

Barshinger Life Science & Philosophy Building

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Structural Option  
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## Thesis Proposal Improving Design Efficiency

### Executive Summary

The Barshinger Life Science and Philosophy Building will be the largest construction project in the long history of Lancaster, Pennsylvania's Franklin and Marshall College. At a total cost of \$45 million, the 102,000 square-foot building will include state-of-the-art classrooms and laboratories, a greenhouse, a multi-story atrium, a 125-seat lecture hall, a commons for meetings and gatherings, and a vivarium for the study of primates and rodents.

This Thesis Proposal distinguishes the specific tasks that I hope to accomplish during the spring 2006 semester. The analyses previously completed for Technical Reports 1 • 3 identified specific aspects of the Barshinger Life Science and Philosophy Building at Franklin and Marshall College for further in-depth investigations. The overriding goal of the investigations can be characterized as "improving design efficiency."

Due to the relative simplicity of the structure, my depth topic will encompass both the lateral and foundation systems. Whereas the lateral system will be made more efficient within the existing concentrically-braced frame design, the foundation system will be investigated for a potential change from shallow spread footings to concrete caissons.

The breadth work focuses on two topics: constructability analyses of the altered systems from the depth topic and acoustic design evaluation for the large lecture hall.

This proposal includes the following categories:

- § Building Program Overview
- § Structural System Overview
- § Depth Topic
- § Breadth Topics (2)
- § Prospective Research Topics
- § Task Breakdown & Methodology
- § Schedule

## 1.0 The Building Program

The Barshinger Life Science and Philosophy Building will be the largest construction project in the long history of Lancaster, Pennsylvania's Franklin and Marshall College. The three-story Georgian-Colonial Revival structure will house the departments of biology, psychology, and philosophy, as well as two interdisciplinary programs in biological foundations of behavior and scientific and philosophical students of mind. At a total cost of \$45 million, the 102,000 square-foot building will include state-of-the-art classrooms and laboratories, a greenhouse, a multi-story atrium, a 125-seat lecture hall, a commons for meetings and gatherings, and a vivarium for the study of primates and rodents.

## 2.0 Structural System Overview

### 2.1 Superstructure

The building superstructure is comprised of composite slab-on-deck in combination with composite wide-flange steel beams supported by wide-flange columns bearing on concrete piers and shallow footings. The framing system is separated into approximately 20'x30' bays. Floor-to-floor heights are typically found to be 14-feet. A typical floor frame consists of 2-inch composite metal deck with 4 ½-inches of normal weight concrete above the flutes. The composite slab is then carried by W16x26 filler beams spaced 7-feet apart. Interior girders, of size W18x40, are typically carried by W12x65 columns, sized for ease of fabrication and erection considering the OSHA-required four anchor bolt pier connection.

### 2.2 Lateral Force Resisting Systems

The structure's main lateral force resisting system is composed of ten concentrically braced steel frames of varying sizes. These frames typically utilize W12 shapes for the vertical and W14 shapes for the horizontal members with ½-inch thick HSS shapes for the braces. All of the steel members in the frames are specified to be A992 steel. The ten frames are located throughout the structure according to the Figure 2.2.1 below.

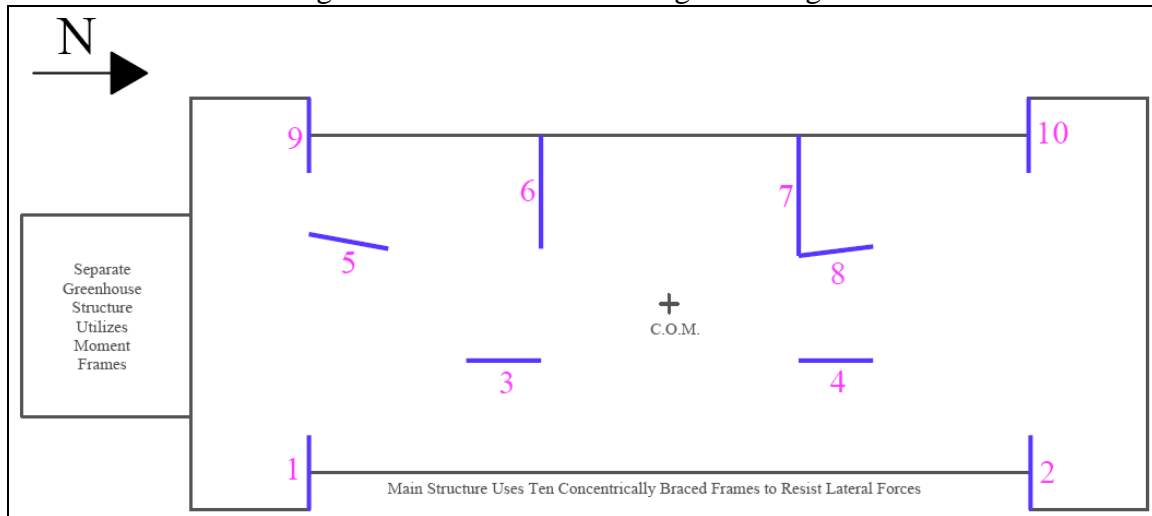


Figure 2.2.1 Layout of the 10 Concentrically Braced Frames

## **2.3 Foundations**

The superstructure of the Barshinger Building rests upon shallow foundations, specifically spread footings. In the geotechnical report for the site, Advanced GeoServices Corp. of West Chester, PA recommended that the foundations not exceed an allowable bearing pressure of 3,000 pounds per square foot (psf). Large footings will be located to transfer the loads from the braced frames into the ground and resist overturning moments. Test borings encountered intact rock at depths ranging from 3 to 23.5 feet. The recommendation put forth requires excavating the rock as necessary to provide an ample soil cushion for the footings to bear on.

## **3.0 Depth Topic**

The depth topic will focus on attempting to make the structure more efficient for environmental loads and constructability.

§ Technical Report #3 analyzed the lateral force resisting system and determined that the use of ten concentrically braced steel frames is somewhat inefficient. Ten frames is typically a lot for a short building such as this one. Through further analysis, I hope to minimize the number of frames in the structure thereby reducing the foundation requirements and improving construction durations by reducing the number of connections.

§ At the same time, I will also investigate the use of caissons or drilled piers as an alternative foundation system. The subsurface investigations demonstrate a potential for caisson foundations that can bear directly on rock, making the structure more stable in the event of a seismic event. I hope to learn more about deep foundation systems through this research. My career path will probably not require much knowledge of foundation systems and I see this as my chance to learn about them.

## **4.0 Breadth Topics**

### **4.1 Constructability Analyses**

The alternate lateral force and foundations systems will warrant constructability analyses to determine any cost or schedule savings that could result from the change. I will utilize R.S. Means 2005 catalogs to evaluate the potential of the new systems by comparing costs and durations for the old and the new systems..

### **4.2 Lecture Hall Acoustic Assessment**

For the second breadth topic, I will analyze the acoustic design of the large lecture hall on the ground floor of the building. It appears that the designers took specific care in designing the shape and acoustics of the space, and I want to evaluate how well they did. I was lead to this space by a peculiar aspect of the structure. The superstructure incorporates a Vierendeel truss into the exterior to span over the lecture hall the juts out of the west side of the building on the ground floor.

## **5.0 Prospective Research Topics**

- § Lateral Bracing Design Efficiency
- § Caisson/Driller Pier Foundations
- § Room Acoustics
- § Vierendeel Truss Application & Design

## **6.0 Task Breakdown & Methodology**

### **Lateral Force Resisting System Efficiency Evaluation/Alteration (*Task #1*)**

- § Develop improved structural models of the existing braced frames using STAAD.Pro computer software to recheck analysis from Technical Report #3.
- § Create Excel spreadsheets to analyze the efficiency of the current and altered systems.
- § Determine foundation requirements for the altered system using hand calculations and Excel spreadsheets.
- § Quantify any material savings for use in the breadth topic.

### **Caisson Foundation Design/Comparison (*Task #2*)**

- § Research the design of caisson foundations.
- § Redesign the current foundations to include any changes made to the lateral system using hand calculations and Excel spreadsheets.

### **Constructability Analyses (*Task #3*)**

- § Determine quantities of steel braced frames, concrete foundations, and excavation material from the depth analyses.
- § Calculate cost and time savings using R.S. Means 2005.

### **Lecture Hall Acoustic Assessment (*Task #4*)**

- § Determine volume and wall areas for lecture hall.
- § Calculate the reverberation time for the space using product information.
- § Evaluate the ceiling reflection capability.

**Compile Final Report for Printing (*Task #5*) | April 5<sup>th</sup>**

**Prepare PowerPoint Presentation for Faculty Jury (*Task #6*) | April 10-12<sup>th</sup>**

**Prepare for Professional Jury Presentation (*Task #7*) | ?????**

## 7.0 Schedule

<b>Week</b>	<b>Date*</b>	<b>Task #</b>
1	January 9	1
2	January 16	1
3	January 23	1
4	January 20	2
5	February 6	2
6	February 13	2
7	February 20	3
8	February 27	3
9	March 6	Spring Break
10	March 13	4
11	March 20	4
12	March 27	5
13	April 3	5, 6
14	April 10	6
15	April 17	7

*\* All dates correspond to Mondays.*