ECMC Skilled Nursing Facility

Architectural Engineering Senior Thesis 2011

Class:	AE 481W
Subject:	Thesis Proposal
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Executive Summary

This proposal will present a challenge involving ECMC Skilled Nursing Facility, propose a solution to this challenge, and provide a detailed analysis as well as a broad study of the impact of these changes throughout multiple disciplines. This building is a new 296,000 square foot long-term nursing facility found at the ECMC campus in the heart of Buffalo, NY. The project cost is roughly $95 million, and only steps away from the ECMC, residents can receive the highest level of care. The buildings main framing system consists of composite steel deck on steel framing. The lateral system consists of concentrically braced frames specifically located throughout the building.

Upon review of previous technical reports, it was found that the building holds few structural flaws and challenges to address. Therefore, it was assumed that an identical building was being designed in downtown Los Angeles, where a building within this area is subject to high seismic activity. In the proposed solution, three areas will be studied and analyzed for adequacy: the foundation, the floor system, and the lateral system. Using ASCE 7-10 to obtain design loads, the existing structure will be analyzed to confirm or deny its adequacy in this large seismic zone. Seismic design considerations such as base isolation and dampers will be researched and possibly be incorporated into the building's design if found necessary.

Since the building will be located in the more semi-arid environment of Los Angeles, CA, an in-depth study will be conducted on the mechanical system to test its performance in this new location. If deemed inefficient, a new design or an upgrade in output will be necessary to achieve specific mechanical specifications. Additionally, any changes in these new designs must also consider cost and schedule considerations. An impact study on the cost and schedule of the project will be performed to help determine the feasibility of specific systems and ultimately influence the design.

Introduction

The new ECMC Skilled Nursing Facility serves as a long term medical care center for citizens found throughout the region. The building is located on the ECMC campus found at 462 Grider Street in Buffalo, NY. This site was chosen to bring residents closer to their families living in the heart of Buffalo. As you can see here in Figure 1, the site sits right off the Kensington Expressway, providing ease of access to commuters visiting the ECMC Skilled Nursing Facility. Since the Erie County Medical Center is found within close proximity of the new building, residents can receive fast and effective care in an event of emergency.

Figure 1: Aerial view of ECMC Skilled Nursing Facility site shown in white. Photo courtesy of Bing Maps.

The new facility is the largest of four new structures being built on the ECMC campus located in central Buffalo, NY. The new campus will also contain a new Renal Dialysis Center, Bone Center, and parking garage. Each of the three new facilities will be connected to the main medical center via an axial corridor, which provides enclosed access to emergency rooms, operation rooms, and other facilities found within the Erie County Medical Center.

Architectural Overview

The new Erie County Medical Center Skilled Nursing Facility is a five-story 296,489 square-foot building offering long-term medical care for citizens in the region. The facility consists of an eight-wing design with a central core. The main entrance to the building is located to the east and is sheltered from the elements by a large porte-cochere. There is a penthouse level that contains the facility's mechanical and HVAC units. Each floor features one garden terrace, providing an outdoor space accessible to both residents and staff. The exterior of the building is clad in brick, stone veneers, composite metal panels, and spandrel glass curtain wall system.

Figure 2: Exterior view of stacked garden terraces, green wall, and the building's vertical and horizontal shading panels. Rendering courtesy of Cannon Design.

The facility also incorporates green building into many of its elegant features. The composite metal panels that run vertically and horizontally across each wing of the building, visible in Figure 2, provide solar shading along with architectural accent. A green wall is featured on each outdoor garden terrace, providing residence with a sense of nature and greenery. The ECMC Skilled Nursing Facility provides an eclectic, modern atmosphere and quality care for long-term care patients found within the Buffalo area.

Structural Systems Overview

The ECMC Skilled Nursing Facility consists of 8 wings and a central core, with an overall building footprint of about 50,000 square feet. The building sits at a maximum height of 90' above grade with a common floor to floor height of 13'-4". The ECMC Skilled Nursing Facility mainly consists of steel framing with a 5" concrete slab on grade on the ground floor. The Penthouse level contains 6.5" thick normal weight concrete slab on metal deck. All other floors have a 5.25" thick lightweight concrete on metal deck floor system. All concrete is cast-in-place.

Foundation System

The geotechnical report was conducted by Empire Geo Services, Inc. The study classified the soils using the Unified Soil Classification System, and found that the indigenous soils consisted mainly of reddish brown and brown sandy silt, sandy clayey silt, and silty sand. The ECMC Skilled Nursing Facility foundations sit primarily on limestone bedrock, although in some areas the foundation does sit on structural fill. Depths of limestone bedrock range from 2ft to 12ft. The building foundations of the ECMC Skilled Nursing Facility are comprised of spread footings and concrete piers with a maximum bearing capacity of 5,000 psf for footings on structural fill and 16,000 psf for footings on limestone bedrock. Concrete piers range in size from 22" to 40" square.

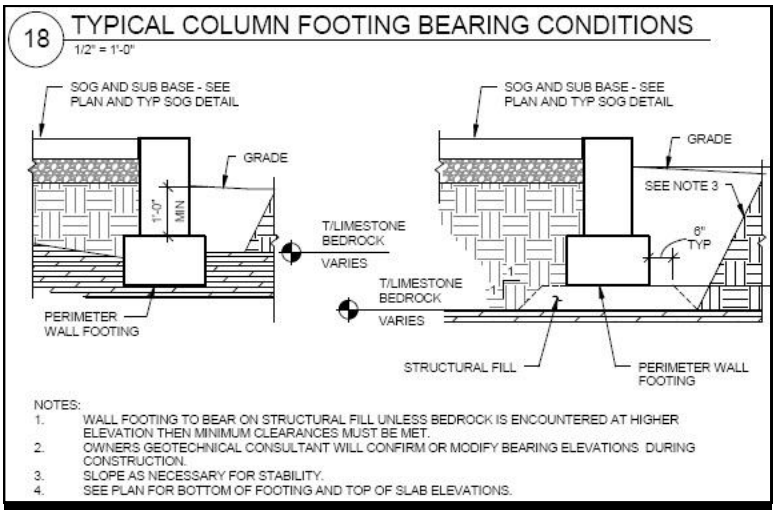


Figure 3: Footing bearing conditions. On bedrock (left detail), and on Structural Fill (right detail). Detail courtesy of Cannon Design.

Floor System

The floor system on all floors except at the penthouse level consists of a 5.25" thick lightweight concrete floor slab on 2" - 20 gage metal decking, creating a one-way composite floor slab system. The concrete topping contains 24 pounds per cubic yard of blended fiber reinforcement. Steel decking is placed continuous over three or more spans except where framing does not permit. Shear studs are welded to the steel framing system in accordance to required specification. Refer to Figures 4 and 5 for composite system details.

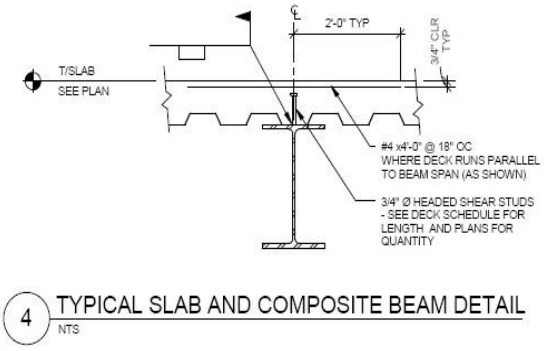


Figure 4: Composite deck system (parallel edge condition). Detail courtesy of Cannon Design.

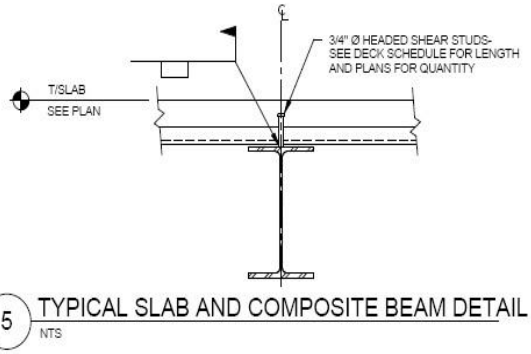


Figure 5: Composite deck system (perpendicular edge condition). Detail courtesy of Cannon Design.

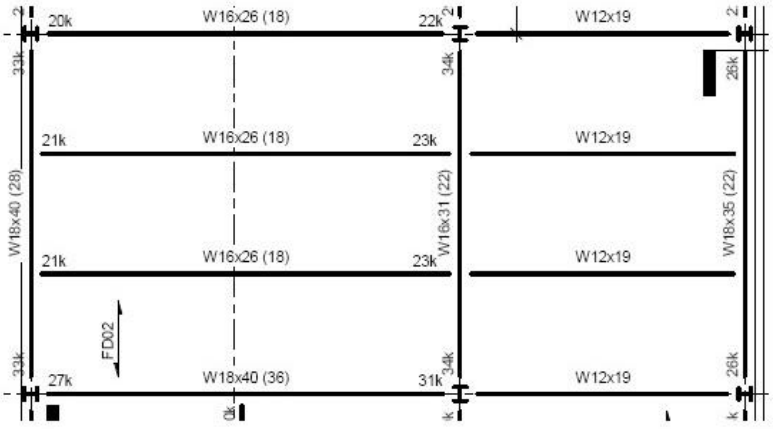


Figure 6: Typical bay layout for building wing. Detail courtesy of Cannon Design.

Framing System

The structural framing system is primarily composed of W10 columns and W12 and W16 beams; however the girders vary in sizes ranging from W14 to W24, mainly depending on the size of the span and applied loads on the girder. Typical beam spacing varies from 6'-8"o.c. to 8'-8"o.c. Figure 6 shows a typical grid layout for a building wing. Columns are spliced at 4' above the 2nd and 4th floor levels, and typically span between 26'-8" and 33'-4".

Lateral System

The lateral resisting system consists of a concentrically brace frame system composed of shear connections with HSS cross bracing. Lateral HSS bracing is predominantly located at the end of each wing, and also found surrounding the central building core. Because of the radial shape of the building and symmetrical layout of the structure, the brace framing can oppose seismic and wind forces from any angle. The HSS bracing size is mainly HSS 6x6x3/8, but can increase in size up to HSS 7x7x1/2 in some ground floor areas for additional lateral strength. Figure 7 contains multiple details and an elevation of a typical brace frame for the ECMC Skilled Nursing Facility.

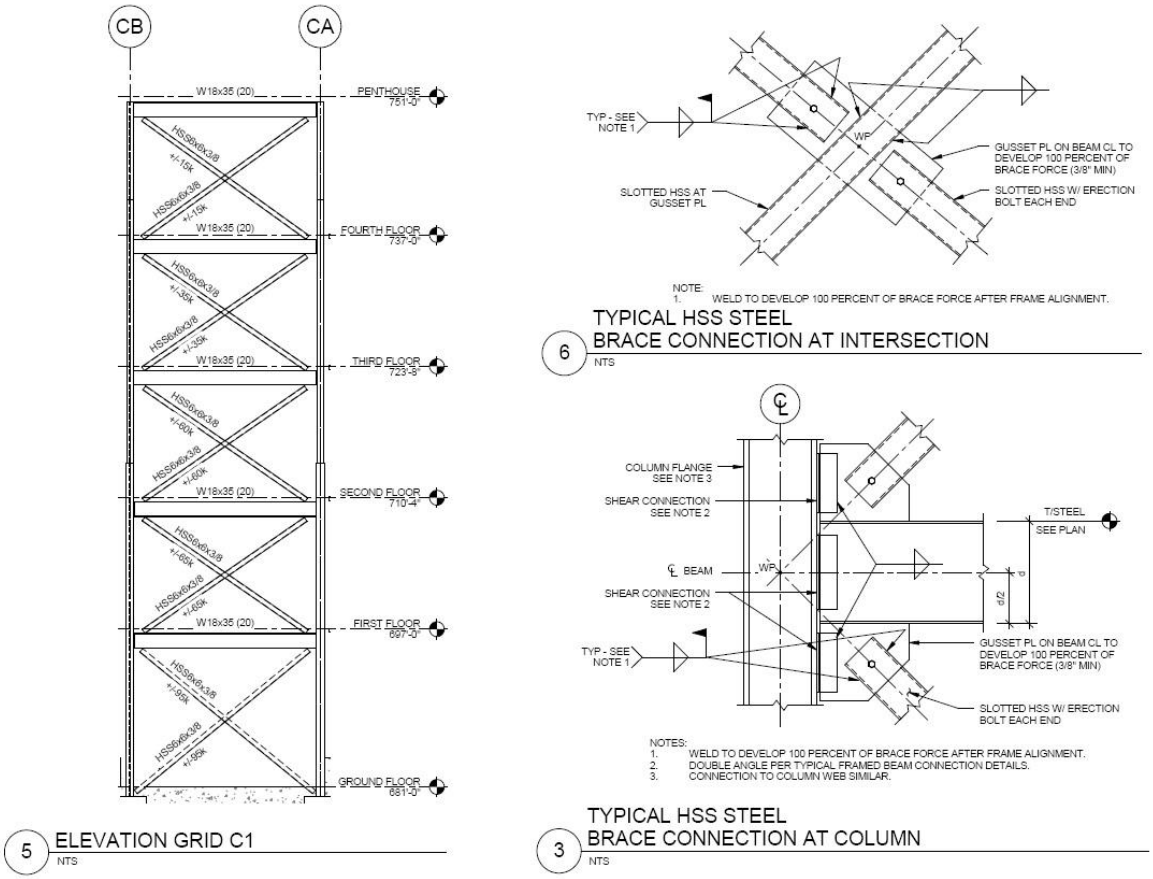


Figure 7: Typical lateral HSS brace frame (left). Typical HSS steel brace connection at intersection (upper right). Typical HSS steel brace connection at column (lower right). Details courtesy of Cannon Design.

Proposal

Proposed Structural Depth

The original structural system for the ECMC Skilled Nursing Facility consists of composite steel framing tied into metal decking using shear studs and concentrically braced frames used to resist lateral forces. After analysis of the building's lateral system and structural framework, it was found that the ECMC Skilled Nursing Facility met all code requirements and industry standards. Furthermore, wind loading was the predominant case for lateral loading on the building.

For this thesis, the design for the ECMC Skilled Nursing Facility will be evaluated in a different location, specifically in Los Angeles, CA where seismic activity will predominate lateral loads. The buildings existing structural system and foundations will be analyzed and compared to other possible alternatives, and the best possible solution will be chosen for design in this different location. The specific systems that would be under further investigation for possible re-design will include the building's soil and foundation system, floor system, and lateral system.

Soils found in Los Angeles, CA will be classified and checked for adequate strength or other possible failure modes such as soil liquefaction. Additionally, the existing foundation system will be analyzed for its adequacy in this new location. Other possible systems will be researched and may be a possible solution if the existing foundation proves inadequate. Also, some research will be conducted on base isolation techniques between the foundation and the structural framework. The use of bearings or springs to dampen seismic effects on the foundation may pose as a useful component in the foundation system.

The building's existing floor system will be evaluated and compared to other possible systems that may benefit in a high seismic zone. Specifically, a floor system with the least amount of mass and weight would benefit greatly and most likely be selected for re-design at this location since it will help reduce the story shear forces produced during an earthquake. In addition, research on building pendulums and dampers may be included as a possibility to incorporate into the re-design.

The lateral system will also be under investigation and compared against other possible systems to find which one would be most adequate to resist the story shear forces caused by seismic activity. The system most likely chosen would be based on its resistance to the story shear forces that are transferred through the floor systems at each story.

Breadth Options

Breadth Study One: *Analysis / Re-design of Mechanical System*

Upon changing the location of the ECMC Skilled Nursing Facility, the thermal impact on the building will change greatly since the climate is significantly different. At its current location in Buffalo, NY, the building experiences lake effect snow in the winter months and a moderate climate in the summer. Los Angeles, CA rarely experiences any snowfall and its average temperatures are significantly higher than in Buffalo, NY throughout the year. Considering these effects, the existing mechanical system will be evaluated and checked against figures for this new location. If the existing system is proven inadequate, a possible re-design of the mechanical system will be made to meet industry standards.

Breadth Study Two: *In-Depth Cost and Schedule Analysis of Depth*

This breadth analysis will be made in connection with the structural depth. Any proposed changes to the foundation system, floor system, or lateral system will have an impact on the project's cost and schedule. In addition, availability of materials and possible labor costs are also important factors to consider. Once the analysis of the cost and schedule changes are considered, these proposed changes to the ECMC Skilled Nursing Facility will be evaluated for feasibility.

Breadth Study Alternative: *Re-design of Building Facade*

The existing facade for the ECMC Skilled Nursing Facility consists mainly of a brick cavity wall with some architectural stone detailing. Since masonry may not perform well in a high seismic zone, another alternative facade system will be investigated and chosen for re-design of the facade system. This change in the facade system will be based on its structural performance, architectural consideration, cost, installation, and thermal properties for this new location.

Required Tasks

Listed below are multiple tasks that must be completed during the research and development of my proposal as well as the tools associated to complete these tasks.

For the Proposal

Task 1

- Analyze and classify soils for Los Angeles, CA.
- Analyze existing foundation system in the building.

Task 2

- Research alternative foundation systems for the building.
- Compare / contrast existing foundation against possible alternatives.
- Research base isolation techniques for seismic foundations.
- Design an adequate foundation for the building at this new location.

Task 3

- Determine story weights for the existing floor system.
- Research and analyze alternative floor systems based on story weight.

Task 4

- Compare / contrast existing story weights against alternative systems.
- Select and design least massive system and compute seismic story shears for that system.
- Determine base shear and analyze its effects on the re-designed foundation.
- Research the incorporation / need for building dampers or pendulums.

Task 5

- Using story and base shears, analyze the adequacy of the existing lateral system.
- Research and analyze other alternative lateral systems.
- Select and design best possible solution for the lateral system.
- Research any types of lateral system solutions / components that can enhance the building's performance against seismic events.

For the Breadths

Breadth #1

Task 1

- Determine thermal load on the building at this new location.

Task 2

- Analyze the existing mechanical system and determine its adequacy.
- If inadequate, re-design the mechanical system to meet industry standards.

Breadth #2

Task 1

- Use RS Means to obtain a preliminary cost and schedule for the re-design involved in the depth.
- Consult with general contractor for a detailed cost and schedule of the existing design.

Task 2

- Compare / contrast re-design against existing cost and schedule.

Breadth #2 (Alternative)

Task 1

- Research masonry performance against seismic activity.
- Research alternative facade systems.
- Research local architecture (in Los Angeles, CA).

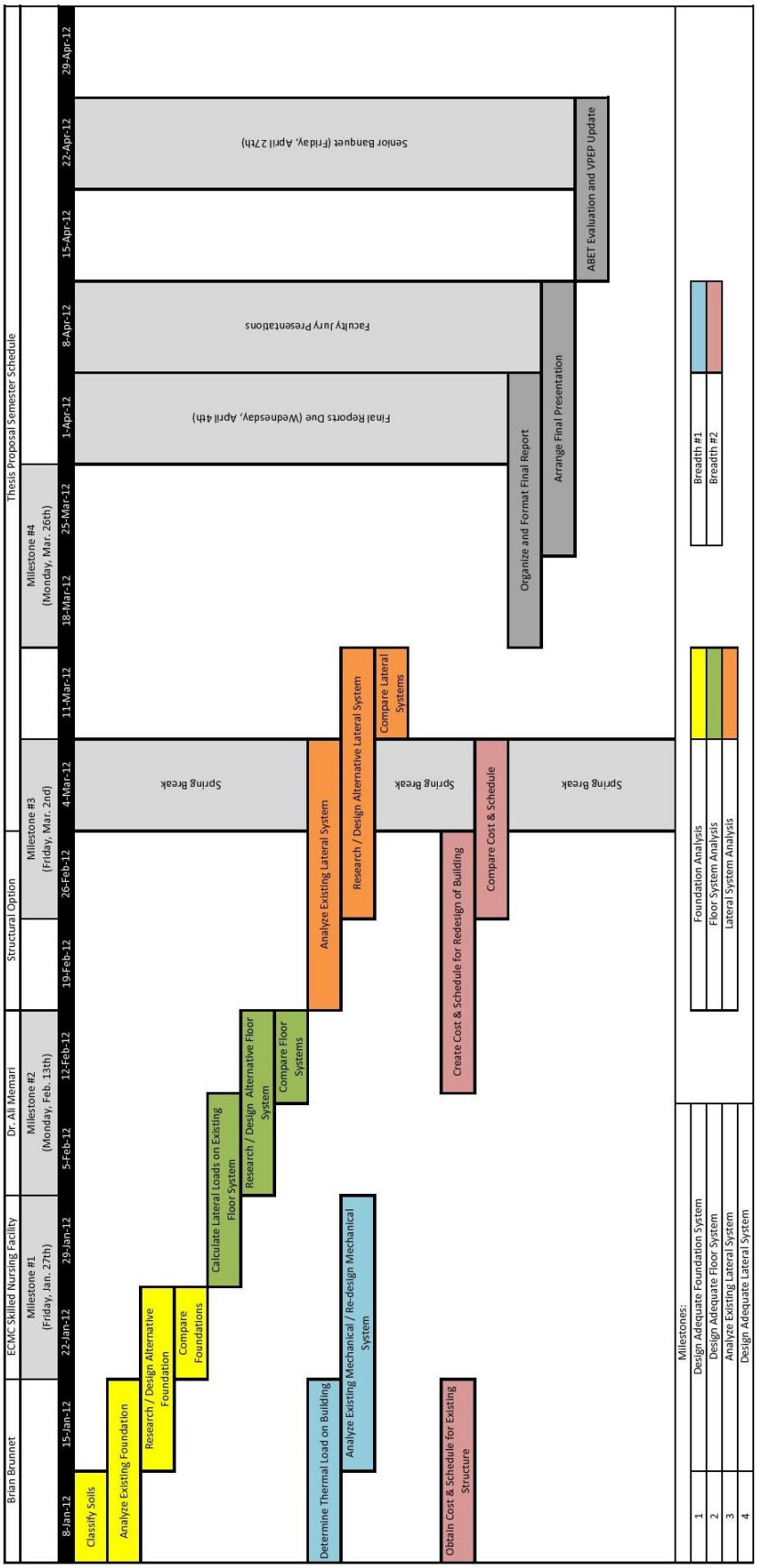
Task 2

- Design an alternative facade system for the building.
- Perform cost estimate and schedule for this system.

Task 3

- Perform cost estimate and schedule for existing facade system.
- Compare and contrast the two different facade systems.

Schedule


Thesis Proposal Semester Schedule
Brian Brunnet
ECMC Skilled Nursing Facility
Dr. Ali Memari
Structural Option
Milestone #1 (Friday, Jan. 27th)
Milestone #2 (Monday, Feb. 13th)
Milestone #3 (Friday, Mar. 2nd)
Milestone #4 (Monday, Mar. 26th)
8-Jan-12
15-Jan-12
22-Jan-12
29-Jan-12
5-Feb-12
12-Feb-12
19-Feb-12
26-Feb-12
4-Mar-12
11-Mar-12
18-Mar-12
25-Mar-12
1-Apr-12
8-Apr-12
15-Apr-12
22-Apr-12
29-Apr-12
Classify Soils
Analyze Existing Foundation
Research / Design Alternative Foundation
Compare Foundations
Calculate Lateral Loads on Existing Floor System
Research / Design Alternative Floor System
Compare Floor Systems
Determine Thermal Load on Building
Analyze Existing Mechanical / Re-design Mechanical System
Analyze Existing Lateral System
Research / Design Alternative Lateral System
Compare Lateral Systems
Obtain Cost & Schedule for Existing Structure
Create Cost & Schedule for Redesign of Building
Compare Cost & Schedule
Spring Break
Spring Break
Spring Break
Organize and Format Final Report
Arrange Final Presentation
Final Reports Due (Wednesday, April 4th)
Faculty Jury Presentations
Senior Banquet (Friday, April 27th)
ABET Evaluation and VPEP Update
Breadth #1
Breadth #2
Foundation Analysis
Floor System Analysis
Lateral System Analysis
Milestones:
1 Design Adequate Foundation System
2 Design Adequate Floor System
3 Analyze Existing Lateral System
4 Design Adequate Lateral System

Conclusion

In conclusion, the proposed redesign of the ECMC Skilled Nursing Facility will mainly focus on the adequacy and performance of the existing structural system in this new location. In addition, other aspects of design such as impacts on the mechanical system, construction costs, and project schedule will be studied and redesigned. After proper verification that the original design possesses minor flaws as well as the control of wind loads on the structure, it was assumed that an identical building was proposed to be designed in the Los Angeles, CA area where it will mainly be subject to high seismic activity and loading. The proposal will focus on three main aspects: the foundation, the floor system, and the lateral system.

An in-depth breadth study of the mechanical system at this new location will be made to verify the systems adequacy. Los Angeles, CA presents a warmer climate, which will produce a significantly different effect on the design and components incorporated in the mechanical system. If the system is found to be inadequate, a new system will be researched and designed for the building at this new location.

Additionally, with any changes on the building at this new location, a detailed cost and schedule analysis will need to be performed. This construction breadth will investigate the adequacy of current systems when considering material availability and shipment costs. This study will also help compare any of these changes and determine the feasibility of systems when considering the impacts on the project cost or schedule.