Dulles Town Center Building One

Dulles, Virginia

THESIS PROPOSAL

Prepared for: Dr. Linda Hanagan
Prepared by: David Geiger - Structural Option

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Executive Summary

The Dulles Town Center Building One project is located in Dulles, Virginia; five minutes north of Dulles International Airport and 25 miles outside of Washington, D.C. It consists of seven stories of office space above grade and one story below grade that includes rentable space, storage, mechanical rooms, a loading area, a trash room, building service offices, and a workout space. The building is approximately 202,000 square feet and reaches a total height of 118 feet above grade. The building has an open floor plan and an average floor-to-floor height of 12'-6" making it ideal for office space. A typical bay is 20 feet by 40 feet, and the gravity system consists of a post-tension concrete beam and non-post-tension one-way slab system with typical 24"x24" columns.

This proposed thesis will not only include the investigation of a composite steel framing system, but also how the current design loads will affect a steel moment frame resisting system. The effects caused by the proposed structural system on the current foundation system due to reduced building weight, overturning moment and uplift are also discussed. Two breadths will be explored, as well, in this proposed thesis. They are a construction management study and a vibration and noise transmission study.

As with any building project, time and cost are very important. The construction management study will analyze the effects of a steel system on the cost and schedule of the project and compare it to that from the existing concrete system. It is already known that Northern Virginia and the Washington, D.C., area are known for their preference in using concrete as a building material due to its lower cost and availability, so an increase in cost is expected.

With the floor system changing from a post-tension beam one-way slab system to a composite steel system vibrations from the mechanical equipment in the penthouse may cause noise issues to those people working on the seventh floor. The second breadth of the proposed thesis will be to analyze effects due to the new steel system on vibration and noise control between the penthouse and seventh floor.

Introduction

The Dulles Town Center Building One project consists of seven stories of office space above grade and one story below grade that includes rentable space, storage, mechanical rooms, a loading area, a trash room, building service offices, and a workout space. It is located in Dulles, Virginia; five minutes north of Dulles International Airport and 25 miles outside of Washington, D.C. The building's architectural use of precast concrete and glass curtain-wall have helped set the tone for the modernist themes conveyed along the Route 28 corridor. At night, this building is one of the most recognizable buildings along Route 28 with its linear neon focal points.

The building is approximately 202,000 square feet and reaches a total height of 118 feet above grade. The building has an open floor plan and an average floor-to-floor height of 12'-6" making it ideal for office space. A typical bay is 20 feet by 40 feet, and consists of a post-tension concrete beam and non-post-tension one-way slab system.

The following thesis proposal will discuss the considered problem, a possible solution and the methods to be used during design and analysis. Two breadth topics, construction management and vibration and noise transmission, will also be discussed. Tasks and tools will be laid out in outline form and will show what needs to be done to complete the proposed thesis. A schedule is also included to show the expected time each task will take and how the final deadline will be met.

Existing Structural System

Floor Systems

The typical floor is a post-tensioned beam and non-post-tensioned one-way slab system. The 7″ thick slab is of normal weight with continuous edge drops that are 3′ wide and 5 ½″ deep along the east face to help support the precast concrete and ribbon window façade. A typical bay is 20′x 40′ with a typical beam length of 40′. Slab reinforcement consists of #4 top bars spaced at 6″ on center and #4 bottom bars at 12″ on center. Reinforced concrete beams are located at stairwells and elevator shafts.

Lateral System

The lateral resistance system in the east-west direction, as seen in Figure 1, is comprised predominantly of concrete moment frames with typical beams being 17″x 48″ and typical columns being 24″x 24″.

Typical Floor - Concrete Moment Frame in East – West Direction

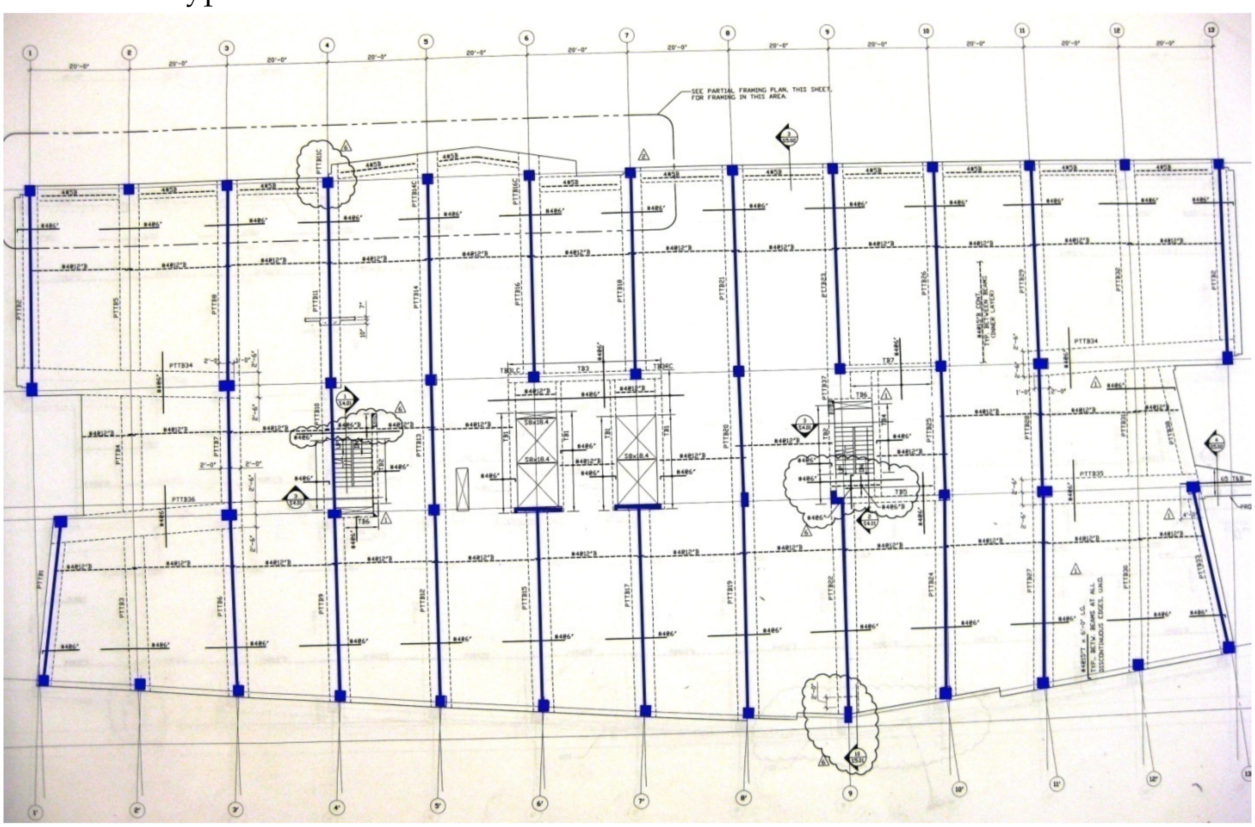

Figure 1

The north-south lateral system, seen in Figure 2, is also made up of concrete moment frames. The middle frames have large 24″x 60″ beams, shown as solid lines, at the frame-ends with the floor slab working laterally throughout the rest of the frame, shown with dashed lines, on typical 24″x 24″ columns. The exterior frames use the 7″ slab, along with a 36″x 5 ½″ drop panel along the frame at plan north, with typical 24″x 24″ columns for lateral resistance.

Typical Floor - Concrete Moment Frame in East – West Direction

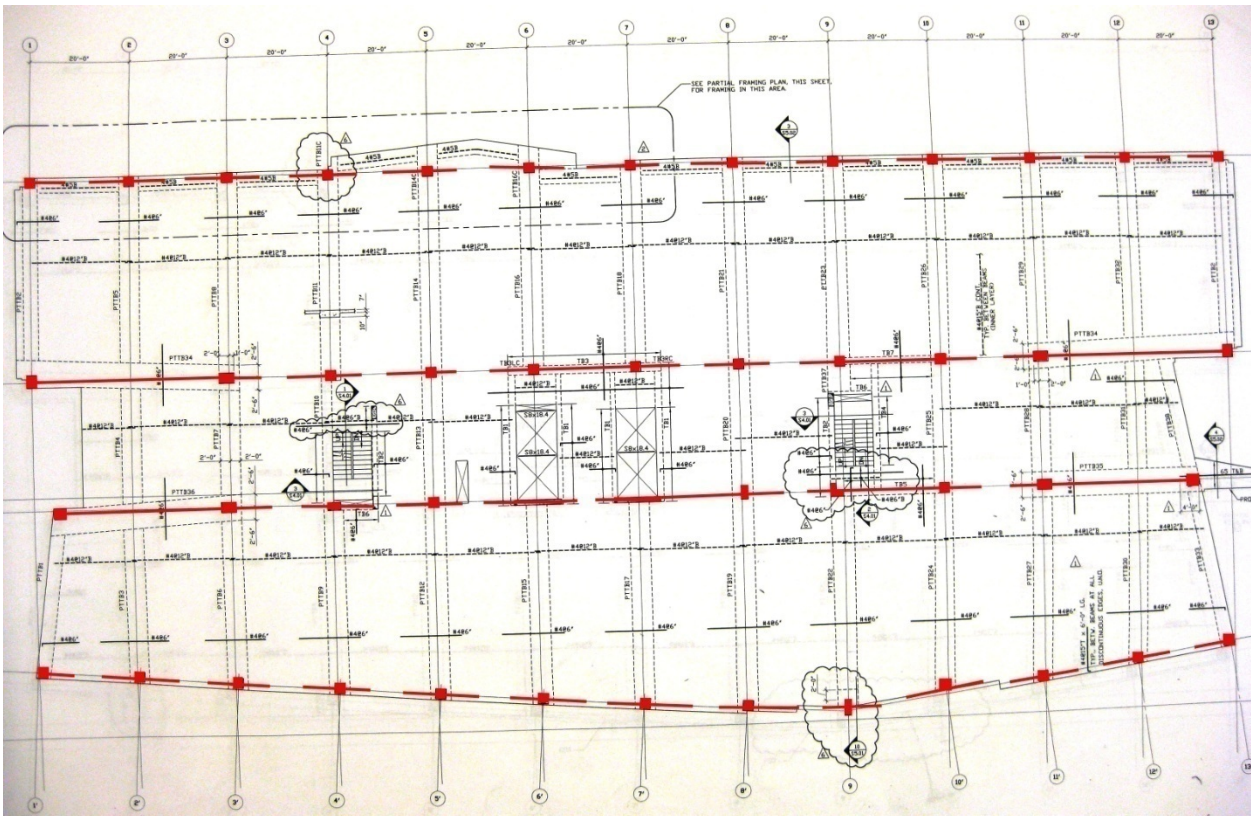

Figure 2

Foundation

The foundation system consists of a slab on grade with strap beams and caissons. The slab is 5″ thick and reinforced with 6x6 – W2.0xW2.0 welded wire fabric. It sits on a 6 mil. polyethylene vapor barrier over 6″ of washed, crushed stone. Strap beams ranging from 24″x 36″ to 48″x 48″ rest on a 2′-0″ thick foundation wall to help support the slab at grade changes. The cast-in-place caissons are capped with reinforced concrete and have shaft diameters that range from 30″ to 75″.

Problem Statement

Due to the location of Dulles Town Center Building One and the parameters set forth by the owner, the most efficient system was used in the original design. This was confirmed in Technical Assignment II when it was compared to three other floor systems. The proposed thesis will be to redesign the structural system out of steel, using a composite metal deck system, and compare it to the current concrete system. The reason for changing the structural system to steel is because concrete was the main focus in the fall. Codes such as the IBC, ASCE 7-05, ACI 318-08 and the 13th Edition of AISC's Steel Construction Manual will be used to design and analyze the strength and serviceability of the new system. Computer software such as ETABS V9.20, PCA Column, and Primavera will be used to assist with design and analysis.

Proposed Solution

Floor System

The proposed floor system to be investigated and applied will be a composite metal deck with steel beam system. It is a way to get the benefits of both building materials into one floor system. The composite steel decking not only acts as permanent formwork but also provides composite interlocking with the concrete to serve as reinforcement for the concrete slab.

After performing initial calculations in Technical Assignment II, W18 beams were chosen to carry a 3", 19 gage metal deck with a 7 ½" total slab depth. This makes the total floor depth 27 ½". Current local codes will be investigated to determine if the overall height of the building peaks over the maximum height.

The material and construction costs associated with the application of this system will be analyzed and compared to the current structural system. The composite metal deck system will most likely have a shorter erection time, but a longer lead time will be required to fabricate W Shapes. The initial fabrication, material, and transport costs may outweigh the time and costs saved during construction time. These topics will be discussed and compared in future reports.

Lateral System

A lateral resisting system consisting of steel moment frames will be investigated in this proposed thesis. The seismic and wind loads calculated in previous technical reports will be used in the design of the new lateral load resisting system. The location of this system will be determined by any torsion effects created by these loads.

Foundation System

The proposed steel structural system will be lighter than that of the current concrete system and therefore causes the need for the foundation system to be analyzed. Overturning and uplift will be investigated to determine if the current caisson system needs to be redesigned for the proposed steel system. In Technical Assignment III, it was assumed by inspection that overturning and uplift did not affect the current system due to building weight and soil friction.

Solution Methods

Floor System

The floor system will be designed with assistance from Vulcraft's *Steel Roof and Floor Deck* design manual. Beam and column sizes will be sized using the 13th Edition of AISC's Steel Construction Manual. An ETABS V9.20 model will also be generated to assist in design and help analyze the proposed system. Hand calculations will be conducted to compare sizes of members determined by computer software. The live loads that will be used in the design process will be taken from Chapter 2 of ASCE 7-05.

Lateral System

As done in Technical Assignment #3, the lateral system will be designed using ASCE 7-05. The number of moment frames required is expected to be similar to that of the existing structure. Chapter 2 will be used for load combinations, Chapter 6 will be used for wind loads, and Chapters 11, 12, and 22 for seismic loads. The ETABS V9.20 model will also assist in the design and help analyze the proposed steel moment frames. RAM Steel may also be used to analyze the structure.

Foundation System

The foundation system will be redesigned to carry new loads brought on from the steel structural system. The system will be designed using the current concrete strength of f'_c=3000 psi and ACI 318-08. PCA Column will be used to help design and analyze the caisson system.

A construction schedule will then be generated using Primavera computer software. A detailed cost analysis will also be conducted using prices from local fabricators and the R.S. Means catalog. When completed, a comparison will be made to the schedule and cost of the existing system.

Breadth Topics

Construction Management Study

A complete investigation of schedules and different construction methods will be performed in order to compare the alternate steel system to the current concrete one. The goal will be to make the construction process as efficient as possible. This will include coordinating when a necessary building material should be ordered, when it should be erected, installed or poured, and the man-power needed to perform such tasks. This will help when offsetting lead times and set-backs. A cost analysis and generated schedule will be used to illustrate the effects changing the structural system has on the construction management of the project.

Vibration and Noise Transmission Study

With the introduction of a steel structural system to the current layout of Dulles Town Center Building One, vibration beneath the mechanical penthouse may lead to noise problems into the prime office space of the seventh floor. This study will not only look at reducing vibration in the steel members to decrease sound, but will also explore different acoustical materials to also help with noise transmission. A cost comparison will be conducted upon completion.

Tasks and Tools

Part I: Proposed Steel Structural System

Task 1: Investigate Composite Metal Deck Floor System

a) Contact manufacturers and practicing engineers to get comments on the floor system and/or information on any advances in the floor system design
b) Use collected information to write an introduction on the floor system

Task 2: Initial Design

a) Use the Vulcraft *Steel Roof and Floor Deck* design manual to determine the floor deck, slab thickness and dead load
b) Establish live loads using ASCE 7-05
c) Calculate preliminary sizes for beams using Steel Manual
d) Determine gravity loads for column transfer
e) Generate ETABS model and find initial column sizes and reference with hand calculations

Part II: Proposed Steel Moment Frame Lateral Load Resisting System

Task 1: Determine wind and seismic loading

a) Determine wind and seismic loading using previous Technical Assignments and ASCE 7-05 Chapters 2,6,11,12,22

Task 2: Design steel moment frame resisting system

a) Design steel moment frame lateral load resisting system in ETABS
b) Spot check moment distribution and member sizes with hand calculations

Part III: Effects on Existing Foundation System

Task 1: Determine effects on foundation system

a) Using results from gravity, wind and seismic loads, determine if foundation system must be redesigned
b) Redesign using PCA Column
c) Spot check sizes with hand calculations

Part IV: Breadth Topics

Task 1: Construction Management Study

a) Contact general contractor and gather information on project schedule and construction methods
b) Input construction data into Primavera to create schedule
c) Create a construction cost estimate of the new structural system using R.S. Means catalog
d) Compare results to existing

Task 2: Vibration Study

a) Research vibration and damping
b) Determine how much vibration will be caused by existing mechanical equipment
c) Research noise caused by vibration

Task 3: Noise Transmission Study

a) Determine noise transmission from vibration
b) Research acoustic building materials
c) Determine which solution, damping or acoustic materials, is most efficient with a cost analysis

Part V: Final Report and Presentation Development and Preparation

Task 1: Final Report

a) Develop a working draft report
b) Edit and correct as needed
c) Create final report

Task 2: Presentation

a) Create Final Presentation
b) Edit and Practice
c) Present

Schedule

Weekly Schedule: January and February							
Task	1/12 - 1/16	1/19 - 1/23	1/26 - 1/30	2/2 - 2/6	2/9 - 2/13	2/16 - 2/20	2/23 - 2/27
I-1							
I-2							
II-1							
II-2							
III-1							
IV-1							
IV-2							
IV-3							
V-1							
V-2							

Weekly Schedule: March and April										
Task	3/2 - 3/6	3/9 - 3/13	3/16 - 3/20	3/23-3/27	3/30 - 4/3	4/6- 4/10	4/13 - 4/17	4/20 - 4/24	4/27 - 5/1	5/4 -5/8
I-1		Spring Break					Presentations			Finals Week
I-2										
II-1										
II-2										
III-1										
IV-1										
IV-2										
IV-3										
V-1										
V-2										

NOTE: Refer to the Tasks and Tools section for task descriptions

Conclusion

The intent of this analysis is to prove that the original design was the most efficient due to location, cost, and constructability. This proposed thesis will focus on comparing the current concrete structure of Dulles Town Center Building One to the same structure if constructed with steel. A composite steel deck system will be investigated along with a steel moment frame lateral load resisting system. The foundation system will also be analyzed. The reduction in building weight could reduce the size of the caissons, but at the same time, now overturning moment and uplift are factors so the size may need to go up. All designs and analyses will be done in accordance with reference to applicable codes.

The breadth studies will include construction management and vibration and noise transmission studies. As part of the construction management study a cost analysis will be performed and a project schedule will be generated. The results found from the steel structure will be compared to that of the concrete structure. The vibration and noise study will analyze how the noise and vibrations from the mechanical systems in the penthouse effect noise transmission into the prime office space of the seventh floor.