December 14, 2007

LOCKWOOD PLACE
BALTIMORE, MD

[THESIS PROPOSAL]

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EXECUTIVE SUMMARY

Lockwood Place in Baltimore, Maryland is a thirteen story, one hundred and ninety four foot, mixed-use development building utilized primarily for retail and corporate businesses. The building enclosure is predominately made of steel with a glass curtain wall façade. Directly adjacent to the building sits a covered mall area and a parking garage. The parking garage connects to the second level of Lockwood Place through a corridor and lobby. Gravity framing consists of a composite steel system and lateral framing is comprised of both eccentric braces and moment frames.

The goal of this report is to propose an alternative structural system to the existing conditions. The alternative system will be fully developed through thorough investigation and redesign. Proposed solutions will be carried out through described methods, tasks and tools, and a preliminary schedule.

The existing structural system accomplishes the goal of long spans and open spaces to allow for tenant flexibility. To accommodate high floor to ceiling height and small depth between floors, MEP systems run through the structural beams and girders. Providing holes and necessary reinforcement through almost all beams and girders to allow space for MEP systems could be costly and time consuming. The sizes of the existing steel members have been increased to accommodate vibration created in large spans and to maintain enough capacity with the holes. Future changes in MEP systems are limited due to the necessity of holes in structural members.

A proposed post-tensioned two-way flat slab will achieve the goals of large floor to ceiling heights and a small structural sandwich between floors. The intent of the new floor system is to allow MEP systems to run underneath the floor and have flexibility for future changes. The lateral system will be adjusted to accommodate the new concrete floor system. It will be comprised of shear walls located around elevators/stairwells and concrete moment frames around the edges of the building. To remain consistent with the new concrete system, columns will be redesigned in concrete to resist gravity and lateral loads when applicable.

Two breadth studies will be completed including a comparative cost and schedule study and a lighting investigation. A comparative cost and schedule study will identify differences between the existing conditions structural system with the proposed structural system. A lighting investigation will be conducted to ensure that the open-spaces the structural system provides are visually appealing and fully utilized.

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INTRODUCTION

As an expansion to the corporate/entertainment district of Baltimore's Inner Harbor, the Lockwood Place Office Building is located directly across from the National Aquarium. The building has a curved glass, curtain wall façade and abuts a covered mall area and an adjacent parking garage. It is comprised of thirteen floors and over 300,000 square feet of floor space.

At ground level, a visitor is welcomed by a grand lobby entrance. At the second level, a visitor has direct access to the adjacent parking garage. At the third level, tenants have the option to utilize two balcony spaces. Each floor is designed with large bay sizes, allowing for open floor plans. The spaces on the first two floors, occupied by retail tenants, rise to a combined height of 34 feet. The third through the twelfth floors are occupied by corporate tenants and each floor height is 13'-6". A penthouse is constructed on the thirteenth floor. The floor height is 18' and it sets back slightly from the rest of the building. Lockwood Place is designed to accommodate a range of tenants' needs, while providing a sleek exterior look with each story consisting of full height glass and large spans.

EXISTING SYSTEMS

Floor System

500 East Pratt Street has a typical superstructure floor framing system made of composite steel beams and girders. The slab is 3-1/4" light weight concrete topping on 3"x20gage galvanized metal deck. For composite beam action, ¾" diameter by 5-1/2" long headed shear studs are used, conforming to ASTM A108, Grades 1010 through 1020. Typical bay sizes are 30'-0" x 30'-0" and 45'-0" x 30'-0." Infill beams are spaced 10'-0" on center, framing into a typical girder size of W24x62. All steel conforms to ASTM A572, Grade 50, unless otherwise noted on the drawings. MEP systems are run through the structural framing system. Holes created in the beams and girders from the MEP systems are reinforced according to AISC Design Guide 2. A two hour fire rating is provided for all floor slabs, beams, girders, columns, roofs, and vertical trusses. The typical floor plan can be viewed in Figure 1 below. A typical bay size is highlighted by a red box.

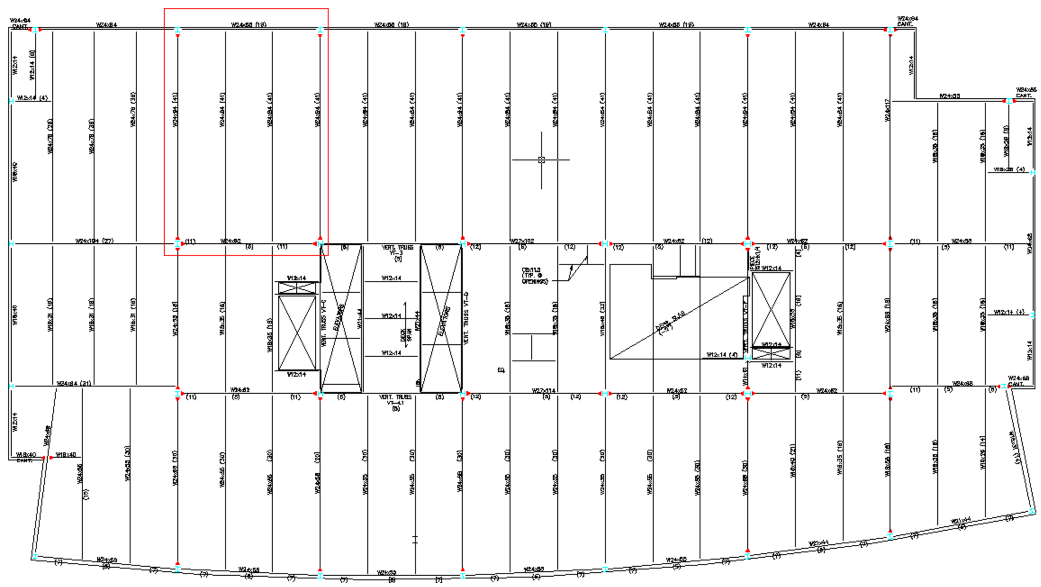

Figure 1. Typical Floor Plan

Roof System

At the penthouse level of Lockwood Place, the building steps back creating a high roof and a low roof. A third roof, the highest point of the building, is created by an extended machine room ceiling located at the penthouse level. The roof on the penthouse is sloped slightly downward into the machine room wall. While the framing of the penthouse floor is consistent with the typical building superstructure system, infill beam sizes are reduced due to smaller bay widths. All three roof systems are 1-1/2"x20ga. Galvanized type 'B' metal deck. Infill beams are located at 6' on center. Beam sizes range from W10x12 to W24x76 depending on their location.

Exterior slabs that are located at level twelve are 4-1/2” normal weight concrete topping on 3”x20gage galvanized composite metal deck. The slabs are reinforced with 6x6-W2.9xW2.9 W.W.F. Waterproofing is required for all exterior slabs.

A screen wall is located on level twelve to disguise mechanical equipment. A canopy extends over a balcony on the twelfth floor. The canopy is also made of 1-1/2”x20gage galvanized type ‘B’ metal deck.

Lateral System

Lockwood Place’s lateral system is comprised of moment frames and eccentric braced frames. Moment frames run both east/west and north/south directions. Eccentric braced frames are located around the elevators/elevator lobby. Sizes of the braces range from W14x90 at the base of the building to W8x31 at the top of the building and are pinned connections. Lateral loads were distributed based on the rigidity of each frame. Columns that have eccentric braces framed into them are designed to be fixed to their supports at the base of the building. All other columns are designed to have pinned bases. The lateral system can be viewed in Figure 2 and Figure 3 shown below.

Figure 2. Lateral System Plan

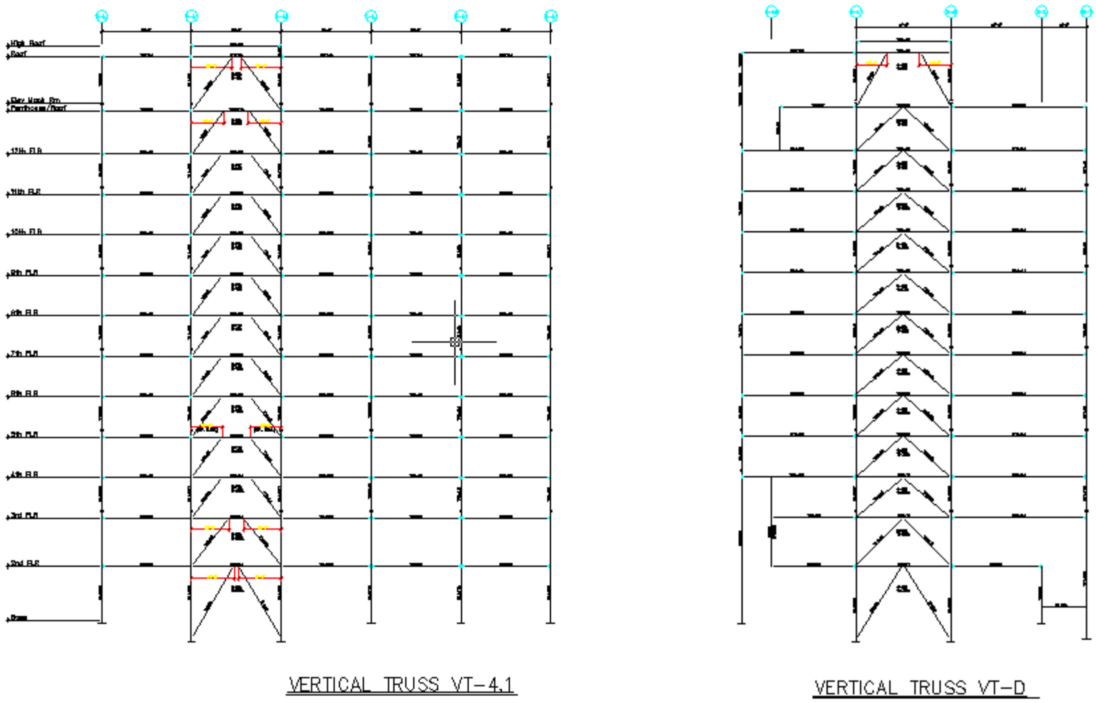

Figure 3. Lateral System Elevation

Foundation

Being located along Baltimore's Inner Harbor, Lockwood Place's soil consists of existing man-made fill. The maximum soil bearing pressure for spread footings is 1000psf. To accommodate for this bearing capacity, the foundation system is made of drilled caissons. Caisson shaft diameters range from 2'-6" to 6'-0." Typically, they extend a minimum of 1'-0" into Gneiss bedrock and have a minimum concrete compressive stress of 4500psi.

Grade beams travel between pile caps and have a minimum concrete compressive strength of 4000psi. Each grade beam ranges in size from 18"x24" to 24"x42" and is reinforced with top and bottom bars.

PROBLEM STATEMENT

The existing structural system accomplishes the goal of long spans and open spaces to allow for tenant flexibility. A composite steel structural system is the logical choice for the existing Lockwood Place building. Large bay sizes to allow for open floor plans and provide tenant flexibility are easy accomplished.

To accommodate high floor to ceiling height and small depth between floors, MEP systems run through the structural beams and girders. Providing holes and necessary reinforcement through almost all beams and girders to allow space for MEP systems could be costly and time consuming. The sizes of the existing steel members have been increased to accommodate vibration created in large spans and to maintain enough capacity with the holes. Future changes in MEP systems are limited due to the necessity of holes in structural members.

PROPOSED SOLUTION

A post-tensioned two-way flat slab will achieve the goals of large floor to ceiling heights and a small structural sandwich between floors. The intent of the new floor system is to allow MEP systems to run underneath the floor and have flexibility for future changes. The lateral system will be adjusted to accommodate the new concrete floor system. It will be comprised of shear walls located around elevators/stairwells and concrete moment frames around the edges of the building. To remain consistent with the new concrete system, columns will be redesigned in concrete to resist gravity and lateral loads when applicable.

Breadth Topics

1. With a complete redesign of the building's structural system, cost and schedule may vary significantly between the old and the new systems. An investigation of cost and schedule for the existing conditions and the proposed solution will be conducted. Results of each study will be compared.

2. The proposed structural system ensures that visitors of Lockwood Place are welcomed into large, open spaces at two different entrance lobbies. A lighting investigation will be conducted to ensure that these open spaces are accentuated and visually appealing. Alternative solutions will be provided in spaces that may lack luster.

METHODS

Structural Depth

Given a complete redesign of Lockwood Place's structural systems, the proposed design will be completed following the updated Maryland Building Code. Relevant references include ASCE7-05 and ACI 2005. The grid layout established for the building will remain. The floor system will be designed with RAM Concept and checked with simple hand calculations. The design will include concepts such as pattern loading and load combinations. A consultation for the post-tensioned design will be conducted with a practicing, professional engineer. Columns will be designed using a comparison of results from hand calculations, CRSI Design Handbook, and PCA Column. Forces distributed to the lateral system will be investigated using ETABS. Shear walls will be designed through hand calculations. Moment frames will be initially designed to assist in resisting gravity loads and will be checked by hand and the ETABS model to ensure that the necessary lateral resistance is provided. An investigation of connection details between the gravity and lateral systems will be conducted throughout the design process to establish the constructability of the proposed solution.

Breadth Studies

1. A comparison study of cost and schedule will be conducted for existing conditions and the proposed solution. Take-offs will be completed using R.S. Means 2005. Schedules will be developed in Microsoft Office Project. A consultation for the costs and schedules will be carried out with a Construction Management faculty advisor.
2. An investigation of the lighting in entrance lobby spaces will be conducted. A site visit will be made to document the existing lighting through photographs and personal notes. Alternative lighting options and improvements will be analyzed using a lighting design program. The optimum program to be used will be selected after the documentation of the site.

TASKS & TOOLS

Phase I: Post-tensioned Two-Way Flat Slab Analysis

1. Develop gravity loads according to ASCE-7-05
2. Design two-way slab using RAM Concept
    a. Establish slab thickness
    b. Design post-tensioned tendons
    c. Check for shear, moment capacity, and deflections
    d. Investigate vibration for floor system and verify acceptable for occupants
    e. Determine total depth of new system with MEP system incorporated

Phase II: Redesign of Columns

1. Determine column gravity loads according to ASCE-7-05
2. Design columns for gravity loads with PCA Column

Phase III: Design of Shear Walls & Moment Frames

1. Develop lateral loads according to ASCE-7-05
2. Determine forces distributed to shear walls and moment frames using ETABS
3. Design shear walls
4. Check moment frame capacity with combined gravity and lateral loads
5. Check deflections at lower levels along the adjacent building and total building deflection

Phase IV: Foundation Investigation

1. Check caissons for applied loads developed from columns
2. Investigate foundation for shear walls

Phase V: Breadth Studies

1. Cost & Schedule
    a. Perform take-off of existing and proposed structural systems
    b. Establish a schedule for existing and proposed structural systems
    c. Conduct comparison of cost and schedule
2. Lighting Investigation
    a. Visit site and document with personal notes and photographs
    b. Investigate lighting alternatives
    c. Check electrical capacity for lighting alternatives
    d. Specify additional electrical capacity if necessary

Phase VI: Final Project

SCHEDULE

Task	Week 1 Jan 14- Jan 19	Week 2 Jan 20- Jan 26	Week 3 Jan 27- Feb 2	Week 4 Feb 3- Feb 9	Week 5 Feb 10- Feb 16	Week 6 Feb 17- Feb 23	Week 7 Feb 24- Mar 1
Research Post-Tensioning	■						
Develop RAM Concept Model	■	■					
Recreate Gravity Loads & Design Floor System		■					
Design Columns for Gravity Loading using PCA Column			■				
Calculate Wind & Seismic Loads			■	■			
Develop ETABS model for Lateral System Analysis				■			
Design Shear Walls & Moment Frames					■	■	
Foundation Analysis & Design						■	■
Breadth 1: Cost & Schedule							
Breadth 2: Lighting Investigation							
Assemble Report							
Assemble Presentation							
Final CPEP Update							

Task	Week 8 Mar 2- Mar 8	Week 9 Mar 9- Mar 15	Week 10 Mar 16- Mar 22	Week 11 Mar 23- Mar 29	Week 12 Mar 30- Apr 5	Week 13 Apr 6 – Apr 12
Research Post-Tensioning						
Develop RAM Concept Model						
Recreate Gravity Loads & Design Floor System						
Design Columns for Gravity Loading using PCA Column						
Calculate Wind & Seismic Loads						
Develop ETABS model for Lateral System Analysis						
Design Shear Walls & Moment Frames						
Foundation Analysis & Design						
Breadth 1: Cost & Schedule	■					
Breadth 2: Lighting Investigation			■			
Assemble Report				■	■	
Assemble Presentation					■	■
Final CPEP Update						■

CONCLUDING REMARKS

The existing structural system of Lockwood Place satisfies the goal of large bay sizes. MEP systems are integrated within the structural system to provide large floor to ceiling heights along with a shallow structural sandwich between floor levels.

The proposed post-tensioned two-way flat slab system also strives to achieve large bay sizes and a shallow structural sandwich between floors, along with removing the need for MEP systems to be carried through the structural system. This new system will attempt to reduce the cost of the floor by eliminating holes in structural steel. The new system will also provide flexibility to changes in the MEP systems in the future. Columns and the main lateral load resisting system will be redesigned in concrete to fit with the proposed floor system. A comparative cost and schedule study will be conducted to identify differences the proposed solution may have compared to the existing conditions. Lighting investigations will be conducted to ensure open spaces that the structural system provides are visually appealing and fully utilized.

To guarantee that the proposed solutions are researched and developed fully, methods, tasks and tools, and a preliminary schedule have been established. Necessary adjustments are sure to be made during redesign process. Valuable experience will be gained through the investigation and completion of the proposed solutions to Lockwood Place.