WESTINGHOUSE ELECTRIC COMPANY CORPORATE HEADQUARTERS

CRANBERRY, PA

Thesis Proposal

December 12, 2008

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Executive Summary

The Westinghouse Electric Company Corporate Headquarters will be a three building campus with site features such as asphalt walking paths and volleyball courts on eighty-three acres in Cranberry, PA. For the purpose of the project, only Building One will be analyzed as the other two are considered a separate project by all parties involved. The truncated V-shape building has been given a look of importance with polished concrete block merging into brick stepped-out columns to accentuate the verticality of the five-story 74'-6" tall structure.

Problem Statement

The building was originally designed using a composite deck and beam system. Due to the bay sizes ($L_2/L_1>2$), the building leads itself to a one way slab. The lateral system of all moment connections in the existing building does not seem as efficient as it could be. The lateral system in a concrete building could be explored without changing the exterior as much as a braced frame would change a steel building. The owners want the building to be a LEED certified building, so maintaining efficiency is a must.

Solution

The current column layout dictates a one way concrete slab. Changing the building to a one way concrete slab with beams system will allow for an in-depth analysis of cost and schedule efficiency compared to the existing composite system. The lateral system will be optimized, determining where shear walls would be effective and where concrete moment connections are necessary. Adding a green roof will help to integrate the building with the site and add to the green building concept. The foundations will have to be resized for the new loads, since it is a new material with new weights. The building will be designed using a combination of hand calculations and an ETABS model.

Sustainable Architecture Breadth

Since the building has a LEED certified requirement, changing the building to sustainable concrete will be a challenge. Sustainable concrete is possible by adding more fly ash and recycled materials and can be greener than steel. The sustainable concrete will need to be carefully researched and implemented. Adding a green roof will help this corporate headquarters building stand out from others even more and still be integrated into the environment. Achieving a LEED silver rating would be ideal if the methods to earn the extra points do not compromise the integrity of the building.

Construction Management Breadth

The building will be changed so drastically, therefore in order to make a well-informed decision on which is more effective, a cost estimate and schedule must be generated and compared. Since the material changes, there will be a cost impact and a schedule impact.

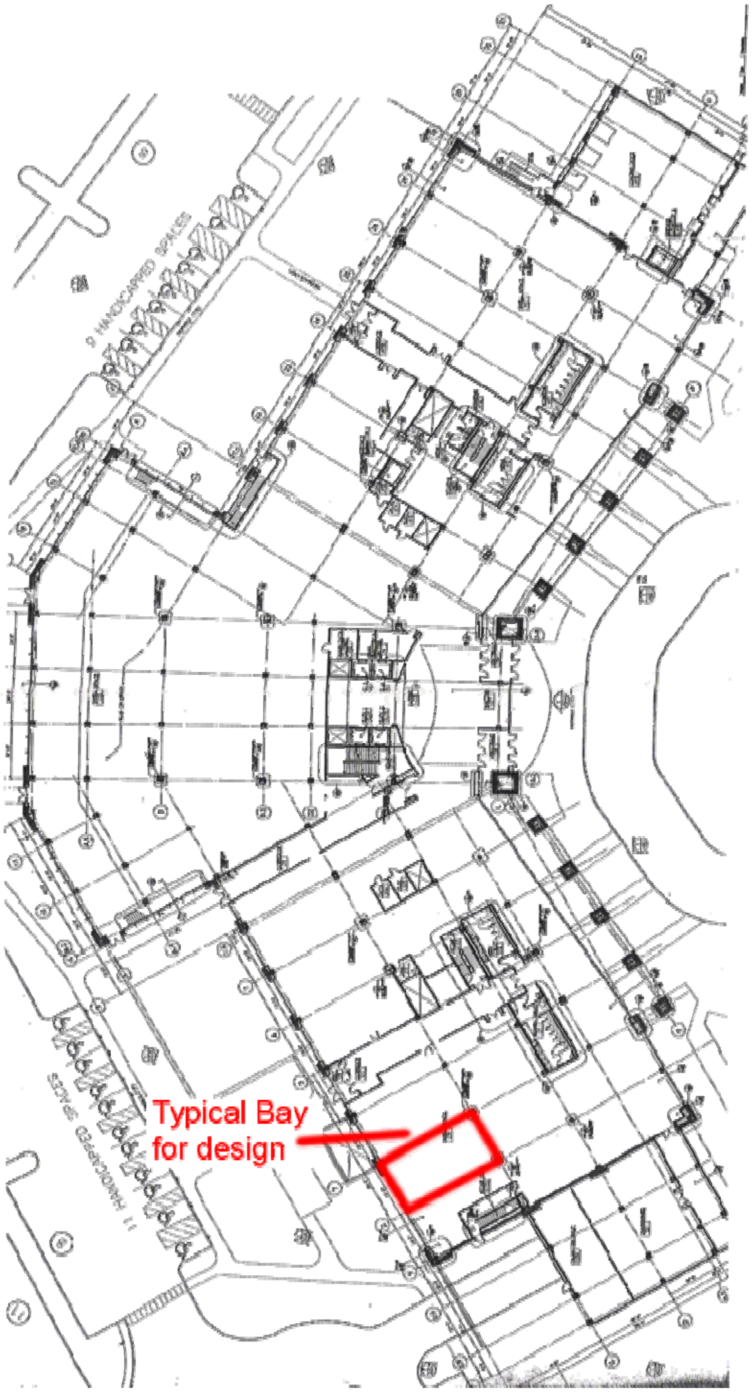
INTRODUCTION

WESTINGHOUSE ELECTRIC COMPANY CORPORATE HEADQUARTERS BUILDING ONE

The Corporate Headquarters building for the Westinghouse Electric Company is located in Cranberry, Pennsylvania. Just north of the city in Butler County, the site is on 83 acres in an office park easily accessible by I-79 and PA-228. With five above grade floors and a full 17' high basement, Building One will be the main building on this campus. Complete with cafeteria, gym, locker rooms, offices, and executive conference rooms, the flagship building comes well equipped. At 434,800 square feet, the building makes quite an architectural statement.

The main building utilizes a powerful entrance with a two-story atrium to express its importance. The first floor also has a height of 18'-0" to emphasize a larger space while floors two through four have floor-to-floor heights of 14'-0". The fifth floor has a height of 14'-6". Building one has a total height of 74'-6" above grade. Aluminum and glass curtain walls add light and make the building feel more open while polished concrete at the base of the brick façade accentuate the height. The foundation system consists of caissons in addition to some spread footings and grade beams. A typical bay is 45'-0" by 24'-0", and uses a steel system with composite beams and deck. In most of the building, the girders are not composite, but the beams framing into the girders have some composite action. The floor system is a 2" 22 gage steel deck with 2-1/2" of lightweight concrete topping. The Westinghouse Electric Company Corporate Headquarters Building One has two expansion joints present, thus creating essentially three structural buildings inside of one. The expansion joints create the East, Center, and West parts of the building. These joints can be seen along column lines 7.9 and 8 between the east and center portions, and column lines 21 and 21.1 between the center and west parts of the building.

The building bay size with the current column layout qualifies to be a one way concrete slab with beams. Adding a green roof to the corporate headquarters will help to set the building apart from other corporate headquarters and incorporate the building into the site. Also, analyzing the feasibility of making the building LEED silver rated instead of just LEED certified will take place. Since the building will be changed an analyzed in concrete, a cost estimate and schedule comparison is required.


Typical Bay
for design

EXISTING STRUCTURAL SYSTEMS

FOUNDATIONS

Caissons are the main element in the foundation system. Each was designed to carry 8,000 psf. The caissons range from 36" to 84" in diameter and from 8'-0" to 30'-8" in height. On top of each caisson, there is a 2'-6" cap with #6@8" each way on the top and the bottom and base plates for the columns. The 5" slab on grade in the basement bears directly on the soil and the thickened slabs under the non-load bearing walls. On the south side and the east portion of the building, where the sixty-seven caissons (67) are not present, there are spread footings or grade beams. The sub-grade walls in the basement (referred to in drawings as grade beams) range from 1'-4" to 1'-8" wide and are 14'-4" deep. The bottom reinforcement in the grade beams is mainly (3) #6, but varies from #6 to #9 and in number. Top reinforcement also varies from #6 to #9 and from two bars to four bars. All end reinforcing bars are #6, but vary from two bars to four bars.

FLOOR SYSTEM

The floor system for the corporate headquarters main building consists of 2" 22 gage metal deck with 2 ½" lightweight concrete topping, for a total slab depth of 4 ½". The typical bay size of this composite steel system is 24'-0" by 45'-0". W21 beams (W21x44 typ.) spaced 24'-0" on center and W18x35 beams spaced 8'-0" on center support the deck and transfer the load to the W24 girders (W24x55 typ.). The girders then continue to transfer the load to the columns. The 5" thick slab-on-grade in the basement of the headquarters is the exception to the typical floors. The roof uses a different system consisting of 1 ½" 20 gage roof deck, steel beams and steel K series joists. However, the roof system uses 2" 20 gage metal deck with a 2 ½" lightweight concrete topping at the penthouse. Where the penthouse is absent, roof uses a fully adhered EPDM roofing system including the membrane over ½" protection board over tapered insulation over 5/8" type X GWB over the roof decking.

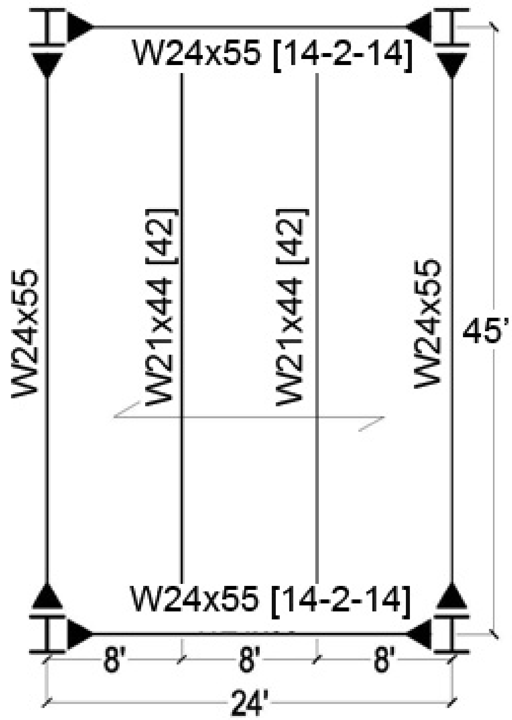
LATERAL SYSTEM

The Westinghouse Corporate Headquarters Building One uses moment connections at every column to resist lateral loads.

COLUMNS

The columns used in the headquarters are typical for a mid-rise building. The large columns in the basement and first floor of the building are W36x230 at the largest, but typically are W14x90. The W36x230 columns are so large due to the entire front façade of the building bearing on a W36x230 beam and the two columns. On the roof, any columns that do not continue up from the fifth floor are W10x49 or W10x33. The rest of the building is generally the same size, of course with some smaller sizes of columns, such as W10's on the fifth and roof levels. The base plates have four possible layouts and range in thickness from 1 ¾" to 3".

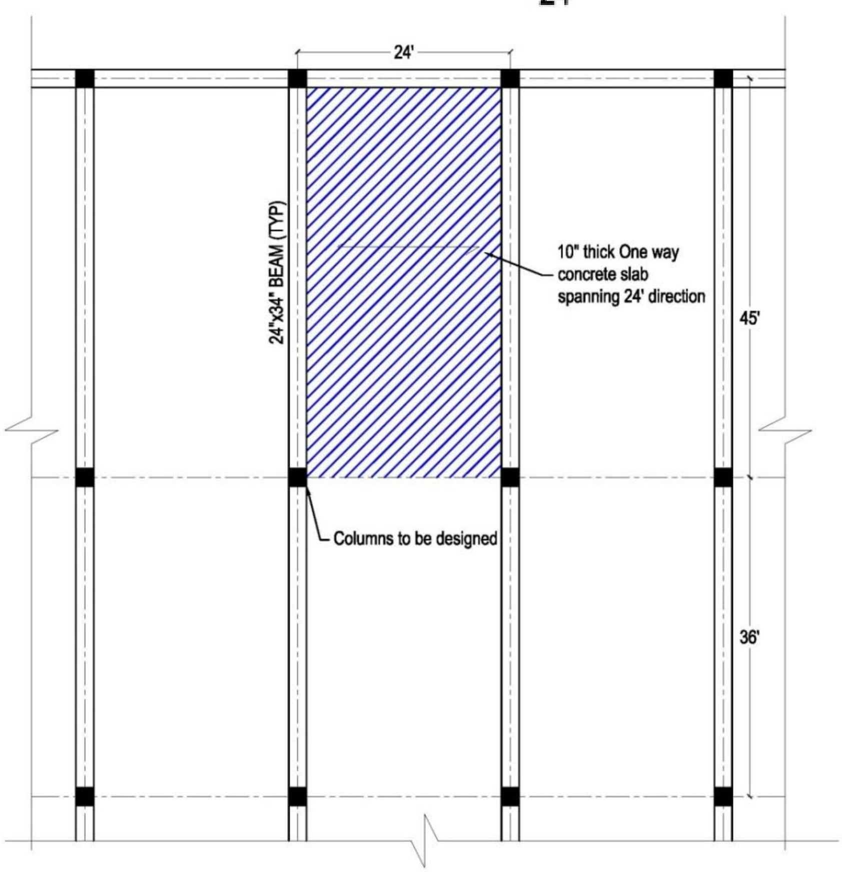
Problem Statement



It has been concluded the original composite deck and beam system is the most logical for time and space considerations. This can be seen in Technical Report 2. However, with wind moment connections at every column, the lateral system could be explored further for efficiency. The size of the typical bays is fairly large and leads to larger beam sizes to keep the deflection reasonable. A one way reinforced concrete slab with beams would be the best way to approach the 2:1 bays.

Due to the desires of the owners, a LEED certified building was required. Making the building a LEED Silver Rated building instead of just certified would be most desirable and would be beneficial research. With a building and campus so large, integrating the site into the building is a must.

Since so much is changing with respect to the structural system of the building, these changes must be evaluated with respect to time and cost, and then deemed worthwhile or not for the building.



Solution Method

The building will be redesigned for concrete with one way reinforced concrete floors with beams. With the current column layout, the one way slab has been shown to be more efficient than the two way slab. Shear walls and concrete moment connections will considered for the lateral system, but shear walls will not be the main system, just a supplement. In addition to changing the building to a concrete system, a green roof will be added to bring the building closer to the campus and its surroundings. Since the building is changed to concrete, the foundations will have to be re-examined and resized for the new loads. The building will be designed using a combination of hand calculations with ACI 318-08, IBC 2006, and an ETABS model.

Breadth Topics

Construction Management Breadth Study

Before a final response to the building once the proposed changes can be made, cost and schedule must be taken into consideration. Since the material is changing, there will definitely be a cost impact. Also, concrete takes more time to erect than steel due to the formwork, and thus creates a schedule impact. Concrete requires less lead time than steel, so the building construction would not be delayed. A construction schedule will be created and analyzed in addition to a cost analysis in order to obtain more thorough conclusion on the effectiveness of the new system.

Sustainable Architecture Breadth Study

The Westinghouse Electric Company also wants the building to be LEED certified. There are ways to make concrete buildings sustainable and even to earn LEED points for the concrete. By changing the admixtures in the concrete, such as adding more fly ash and more recycled material, the concrete has the potential to be greener than a steel alternative. The use of more sustainable concrete will be carefully researched and implemented. Also, as this building is the corporate headquarters, it should stand out. Creating a green roof would incorporate the building into the campus and surroundings. Achieving a LEED Silver rating rather than just certified would be ideal. This thesis project will explore ways to gain these points without compromising the integrity of the building will be explored.

TASKS

PART 1 DEPTH STUDY

TASK 1: Analyze potential sustainable concrete mixtures

a. Research types of admixtures and how they affect the strength of the concrete
b. Select a sustainable concrete mixture with recycled material
c. Determine the strength of the chosen concrete
d. Collect preliminary cost estimates for materials and labor

TASK 2: Determination of loads

a. Determine superimposed loads from construction documents
b. Determine superimposed live loads per ASCE 7-05

TASK 3: Preliminary Sizing

a. Determine slab and beam sizes using Technical Report 2 as a guide
b. Determine all gravity loads for column transfer
c. Determine column sizes

TASK 4: Analyze effect of floor system for building

a. Create ETABS model
b. Compare beam sizes to preliminary sizes
c. Compare slab to preliminary size
d. Compare column sizes to preliminary

TASK 5: Determine lateral loads

a. Calculate seismic loads based on model weights and ASCE 7-05 Chapter 12
b. Calculate wind loads for new building with heights using ASCE 7-05 Chapter 6

TASK 6: Determine lateral system

a. Evaluate where shear walls may be beneficial
b. Design shear walls for lateral loads
c. Determine locations of concrete moment connections
d. Design concrete moment connections
e. Update beam and column sizes for lateral loads
f. Spot check updated column sizes with PCA column
g. Update ETABS model

PART 2 BREADTH STUDIES

TASK 1: Construction Management Study

a. Contact Construction Manager at Turner and obtain schedule and construction cost for existing building, or, if required, generate schedule for composite steel building
b. Determine size of one concrete column without green roof load
c. Using R.S. Means Catalog determine construction cost estimate for concrete columns with and without green roof load
d. Determine implications of new framing system on the schedule
e. Input construction data into Primavera or Microsoft Project to generate schedule
f. Compare existing schedule and cost to generated ones for new structural system and how adding a green roof impacts the cost and schedule

TASK 2: Sustainable Architecture Study

a. Conduct study of LEED certified buildings
b. Investigate ways to achieve LEED silver rating and determine which are practical for this building
c. Integrate these methods into the building
d. Determine number of LEED points achieved and if Silver rating is not only attainable but justifiable

PART 3: MISCELLANEOUS TASKS

TASK 1: Finish final written report

TASK 2: Prepare presentation

TASK 3: Post all files and finalize website

TIMETABLE

Task		Jan. 12-18	Jan. 19-25	Jan. 26- Feb. 1	Feb. 2-8	Feb. 9-15	Feb. 16-22	Feb. 23-Mar. 1	Mar. 2-8	Mar. 9-15
1-1 a	Research types of admixtures									
1-1 b	Select a sustainable concrete mixture									
1-1 c	Determine the strength of the chosen concrete									
1-1 d	Collect preliminary cost estimates for materials and labor									
1-2 a	Determine superimposed loads from documents									
1-2 b	Determine superimposed live loads per ASCE 7-05									
1-3 a	Determine slab and beams sizes									S
1-3 b	Determine all gravity loads for column transfer									P
1-3 c	Determine column sizes									R
1-4 a	Create ETABS model									I
1-4 b	Compare beams sizes to preliminary sizes									N
1-4 c	Compare slab to preliminary size									G
1-4 d	Compare column sizes to preliminary									B
1-5 a	Calculate seismic loads									R
1-5 b	Calculate wind loads									E
1-6 a	Evaluate where shear walls could potentially be beneficial									A
1-6 b	Design shear walls for lateral loads									K
1-6 c	Determine locations of concrete moment connections									
1-6 d	Design concrete moment connections									
1-6 e	Update beam and column sizes for lateral loads									
2-1 a	Contact CM for Schedule and estimate									
1-6 f	Spot check updated column sizes with PCA column									
1-6 g	Update ETABS model									

Task		Mar. 9-15	Mar. 16-22	Mar. 23-29	Mar. 30-Apr. 5	Apr. 6-12	Apr. 13-19	Apr. 20-26	Apr. 27-May 3	May 4-11
1-6 d	Design concrete moment connections									
1-6 e	Update beam and column sizes for lateral loads						P			
1-6 f	Spot check updated column sizes with PCA column						R			
1-6 g	Update ETABS model						E			
2-1 a	Contact CM for Schedule and estimate	S					S			
2-1 b	Determine size of one concrete column without green roof	P					E			
2-1 c	R.S. Means Catalog determine construction cost estimate	R					N			
2-1 d	Determine implications of system on the schedule	I					T			
2-1 e	Generate schedule	N					A			
2-1 f	Compare existing schedule and cost to generated ones	G					T			
2-2 a	Conduct study of LEED certified buildings						I			
2-2 b	Investigate ways to achieve LEED silver rating	B					O			
2-2 c	Integrate these methods into the building	R					N			
2-2 d	Determine number of LEED points achieved	E					S			
3-1	Finish final written report	A								
3-2	Prepare presentation	K								
3-3	Post all files and finalize website									