Science Center Research Park 3711 Market St. Philadelphia, PA

The Pennsylvania State University Department of Architectural Engineering Senior Thesis 2009-2010

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[THESIS PROPOSAL]

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EXECUTIVE SUMMARY

The Science Center Research Park is a 401,032 GSF mixed-use building and is approximately 144 feet tall. It currently has the largest green roof in the city of Philadelphia. The building includes offices, wet labs, retail space, and a 500 car parking garage. The structure is made up of steel construction, and composite deck. Lateral support is provided by steel braced frames using HSS steel shapes for cross-bracing. The ground floor is a reinforced slab on grade with grade beams, and drilled caissons that support the buildings columns.

This thesis proposal states that the existing design of the Science Center Research Park building is a sufficient design. The proposal is for the relocation the building into an active seismic zone. The relocation will cause the need for re-calculation of the lateral loads and an investigation for different lateral systems to resist the new controlling lateral loads. The composite steel slab will be change from normal weight concrete to light weight concrete, and gravity structural members will be reduced in size if possible.

The breadth topics include the investigation of the impact on the scheduling and cost of the building, and the building enclosure option of blast-resisting glazing. Information on the existing building's schedule and cost will need to be obtained. The building enclosure breadth will take more investigation.

At the end of this report is an appendix that contains all the calculations for the loads stated above.

INTRODUCTION

The Science Center Research Park is an addition to the growing research/science development in the University City area. "The Science Center is the nation's preeminent destination for early-stage life science companies across the globe", said Pradip Banerjee. The building includes offices, wet labs, retail space, and a 500 car parking garage. It is covered by glass curtain wall, stone, and a brick veneer along the Market Street facade.

Technical Report 3 analyzes the existing lateral system for the Science Center Research Park building in order to gain a better understanding of how wind and seismic loads are distributed. Conclusion will be made on the validity of structural members designed for the lateral system.

CODE

CODE / REFERENCES

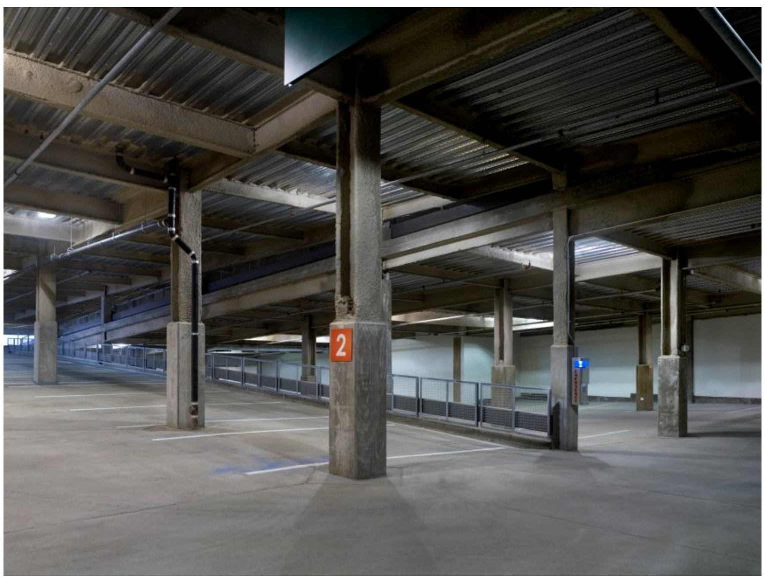
- ASCE 7-05 *Minimum Design Loads for Buildings and Other Structures*
- IBC 2006 *International Building Code*
- ACI 318-08 *Building Code Requirements for Structural Concrete*
- AISC 13th Edition Steel Construction Manual

Note: The following codes and references were used in the original design and in this report. All references are up-to-date building design standards.

EXISTING STRUCTURAL SYSTEM

FOUNDATION

The foundation system is composed of cast-in-place reinforce concrete grade beams and piers. The deep foundation consists of drilled caissons that range from 3 to 5 feet in diameter, and 20 to 30 feet below grade. These caissons can carry loads up to 1900 kips depending on the size. The general thickness of the slab on grade is either 4 or 6inches depending on indication on plans, but is also 12 inches thick in some areas. The columns are also cast-in-place in some areas of the ground floor, but transfer to steel columns. All the concrete in the building has a compressive strength of 4000 psi; except for the caissons and steel column encasements have a compressive strength of 3000 psi.

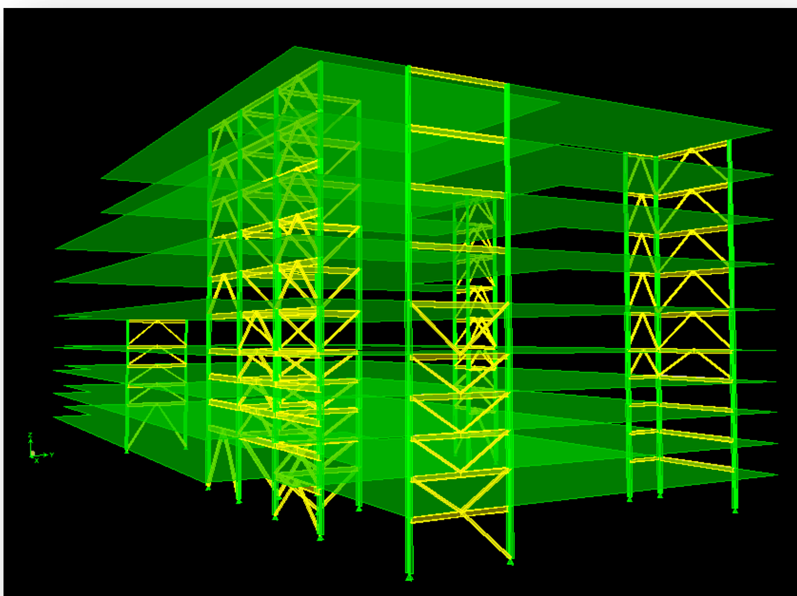


FLOOR SYSTEM

The floor system is a composite steel slab system on steel beams with a typical bay size of 31’6” x 31’6”. The typical composite deck is composed of 6 inches of normal weight concrete and 1.5” – 18 gauge composite steel decking with ¾” studs. The floor is supported typically by W 18 x 40 beams and W 24 x 84 girders, but there are large amount of other W - shapes used. The roof consists of 1.5” – 18 gauge steel roof deck supported typically by W 16 x 26 beams and W 24 x 55 girders. Refer to typical bay layout and overall plan such as shown on page 20.

LATERAL SYSTEM

The lateral system is composed of braced frames strategically placed on each floor. The braced frame can be located in the walls of the main elevator and stairwell core in the center of the building, in some exterior walls, and in the exterior walls of the penthouse. The braces are hollow structural steel members. Typical brace members are HSS 8 x 8's and HSS 6 x 6's were used, but several different sizes were used. The shear at the end of the beams is typically 10 kips, unless indicated otherwise on the plans. Also, column splices transmit compression forces in end bearing with a minimum of 15 kips of shear. Two bays of the braced frames in the center core connect into the buildings foundation transfer the shear load. Refer to typical braced frame layout shown on page 22.



PROPOSAL

PROBLEM STATEMENT

The Science Center Research Park building is composed of a steel structure and a composite steel floor slab using normal weight concrete. The use of a composite steel deck is very economical choice. The lateral system is a braced frame system consisted of HSS steel shape members. The braced frames are located around the edges of the building, and also around the main elevator/stairwell core to resist lateral loads caused by wind and seismic forces. Through analysis in technical reports 1 through 3 it was found that the structural design of the building meets strength, and serviceability requirements.

Changing the structural system to a concrete structural system would not make sense, because the increase of building weight would only increase the seismic load on the building. The composite steel slab system was found to have the largest span and one of the cheapest choices out of the researched steel floor systems in technical report 2. So the floor system will not be changed.

PROPOSED SOLUTION

As stated above, the Science Center Research Park building will remain a steel structure with a composite steel slab floor system. Steel is the most economical choice. The Science Center Research Park building is an 11 story building and by increasing the building weight it would only create a larger base shear created by lateral forces. To reduce the building weight the change from normal weight concrete to light weight concrete is a valid option. The gravity members can be reduced in size if the change to light weight concrete is taken into account.

Proposed Option:

Relocating the Science Center Research Park building into an active seismic zone would cause change of lateral loads. The lateral system will be redesigned to resist the new lateral loads. The existing lateral system is a braced frame system. Alternative lateral systems will be investigated in response to the change of controlling lateral loads. A 3D model will be created in ETABS to compare the drift values for the different lateral systems.

BREADTH OPTIONS

BREADTH STUDY 1: IN-DEPTH COST AND SCHEDULE ANALYSIS (CM)

This breadth study will investigate the scheduling and cost impact of the change of the floor slab to light weight concrete and the change of the lateral system. The scheduling changes consist of the additional time that would possibly be needed. The cost of the original design will be compared to the cost of the proposed redesign. The cost will be affected by change of member sizes, the proposed lateral system, construction time and labor costs.

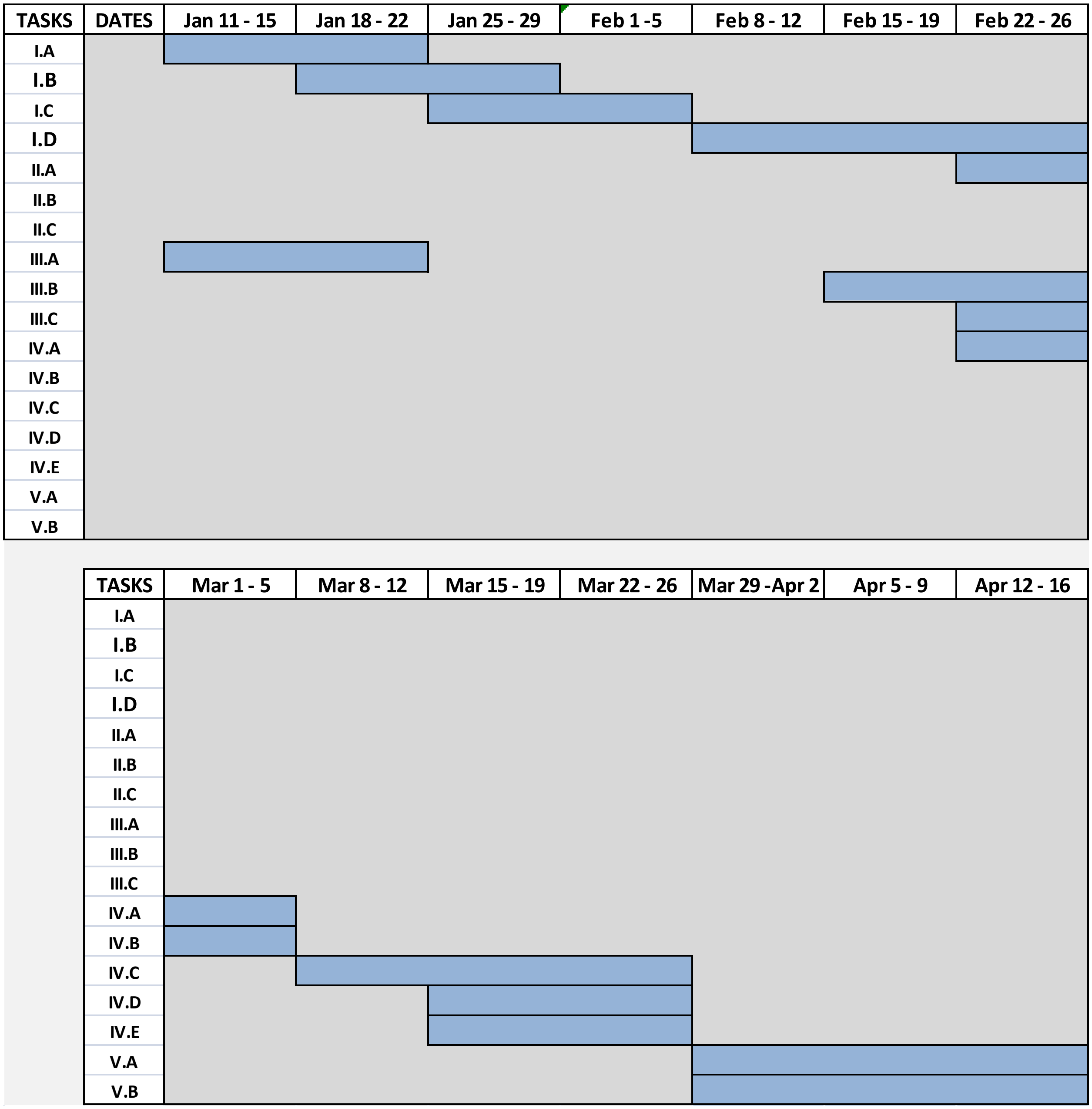
BREADTH STUDY 2: BUILDING ENCLOSURES

This breadth study will investigate the option of a blast-resistant glass façade. By changing the existing glass façade to blast-resistant glass façade considerations for acoustical, lighting and thermal effects have to be taken into account for. The disadvantages of the proposed changed should be investigated. The structure of the building also is able to with stand the blast load. An investigation on blast protection for the structural members in the parking garage should be done. Depending on the lateral system chosen for redesign, the lateral system might take the blast load into consideration also.

TASKS AND TOOLS

I. Structural: Change of slab to light weight concrete
   A. Determine building weight and new lateral loads
   B. Determine if gravity members can be reduced in size
   C. Determine alternative lateral systems
   D. Compare the alternative lateral systems using ETABS
II. Structural: Different Seismic Zone
   A. Determine new governing lateral loads
   B. Design members of the lateral system using ETABS
   C. Check if lateral system is adequate
III. Construction Management: Schedule and Cost Analysis
   A. Obtain schedule and cost information for the building
   B. Create a schedule and cost information for the redesign of structural members and compare with the original information
   C. Analyze benefits of the new design
IV. Building Enclosures
   A. Investigate the existing façade of the building
   B. Research blast loads
   C. Design the blast resistant glass façade using "Blast-Resistant Glazing Design" by H. Scott Norville & Edward Conrath in ASCE Journal of Architectural Engineering
   D. Determine the thermal and lighting loads for the glazing
   E. Compare the existing glazing system to the proposed glazing system
V. Final Presentation
   A. Organize and format final report
   B. Arrange Final Presentation

TIMELINE


TASKS
DATES
Jan 11 - 15
Jan 18 - 22
Jan 25 - 29
Feb 1 -5
Feb 8 - 12
Feb 15 - 19
Feb 22 - 26
I.A
I.B
I.C
I.D
II.A
II.B
II.C
III.A
III.B
III.C
IV.A
IV.B
IV.C
IV.D
IV.E
V.A
V.B
TASKS
Mar 1 - 5
Mar 8 - 12
Mar 15 - 19
Mar 22 - 26
Mar 29 -Apr 2
Apr 5 - 9
Apr 12 - 16
I.A
I.B
I.C
I.D
II.A
II.B
II.C
III.A
III.B
III.C
IV.A
IV.B
IV.C
IV.D
IV.E
V.A
V.B