

ASHA National Office Rockville, MD

Thesis Proposal



Photo Courtesy of Boggs & Partners Architects

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Structures Option**

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Executive Summary

The ASHA National Office building is an office building located in Rockville, MD. The office tower is five stories and there are two floors of subgrade parking. The parking structure is composed of a flat slab system with drop panels and the superstructure is composite steel. The lateral system consists of four braced frames in the office tower with shear walls in the subgrade parking garage. The gross area of the building is 133,870 square feet.

The proposed thesis is a redesign of the office tower's structural system using reinforced concrete rather than steel framing. Using concrete instead of steel has multiple benefits. One of those is that the steel contractor is eliminated. Minimizing the number of trades on the job can help decrease the cost of the project. In addition, using concrete eliminates the need for spray fireproofing. Concrete does not require any additional fireproofing treatment to meet the fire codes, which will help speed up the construction process and save money. The need for column base plates and anchor bolts where the steel structure meets the concrete structure is eliminated, which will also help reduce the cost of the project.

Three types of reinforced concrete floor systems will be considered. One is a one-way joist and beam system. This system allows for wide column spacing, has inherent vibration resistance and reduces the dead load due to the pan voids. The second floor system that will be considered is a one-way slab and beam system. This floor system allows for flat ceilings between beams, and allows for wide column spacing. The last system that will be considered is a two-way slab and beam system. This system was not considered in Technical Report II, but calculations will be done to determine if this system is feasible.

Redesigning the structure as a reinforced concrete structure will impact the structure in multiple ways. The lateral system will have to be completely redesigned. The existing braced frames will have to be replaced with shear walls if the natural moment connections of the concrete are not sufficient to resist the lateral loads. In addition, the higher self weight of the structure will require larger foundations, so the spread footings will have to be redesigned.

Two breadth topics will be explored. One of those is an in depth cost and schedule analysis of the redesign of the structure in order to determine if the redesign is actually a more economic option. The second breadth will explore the architectural impacts of the redesign. Column and shear wall locations may change, and will have to be considered. The façade will also be investigated. Possible alternative facades will be considered and the method of connecting the façade to the new concrete structure will be determined.

Introduction

The ASHA National Office building is a five story office building in Rockville, MD. The American Speech-Language-Hearing Association owns and operates the building. The building was designed with the employees in mind. There is a generous amount of workspace for the employees and the conference rooms are very flexible. A café and kitchen are provided for the employees on the first floor of the office building. There are two levels of subgrade parking beneath the building in addition to surface parking. There are 201 parking spaces in the subgrade parking structure and 224 spaces above grade.

One of the main architectural themes that Boggs & Partners incorporated throughout the building is curves. This was done to mimic the sound waves in the ASHA logo which is shown below. The pre-function space has the curve incorporated into it, and there is a curved piece of art on the landing of the stairway that leads from the lobby to the second floor. The exterior façade has a large three story curved glass curtain wall above the main entrance, and the sidewalks on the exterior of the building are curved as well to further emphasize the main theme of the building.

The five story office building has a total floor area of 133,870 square feet and the roof the building is 69 feet above grade. The top of the penthouse roof is 85 feet above grade. The building façade of the office tower consists of a window wall system and precast concrete spandrels.



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Existing Structural System

Substructure

The substructure of the ASHA National Office building is comprised of two floors of subgrade parking. There is parking underneath the office tower along with a section of the parking structure that is adjacent to the office tower. See Figure 1: Overall Parking Floor Plan. The parking below the office tower is shown in blue and the parking adjacent to the office tower is shown in yellow.

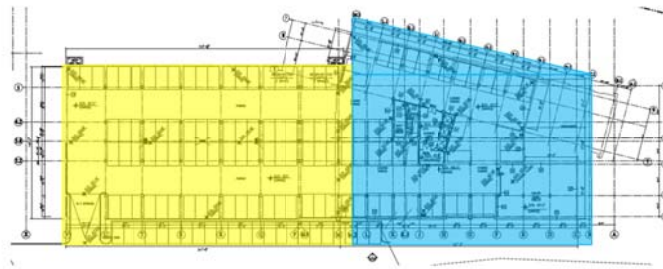


Figure 1: Overall Parking Floor Plan

Foundation

The foundation of the ASHA National Office building consists of a 5" thick reinforced concrete slab with strip footings around the perimeter of the building. There are also footings at the base of all concrete columns. The foundations for the building were designed in accordance with the recommendations included in the geotechnical report prepared by ESC Mid-Atlantic, LLC. See Figure 2: Partial Foundation Plan. The interior column footings are generally 6'x6' and range from 12" to 18" thick.

Floor Structure

The parking structure is a two way reinforced concrete flat slab system that is comprised of a 9" thick slab and 5 1/2" thick drop panels. Unless otherwise noted on the plans, the drop panels are 7'-0"x9'-0" and 10'-0"x10'-0". The bay sizes vary depending on the part of the building, but the typical span ranges from 20' to 40'. The bottom reinforcing mat consists of #5 bars at 12" or 14" each way. The top reinforcing bars vary depending on the location, but are typically #5, #6 or #7 bars.

Columns

The concrete columns in the parking structure are generally 18"x30" with 10 #7 bars, and 24"x21" with 8 #8 bars. The columns have a minimum 28 day compressive strength of 4000 psi. The concrete columns of the parking structure are connected to the steel columns in the office tower above with column base plates.

Superstructure

A five story office tower is the superstructure of the ASHA National Office building. The first level has a large conference room that can be subdivided into five smaller conference rooms. The upper four floors are composed of offices in the central core of the building, and open office space with cubicles on the exterior of the building. There is a penthouse on top of the office tower that houses mechanical and elevator equipment.

Floor Structure

The floor structure for the tower consists of cambered steel beams with a composite concrete floor slab on metal deck. The composite slab consists of 3 ½” normal weight concrete on top of 2” deep 18 gauge galvanized composite steel deck. The composite beams are generally W21x44 and W14x22 members with ¾” diameter shear studs. The girders running along the exterior of the building vary in size, but are mostly W18x35’s.

Roof System

The roof structure consists of K series open web joists and wide flange shapes. The structural roof slab consists of 3 ½” normal weight concrete on top of 2” deep 18 gauge composite steel deck. See Figure 9: Partial roof framing plan.

Columns

The columns for the office tower are steel wide flange shapes. The columns are all W12 and W14 members. The columns are spliced above level 3. The columns that extend to the penthouse roof are spliced again above level 5.

Lateral System

The lateral force resisting elements in the ASHA National Office building consist of shear walls in the subgrade parking structure of the building and braced frames in the office tower. The shear walls below work in combination with the braced frames above to resist the lateral loads on the building. The wind loads are collected by the precast concrete spandrels that make up the façade of the building. These loads are then distributed to the composite floor slabs and beams which then are transmitted to the braced frames in the core of the building. These loads are then transferred to the shear walls below and to the footings at the base of the shear walls. See Figure 2: Floor Plan with Braced Frames. In the figure below the four braced frames are highlighted in red.

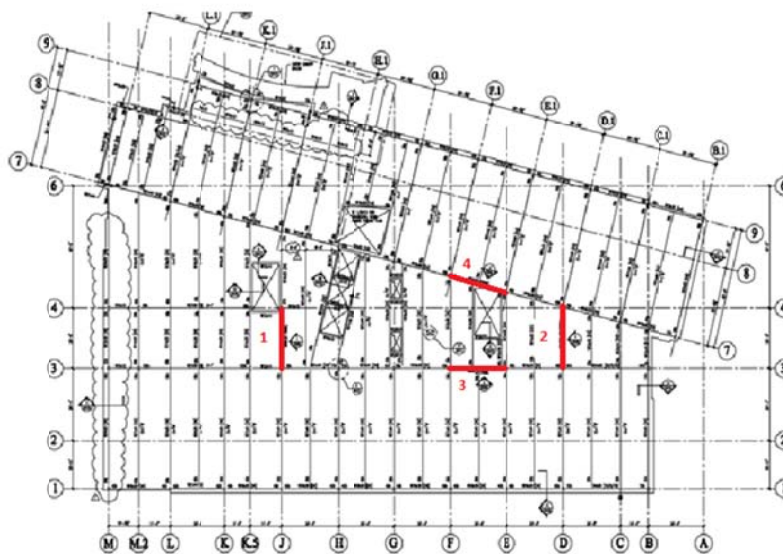


Figure 2: Floor Plan with Braced Frames

Problem Statement

Currently the structure for the subgrade parking garage for the ASHA National Office building is a two-way reinforced concrete flat slab system. The office tower that is above grade has a composite steel structure. The structure was found to be adequate for the gravity and lateral loads on the building, but having both a reinforced concrete system and a composite steel system in the building creates some complications for the design and construction of the building. One issue is that the steel structure above has to be connected to the concrete structure below. In the current design, this is done with baseplates and anchor bolts. These baseplates must be leveled and positioned accurately so that the steel columns are plumb and in the right location. Another issue is that there must be both concrete and steel contractors on the job. Having multiple trades on the jobsite increases the cost of the building significantly. By altering the structural system of the office tower, the cost of the project may be able to be decreased.

Proposed Solution

The ASHA National office will be redesigned as a reinforced concrete structure. Three types of floor systems will be explored for the office tower. One type is a one-way pan joist and beam system. The floor will consist of a 4 ½” slab to achieve a two hour fire rating. As seen below in Figure 3: Pan-Joist and Beam Systems, two orientations will be considered. The first is a system in which the pan joists span the 20’ direction, and in the second the joists span the 40’ direction. Another floor system that will be explored is a one-way slab and beam system. The floor will consist of an 8” slab with beams that are 20”x30”. These beams may have to be post-tensioned to reduce the depth of the floor system. See Figure 4: One-Way Slab and Beam System. The columns will also be changed from steel W-Flange shapes to reinforced concrete columns. The last floor system that will be considered is a two-way slab and beam system. This floor system was not explored in Technical Report II, but calculations will be done to see if this is an economical option.

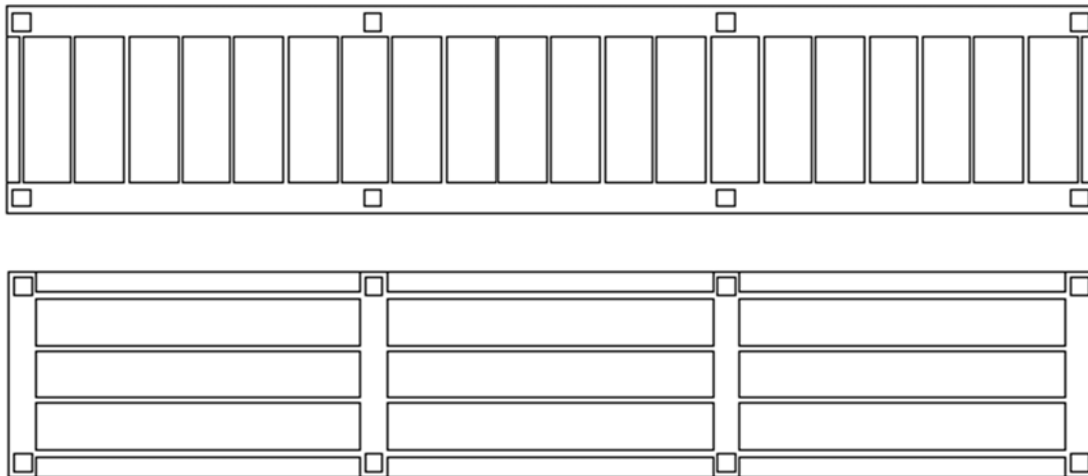


Figure 3: Pan-Joist and Beam Systems

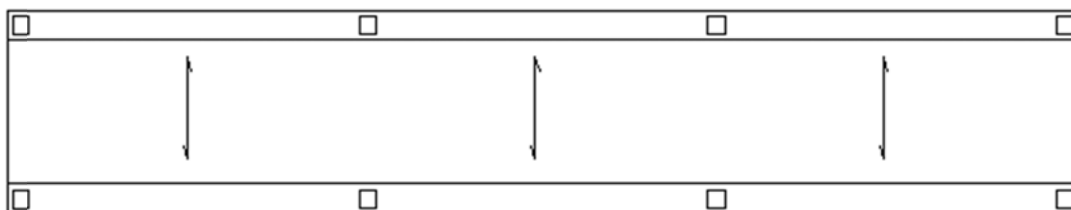


Figure 4: One-Way Slab and Beam System

Redesigning the building as an entirely reinforced concrete structure will eliminate the need for a steel contractor on the job. Decreasing the number of trades on the job can reduce construction costs and save time during construction. By designing the entire structure as a reinforced concrete structure, the issue of connecting the steel office tower structure to the concrete structure below will be eliminated. In addition, the continuity of the concrete structure will create natural moment connections. The concrete structure will also eliminate the need for spray fire proofing. Reinforced concrete does not require any additional fire proofing treatments which will help reduce the cost of the structure.

By changing the design of the structure to reinforced concrete, the lateral system will have to be completely changed. If the natural moment connections in the reinforced concrete structure are not adequate to resist the lateral loads, then concrete shear walls may have to be implemented. The heavier weight of the structure will also increase the seismic loads on the building.

The impact on the foundation will also have to be considered. Because the structure will be redesigned as a reinforced concrete structure, the weight of the building will increase resulting in higher loads on the lower parking structure and foundation below. This will most likely require the size of the foundations to be increased.

Solution Methods

The design of the reinforced concrete office tower will be based on the code in ACI 318-08. The loads used in the design will be determined by ASCE7-10 and by industry standards. This has been done in Technical Report I, but will have to be done again for the new loads and the concrete structure.

The concrete slabs will be designed using the Equivalent Frame Method in ACI 318-08. ADOSS will also be used in order to aid in the design the slab reinforcing for the gravity loads on the structure. LRFD design methods will be used for all calculations.

ETABS will be used to create a computer model of the reinforced concrete structure. The foundations, gravity and lateral systems will all be modeled. All applicable load combinations and live load patterns will be considered. The ETABS output will be used to check drift, torsion and overturning.

MS Office will be used to create a project schedule and and RS Means will be used to estimate the overall cost of the structural system.

Breadth Studies

Redesigning the structure as reinforced concrete will affect the cost and schedule of the project. For this reason, an in-depth study will be done on the cost and schedule impacts of redesigning the structure. The overall cost and a construction schedule will be determined for the concrete structure. The cost and schedule of the redesigned concrete structure will be compared to that of the existing composite steel structure, and feasibility of the redesign will be determined.

Another study that explores the architectural affects of changing the structure to concrete will be done. Certain columns may have to be relocated which will affect the floor plan of the office building. In addition, the shear walls that will be used in the building will affect the layout of the building. A study on the façade will also be done. Because the structure is being changed to a reinforced concrete structure, the way that the precast panels are connected to the structure will change. Other façade options will be explored and how the façade is attached to the structure will be determined.

MAE Requirements

The MAE requirement for this class will be met by utilizing ETABS and other computer modeling programs. By generating computer models of the building, the course material taught in AE 597A- Computer Modeling of Buildings, will be directly applied to this thesis project. Although the building is being redesigned as a reinforced concrete structure, if any steel connections need to be designed, the material taught in AE 534-Steel Connections will be used to do so.

Tasks and Tools

- I. Redesign Gravity System as reinforced concrete
 1. Determine best concrete floor system
 - a. Determine and compare approximate price of different options
 - b. Consider constructability of options based on formwork and construction processes
 - c. Consider vibration, deflection and impact on foundations
 - d. Choose a system
 2. Establish trial slab and beam sizes
 - a. Determine beam sizes based on ACI 318-08 and deflection criteria if necessary
 - b. Establish slab thickness by ACI 318-08
 - c. Determine economical balance between beam and slab thickness using RSMMeans
 3. Determine floor loads and trial column sizes
 - a. Find self weight based on member sizes in Task 2
 - b. Find superimposed dead loads based on building plans
 - c. Determine live loads based on ASCE7-10
 - d. Determine trial column sizes for office tower and subgrade parking garage

- II. Redesign lateral system with concrete shear walls
 1. Determine new design loads
 - a. Determine wind loads per MWFRS Directional Procedure of ASCE7-10
 - b. Determine seismic loads per Equivalent Lateral Force Procedure of ASCE7-10 using new floor weights
 2. Design shear walls using ETABS
 - a. Develop model in ETABS
 - b. Determine thickness and placement of shear walls in building
 - c. Include effects of torsion
 - d. Verify that all drift criteria are met per ASCE7-10
 3. Verify that gravity members are adequate for lateral loads
 - a. Input gravity members into ETABS model
 - b. Verify that gravity members have adequate strength

- III. Redesign foundations
 1. Model foundation system in ETABS
 - a. Analyze forces at base of columns
 - b. Design footings under all load combinations
 2. Check computer design
 - a. Verify footing designs by hand
 - b. Check overturning of foundations

- IV. Determine cost and schedule impact of redesign
 1. Perform in-depth cost analysis for redesign
 - a. Determine material, labor and equipment costs using RSMeans
 - b. Create detailed spreadsheet including all costs
 2. Create construction schedule using MS Project
 - a. Determine critical path of construction process
 - b. Determine sequencing and overlap for construction
 3. Compare cost and schedule of redesign and existing structure
 - a. Determine which is more economical based on cost and constructability

- V. Investigate architectural impacts
 1. Determine floor plan impacts
 - a. Determine impacts if column locations changed
 - b. Determine impacts if shear wall locations changed
 2. Investigate façade
 - a. Explore other options for façade of building
 - b. Choose best façade option based on architecture and constructability
 - c. Explore how façade will connect to concrete structure

Ryan Dalrymple		Structural Option		Dr. Thomas Boothby		ASHA National Office Building									
Proposed Thesis Semester Schedule January 2011 - April 2011															
	1/28/2011 Milestone 1		2/18/2011 Milestone 2		3/4/2011 Milestone 3		3/25/2011 Milestone 4		4/7/2011 Final Report Due						
10-Jan-11	17-Jan-11	24-Jan-11	31-Jan-11	7-Feb-11	14-Feb-11	21-Feb-11	28-Feb-11	7-Mar-11	14-Mar-11	21-Mar-11	28-Mar-11	4-Apr-11	11-Apr-11	18-Apr-11	25-Apr-11
Determine best floor system		Establish trial slab and beam sizes		Determine floor loads and trial column sizes		Determine new lateral loads		Design lateral system using ETABS		Verify that gravity members are adequate for lateral loads using ETABS		Model and design foundations in ETABS and check by hand			
Obtain cost and schedule information				Investigate façade options						Finalize design		Create cost and schedule information for redesign		Compare cost and schedule of redesign and existing structure	
										Choose a façade type and explore connection to structure		Organize and format final report		Create final presentation	
												ABET evaluation and CPEP update			
Milestones															
1 Floor system chosen															
2 Lateral system design completed															
3 Gravity members and foundation design completed															
4 Design finalized and cost and schedule created															