

ASHA National Office Rockville, MD

Thesis Proposal



Photo Courtesy of Boggs & Partners Architects

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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. This will create continuity between the sub-grade parking structure and the office tower. 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.

Two types of reinforced concrete floor systems will be considered. The first 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 second system that will be investigated is a two-way flat slab system with drop panels. This is the system that is used in the sub-grade parking structure, so the continuing this system in the office tower may help reduce the cost of the structure.

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.

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. The two-way flat slab system will require two additional column lines in the office tower. The impact of these extra columns will be explored on the plaza level and the office floors.

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.

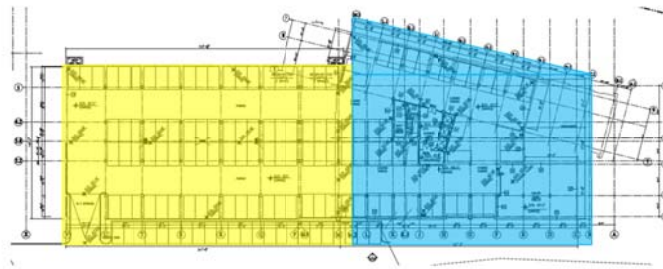


Figure 1: Overall Parking Floor Plan

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.

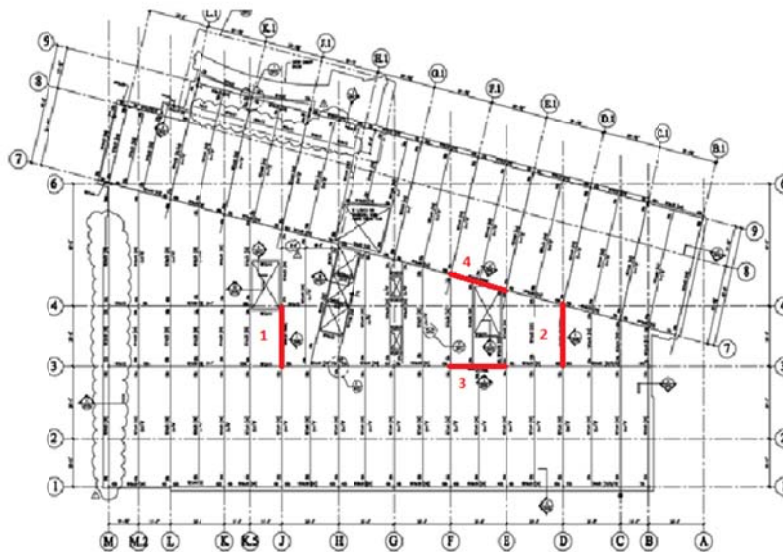


Figure 2: Floor Plan with Braced Frames

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. 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 tower will be redesigned as a reinforced concrete structure. Two floor systems will be explored. The first floor system that will be considered is a one-way slab and beam system. The beams will span the 40' direction and will be wide and shallow to reduce the floor system depth as much as possible. 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 second system that will be investigated is a two-way flat slab system with drop panels. This type of floor system will be considered because the subgrade parking structure consists of this type of floor system. By continuing this type of floor system in the office tower, the design and construction costs may be reduced. Another option that includes using the flat slab system for floors two through four, and using the one-way slab and beam system for the fifth floor will be explored.

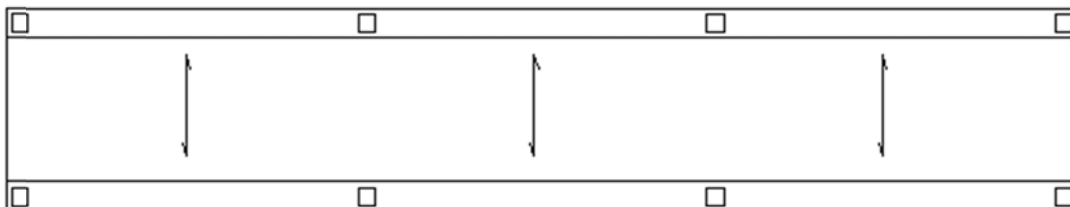


Figure 4: One-Way Slab and Beam System

By designing the entire structure as a reinforced concrete structure, the issue of connecting the steel office tower structure to the concrete parking 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. It will be determined if a reinforced concrete office tower is an economical option when compared to a composite steel 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. A couple of the spread footings will be redesigned for the higher dead loads in order to determine the cost and schedule impact of the larger foundations.

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 two-way concrete slabs will be designed using the Equivalent Frame Method in ACI 318-08. Structure Point will be utilized to design the concrete floor systems. SPslab will be used to design the two-way flat slab system with drop panels. SPbeam will be used to design the concrete beams in the one-way slab and beam system. LRFD design methods will be used for all calculations.

ETABS will be used to create a computer model of the reinforced concrete structure. The gravity and lateral members 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 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. The two-way flat slab system will require the need for two more column lines. The impact of these additional columns on the office tower floor plan will be considered. The plaza level will be the floor that is most affected by these additional columns. This is due to the conference rooms that are located on this level. The floor plan will be rearranged in order to work with the new structural column layout. Research on cubicle sizes will be done, and a cubicle layout will be created for part of the plaza level.

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

- 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. Explore impact on foundations
 1. Spot design spread footings
 - a. Design a few spread footings at critical locations
 - b. Compare to current footing sizes

- 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 of additional columns
 - b. Determine impacts if shear wall locations
 - 2. Rearrange plaza level floor plan
 - a. Consider plan alternatives
 - b. Create new plan in AutoCAD
 - 3. Create cubicle layout
 - a. Research cubicle types and sizes
 - b. Create cubicle layout in AutoCAD