THESIS PROPOSAL

Aubert Ndjolba | Structural Option

PENN COLLEGE OF TECHNOLOGY

Faculty advisor: Dr. Boothby

Date: 12/09/11

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EXECUTIVE SUMMARY

The Dauphin Hall (DH), located in Williamsport, Pennsylvania, is 70 feet high, 196 feet wide and 362 feet long. This 4 story student housing, completed in August, 2010, has a gravity system consisting of lightweight concrete on metal deck and Concrete Masonry Unit (CMU) walls. The metal deck rests on k-series steel joists. The lateral resisting system of the DH consists of moment connections in both the East-West and North-South direction.

The focus of this report is to alter the lateral resisting systems of the DH. The proposed lateral system will utilize concentric braced frames and will be compared to the existing wind moment frames. The two configurations which will be studied are:

- X bracing
- Chevron bracing

The optimal configuration will be determined based on frame stiffness, lateral movement, and both the direct and torsional shear.

In addition to this structural depth, two non-structural breadths will be undertaken. A cost and schedule analysis will be used to compare the effect of the alternate lateral system to the original design in terms of time and economy. Also, an architectural breadth will be undertaken to investigate the effects of the concentric braced frames on the exterior facades and interior layout of the rooms throughout the structure.

To complete the above tasks, a four milestone schedule was created to ensure work will be completed by the deadline.

BUILDING INTRODUCTION

The Pennsylvania College of Technology is located in the 200 block of Rose Street in Williamsport, PA. Dauphin Hall, the newest dormitory on campus, is constructed in August 2010 by Murray Associates Architects, P.C in collaboration with IMC as the general contractor; Woodburn & Associates, INC as the food service designer; Whitney, Bailey, Cox & Magnani, LLC as the civil engineering firm; and Gatter & Diehl, INC as the MEP firm. This new structure costs approximately $ 26,000,000 and was delivered using the design-bid-build project delivery method.

At approximately 123,676 GSF, this latest addition to the student housing, provides 268 students with suites and single rooms. A 40-50 student seating commons enclosed with glass provides a social space for student collaboration. Located within the dormitory are other amenities such as: a 460 seat dining room, two private dining rooms for faculties, a 40 station satellite fitness center, two large leisure rooms, a student grocery store, laundry facilities, student mail boxes, Resident Life Offices, campus police office, and a Hall Coordinator apartment.

Figure 2: South facade

Figure 3: South facade

STRUCTURAL OVERVIEW

The structure of the DH is a combination of shallow foundation and stone piers, and composite steel decking with steel framing. The exterior and interior walls are composed primarily of brick and concrete masonry.

FOUNDATIONS

CMT Laboratories, Inc, performed several test borings of the DH. According to their analysis for this site, the geotechnical engineers have determined that the site was filled with brown silty clay, and brown silty sand with gravel. Furthermore, it was found that the cohesive alluvial soils beneath the fill materials have low shear strength.

In light of these conditions, the conventional spread/column and continuous footing foundations will not provide adequate bearing capacity to support the building. Deep foundations such as concrete filled tapered piles could support the structure but are not the most economical approach. Therefore, a practical solution is subsurface improvement with the use of shallow foundation.

Lastly, the final decision was to use stone piers which were considered the most technically sound and economically feasible method. Those stone piers are typically eighteen (18) to thirty-six (36) inches in diameter depending on their loading and settlement criteria.

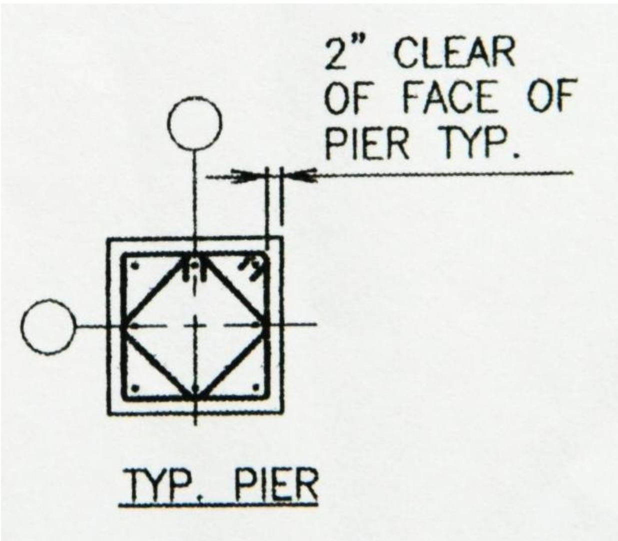


Figure 4: Typical Pier Detail

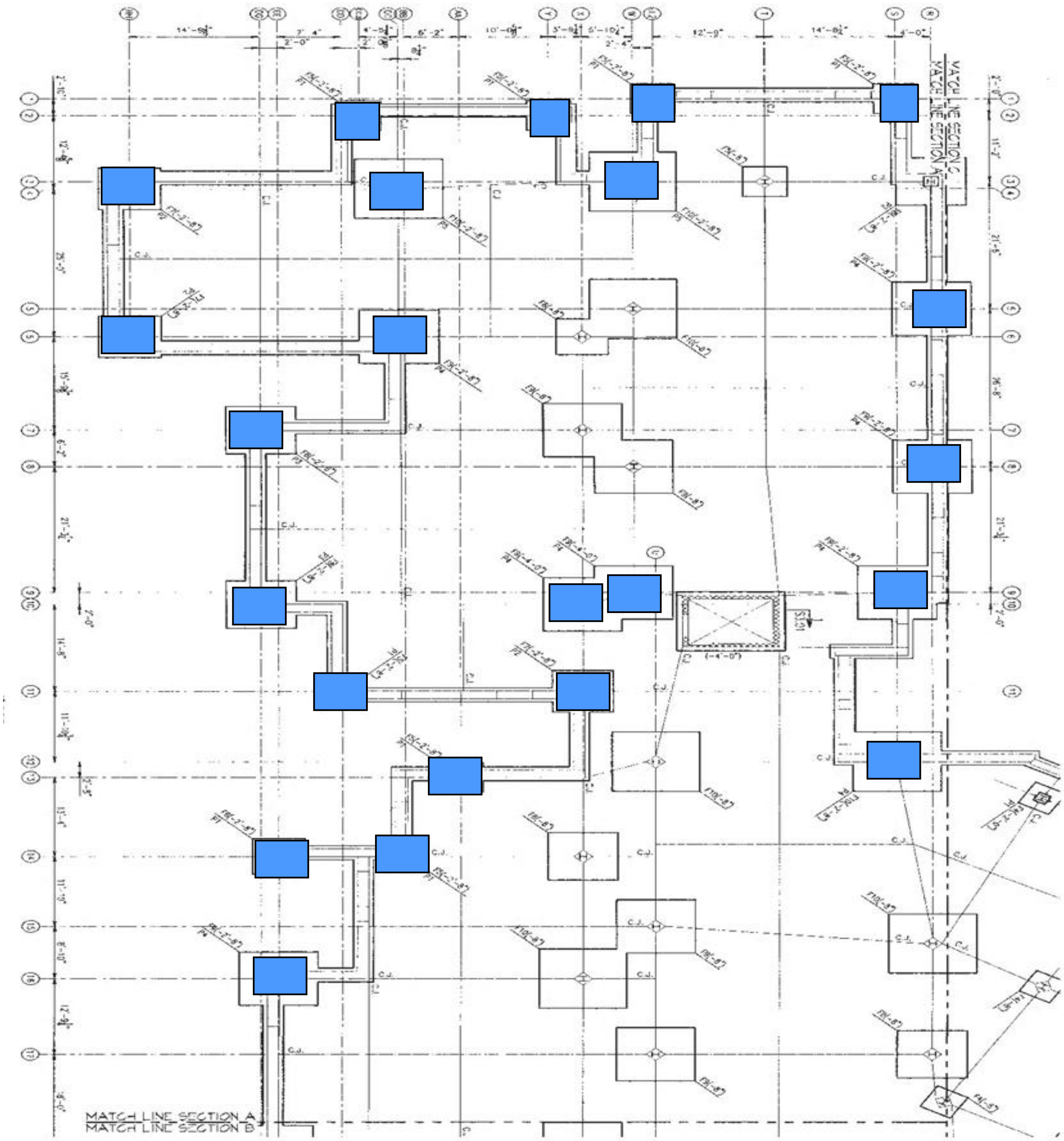


Figure 5: Stone Pier locations

N

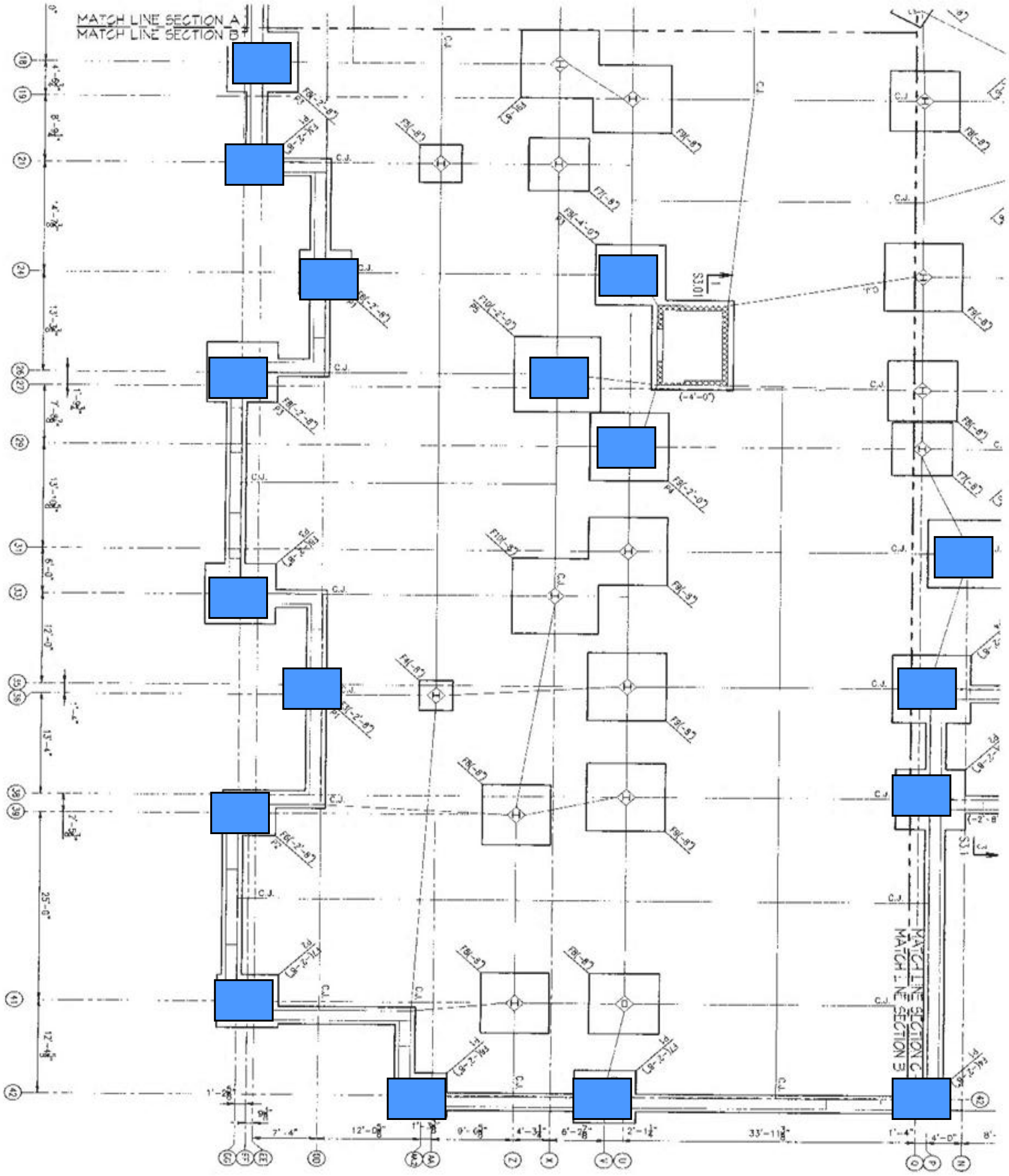
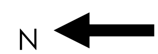


Figure 6: Stone Pier locations



FLOOR SYSTEMS

The floor system of the DH is composed of 4” Light weight concrete slab, reinforced with 6”×6” –W2.9×W2.9 welded wire mesh, on 1 ½” - 20 gage Vulcraft composite deck. The joists, supporting the floor system, are spaced equally in column bays with a maximum spacing of 2’-0” O.C in areas of floor framing.

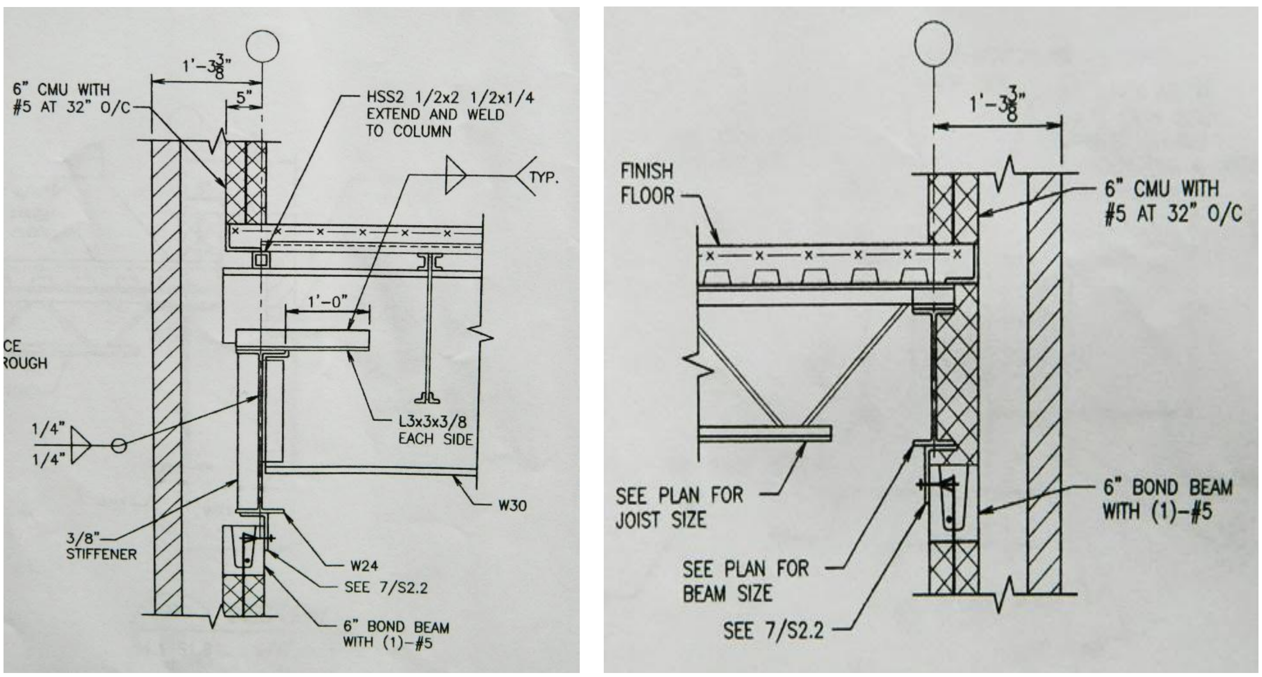


Figure 7: Typical Floor Section showing beam and columns relationship

FRAMING SYSTEM

The superstructure of the DH is primarily a combination of K-series joists, W24 girders, steel columns raging in size from W8's to W10's, and light gage metal framing. The K-series joists are spaced 2'-0" on O.C. The columns are typically on a 25'x30' grid and encased by 5/8" Gypsum board or 6" painted CMU. HSS columns were used in locations near the stairwells. Interior partitions consist of Concrete Masonry Units (CMU).

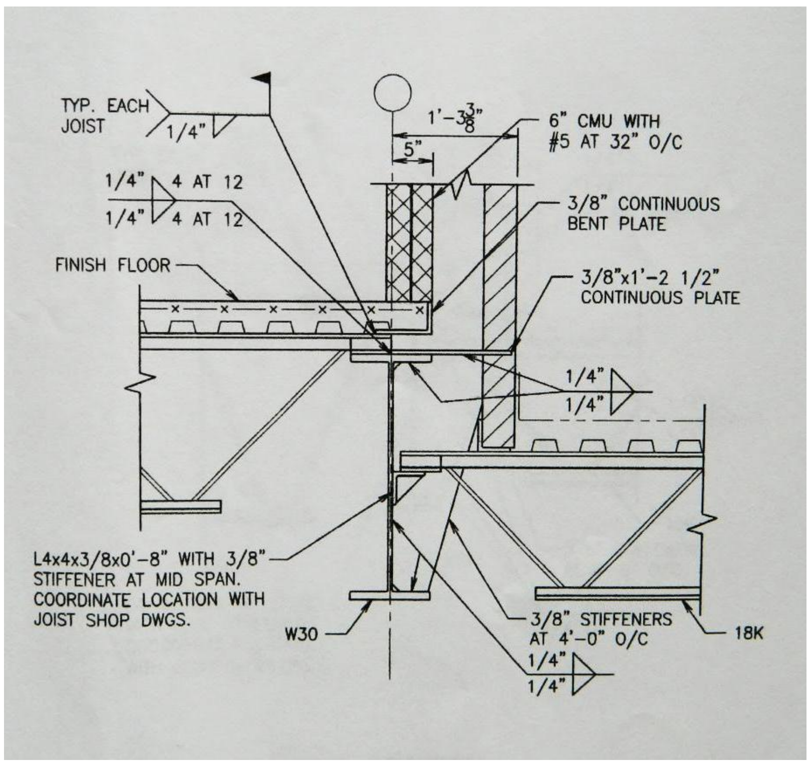


Figure 8: Joists and beam interaction

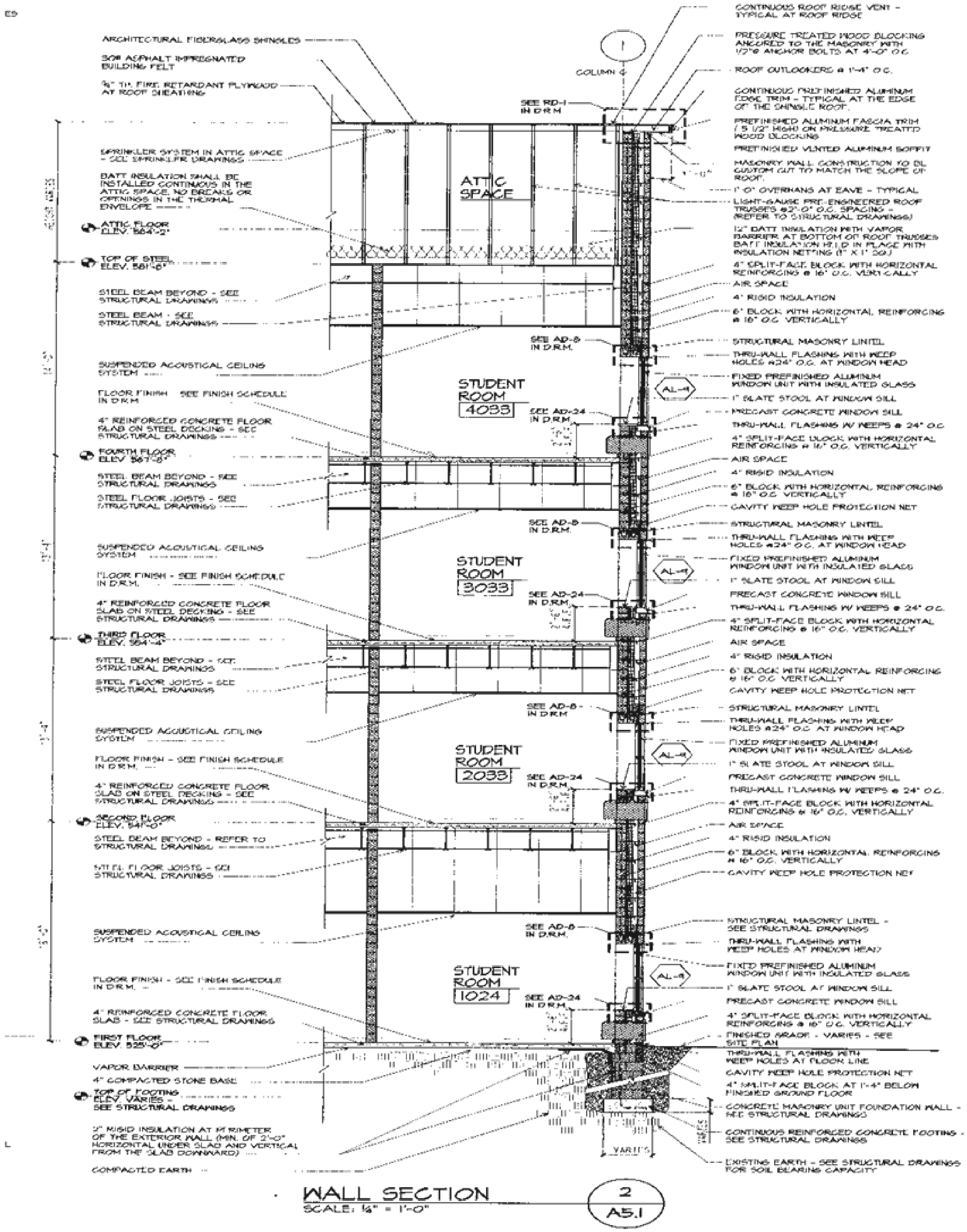


Figure 9: Wall Section

LATERAL SYSTEM

The lateral resisting system in the DH consists of steel moment connections in both the East-West direction and the North-South direction. The lateral resisting connections can be seen in figure 10 below.

The building façade collects wind forces that are then transferred to the respective floor diaphragm. These forces then travel through the diaphragm until the moment connections are engaged. The remaining of the technical report will discuss the lateral system in more detail.

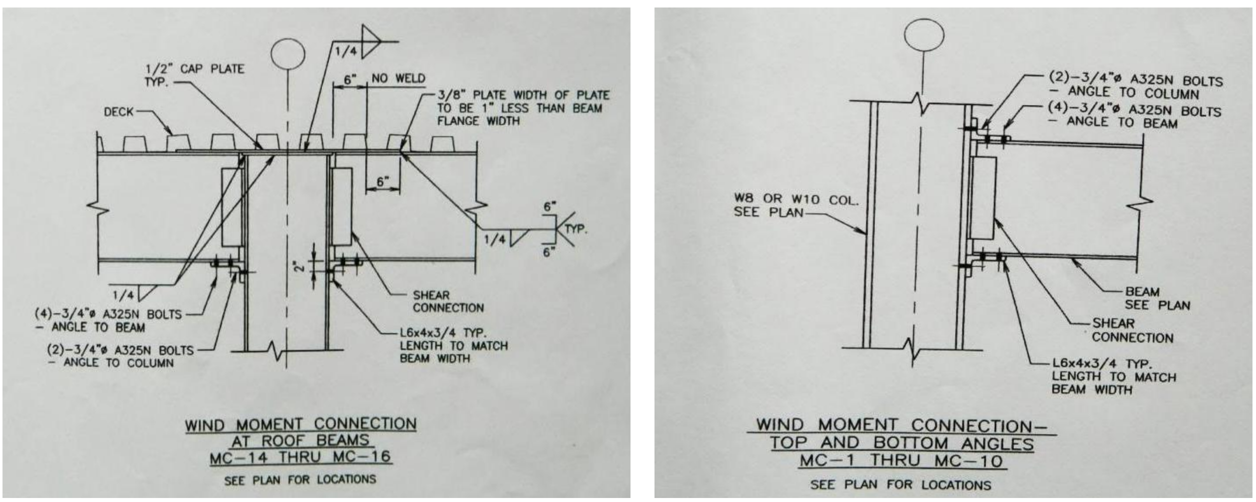


Figure 10: Moment Connections

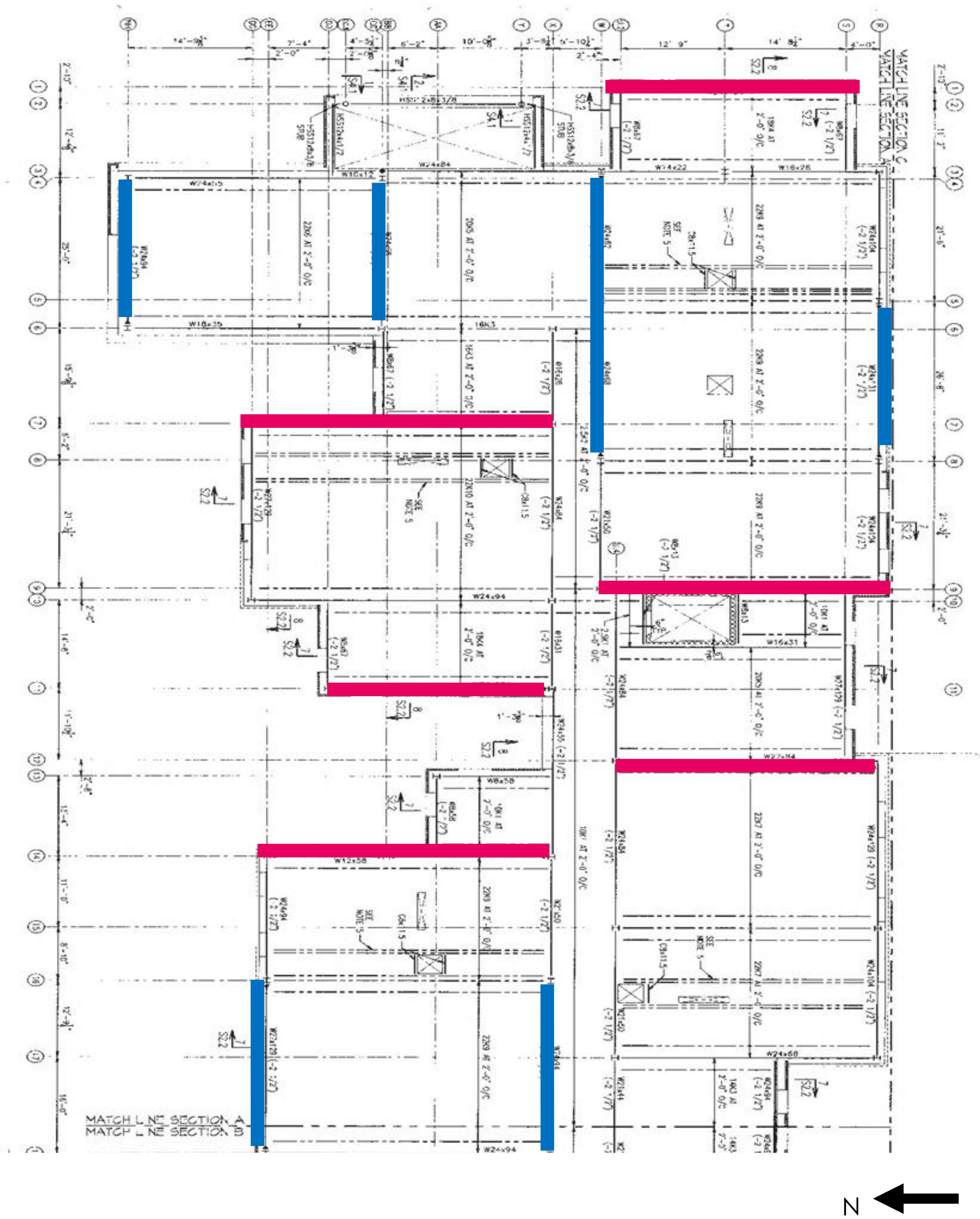


Figure 11: Moment Connections Location on the Building

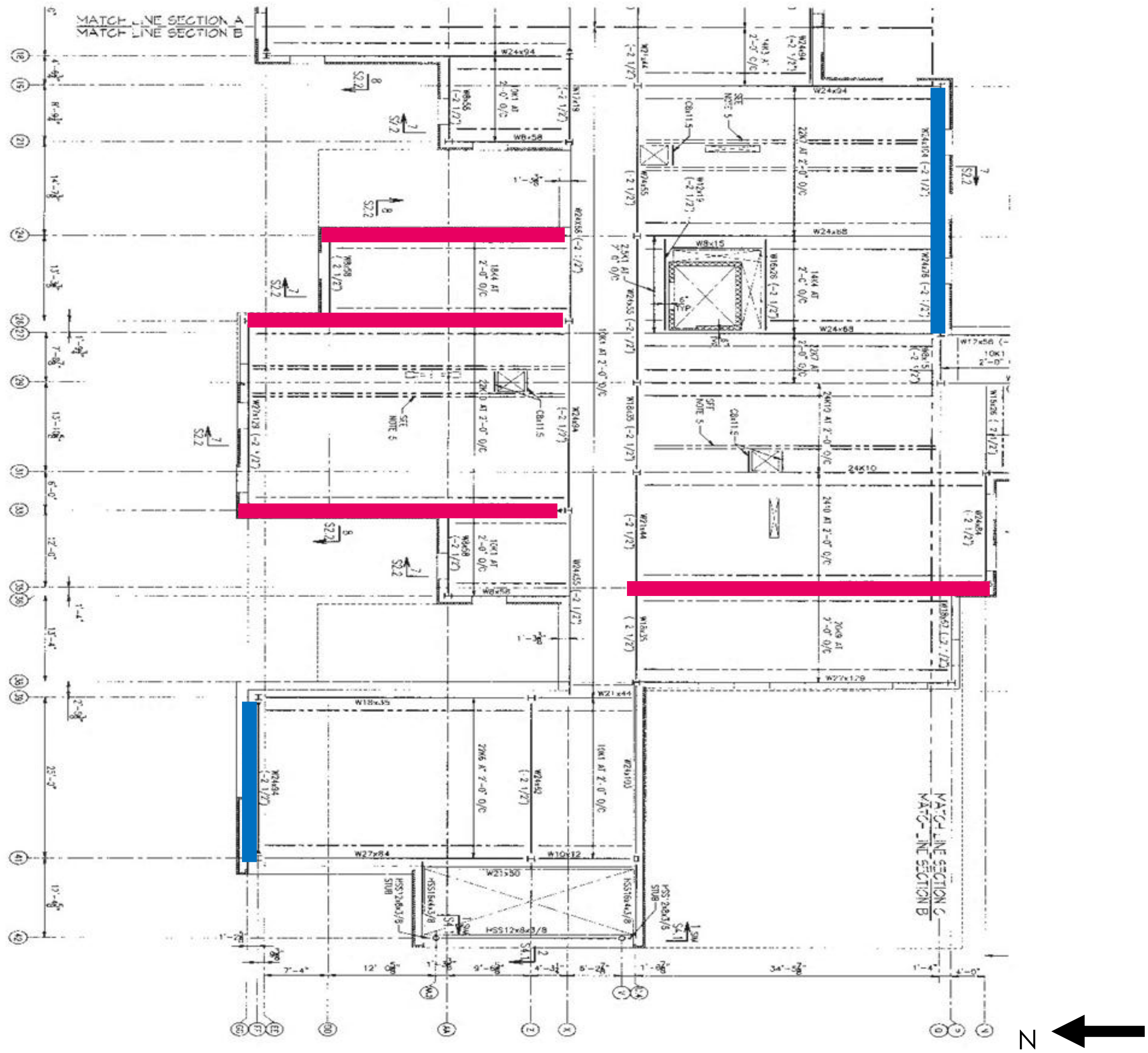


Figure 12: Moment Connections Location on the Building

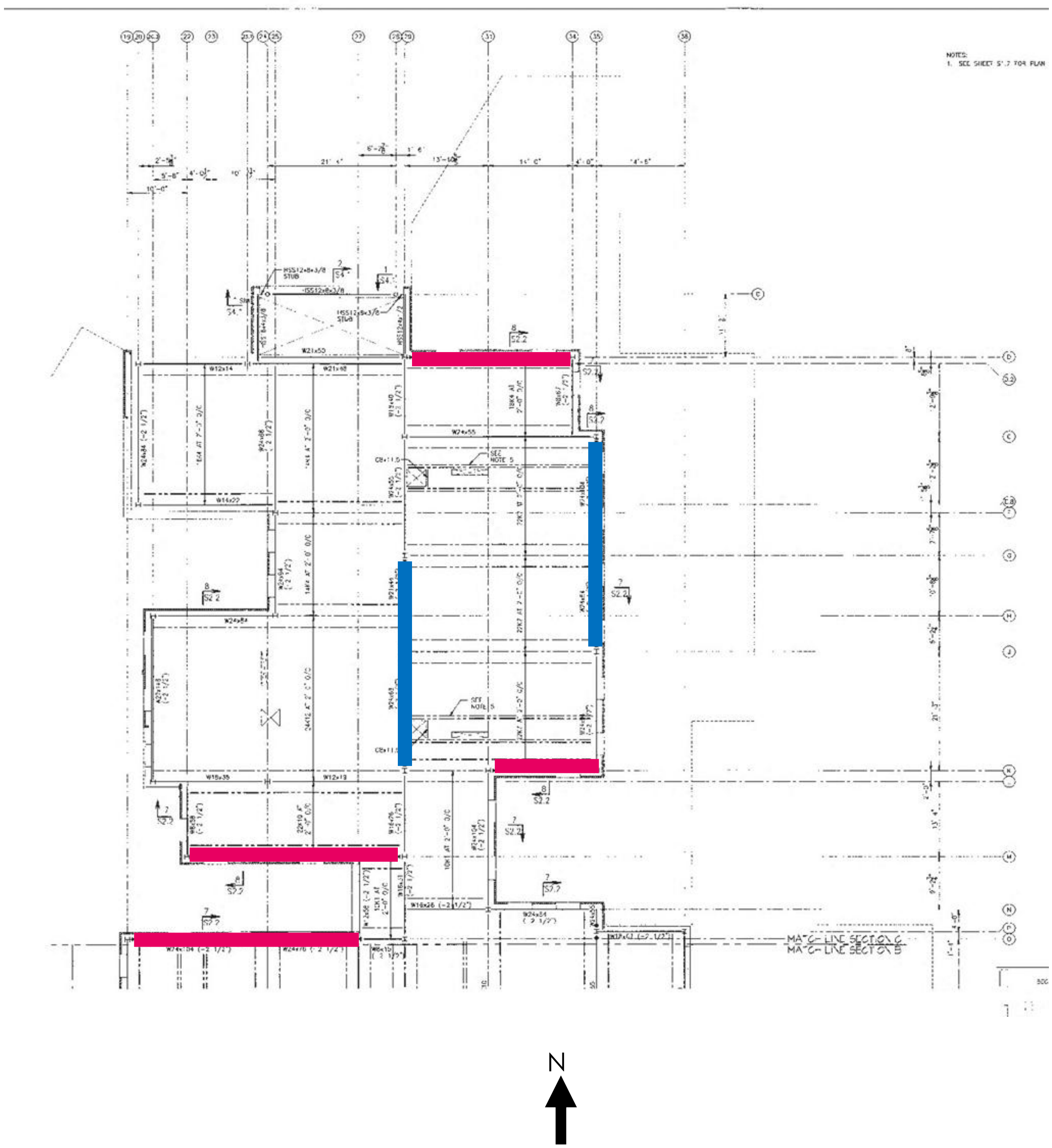


Figure 13: Moment Connections Location on the Building

ROOF SYSTEMS

There is only one roof system on the DH dormitory. It consists of 1 1/2" – 20 gage type B roof deck. The roof deck is then supported by joists spaced at a maximum distance of 4'-0" O.C. between the column bays.

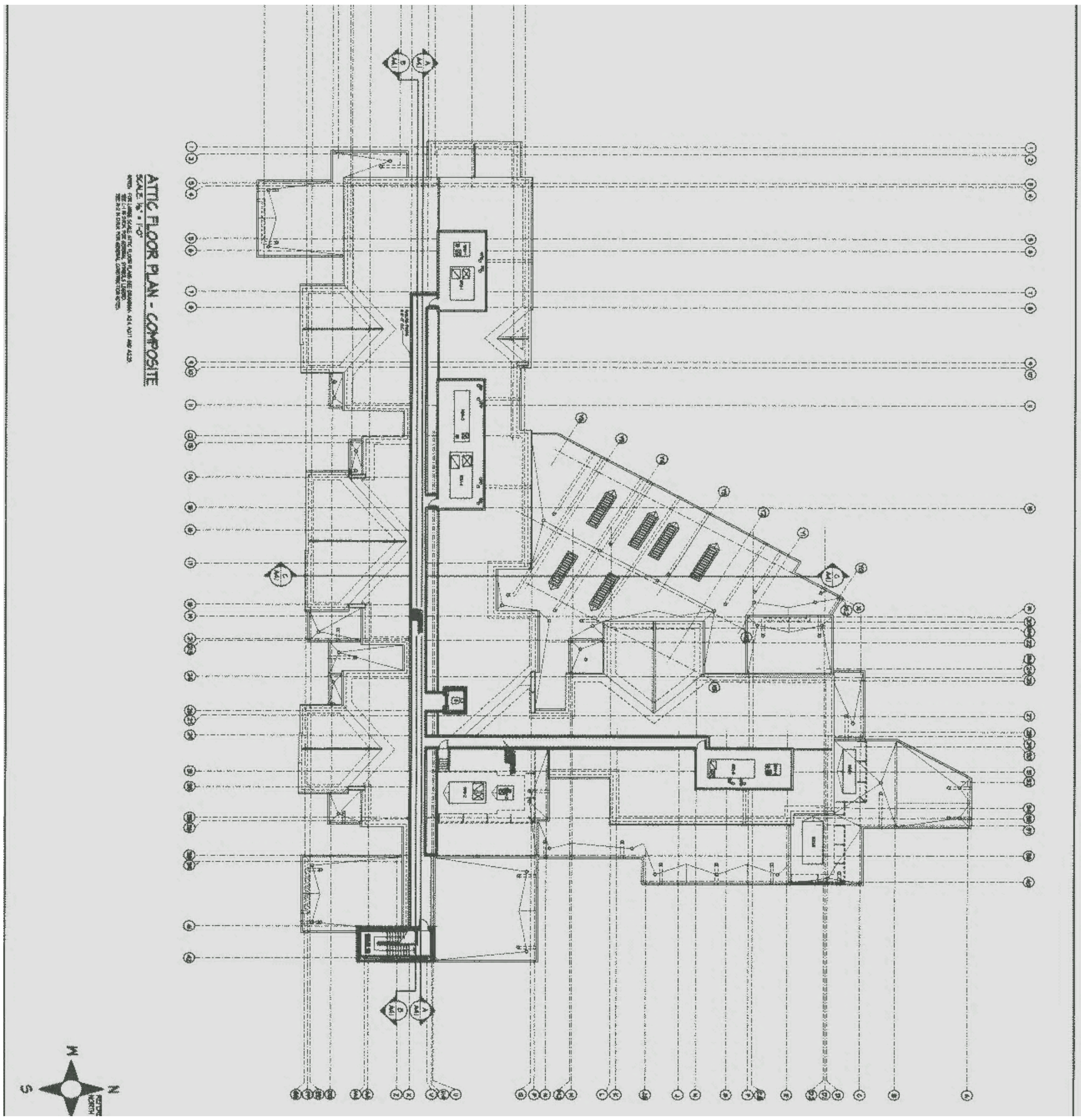


Figure 14: Roof plans

DESIGN CODES

All equipment and components of the DH are designed to comply with all applicable latest editions of articles and sections of the following codes in compliances with all Federal, State, County, and Local ordinances and regulations:

- 2006 International Building Code (IBC)
- National Electrical Code (NEC),
- Uniform Plumbing Code (UPC),
- National Sanitation Foundation (NSF)
- Specifications for structural concrete for buildings (ACI 301)
- Building Code Requirements for Reinforced Concrete (ACI 318-08)
- Recommended Practice for Hot Weather Concreting (ACI 305R)
- Recommended Practice for Cold Weather Concreting (ACI 306R)
- Recommended Practice for Concrete Formwork (ACI 347)
- American Society of Civil Engineers (ASCE 7- 10)

PROBLEM STATEMENT

In technical Report 1 and 3, the gravity and lateral resisting system of the DH were analyzed and it was found that both systems are adequate in both strength and serviceability. However, the existing lateral system described above is composed of complicated moment connections that are time consuming and labor intensive. An example of this type of connection can be seen in the figure 15 below, where a combination of welds and bolts are being used. This presents an opportunity for an alternative design of the lateral system.

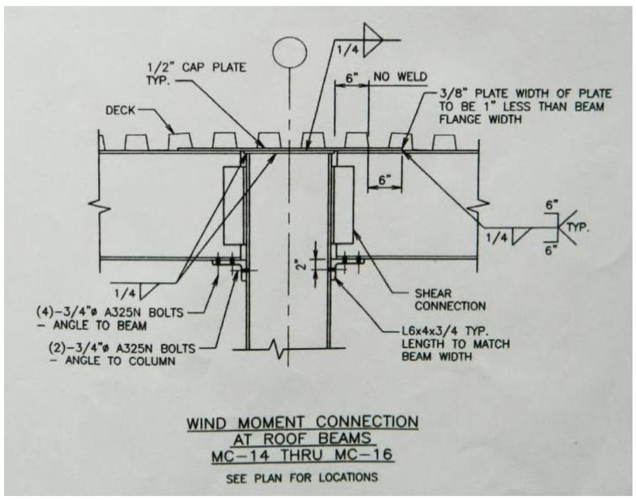
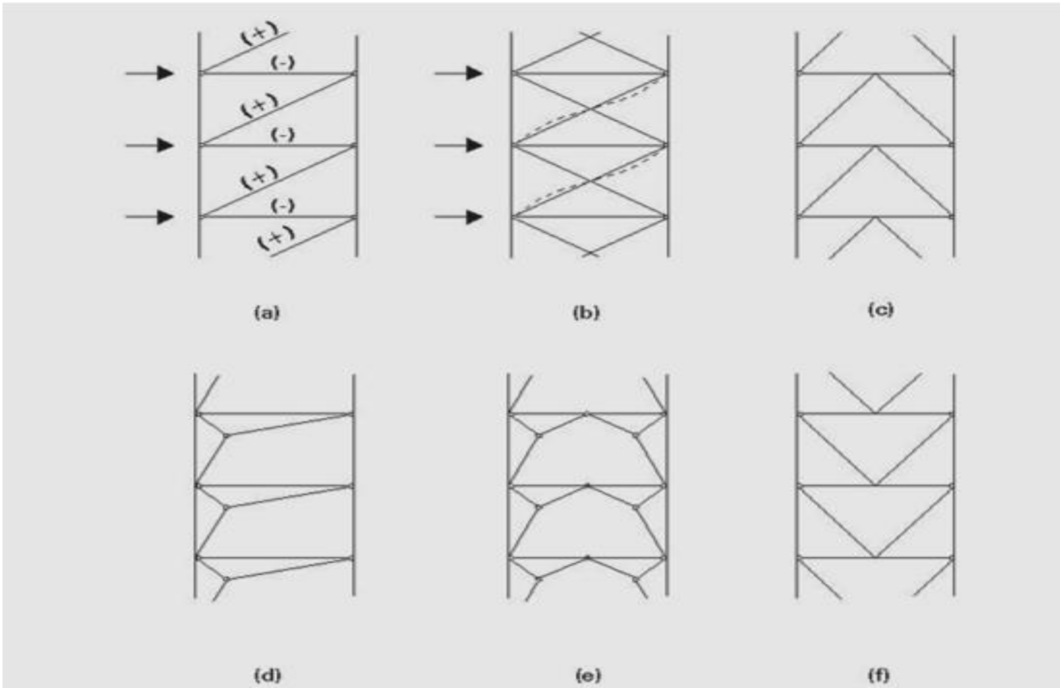


Figure 15: Wind moment Connection

PROPOSED SOLUTION

The purpose of this thesis investigation will be to redesign the lateral system of the DH to make use of concentric braced frames.

This analysis will determine how lattice frames can be used as vertical trusses to support the wind loads by cantilever action. Depending on the wind direction, one diagonal member can take all the tension while the other member is assumed to remain inactive. However, the most common arrangement is the “V” brace when the member is designed to resist compression forces. The following figure provides an example of deferent types of bracing.



Typical cross bracing and "K" bracing

The change in the lateral system from moment frames to braced frames will result in simpler and easier frames to construct. An ETAB's model will be developed to compare frame stiffnesses, and lateral movement; and both direct shear and torsional shear will be computed in the lateral system analysis. The most effective configuration will be selected, and then the breath topics will be complete.

BREADTH TOPICS

CONSTRUCTION

Due to the redesign of the new lateral system; a cost and schedule impact will also be undertaken to determine the effects of the alterations. Including in this breadth will be estimates on the prices of new materials as well as installation costs. The overall cost of the new system will then be compared to the cost of the existing system. In addition, a schedule analysis will be done to determine whether the deadline of August 2010 would still be met.

ARCHITECTURAL

The current structural system of the DH is composed of moment frames, which offer a considerable amount of flexibility for architectural design. If these concentric braced frames are added to the perimeter of the existing building, they will have an impact on the floor plan as well as the façade. Therefore, an architecture breadth will be included to detail the impact of the braced frames on the overall building.

METHODS

The investigation of the new lateral system will begin by determining the optimal locations for the braced frames through consulting with faculty members and industry professionals as well as independent research.

After the optimal brace location is determined, the new lateral system will be modeled in ETAB and its results will then be compared to the existing system. Changes in frame stiffnesses, lateral movement, and both direct and torsional shear will be analyzed as well as lateral member spot checks.

In addition, the effects of the alternate system on construction and architecture will be analyzed. Frist, the braces will have to be design and implemented in optimal locations. After the members are designed and approved by industry professionals and faculty members; the amount of man hours needed for construction, the cost of materials and overall saving, will then be obtained using RSMeans 2010 Building construction Cost Data Book and other materials.

The optimal configuration will be determined based on the above criteria.

TASKS

Task 1

Determine alternate lateral system

Task 2

Determine the optimum location for the braces based on faculty members and industry professionals' advice.

Task 3

Create ETABS model with the new lateral system.

Task 4

Perform wind and seismic hand calculations and compare them to ETABS model.

Task 5

Check direct shear and torsion.

Task 6

Check strength and serviceability against code and industry standards

Task 7

Architectural impact breadth

Task 8

Cost and schedule impact breadth

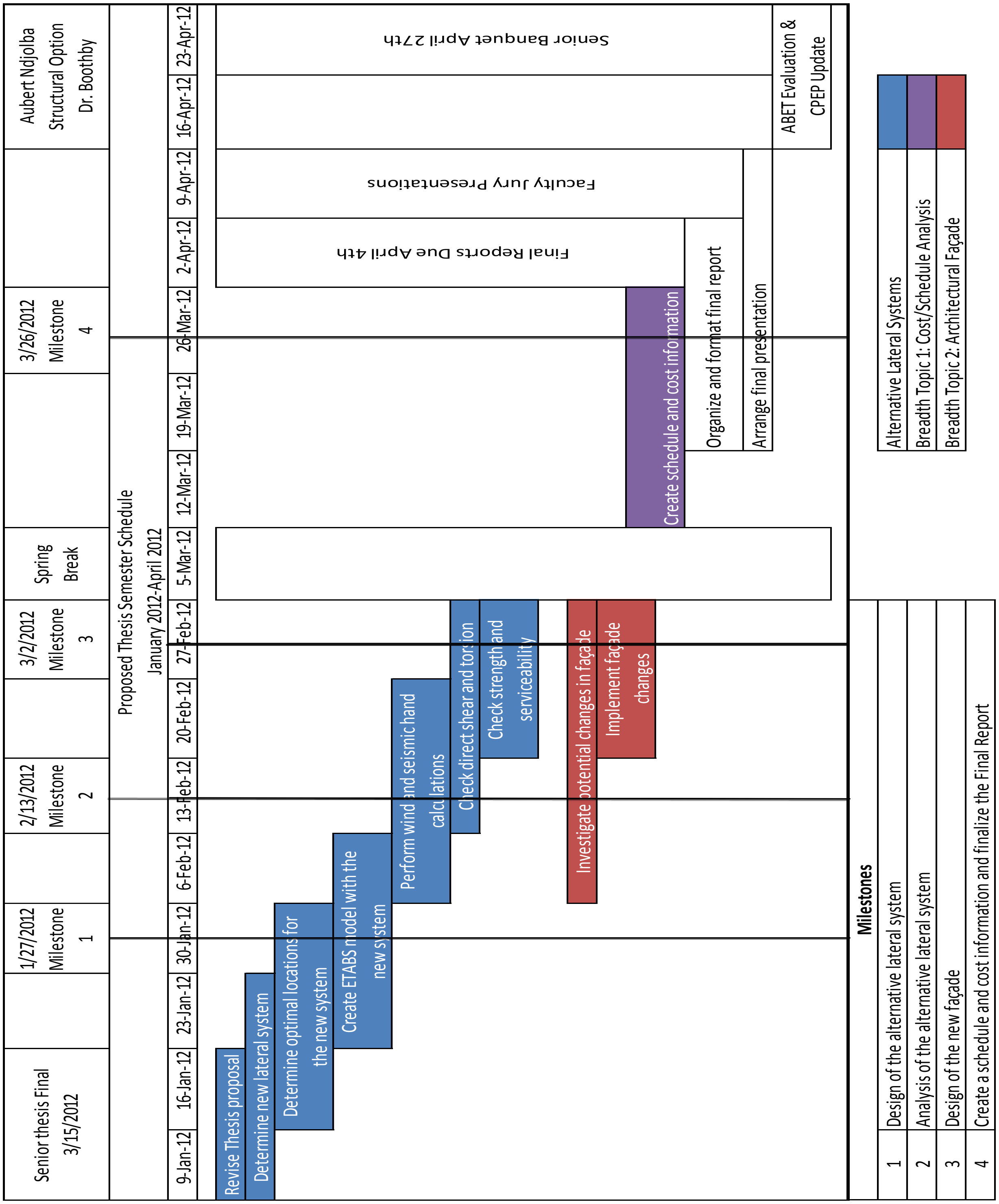
Task 9

Prepare for final presentation.

Task 10

Write paper and make revisions as necessary.

TIMETABLE


Aubert Ndjolba
Structural Option
Dr. Boothby
Senior thesis Final 3/15/2012
1/27/2012 Milestone 1
2/13/2012 Milestone 2
3/2/2012 Milestone 3
Spring Break
3/26/2012 Milestone 4
Proposed Thesis Semester Schedule
January 2012-April 2012
9-Jan-12
16-Jan-12
23-Jan-12
30-Jan-12
6-Feb-12
13-Feb-12
20-Feb-12
27-Feb-12
5-Mar-12
12-Mar-12
19-Mar-12
26-Mar-12
2-Apr-12
9-Apr-12
16-Apr-12
23-Apr-12
Revise Thesis proposal
Determine new lateral system
Determine optimal locations for the new system
Create ETABS model with the new system
Perform wind and seismic hand calculations
Check direct shear and torsion
Check strength and serviceability
Investigate potential changes in façade
Implement façade changes
Create schedule and cost information
Organize and format final report
Arrange final presentation
ABET Evaluation & CPEP Update
Final Reports Due April 4th
Faculty Jury Presentations
Senior Banquet April 27th
Milestones
1 Design of the alternative lateral system
2 Analysis of the alternative lateral system
3 Design of the new façade
4 Create a schedule and cost information and finalize the Final Report
Alternative Lateral Systems
Breadth Topic 1: Cost/Schedule Analysis
Breadth Topic 2: Architectural Façade

CONCLUSION

An in-depth investigation will be undertaken to evaluate the impact of implementing concentric braced frames in lieu of the existing moment frames. Once the optimal configuration and location of the brace frames have been selected, the alternate lateral system will be analyzed and compared to the existing. By altering the structural system, construction and architectural aspects of the DH will have to be studied and adjusted appropriately.