Jackson Crossing | Located in Alexandria, VA

Technical Report 1

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Structural Option

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Executive Summary

Jackson Crossing is a development in Alexandria, Virginia by AHC, Inc. Offering one, two, and three-bedroom apartments, it is targeted at low-income residents with families. The structure is five floors and 107,740 square feet. Included in the building is an underground parking garage. The project will be completed by December 2015 and will come to a total project cost of sixteen million dollars.

The gravity system consists of four floors of wood floors with wood trusses and bearing walls. The wood members sit on two floors of concrete, one of which is below grade. The slab on the second floor is a reinforced two-way slab while the ground floor is a reinforced one-way slab with concrete beams.

The lateral system for the top four floors includes an Intermediate Reinforced Masonry Shear Wall, IRMSW, and a Light Framed Walls Sheathed with Wood Structural Panels, LFW. The LFW is anchored into the second floor slab while the IRMSW is integrated into Ordinary Reinforced Concrete Shear Walls, ORCSW, that extend down into the foundation.

Introduction

Purpose

To prepare for a redesign of Jackson Crossing, this report will examine the existing structure and identify how it was designed to find an alternate structural system.

Scope

The first section will cover the general information on Jackson Crossing. Then the existing structural system will be detailing including the gravity frame, lateral system, and the material properties that are used in these systems.

General Building Description

Jackson Crossing is a five story above grade residential apartment for low income residents. AHC, Inc., the owner, located the building in Alexandria, Virginia and contracted Harkins Builders, Inc. to handle the construction. Construction began in April 2014 and is scheduled to finish in December 2015. The project cost of the building came to a total of 16 million dollars. Jackson Crossing is a very elongated building with its longer dimension at around 255 feet and its shorter dimension at around 60 feet. The location of Jackson Crossing in relation to Washington D.C. is in Figure 1.

Figure 1 (Courtesy of Google Maps)

Structural System

This section describes the structural system of Jackson Crossing including its gravity system and lateral system while providing an overview of the structure as a whole. The properties of the structural materials are also detailed.

Structural System Overview

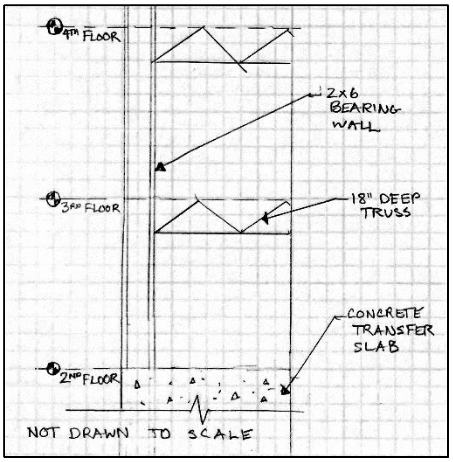

Figure 2

Rathgeber Goss Associates designed the structure of Jackson Crossing with concrete and wood members. Figure 2 depicts how the concrete and wood levels interact. From the second floor to the roof level the structure is a wood frame designed to handle residential units. The bearing walls, part of the wood frame, extend down to the second floor where they rest on a concrete slab. The floors below the second floor to the level on grade is a concrete frame that is designed as both a one-way or two-way slab depending on the level. The columns in the concrete system rest their load on a pile cap which is generally two feet below the elevation of the slab on grade. The foundation system uses 12 inches in diameter auger cast piles.

Gravity System

The top four levels are residential units framed with 18” deep trusses at 24” o.c. and 2x6 wood bearing walls. At the second floor the 2x6 bearing walls transfer their load to a twelve inch concrete slab. Two interior wood bearing walls are located along the longer length of the building along with exterior bearing walls along the perimeter. The maximum span of the bearing walls is twenty-four feet and two inches and a minimum span of around five feet and five inches between the two interior bear walls. The general location of these bearing walls are highlighted in Figure 3 on a Fifth Floor plan. This condition is typical for each of the wood levels.

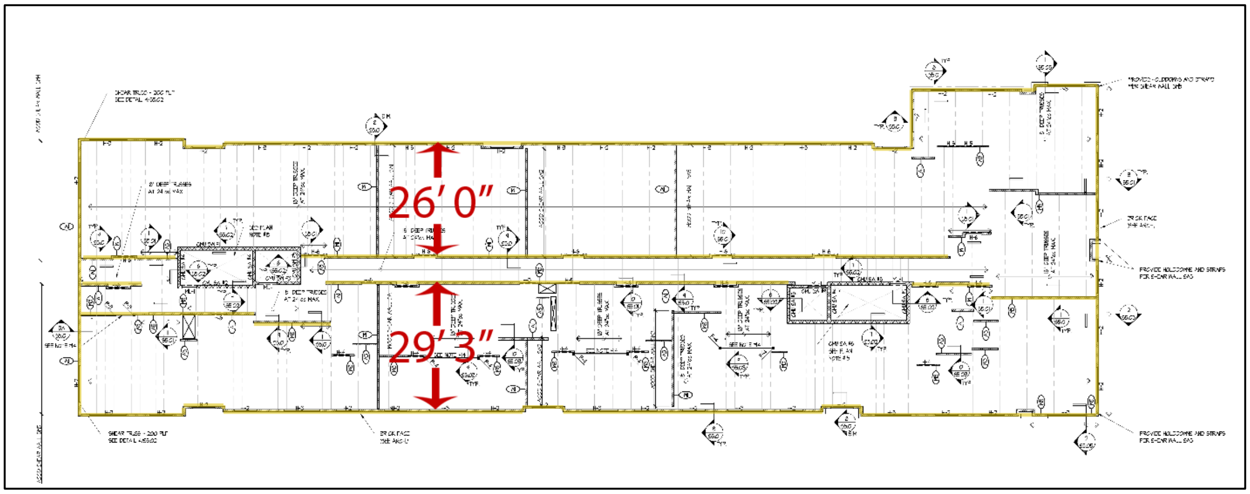

Figure 3

The second floor that takes the load of the wood levels above is a 12 inch two-way slab. The slab has a bottom mat of #5 at 12” o.c. in both directions. The top steel over the column strips are typically #6 bars as are the top steel over the middle strip. The concrete columns below the second floor are typically 16”x24” and have a maximum span of 26 feet and 3 3/8 inches. The ground floor or first floor of the structure is also a 12 inches thick but is designed as a concrete one-way slab. Not all of the columns coming from below the second floor continue below the ground floor. The inconsistent column layout is because the ground floor contains residential units while the floor below is a garage and requires a different column layout. Because of this, the ground floor has continuous concrete beams running along the longer dimension of the building. The location of the columns that terminate at the ground floor are highlighted in Figure 4. In reference to Figure x, the garage level is split between half the area open to the lower garage level and a 5 inch slab on grade. The slab on grade is reinforced with 6x6 – W2.9xW2.9 WWF on a 10 mm vaper barrier over a 6 inch gravel base. In addition the subgrade is properly compacted. All of the concrete columns below the garage level are typically 16”x30”.

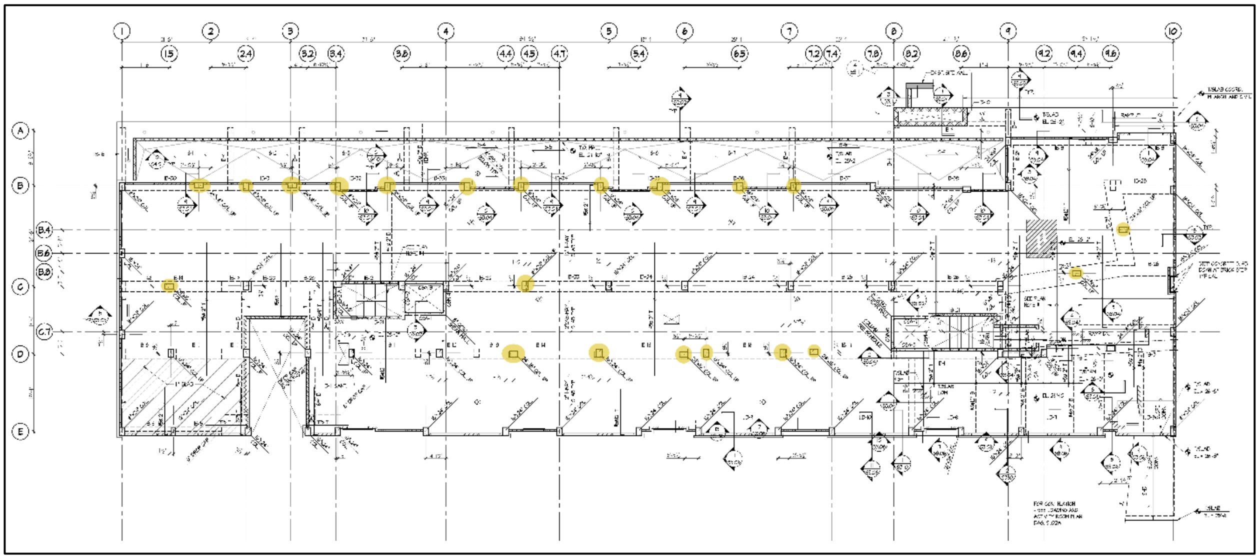

Figure 4

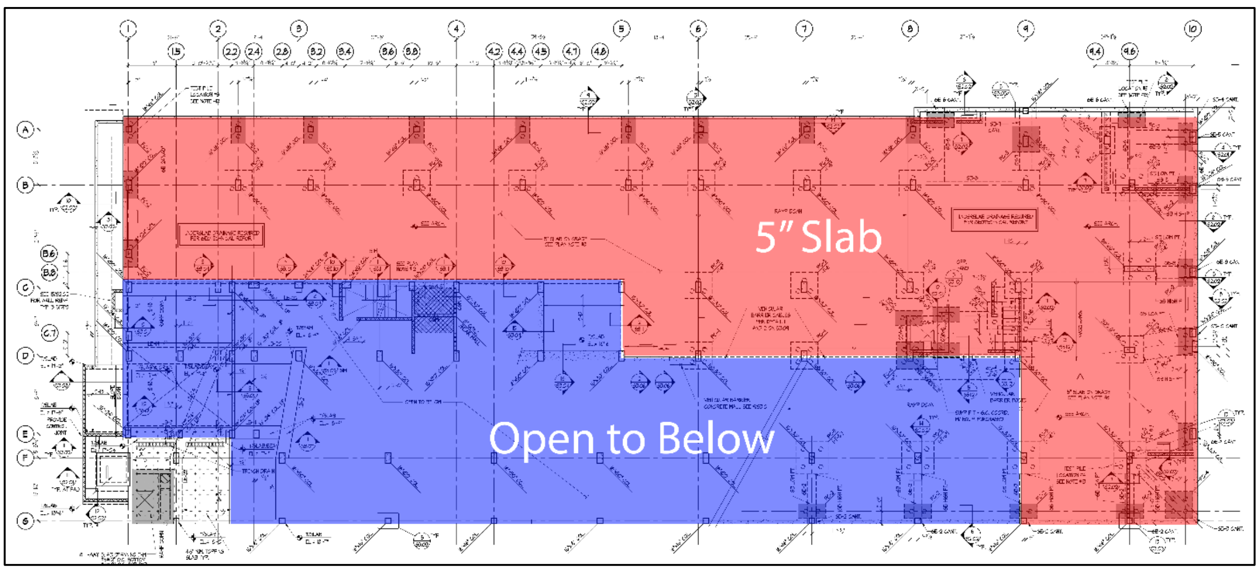

Figure 5

Materials

The engineered wood columns are specified in the general notes as "1.8E Parallam PSL" or approved equal and have the mechanical properties shown in Table 1. The engineered wood beams are specified as "1.9E Microllam LVL", "2.0E Parallam PSL", or approved equal. The beams mechanical properties are detailed in Table 2. The properties of the concrete specified for use in Jackson Crossing are listed in Table 3.

Table 1	
Fb	2,400 psi
Fc (PAR)	2,500 psi
Fc (PERP)	425 psi
Fv	190 psi
E	1,800,000 psi

Table 2	
Fb	2,600 psi
Fc (PAR)	2,510 psi
Fc (PERP)	750 psi
Fv	285 psi
E	1,900,000 psi

Table 3			
Application	f'c @ 28 days (psi)	Weight (PCF)	W/C (Max)
Slabs-on-Grade (Interior)	3000	145	0.50
Slabs-on-Grade (Exterior)	4500	145	0.45
Reinforced Slabs	5000	145	0.45
Reinforced Beams	5000	145	0.45
Columns	4000	145	0.50
Walls	4000	145	0.50
Grade Beams	3000	145	0.55
Pile Caps	3000	145	0.55
Footings	3000	145	0.55
Parking Structure Concrete, Excluding Slabs-on-Grade	5000	145	0.40
Interior Topping Slab	4500	115	0.45
Exterior Topping Slab	4500	145	0.45

Lateral System

The lateral system for Jackson Crossing that Rathgeber Goss designed consists of 5 different types of wood shear walls that span from the second floor up to the roof. The wood shear walls are anchored into the second floor concrete slab with a bottom plate and ½" diameter HILTI HAS rods. The locations of the wood shear walls are in Figure 6. In addition there are 9 different types of CMU shear walls that also extend from the second floor up. The locations of the CMU shear walls are in Figure 7. These CMU shear walls rest on concrete shear walls and are connected together with dowels as Figure 8 depicts.

The lateral load that impacts the wood shear walls is transferred through its connection to the second floor slab. The slab then transfers the lateral load into the concrete shear walls. The CMU shear walls transfer their lateral load either directly into the concrete shear walls through the dowels that connect them or through a connection to a concrete beam. The concrete shear walls rest on grade beams that distribute the load into the foundation system.

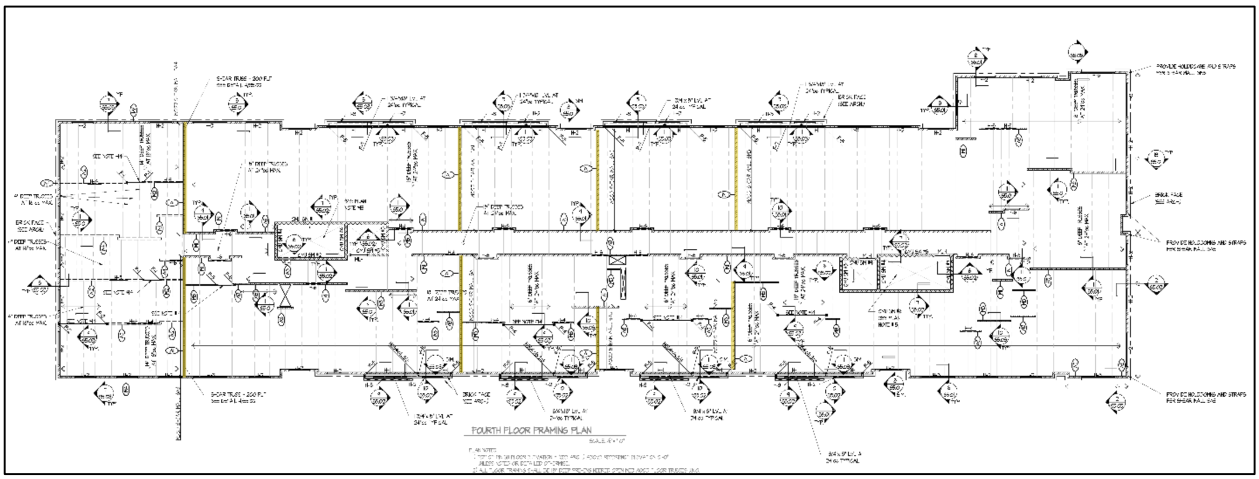

Figure 6

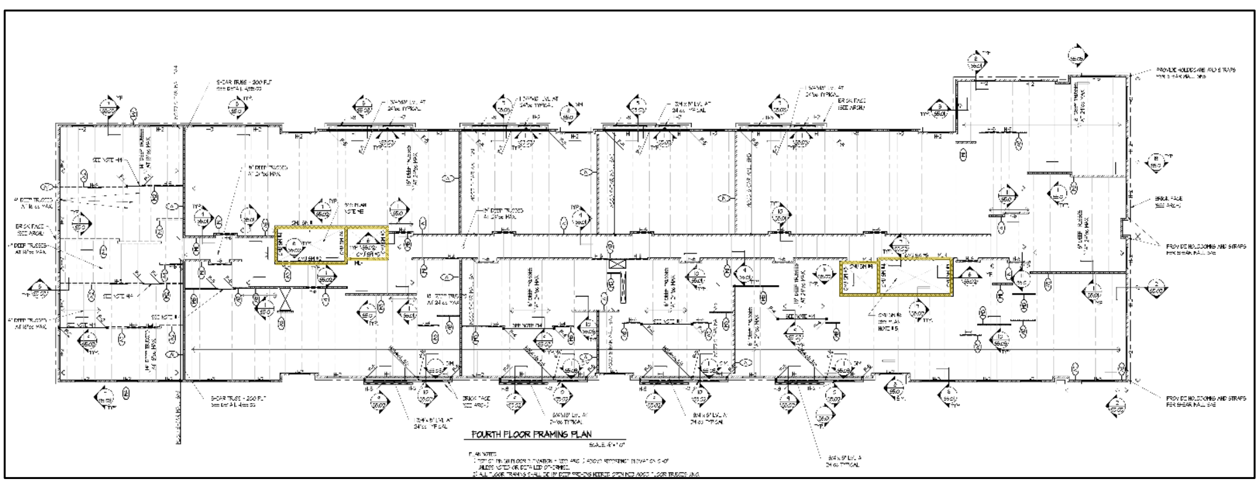

Figure 7

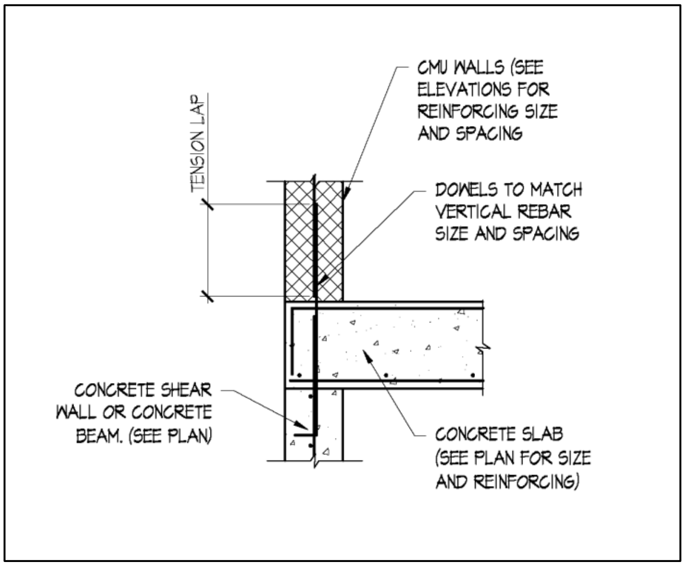
CMU WALLS (SEE
ELEVATIONS FOR
REINFORCING SIZE
AND SPACING
TENSION LAP
DOWELS TO MATCH
VERTICAL REBAR
SIZE AND SPACING
CONCRETE SHEAR
WALL OR CONCRETE
BEAM. (SEE PLAN)
CONCRETE SLAB
(SEE PLAN FOR SIZE
AND REINFORCING)

Figure 8

Building and Design Codes

The general building codes and standards used for Jackson Crossing were IBC-2009, ASNI/ASCE 7-02-2005, and VIRGINIA UNIFORM STATEWIDE BUILDING CODE-2009. Additional codes are listed in Table 4.

Table 4	
Code Category	Applicable Code
Concrete	"Building Code Requirements For Reinforced Concrete, ACI 318", American Concrete Institute "Specifications For Structural Concrete, ACI 301" "Manual of Standard Practice", Concrete Reinforcing Steel Institute
Masonry	"Building Code Requirements For Masonry Structures, ACI 530/ASCE 5" And "Specifications For masonry Structures, ACI 530.1/ASCE 6"
Wood	"National Design Specification For Wood Construction" (With Supplement), National Forest And Paper Association "Performance Standard And Policies For Structural Use Panels", PRP-108, American Plywood Association (APA) "American National Standard For Wood Products – Structural Glued Laminated Timber", ANSI/AITC A190.1-A992, American Institute of Timber Construction
Steel	"Steel Construction Manual", Latest Edition, American Institute of Steel Construction (Including Specifications For Structural Steel Buildings, Specification For Structural Joints Using ASTM A325 or A490 Bolts, And AISC Code of Standard Practice With Exception, If Any, As Indicated In the Specifications "Detailing for Steel Construction", American Institute of Steel "Structural Welding Code ANSI/AWS D1.1", American Welding Society
Other Applicable Codes	2009 Virginia Construction Code 2009 Virginia Plumbing Code 2009 Virginia Mechanical Code 2009 Virginia Energy Conservation Code 2008 National Electric Code (NFPA 70) 2003 ICC/ANSI A117.1

Design Loads

This section focuses on the design loads Rathgeber Goss used in their analysis based off the codes listed in the *Building and Design Codes* section.

Gravity Dead Load

The Superimposed Dead Load in addition to Structure Dead Loads is detailed in Table 5.

Table 5	
Area	Load
Concrete Levels	15 PSF
Wood Floor Level	25 PSF (20 PSF Top Chord and 5 PSF Bottom chord)
Roof Terrace	45 PSF (40 PSF Top Chord and 5 PSF Bottom Chord)
Roof	20 PSF (15 PSF Top Chord and 5 PSF Bottom Chord)

Gravity Live Load

The Live Loads are listed in Table 6. Live Load Reduction was used when applicable per code.

Table 6	
Area	Load
Living Units	40 PSF
Lobbies/Stairs/Exits	100 PSF
Corridors Above 1st Floor	80 PSF
Parking Decks	40 PSF
Parking Decks (Top Level)	70 PSF (40LL+30 SNOW)
Roof Terrace	100 PSF
Loading Dock	250 PSF

Gravity Roof Live Loads

The existing design uses a Roof Live Load of 30 PSF at a minimum unless the Snow Load is greater. The Roof Snow Load is detailed in Table 7.

Table 7	
Roof Snow Load (Plus Drift Where Applicable)	
Pg	25 PSF
Pf	17.5 PSF
Ce	1.0
I	1.0
Ct	10

Lateral Wind Load

The location of Jackson Crossing necessitated a basic wind speed of 90 MPH. The other parameters for the lateral wind forces are in Table 8.

Table 8	
Importance Factor	1.0
Exposure Category	B
Internal Pressure Coefficient	GCpi = +/- 0.18
Roof Uplift	10 PSF

Lateral Earthquake Load

The parameters used to find the lateral earthquake load in an equivalent lateral force procedure are detailed in Table 9.

Table 9	
Occupancy Category	II
Seismic Importance Factor	1.0
Mapped Spectral Response Accelerations	SS=0.153 S1=0.050
Site Class	D
Spectral Response Coefficients	SDS=0.163 SD1=0.081
SD1	0.081
Seismic Design Category	B
Design Base Shear	63 KIPS
Seismic Response Coefficient	CS=0.041 for Concrete Shear Walls CS=0.047 for Masonry Shear Walls
Response Modification Factor	R=4 for Concrete Shear Walls R=3.5 for Masonry Shear Walls R=6.5 for Wood Shear Walls

Lateral Earth Pressure

The lateral equivalent fluid pressure used at a rest condition for braced walls was 60 PSF per foot of depth. At an active condition the lateral equivalent fluid pressure used was also 60 PSF per foot of depth for cantilevered retaining walls.

Details

This Section deals with the connection details between structural members.

Typical Interior Bearing Wall at Roof

At a typical interior bearing wall, plywood sits on top of the roof truss. The roof truss leans on the stud wall protected by Pre-Rock with DensShield gypsum. The gypsum is tied every other stud with a Simpson H2.5A Hurricane Tie. Also Simpson H6 Hurricane Tie at 4’-0” o.c. are attached to the band board as Figure 9 depicts.

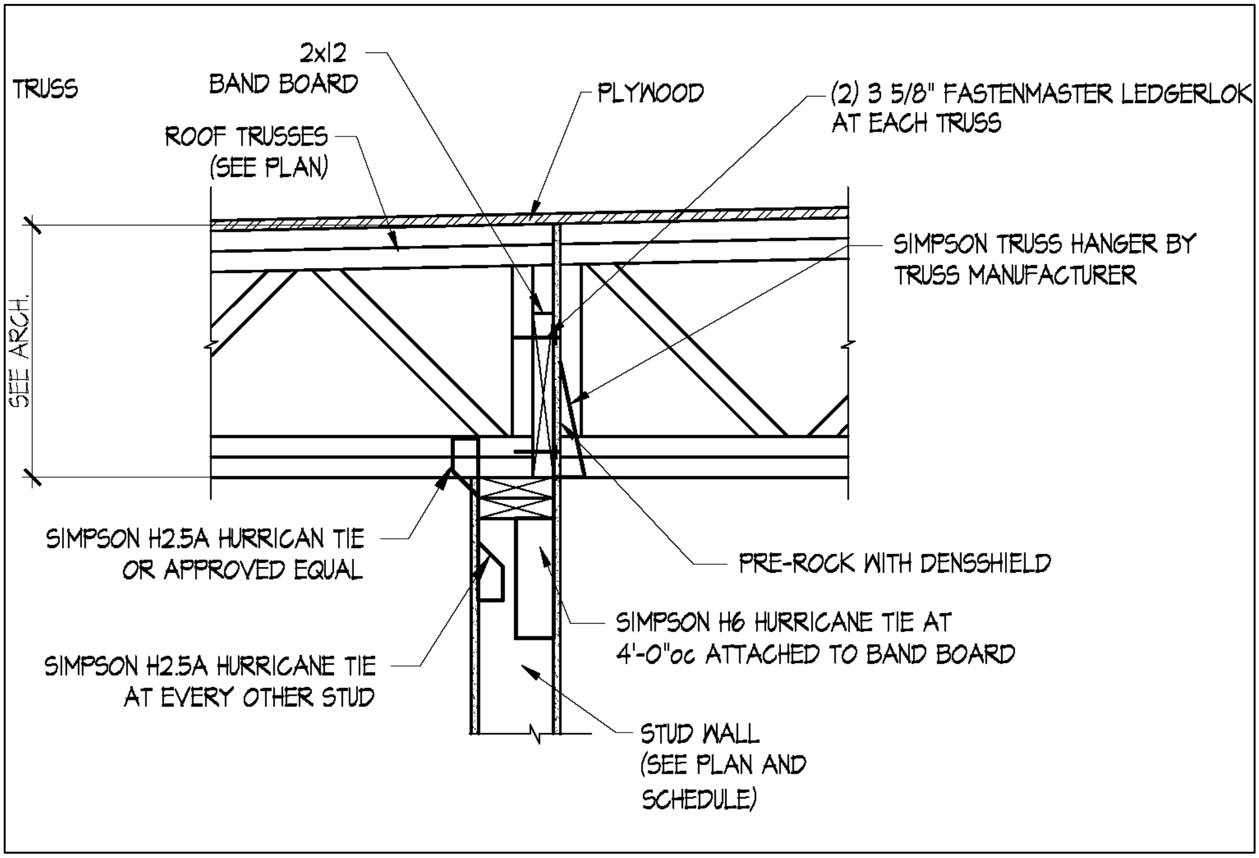

Figure 9

Typical Bearing at Exterior Trusses Parallel to Wall

At an exterior wall for a floor level, 1" Gyp-Crete sits on plywood over the floor joist system. 2x4 flat braces are set at 4 feet o.c. and nailed to each bottom chord with two 10d nails. Also, 2x4 Kickers brace the joists and are connected with two 10d nail as Figure 10 depicts.

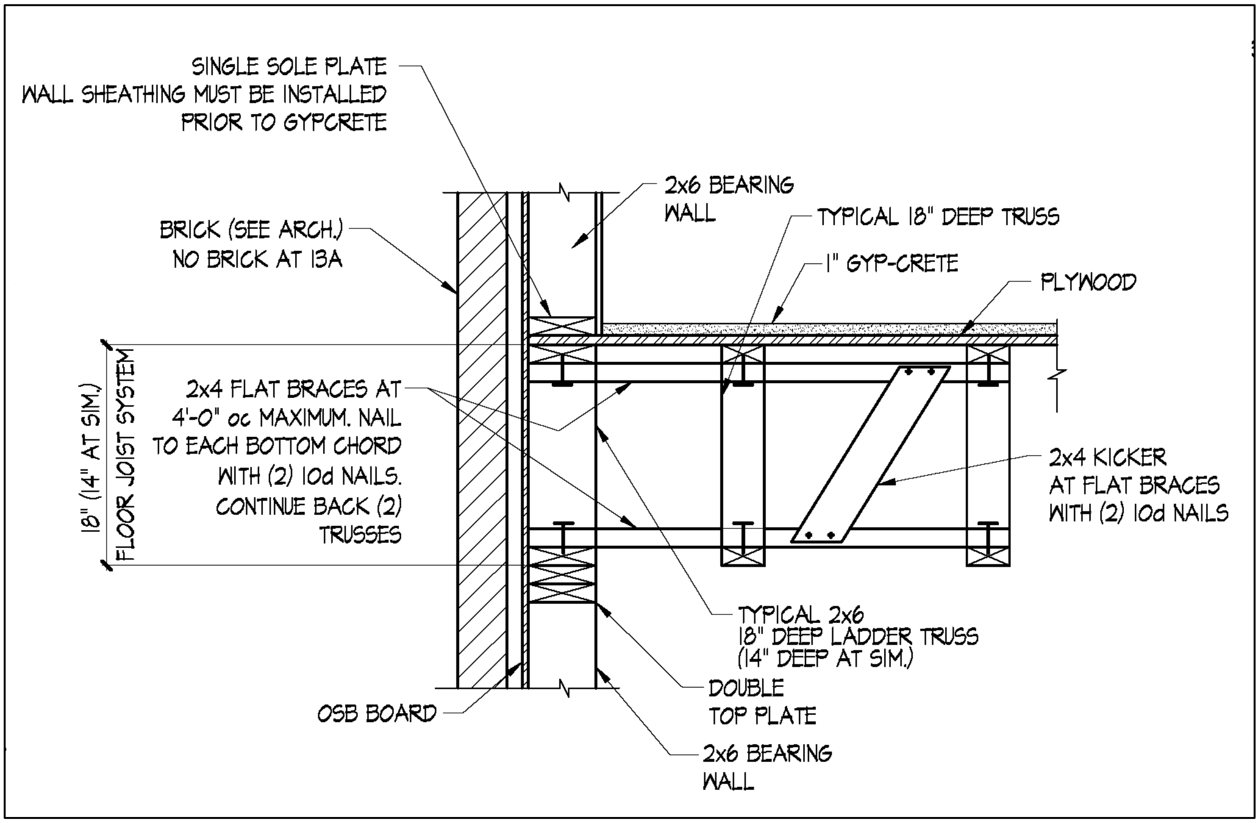

Figure 10

Closing

Jackson Crossing is a challenging building to design as the columns are not consistent from top to bottom. As the redesign process begins, the most important issue will be how to handle the transfers in load that are caused by the changes in column layout between floors. The existing design handles these transfers with deep concrete beams that take away space from other systems in the building. Moving forward, a redesign should take into account whether there is a more ideal solution.

Appendix

Elevations

Fifth	Fouth	Third	Second	First	Garage	L. Garage

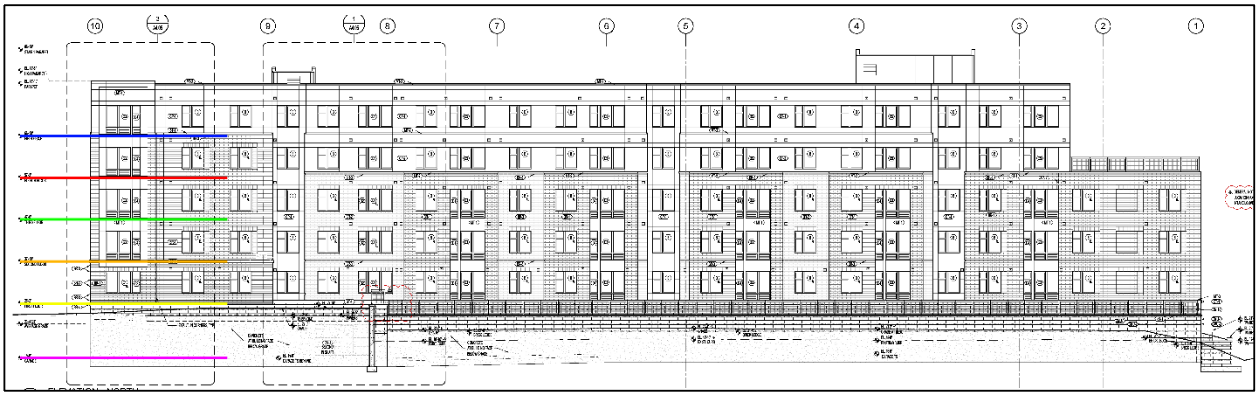

Figure 11 – North Elevation

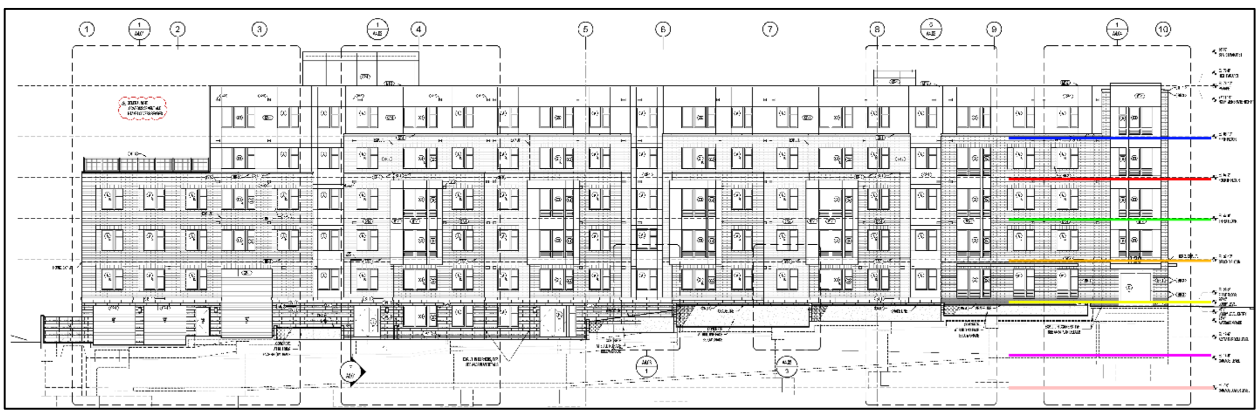

Figure 12 - South Elevation

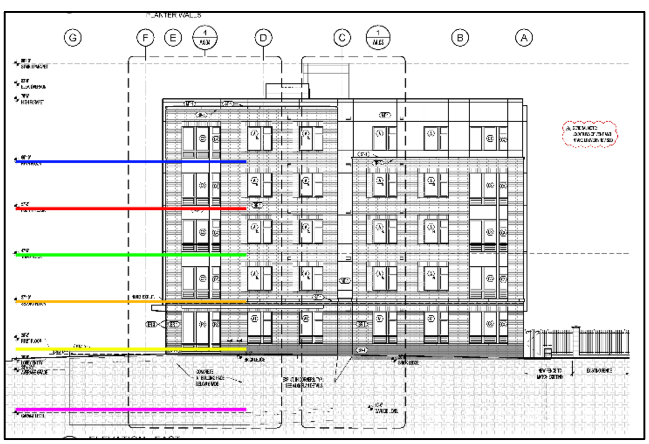

Figure 13 – East Elevation

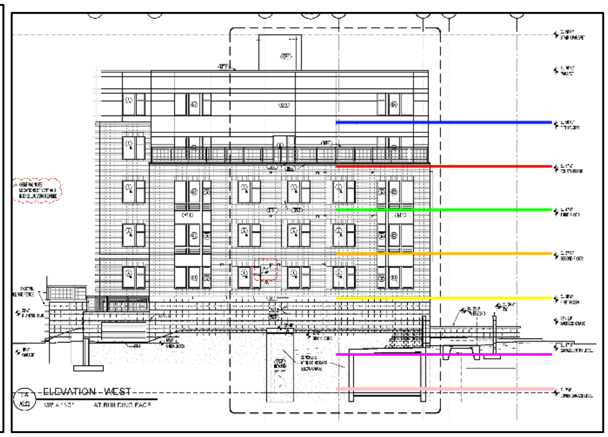

Figure 14 – West Elevation