck Catalog

Live Loads		
	Design Loads	*ASCE 7-05*
Ground Floor	250 psf	
Typical Hotel Rooms	80 psf	40 psf
Hotel 2nd Floor	125 psf	
11th Floor Suites	125 psf	40 psf
Roof and Mezzanine	200 psf	20 psf
Corridors, Stairs, Lobbies	100 psf	100 psf
Mechanical Rooms	200 psf	

Note: Due to drastic differences in ASCE 7-05 values and the Design Loads listed in the specifications, the provided design loads were always used in calculations.

Snow Loads		
	Design Loads	*ASCE 7-05*
Roof Snow Load	40 psf	38.5 psf
Ground Snow Load	50 psf	CS
Drift Snow Load	-	20.5 psf

Note: CS in ASCE 7-05 stands for Case Study snow loads, which is why the 50 psf Design Load was used in calculations, taken from the specifications for the 2010 New York State Building Code.

Problem Statement

With the previous technical reports, it was determined that the SAC Hotel addition was adequately designed to carry applied loads and resist lateral forces. Calculations performed for each technical report showed that the individual steel members may have been slightly larger than required, which could have been due to multiple reasons, such as differing load calculations between ASD and LRFD, serviceability requirements outside the scope of these technical reports, or availability of materials. The SAC Hotel addition also ties-into an existing hotel tower with a similar framing scheme as the new addition, so design consistency could have been another factor.

Solution

Technical Report 2 was specifically focused on researching alternative designs for the gravity framing system in the SAC Hotel. Since the hotel addition makes use of repetitive floor plans and framing schemes, multiple options exist. It was determined that monolithic concrete construction would not be suitable due to the project's location in Salamanca, New York, which has a colder climate and could cause project delays. Precast concrete planks on steel members were also investigated, but would require larger beams than the existing beams to carry the loads of the planks.

The other alternative system investigated was a staggered truss. The analysis of the staggered truss in Technical Report 2 only took account of gravity loads from precast concrete planks, and it was determined to be potentially viable. In order for this system to be implemented into the SAC Hotel addition effectively, a few concerns will need to be addressed, such as:

- The most effective layout of the trusses to carry gravity loads and work as the lateral system, replacing the braced frames in the N-S direction, while investigating the possible change from moment frames to braced frames in the E-W direction.
- Redesign of the foundation, potentially reducing the size of the driven piles
- Change in overall building weight with the use of precast planks
- Impact on interior layout of hotel rooms

The following pages illustrate how the staggered truss may impact the existing floor plans and how the truss will line up with the hotel room walls and corridor.

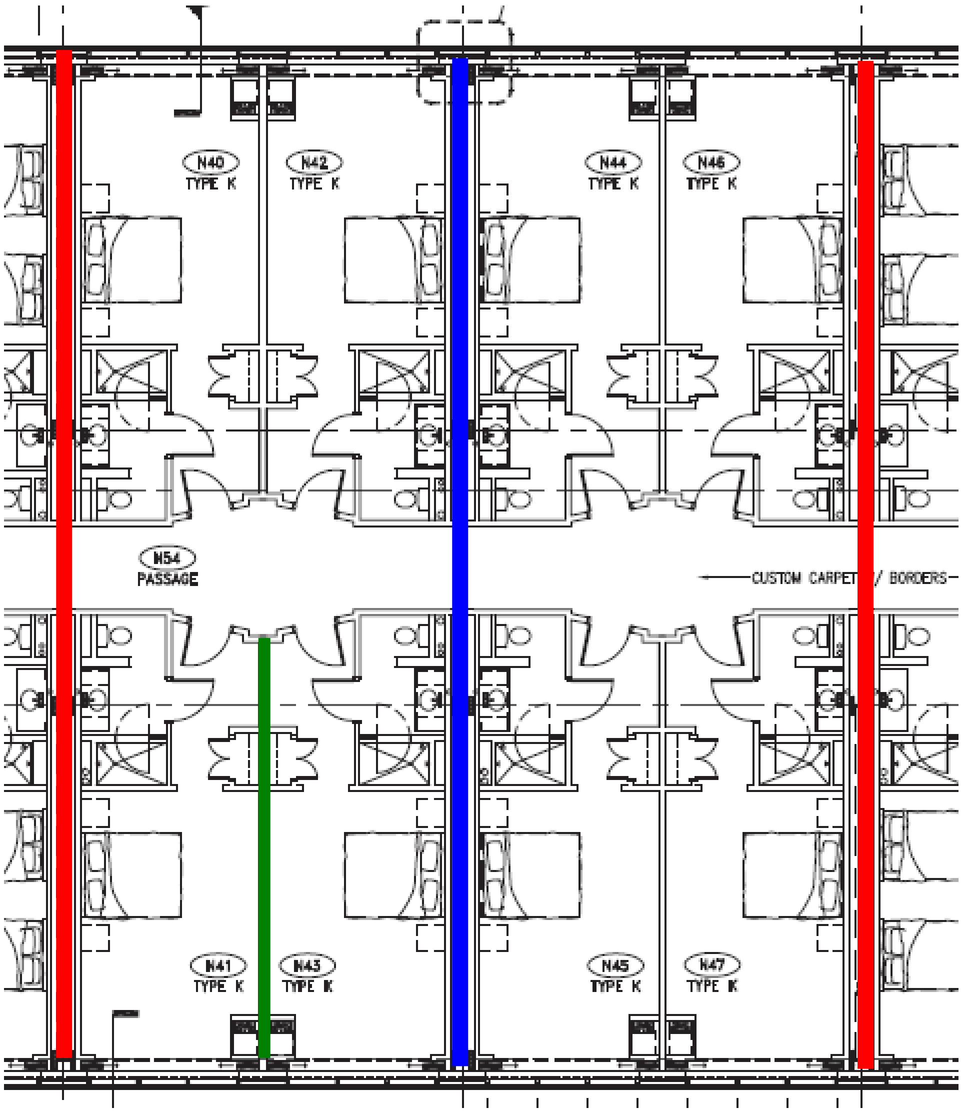


Figure 14 - Typical Bay 4th - 11th floor
Drawings Courtesy of JCJ Architecture

Shown above is an example of a possible truss layout, with the trusses in red on the 4th floor while the truss in blue is on the 5th floor above. With this layout, the floor plans would not be impacted, but once investigation into the best possible truss layout begins, trusses could be required where the room partitions (shown in green) are currently located. This would change the wall thickness between rooms which could result in less floor space and the need to shift room location.

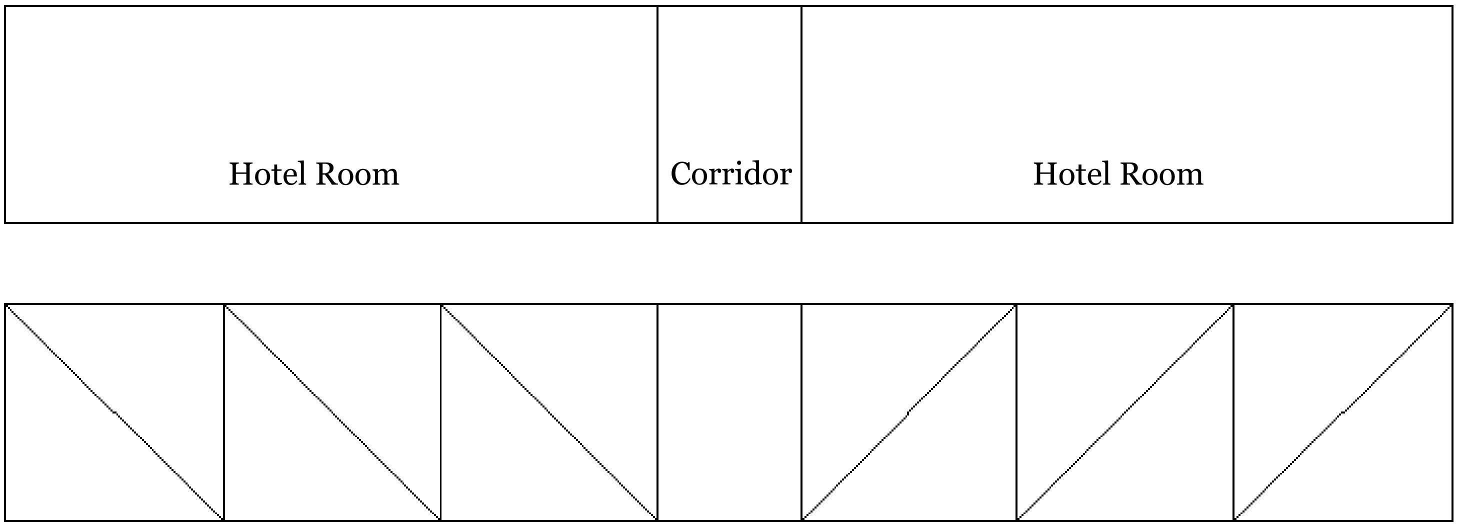


Figure 15 - Ex. N-S Elevation and Vierendeel Truss

The dimensions of the corridor and hotel rooms are repeated from the 4th foor to the 11th floor, allowing for repetitive truss geometry to be used. The interior bay of the truss will line up with the corridor on each floor, while the diagonal members will be hidden within the walls separating the hotel rooms.

Breadth Topic I

Since the staggered truss system requires moving the location of the trusses as they move up the building, the layout of the hotel rooms will be impacted significantly. A common feature of hotels is the inclusion of a connecting door between rooms with a shared wall. The web members of the truss could obstruct these doors in the existing layout of the rooms, so a study of the best location of the trusses and whether or not the hotel rooms will need to be moved around will be conducted. Also, the use of precast planks will impact the ceiling design of the rooms, such as aesthetics, duct runs and exhaust vents and lighting. The first breadth will focus on the architectural impact on the interior spaces.

Breadth Topic II

The ultimate result of using a staggered truss will be to reduce the overall weight of the SAC Hotel while maintaining adequate lateral resistance. The AISC Steel Design Guide 14 on staggered truss design states that a reduced number of columns and precast planks will reduce the foundations. Since the building will potentially weigh less, there will be no need for the large piles in the foundation that currently exist to carry the weight of the interior columns. Thus, a redesign of the foundation will need to be conducted. For the second breadth, a detailed cost analysis and changes in construction schedule for the foundation will be investigated.

Task and Tools

Structural Depth: Staggered Truss

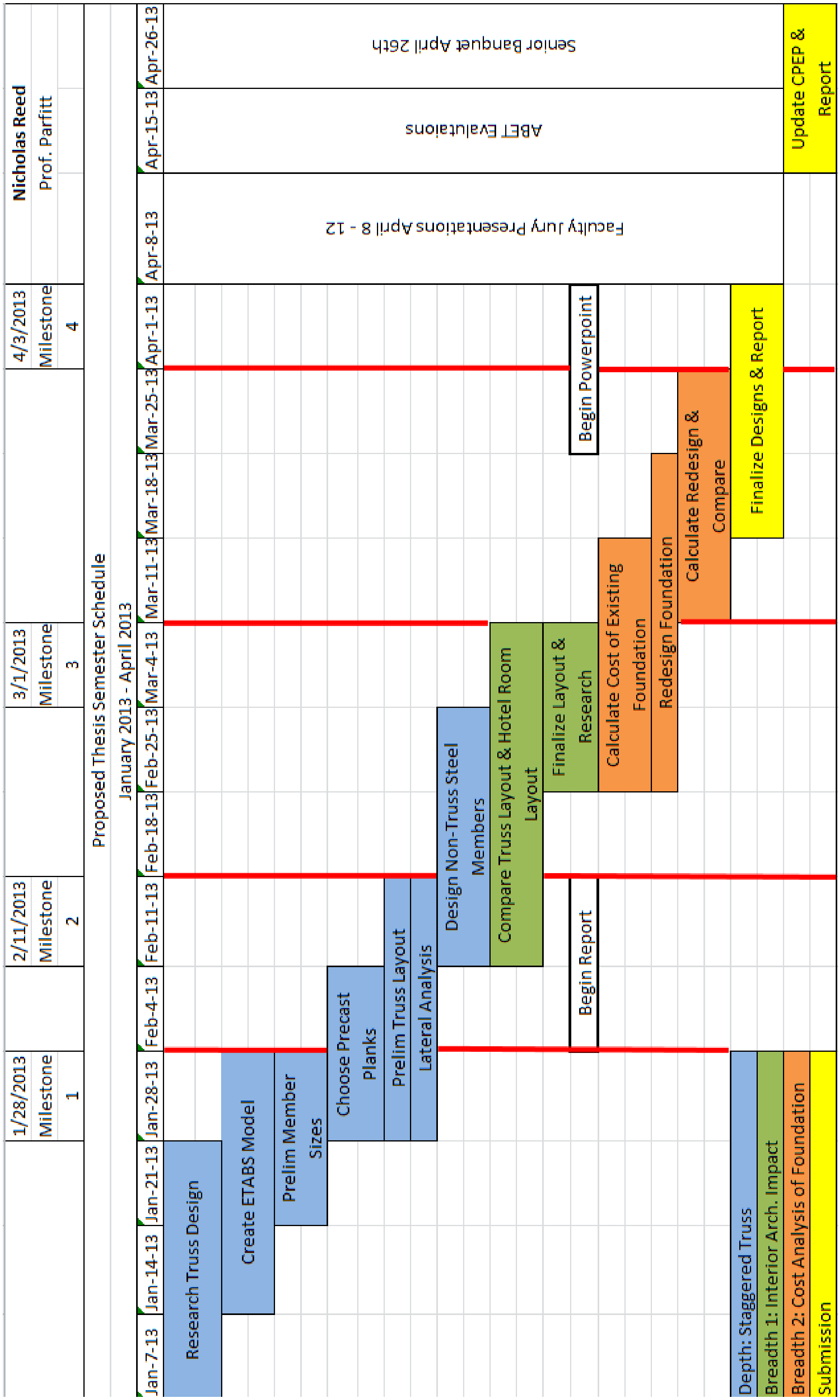
- Develop initial plan of truss locations and layout per floor
- Create computer model in Etabs
- Determine precast plank specs based on existing bay sizes
- Determine required member sizes
- Check loads from planks on trusses and redesign accordingly
- Perform lateral analysis
- Design standard steel framing for sections of hotel that will not be supported by trusses, such as the stairwell at one end of the building, and the lower floor levels
- Redesign foundation for new loads, determine whether piles should be changed to caissons

Breadth I: Architectural Impact (Interior)

- Check initial layout of trusses with room locations
- Determine best truss locations that require the least amount of room layout changes
- Research typical ceiling designs with planks
- Check if changes would be needed for room aesthetics, ventilation or lighting

Breadth II: Cost Analysis of Foundation

- Calculate cost of existing foundation
- Reduce piles according to new building weight, calculate cost
- Compare results
- Determine schedule impacts and costs related to changes in time


Nicholas Reed
Prof. Parfitt
Proposed Thesis Semester Schedule
January 2013 - April 2013
1/28/2013
Milestone
1
2/11/2013
Milestone
2
3/1/2013
Milestone
3
4/3/2013
Milestone
4
Jan-7-13
Jan-14-13
Jan-21-13
Jan-28-13
Feb-4-13
Feb-11-13
Feb-18-13
Feb-25-13
Mar-4-13
Mar-11-13
Mar-18-13
Mar-25-13
Apr-1-13
Apr-8-13
Apr-15-13
Apr-26-13
Research Truss Design
Create ETABS Model
Prelim Member Sizes
Choose Precast Planks
Prelim Truss Layout
Lateral Analysis
Design Non-Truss Steel Members
Compare Truss Layout & Hotel Room Layout
Finalize Layout & Research
Calculate Cost of Existing Foundation
Redesign Foundation
Calculate Redesign & Compare
Finalize Designs & Report
Begin Report
Begin Powerpoint
Faculty Jury Presentations April 8 - 12
ABET Evaluations
Senior Banquet April 26th
Update CPEP & Report
Depth: Staggered Truss
Breadth 1: Interior Arch. Impact
Breadth 2: Cost Analysis of Foundation
Submission

Conclusion

This thesis will focus on redesigning the Seneca Allegany Hotel addition's structural system by way of a staggered truss. Through use of computer modeling and careful planning, the staggered truss will be compared to the existing metal deck on steel framing system to determine whether or not the staggered truss could be a viable alternative. The truss will take the place of interior columns and remove filler beams in an attempt to lighten the overall weight of the building. This will impact the foundations considerably, requiring a redesign to reduce the size and number of the existing steel piles.

A cost analysis of the existing foundation and changes to the foundation will be investigated, as well as the impact on the critical path of the schedule during foundation construction. The results will be compared to determine the best option. After a reasonable layout of trusses is developed, a study of their impact on the interior room layout will be conducted. The use of pre-cast planks will also change the aesthetics of the individual rooms' appearances, which will require a look into lighting fixture and ventilation planning.