THESIS PROPOSAL

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Structural

Layfield Tower
Peninsula Regional Medical Center
Salisbury, MD
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EXECUTIVE SUMMARY

This paper will propose an alternative design for the structural system of Layfield Tower to be presented as a thesis in April 2009. The original design of Layfield Tower is a structural steel frame with steel braced frames for lateral support. The proposed thesis will analyze and evaluate a reinforced concrete two-way flat slab system with drop panels at column locations. The lateral system will be comprised of reinforced concrete shear walls. This design will allow the building to maintain floor to floor heights and all architectural aspects. The original and alternative designs will then be compared based on efficiency and constructability.

Two breadth topics will also be investigated. First the costs and schedules of the original design and the alternative system will be compared and evaluated to see if there is any benefit to changing the structural design. The second breadth will be an analysis of the mechanical system located in the isolation rooms of the hospital.

INTRODUCTION

The Layfield Tower is part of an expansion and renovation project at Peninsula Regional Medical Center. It is located at 100 East Carroll Street in Salisbury, MD. It is a 200,000 square foot facility that will house a new emergency/trauma center, pediatric unit, intensive care unit, cardiac and thoracic and vascular unit and a neurosciences and stroke unit. The building also features a helipad on the lower roof with access to the third floor of the main tower. There is a connection to the existing hospital at the northeast corner. Construction on Layfield Tower was completed in 2008.

The structure is divided into two parts: the east side (Area A) with three stories and the west (Area B) with one story. An expansion joint connects the two sections of the building.

CODES AND MATERIAL PROPERTIES

Codes

The structural design of the Layfield Tower conforms to the requirements of the Maryland Building Performance Standards (MBPS) which has adopted the 2003 International Building Code (IBC) and ASCE 7-02. Structural steel design used the AISC Manual of Steel Construction Load and Resistance Factor Design, Second Edition, 2003. Concrete design used American Concrete Institute, ACI 318-02.

For this report, the latest versions of these codes were used. IBC 2006 and ASCE 7-05 were used for design loads and structural analysis. ACI 318-08 was used for structural concrete design and AISC Manual of Steel Construction, Load and Resistance Factor Design, Fourth Edition 2007 for structural steel.

Material Properties

Steel Members	
W-Shapes	ASTM A992, Grade 50
Channels, Angles, Plates, Bars	ASTM A36 or A572, Grade 50
HSS Sections	ASTM A500, Grade B
Structural Pipe	ASTM A53, Type E or S, Grade B
Braced Frame Members	ASTM A992 or A36
Steel Reinforcement	Grade 60

Concrete		
Footings	3000 psi	145 pcf
Slab-on-grade	3500 psi	145 pcf
Foundation walls	4000 psi	145 pcf
Suspended slabs	4000 psi	145 pcf
Slabs on Metal Deck	3000 psi	115 pcf
Building frame members	4000 psi	145 pcf
Building walls	4000 psi	145 pcf
Precast panels	5000 psi	145 pcf or 115 pcf

STRUCTURAL SYSTEM

Foundation

The foundation of Layfield Tower consists of cast-in-place reinforced concrete walls with spread footings along the perimeter of the building and spread footings underneath all interior columns. The wall footings vary from 6'-0" to 24'-0" and are 24 inches thick. Typical column footings in Area A are 12'-6" x 12'-6" and 35 inches thick. In Area B typical column footings are 8'-0" x 8'-0" and 24 inches thick. On the south side of both Areas A and B the basement floor is either 2'-0" or 6'0" below the basement floor on the north so the footings on the south side are all lower than those on the north side.

Superstructure

The main structural system is made up of structural steel W-shape members. Most connections are shear connections. The typical beam size in Area A (Figure 1) is W18x35 space at 10'-0" on center and in Area B (Figure 2) it is W 18x35 also spaced at 10'-0" on center(Beams are running east-west in figures below). Girders are typically W21x50 in both areas(running north-south in figures below). Columns in Area A are various W12 sizes. In Area B the typical column size is W12x53. The most typical bay is 30'0" by 30'0", but there are also column spacings of 28'0", 27'-8", and 26'0".

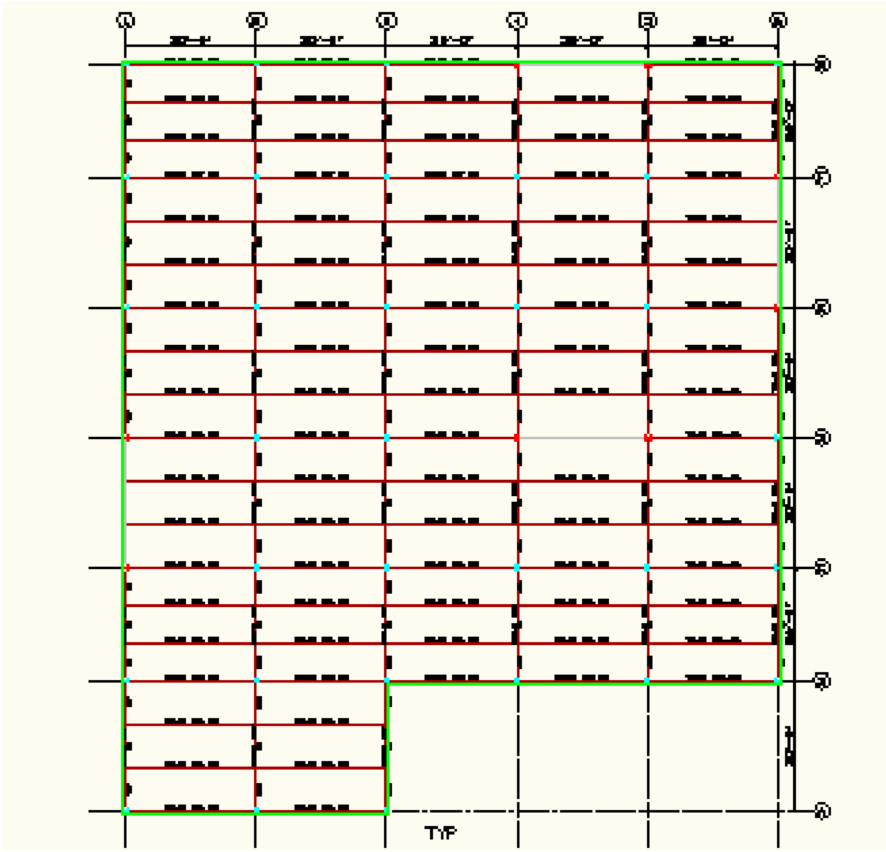


Figure 1, Area A

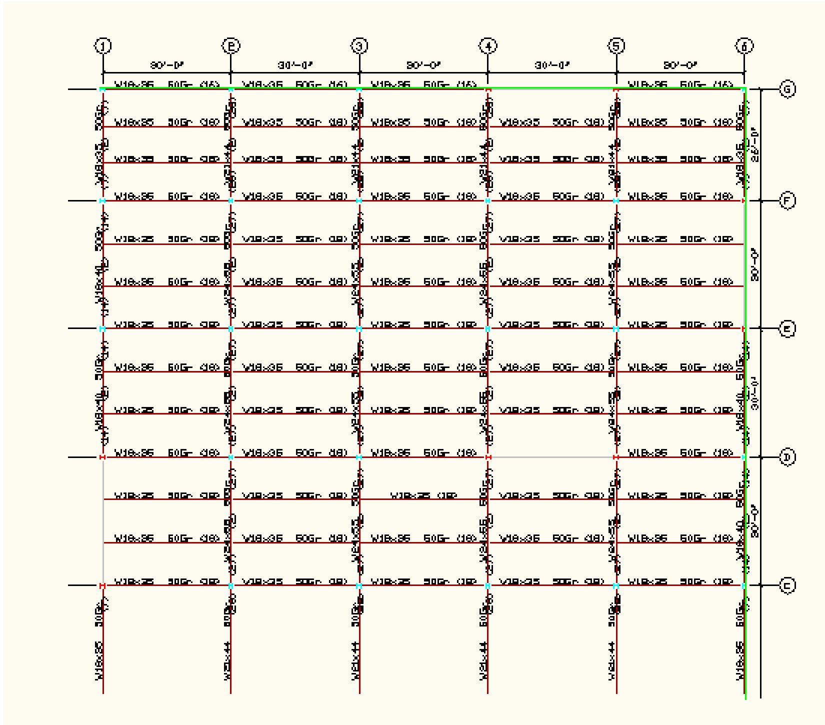


Figure 2, Area B

Floor System

Floor slabs are 3-1/4" lightweight concrete on 3" deep 20 gage, galvanized composite metal deck for a total thickness of 6-1/4". They are reinforced with 6x6 W2.1xW2.1 welded wire fabric. All shear studs are 3/4" x 5 3/16". The floor slab of the connector corridor is 4-1/2" normal weight concrete on 3" deck.

Roof System

The roof structural system of Area A is similar to the other floors. The roof of Area B has a typical beam size of W16x26 spaced at 10'-0 on center. Girders are similar to the rest of the building.

Lateral System

The lateral structural system is composed of braced frames, one in each direction. W12's are the typical members for the braced frames. All of the main frames are one bay wide, extending the full height of the building, and most are located along the perimeter walls of both Areas A and B. In Area A there is one near the elevator shafts located in the center of the building. Figures 3 and 4 show the locations of the braced frames by the orange highlighted lines. In Area B all frames are K-frames. All penthouses as well as the heliport are braced along all sides.

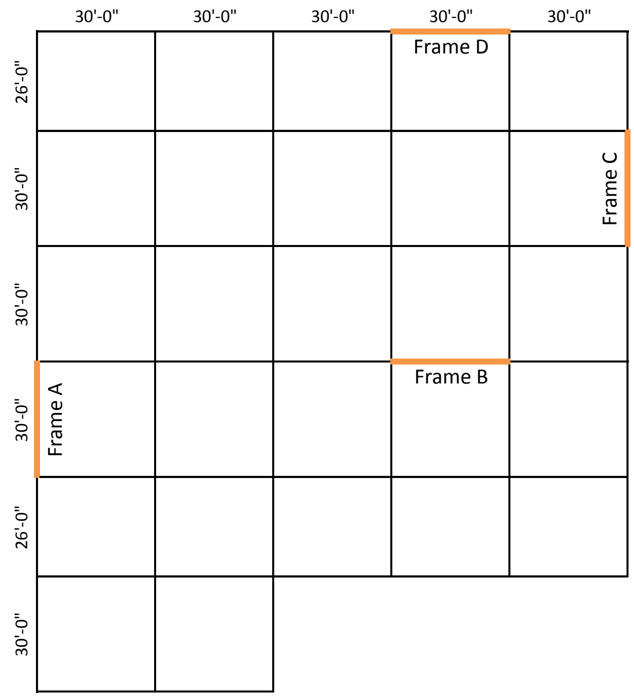


Figure 3, Lateral Braces Area A

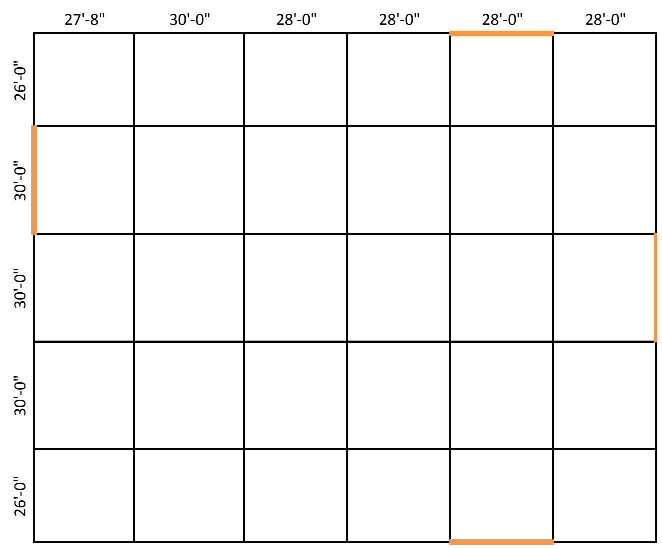
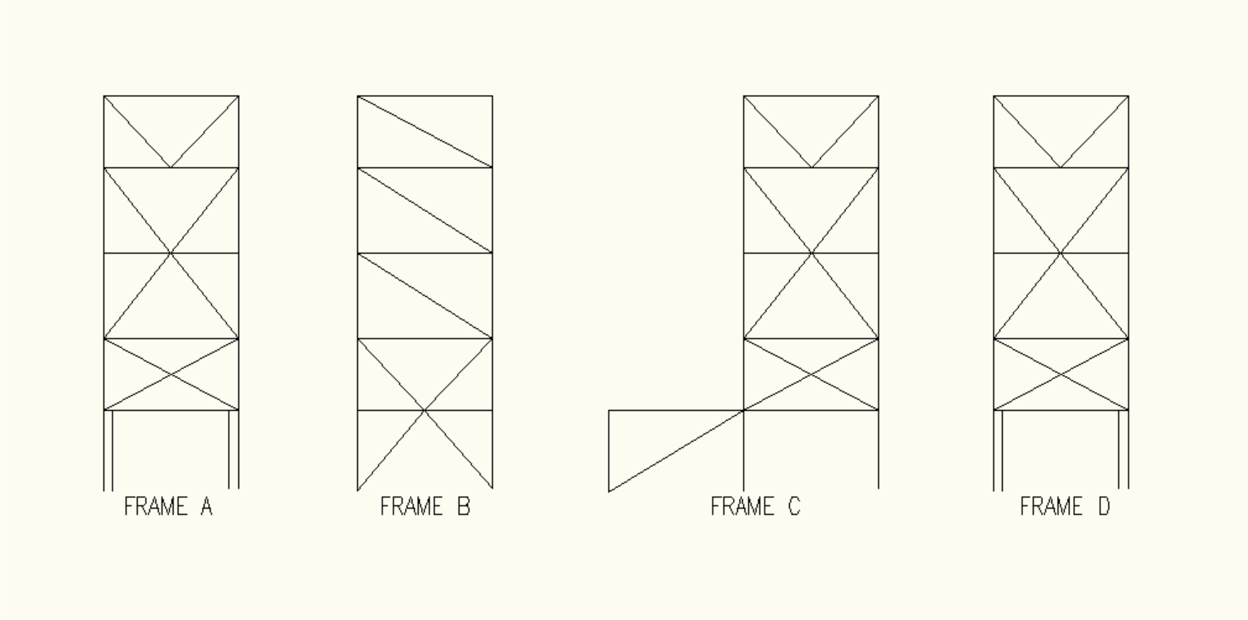


Figure 4, Lateral Braces Area B



PROBLEM STATEMENT

The current structural system and lateral system have been evaluated and it has been determined that an alternate system can be analyzed and evaluated. It must be designed to resist all loading including dead, live, wind and seismic loads. Current floor to floor heights must be maintained at either 16 feet or 19 feet.

PROBLEM SOLUTION

The alternative system to be investigated will be a reinforced concrete two-way flat slab system with drop panels at column locations. Floor thickness will be 8" and 18" at drop panels. Column sizes will be 24" x 24" and no beams will be necessary unless further analysis proves otherwise. The lateral system will consist of reinforced concrete shear walls located at elevator shafts and stairwells. Loads will be taken from IBC 2006 as well as self-weight of the system.

SOLUTION METHOD

The design of the reinforced concrete two-way flat slab floor system will be completed in accordance with ACI 318-08 Chapter 13 with help from a computer model analysis performed in RAM Structural System and PCA Slab. After obtaining this new slab, column load takedowns will be performed to acquire the new vertical loads imposed on the columns and checked using a computer model created in PCA Column. With these new loads the columns will then be redesigned. Shear walls will be reviewed by adding, subtracting, or moving them to new locations that will serve the new design more effectively. With these shear walls now in place both seismic and wind loads will be placed on the building using hand calculated loads in accordance with ASCE7-02 and distributed to the shear walls with the help of a RAM model. Finally the shear walls will be designed for the new loads imposed on them.

BREADTH STUDIES

1. Construction management issues based upon redesign of the structural system will be compared with the original costs and schedules to see if the new design is beneficial.
2. An analysis of the mechanical system for the isolation rooms will be performed.

TASKS & TOOLS

1. Two-way Flat Slab Floor System
    a. Determine loads per IBC 2006
    b. Determine slab thickness from ACI 318-08
    c. Design using Equivalent frame method
    d. Evaluate need for beams
    e. Check design using PCA Slab
2. Column Redesign
    a. Determine loads
    b. Design columns according to ACI 318-08 with aid of PCA Column
3. Lateral System
    a. Determine most efficient locations for shear walls
    b. Find wind and seismic loads on building using ASCE7-02
    c. Create RAM model
    d. Design walls using RAM
4. Breadth Studies
    a. Construction Management
        i. Obtain original costs and schedules
        ii. Determine new costs and schedules for structural redesign

iii. Compare and contrast original and redesign

b. Mechaniical Engineering

i. Find equipment data

ii. Perform analysis on isolation rooms

TIMETABLE

	Week 1 1/12-1/17	Week 2 1/18/-1/24	Week 3 1/25-1/31	Week 4 2/1-2/7	Week 5 2/8-2/14	Week 6 2/15-2/21	Week 7 2/22-2/28
Determine loads	■						
Design flat slab system		■	■				
Check design using PCA Slab			■				
Create Ram Model				■	■		
Column Design					■		
Determine wind/seismic loads						■	■
Design Shear walls							■
Breadth 1							
Breadth 2							
Final Report							
Final Presentation							
Present to faculty							

	Week 8 3/1-3/7	Week 9 3/8-3/14	Week 10 3/15-3/21	Week 11 3/22-3/28	Week 12 3/29-4/4	Week 13 4/5-4/11	Week 14 4/12-4/18
Determine loads							
Design flat slab system							
Check design using PCA Slab							
Create Ram Model							
Column Design							
Determine wind/seismic loads							
Design Shear walls	■	■					
Breadth 1			■				
Breadth 2				■			
Final Report					■		
Final Presentation					■	■	
Present to faculty							■