TECHNICAL REPORT 1

Daniel Goff
Structural Option

Faculty Advisor
Linda M. Hanagan

Executive Summary

The Primary Health Networks Medical Office Building is located in Sharon, Pa in between Pitt and E Silver streets next to the Shenango River. It will be a 5 story structure rising 85 feet, having four elevated floors and a roof. The building offers 78,000 square feet of occupiable space and will cost approximately $10 million.

The site soil was found to have a bearing capacity of 2500psi allowing for concrete spread and mat footings to serve as a foundation for the building. The building is primarily a steel framed structure with steel columns supporting wide flange steel girders and steel bar joists. Typical sizes for floor joists and girders range from 10 inch to a maximum depth of 24 inches. The floor structure is concrete on metal deck for all four elevated floors, whereas the first floor is concrete slab on grade. Typical bay sizes range from 30'x26' to 33'-10"x30'.

The building's lateral force resisting system is comprised of three Ivany block shear walls. Ivany block is a concrete masonry unit with pre-determined locations for the rebar and having an f'm of 3000psi. The shearwalls are located around stairwells throughout the building.

Typical shear and moment connections are to be designed by the steel fabricator. Other connections typical to this building discussed in detail include joist to ivany block wall connections and concrete slab on metal deck to ivany block to wall connections.

The building was designed using the International Building code (IBC) edition 2009 which references the American Society of Civil Engineers (ASCE) document 7-05. The exception to this is the lateral loads on the building, which were determined with and designed to the IBC 2012 -edition which adopts ASCE 7-10.

Table of Contents

Purpose

The objective of this technical report is to evaluate the existing structure as well as the concepts used in the design of the Primary Health Network's Medical Office Building located in Sharon, Pa. Included in technical report 1 are descriptions of the buildings gravity, lateral and foundation systems. Relevant building codes, building materials, and building design choices will be addressed.

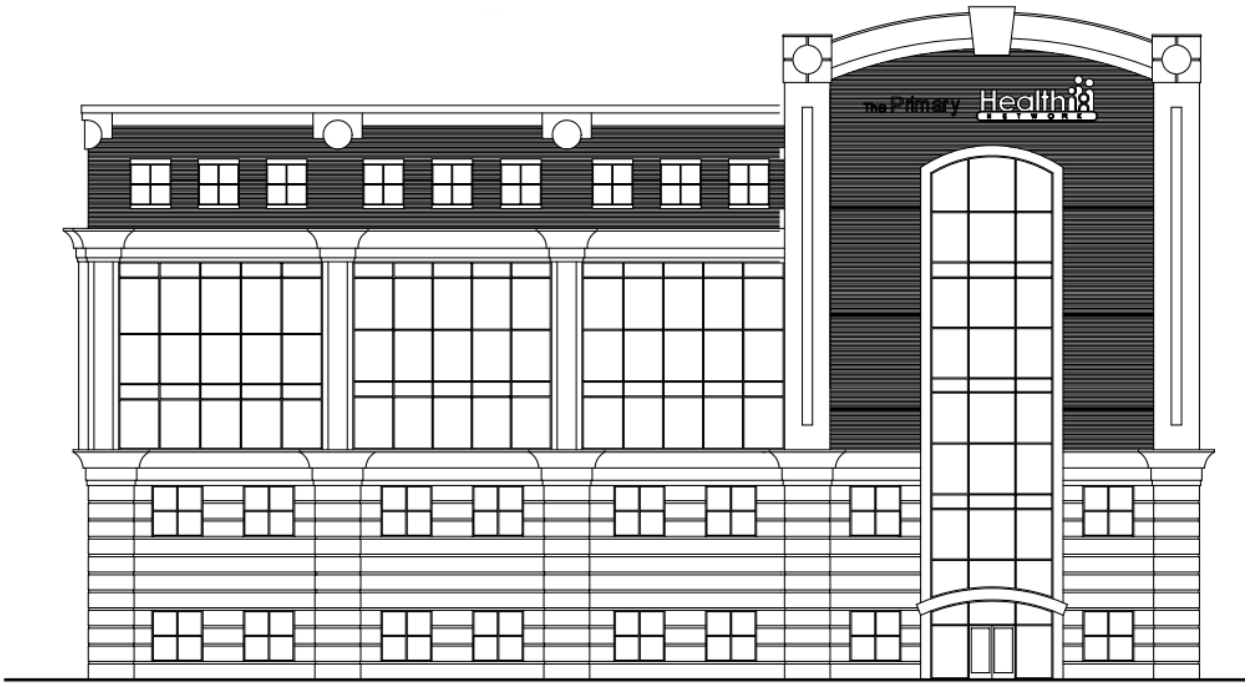


Figure 1 – Elevation
Image courtesy of Taylor Structural Engineers

Building Summary

The Primary Health Network's Medical Office Building, as shown in figure 1, will be located between Pitt and E Silver streets near the Shenango River in Sharon, Pa as denoted in red on figure 2. The building will be 5 stories above grade, four elevated floors and a roof comprising a total building height of 85 feet. The approximate building cost of $10 million will provide 78,000 square feet of occupiable space.

Figure 2 – Site Map

Image courtesy of Taylor Structural Engineers

Structural Framing Overview

The Primary Health Network's Medical Office Building in Sharon, Pa is primarily a steel framed structure. Steel columns and rolled steel girders comprise the gravity support system. The four elevated floors consist of concrete on metal deck supported by steel bar joists. The roof structure is comprised of an adhered membrane on rigid insulation supported by metal deck. Fully grouted Ivany block masonry walls encasing the three main stairs comprise the lateral force resisting system for the building. The building first floor is supported by a reinforced concrete slab-on-grade while the remaining building load is transferred through the columns to reinforced concrete footings.

Design Codes

- International Building Code 2009
  - NOTE: IBC 2012 selected for wind load calculations
- American National Standards Institute 2006
- American Society of Civil Engineers 7-05
  - ASCE 7-10 for wind calculations
- American Concrete Institute 318-08
- American Institute of Steel Construction
  - Structural Steel Buildings 2005

Materials

Steel

Shape	ASTM	Grade	Fy(ksi)
Beams and Girders	A992	50	50
Plates and Bars	A36	-	36
Steel HSS	A500	B	46
Pipe	A53	B	30
Columns	A992	50	50
Bolts	A325	-	-

Concrete

	Minimum Strength(ksi)	Weight (pcf)	Max Water/Cement Ratio
Mat Footings	4	144	0.50
All Other Foundation	3	144	0.50
Interior Slabs	4	144	0.45
Exterior Slabs	4	144	0.40

Masonry

	Minimum Strength(ksi)	ASTM
Hollow Units	1.5	C90
Solid Units	1.5	C90
Ivany Block	3	-
Standard Mortar Above Grade	3	C270 Type S
Standard Mortar Below Grade	3	C270 Type M
Mortar for Ivany Block	3	C270 Type M

Foundation Design

Greenleaf development services conducted a site survey. Their geotechnical report showed that the soil had a bearing capacity of 2500 psf. This was the basis for the design of the buildings footings. The overall design ideology for the foundation was to keep a shallow profile of individual and spread footings resting on the soil.

All interior columns rest on individual concrete spread footings, a section of which is shown in figure 3. Exterior columns rest on a continuous concrete wall footing. The ivany block walls sit on mat footings as can be seen in figure 4.

Figure 3 – Spread Footing
S-12 Section 2

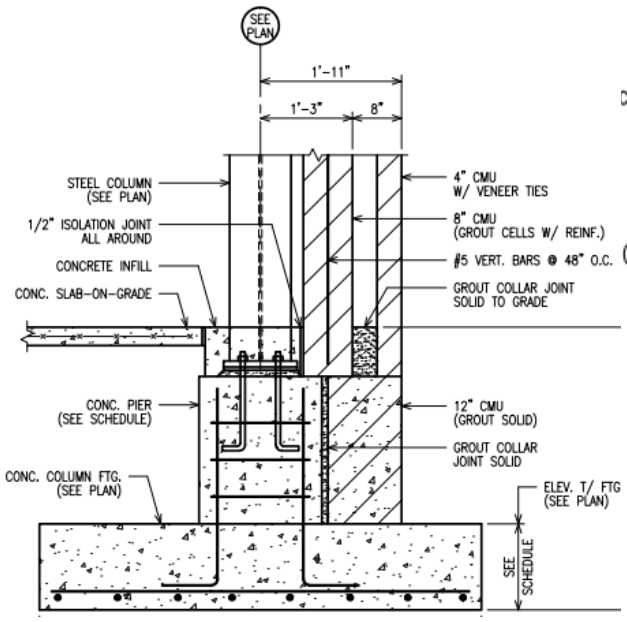
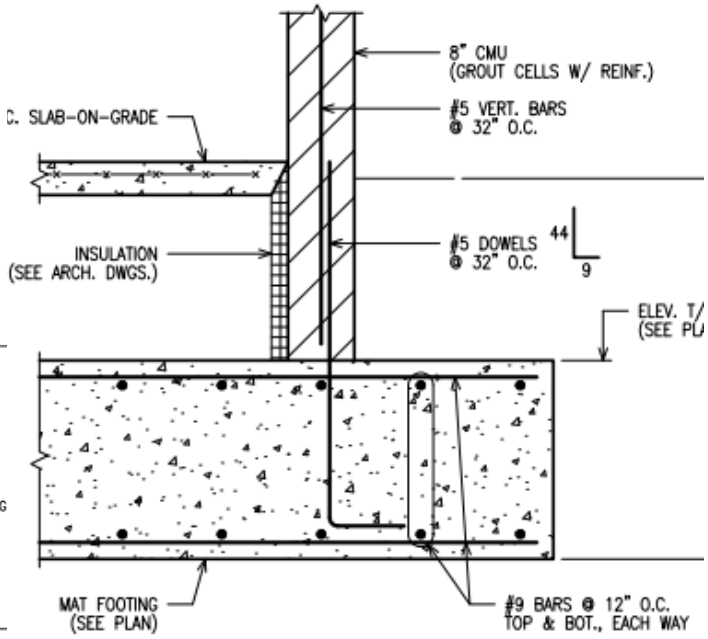


Figure 4 – Mat Footing
S-12 Section 4



Floor System

The Medical Office Building's floor system consists of normal weight concrete on 19/32" 26 gage galvanized form deck. K series steel bar joists of various sizes ranging from 10 inch to 24 inch depth support the floor deck. These joist are in turn supported by wide flange sections with similar variances in depth. In areas where joist span direction changes HSS sections are used to maintain deck elevation consistent with joist seat height as noted in figure 5 below.

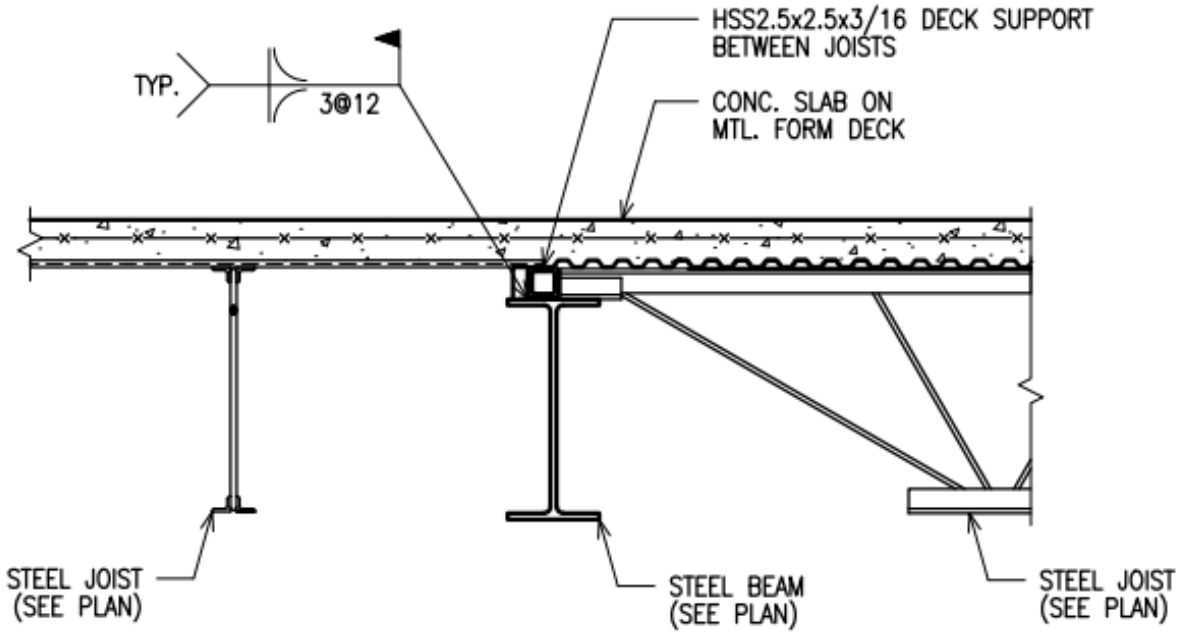


Figure 5 – Typical Framing Detail
S-13 Section 9

Typical Bay

A typical bay in this building is roughly 30'x30' with the joists spanning north to south on the western half of the building and east to west on the eastern half. Steel columns support the floor and roof structures. All columns are W10's with weights ranging from 33 to 60 plf. At the third floor level the columns are spliced with the majority being decreased to W10x33's.

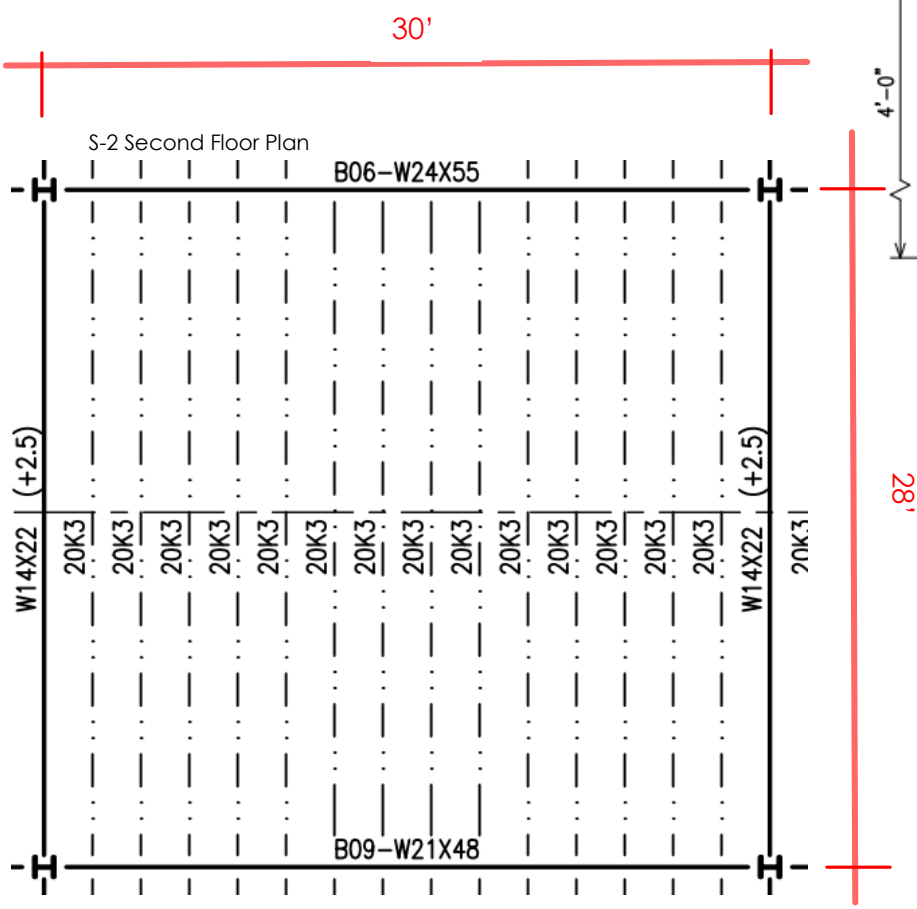


Figure 6 – A typical 30ft. by 28ft. bay framed with joists spanning the north-south direction. A typical floor plan is shown in full on the following page

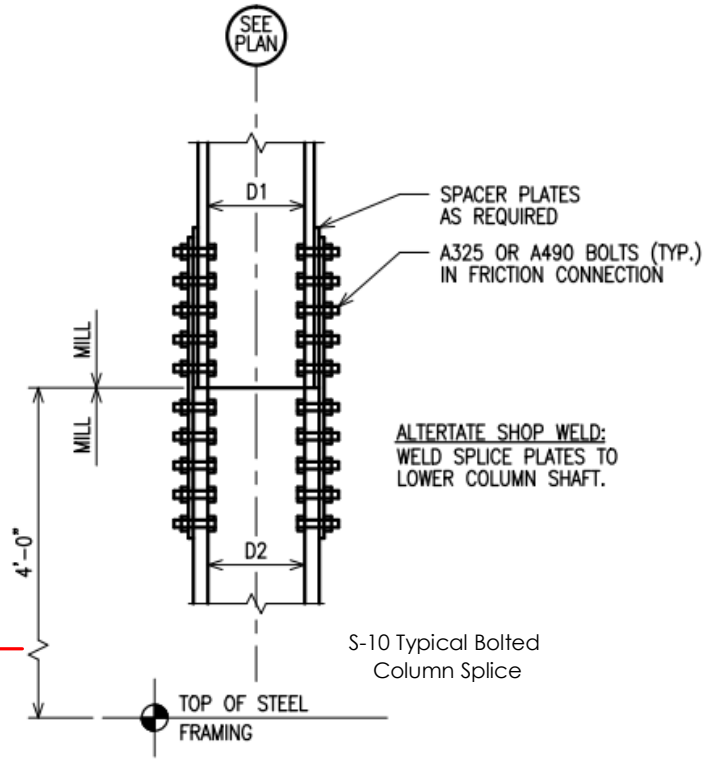


Figure 7 – Details the typical spliced connection at the third floor level where column sizes are reduced.

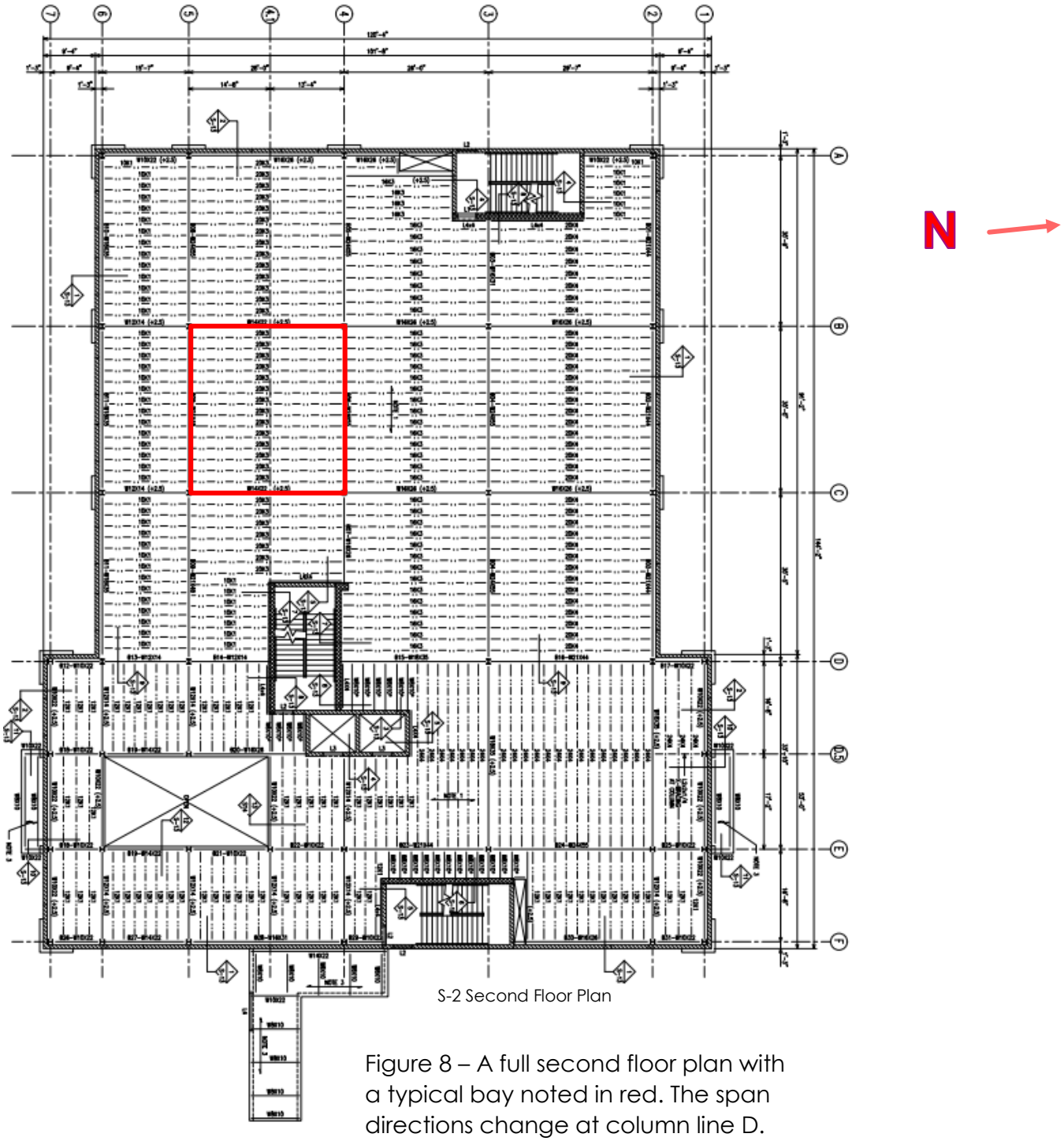


Figure 8 – A full second floor plan with a typical bay noted in red. The span directions change at column line D.

Building Lateral System

The main lateral force resisting system in the Primary Health Networks Medical Office Building is Ivany block shear walls. Ivany block is a concrete masonry unit which, when fully grouted, provides similar performance as an f'c=3ksi cast in place concrete shear wall system with significant cost savings. Ivany block gains another advantage over typical CMU blocks in the placement of reinforcement; Ivany block has slots for rebar allowing for a consistent "d" value to be used in flexural calculations, as shown in figure 9. Ivany block shear walls partially encase the three stair towers as shown in red on figure 10 below.

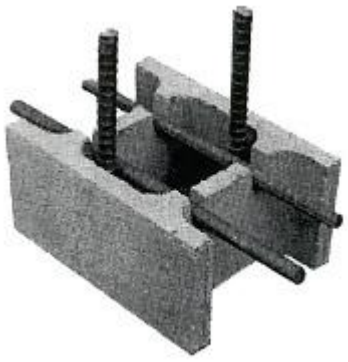


Figure 9 – (Source: koltcz.com)

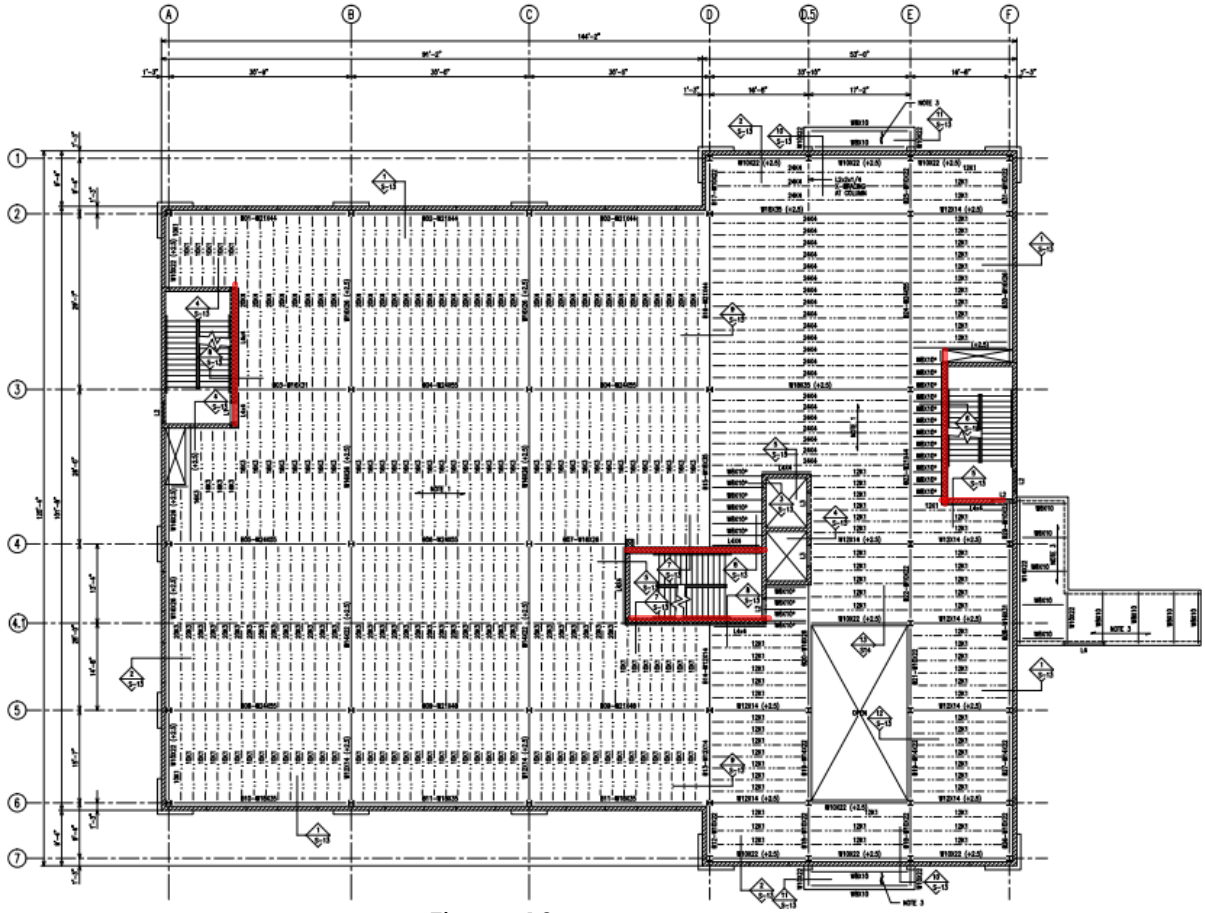


Figure 10
S-2 Second Floor Plan

Shearwall considerations

Lateral loads enter the building through the façade and transfer through girders and tie-beams to ultimately be taken by the Ivany Shear walls. These shear walls which rest on mat footings extend vertically to the roof level. The shear wall located on the western side of the building has openings in the wall at each floor level, this restricted the flexural capacity of the wall by decreasing its depth by 4 feet. The vertical and horizontal bars are #4 spaced at 16" on center. The flexural reinforcing consists of twelve #6 bars spaced at 8" on center up to the third floor where a 28" overlap splices into twelve #5 bars at the same spacing.

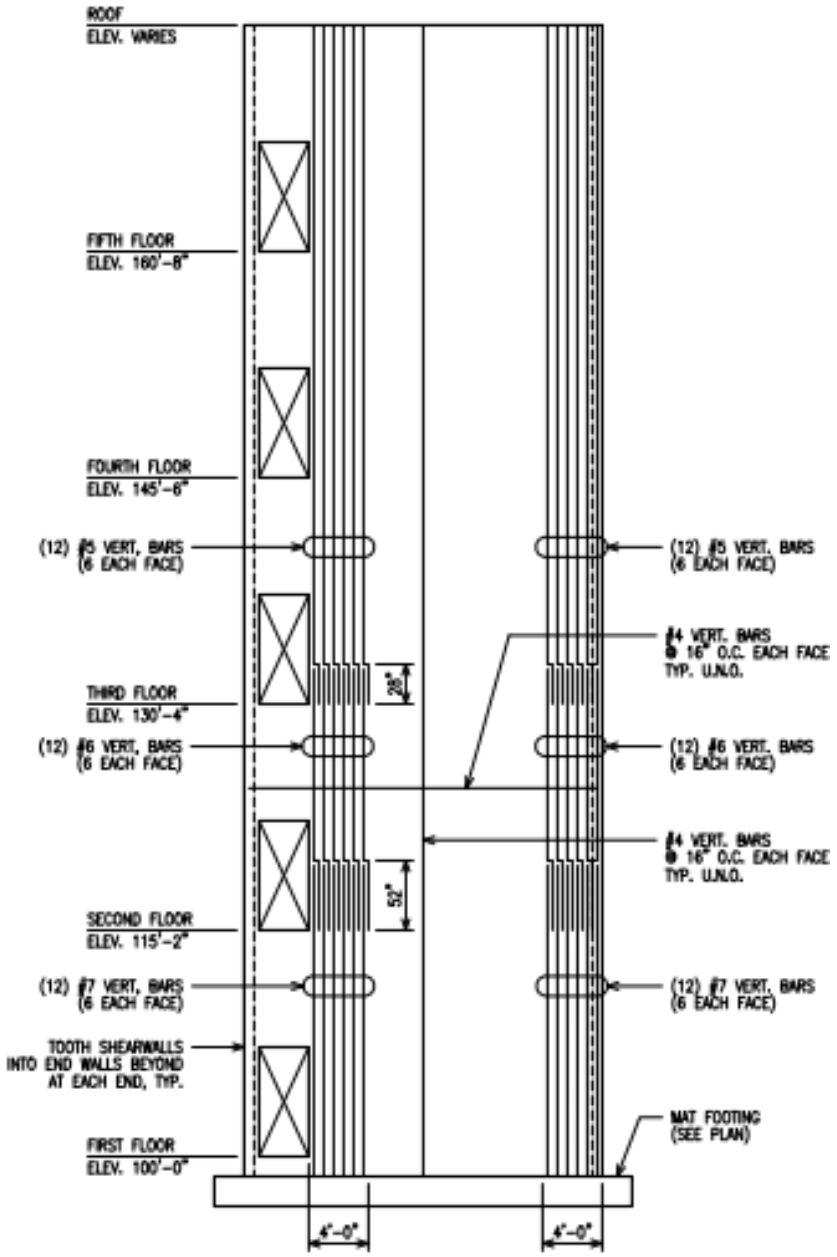


Figure 11
S-11 Shearwall notes

Load Path

This section discusses the manner in which forces are transferred and distributed through the building structure ultimately leading to their dissipation.

Gravity

Gravity Loads in The Primary Health Networks Medical Office Building are received by the concrete floor deck which transfers the load to the steel bar joists. The bar joists transfer the load into the wide flange steel girders which bring the load to steel columns. From there the load is transferred down into spread footings which ultimately dissipate the force into the soil.

Lateral Loads

Wind forces are received by the building façade and then transferred into exterior girders. The lateral loading continues through the floor diaphragm to the Ivany block shear walls. These shear walls dissipate the energy into the foundations and ultimately the soil.

Design Loads

In the design of The Primary Health Network's Medical Office Building two different codes were used to determine design loads. All gravity loads were determined using ASCE 7-05, whereas the lateral forces were determined using ASCE 7-10.

Dead Loads

The floor dead load was taken as 50 psf to account for the concrete deck, steel joists and girders, MEP and a false ceiling. 20 psf was used as the roof dead load, the reduction due to an adhered membrane being used instead of concrete on the roof deck.

Live Loads

The floor live load was designed at the lobby or first floor corridor rating of 100 psf in the office category of ASCE 7-05. This allows for flexibility in future changes to the floor layout. A roof live load of 35 psf controlled of the ground snow load rating of 25 psf. This design choice was likely made to account for additional mechanical equipment as well as snow drift where the roof level changes.

Lateral Loads

Wind loads were calculated using ASCE 7-10 with a building category II, exposure B and a 90mph base wind speed. The building was designed using seismic design category A, site class B and use group 1.

Joint Details

In the Medical Office Building typical connections include joist to girder, girder to column, joist to block wall and deck to block wall. The first of these two connection types are to be detailed by the steel fabricator, as such this section will focus on the remaining two.

Typical joist to block wall connection

Steel bar joists and steel girders transfer loads into the Ivany block walls via ½" Plates with two ½" dia. By 6" headed studs. Figure 12 below shows a joist seat sitting on the plate supporting the joist floor system. The concrete deck is flush to the wall with a ½" isolation joint.

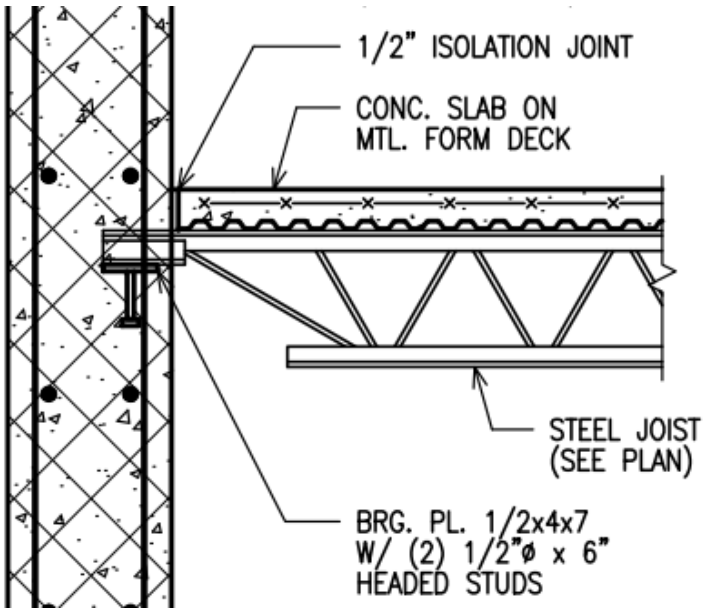


Figure 12
S-13 Section 4

Typical concrete deck to block wall connection

Where the concrete on metal deck meets the masonry block walls in an unsupported condition a 4"x4"x1/4" steel angle is fastened to the block wall in order to support the deck via ¾" dia hilti sleeve anchors spaced at 16" on center. This type of fastener has a casing that expands as the connection is tightened. This is shown in figure 13 below.

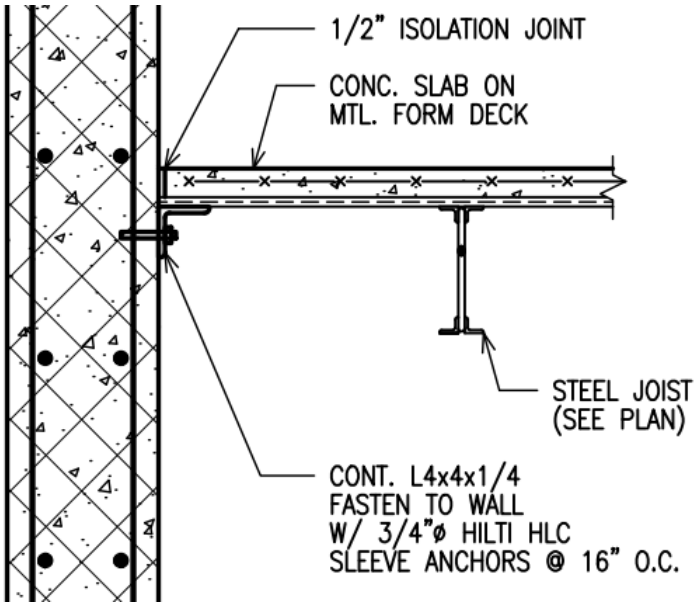


Figure 13
S-13 Section 8

Conclusion

The existing conditions of The Primary Health Networks Medical Office Building were analyzed in technical report 1. A summary of the building codes used in the design process were given along with material specifications. The building structure was described in detail specifying foundation systems, floor systems, gravity systems, lateral systems, and typical connection details. A load path was traced through the building for both gravity and lateral load cases. The design loads used were referenced back to appropriate building codes and their ideology explained.

Cost was a leading factor in the design of this building, increasing, or at a minimum maintaining, the current level of efficiency will prove challenging in the redesign. The building façade features large areas of glass, any redesign must take the depth of the structure into careful consideration in order to maintain exterior aesthetics.

The floor framing system consists of concrete on metal deck which is supported by steel bar joists. In the current design a typical joist span is 30 feet which can potentially cause vibration problems. The joists are supported by steel girders with depths varying from 10 to 24 inches. Steel columns bring the floor and roof loads down into spread footings. Lateral loads are distributed from the girders into three ivany block shear walls which transfer the load into mat footings. Ivany block is a concrete masonry unit with preset rebar locations that exhibits strengths similar to f'c=3000psi concrete. The soil bearing capacity of 2500psi proved enough to carry the building loads using spread and mat footings.

The building was designed using the International Building Code 2009 edition which references ASCE 7-05. The design team decided to use the International Building Code 2012 edition for lateral load calculations. This edition references ASCE 7-10.

The Primary Health Networks Medical Office Building will provide an excellent opportunity to conduct studies of alternate framing systems due to its design.