TECHNICAL REPORT III

LATERAL STRUCTURAL SYSTEM ANALYSIS

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EXECUTIVE SUMMARY

In this report the lateral structural system of Layfield Tower is analyzed and evaluated. A computer model was created using RAM Structural System, and using the Frame Module the braced frames of the building were analyzed for wind and seismic loading. Frames and individual members were evaluated for strength and drift. All members of the frames were found to be adequate to resist these lateral forces and it was found that the design of these members was governed by strength.

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.

This report will analyze the lateral force resisting system of Layfield Tower. Both wind and seismic loads will be considered. The results will be analyzed for strength and drift.

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

Gravity Framing System

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”.

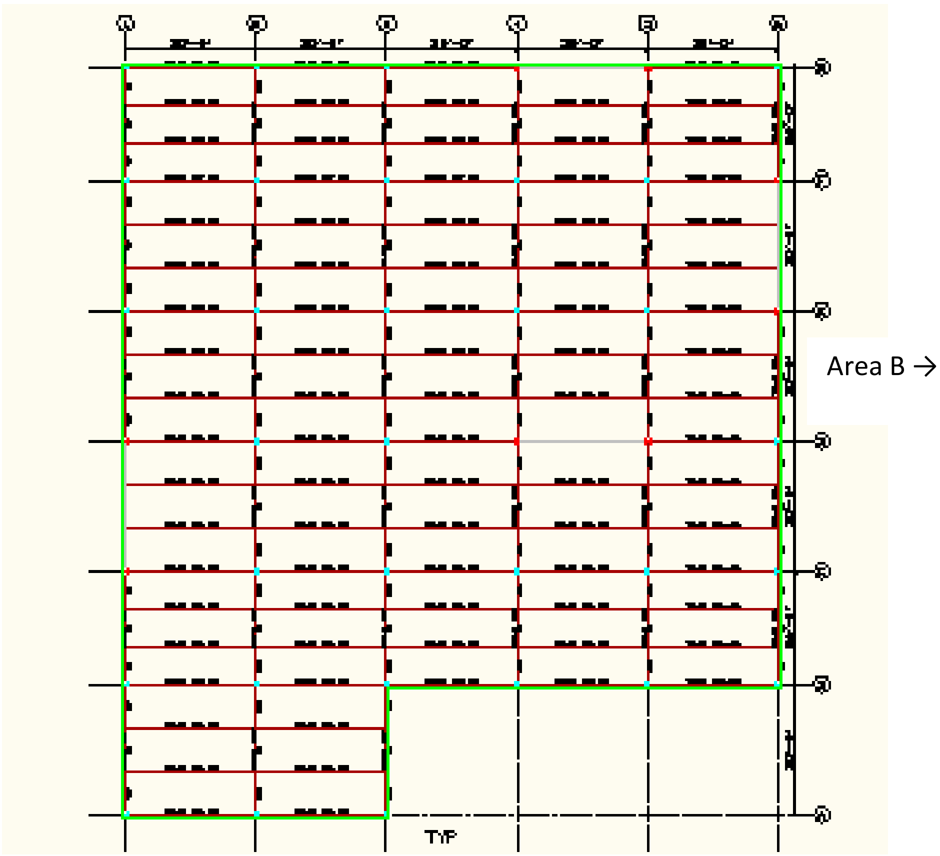


Figure 1, Area A

←Area A

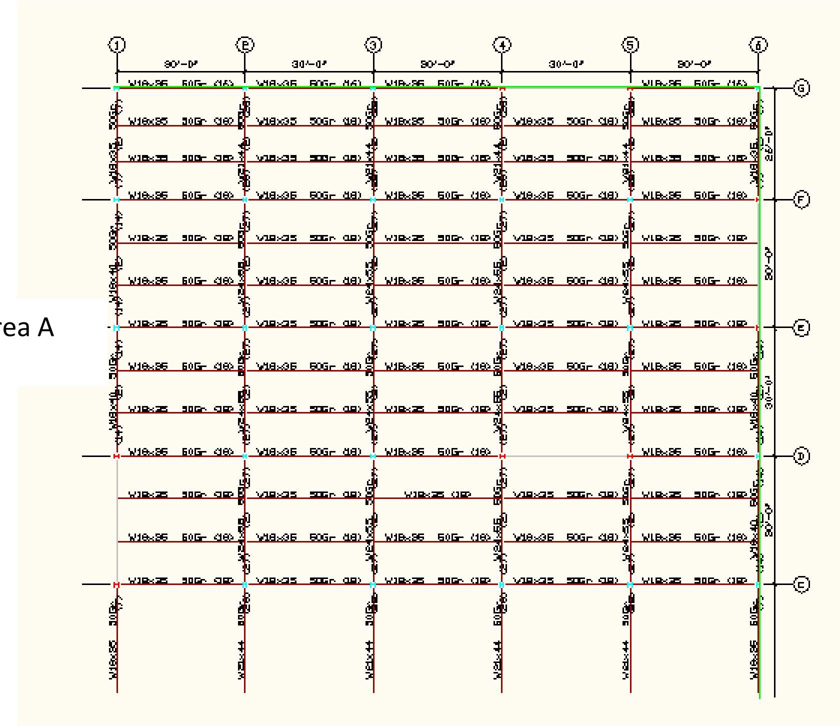


Figure 2, Area B

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.

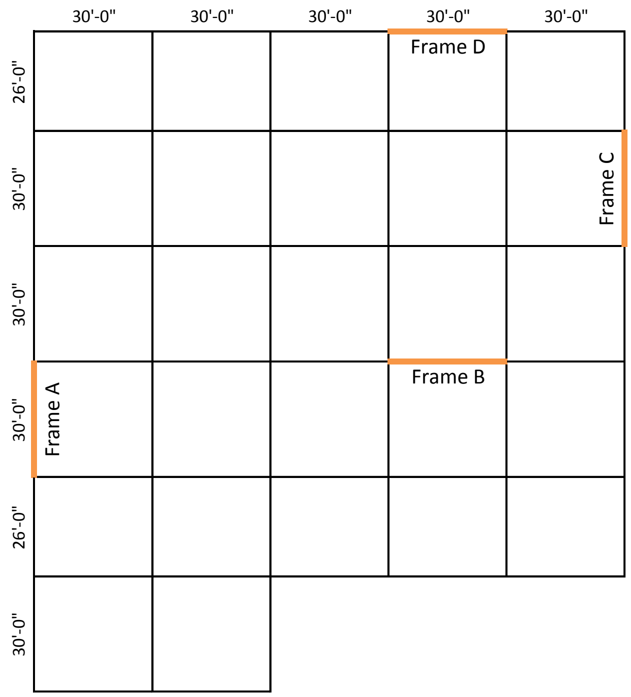


Figure 3, Lateral Braces Area A

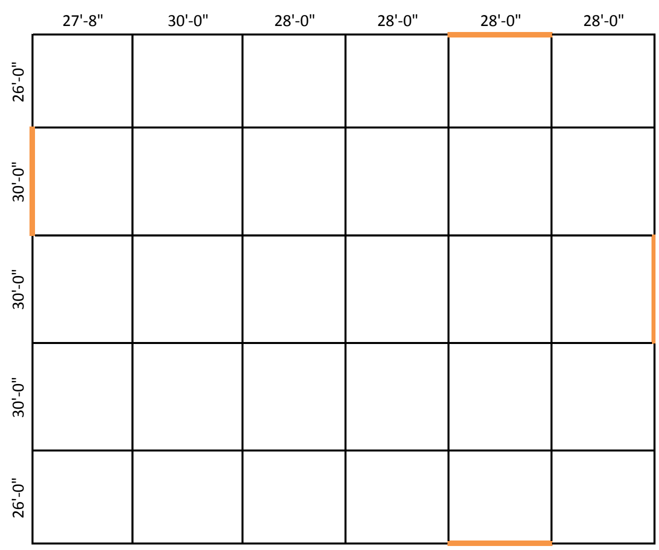


Figure 4, Lateral Braces Area B

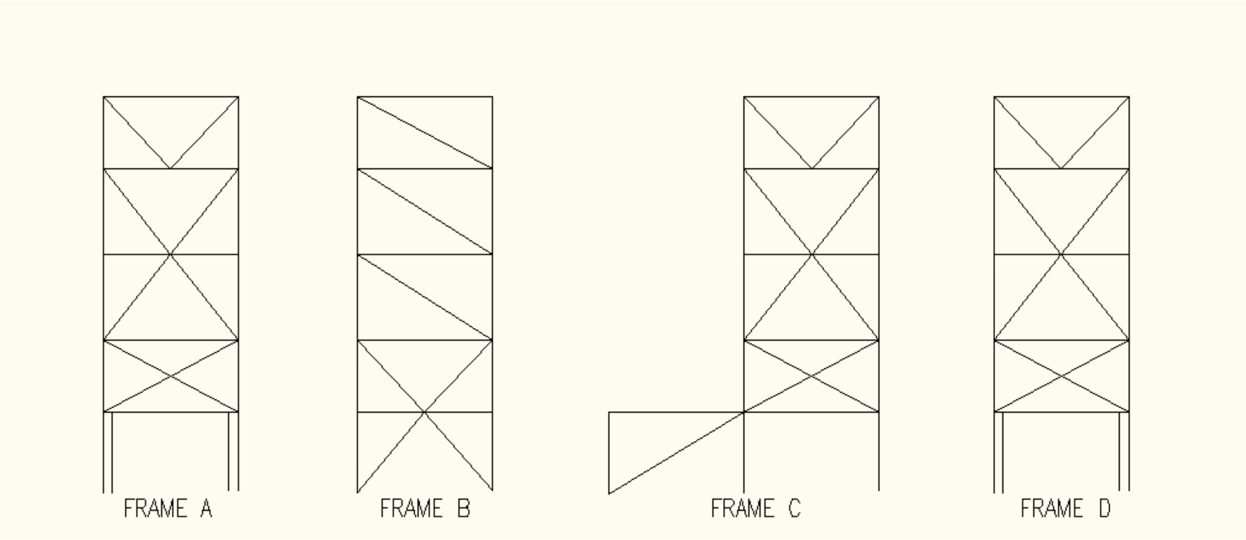


Figure 5, Braced Frames

Wind Loads

Wind loads were determined using RAM Structural System

- Basic Wind Speed, V = 110 mph
- Wind Directionality Factor, K_d = 0.85
- Building category = IV
- Importance Factor = 1.15
- Exposure Category = C
- Topographic Factor, K_{zt} = 1.0
- External Pressure Coefficient, $C_{p,w}$ = 0.8
- External Pressure Coefficient, $C_{p,l}$ = -0.5
- External Pressure Coefficient, $C_{p,s}$ = -0.7

Wind Forces

Level	Pressure (psf)	Force Applied (kips)
Roof	39.35	53.86
5	38.06	114.73
3	36.06	117.88
2	32.88	101.18

Wind Story Shears

Level	East-West	North-South
Roof	54.72	46.87
5	170.51	145.94
3	289.42	247.46
2	391.68	333.54
Base	13.96	75.3

Seismic Loads

Seismic Loads were designed in accordance with sections 11 and 12 of ASCE 7-05. The geotechnical information was unavailable for this report so the site class was assumed to be site class D because that is what was used in the original design of the building.

- Ss = 0.124
- S1 = 0.045
- SDS = 0.132
- SD1 = 0.072
- Seismic Design Category C
- Response Modification Factor, R = 3
- Importance Factor, I = 1.5

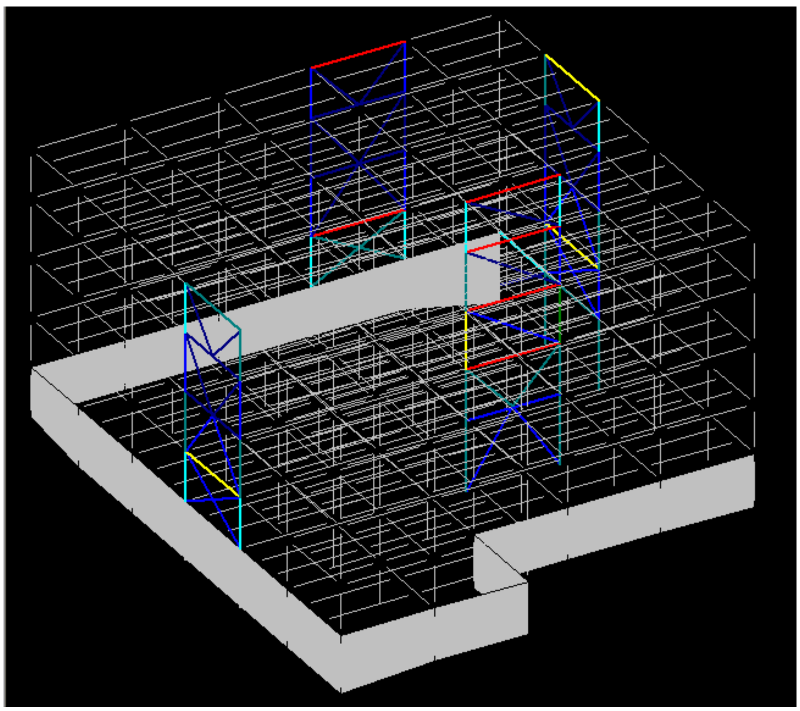
	Area A	Area B
Base Shear	630 kips	592 kips
Overturning Moment	79061 ft-kips	24234 ft-kips

Seismic Story Shear

Level	East-West	North-South
Roof	96.63	98.23
5	169.71	172.6
3	214.42	217.93
2	232.62	235.87
Base	5.73	74.41

Strength Check

A strength check of all frame members was performed using RAM. Members were first analyzed as W12x50's and found that the sizes had to be increased on floors one through three. When sizes were changed to the actual sizes of the members according to plans, all members were found to satisfy strength checks. Below is a figure from RAM showing the frames and the members in question. All blue members are ok while red are not. The red beams are that way most likely because they are not considered in part of the frame for lateral force resistance and are only sized according to gravity loading.



Drift

Building drift and story drift were found with RAM. These values were to be less than h/400 where h is the height of the building or height of the floors. h/400 for the building is 70'/400 = 2.1". For story drift h/400 is either 16'/400 = 0.48" or 19'/400 = 0.57".

	drift
Wind	0.61483
Seismic	0.5262

story	Wind	Seismic
2	0.1472	0.0994
3	0.1709	0.1349
5	0.1688	0.1563
Roof	0.1279	0.1357

CONCLUSION

The lateral system in place on Layfield Tower is satisfactory to resist both wind and seismic loads. The design was controlled by strength and found to be adequate for drift.