One and Two City Center Washington D.C.

Structural Existing Conditions Report and Proposal

Report 5

By: Jeremy Swartz

Option: Structural

Advisor: Dr. Aly Said

1. Executive Summary

One and Two City Center are commercial buildings that are a part of a multi-use development located in Washington D.C. Being approximately 312,000 square feet the building is part of a four lot project. Planning and design began as early as April 2007 but due to the economic recession, construction was delayed until April of 2011 and was finished later in 2014.

The twin office buildings now stand 12 stories tall with a floor to floor height of 12'. The shell of the structures is a glazed aluminum curtain wall with movable louvers. Like many roofs in D.C., there is a rooftop mezzanine on both One and Two City Center with several areas used as a green roof. Connecting the two buildings on every floor are glass coated walkways which span the alleyway separating the One and Two City Center. The building has achieved LEED Gold certification and the development has been one of the first to achieve LEED-ND (Neighborhood Development) certification.

The structural floor systems are two way post tensioned concrete slabs supported by typical 24" x 24" concrete columns. These columns run down through the building into the below grade parking and come to rest on shallow concrete foundations. Lateral loads are resisted by a series of shear walls which surround the elevators and stairwells. The glazed aluminum curtain wall is fastened to the structure at the concrete slab and supported by HSS sections. The penthouse roof and floor are supported by a series of W10's.

The additional lots feature commercial, residential, parking and public areas. To the north of One and Two City Center (Lot46) is an outside plaza with a captivating reflecting pool. To the east of the site is a four structure commercial and residential development (Lot 47). The two main lots are connected by an alleyway lined with retail stores. At the center of Lot 47 is a small courtyard offering relief from the city. Underneath Lot 46 and 47 is a four story parking garage for public access and the use of delivery trucks.

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2. Introduction

2.1 Purpose and Scope

This report will detail the structural existing conditions of One and Two City Center. Elements of the structure that shall be discussed are the buildings' general framing system consisting of typical bays and their columns, beams, slabs and how the load transfers through them. Furthermore this preliminary report will also describe structural components such as the lateral systems, foundation systems, building loads, national codes and joint details. The following pages shall provide a general understanding of the building through details and images provided by the owner and design team.

2.2 General Building Information

One and Two City Center are type B mixed use buildings located in Washington D.C. that stand 12 stories above grade. Both buildings are similar enough to each other in that they are twins with identical structural systems. Each floor is approximately 26,000 square feet with the total square footage of one building nearing 312,000 square feet. The two buildings are a part of the larger city center development consisting of additional residential and retail complexes. The entire site sits on top of a four story below grade parking garage. City Center has also achieved LEED Gold certification and has become a popular, high end, area of central D.C.

Located in D.C., One and Two City Center has to adhere to the height limitations due to zoning. The most common way to maximize floors and floor height is to use post tensioned slabs. The slabs system for One and Two City Center is 8.5" post tensioned concrete allowing for a greater floor to floor height of 12'. The two twin buildings are connected at every other floor by a concrete on steel deck bridge. Similar to other D.C. structures the City Center offices have a roof top mezzanine with a green roof. Foundations underneath the buildings are isolated concrete footers which support the columns above. Pictures of the buildings are shown in Figure 1 and a site plan is shown in Figure 2.

Figure 1: North West exterior view of One and Two City.

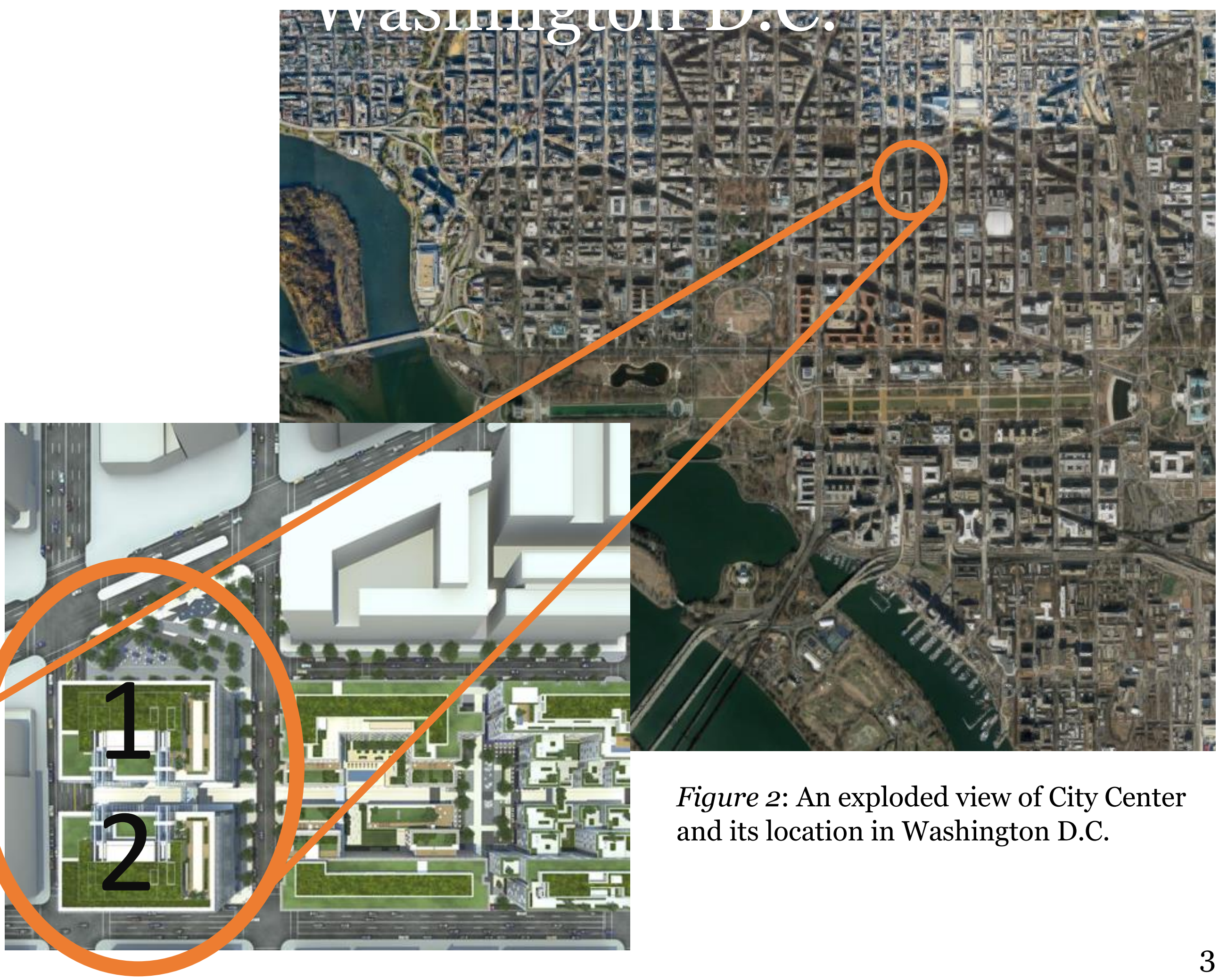


Figure 2: An exploded view of City Center and its location in Washington D.C.

2.3 Structural Framing System

The bulk of the structural framing for One and Two City Center is concrete. Slabs are 8.5" thick with both post tensioned and conventional steel reinforcement. These slabs are supported by reinforced concrete columns which have drop panels around them. The columns in turn are supported by shallow isolated concrete footings. Resisting the lateral loads on the structure are 16 shear walls, which are located near the main areas of egress. The rooftop mezzanine is supported by steel wide flange sections that are tied into the concrete structure. Bridges span between the two buildings and are connected through a pin and sliding mechanism. Figure 3 below shows the structure of One and Two City Center during construction.

Figure 3.1: Construction of One and Two City Center with structure exposed.

3. Structural Analysis

3.1 Floor Layout

The bays in both buildings are not typical in dimension. They range from the largest being 30’ x 30’ and the smallest being 25’ x 20’. The compressive strength for the concrete used in the slabs is 5000 psi with the exception of the second floor which is 6000 psi. These slabs are typically 8.5” deep and contain 6” drop panels. Several floors are repetitive in structure. For example, the structural floor layout of level 4 is repeated on levels 5-8. Also the structural floor plan of level 11 is the same as level 10. A more detailed sketch of the structural elements throughout the buildings height is shown in Figure 3.2.

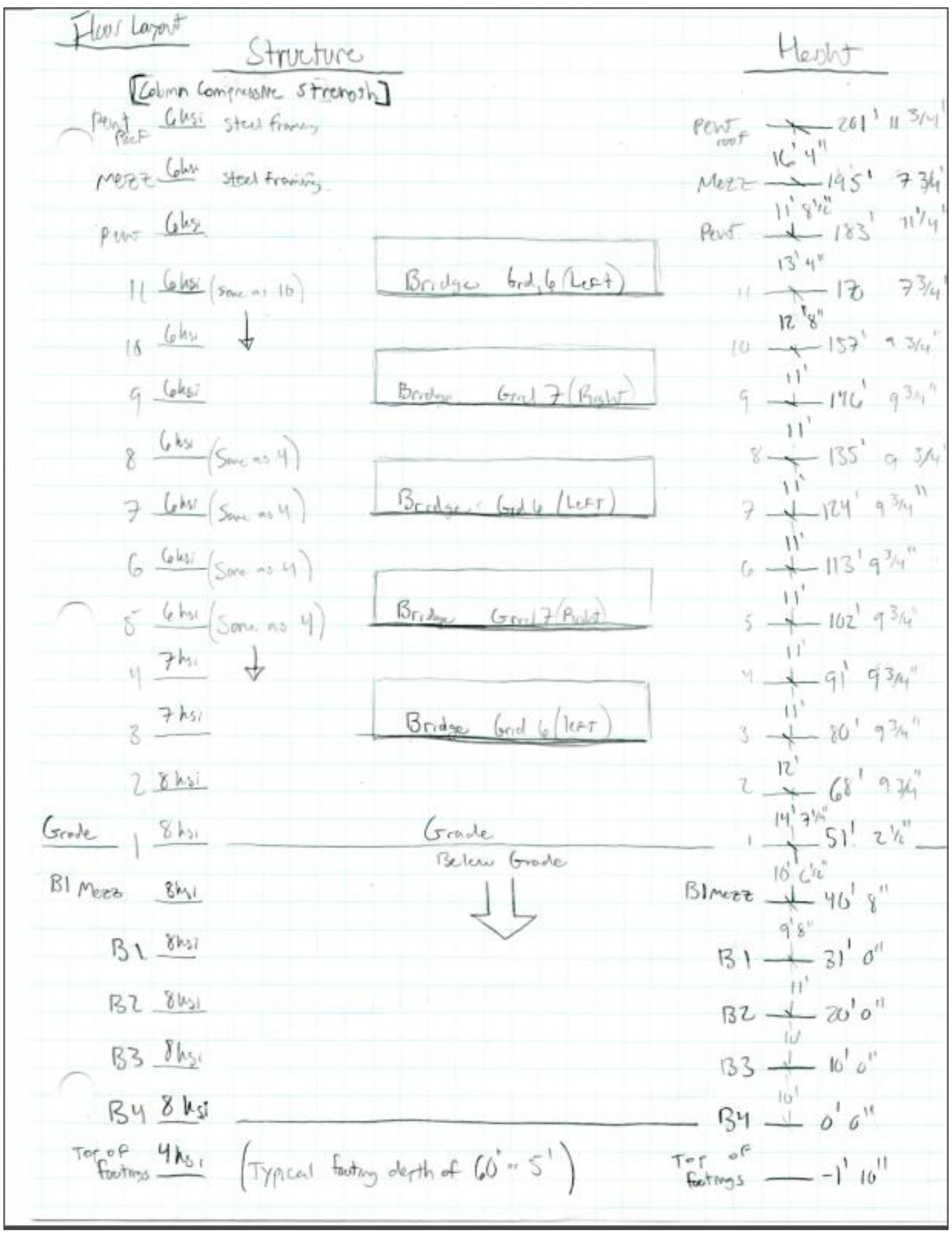


Figure 3.2: A hand drawn elevation showing basic structural elements throughout the building.

3.2 Post Tensioned Slabs

From level 2 to the penthouse (level 12), the floor system is post tensioned slab. Cables used are ½" diameter, 7-wire strand, grade 270, low relaxation tendons, which run in both directions of the building as seen in Figure 4 below. The tendons that run north to south have been detailed to be spaced 6' apart and stressed to 20 kips/ft. The tendons in the east west direction were detailed to only meet 810 kips. The engineer of record (EOR) most likely let the post tensioning subcontractor decide the layout for these tendons.

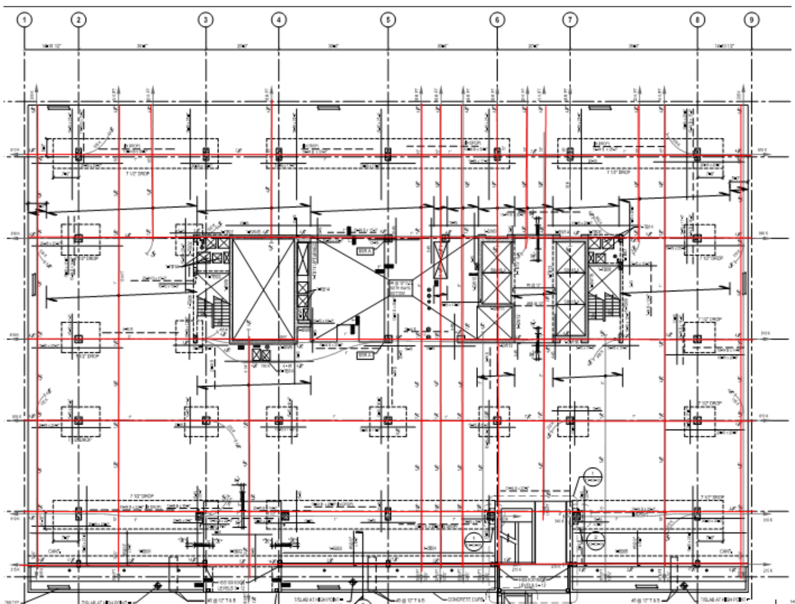


Figure 4: A typical floor plan with emphasis on the post tensioned cables.

3.3 Openings in the Slab

The main ways to traverse the buildings are through elevators, stairwells and bridges. These areas create openings in the structural slab of the building that have an impact on the load path of the slabs. There are 6 elevators in the same area that are approximately 500 square feet and a service elevator that is approximately 550 square feet. Stairwells can be found next to both the garage intake (service) and public elevators. 42' long bridges span the gap between One and Two City Center. A typical plan of these openings can be seen in Figure 5.

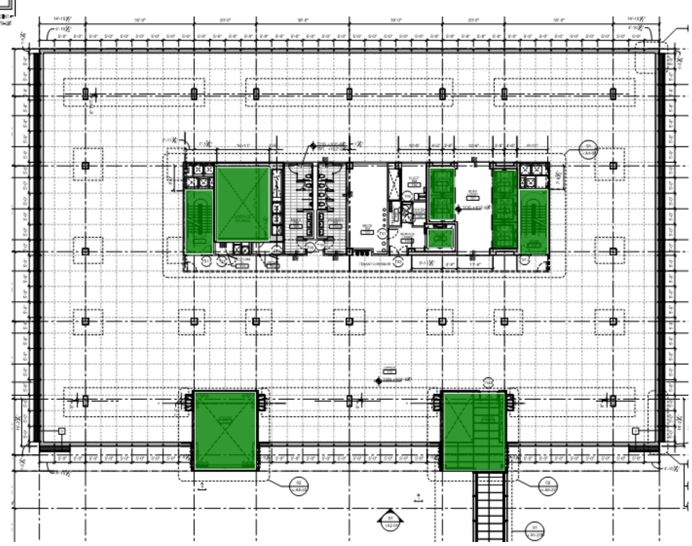


Figure 5: A typical floor plan showing the opening in the slab in green.

3.4 Stairwells

A sizable amount of the buildings openings comes from stairwells. The stairwells typically have 2 flights in between floors. These stairs are cast with 3000 psi concrete and contain steel reinforcement depending on the stair span and thickness. This reinforcement schedule can be seen in Figure 9. The stairwells are supported by concrete beams, shown in blue on Figure 10. These beams transfer the load from the stairs into the columns. A typical elevation shown in Figure 11 details the structure of the stairs throughout the building. What isn't shown in Figure 11 is that the stairs are also supported by the elevator cores or shear walls.

STAIR REINFORCING SCHEDULE		
STAIR (& LANDING FOR DOUBLE RUN) SPAN 'L'	SLAB THICKNESS 't'	REINFORCING
L ≤ 10	6"	#4@10"
10 < L ≤ 12	7"	#5@12"
12 < L ≤ 14	7"	#5@9"
14 < L ≤ 16	7"	#5@7"
16 < L ≤ 18	8"	#5@6"
18 < L ≤ 20	8"	#6@7"
20 < L ≤ 22	8"	#6@6"

Figure 9:

6 STAIR THICKNESS AND REINFORCING SCHEDULE

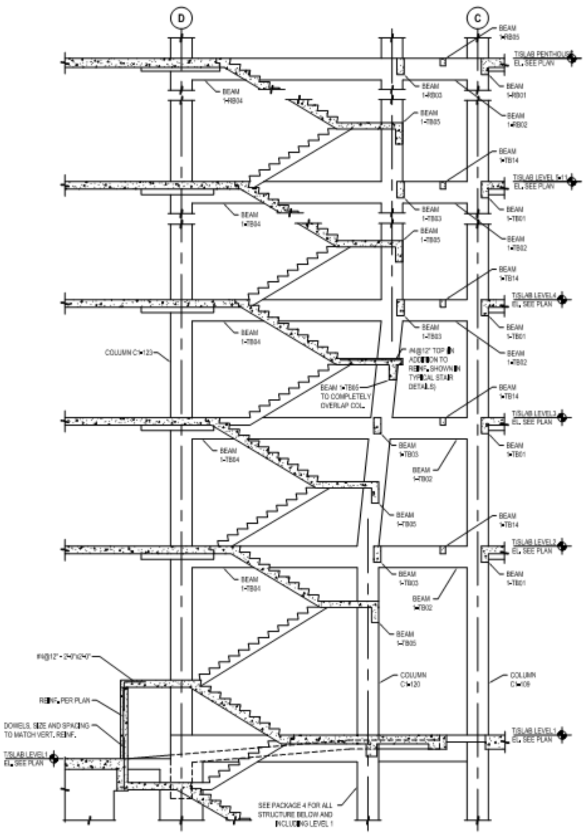


Figure 11: A typical stair section that shows the columns and beams that support the stairs.

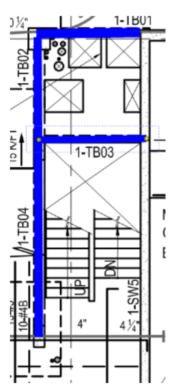
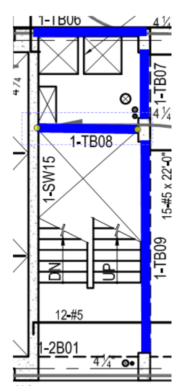


Figure 10: Plan view of two stairwells with the beams supporting them shown in blue.



3.5 Shear Walls

The elevator cores also act as shear walls taking the lateral loads of the building. The compressive strength of the shear walls follows the compressive strength of the columns. That said it varies by floor, see Figure 3.2 for compressive strength details. The shear walls that surround the elevator shafts have a typical thickness of either 10” or 12” depending on their orientation. This is likely due to the lateral loads from one direction being greater than the other. The reinforcement of the shear walls is either #4 or #5 bars spaced 12” running both horizontally and vertically. Some shear walls change geometry near the bottom floors and become longer as seen in Figure 13. This change in geometry could be due to higher shear at the base of the building. The location of the shear walls are shown on plan in Figure 12.1. Their configuration is most likely to minimize the distance between center of mass and center of rigidity. This will create a smaller eccentricity and make the building more effective at resisting seismic loads.

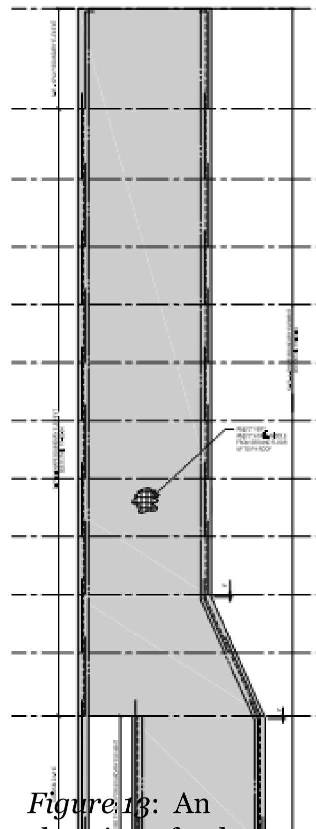
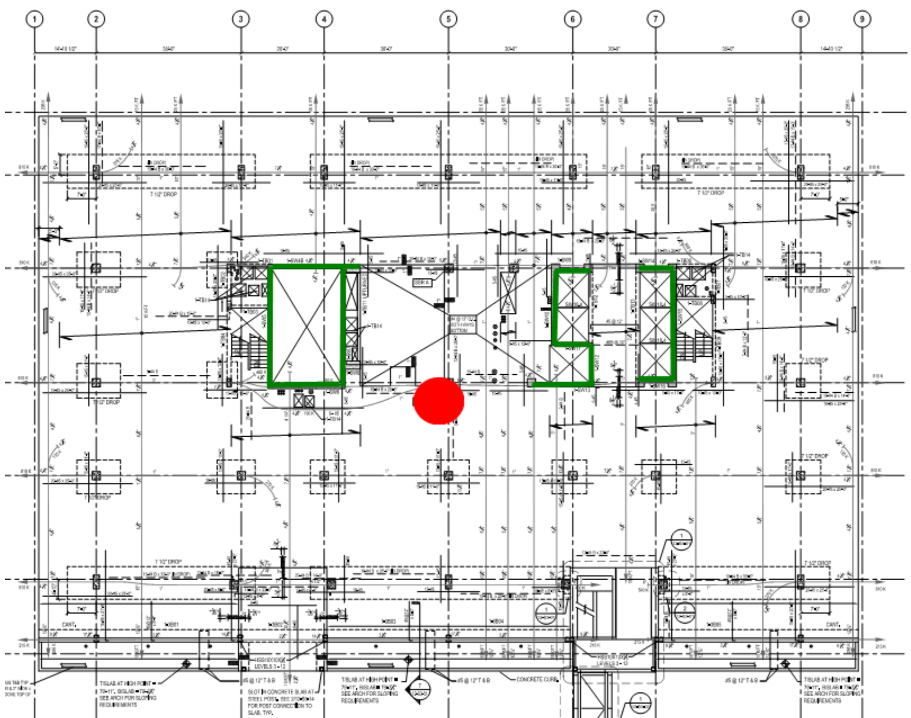


Figure 13: An elevation of a shear wall that widens at the lower levels



3.6 Drop Panels

On every above grade floor with a post tensioned slab system there are drop panels around several columns. The dimensions of these drop panels are, unless otherwise noted, dependent on the column to column span. It is detailed that the panels will be a length of L/6 where L is the center to center measurement of the span between columns. To ensure that punching shear does not occur the drop panels' length cannot be less than 2' on each side. The minimum extended depth from the slab is the thickness of the slab denoted as h divided by 4 (h/4). The typical reinforcement at each column location is 15 to 25 #5 bars placed each way. Figures 6 and 7 show a typical drop panel detail and location on the plan.

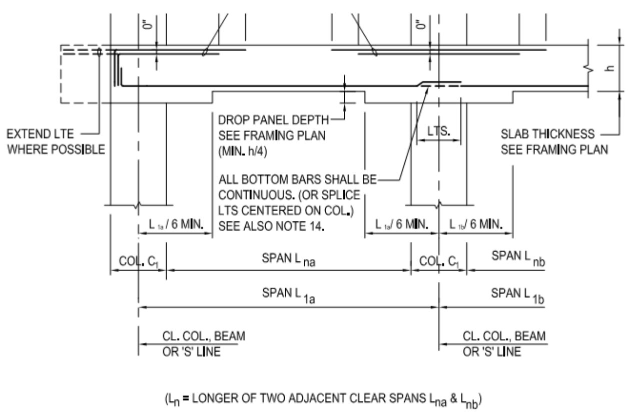


Figure 6: TYPICAL DETAIL AT COLUMN STRIP WITH DROP PANELS (3)

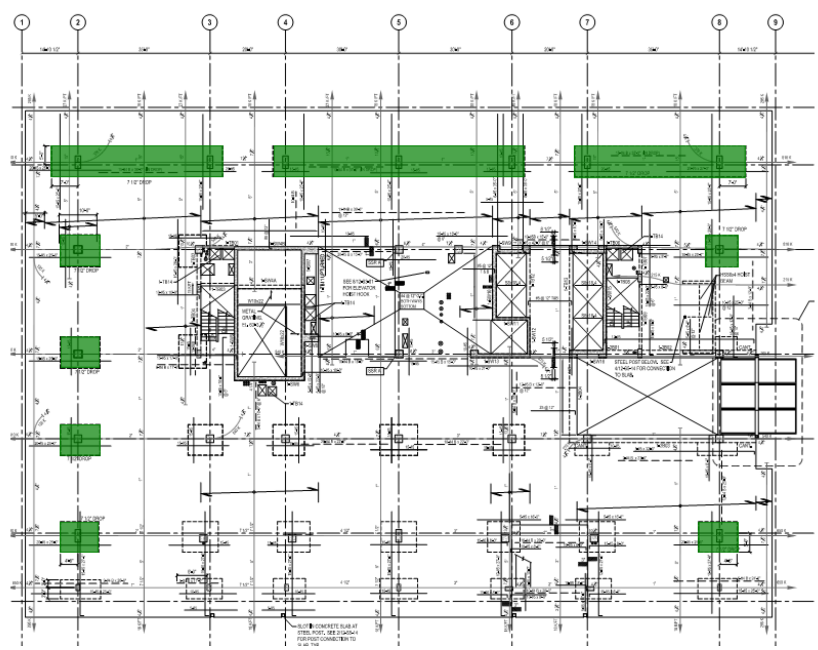


Figure 7: A floor plan showing the location and outline of drop panels.

3.7 Columns

There are typically 45 columns on each floor. These Columns vary in both compressive strength, size and height throughout the building. Typical steel reinforcing along the length of the column is 8 #8 bars. The compressive strength of the columns decreases at higher levels as seen in Figure 3.2. Column ties are based off of the size of the vertical bars. Figure 14 shows the different spacing of horizontal reinforcement, depending on the vertical reinforcement. Figure 15 details sections of columns and shows the typical layout of reinforcement.

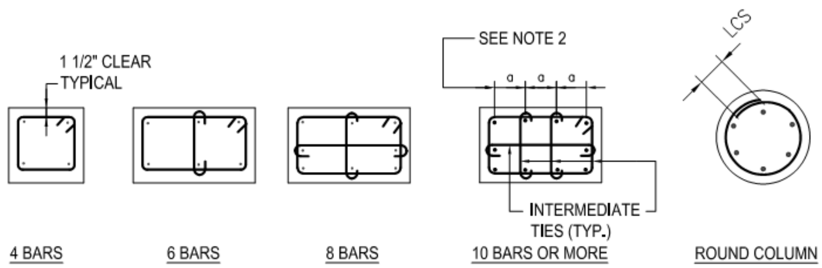


Figure 14: Specified column ties based on the vertical reinforcement.

MAX. SPACING "S" OF COL. TIES	
VERTICAL BAR SIZE	TIE SIZE & SPACING*
#5	#3 @ 10"*
#6	#3 @ 12"*
#7	#3 @ 14"*
#8	#3 @ 16"*
#9	#3 @ 18"*
#10	#3 @ 18"*
#11	#4 @ 18"*

* TIE SPACING NOT TO EXCEED LEAST COLUMN DIMENSION

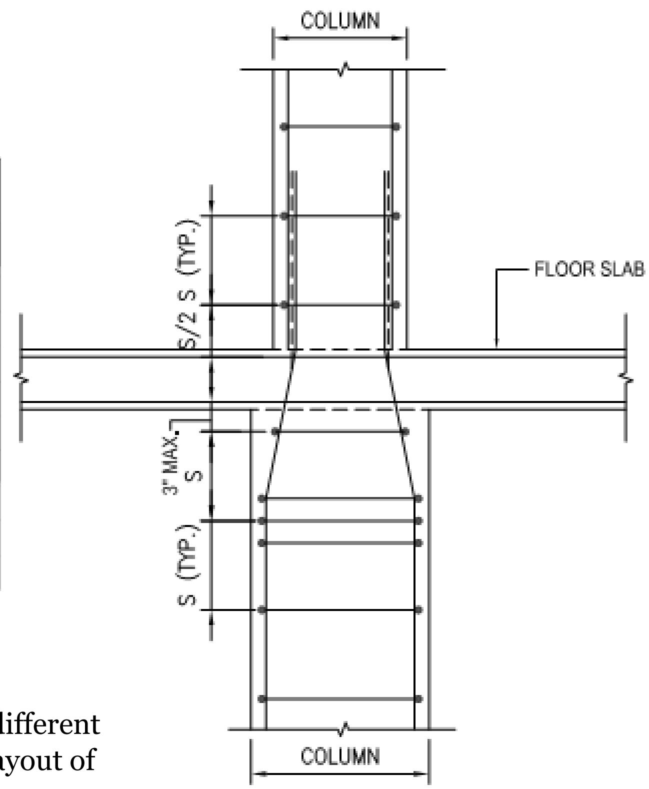


Figure 15: Sections of different columns showing the layout of reinforcement.

3.8 Foundation/Garage

The columns detailed above come to rest on shallow isolated concrete footings. These footings are several levels below grade. This is because there are five levels of below grade parking underneath One and Two City Center. The decision to include the garage as a part of the building analysis has yet to be made. Therefore the existing structure below grade will be shortly summarized due to how separate the building and garage structures are.

The structure of the parking garage consists of a 10” concrete slab with drop panels extending L/6 distance from the columns and 6” in depth similar to the above grade floors. Normal weight concrete is specified with a compressive strength of 5000 psi. The expansion joints for the garage vary in location and are typically 2” in width. The main reinforcing steel used in the garage slabs are #6 bars both ways with a minimum cover distance of 2” on top and 1” on bottom. The spacing of #6 bars depends on the location and the column.

The columns, at the same location as the columns above grade, have a compressive strength of 8000 psi. These columns are supported by concrete footings and slab foundations. The concrete footings have a compressive strength of 4000 psi and are typically 60” deep. There is no typical size of footing but the average size is 15’ x 15. Typically 28 or 30 #10 bars run both ways to support the footing for shear, bending, temperature and shrinkage. Columns are also supported by slab foundations which like the footings have a compressive strength of 4000 psi. Shown in Figure 16 are the locations of the slab foundations underneath One City Center.

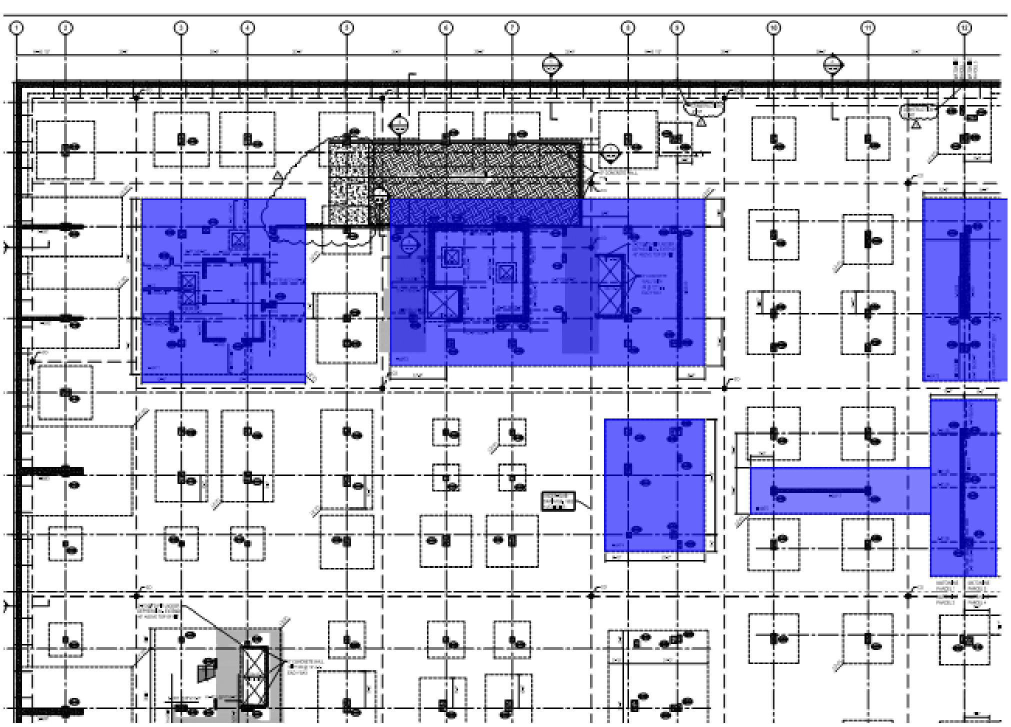
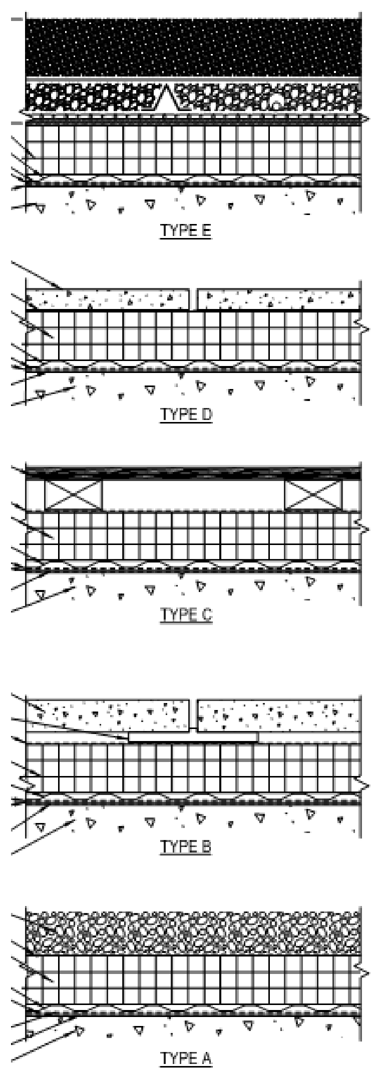


Figure 16: A plan view of the slab foundations beneath One City Center.

3.9 Roof

Three levels make up the roof component, the penthouse the penthouse mezzanine and the penthouse roof. The penthouse level is similar to the lower 11 floors in that it is post tensioned concrete. Structural steel framing is used for the penthouse mezzanine and the penthouse roof. Both the penthouse mezzanine and roof are approximately 8,000 square feet. W10's are used as beams for the roof while w14's are used as girders to support them. Supporting the glass wall on the roof are a series of HSS members. Shown in Figure 17 are beams drawn in red, girders in blue and HSS members in green. The mechanical penthouse (mezzanine and roof) are permitted to exceed the 130' height limit because it has an occupancy group U.

Figure 18: The five different types of roof systems.



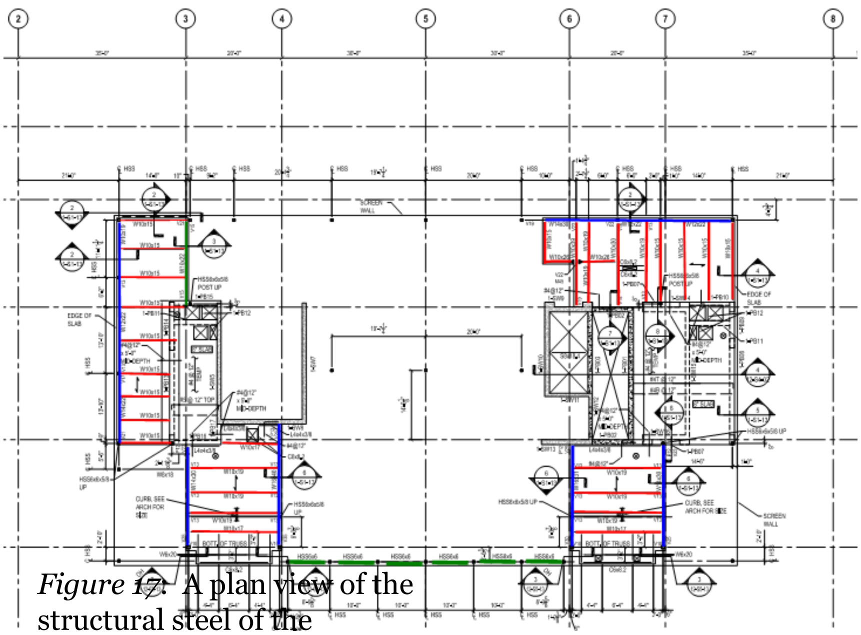


Figure 17: A plan view of the structural steel of the penthouse mezzanine.

The roof membrane consists of five different construction types as shown in Figure 18. All roof construction types have hot fluid applied asphalt as the waterproofing layer with 3" polystyrene insulation board topped with a filter fabric. The discrepancies between the roof types is what lays on top of the filter fabric. The various types of roofing have a topping of either stones, concrete pavers, wood decking or topsoil.

3.10 Bridge

One of the noteworthy architectural and structural aspects of One and Two City Center is that there are a series of bridges than span 25’ between the two buildings. The bridges occur every other level starting at level 3 and ending at level 11. Every other bridge changes gridlines thus creating a pattern similar to that in Figure 19. The structure of the bridges is 3.25” lightweight concrete on 2”18 gauge composite steel deck. This deck is supported by double steel angles as shown in Figure 20.

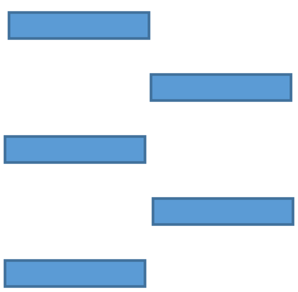


Figure 19: Simplified section of what the bridge configuration looks like.

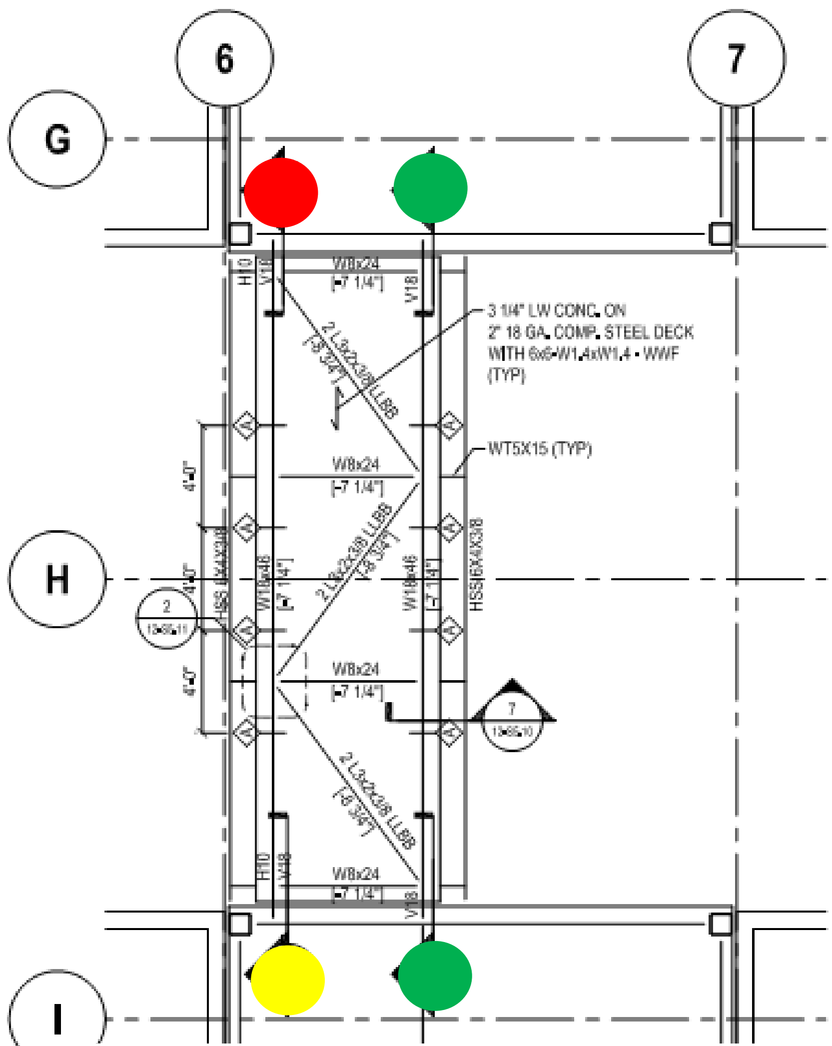
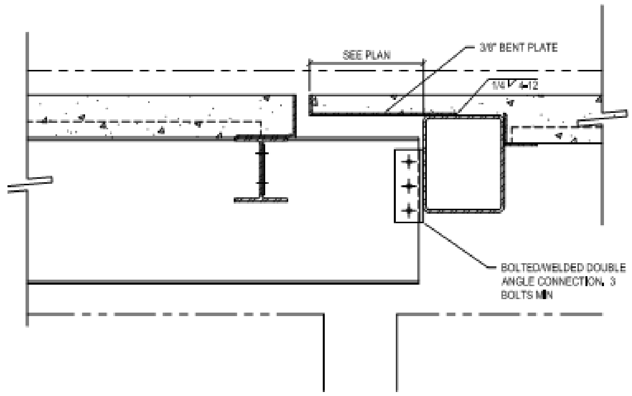


Figure 20: Bridge detail where the colored circles represent the type of connection

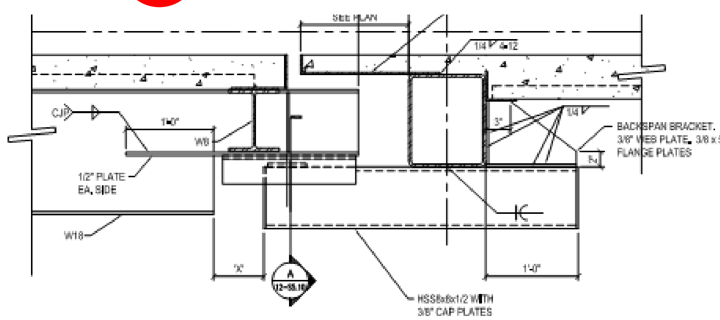
1 BRIDGE FLOOR AT LEVELS 3, 7, 11
SCALE: 1/4"=1'-0"

The bridge is connected to each building through pins and sliders. The various connections shown with colored circles in Figure 20 represent different connections. These connections are further detailed in Figure 21. Due to the nature of the connections the two building do not share any loads except for those on the bridges. The bridge does not transfer any lateral loads between the buildings.



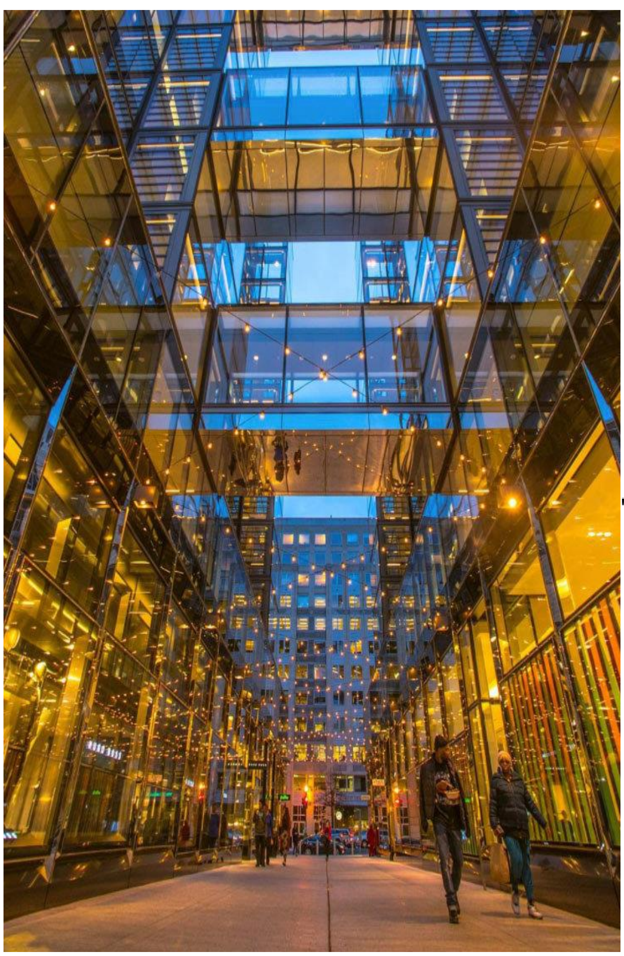
BRIDGE FLOOR GIRDER CONNECTION AT "PIN"
SCALE: 1 1/2" = 1'-0"

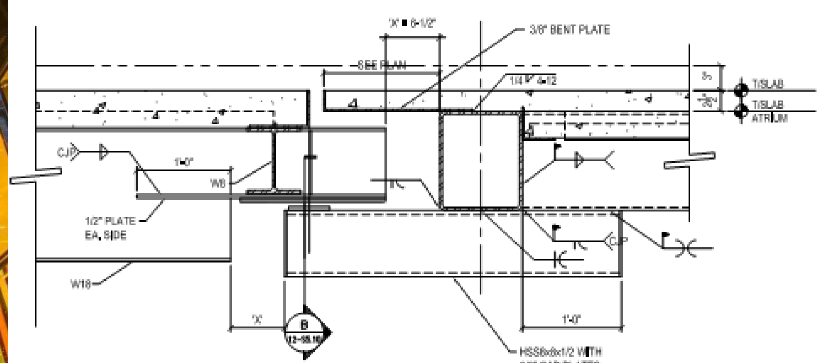
Figure 21: Connection details for the bridges at levels 3, 7, and 11.



BRIDGE FLOOR GIRDER AT GUIDED SLIDING CONNECTION
SCALE: 1 1/2" = 1'-0"

Figure 22: Upward view from beneath bridges.





BRIDGE FLOOR GIRDER AT SLIDING CONNECTION
SCALE: 1 1/2" = 1'-0"

3.11 Envelope

The façade of the building is made of a glazed aluminum curtain wall. The glass wall encases the building and is supported by connections to the slab. This connection consists of two steel angles bolted into the side of the slab as shown in Figure 23.

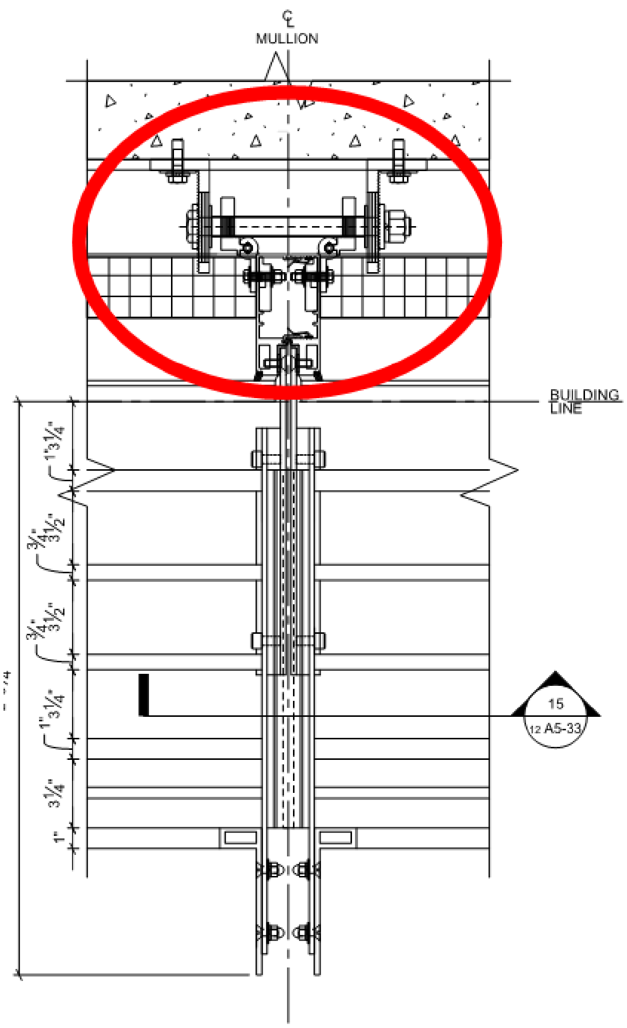


Figure 23: Plan detail of curtail wall connection to slab.

The envelope of the building also features an atrium space that extends the full height of the building. This can be seen in a general geometric model of the building shown in Figure 24. The glass wall of the atrium space is supported by steel HSS members.

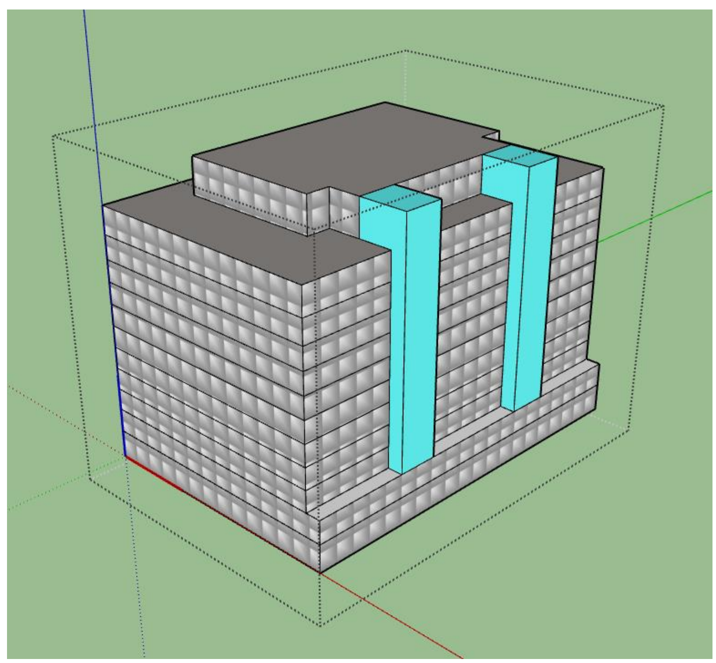


Figure 24: Geometric model of One City Center showing the atrium spaces in light blue.

4. Loads and Codes

The following load tables consist of the design loads in accordance with the District of Columbia DCRA-12 2003 and International Building Code (IBC) 2000 which in turn references ASCE 7-98. Other design codes used are ACI 318-02 and 530-2000 along with AISC-LRFD second edition. It is important to note that the structural members are not designed for any vibratory loading from equipment as specified by the engineer of record.

4.1 Live Loads

These loads are based on the expected occupancy load for given areas of the building. The loading of mechanical rooms was based on assumed weights of the mechanical equipment. Occupancy loads are derived from probabilities and have different safety factors applied for different loading conditions.

Live Loads	Pounds per square foot (PSF)
Office	80 psf
Ground floor, Retail, Lobbies, Stairs	100 psf
Mechanical rooms, Storage	150 psf
Terraces	100 psf

4.2 Dead Loads

Dead loads are more accurate than live loads because they are based on material weight not presumed occupancy. Mechanical dead loads, same as live loads, are assumed equipment weight. The following table does not include the self-weight of structural members rather the loads that those members would support.

Dead Loads	Pounds per square foot (PSF)
Office Floor/Partitions	20 psf
Mechanical Equipment	10 psf
Green Roof (roof)	50 psf

4.3 Snow Loads

Loading caused by seasonal snow on buildings is estimated using the specified building code. The code contains maps and minimum standards to abide by for snow loading. The table below shows the variables used in calculating the roof snow load. It is specified that the calculated snow load comes from the variable below plus sliding and drift. It is also noted that the greater of the two loads, from the map (30psf) or from calculations, will govern.

Snow Factor	Value
ground snow load (Pg)	25 psf
exposure factor (Ce)	1
importance factor (I)	1
thermal factor (Ct)	1
roof snow load (Pf)	17.5 psf

4.4 Wind Loads

Wind loads, like snow loads, have their own map in the code that details a statistical wind speed in miles per hour. The winds pressure on the building is then determined from the wind speed in combination with other factors. The wind load acts on the cladding and in turn the cladding or curtain wall imposes forces on the building. It has been assumed by the engineer of record that theses imposed wind loads from the cladding system create no moments or torsional effects on the structural members. In future reports the wind loads and their torsional effects will be investigated.

Wind Factor	Value
Wind speed	90 miles per hour
Importance factor	1
Exposure category	B

4.5 Seismic Loads

Seismic loads can place the building under a variety of loading conditions. During an earthquake the building can be pushed up pulled down or be shifted laterally. The most common condition, and thus the design condition, is lateral shift. The seismic resisting system in One and Two City Center are reinforced concrete shear walls which transfer the lateral load throughout the structure to the foundations. It is important to locate the shear walls in such a manner that the buildings center of mass and center of rigidity are not far apart. If they are, then the building will experience torsional twisting effects during high lateral loads. Figure 12.1 below shows the location of the shear walls and an estimated location of the buildings center of mass and center of rigidity. The procedure for determining the seismic forces on the building is the equivalent lateral force procedure. Below is a table showing the factors and results from that analysis.

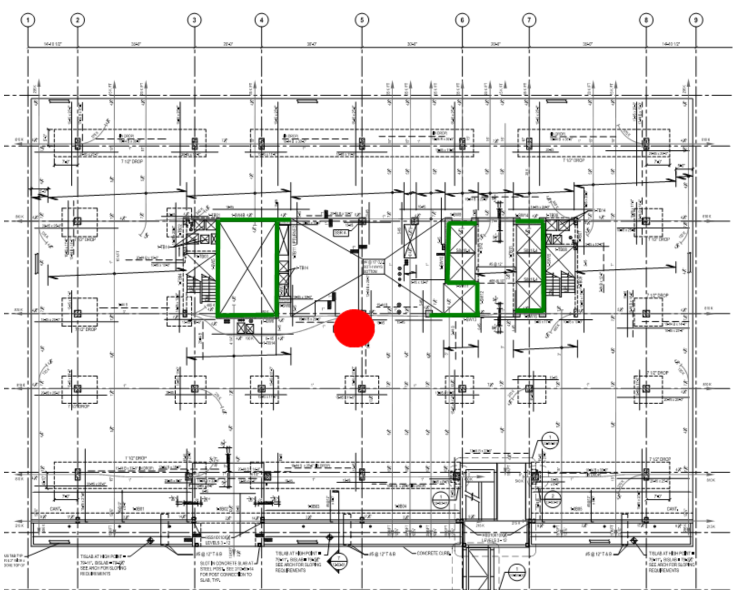


Figure 12.1: A plan view of the shear wall locations in green and an estimated location of the center of mass and rigidity in red.

Seismic Factor	Value
Use group	1
Site Class	C
Spectral response coeff	S_{ds}=0.143 S_{d1}=0.071
Design Category	B
Base shear	NS-1082Kips EW-1255Kips

5. Proposal

5.1 Background

The existing structure is such that the building can achieve large floor to floor height and be relatively inexpensive. The gravity system is reinforced concrete columns with an 8 ½" post-tensioned slab. The lateral system is reinforced concrete shear walls around the major means of egress. It is fairly common in Washington D.C. to use a post-tensioned system to create a large floor to floor height. Due to the height restrictions in the area the maximum permissible height for occupied space is 130'. In order to achieve the most usable space a small ceiling to floor height must be used. Thus the floor to floor height is 11' due to the ability to have a slim 8 ½" slab. The foundations for the building consist of shallow concrete footers and mat slabs. One and Two City Center are connected in two locations. The first is through a below grade parking garage which supports both buildings. The second is a series of bridges that connect the two buildings above grade. These connections are crucial to the way in which One city center will be analyzed in such that the two buildings do not transfer load between each other. This will be achieved by cutting One City Center at grade level and at the bridge connections. The below grade connection will be treated as a rigid fixed connection while the bridge connection transfers no forces between the buildings due to its pin and roller supports. This figurative "cut" can be seen in Figure 25 below.

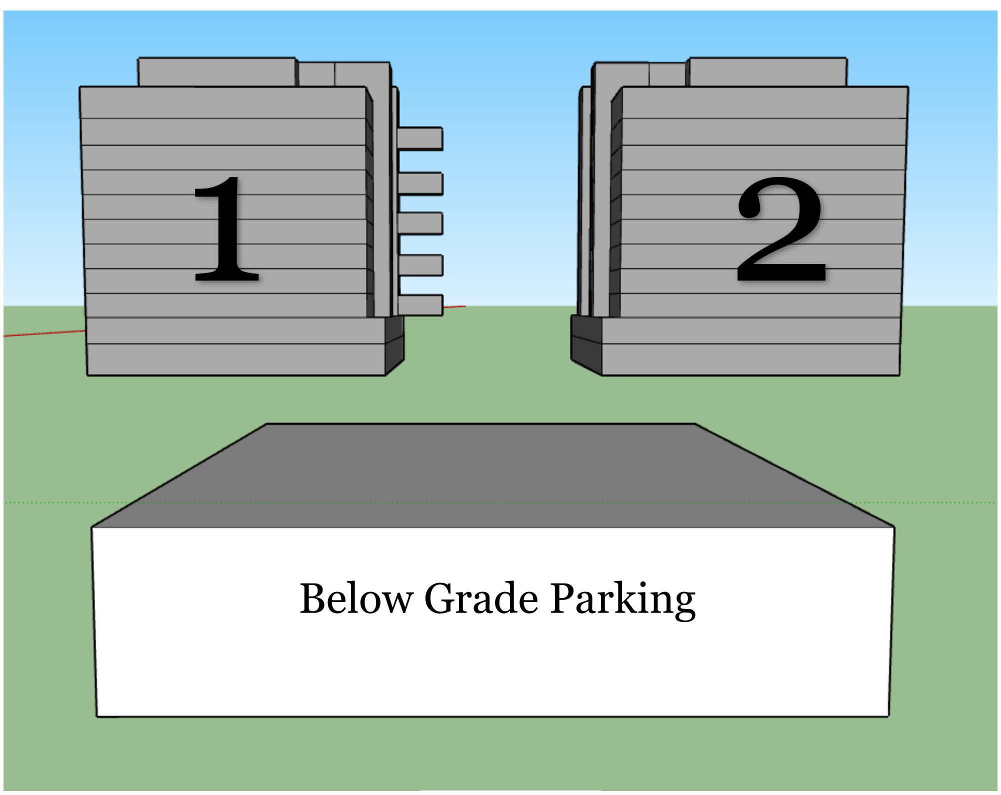


Figure 25

5.2 Problem Statement

The goal of this proposal is to design a new structural system for One City Center such that the overall height of 130' is not changed and the floor to floor height of 11' only differs by 5%. The new design shall not alter the existing structural grid or architecture unless proven reasonable. Additionally the effects on overall cost and schedule for both original and alternative systems will be compared. An alternative design shall be chosen from the analysis performed in notebook submission B. The alternative systems comparison table is presented below.

System	Height	Cost(per bay)	Notes
Post Tensioned Slab	-8.5" slab - 7.5" drop panels Total Height = 16"	$29,000	-complex analysis -involves only concrete subcontractors
Composite Metal Deck	-3.5" concrete slab -1.5" metal deck -12" beam -18" girder Total Height = 24" max	$33,000	-moderate analysis -high level of capacity -best for vibration control
One Way Slab	-6" slab -18" beam -24" girder Total Height = 30"	$34,250	-most expensive system -lowest floor to floor height
Two Way Slab	-10.5" reinforced slab -#9, #5 bars both ways top and bottom Total Height = 10.5"	$30,750	-low level of capacity - heavily dependent on reinforcing steel -best overall height
Hollow Core Planks (Design 2)	-8" plank -18" girder Total Height = 26"	$28,100	-simple analysis -involves multiple contractors of various trades

5.3 Problem Solution

The problem statement shall be met through the use of both hand calculations and structural modeling software. Concrete designs for both gravity and Lateral systems will conform to ACI 318-11 along with IBC 2009 and ASCE 7-10. These codes have been chosen due to the time at which this building was initially designed. It is proposed for this thesis that a two way reinforced concrete flat slab shown in Figure 26 be used for the alternative gravity system. The lateral system will still consist of reinforced concrete shear walls but shall be redesigned with the loads and reactions that come from the new gravity system. This system was chosen due to its feasibility and effective height. The other alternative systems analyzed in notebook B either increase the effective height from ceiling to floor by too much, their cost is too great, or their feasibility will not work as well with the existing architectural grid. Both gravity and lateral systems shall be designed by hand in accordance with the codes previously stated and through software such as RAM Concept, ETABS and spSlab. Loads will be determined from these designs along with the controlling load case. The existing post-tensioned structure will be analyzed through the use of both the equivalent frame method and RAM Concept. Both initial and alternative designs will be compared through their capacities, effective depth, cost and schedule. RS means will be utilized in order to estimate the cost and schedule of each system. The various results of design and construction will be graphed and compared.

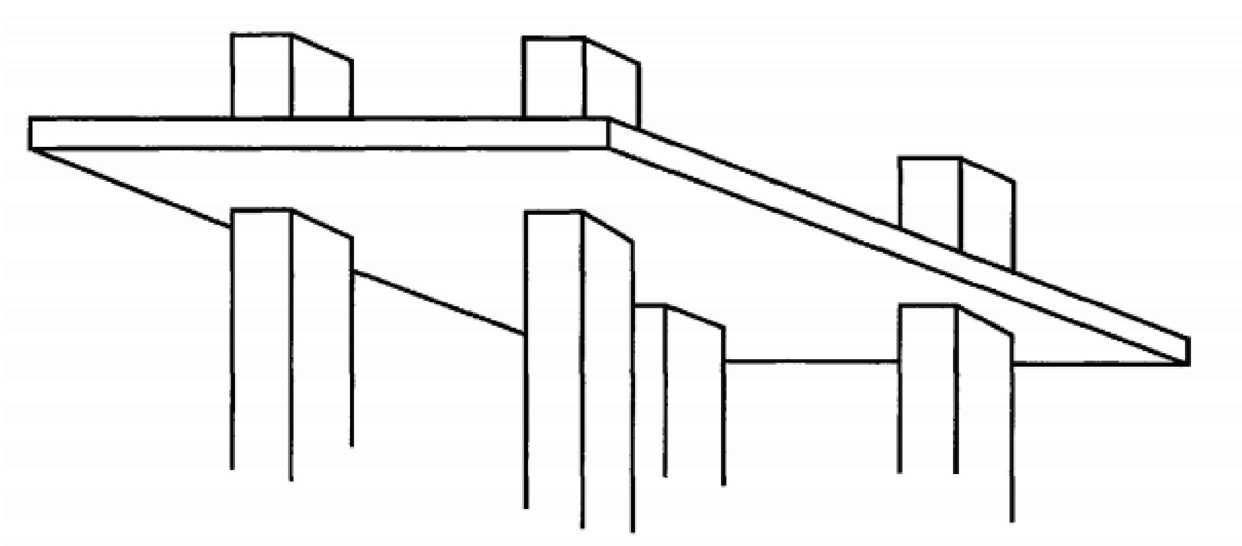


Figure 26: Image of a concrete flat slab

5.4 Methods

The problem solution will be achieved through the knowledge gained from structural courses previously taken and currently taking. Courses such as AE 402 and 431 will aid in the hand calculations and manual design of the slabs, columns and shear walls. These designs will be checked through the use of software that was learned in AE530 and codes from ACI 318. The existing post tensioned slab will be analyzed through learned methods from AE 597. Construction costs and scheduling will be determined from experience gained in AE 372. Additionally the advice from the AE professors will be available.

5.5 Tasks and Milestones

I. Analyze Existing System
   A. Determine slab capacity by hand and RAM concept
   B. Determine column capacity by hand
   C. Determine shear wall capacity
   D. Calculate cost of single floor
   E. Estimate schedule of construction for single floor

II. Design proposed slab system
   A. Determine new loads
   B. Design slab strips in both directions
   C. Check floor system with software
   D. Compare floor cost to existing system

III. Design columns for proposed slab
   A. Determine loads
   B. Design columns
   C. Compare capacities to existing columns

IV. Design proposed lateral system
   A. Determine loads on shear walls
   B. Design walls
   C. Check lateral system with software

V. Construction Management Breadth
   A. Calculate cost per floor then overall cost
   B. Calculate amount of overall material needed
   C. Create schedule for proposed system

D. Create critical path schedule for proposed system (try to make the schedule close to that of existing building based on dates of construction)
E. Create graphs and images that compare the two in terms of cost and schedule

VI. Acoustical Breadth
A. Determine typical room finishes and materials
B. Show floor plan of different areas and their sound transmission class
C. Calculate sound transmission between areas
D. Discuss how the changed materials would improve the space

VII. Finalization
A. Create final report draft (periodically)
B. Create Final presentation draft (periodically)
C. Finalize both report and presentation draft.
D. Update CPEP (periodically)

5.6 MAE Incorporation

Masters level work shall be thoroughly incorporated in this report. The bulk of this work will consist of computer modeling from software learned throughout AE 530. Additionally MAE work will be shown in the analysis of the existing post tensioned system leaned from AE 597.

5.7 Breadth Topics

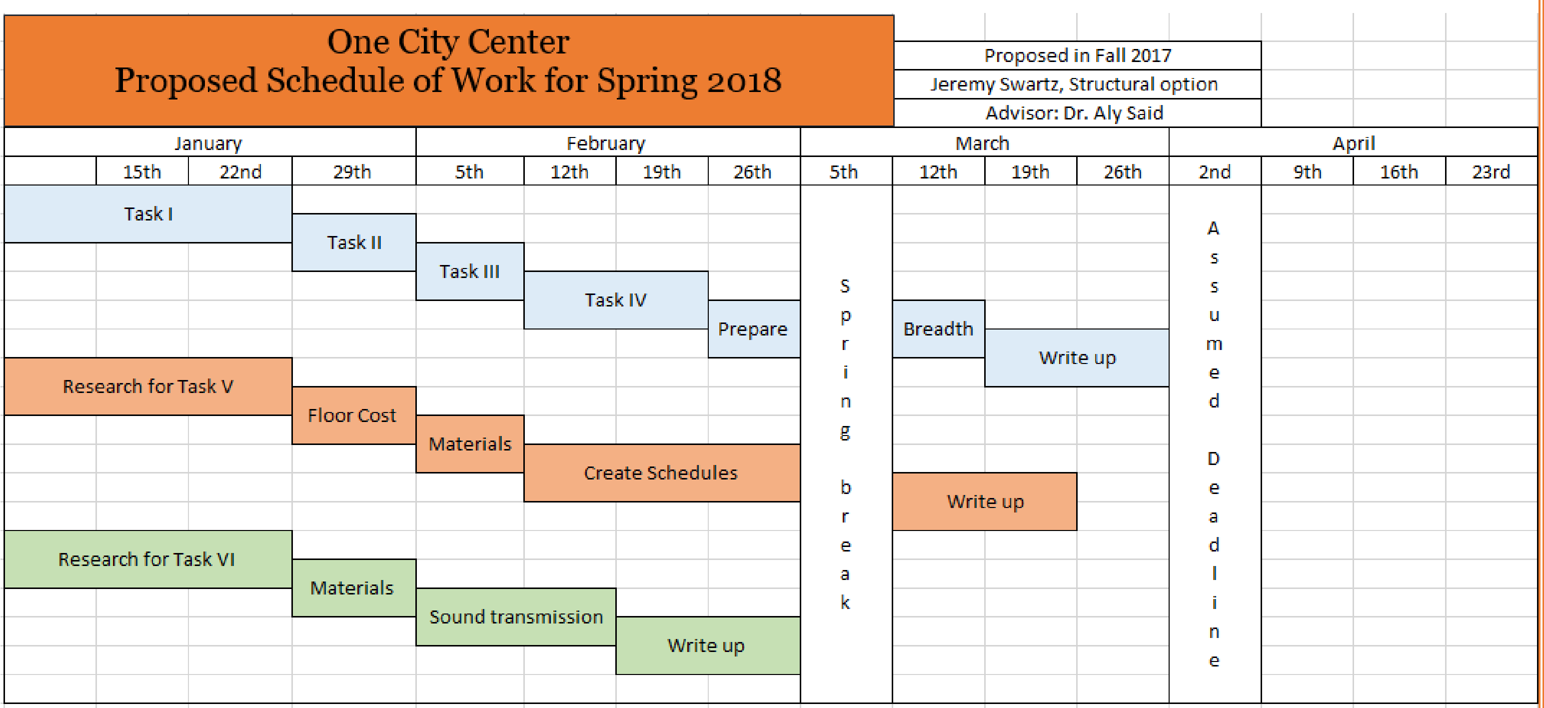
Construction Management

The construction management aspect of One City Center will be analyzed under the newly proposed structural system. Such an analysis could include scheduling, site plans, cost comparisons, project delivery methods, inspections and quality assurance. This information is key to understanding how the building comes together as a whole. In addition it will provide insight as to how various contractors and sub-contractors coordinate on a job site. Furthermore this analysis of the new system can be compared to an analysis of the old system. Through this comparison greater knowledge will be gained about how changing the structural system has an impact on the constructability of the building.

Acoustics

The way sound travels throughout a space can very much effect the functions of those inside that space. It is proposed that the architectural acoustics be studied for several typical spaces in One City Center. Furthermore the material properties of each space and their effect on the overall acoustics will be analyzed. This topic is of high interest due to the existing materials inside the building which are smooth and hard. This leads to a potential echo and reverberation in sound. It is proposed that the dimensions and surface materials of public and private areas in the building be examined for auditory comfort.

5.8 Schedule



6. Conclusion

One and Two City Center was constructed in 2011 and is a type B mixed use building. The structural floor system uses post tensioned concrete slabs to allow for greater floor to floor height. The openings in the slab are for means of egress and for atriums. Where there are elevators and stairwells there are reinforced concrete shear walls which resist the later loads of the building. The columns support the gravity loads of the building and have drop panels typically 6" in depth surrounding the columns. Both building are also connected with a series of bridges connected with a pin and slider mechanism. This connection transfers no load from one structure to the other. Between the building and the foundation is a four story below grade parking garage which supports both One and Two City Center. Supporting the superstructure above is a combination of shallow concrete footings and mat foundations. It has been decided that the garage analysis and redesign will not be a part of the scope of this project. The main building to be considered is One City Center.

The proposed redesign for this thesis is a two way reinforced concrete flat slab. This system will have gravity supports of reinforced concrete columns and lateral supports of reinforced concrete shear walls. It has been determined from previous reports that this system is considerably feasible. Furthermore this proposed redesign will feature a in depth analysis into the cost and scheduling differences of the new system and the existing one. Additionally the material properties of certain spaces will be studied and redesigned to achieve a higher acoustical rating.

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