ANDREW SOLOMON
STRUCTURAL EMPHASIS
SPRING 2006

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STRUCTURAL EMPHASIS

Architecture

- Bernardon Haber Holloway Architects
  Kennett Square, PA
- Y-shaped 4-story assisted living building.
- Porte-cochere entrance into grand lobby.
- Located in retirement community in Willow Street, PA
- Two tone brick façade with mansard gabled shingled roof.

Structural

- Baker Ingram and Associates
  Lancaster, PA
- Spread footings under columns and wall footings under masonry walls.
- Load bearing masonry walls w/ limited structural steel columns.
- Shear resisted by masonry walls.
- Pre-cast plank flooring and roofing.

Construction

- Paul Risk Associates, Inc.
  Quarryville, PA
- Design-Build Project
- May 15th 2005 thru April 1st 2006
- $11.8 Million
- 118,400 Square Feet

Willow Valley Retirement Community, Inc.
Spring Run Assisted Living

Lighting/Electrical

- Haller Enterprises
  Lititz, PA
- Retirement community owns their own electrical grid on site.
- 480/277 Volt secondary services.
- Incandescent lights in dwelling units
- 2x4 fluorescent lights in common areas

Mechanical

- Protech Mechanical Contractors
  Landisville, PA
- Water source heat pump services building for heating and cooling.

Renderings are courtesy of Bernardon Haber Holloway Architects
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Executive Summary:

Spring Run Assisted Living is a 4 story, 116,200 square foot assisted living building in a retirement community. This community, Willow Valley Retirement Community is located only 5 miles south of the heart of Lancaster.

This report is a compilation of two semesters work based on a structural analysis and a possible alternate structural design. It was proposed that the structural system was quite adequate but an inquiry into if a structural steel skeleton could be more efficient. The current bearing wall and plank floor system are to be changed to the new steel system. The lateral load which was carried by the original shear walls has now been altered to be carried by moment frames. The actual design was produced using ram structural system.

Since the new design altered several things, these things were checked in breadth studies. The exterior wall was altered and needed to be checked against ASHRAE standards. Also, a construction management breadth checking the difference in cost and duration of construction was performed.

Table of Contents:

Introduction

Introduction:

The purpose of this report is to summarize my thesis project. Thesis was a 2 semester course in which I performed multiple analyses and a new design of the structural system of Spring Run Assisted Living. This report shows the steps I took during the analysis of the current design as well as the process of the new design. In addition to several figures is an appendix with my new design. Because of the changes made to the building, it was necessary to analyze how the exterior wall would be affected through heat loss and condensation. A cost and schedule comparison of the two designs was preformed.

Please note - While designing the building, it was necessary to make certain design assumptions and in no way should my report be used to call into question any aspect of the current design. This exercise was performed to gain a better knowledge of the overall building design and is for educational purposes only.

Architecture:

Spring Run Assisted Living is the newest building on Willow Valley Retirement Community's property. It is an 116,200 square foot, $11.8 million design-build project. The community is located approximately 5 miles south of the heart of Lancaster on Route 222. Although some residents are not independent, the ones who have the ability can travel to the borough on their own because of the close proximity.

A two toned brick façade with a mansard / false gabled shingle roof was used on this building to complement the existing buildings in Willow Valley Retirement Community. There are three wings making Spring Run Assisted Living a Y shaped building and each wing is anchored on the building end with a hipped roof tower. False windows are used to minimize the look of the blank exterior walls.

A porte-cochere was added at the grand entrance to allow for a tour bus to pass through. The entrance acts as a "grand hotel" entry lobby with a two story atrium. The first floor public thorough fare (from entry to dining room) is designed to reflect as a retail "main street" to the residents and visitors. This hall has access to dining, café, administration, rest rooms, library, mailroom, and lounge areas.

Project Team:

Owner	Willow Valley Retirement Community, Inc. 850 Willow Valley Lakes Drive Willow Street, PA
Designer / Builder	Paul Risk Associates, Inc. Quarryville, PA
Architect	Bernardon Haber Holloway Architects Kennett Square, PA
Structural Engineer	Baker Ingram and Associates Lancaster, PA
Electrical Engineer	Haller Enterprises Lititz, PA
Civil Engineer	RGS Associates Brownstown, PA
Interior Designers	JSA Architects Portsmouth, PA
Food Service Designer	Clark Food Service Lancaster, PA
Geotechnical Consultants	CVM Industries Huntington Valley, PA

Current Building Systems Background:

Electrical:

Willow Valley Retirement Community, Inc. owns their own primary electric grid on their property. All buildings are supplied with 480/277 volt secondary services. Electrical systems within the building are standard and include power, lighting, fire alarm, communications, data and sound systems. Emergency power is obtained through the use of diesel and natural gas powered generators.

Lighting:

The typical ceiling in Spring Run Assisted Living is a 2x4 ACT suspended ceiling. For this reason, the main lighting systems are 48" fluorescent bulbs.

Mechanical:

The majority of buildings in this retirement community are serviced by a water source heat pump system. This particular system uses a closed loop of circulated water to serve as the primary heat exchange media for both cooling and heating seasons. Heat is rejected from the loop with an outdoor cooling tower; heat is introduced into the loop through a gas boiler depending on the building demand for cooling or heating. This system is very efficient for large, full time occupied building such as Spring Run Assisted Living.

Structural System:

The 8" load bearing reinforced masonry walls are also the shear resistance for the building. The floors and roof are comprised of pre-cast concrete plank flooring along with a topping to make for a smooth surface. The use of a pre-cast floor system limited the distance of spans to 30 feet. There are steel columns where a masonry wall is not feasible. The load bearing masonry walls rest upon wall footings while the steel columns are supported by spread footings.

Telecommunications:

A communications duct bank parallels the primary electric grid throughout the property.

Transportation:

There are two elevators located near the main lobby/grand entry along with 1 stairwell at the end of each wing.

Fire Protection:

There are both passive and active fire protection systems. All masonry walls act as a fire wall and the pre-cast concrete floor planks contain their own fire rating. There is a full sprinkler system in all parts of the building to suppress a fire.

Exiting Structural Design:

Foundations:

The foundation system for Spring Run Assisted Living is concrete footings. These footings rest upon 1' of compacted structural fill and then bedrock. Since there are current two types of vertical gravity load resisting members, several steel columns and masonry walls, the footings vary based on use. Steel column footings are supported by spread footings while the masonry walls are supported using wall footings. Regardless of the footing type, all footings specified to be comprised of 3000 psi concrete with reinforcement bars of grade 60 while piers are to be 4000 psi concrete. Some of these reinforcement bars located in the wall footings are actually dowels which continue up and into the masonry walls.

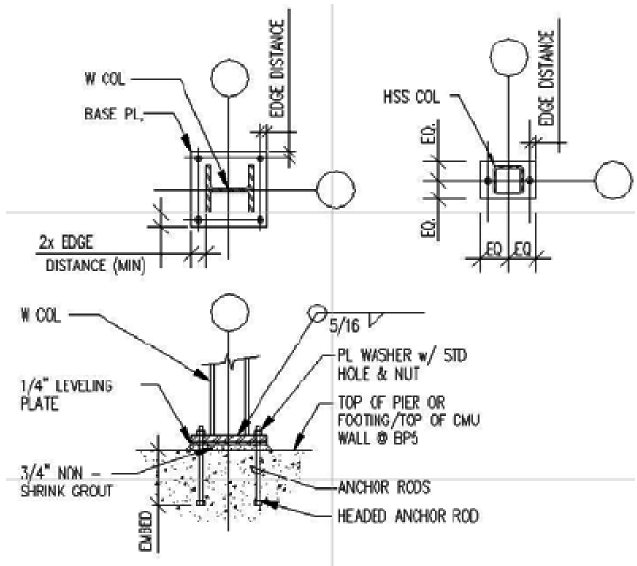

Figure 1

Structural Steel:

The main thoroughfare and open spaces on the ground level made it hard to find a way to make the building only dependant on masonry walls and thus the architect and engineer decided that columns would be necessary. There is 1 HSS column used with several more hot formed wide flange shapes. In certain instances, steel lintels are attached to these columns integrating the steel and masonry aspects of the building.

Masonry:

While the steel columns are only for gravity loads, the masonry walls serve a duel purpose. The masonry walls are the main lateral reinforcement for the building. The shear walls range from 14" CMU fully grouted below grade to an 8" CMU grouted at 48" o.c. as part of the fourth floor walls. For walls denoted as shear walls, there are to be 2 - #5 bars placed in the last two cells.

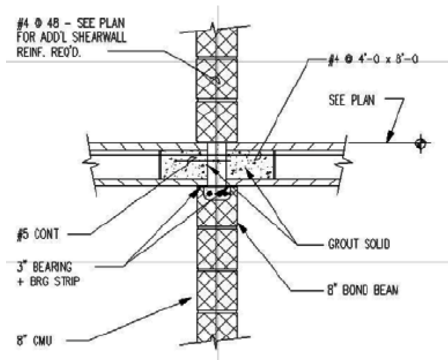

Figure 2

Structural Floor:

The structural floor is comprised of 8" pre-cast hollow core planks. These planks are specified to be 5000 psi concrete and are to be manufactured offsite. Also, the planks are denoted by the load they are supposed to carry and are to be designed by the fabricator or a registered professional engineer of their choosing. With the idea of unifying the building and having the masonry shear walls act as one rigid diaphragm, the planks are to connected to the wall which it is bearing on typically using #4 spaced at 48" o.c. Where the building will see heavy traffic, or at least where the presence of a visible joint in the flooring is unwanted, there is to be placed a 2" topping.

Introduction to Building Redesign

Problem Statement:

Due to the surroundings and purpose of Spring Run Assisted Living; it is difficult to choose another method of support for this building. The architect had designed the building to be a masonry load bearing wall system. During the fall 2005 semester, I analyzed multiple options for an alternate design at Spring Run Assisted Living. After an investigation into altering the building's floor system to 3 other options, I concluded that the original design seemed to be the most efficient. The other options were steel structure, pre-cast pre-stressed double tees, and a one-way concrete joist system. Following the analysis of different floor systems, I took an extensive look into the current building lateral resistance system. As a conclusion to my analysis I concluded that the current lateral system was not only sufficient but possibly the most viable solution based on the building use and architecture.

At the conclusion of fall semester, I proposed to completely abandon the current structural design and redesign it with structural steel and cast-in-place concrete slabs on metal deck. A mechanical study was performed to consider how change the exterior walls would affect the heat transfer through the walls. A cost and schedule comparison was completed to study the affects the new design would have on the building.

Solution Overview:

To start the new design, it was necessary to analyze the current wall layouts as well as any areas considered to be dead space. This then allowed me to create a column grid without affecting the interior layout of the building. Once the new grids were laid out I was able to begin utilizing software programs to model the structure. The structural modeling program I chose was RAM Structural System. With the new structural system, it was necessary to reanalyze the lateral resistance and this was also done with RAM Structural System. Once the design was complete, I needed to check to verify that my new design maintained the resistance to heat transfer set forth by ASHRAE. Finally and most importantly, I studied how the new design would affect the owner through cost and time. I completed my cost analysis by using a program named Cost Works 2005. Cost Works is essentially R.S. Means through a computer program. To complete a schedule comparison I was able to contact Bill Koch, the project manager representing Paul Risk & Ass., in which he gave me standard times for construction in and around Lancaster, Pennsylvania.

Structural Redesign

Alternate Structural design:

Gravity Loads:

The gravity loads utilized during the design were gathered from various sources. ASCE 7-02 was used to find the live loads the floor would encounter based on their use. The dead loads were gathered from various handouts from previous internships and also classroom experiences. Dead loads from the form decking and concrete were taken directly from the deck catalogues used. The following is the loading criteria used during the design process.

Live Loads:

Corridors – First Floor................100 PSF
Others........................40 PSF
Lobbies..100 PSF
Mechanical Rooms.......................150 PSF
Storage (Light).............................125 PSF
Dwelling Units...............................40 PSF
Partitions..20 PSF

Dead Loads:

Slab 5” w/ 20 gage TF125 ....55 PSF
U.L. P241
Brick...40 PSF
HVAC ....5 PSF
Ceiling...2 PSF
Misc...3 PSF

Gravity Design:

Once columns were laid out in RAM Structural System, I was able to begin the layout of the floor system. Since the original design had a structural floor depth of either 8" or 10" (dependant on the presence of a topping on the 8" pre-cast hollow-core planks) it was important to me to try to maintain as small of a depth as possible. I was able to keep the structural floor depth to roughly 23". That is the depth of a W18x40 member and a 5" slab. Once the basic layout of the beams was determined, I concluded that there was an efficient way to determine the amount of steel being used. With this in hand, I was able to layout multiple possibilities and use the takeoff feature in RAM Structural System. I could then compare tonnage of steel used. It was my conclusion that a 4' spacing of beams was quite efficient. I was also able to conclude that a 6' spacing of joists on the roof was efficient. This is because cold formed steel will be used to create the sloped roof and will bear on the joists.

Wind Loads:

ASCE 7-02 was used to determine the applicable wind loads. According to 6.4.1.2, Spring Run Assisted Living may be considered to fall into the category of components and cladding. Since RAM Structural System has a module for wind loads, the following values were actually used during the lateral analysis. Following is the necessary information gathered from ASCE 7-02 followed by the modular for RAM Structural System.

Exposure category:	C
Kzt:	1.00
Base Wind Speed:	90.0 MPH
Importance Factor:	1.15

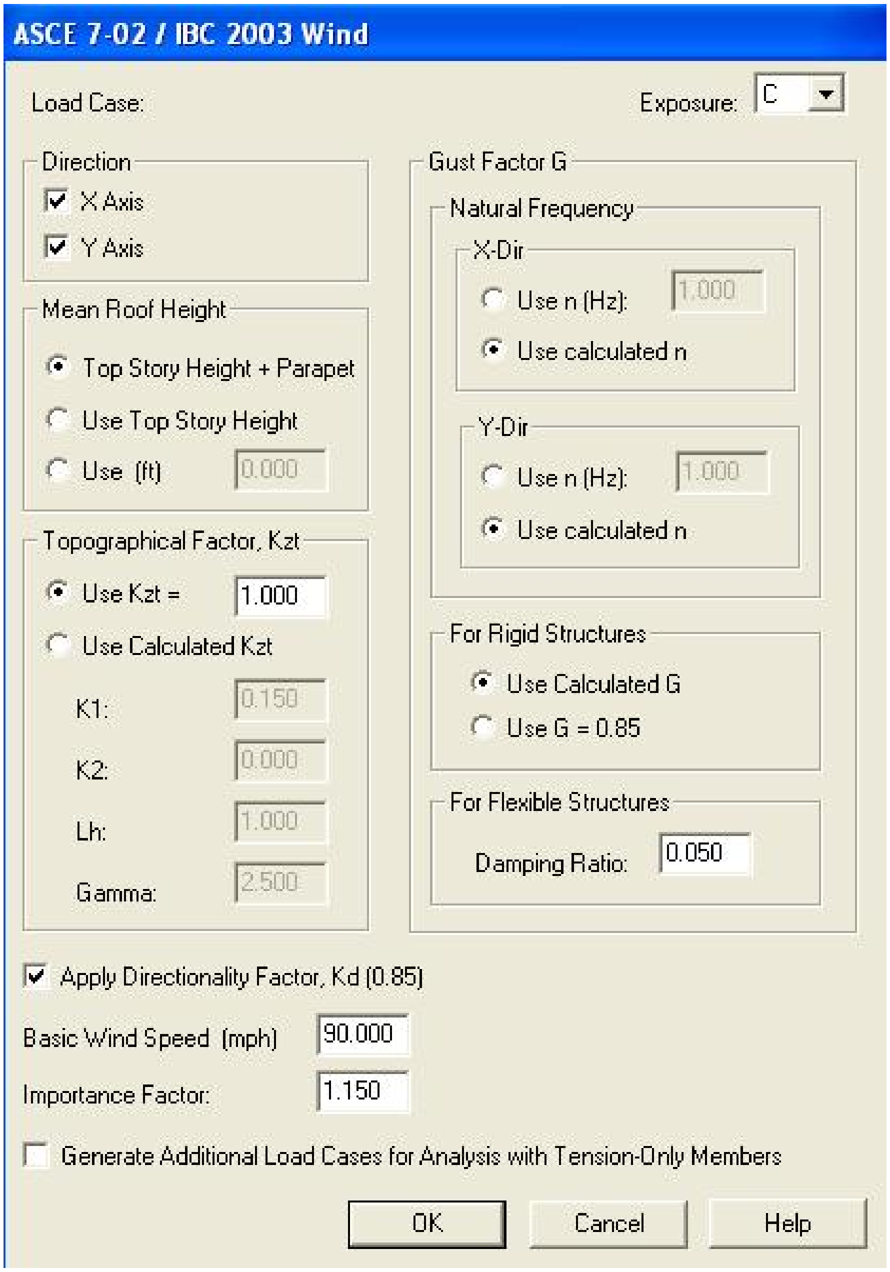

Figure 3: Wind Load Module

Seismic Loads:

Using the modular in RAM Structural System, I was able to use ASCE 7-02 to gather the necessary information to input. The following is information gathered from ASCE 7-02 and a sample of the RAM Structural System modular for seismic loading.

Seismic Use Group:	II
Site Class:	A
Ss:	0.279g
S_1:	0.075g
Importance Factor:	1.25
Response Modification Coefficient:	3.5

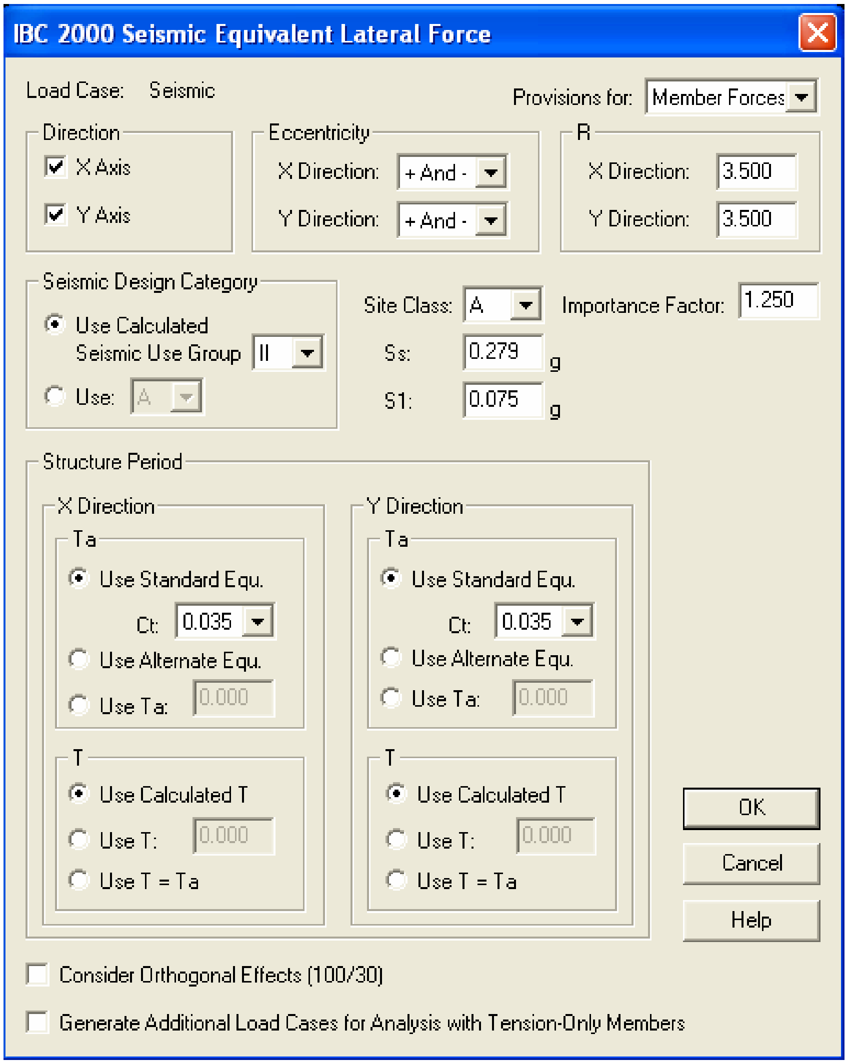

Figure 4: Seismic Load Module

Lateral Load Resistance:

The original design for Spring Run Assisted Living utilized shear walls. Since the new design is now a steel skeleton, it was necessary for me to determine the most efficient method of laying out frames. I completed this task by a very tedious process. Through trial an error, I was able to adjust members to be part of a frame to be only gravity members. I would systematically change members from gravity frame to lateral frame analyze how much it changed the overall building drift. I limited the building drift to l/400 in accordance with my design criteria. To be certain my building was not swaying this much I limited it 1". My worst case building drift occurred at column lines AW and 05W and was a total 0.98" in the building north south direction. Because of the complexity of the building and the lack of possible frames which would continue through the building, I needed to utilize a majority of the columns and beams to ensure limited drift. This can be seen in figure 5.

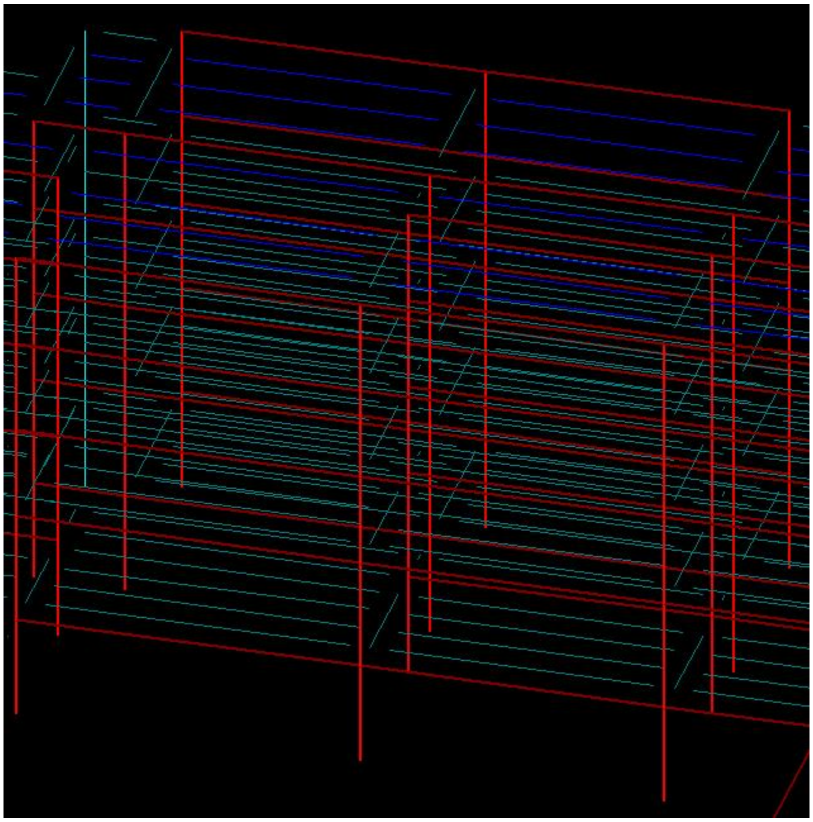

Figure 5: Sample of Frame Members

Foundations:

Due to the lack of sub-grade information which was obtainable, a final design was not performed for these footings. Although, it will be necessary to use spread footings rather than the original wall footings. Footing concrete would still need to be 3000 psi concrete, while any piers, which may be necessary, would need to be 4000 psi concrete.

More Final Design Considerations:

One of the most important parts to me about the alternate design was to avoid hindering the architect's plan for the interior. Unfortunately, the columns I used in my design would not be hidden by the interior walls. This obviously is not the first building in which this occurs so I am confident that the architect would be able to wrap the columns to make them less obvious.

Once the beams, joists and columns were finally designed, based on recommendations made to me by the structural engineer and various professors during class, I went through the building one more time and changed member sizes to ensure consistency. By doing this I can ensure a better price from the steel fabricator as well as ease of construction.

Since the new design is a steel skeleton, it is my opinion that the interior walls were no longer need to be masonry and I can switch these to steel stud partitions with 5/8" gypsum wall board on either side. This lessened the weight on the floors drastically. This process was also faster and cheaper. The backup to the brick veneer also did not need to be masonry any longer and thus; I changed it to a steel stud backup. This section is discussed further in depth in my breadth studies.

Exterior Wall Design

Mechanical Breadth

Exterior Wall Design (Mechanical Breadth):

Given the new structural design, the use of masonry for exterior wall was no longer needed. It is because of this that I decided to alter the exterior wall to be a steel stud wall. The new design of the construction of the exterior wall is to be a brick veneer with a 1" air space before a 2" layer of rigid insulation. On the interior side of the insulation is the vapor barrier, followed by the 2"x4" steel studs sheathed with 5/8" gypsum wall board.

Using the ASHRAE Handbook of Fundamentals 2001 I gathered the outdoor design conditions for Lancaster, Pennsylvania (Lancaster and Willow Street are less then 5 miles apart). The summer design conditions are a dry bulb temperature of 93.2°F at the 1% condition. During winter, the dry bulb temperature is 9°F at the 99% condition. Also, using a psychometric chart, I was able to determine that my dew point temperatures. During summer conditions of 75°F and 50% relative humidity, the dew point is at 55°F. During winter conditions of 70°F and 50% relative humidity, the dew point is at 51°F.

Spring Run Assisted Living falls in climate zone 5A. Therefore, table 5.5-5 in ASHRAE std. 90.1 – 2004, which is based on building construction and use, was used to determine that the building needs to maintain a u-value no greater than 0.064. I used Carrier's Hourly Analysis Program v4.20 to determine the R-values of my materials. Using an excel spreadsheet I was able to determine the temperature drop over each material as well as the location of condensation. The location of condensation is on the exterior side of the vapor barrier thus eliminating the opportunity for mold growth on the gypsum wall board.

EXTERIOR WALL						
MATERIAL	THICKNESS, IN.	R-VALUE	DELTA T		TEMPERATURE	
			WINTER	SUMMER	WINTER	SUMMER
OUTSIDE AIR SR	0.00	0.33	1.15	0.34	9.00	93.20
BRICK VENEER	4.00	0.43	1.49	0.44	10.15	92.86
AIR SPACE	1.00	0.91	3.13	0.93	11.64	92.41
BOARD INSULATION	2.00	13.89	47.81	14.27	14.77	91.48
VAPOR BARRIER	0.01	0.00	0.00	0.00	62.58	77.21
AIR SPACE	3.50	0.91	3.13	0.93	62.58	77.21
GWB	0.63	0.56	1.93	0.58	65.71	76.28
INSIDE AIR	0.00	0.69	2.36	0.70	67.64	75.70
Totals	11.14	**17.72**			70.00	75.00

Max allowable U-value	0.064
Wall Constr. U-value	0.056

Q-WINTER(MAN. WALL)	3.44
Q-SUMMER(MAN. WALL)	1.03

WINTER OUTDOOR TEMP.	9
SUMMER OUTDOOR TEMP.	93.2
Summer INDOOR TEMP.	75
Winter Indoor Temp	70

Figure 6: Excel Spreadsheet used for Exterior Wall Design

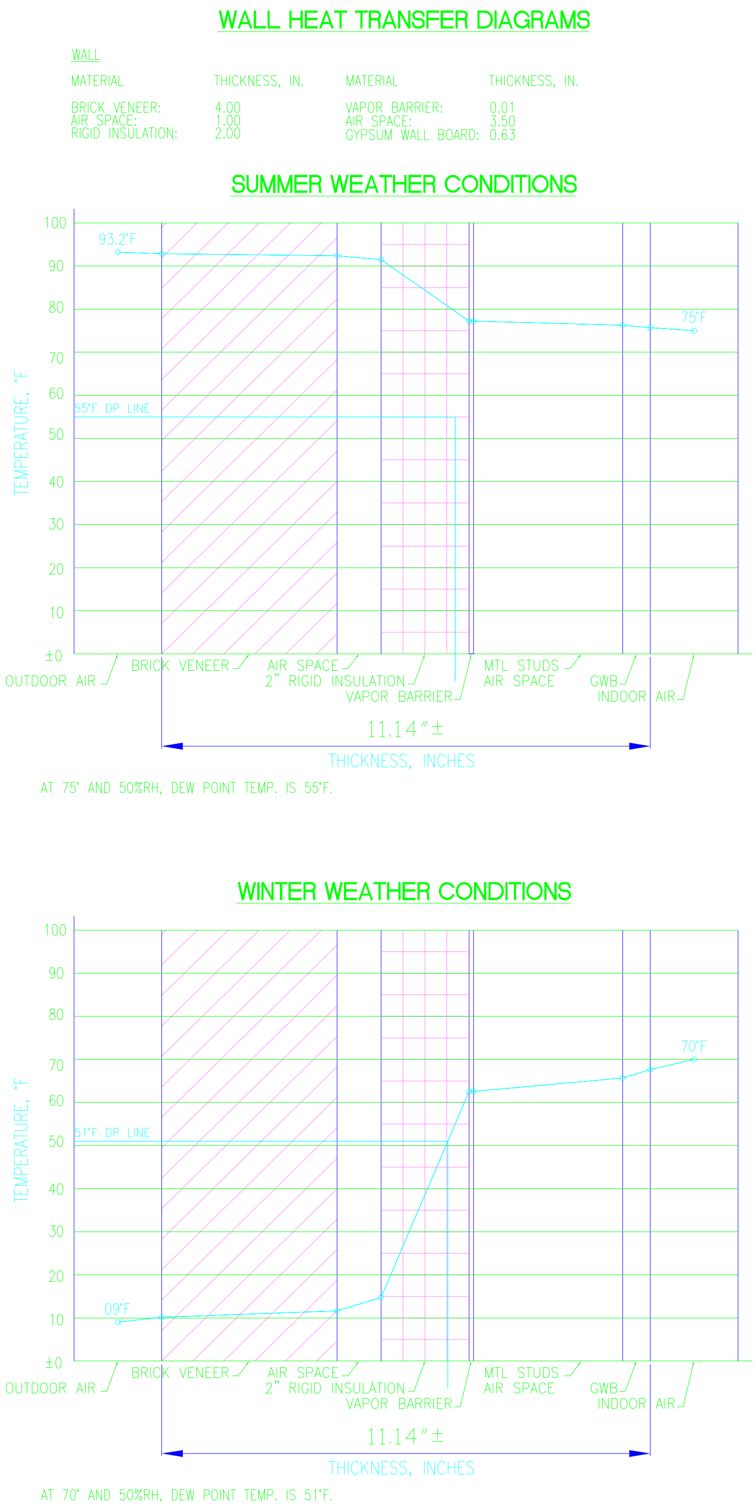

Figure 7: Heat Loss and Vapor Barrier Placement

Cost and Schedule Analysis

Construction Management Breadth

Cost Comparison (Construction Management Breadth Part 1):

It seems that the main concern of most people working on a project to ensure the happiness of the owner. This happiness usually comes in the form of money. I chose to do my second breadth study based on the happiness of the owner. Since money is a major concern and time is money, I chose to analyze how my new design would affect both cost and schedule.

Cost of the Existing Design:

Taking into consideration only the aspects of the building which would change, I was able to compile a cost analysis using data from Cost Works 2005, Bill Koch of Paul Risk and Associates, and Excel. Cost Works 2005 is a computer program produced by R.S. Means and is a very efficient method of analyzing the cost of building. I utilized both assemblies' costs and unit costs. All except the spray on fireproofing was able to be found in the assemblies cost.

Cost of the New Design:

By altering the original design of masonry bearing walls and pre-cast hollow core planks to a structural steel skeleton, it was necessary to verify that the building was still constructible. These alterations included the exterior wall design, interior partitions, new steel members, new slab design, and fireproofing.

Cost Comparison:

As seen in the following diagram, there is roughly a four hundred thousand dollar savings for the construction of the new design. For the entire building, the new design is only a savings of roughly 3.3%.

Spring Run Assisted Living - Existing

Qty	Assembly Number	Description	Unit	Mat.	Inst.	Total	Release
17,000.000	A20101103500	Excav & f, 4000 SF, 16' d, sand, gvl, or com earth, on site storage	S.F.	0.00	110,500.00	110,500.00	2005
24,800.000	A10301202240	Slab on grade, 4" thick, non industrial, reinforced	S.F.	35,216.00	44,392.00	79,608.00	2005
39,400.000	B20101245330	Deep grv hol reinf blk wall,8x8x16",125 PCF wt,#5@16"vert reinf&gt sp	S.F.	208,820.00	244,280.00	453,100.00	2005
20,000.000	B20101245330	Deep grv hol reinf blk wall,8x8x16",125 PCF wt,#5@24"vert reinf&gt sp	S.F.	102,000.00	118,000.00	222,000.00	2005
20,000.000	B20101245320	Deep grv hol reinf blk wall,8x8x16",125 PCF wt,#5@32"vert reinf&gt sp	S.F.	98,000.00	110,000.00	208,000.00	2005
20,000.000	B20101245300	Deep grv hol reinf blk wall,8x8x16",125 PCF wt,#4@48"vert reinf&gt sp	S.F.	94,000.00	106,000.00	200,000.00	2005
0.000	C10101265500	Ptns/met,5/8"fr drwl f,none b,3-5/8"@24" OC fmg,nothng opp f,0 insul	S.F.	0.00	0.00	0.00	2005
0.000	C10101265400	Ptns/met,5/8"fr drwl f,none base,3-5/8"@24" OC fmg,same opp f,0 insul	S.F.	0.00	0.00	0.00	2005
24,800.000	B10102291300	Prcst plk w/no top,30'span,75PSF supimp,8" tot d,55PSF dl,130PSF tot	S.F.	138,880.00	32,984.00	171,864.00	2005
74,400.000	B10102303500	Prcst plk w/2"conc tp,30'sp,75PSF supimp,10"tot d,80PSF dl,155PSF tot	S.F.	476,160.00	197,904.00	674,064.00	2005
17,000.000	B10102303500	Prcst plk w/2"conc tp,30'sp,75PSF supimp,10"tot d,80PSF dl,155PSF tot	S.F.	108,800.00	45,220.00	154,020.00	2005
0.000	B10102580950	Met dk/conc f,125 PSF supimp,8' span,20ga 1.5"d,5" slb,165 PSF tot	S.F.	0.00	0.00	0.00	2005
0.000		Structural Steel (price given by CM on jobsite)	TON	0.00	0.00	0.00	2005
0.000	78126000400	Cementitious Fireproofing, sprayed mineral fiber or cementious for fireproofing, beams, 1 hour rated, 1-3/8" thick, excl. tamping or canvas protection	S.F.	0.00	0.00	0.00	2005
			Totals	$1,261,876.00	$1,009,280.00	$2,273,156.00	

Figure 8: Existing Cost Analysis

Spring Run Assisted Living - New

Qty	Assembly Number	Description	Unit	Mat.	Inst.	Total	Release
24,800.000	A20101103500	Excav & f, 4000 SF, 16' d, sand, gvl, or com earth, on site storage	S.F.	0.00	161,200.00	161,200.00	2005
24,800.000	A10301202240	Slab on grade, 4" thick, non industrial, reinforced	S.F.	35,216.00	44,392.00	79,608.00	2005
21,000.000	B20101245330	Deep grv hol reinf blk wall,8x8x16",125 PCF wt,#5@16"vert reinf&gt sp	S.F.	111,300.00	130,200.00	241,500.00	2005
0.000	B20101245330	Deep grv hol reinf blk wall,8x8x16",125 PCF wt,#5@24"vert reinf&gt sp	S.F.	0.00	0.00	0.00	2005
0.000	B20101245320	Deep grv hol reinf blk wall,8x8x16",125 PCF wt,#5@32"vert reinf&gt sp	S.F.	0.00	0.00	0.00	2005
0.000	B20101245300	Deep grv hol reinf blk wall,8x8x16",125 PCF wt,#4@48"vert reinf&gt sp	S.F.	0.00	0.00	0.00	2005
49,300.000	C10101265500	Ptns/met,5/8"fr drwl f,none b,3-5/8"@24" OC fmg,nothng opp f,0 insul	S.F.	29,087.00	49,793.00	78,880.00	2005
38,100.000	C10101265400	Ptns/met,5/8"fr drwl f,none base,3-5/8"@24" OC fmg,same opp f,0 insul	S.F.	33,528.00	61,341.00	94,869.00	2005
0.000	B10102291300	Prcst plk w/no top,30'span,75PSF supimp,8" tot d,55PSF dl,130PSF tot	S.F.	0.00	0.00	0.00	2005
0.000	B10102303500	Prcst plk w/2"conc tp,30'sp,75PSF supimp,10"tot d,80PSF dl,155PSF tot	S.F.	0.00	0.00	0.00	2005
0.000	B10102303500	Prcst plk w/2"conc tp,30'sp,75PSF supimp,10"tot d,80PSF dl,155PSF tot	S.F.	0.00	0.00	0.00	2005
99,200.000	B10102580950	Met dk/conc f,125 PSF supimp,8' span,20ga 1.5"d,5" slb,165 PSF tot	S.F.	237,088.00	173,600.00	410,688.00	2005
231.000		Structural Steel (price given by CM on jobsite)	TON	462,000.00	231,000.00	693,000.00	2005
100,000.000	78126000400	Cementitious Fireproofing, sprayed mineral fiber or cementious for fireproofing, beams, 1 hour rated, 1-3/8" thick, excl. tamping or canvas protection	S.F.	41,000.00	82,000.00	123,000.00	2005
			Totals	$949,219.00	$933,526.00	$1,882,745.00	

Figure 9: New Cost Analysis

Schedule Comparison (Construction Management Breadth Part 2):

Schedule Comparison:

Using Microsoft Project, I was able to compile a schedule of the construction process. With the help of the Bill Koch of Paul Risk and Associates, a schedule which best represented the current schedule was created. After completing a schedule of the current design, I was able to apply the changes I made through the building into a new schedule. The times for construction are a compilation of data from Cost Works 2005's assembly's costs and unit costs as well as the productivity of local contractors.

Since I was only trying to compare the actual duration of construction, I am sure there are factors I failed to incorporate. These factors include weather, fabrication time, and other items which affect the schedule.

After comparing the original schedule with the new schedule I was able to conclude that the new design would take roughly 3 months longer to complete. There are several factors which could shorten the erection time of Spring Run Assisted Living's new design. They are:

1. Enlarge the crew sizes for partitions.
2. Place concrete in less then the optimum amount.
3. Use more then one steel erection crew and crane.

Existing Design Schedule:

ID	Task Name	Duration	Start	Finish
1000	Rock Removal/Overdig	10 days	Mon 6/13/05	Fri 6/24/05
1010	Foundations	20 days	Mon 6/27/05	Fri 7/22/05
1020	Underground Utilities	15 days	Tue 7/12/05	Mon 8/1/05
1030	Basement Walls	20 days	Tue 7/19/05	Mon 8/15/05
1040	Slab-on-Grade Basement	5 days	Tue 8/23/05	Mon 8/29/05
1970	Water Proofing	25 days	Mon 8/1/05	Fri 9/2/05
1980	Backfill Basement	10 days	Thu 8/25/05	Wed 9/7/05
1050	First Floor Precast	10 days	Mon 8/8/05	Fri 8/19/05
1060	First Floor CMU Walls	15 days	Mon 8/15/05	Fri 9/2/05
1070	Slab-on-Grade First Floor	5 days	Mon 9/5/05	Fri 9/9/05
1080	Topping	5 days	Mon 9/19/05	Fri 9/23/05
1090	Layout	10 days	Mon 9/19/05	Fri 9/30/05
1100	Core Drill	10 days	Tue 9/26/06	Mon 10/9/06
1110	Metal Studs	20 days	Mon 10/3/05	Fri 10/28/05
1120	MEP Rough-in	30 days	Mon 10/17/05	Fri 11/25/05
1130	Kitchen Hoods	5 days	Mon 11/14/05	Fri 11/18/05
1140	Hang Drywall	20 days	Mon 11/28/05	Fri 12/23/05
1150	Drywall Finish	20 days	Mon 12/5/05	Fri 12/30/05
1160	Trim/Cabinets	15 days	Mon 12/12/05	Fri 12/30/05
1170	Prime & Ceilings	15 days	Mon 12/26/05	Fri 1/13/06
1180	Finish Paint	10 days	Mon 1/9/06	Fri 1/20/06
1190	MEP Trim/Access	10 days	Mon 1/16/06	Fri 1/27/06
1200	Flooring	15 days	Mon 1/23/06	Fri 2/10/06
1210	Kitchen Finishes	15 days	Mon 2/13/06	Fri 3/3/06
1220	Public Doors/Trim	25 days	Mon 2/27/06	Fri 3/31/06
1230	Kitchen Equipment	10 days	Mon 3/6/06	Fri 3/17/06
1240	Public Tile/MEP Trim	15 days	Mon 3/20/06	Fri 4/7/06
1250	Finish Paint	20 days	Mon 3/27/06	Fri 4/21/06
1260	Public Flooring	15 days	Mon 4/10/06	Fri 4/28/06

ID	Task Name	Duration	Start	Finish
1270	Second Floor Precast	10 days	Mon 8/29/05	Fri 9/9/05
1280	Second Floor CMU Walls	15 days	Mon 9/5/05	Fri 9/23/05
1290	Topping	5 days	Mon 10/3/05	Fri 10/7/05
1300	Layout	10 days	Mon 10/3/05	Fri 10/14/05
1310	Core Drill	10 days	Mon 10/10/05	Fri 10/21/05
1320	Metal Studs	30 days	Mon 10/17/05	Fri 11/25/05
1330	MEP Rough-in	20 days	Mon 11/7/05	Fri 12/2/05
1340	Hang Drywall	20 days	Mon 12/12/05	Fri 1/6/06
1350	Drywall Finish	20 days	Mon 12/19/05	Fri 1/13/06
1360	Trim/Cabinets	15 days	Mon 12/26/05	Fri 1/13/06
1370	Prime & Ceilings	15 days	Mon 1/9/06	Fri 1/27/06
1380	Finish Paint	10 days	Mon 1/23/06	Fri 2/3/06
1390	MEP Trim/Access	10 days	Mon 1/30/06	Fri 2/10/06
1400	Public Doors	10 days	Mon 1/30/06	Fri 2/10/06
1410	Flooring	15 days	Mon 2/6/06	Fri 2/24/06
1420	Public Trim	10 days	Mon 2/6/06	Fri 2/17/06
1430	Public Tile	10 days	Mon 2/13/06	Fri 2/24/06
1440	Public Finish Paint	10 days	Mon 2/20/06	Fri 3/3/06
1450	Public Flooring	10 days	Mon 2/27/06	Fri 3/10/06
1460	Third Floor Precast	10 days	Mon 9/19/05	Fri 9/30/05
1470	Third Floor CMU Walls	15 days	Mon 9/26/05	Fri 10/14/05
1480	Topping	5 days	Mon 10/24/05	Fri 10/28/05
1490	Layout	10 days	Mon 10/24/05	Fri 11/4/05
1500	Core Drill	10 days	Mon 10/31/05	Fri 11/11/05
1510	Metal Studs	20 days	Mon 11/7/05	Fri 12/2/05
1520	MEP Rough-in	20 days	Mon 11/28/05	Fri 12/23/05
1530	Hang Drywall	20 days	Mon 12/26/05	Fri 1/20/06
1540	Drywall Finish	20 days	Mon 1/2/06	Fri 1/27/06
1550	Trim/Cabinets	15 days	Mon 1/9/06	Fri 1/27/06
1560	Prime & Ceilings	15 days	Mon 1/23/06	Fri 2/10/06

ID	Task Name	Duration	Start	Finish
1570	Finish Paint	10 days	Mon 2/6/06	Fri 2/17/06
1580	MEP Trim/Access	10 days	Mon 2/13/06	Fri 2/24/06
1590	Public Doors	10 days	Mon 2/13/06	Fri 2/24/06
1600	Flooring	15 days	Mon 2/20/06	Fri 3/10/06
1610	Public Trim	10 days	Mon 2/20/06	Fri 3/3/06
1620	Public Tile	10 days	Mon 2/27/06	Fri 3/10/06
1630	Public Finish Paint	10 days	Mon 3/6/06	Fri 3/17/06
1640	Public Flooring	10 days	Mon 3/13/06	Fri 3/24/06
1650	Fourth Floor Precast	10 days	Mon 10/10/05	Fri 10/21/05
1660	Fourth Floor CMU Walls	15 days	Mon 10/17/05	Fri 11/4/05
1670	Topping	5 days	Mon 11/14/05	Fri 11/18/05
1680	Layout	10 days	Mon 11/14/05	Fri 11/25/05
1690	Core Drill	10 days	Mon 11/21/05	Fri 12/2/05
1700	Metal Studs	20 days	Mon 11/28/05	Fri 12/23/05
1710	MEP Rough-in	20 days	Mon 12/19/05	Fri 1/13/06
1720	Hang Drywall	20 days	Mon 1/16/06	Fri 2/10/06
1730	Drywall Finish	20 days	Mon 1/23/06	Fri 2/17/06
1740	Trim/Cabinets	15 days	Mon 1/30/06	Fri 2/17/06
1750	Prime & Ceilings	15 days	Mon 2/13/06	Fri 3/3/06
1760	Finish Paint	10 days	Mon 2/27/06	Fri 3/10/06
1770	MEP Trim/Access	10 days	Mon 3/6/06	Fri 3/17/06
1780	Public Doors	10 days	Mon 3/6/06	Fri 3/17/06
1790	Flooring	15 days	Mon 3/13/06	Fri 3/31/06
1800	Public Trim	10 days	Mon 3/13/06	Fri 3/24/06
1810	Public Tile	10 days	Mon 3/20/06	Fri 3/31/06
1820	Public Finish Paint	10 days	Mon 3/27/06	Fri 4/7/06
1830	Public Flooring	10 days	Mon 4/3/06	Fri 4/14/06
1840	Roof Precast	10 days	Mon 10/31/05	Fri 11/11/05
1850	Roof CMU	5 days	Mon 11/7/05	Fri 11/11/05

ID	Task Name	Duration	Start	Finish
1860	Truss/Mansard Framing	20 days	Mon 11/7/05	Fri 12/2/05
1870	Roof Membrane	20 days	Mon 11/14/05	Fri 12/9/05
1880	Roof Shingles	15 days	Mon 11/21/05	Fri 12/9/05

New Design Schedule:

ID	Task Name	Duration	Start	Finish
1000	Rock Removal/Overdig	10 days	Mon 6/13/05	Fri 6/24/05
1010	Foundations	25 days	Mon 6/27/05	Fri 7/29/05
1020	Underground Utilities	15 days	Tue 7/12/05	Mon 8/1/05
1030	Basement Walls	20 days	Tue 7/19/05	Mon 8/15/05
1040	Slab-on-Grade Basement	10 days	Tue 8/23/05	Mon 9/5/05
1970	Water Proofing	25 days	Mon 8/1/05	Fri 9/2/05
1980	Backfill Basement	15 days	Thu 8/25/05	Wed 9/14/05
1050	First Floor Framing	15 days	Mon 8/8/05	Fri 8/26/05
1060	First Floor Deck	3 days	Mon 9/12/05	Wed 9/14/05
1070	CIP Slab	2 days	Thu 9/15/05	Fri 9/16/05
9999	Fireproofing	10 days	Mon 11/21/05	Fri 12/2/05
1080	Topping	5 days	Mon 9/26/05	Fri 9/30/05
1090	Layout	10 days	Mon 9/26/05	Fri 10/7/05
1100	Core Drill	10 days	Mon 10/3/05	Fri 10/14/05
1110	Metal Studs	40 days	Mon 10/10/05	Fri 12/2/05
1120	MEP Rough-in	30 days	Mon 10/24/05	Fri 12/2/05
1130	Kitchen Hoods	5 days	Mon 11/21/05	Fri 11/25/05
1140	Hang Drywall	40 days	Mon 12/5/05	Fri 1/27/06
1150	Drywall Finish	40 days	Mon 1/9/06	Fri 3/3/06
1160	Trim/Cabinets	15 days	Mon 2/13/06	Fri 3/3/06
1170	Prime & Ceilings	15 days	Mon 2/27/06	Fri 3/17/06
1180	Finish Paint	10 days	Mon 3/13/06	Fri 3/24/06
1190	MEP Trim/Access	10 days	Mon 3/20/06	Fri 3/31/06
1200	Flooring	15 days	Mon 3/27/06	Fri 4/14/06
1210	Kitchen Finishes	15 days	Mon 4/17/06	Fri 5/5/06
1220	Public Doors/Trim	25 days	Mon 5/1/06	Fri 6/2/06
1230	Kitchen Equipment	10 days	Mon 5/8/06	Fri 5/19/06
1240	Public Tile/MEP Trim	15 days	Mon 5/22/06	Fri 6/9/06
1250	Finish Paint	20 days	Mon 5/29/06	Fri 6/23/06
1260	Public Flooring	15 days	Mon 6/12/06	Fri 6/30/06

ID	Task Name	Duration	Start	Finish
1270	Second Floor Framing	10 days	Mon 8/29/05	Fri 9/9/05
1280	Second Floor Deck	3 days	Mon 9/12/05	Wed 9/14/05
1290	CIP Slab	2 days	Mon 10/3/05	Tue 10/4/05
9999	Fireproofing	10 days	Mon 12/5/05	Fri 12/16/05
1300	Layout	10 days	Mon 10/3/05	Fri 10/14/05
1310	Core Drill	10 days	Mon 10/10/05	Fri 10/21/05
1320	Metal Studs	50 days	Mon 10/17/05	Fri 12/23/05
1330	MEP Rough-in	20 days	Mon 12/5/05	Fri 12/30/05
1340	Hang Drywall	40 days	Mon 1/9/06	Fri 3/3/06
1350	Drywall Finish	40 days	Mon 2/13/06	Fri 4/7/06
1360	Trim/Cabinets	15 days	Mon 3/20/06	Fri 4/7/06
1370	Prime & Ceilings	15 days	Mon 4/3/06	Fri 4/21/06
1380	Finish Paint	10 days	Mon 4/17/06	Fri 4/28/06
1390	MEP Trim/Access	10 days	Mon 4/24/06	Fri 5/5/06
1400	Public Doors	10 days	Mon 4/24/06	Fri 5/5/06
1410	Flooring	15 days	Mon 5/1/06	Fri 5/19/06
1420	Public Trim	10 days	Mon 5/1/06	Fri 5/12/06
1430	Public Tile	10 days	Mon 5/8/06	Fri 5/19/06
1440	Public Finish Paint	10 days	Mon 5/15/06	Fri 5/26/06
1450	Public Flooring	10 days	Mon 5/22/06	Fri 6/2/06
1460	Third Floor Framing	15 days	Mon 9/19/05	Fri 10/7/05
1470	Third Floor Deck	3 days	Thu 11/3/05	Mon 11/7/05
1480	CIP Slab	2 days	Tue 11/8/05	Wed 11/9/05
9999	Fireproofing	10 days	Mon 12/19/05	Fri 12/30/05
1490	Layout	10 days	Tue 11/8/05	Mon 11/21/05
1500	Core Drill	10 days	Tue 11/15/05	Mon 11/28/05
1510	Metal Studs	50 days	Tue 11/22/05	Mon 1/30/06
1520	MEP Rough-in	20 days	Tue 1/10/06	Mon 2/6/06
1530	Hang Drywall	40 days	Tue 2/14/06	Mon 4/10/06

ID	Task Name	Duration	Start	Finish
1540	Drywall Finish	40 days	Tue 3/21/06	Mon 5/15/06
1550	Trim/Cabinets	15 days	Tue 4/25/06	Mon 5/15/06
1560	Prime & Ceilings	15 days	Tue 5/9/06	Mon 5/29/06
1570	Finish Paint	10 days	Tue 5/23/06	Mon 6/5/06
1580	MEP Trim/Access	10 days	Tue 5/30/06	Mon 6/12/06
1590	Public Doors	10 days	Tue 5/30/06	Mon 6/12/06
1600	Flooring	15 days	Tue 6/6/06	Mon 6/26/06
1610	Public Trim	10 days	Tue 6/6/06	Mon 6/19/06
1620	Public Tile	10 days	Tue 6/13/06	Mon 6/26/06
1630	Public Finish Paint	10 days	Tue 6/20/06	Mon 7/3/06
1640	Public Flooring	10 days	Tue 6/27/06	Mon 7/10/06
		1 day?	Mon 6/13/05	Mon 6/13/05
1650	Fourth Floor Framing	15 days	Mon 10/10/05	Fri 10/28/05
1660	Fourth Floor Deck	3 days	Mon 10/31/05	Wed 11/2/05
1670	CIP Slab	2 days	Thu 11/3/05	Fri 11/4/05
9999	Fireproofing	10 days	Mon 1/2/06	Fri 1/13/06
1680	Layout	10 days	Thu 11/3/05	Wed 11/16/05
1690	Core Drill	10 days	Thu 11/10/05	Wed 11/23/05
1700	Metal Studs	50 days	Thu 11/17/05	Wed 1/25/06
1710	MEP Rough-in	20 days	Thu 1/5/06	Wed 2/1/06
1720	Hang Drywall	40 days	Thu 2/9/06	Wed 4/5/06
1730	Drywall Finish	40 days	Thu 3/16/06	Wed 5/10/06
1740	Trim/Cabinets	15 days	Thu 4/20/06	Wed 5/10/06
1750	Prime & Ceilings	15 days	Thu 5/4/06	Wed 5/24/06
1760	Finish Paint	10 days	Thu 5/18/06	Wed 5/31/06
1770	MEP Trim/Access	10 days	Thu 5/25/06	Wed 6/7/06
1780	Public Doors	10 days	Thu 5/25/06	Wed 6/7/06
1790	Flooring	15 days	Thu 6/1/06	Wed 6/21/06
1800	Public Trim	10 days	Thu 6/1/06	Wed 6/14/06
1810	Public Tile	10 days	Thu 6/8/06	Wed 6/21/06
1820	Public Finish Paint	10 days	Thu 6/15/06	Wed 6/28/06

ID	Task Name	Duration	Start	Finish
1830	Public Flooring	10 days	Thu 6/22/06	Wed 7/5/06
1840	Roof Framing	10 days	Mon 10/31/05	Fri 11/11/05
1850	Roof Deck	3 days	Mon 11/14/05	Wed 11/16/05
1990	CIP Slab	2 days	Thu 11/17/05	Fri 11/18/05
9999	Fireproofing	10 days	Mon 1/16/06	Fri 1/27/06
1860	Truss/Mansard Framing	20 days	Mon 11/7/05	Fri 12/2/05
1870	Roof Membrane	20 days	Mon 11/14/05	Fri 12/9/05
1880	Roof Shingles	15 days	Mon 11/21/05	Fri 12/9/05

Construction Management Breadth Conclusion:

The owner of the building would have a decision to make. His options are

A. Spend 3.3% more for construction costs but wait roughly 3 months longer for completion
B. Save the extra money, have the building done sooner and make money off of the tenants earlier.

It is my belief that the later of the two options is a better choice financially. This means that the current structural design of a masonry building with pre-cast hollow core planks is best suited for the owner.

Conclusion

Conclusion:

The overall goal of my thesis project was to analyze the feasibility of altering the current structural system. I altered the system from the original load bearing masonry walls with pre-cast hollow core planks to a structural steel skeleton. Since such a structural change affects other aspects of the building, it was necessary to study the feasibility of these changes mechanically and also how they affect the constructability of the building.

After a thorough analysis structurally, it seemed as if the building would be able to be redesigned as a structural steel skeleton. Although, it was necessary to realize that changing from the current system would yield consequences architecturally. For example, the new columns necessary for the redesign did not fit into the new partition walls. This can be changed easily by altering the design of interior partitions.

Another change that had to be analyzed was the exterior wall. Once I analyzed the exterior wall for my new design I was able to conclude that new design did meet ASHRAE standards and low heat transfer was maintained.

Finally, everything was redesigned, and it was time to analyze the impact the new changes would have on the cost and duration of construction. I conclude that a savings of roughly 3.3% was not a substantial enough amount to render a decision of changing the structural system. This is because the completion of the building would have to be pushed back to a later date by about 3 months. The original design is best suited for the owners needs.

References

References:

Design Codes and Aids:

1. International Design Code 2003. International Code Council.
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4. Manual of Steel Construction, Load and Resistance Factor Design, Third Edition. American Institute of Steel Construction.
5. Wheeling Deck Products.
6. ANSI/ASHRAE/IESNA std. 90.1-2001. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
7. ASHRAE Handbook of Fundamentals 1993. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

Cost Data:

1. CostWorks 2005. R.S. Means Inc.

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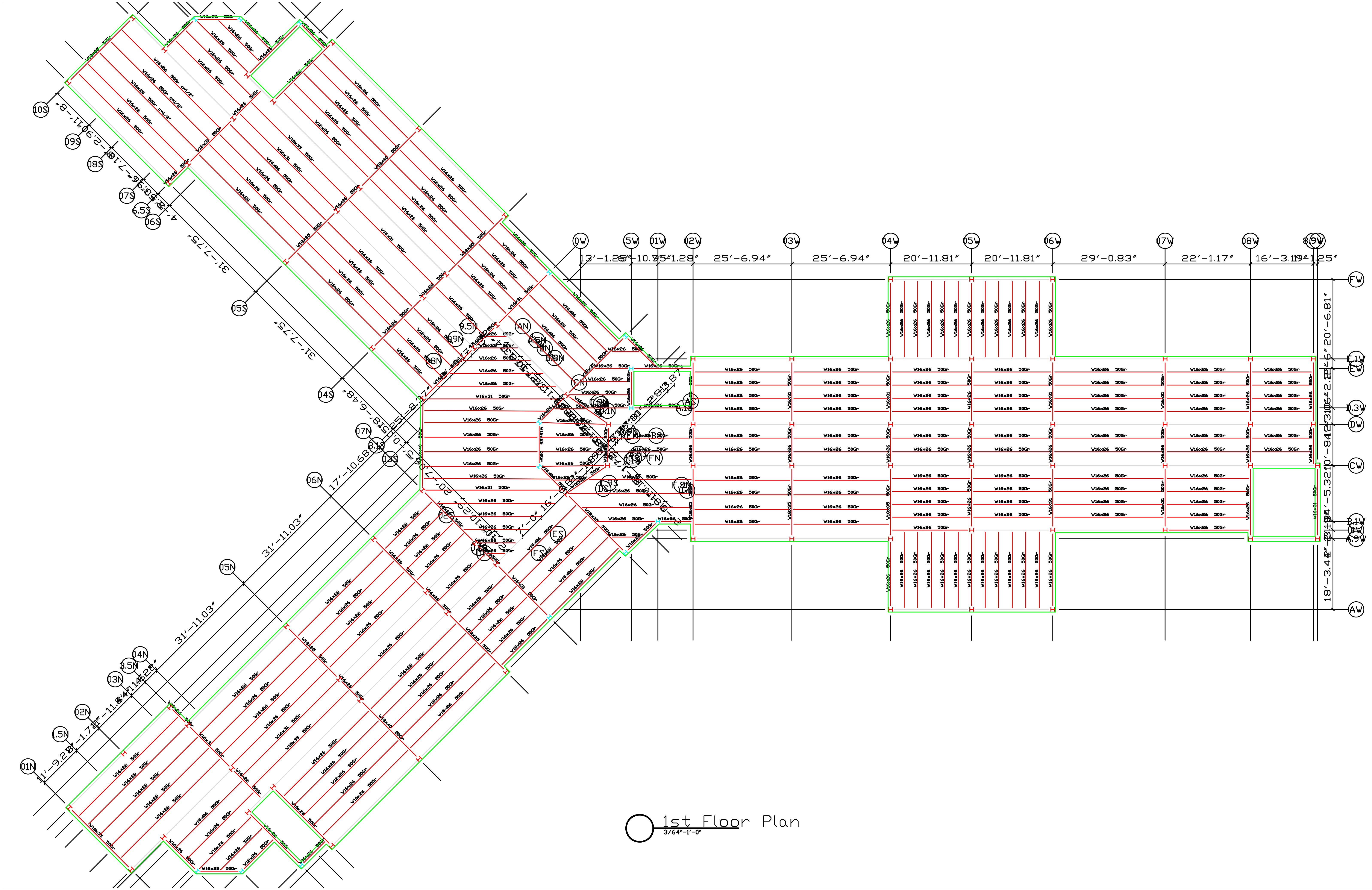
Appendix



1st Floor Plan

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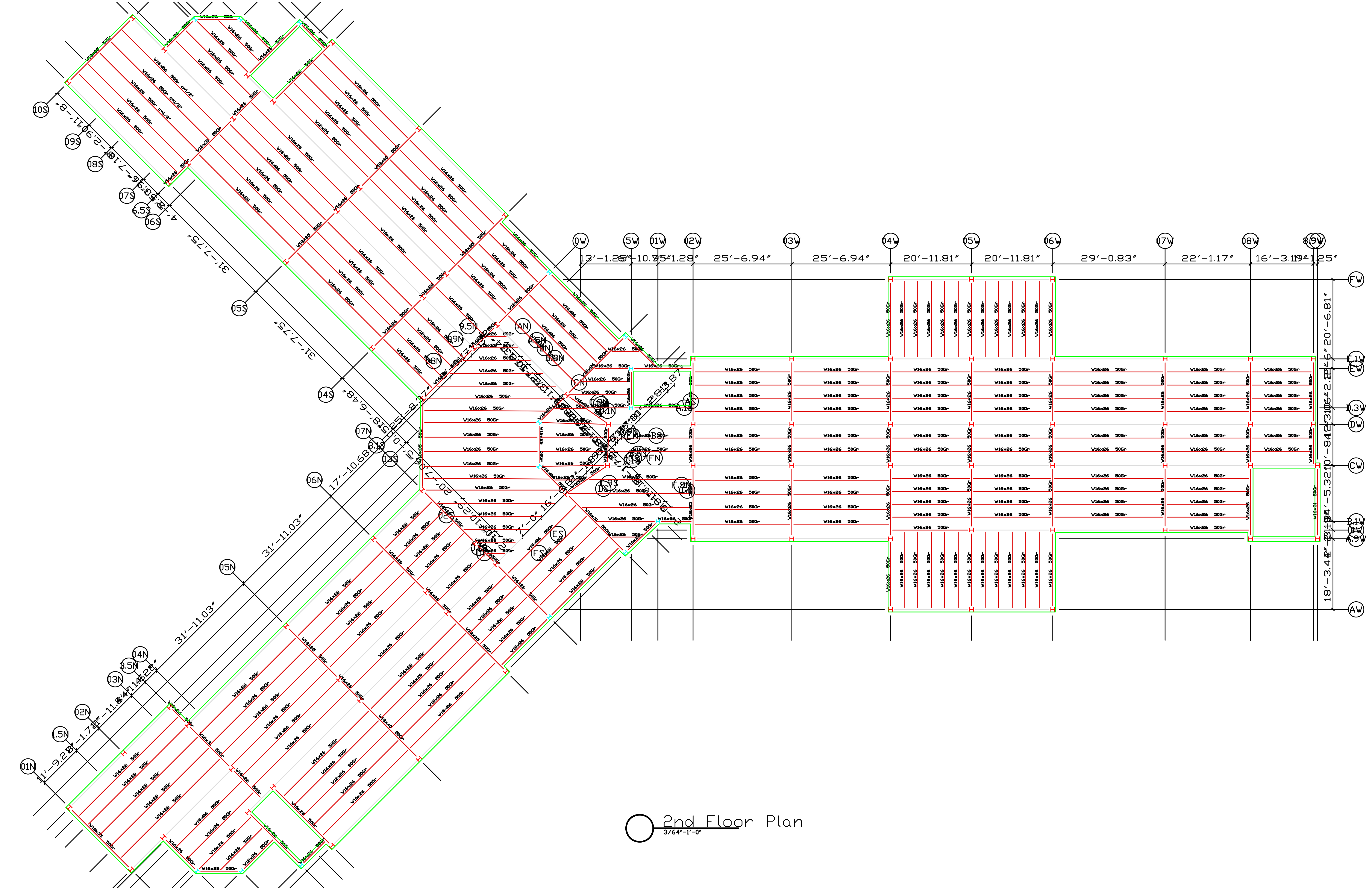

2nd Floor Plan

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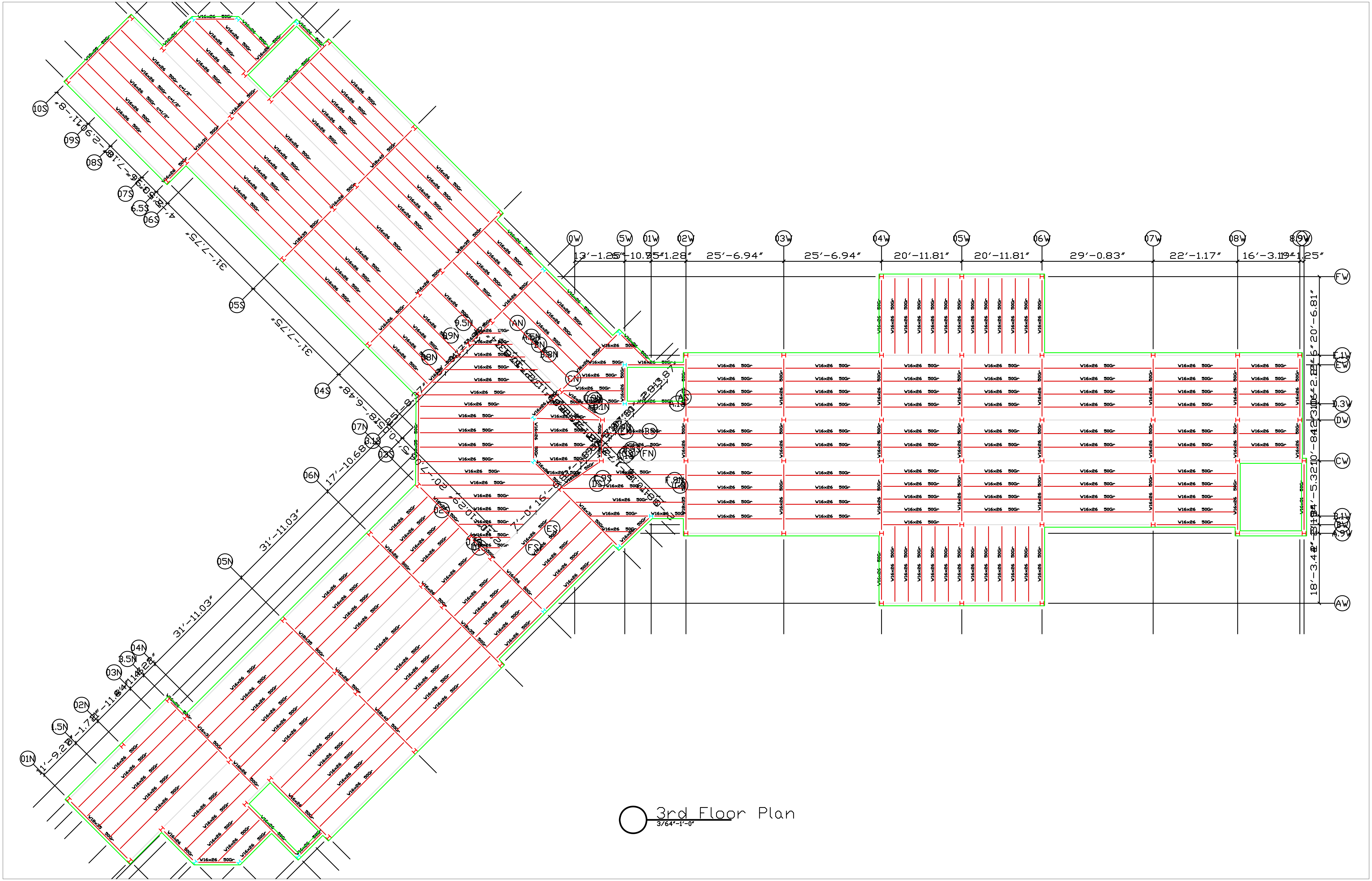

3rd Floor Plan

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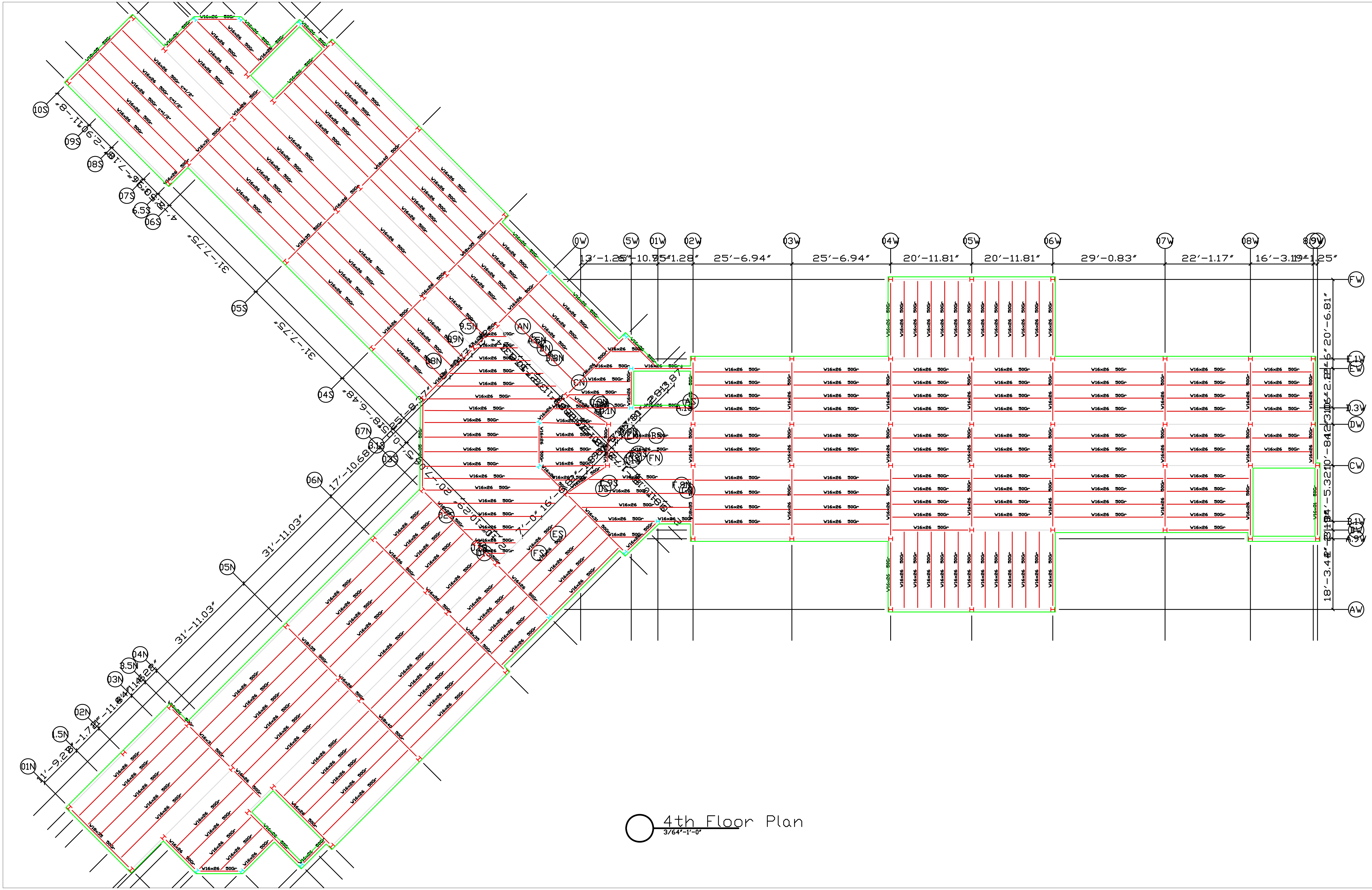

4th Floor Plan
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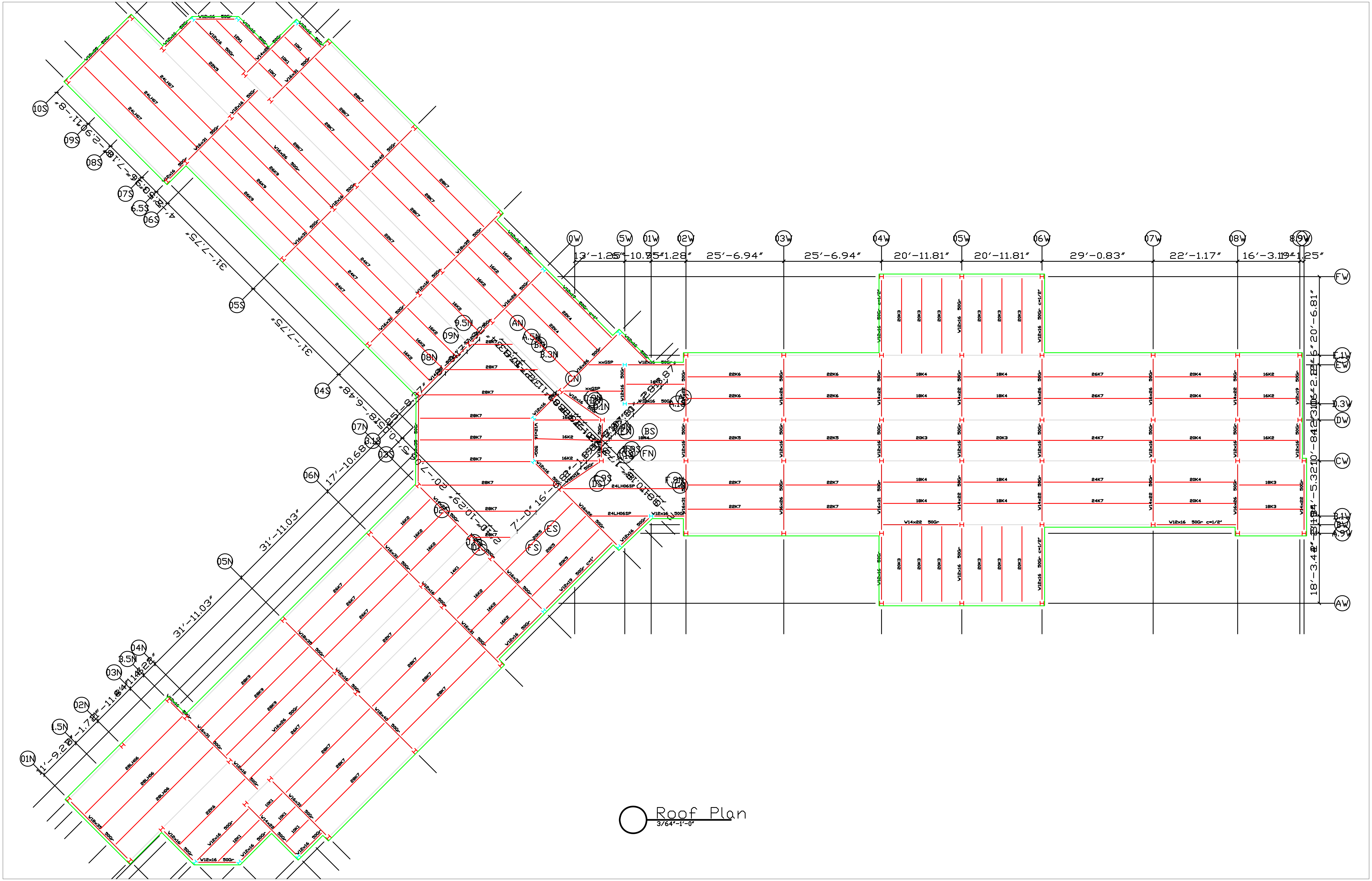

Roof Plan
3/64"=1'-0"