Overlook Towers

Herndon, VA

Anthony Perrotta
AE Senior Thesis Final Report
Advisor: Prof. Ali Memari

Overlook Towers
at Dulles Corner
Herndon, VA

Anthony Perrotta
Structural

http://www.arche.psu.edu/thesis/eportfolio/2007/portfolios/amp324

Architectural
- Two nine story office buildings and two one five story parking deck
- The facade is composed of precast architectural panels and mirrored glass curtain walls
- Rooftop mechanical penthouse housing major mechanical equipment

Primary Project Team
Owner: S. Vardell Realty Investments, LLC
Architect: Nortike Associates
Landscape Architect: Lewis Scully Gionet
Structural Engineer: Haynes Whaley Associates
M.E.P.: KTA Group Inc.
Civil Engineer: William H. Gordon Associates

Mechanical
- 4 Centrally located elevators
- 2 water cooled chillers located in the penthouse
- 30 HP 480V floor AHU (floors 2-9)
- 50 HP Make-up heating unit on the roof

Project Overview
Total Size: 262,200 squre feet
Project Cost: $20.5 million per office building
Estimated Schedule: Sept. 2006 - Dec. 2007
Delivery Method: Desing-Bid-Build
Occupancy Type: Office Building

Structural
Foundation: 5"TH S.O.G. with #3 reinforcing
10 mil vapor barrier over 4" stone
8' - 14' square spread footings
Superstructure: The typical floor beam is a W24x55 and are spaced at 10'o.c. The roof is is supported by different sized trusses spaced at approximately 6'-0" o.c. The major lateral supporting system are braced frames located near the elevator shafts and the central core.
Roofing System: Open web joists at 6'-0" o.c.
4" extruded polystyrene insulation on metal decking.
Penthouse sits on 6.25" lightwieght concrete slab.

Lighting/Electrical
- 3 phase/480V electrical service provided
- 3 phase/4 wire 350kW backup generator
- 2 4,000A main switchboards
- Metal-hallide site lighting
- Office space is lit by flourscent lighting

Table of Contents

Building Statistics Sheet

Project Overview

- Overlook Towers at Dulles Corner
- 2550 Wasser Terrace
- Herndon, VA
- Construction: Sept. '06 – Dec. '07
- Cost: $20.5 million

Project Team

- **Owner:** Vardell Real-estate Investments
- **Architect:** Noritake Associates
- **Civil:** William H. Gordon Associates
- **Landscape:** Lewis Scully Gionet
- **GM:** Clark Construction

Architecture:

Overlook Towers is a three building complex consisting of two nine story office buildings and a five story parking deck. The office buildings have an open plan with elevators and stairways in the central core. Each office building has a foot print of approximately 24,500 square feet and is octagonal in shape. Overlook Towers will stand approximately 140 feet. The facade is primarily precast concrete panels with large tinted window units. A penthouse on the top houses all of the major mechanical equipment.

Site Overview & Location

Building Envelope:

Architectural precast concrete panels make up most of the exterior of the building. The two entrances are accented with a 24' glass curtain wall. The windows are constructed of one inch insulted glazing with aluminum frames. Behind the precast panels are insulated 3 5/8" metal stud gypsum board walls. The roofing membrane is supported by open-web steel trusses.

National Codes Used:

- 2000 International Building Code w/2001 Supplement
- 2000 ICC International Mechanical Code w/2001 Supplement
- 2000 ICC International Plumbing Code w/2001 Supplement
- 1999 National Electrical Code as referenced in 2000 ICC Electrical Code

Executive Summary

Overlook Towers is a nine story office building situated right outside of Washington D.C. Overlook Towers is a three building complex, two nine story office buildings and a five story parking deck. For the purposes of this report, only one of the office buildings will be researched. Long interior spans are used to reduce the number of columns and make the office space more versatile for the tenants. The exterior walls are made of architectural precast concrete panels. Structural steel and a lightweight composite concrete deck make up the structural system. The office building has a footprint of 24,000 square feet and stands 140' tall. Each floor provides 21,000 square feet of useable office space.

First, I propose for the structural system change from a steel building to a precast concrete building. Several construction management issues will be addressed to help decide a good structural design. The floor-to-floor heights will remain the same. The column grid will also remain the same, using a bay size of 30' x 46'. The system will utilize precast concrete so that construction time and money can be saved. Pre-stressed double-T planks will be used as the flooring system, spanning in the 46' direction. Supporting the planks will be pre-stressed inverted-T beams. The beams will then frame into a steel column system, very similar to the existing. The lateral system will also remain relatively unchanged due to its effectiveness in the building design.

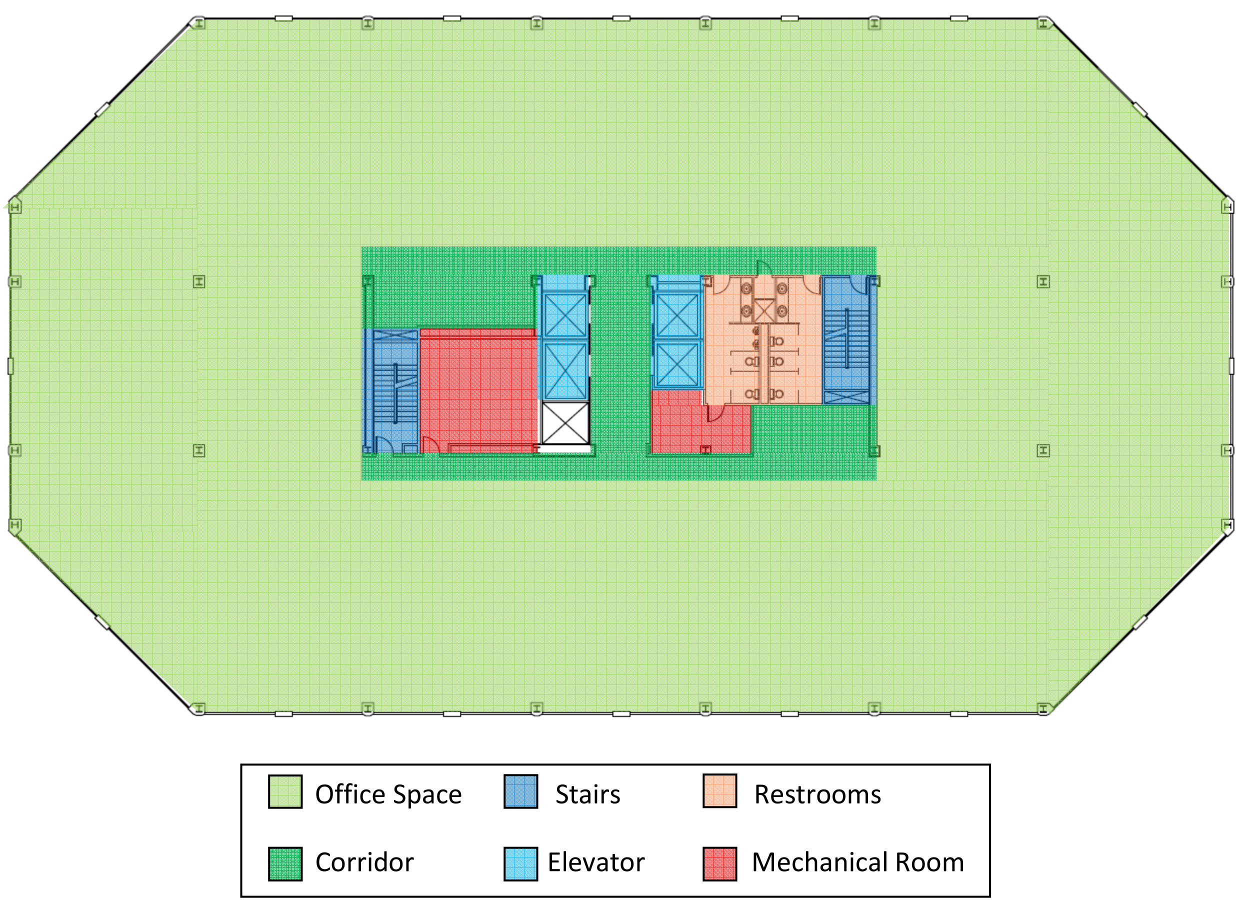
A cost analysis and proposed construction schedule has also been developed. The proposed structural system has an estimated cost of & 3.5 million, while the existing steel system came in at just above $ 4 million. Construction time has also been estimated to end about a week earlier. Considering the savings alone and a faster erection time, the new design for overlook towers' structural system seems to be a feasible alternative to the existing system.

An acoustic evaluation has also been performed on the office space of the building. A mechanical room on each floor poses a potentially high background noise. Also a floor-to-floor sound transmission loss calculation and it was found that the existing construction will be adequate for unwanted noise to travel between offices. In many open plan office buildings, other factors such as speech privacy also become an issue. Some minor changes to the space can isolate some of the speech to a smaller area. A more absorptive ceiling tile can be used to better reduce sound reflection or the ceiling can be broken up with headers to isolate speech to a smaller area. There are also a number of other ways to improve on speech privacy. One drawback is that if a design is chosen for one plan, it may not work with another. Tenants can move in and out and it is likely for each tenant to have different requirements for the space. Careful consideration must be made to keep the versatility of the office space.

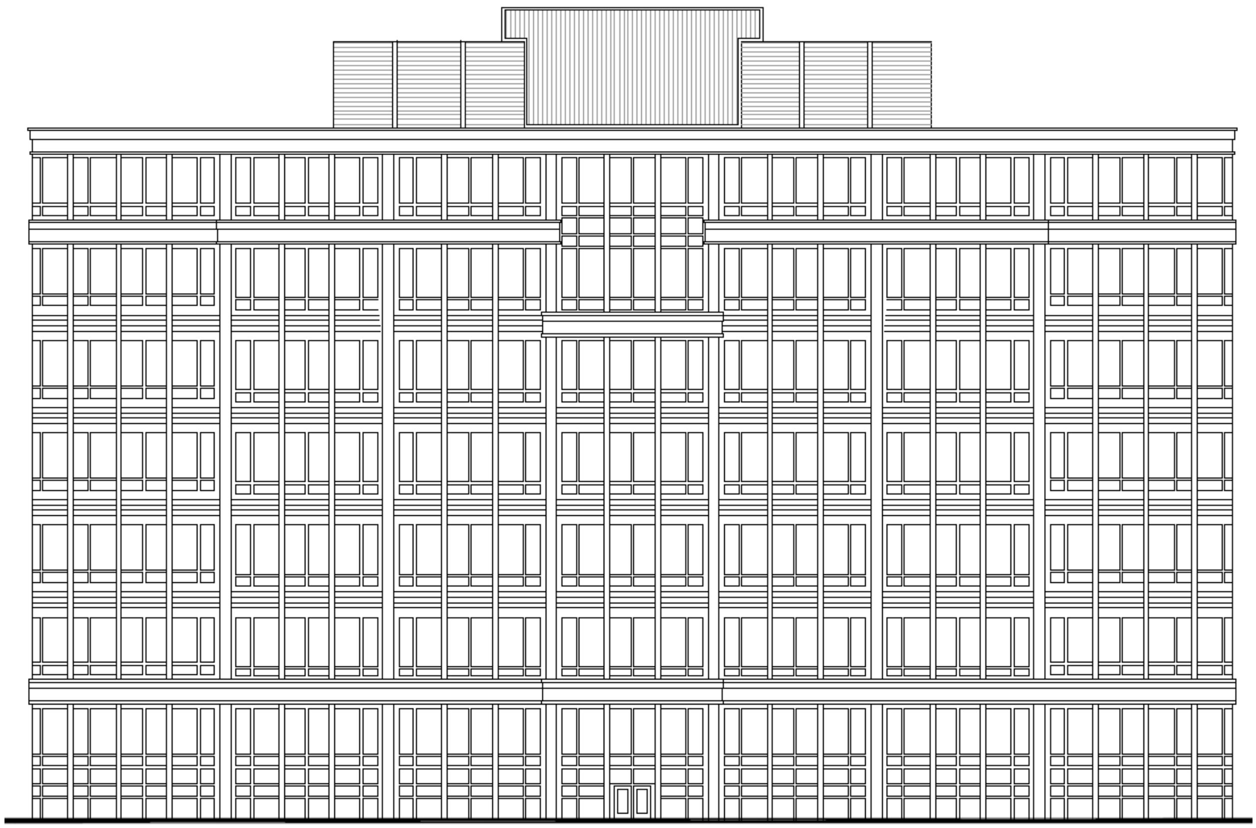
Existing Conditions

Building Summary

Overlook Towers is a nine story, 260,000 square foot steel office building. Located just minutes south of Washington-Dulles International Airport, the building is in a desirable location for prospective renters. The project consists of two office buildings and a five story parking deck. The overall dimensions of each building are 219'-2" by 125'-2". Illustrated below is a typical floor plan for Overlook Towers. All of the office space is located around the perimeter of the building. The central core of the building is where all other spaces are located. Each typical floor has approximately 21,000 square feet reserved for office space. In addition to the office space, there is 430 square feet of mechanical space, two restrooms and an elevator lobby/corridor. Vertical transportation is obtained via two stairways and four elevator shafts, all of which are located in the central core. The open floor plan allows for a more versatile use of the office space and the use of moveable partitions. Few supporting members obstruct the office space, allowing for a more attractive space, both visually and functionally. The first floor has two main entrances on the north and south side of the building. The space is split up into additional mechanical rooms, egress corridors and 15,000 square feet of office space.



Additional mechanical space is provided in a 3,500 square foot rooftop penthouse. The elevator lift system along with other major mechanical and plumbing equipment takes up a majority of the space. The roofing membrane is made of metal decking and extruded polystyrene insulation and is supported by steel joists. Architectural precast panels and large windows make up the building envelope. At a height of nine stories plus the mechanical penthouse, Overlook Towers stands approximately 140'. The second floor has a height of 15'-8" and a typical floor spacing of 13'-6". Elevation to the top of the roof is 127'-8" plus a one foot parapet.



North/South Elevation

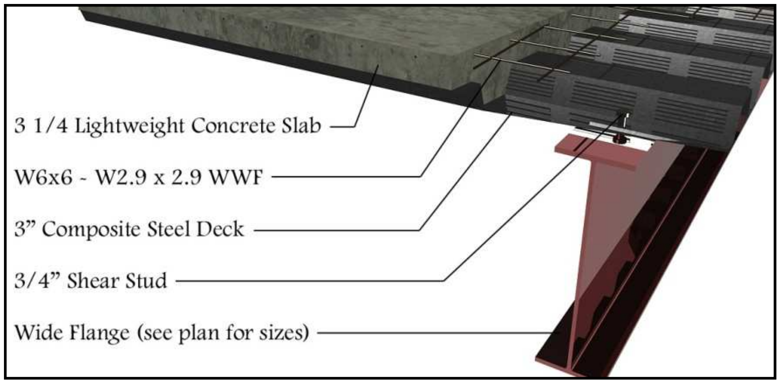
Design Loads (IBC 2000)

Gravity Loads		Live Loads	
Mechanical & Ceiling	5 PSF	Roof Snow Load	30 PSF
Single Ply Roof	11 PSF	Office Space	100 PSF
Finishes	As Required	Permanent Corridors	100 PSF
Sprinkler System	As Required	Lobbies & Stairs	100 PSF
		Mechanical Space*	125 PSF

* Non-Reducible

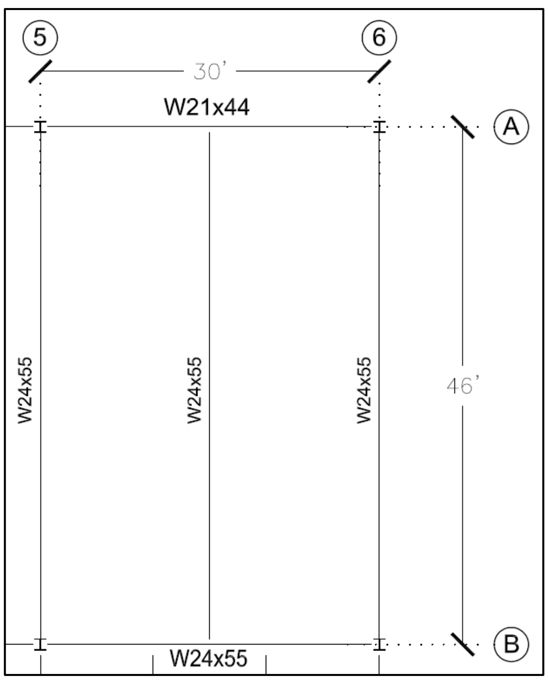
Structural Summary

Having such an open office plan requires the spans to be rather large, with a maximum span of 46 feet. Beam sizes range from W12x14 through W24x68 with spans of 10'0" and 46'-0". Column size varies from floor to floor with the largest size being a W12x170. Column splices occur every other floor creating a typical column length of 27'-0". Forces are then transferred to a spread footing foundation. The most common footing size is 7'-0" x 7'-0" x 1'-10". Also, a 3'-6" continuous footing runs along the perimeter of the building. The first floor is a 5" thick slab-on-grade over 4" compacted granular stone.



Existing Floor System

The existing floor system is a 6 ¼" composite beam and deck, supported by a steel frame. The slab is 3 ¼" of lightweight concrete (115 pcf) with a 28-day strength of 4000 psi. The concrete is formed into a 3" 18 gauge composite deck. Shear reinforcing is provided by ¾" headed shear studs. The typical beam size is W24x55 spaced at 12'-6" o.c. The beams frame into a W21x44 exterior girder and a W24x55 interior girder. The typical by size is shown below and an overall framing plan on the following page. Although the beams are not spaced evenly with the column lines, I will be using a bay size of 46' x 30' for the design of alternate framing systems.

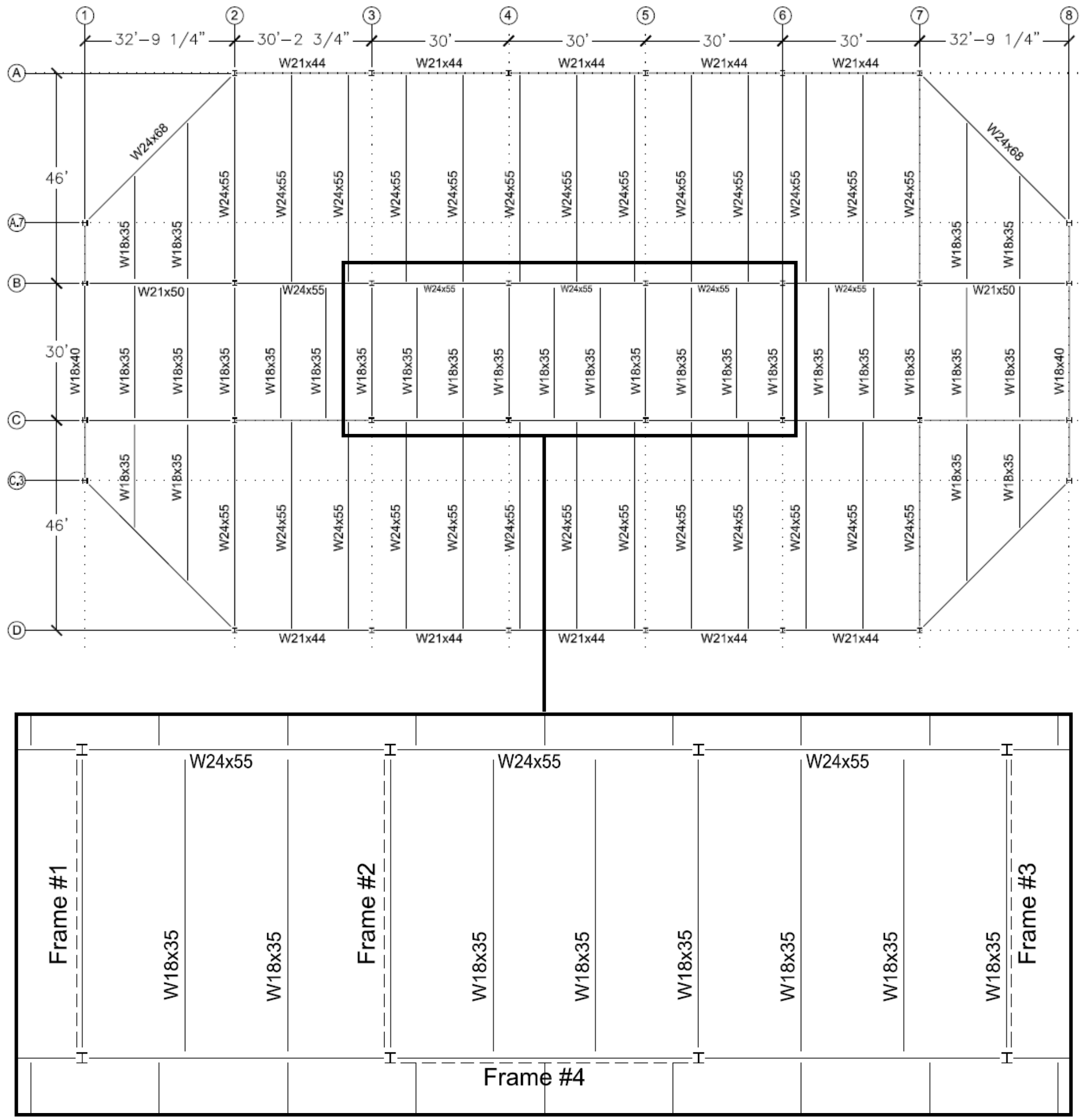


Typical Bay Size

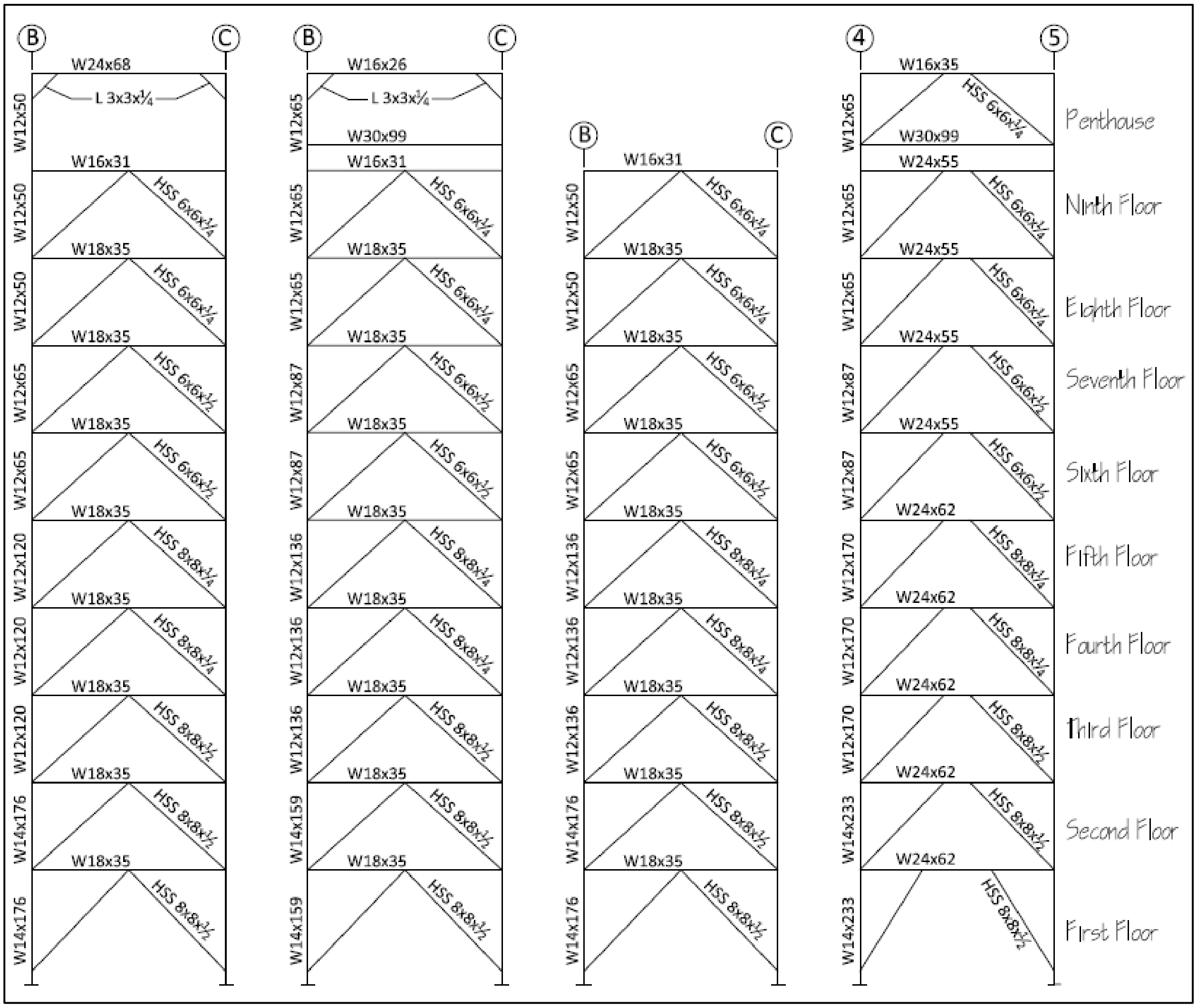
A big advantage to this system is the use of lightweight concrete. Steel structures are known for their quick erection and are relatively cheap compared to other systems. Fabrication is performed in the factory, thus reducing the time for on-site preparation. However, there is a possibility of down time due to the members not being delivered to the site in a timely manner. As with all steel structures, the major downfall to this system is the need for fireproofing. Since all structural members require fireproofing, extra time and money is required for installation. This is a very suitable system for this building type and occupancy.

Existing Lateral System

Wind and seismic forces are resisted through a system of four braced frames located in the core of each tower. A typical framing plan is shown below. Enlarging the core of the building, the location and orientation of each braded frame is shown. Frames one through three are oriented in the north-south direction because this is the controlling direction for wind design. Building design loads and calculations are included in the next section. The frames use wide flange shapes for beam members and HSS shapes for the diagonal bracing. An elevation and all member sizes can be found on the next page. Frame 1, 2, and 4 also provide lateral support for the penthouse while frame 3 only reaches to the roof.

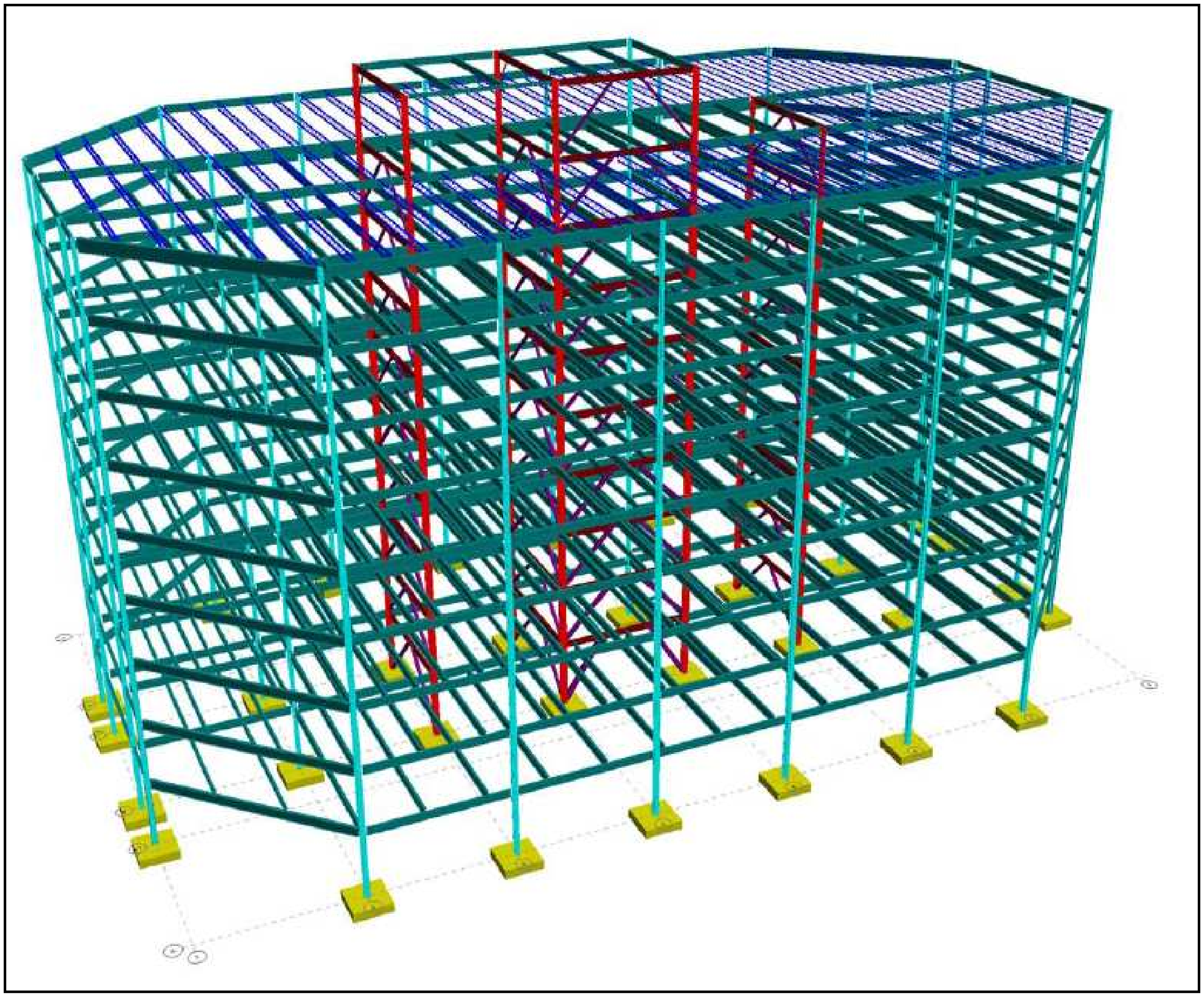


Below are the layouts of the four braced frames in Overlook Towers. Each floor is spaced at 13’-6” and 15’-8” to the second floor. The controlling factor of wind and seismic forces will be in the north-south direction, thus three of the four frames are oriented in this direction. One weakness to this system is the use of only one frame in the east-west direction. Having only one frame such as this creates an overall building torque, resulting in unwanted forces and stresses in other building components. Since the building is symmetric in both directions, this problem can be avoided. The columns and beams are W shapes with HSS for the diagonal bracing. Lateral forces are distributed through the frame via 5/8” gusset plates and the steel tubing. Forces are then transferred to the ground through concrete spread footings. Footing sizes range from 5’-6” square to 13’-6” square at a depth of two through six feet. A 3’-6” grade beam also runs along the perimeter of the building. Notice the large W30x99 beams on frame tow and frame three. Located in this section is the mechanical equipment for the elevator system. Loads can get quite large thus requiring heavier beam members. Detailed loading calculations can be found in the appendices of this report.



Frame 1	Frame 2	Frame 3	Frame 4

The lateral system for Overlook Towers is highlighted in the rendering below. As you can see, the entire later frame is located about the central of the building and nowhere else. This is an ideal location for the later system as it has little effect on the architectural design. Placing bracing along of the perimeter of the building may restrict the size and location of windows and the rest of the building can be left open with no interfering walls to hide the bracing. The layout of each spread footing is also displayed in yellow. There is also a 3’-6” continuous footing that rungs along the perimeter of the building.



Existing Building – Later Bracing

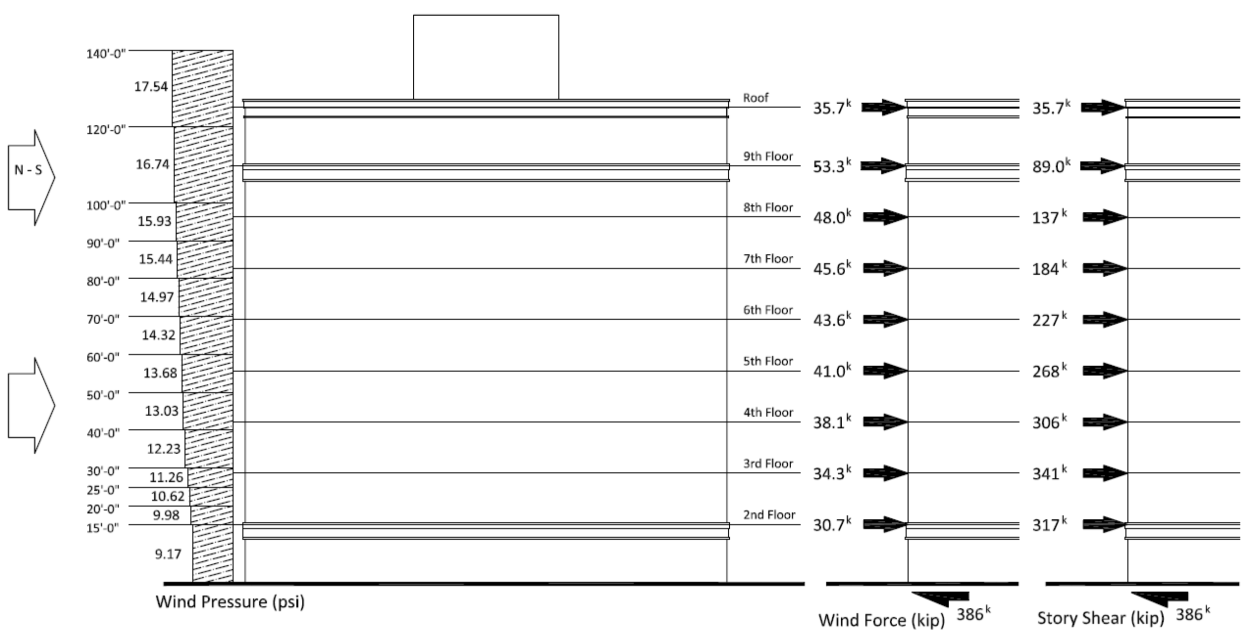
Loading Conditions

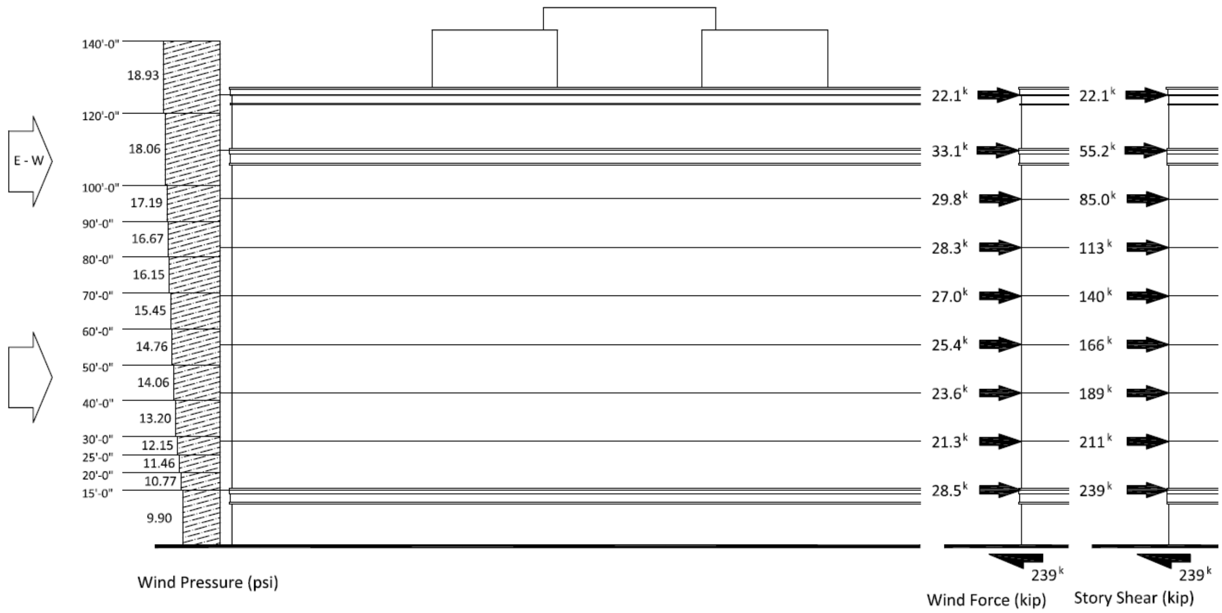
General design information from ASCE7-05:

Wind Loading		Seismic Loading	
Wind Speed	90 mph	Seismic Use Group	I
Importance Factor	1.0	Importance Factor	1.0
Wind Exposure	B	Design Category	B
Enclosure Class.	0.18		

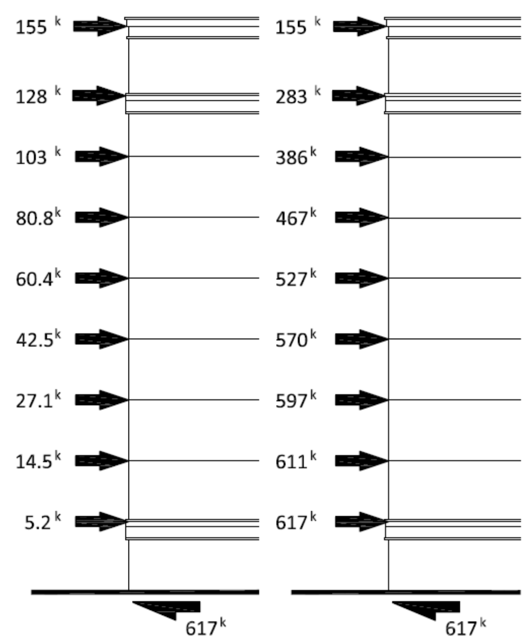
Overlook towers is a fully enclosed building. No special considerations were needed for the calculation of wind loading. The longest side of the building will be receiving the largest wind force, so the N-S direction will be the determining factor in the design. The two drawings below summarize the calculations into wind pressure, the force at each level and finally the story shear. Total base shear was calculated to be 386^k and a base moment of $27{,}232'^k$. The building weight alone is more than enough to counterbalance the overturning force due to the wind.

Through a RAM analysis, average story drift was found to be about 0.36" with a total drift of 3.61". This value meets a suggested story drift of about 0.405" per story. This deflection limit allows for minimal damage of walls, partitions and finishes. Exceeding a drift of 0.405" may result in damage to non-structural components of the building. Detailed wind and seismic calculations are available in Appendix A, both hand calculations and a RAM output is included.





The equivalent lateral force procedure was used to calculate seismic loading. Detailed calculations of seismic forces can be found in Appendix B. With an occupancy category I, table 12.12-1 of ASCE7-05 states that the allowable drift is $0.020h_{fx}$ or 3.24”. Total seismic base shear is calculated to be $617'^{k}$. The controlling direction for seismic force is also in the N-S direction. These values are tabulated in Appendix B with a summary of the forces to the left. The overturning moment was checked and the building weight was found to be adequate to balance these forces. Member checks are performed on the following page. The top two floor of braced frame three will be checked.



Problem Statement

The design of Overlook Towers is a functional open plan office building. Having long spans and unobstructed office space allows for flexibility of the office spaces being rented. Given the circumstances, it may be in the best interest to the owner complete construction as quickly as possible. Shortening the construction time will decrease labor costs and will allow the owner quickly move in tenants and start to collect rent. An alternate structural system will be investigated to see if a savings in time and cost can be found. However, time and money are not everything; there are both advantages and disadvantages to each structural system. Once designs are complete, the owner would have to make a decision weighing out advantages for each system.

The existing structural system has proven to be a very good choice for the given conditions. Steel structures typically weight less than other systems due to its high strength to weight ratio, resulting in less foundation work. Fireproofing must also be applied once erected, taking up valuable time and money. One time issue is the use of an elevated slab system. Wet concrete is formed into a composite steel deck, making that floor level inaccessible until concrete has hardened. In previous reports, alternate flooring systems were compared to the existing system. Four designs were considered; open-web steel joists, hollow-core precast planks, precast double-T planks, and post tensioning. Pre-stressed Double-T's and post-tensioning were found to be a viable alternative. Trying to keep the cost of the building down, post-tensioning will not be considered as this typically raises the overall cost of the building.

A precast concrete structure will be designed for Overlook Towers, replacing the current system. This change will affect all aspects of the building design, two of which will be investigated through the breadth analysis. Possible savings in material, labor and construction time will be presented. The first and most obvious change will be the redesign of the beams, columns and girders. Floor to floor heights will remain the same at 13'-6" for a typical floor. As found in technical assignment 2, if double-T planks are used, the total floor depth will remain approximately the same. All floor heights will be the same; however slight changes will be made to the overall depth of the flooring system. Steel columns and braced frames will remain the main gravity and lateral supporting system, although it will have to be redesigned due to the difference in dead and wind loads. Cost, erection time and impacts on other systems will be compared to see if a more suitable system has been chosen.

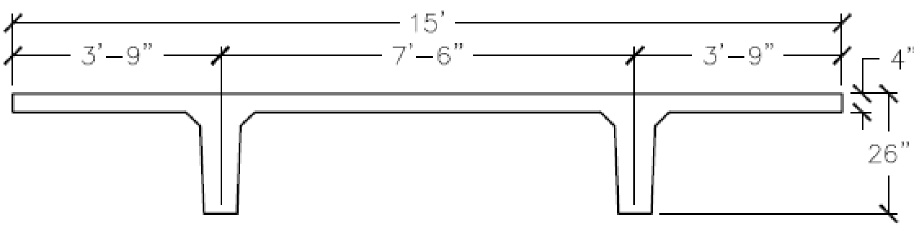
The flooring system will be precast double T planks. All concrete systems have an advantage over steel systems because there is no need for fireproofing. Using precast members allows for a quick and continuous erection of the building. The double-T beams will act as beams and a slab, which can be erected at the same time. Having a span of 46'-0" will result in a camber of approximately 0.5" – 0.75" resulting in an uneven floor. A thin layer of concrete will need to be applied once the members are set into place. A slight increase in strength will also result in the topping; however the major area of concern will be creating a level floor before applying the desired finishes. The study of the breadth topics will be conducted to help decide the best structural system for Overlook Towers.

Proposed Alternate System

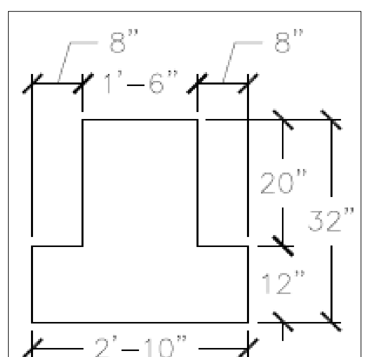
A precast concrete structure will be designed for Overlook Towers, replacing the current system. This change will affect all aspects of the building design, two of which will be investigated through the breadth analysis in the following section. The composite deck system will be replaced by precast double-T planks. Taking advantage of the quick erection time for precast components will reduce overall construction time and in turn will save money. Floor to floor heights will remain the same at 13'-6" for a typical floor. Steel columns and braced frames will remain the main gravity and lateral supporting system, although it will have to be redesigned due to the difference in dead and wind loads. Cost, erection time and impacts on other systems will be compared to see if a more suitable system has been chosen.

Alternate Floor System

The 6th edition PCI Handbook will be used to aide in the design of member sizes. Each member is pre-stressed unless otherwise noted. The reduced live load for the floor system was calculated to be 53.5 PSF. From the calculations found in Appendix D the total floor load is 120 PSF. Given the loading conditions, a 15LDT26 168-S was chosen.

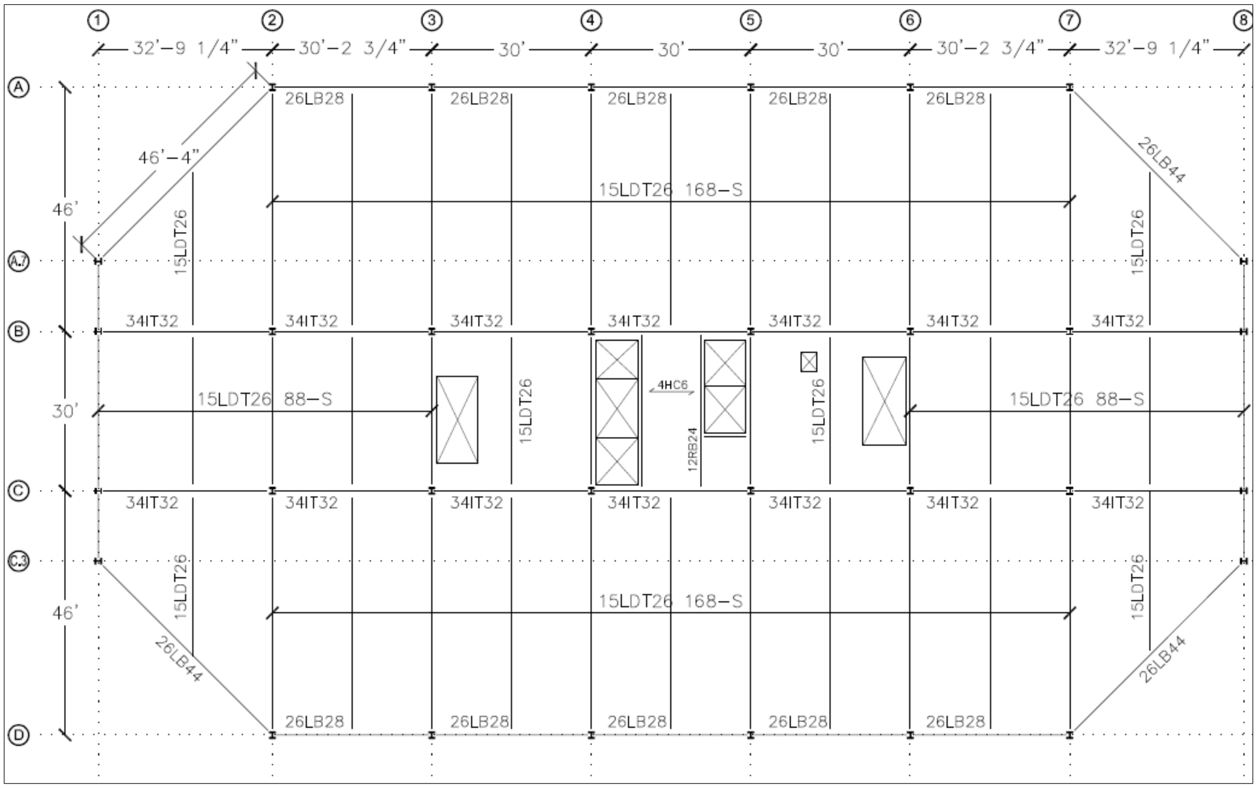


Lightweight concrete will also be used in this system. Typically concrete weights considerably more than steel and normal weight concrete would add considerable amount to total building weight thus driving up the cost of foundation work. The member will span in the 46' north-south direction with a design load of 126 PSF. Each member weighs 861 PLF resulting in a total weight of 39.6 kips. A fifteen-foot wide double-T was chosen to minimize the number of members used in the construction of each floor. With fewer members to erect, construction time is cut back and allows other practices to quickly move in and begin work. For each 46' member, there will be a camber of 0.5", possibly more, so thin concrete topping will be required once erected in the field. Adding this topping will contribute to the strength of the system, but more importantly it will provide a level floor. Although a topping will still need to be applied in the field, I chose to use a pre-topped double to in order to have a higher strength member with a smaller depth. Choosing a normal member could have resulted in a member up to 12" deeper than the current section that has been chosen.



34IT32 Dimensions

Since the double-T planks will be span north-south, beams will only be required in the east-west direction. For a typical interior bay with a span of 30', a 34IT32 238-S inverted T beam will be used to carry a design load of 6,740 PLF. At a span of 30' each beam is designed to carry a load of 7,032 PLF with a self weight of 800 PLF. Along the perimeter of the building L beams were chosen to carry both the slab and precast façade. Refer to the following page and appendix D for a complete list of member sizes used.



Proposed Precast Framing Plan

The double-T planks are unable to be used for the elevator corridor. The lobby floor system will use hollow core planks supported by rectangular precast beams. The span will only be 12'-6" with a load of 110 PSF. From the PCI Handbook a 4HC6 66-S hollow core slab was selected. The planks will be supported by two 30' 12" x 24" beams. As for the mechanical space, the same sized double-T with a shorter span of 30' will be able to carry the increased loading. Each pre-cast component will have to be connected to one another through steel rods and grouting. Some typical pre-cast details can be found on the following page. Included in the set is a double-T flange connection as well as double-T to inverted-T.

This flooring system offers a faster erection time when compared to the existing system. Each of the members will be connected using grout thus little time is needed for concrete work. Mechanical and plumbing systems can be installed earlier due to the pre-topping. Another advantage to all concrete structures is that there is no need for fireproofing. The calculated weight of the new system is heavier than the original weight. With pre-cast, each floor is approximately 28% heavier than a composite deck system; this will have a slight impact on the design of the foundation and column design.

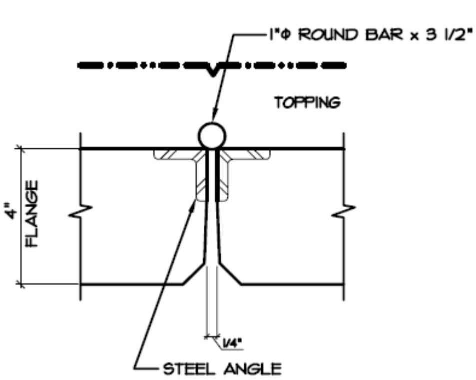
Precast	Weight (plf)	Length (ft)	Qty/fl.	Total
15LDT26	861	46	20	**792.12 kip**
	861	30	10	**258.3 kip**
34IT32	800	30	14	**336.00 kip**
26LB28	450	30	12	**162.00 kip**
4HC6	195	13	11	**27.89 kip**
12RB24	300	30	2	**18.00 kip**
26LB44	958	46	4	**176.27 kip**
Topping			1	**592 kip**
			SUM	**2,363 kip**

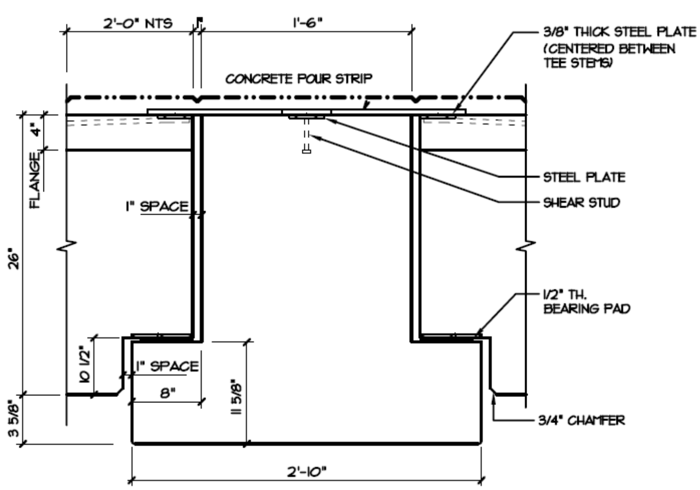
Existing Floor Weight: 1,845 kip

$$\frac{2363 - 1{,}845}{1{,}845}(100\%) = 28\%$$

Steel columns will also be used in the design of this system. In order to maintain a fast erection time the use of steel columns prove to be an economical choice. RAM structural system will be used as a column design aide. On the next page is a rendering of the structural system for the building and a column schedule has been provided at the end of the appendix. The largest beam used in this design is a W14x132. Steel columns will also allow the use of lateral bracing similar to the original design. One more braced frame has been added to the design than was in the original plans. As the building is designed, having only one braced frame in the transverse direction naturally creates a torque on the building. Taking the frames location and mirroring it with respect to the x-axis will counter-balance this effect. This will create a more rigid design and fewer complications when considering torque and how that may affect other building components, both structural and architectural. When compared to other methods of lateral support, this has a good erection time and involves the least amount of material.

Wind and seismic forces were recalculated for the new system. The overall floor height ended up being very similar, as the original system thus building height did not change. Previous calculations of wind forces can be used and are located in appendix B. As for seismic forces, they will need to be recalculated because of the differences in weight. Below is a summary of these forces and effects they cause on the building and the current lateral system. Not much alteration was necessary, as the wind forces remained to be the controlling factor. Seismic forces have little effect on the design due to its geographical location.





Breadth Topic 1 - Construction Management

Changing the structural system of a building involves many changes and not just to the structural system. The study of two breadth topics will also be included in the report. These topics will help to determine a structural system for Overlook Towers. Existing construction management information was provided by Clark Construction Group. Construction of the structural system is scheduled from October 20, 2006 through March 21, 2007 with a total structural cost of $ 4.08 million. A detailed breakdown can be found in the following sections.

First, a cost estimate will be performed for each of the systems. Building cost has a big influence on type and design of the building. Performing and approximate cost for each system and considering other construction management issues will be one determining factor for the use of a system. Secondly, a construction schedule will be made. Cutting down the construction time could noticeably drop the cost of the building.

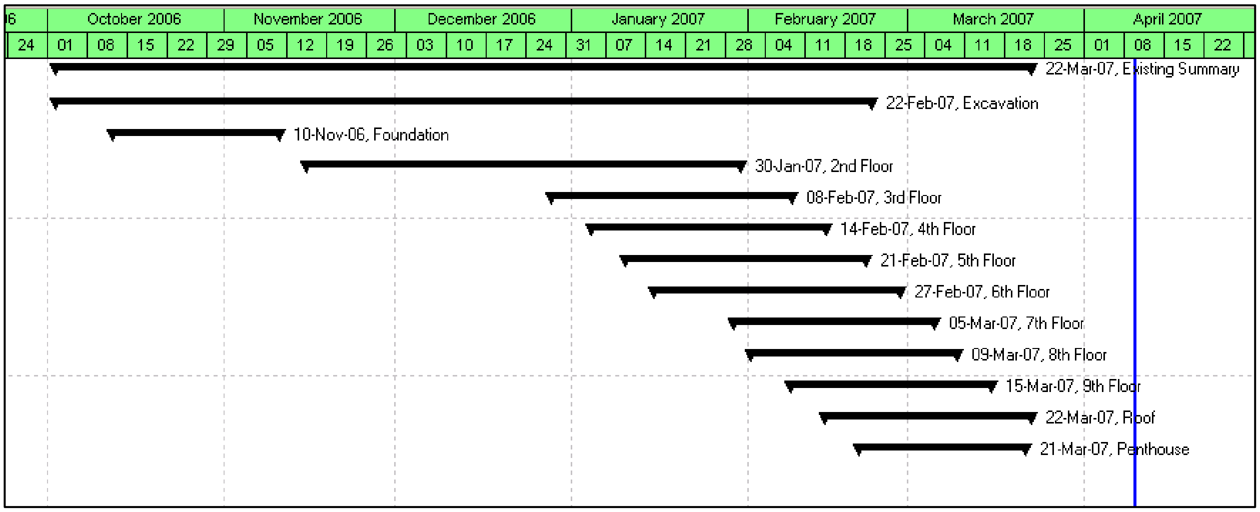
Construction Schedule

The construction schedule provided gives a detailed account of all structural activities for one tower. Construction begins on October 2 with clearing site for foundation. The differences in schedule are not noticeable until construction of the superstructure begins. Since the building weights were found to be approximately the same weight, comparison of the schedules will begin with construction of the second floor. Below is the start and finish date for each system and the schedule on the next page gives a breakdown of the start and end of the construction of each floor.

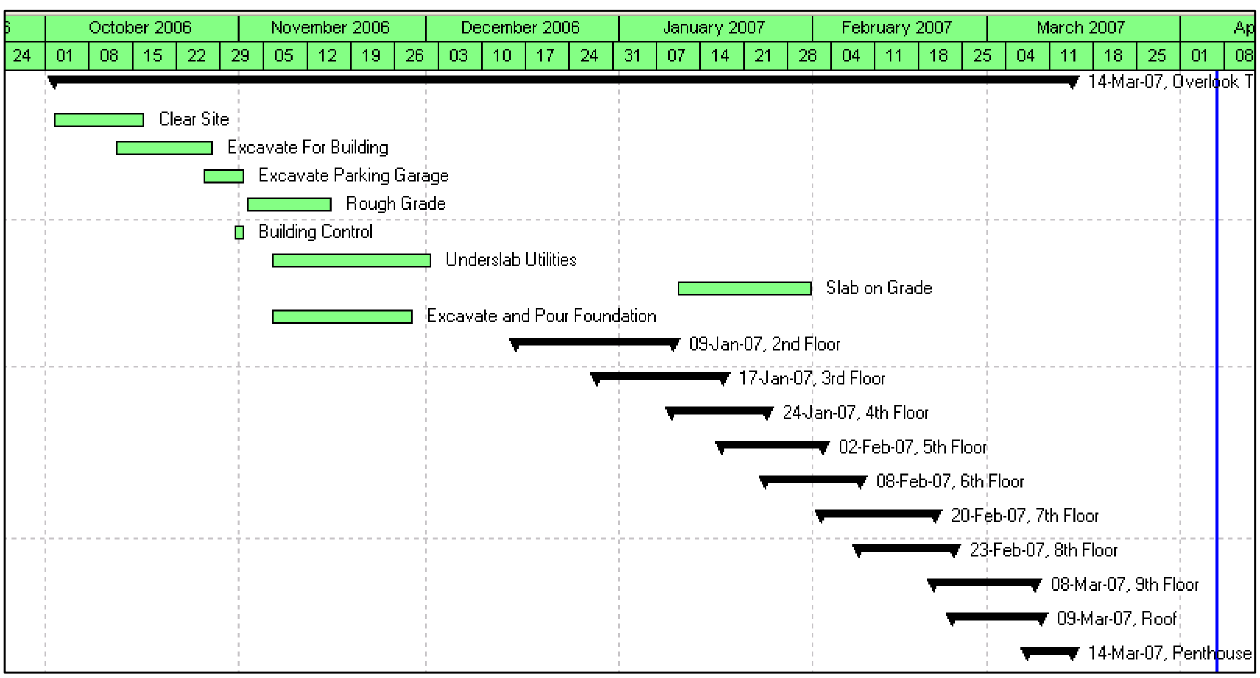
Construction Overview			
	Start	**Finish**	**Total (days)**
Existing System	10/02/06	03/22/07	**120**
Proposed System	10/02/06	03/14/07	**114**
Difference	**0**	**6**	**-6 Days**

For both projects, construction will begin on October 2, 2006 with excavation and preparation of the site. The steel structure is capable of being constructed quickly. Once the steel has been laid out, the next floor can start construction. I found in the steel structure that construction on the next floor can begin sooner than in the precast. Once steel is erected on the second floor, both the metal decking can be started and steel workers can move to the next floor. The average completion for one floor is approximately 26 days. The concrete can be poured while construction continues on the floors above, although other workers will have to wait for drying of the concrete to begin work on a particular floor. This will be one disadvantage to using cast-in-place concrete. This process can be continued through the construction of the building.

The construction of the precast has a different situation. Since each member is so large, floors cannot be built on top of each other. Instead, most of the double-T planks must be set into place. First, the columns will be set into place then the precast beams. With the beams in place, the second crane can begin placing the double-T slabs. Once construction of one floor has neared completion, construction of the next floor will begin. The average completion time per floor is 16 days, ten days less than previously. However construction on the next floor will not begin until about eight or nine days after. In the steel structure, construction on the next story can begin soon after the steel is in place and the crane is no longer needed for heavy lifting. In the end, the construction schedules only have a six day difference. Once the floor system has been set into place, other practices are able to start work earlier. This can reduce overall construction time and will benefit both the owner and general contractor. Next, the cost of the two systems will be compared and a conclusion can be drawn.



Existing Schedule



Proposed Schedule

Cost Estimate

Analysis of the construction schedule showed positive results. This is also seen in the cost estimate for each system. The total estimated cost of the existing building is $ 4 million and has been broken down into these categories:

Existing Structural Costs			
Foundations	$ 133,040	**Rebar**	$ 71,990
Walls	$ 72,034	**Structural Steel**	$ 2,400,000
Slab on Grade	$ 159,864	**Fireproofing**	$ 182,900
Slab on Deck	$ 1,058,317		
		Total:	$ 4,078,145

Proposed Structural Cost			
Foundations	$ 133,040	**Rebar**	$ 42,890
Walls	$ 72,034	**Structural Steel**	$ 516,500
Slab on Grade	$ 128,742	**Fireproofing**	$ 63,494
Double-T	$ 1,406,134		
Beams	$ 1,146,103	Total:	$ 3,507,378

Since it was found that the weight of each building is approximately the same, it was assumed that foundation work will be very similar. An estimate for the precast structure was found to be approximately $ 3.5 million with a saving of about $ 500,000. Immediately savings can be seen in the cost of the slab on deck. Each floor member has been pre-topped at the factory. The total estimate for the double-T came to $ 1.5 million, 50% more than the cost of the slab on deck. The other precast components contributed $ 1.15 million, making a total of $ 2.65 million for the flooring system. Since the columns will still need to be fireproofed, however it is less than having to fireproof all of the building components.

The alternative system seems to be a plausible choice with a savings of almost $ 500,000 and six days. The steel system cost $ 15.69 per square foot and $ 13.49 per square foot.

Breadth Topic 2 – Office Acoustics

Open-plan office buildings are a popular design for larger office spaces allowing for versatility of the space. Along with increased popularity acoustical problems arise with large, open-space office plans. For my second breadth analysis, I will investigate the acoustics of a typical office space. Transmission loss between a mechanical room and effects of adjacent office spaces will be evaluated. Also, the office space itself and effects of sound levels and speech privacy will be discussed, offering design alterations to improve on various aspects of the acoustical design. Speech privacy is one item to consider when dealing with such office plans.

Design Goals:

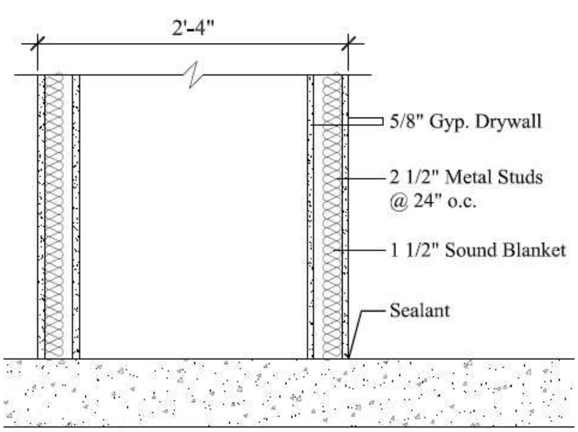
- Improve on overall acoustical problems
- Provide improved speech privacy
- Maintain versatility of office space

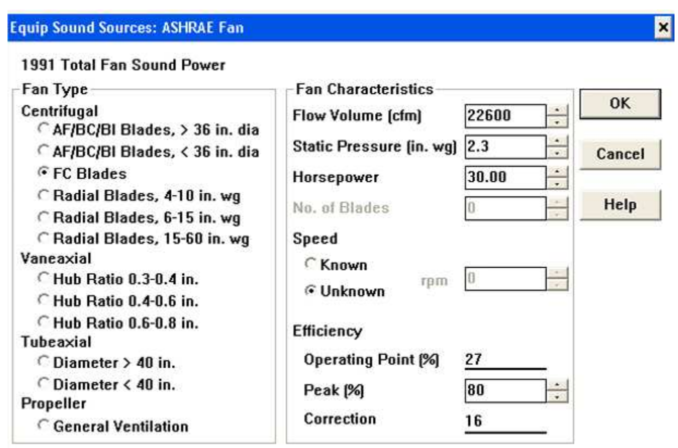
Overview of Existing Conditions:

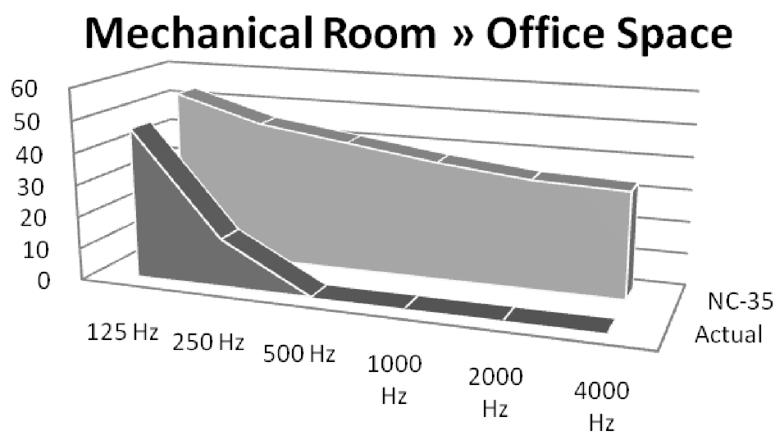
The office space to be analyzed is about 46’-0” wide and runs along the entire length of the building, approximately 210’-0”. Corridor space is designated to run along the central core of the building. There are no full-height partitions and the only obstructions are four columns, which will not have a significant impact on the design. Floor-to-ceiling height is set at 9”-0” with a suspended ceiling system. When occupied, it is assumed that the space will be separated into cubical style offices. Different partition heights will be considered to provide different options for the owner/renter.

Mechanical Room Check:

Located on each office floor is a 430 square foot mechanical room. The mechanical room houses a 22,600 CFM air handling unit. The Trane Acoustics Program (TAP) was used in the calculation of the AHU sound levels. Properties of a typical AHU are shown below. The recommended NC ranges for a large office space ranges from 35-40. Taking the conservative approach, I will use NC-35 for calculations. The mechanical room wall construction is shown below. A summary of calculations is shown on the next page.





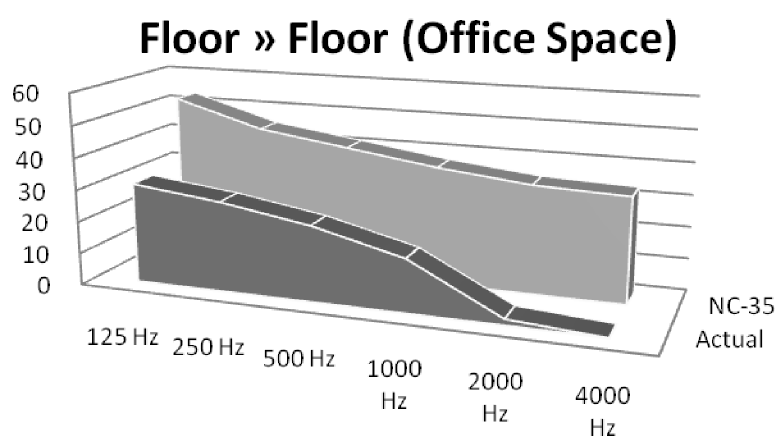


	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Actual	47	15	0	0	0	0
NC-35	53	45	41	37	34	33

All acoustical products used in the design are from a local manufacturer, Acoustical Solutions, Inc. from Richmond, VA. The 1-1/2" sound blanket is one of the AudioSeal sound blanket product line. Calculations show that most of the sound will be completely absorbed by this wall construction. Two blankets are necessary to achieve a transmission loss below recommended values. One blanket was sufficient for the higher frequencies, however to keep out lower frequencies a second sound blanket is used. The graph illustrates that sound from the AHU will not have an effect on the surrounding office space. Tables from the excel spreadsheet calculations can be found in the appendix.

Floor-to-Floor Transmission Loss:

In addition to the mechanical room, sound transmitted through the floor construction was checked to see in additional acoustical materials may be needed to keep the sound at an acceptable level. The floor construction consists of heavy carpet, precast double-T floor and suspended acoustical ceiling tile. ACT data was also obtained from the Acoustical Solutions web site. The floor to floor transmission loss is less than the mechanical room, however sound pressure levels are below the recommended values associated with an NC-35. This concludes that no additional considerations will have to be made to the acoustics of the current floor



	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Actual	31	28	24	17	2	0
NC-35	53	45	41	37	34	33

system. Also, a spreadsheet can be found in the appendix.

Other Design Considerations:

Calculations show that sound levels are at an acceptable level when considering adjacent rooms, however other problems can potentially arise within the office space itself. Depending on the occupants, speech privacy between cubicles and adjacent areas can be a problematic. In order to maintain acceptable speech privacy, studies have been conducted to improve these conditions. Office designers will need to verify what type of office situation needs to be created to have an acoustically sound design. Some situations require greater speech privacy than others. I have opted to install a highly efficient acoustical ceiling tile in order to keep sound reflections to a minimum, as this is one of the largest surface areas in an office and can be applied to any office situation. Orientation of cubicles will have to be further analyzed. These are just a few considerations to improve the satisfaction of the tenants.

Conclusion

The proposed alternate system has proven to be a viable alternative to the existing steel structural system. The main goal of the system was to reduce construction time save the owner some money. The construction time remained about the same and more savings can be found if researched further. The significant savings is not in the schedule, but the cost. With a savings of $ 500,000 and weeks cut off of the construction time, it is possible to see savings top one million dollars. With this savings, it would offset the total project cost of about 4.9%. Considering that Overlook Towers is in the Washington DC area, concrete is a readily available material. Transportation costs will be reasonable with the use of local materials.

Using a pre-stressed concrete in the design made a more efficient use of concrete with long spans and considerable loading. Office buildings are designed to make maximum use of the space, which is achievable with this design. One must also consider the effects of vibrations and how that may apply to each system. Precast concrete should have fewer vibrations than a steel structure due to its rigidity and massive size.

The use of steel columns is taken advantage of in the design of the lateral system. First, the steel columns will allow for a quick erection time and is easier to make a lateral bracing than concrete. If some sort of concrete shear wall is used, time is needed for curing of concrete possibly a longer construction time altogether. Concrete shear walls are masses of concrete while the steel bracing is just an arrangement of wide-flange shapes and hollow steel sections. Once again steel is used in the roofing system. Structural steel joists offer maximum benefits when used in a roofing system. They are cheap to buy, easily accessible and quick to erect. They will make the most efficient use of material thus saving cost.

In the end, both of the systems discussed in this report have proven to be a good structural design for the towers. Each has its advantages and disadvantages to offer. You start to see more benefit into the precast system as it has a lower overall cost and may be more appealing to the owner. However, construction of the steel system may prove to be easier. After researching, I would choose to stay with the current system as this seems the best choice. Other systems may also be ok, however that would require more research. As stated before budget is not everything and you must take other aspects into consideration that were not explored in this report. Some of these include, but are not limited to effects to the mechanical and electrical systems.

Acknowledgements

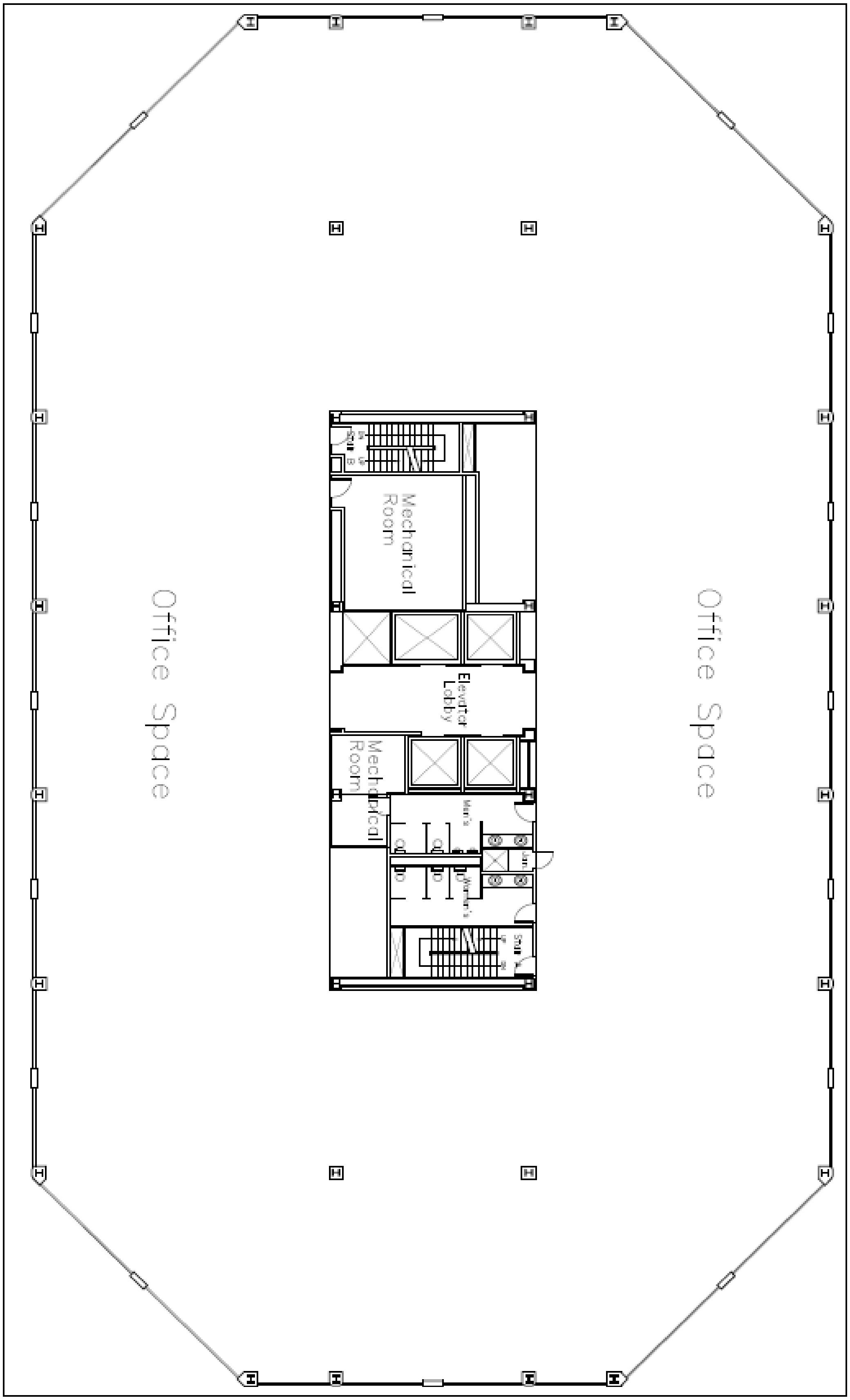
Penn State Faculty

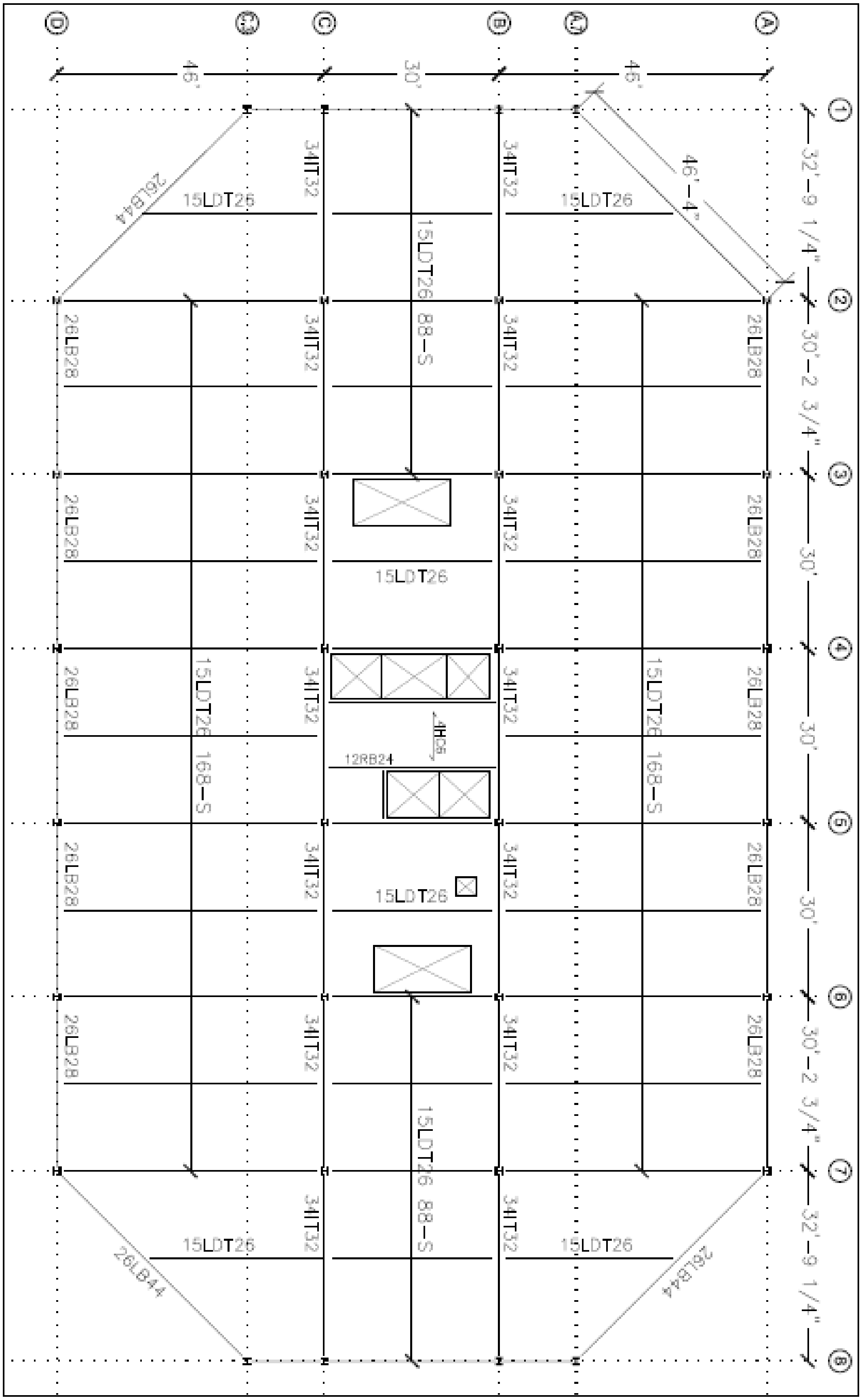
Professor Ali M Memari	THESIS ADVISOR, ARCHITECTURAL ENGR
Professor Robert J Holland	ASSOC PROF ARCHITECTURE
Professor Kevin M. Parfitt	PROGRAM COORDINATOR, ARCHITECUTRAL ENGINEERING

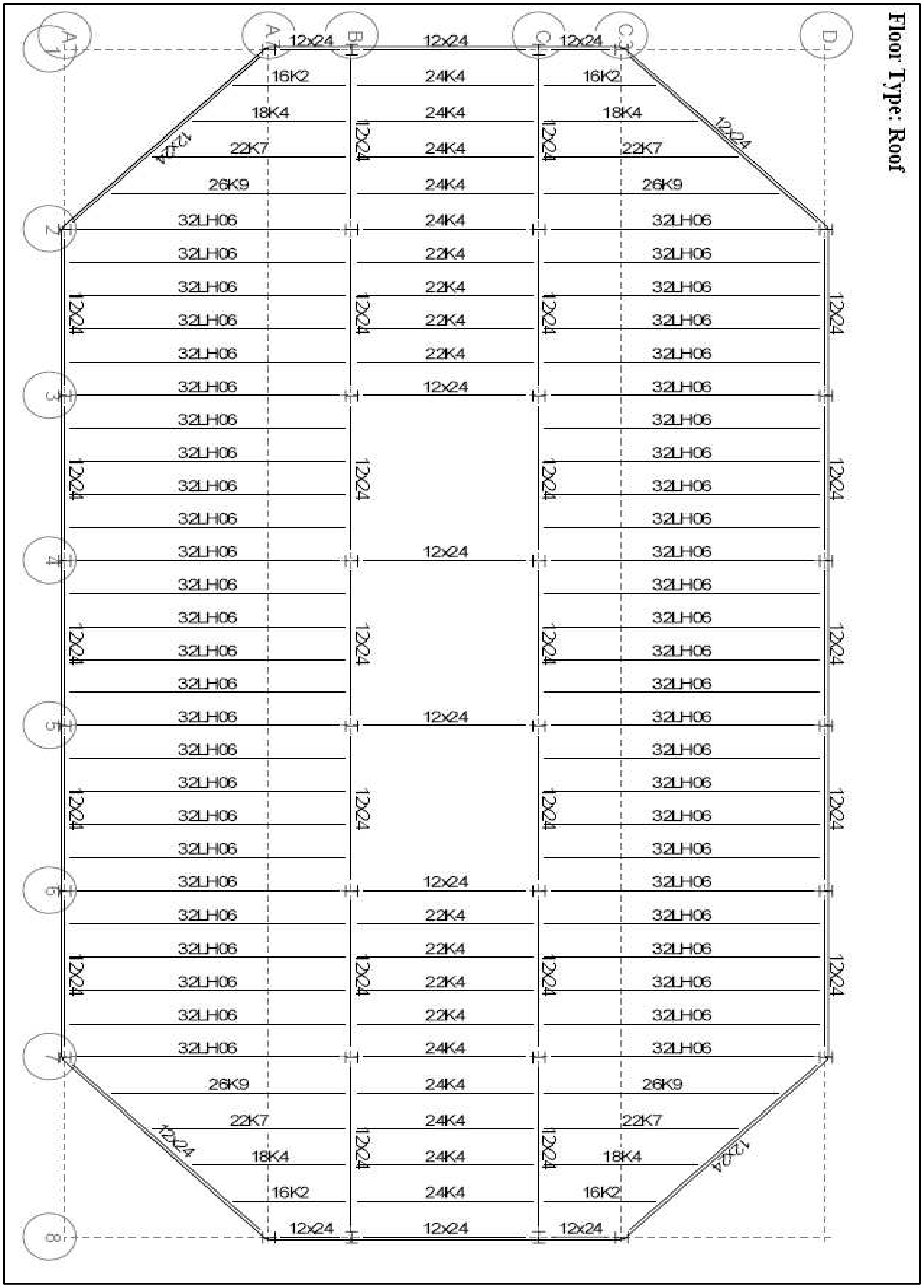
Design/Construction Team

Michael Vardell	Owner, Vardell Real-estate Investments
Dustin J. Wakefield	Structural Engineer, Haynes Whaley Associates
Howen Kelmers	Architect, Noritake Associates
Matt Power	Project Manager, Clark Construction Group, LLC

Appendix

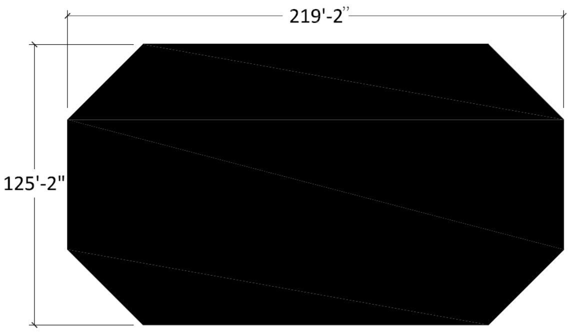

Office Space
Office Space
Mechanical Room
Elevator Lobby
Mechanical Room
Men's
Women's
Jan.


D
C.3
C
B
A.7
A
46'
30'
46'
1
2
3
4
5
6
7
8
32'-9 1/4"
30'-2 3/4"
30'
30'
30'
30'-2 3/4"
32'-9 1/4"
46'-4"
26LB44
15LDT26
34IT32
15LDT26 88-S
26LB28
15LDT26 168-S
12RB24
4HD6


Floor Type: Roof
12x24
16K2
24K4
18K4
22K7
26K9
32LH06
22K4
12X24

Appendix A – Wind Calculations (same as existing)

Analytical Procedure (ASCE7-05):



Dimensions:		Design Values:
h = 127’		Exposure B
B = 127’		V = 90 mph
L = 220’		I = 1.0
Constants:		
K_d = 0.85		G = 0.83
K_z = (see chart)		GC_p = 0.664
K_{zt} = 1.0		GC_{pi} = ±0.18

$$G = 0.925\left(\frac{(1+1.7g_Q I_{\bar{z}} Q)}{1+1.7g_v I_{\bar{z}}}\right) = 0.925\left(\frac{1+1.7(3.4)0.261(0.828)}{1+1.7(3.4)0.261}\right) = 0.83$$

$$Q = \sqrt{\frac{1}{1+0.63\left(\frac{B+h}{L_{\bar{z}}}\right)^{0.63}}} = \sqrt{\frac{1}{1+0.63\left(\frac{127+127}{422.96}\right)^{0.63}}} = 0.828$$

Where: $I_{\bar{z}} = c\left(\frac{33}{\bar{z}}\right)^{1/6} = 0.3\left(\frac{33}{76.2}\right)^{1/6} = 0.261$ & $L_{\bar{z}} = l\left(\frac{\bar{z}}{33}\right)^{\epsilon} = 320\left(\frac{76.2}{33}\right)^{\frac{1}{3.0}} = 422.96$

$q_z = 0.00256 K_z K_{zt} K_d V^2 I$ $\rightarrow$ *see chart below*

Wind Pressure							
			Windward			Leeward	
Height (Z_t)	K_z	q_z	N-S	E-W	q_h	N-S	E-W
0-15	0.57	10.0466	9.173 psi	9.897 psi	5.2877	4.828 psi	5.209 psi
20	0.62	10.9279	9.977 psi	10.765 psi	5.2877	4.828 psi	5.209 psi
25	0.66	11.6329	10.621 psi	11.460 psi	5.2877	4.828 psi	5.209 psi
30	0.7	12.3379	11.265 psi	12.154 psi	5.2877	4.828 psi	5.209 psi
40	0.76	13.3955	12.230 psi	13.196 psi	5.2877	4.828 psi	5.209 psi
50	0.81	14.2767	13.035 psi	14.064 psi	5.2877	4.828 psi	5.209 psi
60	0.85	14.9818	13.678 psi	14.759 psi	5.2877	4.828 psi	5.209 psi
70	0.89	15.6868	14.322 psi	15.453 psi	5.2877	4.828 psi	5.209 psi
80	0.93	16.3918	14.966 psi	16.148 psi	5.2877	4.828 psi	5.209 psi
90	0.96	16.9206	15.448 psi	16.669 psi	5.2877	4.828 psi	5.209 psi
100	0.99	17.4493	15.931 psi	17.190 psi	5.2877	4.828 psi	5.209 psi
120	1.04	18.3306	16.736 psi	18.058 psi	5.2877	4.828 psi	5.209 psi
140	1.09	19.2119	17.540 psi	18.926 psi	5.2877	4.828 psi	5.209 psi

Overturning Moment

N-S:	R:	35.7^k (125.5') = $4480'^k$	**E-W**:	R:	22.1^k (125.5') = $2774'^k$
	9:	53.3^k (110.17') = $5872'^k$		9:	33.1^k (110.17') = $3647'^k$
	8:	48.0^k (96.67') = $4640'^k$		8:	29.8^k (96.67') = $2881'^k$
	7:	45.6^k (83.16') = $3792'^k$		7:	28.3^k (83.16') = $2353'^k$
	6:	43.6^k (69.67') = $3038'^k$		6:	27.0^k (69.67') = $1881'^k$
	5:	41.0^k (56.16') = $2303'^k$		5:	25.4^k (56.16') = $1426'^k$
	4:	38.1^k (42.67') = $1626'^k$		4:	23.6^k (42.67') = $1007'^k$
	3:	34.3^k (29.16') = $1000'^k$		3:	21.3^k (29.16') = $621'^k$
	2:	30.7^k (15.67) = $481'^k$		2:	28.5^k (15.67) = $447'^k$
SUM:		$27{,}232'^k$			$17{,}037'^k$

Building Weight: $15{,}354^k$

N-S Overturning Check: $15{,}354^k$ (63.16') = $969{,}758'^k$ >> $27{,}232'^k$ **O.K.**

Drift:

		Horizontal	Vertical	Horizontal	Resultant	Rotational		
Node	L/C	X in	Y in	Z in	in	rX rad	rY rad	rZ rad
1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	1 LOAD CAS	0.700	0.003	0.000	0.700	0.000	0.000	-0.004
5	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	1 LOAD CAS	0.692	-0.003	0.000	0.692	0.000	0.000	-0.004
7	1 LOAD CAS	1.379	0.004	0.000	1.379	0.000	0.000	-0.003
8	1 LOAD CAS	0.699	0.004	0.000	0.699	0.000	0.000	0.002
9	1 LOAD CAS	1.373	-0.004	0.000	1.373	0.000	0.000	-0.003

Structure1.std - Beam Relative Displacement Detail:

All Relative Displacement | Max Relative Displacements

Beam	L/C	Dist ft	x in	y in	z in	Resultant in
1	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000
		5.045	0.100	0.111	0.000	0.149
		10.090	0.114	0.127	0.000	0.171
		15.135	0.072	0.080	0.000	0.107
		20.180	0.000	0.000	0.000	0.000
2	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000
		7.500	-0.000	-0.126	0.000	0.126
		15.000	-0.000	-0.001	0.000	0.001
		22.500	-0.000	0.124	0.000	0.124
		30.000	0.000	0.000	0.000	0.000
3	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000
		7.500	0.000	-0.085	0.000	0.085
		15.000	-0.000	0.001	0.000	0.001
		22.500	0.000	0.087	0.000	0.087
		30.000	0.000	0.000	0.000	0.000
4	1 LOAD CAS	0.000	0.000	0.000	0.000	0.000
		3.375	-0.091	0.000	0.000	0.091
		6.750	-0.077	0.000	0.000	0.077
		10.125	-0.025	0.000	0.000	0.025
		13.500	0.000	0.000	0.000	0.000

Appendix B – Seismic Load

S_s = 0.20g	Site Class:	C
S_1 = 0.08g	Seismic Use Group:	I
S_{DS} = 0.16	Importance Factor:	1.0
S_{D1} = 0.09	Design Category:	B

Calculations based on the equivalent lateral force method ASCE7-05.

$$T_a = C_t h_n^x = 0.028(127')^{0.8} = 1.36\ sec. > 0.563 = T_s$$

$$C_s = \frac{S_{DS}}{R/I} = \frac{0.160}{3.0/1.0} = 0.053$$

$C_s > 0.044 S_{DS} I = 0.044(0.16)1.0 = 0.00704$

$C_s \leq \frac{S_{D1}}{T^2(R/I)} = \frac{0.09}{0.864^2(3.0/1.0)} = 0.0402$

$$\therefore C_s = 0.0402$$

Base Shear: $V = C_s * W = 0.0402(15{,}354^k) = 617^k$

Vertical Distribution: $F_x = C_{vx} V$ where: $C_{vx} = \frac{w_x h_x^k}{\sum_{i=1}^{9} w_x h_x^k}$ See Below: K= 1.64

Seismic Calculations

	Weight (kips)	Height (ft)	H^k	C_{vX}	F_x	Moment
1	1893.14	15.67'	91.18	0.00848	5.2 kips	81.9
2	1901.84	29.17'	252.6	0.0235	14.5 kips	422.9
3	1901.84	42.67'	471.4	0.04384	27.1 kips	1154
4	1901.84	56.17'	739.9	0.06881	42.5 kips	2384
5	1901.84	69.67'	1053.4	0.09797	60.4 kips	4211
6	1901.84	83.17'	1408.5	0.13099	80.8 kips	6721
7	1901.84	96.67'	1802.5	0.16763	103.4 kips	9998
8	1901.84	110.2'	2233.5	0.20771	128.2 kips	14119
9	1901.84	123.67	2699.7	0.25107	154.9 kips	19157
∑	**17107.8**		**10752.7**		**617.0 kips**	**58249'^{k}**

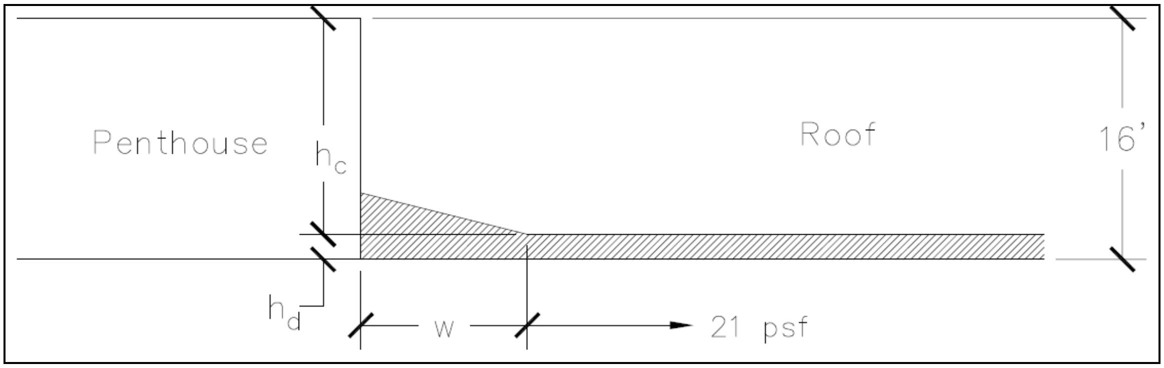
Appendix C – Snow Load

Flat Roof Snow Loading

$p_f = 0.7(C_e C_t I p_g) = 0.7(30) = 21$ psf roof load

$C_e = 1.0$ $C_t = 1.0$ $I = 1.0$ $p_g = 30$ psf

Snow Drift Considerations



$h_b = \frac{p_f}{\gamma}$; $\gamma = 0.13p_g + 14 = 18 \rightarrow 30\ pcf$

$w = 4h_d = 4(2.75') = 11'$ $\quad$ $snow\ drift\ load = {}^{1}/_{2}\,\gamma\, w\, h_d$

$From\ PCI\ Handbook - Fig. 3.10.4(b) \rightarrow h_d = 2.75'\ for\ l_u = 56'$

$\rightarrow h_d = 2.25'\ for\ l_u = 40'$

${}^{h_c}/_{h_d} = {}^{20}/_{30} = 0.667 \rightarrow p_{fdrift} = 30\ psf$

Total Roof Snow Loading (Span 46' maximum):

DL = 25 psf
LL = 20 psf
TL = 45 psf

Appendix D – Alternate System Design

Dead Load Calculations

Precast	Weight (plf)	Length (ft)	Qty/fl.	Total
15LDT26	57	46	20	52.44 kip
	57	30	8	13.68 kip
??LDT??				0.00 kip
34IT32	800	30	14	336.00 kip
26LB28	450	30	12	162.00 kip

4HC6	195	13	11		**27.89 kip**
12RB24	300	30	2		**18.00 kip**
				SUM	**610.01 kip**
Roof					
Member	Weight (psf)	Area (sf)	Qty/fl.		**Total**
Steel Joist (RAM Takeoff)					**37.08 kip**
Stories					9
Total Building Weight					4,917 kip

Strand Pattern Designation

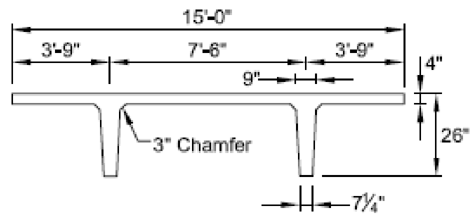
208 - D 1
- No. of strand (20)
- S = straight D = depressed
- No. of depression points
- Diameter of strand in 16ths

Because these units are pretopped and are typically used in parking structures, safe loads shown do not include any superimposed dead loads. Loads shown are live load. Long-time cambers do not include live load.

Key
194 – Safe superimposed service load, psf
0.2 – Estimated camber at erection, in.
0.4 – Estimated long-time camber, in.

PRETOPPED DOUBLE TEE

15′-0″ x 26″



$f'_c = 5{,}000$ psi
$f_{pu} = 270{,}000$ psi
Special Strand

Section Properties

		Normal Weight		Lightweight	
A	=	1078	in.^{2}	1078	in.^{2}
I	=	53280	in.^{4}	53280	in.^{4}
y_b	=	19.82	in.	19.82	in.
y_t	=	6.18	in.	6.18	in.
S_b	=	2688	in.^{3}	2688	in.^{3}
S_t	=	8618	in.^{3}	8618	in.^{3}
wt	=	1122	plf	861	plf
DL	=	75	psf	57	psf
V/S	=	2.38	in.	2.38	in.

15DT26

Table of safe superimposed service load (psf) and cambers (in.) **Normal Weight – No Topping**

Strand Pattern	y_e(end) in. y_e(center) in.	Span, ft																									
		26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76
88-S	7.00 7.00	194 0.2 0.4	159 0.3 0.4	132 0.3 0.4	109 0.3 0.4	90 0.3 0.4	74 0.3 0.4	61 0.3 0.4	49 0.2 0.3	40 0.2 0.2	31 0.1 0.1																
128-S	5.83 5.83					175 0.7 0.9	150 0.7 1.0	129 0.8 1.0	111 0.8 1.1	95 0.8 1.1	82 0.8 1.1	70 0.8 1.0	60 0.7 1.0	51 0.7 0.9	43 0.6 0.8	36 0.5 0.6	29 0.3 0.4										
168-S	5.69 5.69							191 1.2 1.6	167 1.2 1.7	146 1.3 1.7	128 1.3 1.8	112 1.4 1.9	99 1.4 1.9	87 1.4 1.9	76 1.4 1.9	66 1.4 1.9	58 1.3 1.8	50 1.2 1.6	43 1.1 1.4	37 0.9 1.2	31 0.7 0.9	26 0.5 0.6					
208-S	5.95 5.95									192 1.6 2.3	170 1.7 2.4	150 1.8 2.5	134 1.9 2.6	119 1.9 2.6	105 2.0 2.7	94 2.0 2.7	83 2.0 2.7	74 2.0 2.7	65 2.0 2.7	58 1.9 2.6	51 1.8 2.4	44 1.6 2.2	38 1.5 1.9	31 1.2 1.6	26 1.0 1.2		
248-S	6.42 6.42																							45 2.2 2.9	39 2.0 2.7	33 1.8 2.3	27 1.5 1.9

15LDT26

Table of safe superimposed service load (psf) and cambers (in.) **Lightweight – No Topping**

Strand Pattern	y_e(end) in. y_e(center) in.	Span, ft																									
		28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78
88-S	7.00 7.00	172 0.5 0.6	145 0.5 0.7	122 0.5 0.7	103 0.5 0.8	87 0.6 0.8	74 0.6 0.8	63 0.6 0.8	53 0.5 0.7	44 0.5 0.7	37 0.4 0.6	30 0.4 0.5															
128-S	5.83 5.83				188 1.1 1.5	163 1.2 1.6	142 1.3 1.7	124 1.3 1.8	109 1.4 1.9	95 1.5 2.0	83 1.5 2.0	73 1.5 2.1	64 1.5 2.1	56 1.5 2.0	49 1.4 2.0	42 1.4 1.8	36 1.2 1.7	31 1.1 1.4	27 0.9 1.2								
168-S	5.69 5.69							180 2.0 2.7	159 2.1 2.9	141 2.3 3.0	126 2.4 3.2	112 2.5 3.3	100 2.6 3.4	89 2.6 3.4	79 2.7 3.5	71 2.7 3.5	63 2.7 3.5	56 2.6 3.5	50 2.6 3.4	44 2.5 3.3	39 2.4 3.2	34 2.2 2.9	30 1.9 2.5	26 1.6 2.1			
208-S	5.95 5.95													119 3.4 4.6	107 3.6 4.8	96 3.7 4.9	86 3.7 5.0	77 3.8 5.0	69 3.8 5.0	61 3.8 4.9	55 3.8 4.9	49 3.7 4.8	44 3.6 4.7	40 3.5 4.5	36 3.3 4.3	32 3.1 4.0	28 2.8 3.6
248-S	6.42 6.42																										

Strength is based on strain compatibility; bottom tension is limited to $12\sqrt{f'_c}$; see pages 2–7 through 2–10 for explanation.
Shaded values require release strengths higher than 3500 psi.

Strand Pattern Designation
76-S

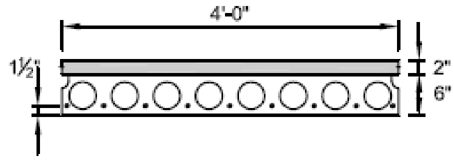
- S = straight
- Diameter of strand in 16ths
- No. of Strand (7)

Safe loads shown include dead load of 10 psf for untopped members and 15 psf for topped members. Remainder is live load. Long-time cambers include superimposed dead load but do not include live load.

Capacity of sections of other configurations are similar. For precise values, see local hollow-core manufacturer.

Key
444 – Safe superimposed service load, psf
0.1 – Estimated camber at erection, in.
0.2 – Estimated long-time camber, in.

HOLLOW-CORE
4′-0″ x 6″
Normal Weight Concrete



f'_c = 5,000 psi
f_{pu} = 270,000 psi

Section Properties

		Untopped		Topped	
A	=	187	in.^{2}	283	in.^{2}
I	=	763	in.^{4}	1,640	in.^{4}
y_b	=	3.00	in.	4.14	in.
y_t	=	3.00	in.	3.86	in.
S_b	=	254	in.^{3}	396	in.^{3}
S_t	=	254	in.^{3}	425	in.^{3}
wt	=	195	plf	295	plf
DL	=	49	psf	74	psf
V/S	=	1.73	in.		

4HC6

Table of safe superimposed service load (psf) and cambers (in.) — **No Topping**

Strand Designation Code	Span, ft																				
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
66-S	444	382	333	282	238	203	175	151	131	114	100	88	77	68	59	52	46	40	33	28	
	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.0	−0.1	−0.2	−0.4	−0.5	−0.7		
	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.0	−0.1	−0.3	−0.5	−0.7	−0.9	−1.2	−1.5	−1.9	
76-S		445	388	328	278	238	205	178	155	136	120	105	93	82	73	65	57	49	42	36	31
		0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.1	0.1	0.0	−0.1	−0.3	−0.4	−0.6
		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.1	0.0	−0.1	−0.2	−0.4	−0.7	−0.9	−1.2	−1.6	−2.0
96-S		466	421	386	338	292	263	229	201	177	157	139	124	110	99	88	78	68	60	53	46
		0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.3	0.3	0.1	0.0	−0.1
		0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.5	0.4	0.3	0.2	0.1	−0.1	−0.3	−0.6	−0.9	−1.3
87-S		478	433	398	362	322	290	264	240	212	188	167	149	134	119	107	95	85	76	68	60
		0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.7	0.7	0.6	0.5	0.4	0.3
		0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.7	0.7	0.6	0.5	0.3	0.2	0.0	−0.3	−0.6
97-S		490	445	407	374	346	311	276	242	220	203	186	166	148	133	119	107	96	86	78	70
		0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.8	0.7	0.6
		0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.0	0.9	0.9	0.8	0.7	0.5	0.3	0.1	−0.2

4HC6 + 2

Table of safe superimposed service load (psf) and cambers (in.) — **2 in. Normal Weight Topping**

Strand Designation Code	Span, ft																		
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
66-S	470	396	335	285	244	210	182	158	136	113	93	75	59	46	34				
	0.2	0.2	0.2	0.2	0.2	02	0.2	0.2	0.2	0.2	0.1	0.1	0.0	−0.1	−0.2				
	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.0	−0.1	−0.2	−0.3	−0.5	−0.7	−0.9	−1.2				
76-S		461	391	334	287	248	216	188	163	137	115	95	78	63	50	38	27		
		0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.1	0.1	−0.0	−0.1	−0.3		
		0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.0	−0.2	−0.3	−0.5	−0.7	−0.9	−1.2	−1.5		
96-S			473	424	367	319	279	245	216	186	160	137	116	98	82	68	55	43	33
			0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.3	0.3	0.1	0.0	−0.1
			0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.2	0.1	−0.1	−0.3	−0.5	−0.7	−1.0	−1.4	−1.7
87-S			485	446	415	377	331	292	258	224	195	169	147	127	109	94	80	67	55
			0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.7	0.7	0.6	0.5	0.4	0.3
			0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.5	0.4	0.4	0.2	0.1	−0.1	−0.3	−0.5	−0.8	−1.2
97-S			494	455	421	394	357	327	288	251	219	192	168	146	127	110	95	82	70
			0.5	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.8	0.7	0.6
			0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.5	0.4	0.2	0.0	−0.2	−0.5	−0.8

Strength is based on strain compatibility; bottom tension is limited to $7.5\sqrt{f'_c}$; see pages 2–7 through 2–10 for explanation.

RECTANGULAR BEAMS

Normal Weight Concrete

f'_c = 5,000 psi
f_{pu} = 270,000 psi
½ in. diameter
low-relaxation strand

Designation	b in.	h in.	A in.[2]	I in.[4]	y_b in.	S in.[3]	wt plf
	Section Properties						
12RB16	12	16	192	4,096	8.00	512	200
12RB20	12	20	240	8,000	10.00	800	250
12RB24	12	24	288	13,824	12.00	1152	300
12RB28	12	28	336	21,952	14.00	1568	350
12RB32	12	32	384	32,768	16.00	2048	400
12RB36	12	36	432	46,656	18.00	2592	450
16RB24	16	24	384	18,432	12.00	1536	400
16RB28	16	28	448	29,269	14.00	2091	467
16RB32	16	32	512	43,691	16.00	2731	533
16RB36	16	36	576	62,208	18.00	3456	600
16RB40	16	40	640	85,333	20.00	4267	667

1. Check local area for availability of other sizes.
2. Safe loads shown include 50% superimposed dead load and 50% live load. 800 psi top tension has been allowed, therefore, additional top reinforcement is required.
3. Safe loads can be significantly increased by use of structural composite topping.

Key

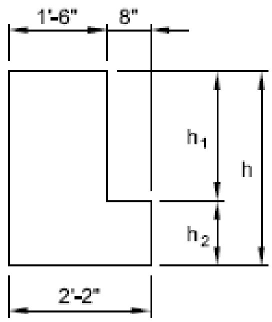
3553 – Safe superimposed service load, plf.
0.4 – Estimated camber at erection, in.
0.2 – Estimated long-time camber, in.

Table of safe superimposed service load (plf) and cambers (in.)

Desig-nation	No. Strand	y_s(end) in. y_s(center) in.	16	18	20	22	24	26	28	30	32	34	36	40	42	44	46	48	50	52
			Span, ft																	
12RB16	58-S	3.00	3553	2772	2212	1799	1484	1239	1045											
		3.00	0.4	0.5	0.6	0.8	0.9	1.0	1.1											
			0.2	0.2	0.2	0.2	0.3	0.3	0.3											
12RB20	88-S	3.00	6163	4825	3867	3159	2620	2201	1868	1600	1380	1198	1046							
		3.00	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.3	1.4	1.5	1.7							
			0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5							
12RB24	108-S	3.60	8950	7018	5636	4613	3835	3230	2749	2362	2045	1782	1562	1375	1216	1079	960			
		3.60	0.4	0.4	0.5	0.7	0.8	0.9	1.0	1.1	1.3	1.4	1.5	1.6	1.8	1.9	2.0			
			0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.6			
12RB28	128-S	4.00		9781	7866	6448	5370	4532	3866	3329	2890	2525	2220	1962	1741	1552	1387	1244	1118	1006
		4.00		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.3	1.4	1.5	1.7	1.8	1.9	2.0	2.1	2.2
				0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8
12RB32	138-S	4.77				8320	6936	5859	5005	4316	3752	3284	2892	2561	2278	2034	1823	1639	1477	1334
		4.77				0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9
						0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6
12RB36	158-S	5.07					9015	7624	6521	5631	4902	4298	3792	3364	2999	2684	2411	2173	1964	1780
		5.07					0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
							0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7
16RB24	138-S	3.54		9397	7547	6177	5136	4325	3682	3164	2739	2387	2092	1843	1629	1446	1287	1149	1027	
		3.54		0.4	0.5	0.6	0.8	0.9	1.0	1.1	1.2	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	
				0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.5	
16RB28	148-S	3.71				8730	7272	6137	5237	4510	3915	3423	3010	2660	2362	2105	1883	1688	1518	1368
		3.71				0.5	0.6	0.7	0.8	0.9	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.9
						0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
16RB32	188-S	4.67					9340	7891	6741	5813	5054	4425	3897	3451	3070	2742	2458	2210	1992	1800
		4.67					0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.5	1.6	1.7	1.8	1.9	2.0
							0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7
16RB36	208-S	5.40						9946	5805	7343	6391	5603	4942	4383	3905	3494	3138	2827	2555	2314
		5.40						0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
								0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6
16RB40	228-S	6.00								9122	7949	6976	6160	5470	4881	4374	3935	3552	3215	2918
		6.00								0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7
										0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6

L-BEAMS

Normal Weight Concrete



f'_c = 5,000 psi
f_{pu} = 270,000 psi
½ in. diameter
low-relaxation strand

Section Properties								
Designation	h in.	h_1/h_2 in./in.	A in.^{2}	I in.^{4}	y_b in.	S_b in.^{3}	S_t in.^{3}	wt plf
26LB20	20	12/8	424	14,298	9.09	1,573	1,311	442
26LB24	24	12/12	528	24,716	10.91	2,265	1,888	550
26LB28	28	16/12	600	39,241	12.72	3,085	2,568	625
26LB32	32	20/12	672	58,533	14.57	4,017	3,358	700
26LB36	36	24/12	744	83,176	16.45	5,056	4,255	775
26LB40	40	24/16	848	114,381	18.19	6,288	5,244	883
26LB44	44	28/16	920	152,104	20.05	7,586	6,351	958
26LB48	48	32/16	992	197,159	21.94	8,986	7,566	1,033
26LB52	52	36/16	1,064	250,126	23.83	10,496	8,879	1,108
26LB56	56	40/16	1,136	311,586	25.75	12,100	10,300	1,183
26LB60	60	44/16	1,208	382,118	27.67	13,810	11,819	1,258

1. Check local area for availability of other sizes.
2. Safe loads shown include 50% superimposed dead load and 50% live load. 800 psi top tension has been allowed, therefore, additional top reinforcement is required.
3. Safe loads can be significantly increased by use of structural composite topping.

Key

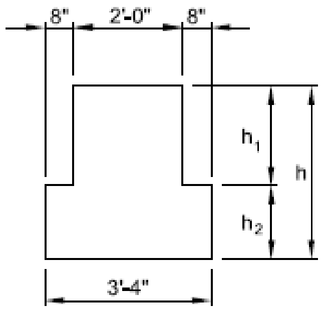
9672 – Safe superimposed service load, plf.
0.4 – Estimated camber at erection, in.
0.2 – Estimated long-time camber, in.

Table of safe superimposed service load (plf) and cambers (in.)

Designation	No. Strand	y_s(end) in. y_s(center) in.	Span, ft 16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
26LB20	158-S	2.67	9672	7563	6054	4938	4089	3428	2903	2480	2134	1847	1607	1403	1230	1080	950			
		2.67	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.2	1.4	1.5	1.6	1.7	1.8	1.9	1.9			
			0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.6			
26LB24	158-S	2.67			9165	7493	6221	5231	4445	3811	3293	2863	2503	2198	1938	1714	1520	1350	1202	1070
		2.67			0.5	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.5	1.5
					0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.0
26LB28	188-S	3.33					8437	7170	6056	5207	4511	3935	3452	3043	2694	2394	2134	1907	1707	1532
		3.33					0.6	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6
							0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2
26LB32	218-S	4.00						9265	7906	6809	5912	5169	4545	4018	3568	3180	2844	2551	2294	2067
		4.00						0.6	0.7	0.7	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.4	1.5	1.5
								0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3
26LB36	248-S	4.50								8722	7585	6643	5854	5186	4615	4125	3699	3328	3002	2715
		4.50								0.7	0.8	0.9	0.9	1.0	1.1	1.2	1.3	1.3	1.4	1.5
										0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
26LB40	278-S	5.11									9372	8216	7246	6426	5726	5123	4601	4145	3745	3392
		5.11									0.7	0.8	0.9	0.9	1.0	1.1	1.2	1.2	1.3	1.4
											0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4
26LB44	288-S	5.29											8992	7986	7127	6388	5748	5189	4698	4266
		5.29											0.8	0.8	0.9	1.0	1.0	1.1	1.2	1.2
													0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
26LB48	328-S	5.75												9635	8609	7726	6961	6294	5708	5191
		5.75												0.8	0.9	1.0	1.0	1.1	1.2	1.3
														0.3	0.4	0.4	0.4	0.4	0.4	0.4
26LB52	358-S	6.29														9137	8241	7459	6773	6167
		6.29														0.9	1.0	1.1	1.1	1.2
																0.4	0.4	0.4	0.4	0.5
26LB56	378-S	7.00															9539	8641	7853	7158
		7.00															0.9	1.0	1.1	1.1
																	0.4	0.4	0.4	0.4
26LB60	388-S	7.68																9904	9008	8217
		7.68																0.9	0.9	1.0
																		0.3	0.3	0.3

INVERTED TEE BEAMS

Normal Weight Concrete



f'_c = 5,000 psi
f_{pu} = 270,000 psi
½ in. diameter
low-relaxation strand

Section Properties								
Designation	h in.	h_1/h_2 in./in.	A in.^{2}	I in.^{4}	y_b in.	S_b in.^{3}	S_t in.^{3}	wt plf
40IT20	20	12/8	608	20,321	8.74	2,325	1,805	633
40IT24	24	12/12	768	35,136	10.50	3,346	2,603	800
40IT28	28	16/12	864	55,765	12.22	4,563	3,534	900
40IT32	32	20/12	960	83,200	14.00	5,943	4,622	1,000
40IT36	36	24/12	1,056	118,237	15.82	7,474	5,859	1,100
40IT40	40	24/16	1,216	162,564	17.47	9,305	7,215	1,267
40IT44	44	28/16	1,312	216,215	19.27	11,220	8,743	1,367
40IT48	48	32/16	1,408	280,266	21.09	13,289	10,415	1,467
40IT52	52	36/16	1,504	355,503	22.94	15,497	12,233	1,567

1. Check local area for availability of other sizes.
2. Safe loads shown include 50% superimposed dead load and 50% live load. 800 psi top tension has been allowed, therefore, additional top reinforcement is required.
3. Safe loads can be significantly increased by use of structural composite topping.

Key

8427 – Safe superimposed service load, plf.
0.5 – Estimated camber at erection, in.
0.2 – Estimated long-time camber, in.

Table of safe superimposed service load (plf) and cambers (in.)

Designation	No. Strand	y_s(end) in. / y_s(center) in.	Span, ft																	
			16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
40IT20	188-S	2.22			8427	6870	5686	4764	4033	3444	2961	2561	2225	1942	1699	1491	1310	1153	1014	
		2.22			0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.5	
					0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.0	–0.1	
40IT24	228-S	2.67				9994	8288	6961	5907	5057	4362	3786	3303	2894	2545	2244	1984	1757	1558	1382
		2.67				0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.4	1.4	1.4	1.5	1.5
						0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.1	0.0
40IT28	268-S	3.08						9672	8233	7073	6123	5336	4676	4118	3641	3231	2875	2565	2293	2052
		3.08						0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.5
								0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3
40IT32	308-S	3.33								9527	8269	7227	6354	5615	4984	4441	3970	3560	3199	2881
		3.33								0.8	0.8	0.9	1.0	1.1	1.2	1.3	1.3	1.4	1.5	1.5
										0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
40IT36	328-S	3.50										9410	8292	7345	6537	5842	5239	4713	4252	3844
		3.50										0.8	0.9	1.0	1.1	1.1	1.2	1.3	1.4	1.4
												0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.3	0.3
40IT40	388-S	4.32												8947	7969	7127	6398	5761	5202	4709
		4.32												0.9	1.0	1.1	1.2	1.2	1.3	1.4
														0.4	0.4	0.4	0.4	0.4	0.4	0.4
40IT44	408-S	4.40													9950	8916	8020	7238	6552	5946
		4.40													0.9	1.0	1.1	1.1	1.2	1.3
															0.3	0.4	0.4	0.4	0.4	0.4
40IT48	448-S	4.87															9652	8724	7910	7191
		4.87															1.0	1.1	1.2	1.2
																	0.4	0.4	0.4	0.4
40IT52	468-S	5.05																	9494	8645
		5.05																	1.1	1.1
																			0.4	0.4

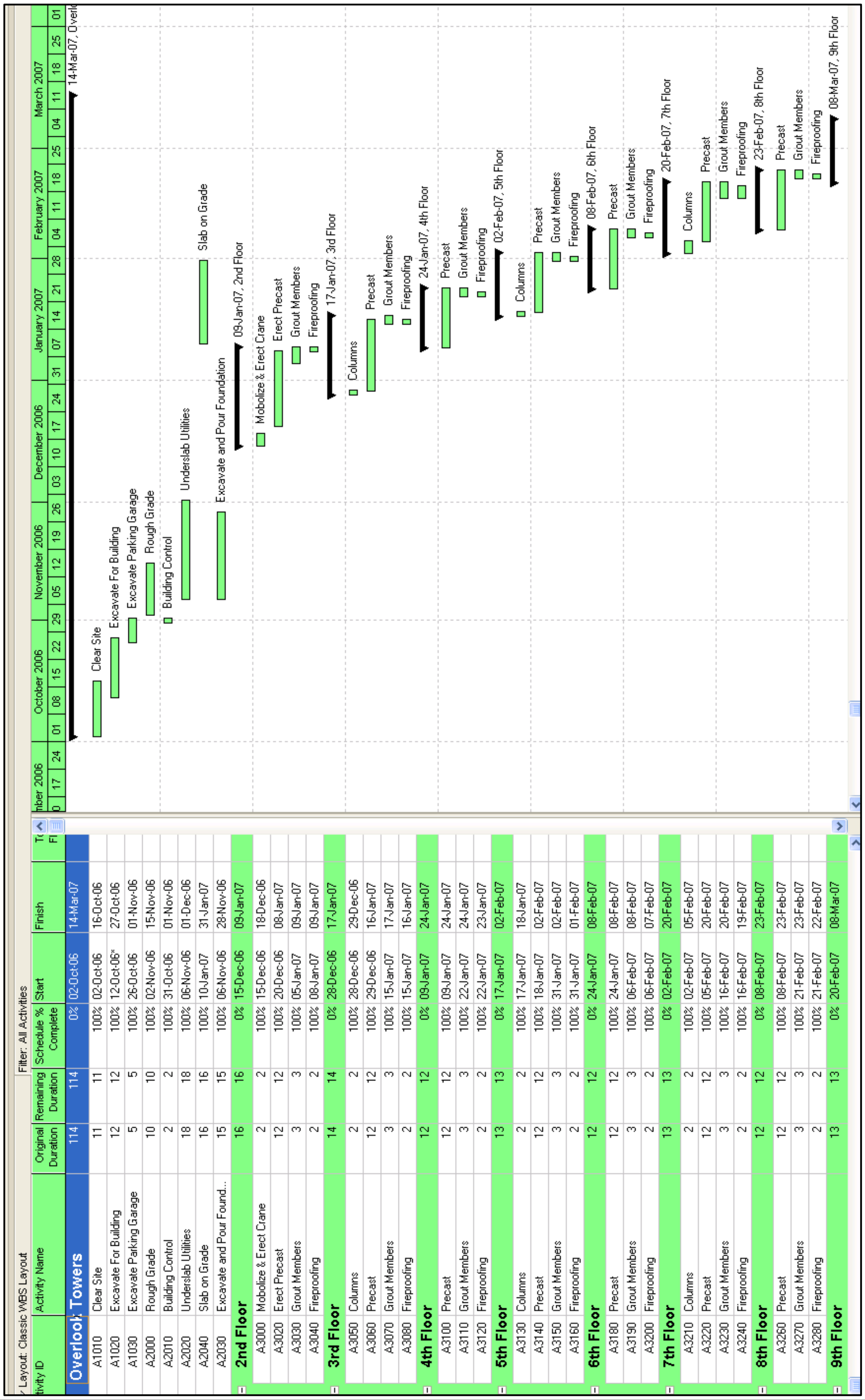
Estimate Detail - Overlook Towers

Detail - Without Taxes and Insurance

Estimator :
Project Size : 0

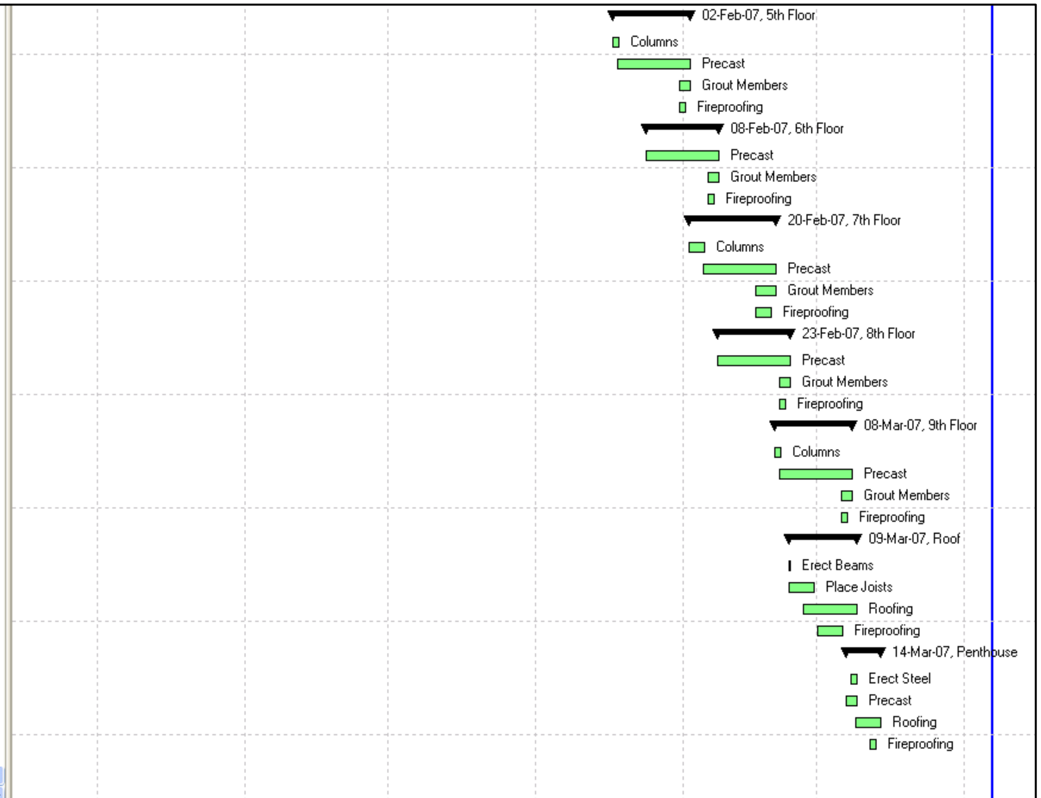
ItemCode	Description	Quantity	UM	Lab.Unit	Mat.Unit	Eqp.Unit	Sub.Unit	Eqp.Rent.Unit	Temp.Mat.Unit	Other Unit	Tot.UnitCost	TotalCost
02316.002	MACHINE FINE GRADE FLOOR	24,200.00	SQFT	0.2642		0.015					0.279	6,756.64
02316.023	CRUSHED STONE SLAB FILL	298.77	CUYD	16.1864	16.350						32.536	9,720.75
03110.520	COLUMN FOOTING EDGE FORMS	3,833.55	SQFT	4.4257	1.039						5.464	20,948.07
03110.701	FLOOR EDGE FORMS	600.00	LNFT	3.0729	0.851						3.924	2,354.58
03150.650	SCREEDS FOR SLAB	2,904.00	LNFT	0.9219	0.320						1.242	3,606.48
03150.652	EXPANSION JOINT	30.00	LNFT	1.7199	0.703						2.422	72.67
03210.109	SOG REBAR	701.80	CWT	32.3636	26.750						59.114	41,485.92
03310.150	**CONC IN CONTINUOUS FOOTING**		****									
03310.151	3000 PSI DIRECT	59.37	CUYD	11.0090	55.000						66.009	3,918.98
03315.971	* CONTINUOUS FOOTING LENGTH *	458.00	LNFT									
03310.150	**CONC IN CONTINUOUS FOOTING**		****									
03310.152	3000 PSI W/CRANE	0.94	CUYD	13.9420	55.000						68.942	64.68
03310.200	**CONC IN COLUMN FOOTING**		****									
03310.201	3000 PSI DIRECT	320.45	CUYD	11.0090	55.000						66.009	21,152.43
03315.972	* NO. OF COLUMN FOOTINGS *	35.00	EACH									
03310.350	**CONC IN SLAB ON GRADE**		****									
03310.375	4000 PSI DIRECT	373.46	CUYD	11.0090	56.000						67.009	25,024.97
03315.976	* SOG AREA *	24,200.00	SQFT									
03350.148	HAND TROWEL FINISH	24,200.00	SQFT	0.3304							0.330	7,995.68
03390.010	PROTECT & CURE	24,200.00	SQFT	0.1102	0.019						0.129	3,131.48
03410.120	PRECAST BEAM	8,234.00	LNFT	17.6840	108.800						126.484	1,041,469.26
03410.120	PRECAST BEAM	14.00	LNFT	17.6840	108.800						126.484	1,770.78
03410.105	PC HOLLOW CORE PLANK	3,440.00	SQFT	1.1228	3.584						4.707	16,191.39
03410.115	PC DOUBLE TT SLAB	172,000.00	SQFT	1.2632	6.912						8.175	1,406,134.40
05129.121	STEEL COLUMNS		****									
05129.122	I SHAPES	3,579.94	CWT	28.7300	35.000	5.000					68.730	246,049.28
05129.501	SHOP PAINT		****									
05129.502	RED OXIDE	26,030.94	SQFT	0.0990	0.077						0.176	4,576.24
05129.990	*STRUCTURAL STEEL WEIGHT *	179.00	TONS									
05210.011	STEEL JOISTS, SERIES K	4.00	CWT	22.9840	27.500						50.484	201.94
05210.011	STEEL JOISTS, SERIES K	1,014.00	LNFT	22.9840	27.500						50.484	51,190.78
05210.013	STEEL JOISTS, SERIES LH	2,392.00	LNFT	20.8945	27.500						48.395	115,759.64
07260.012	6MIL VISQUEEN SUBGRADE PAPER	266.20	SQS	1.1018	2.900						4.002	1,065.28
07810.032	MINERAL FIBER FIREPROOFING	52,061.88	BDFT	0.1098	0.410						0.519	27,040.94
07810.111	FIREPROOF STEEL STRUCT	21,500.00	SQFT	1.0551	0.640						1.695	36,444.65
	Total Estimate											3,094,127.90

Proposed Construction Schedule:



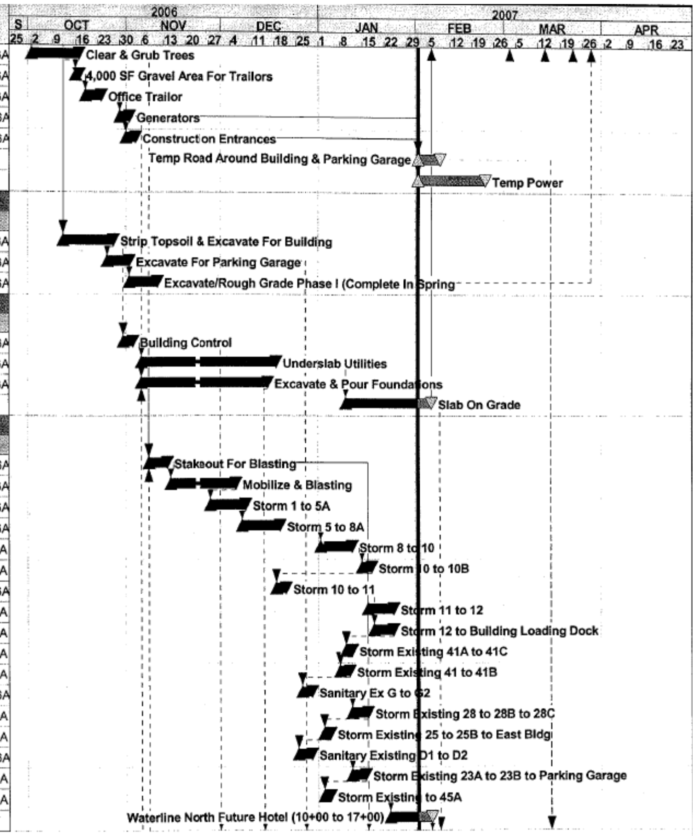
Activity ID	Activity Name	Original Duration	Remaining Duration	Schedule % Complete	Start	Finish
Overlook Towers		114	114	0%	02-Oct-06	14-Mar-07
A1010	Clear Site	11	11	100%	02-Oct-06	16-Oct-06
A1020	Excavate For Building	12	12	100%	12-Oct-06*	27-Oct-06
A1030	Excavate Parking Garage	5	5	100%	26-Oct-06	01-Nov-06
A2000	Rough Grade	10	10	100%	02-Nov-06	15-Nov-06
A2010	Building Control	2	2	100%	31-Oct-06	01-Nov-06
A2020	Underslab Utilities	18	18	100%	06-Nov-06	01-Dec-06
A2040	Slab on Grade	16	16	100%	10-Jan-07	31-Jan-07
A2030	Excavate and Pour Found...	15	15	100%	06-Nov-06	28-Nov-06
2nd Floor		16	16	0%	15-Dec-06	09-Jan-07
A3000	Mobilize & Erect Crane	2	2	100%	15-Dec-06	18-Dec-06
A3020	Erect Precast	12	12	100%	20-Dec-06	08-Jan-07
A3030	Grout Members	3	3	100%	05-Jan-07	09-Jan-07
A3040	Fireproofing	2	2	100%	08-Jan-07	09-Jan-07
3rd Floor		14	14	0%	28-Dec-06	17-Jan-07
A3050	Columns	2	2	100%	28-Dec-06	29-Dec-06
A3060	Precast	12	12	100%	29-Dec-06	16-Jan-07
A3070	Grout Members	3	3	100%	15-Jan-07	17-Jan-07
A3080	Fireproofing	2	2	100%	15-Jan-07	16-Jan-07
4th Floor		12	12	0%	09-Jan-07	24-Jan-07
A3100	Precast	12	12	100%	09-Jan-07	24-Jan-07
A3110	Grout Members	3	3	100%	22-Jan-07	24-Jan-07
A3120	Fireproofing	2	2	100%	22-Jan-07	23-Jan-07
5th Floor		13	13	0%	17-Jan-07	02-Feb-07
A3130	Columns	2	2	100%	17-Jan-07	18-Jan-07
A3140	Precast	12	12	100%	18-Jan-07	02-Feb-07
A3150	Grout Members	3	3	100%	31-Jan-07	02-Feb-07
A3160	Fireproofing	2	2	100%	31-Jan-07	01-Feb-07
6th Floor		12	12	0%	24-Jan-07	08-Feb-07
A3180	Precast	12	12	100%	24-Jan-07	08-Feb-07
A3190	Grout Members	3	3	100%	06-Feb-07	08-Feb-07
A3200	Fireproofing	2	2	100%	06-Feb-07	07-Feb-07
7th Floor		13	13	0%	02-Feb-07	20-Feb-07
A3210	Columns	2	2	100%	02-Feb-07	05-Feb-07
A3220	Precast	12	12	100%	05-Feb-07	20-Feb-07
A3230	Grout Members	3	3	100%	16-Feb-07	20-Feb-07
A3240	Fireproofing	2	2	100%	16-Feb-07	19-Feb-07
8th Floor		12	12	0%	08-Feb-07	23-Feb-07
A3260	Precast	12	12	100%	08-Feb-07	23-Feb-07
A3270	Grout Members	3	3	100%	21-Feb-07	23-Feb-07
A3280	Fireproofing	2	2	100%	21-Feb-07	22-Feb-07
9th Floor		13	13	0%	20-Feb-07	08-Mar-07

5th Floor		13	13	0%	17-Jan-07	02-Feb-07
A3130	Columns	2	2	100%	17-Jan-07	18-Jan-07
A3140	Precast	12	12	100%	18-Jan-07	02-Feb-07
A3150	Grout Members	3	3	100%	31-Jan-07	02-Feb-07
A3160	Fireproofing	2	2	100%	31-Jan-07	01-Feb-07
6th Floor		12	12	0%	24-Jan-07	08-Feb-07
A3180	Precast	12	12	100%	24-Jan-07	08-Feb-07
A3190	Grout Members	3	3	100%	06-Feb-07	08-Feb-07
A3200	Fireproofing	2	2	100%	06-Feb-07	07-Feb-07
7th Floor		13	13	0%	02-Feb-07	20-Feb-07
A3210	Columns	2	2	100%	02-Feb-07	05-Feb-07
A3220	Precast	12	12	100%	05-Feb-07	20-Feb-07
A3230	Grout Members	3	3	100%	16-Feb-07	20-Feb-07
A3240	Fireproofing	2	2	100%	16-Feb-07	19-Feb-07
8th Floor		12	12	0%	08-Feb-07	23-Feb-07
A3260	Precast	12	12	100%	08-Feb-07	23-Feb-07
A3270	Grout Members	3	3	100%	21-Feb-07	23-Feb-07
A3280	Fireproofing	2	2	100%	21-Feb-07	22-Feb-07
9th Floor		13	13	0%	20-Feb-07	08-Mar-07
A3290	Columns	2	2	100%	20-Feb-07	21-Feb-07
A3300	Precast	12	12	100%	21-Feb-07	08-Mar-07
A3310	Grout Members	3	3	100%	06-Mar-07	08-Mar-07
A3320	Fireproofing	2	2	100%	06-Mar-07	07-Mar-07
Roof		11	11	0%	23-Feb-07	09-Mar-07
A3330	Erect Beams	1	1	100%	23-Feb-07	23-Feb-07
A3340	Place Joists	4	4	100%	23-Feb-07	28-Feb-07
A3350	Roofing	10	10	100%	26-Feb-07	09-Mar-07
A3400	Fireproofing	4	4	100%	01-Mar-07	06-Mar-07
Penthouse		6	6	0%	07-Mar-07	14-Mar-07
A3360	Erect Steel	2	2	100%	08-Mar-07	09-Mar-07
A3370	Precast	3	3	100%	07-Mar-07	09-Mar-07
A3380	Roofing	4	4	100%	09-Mar-07	14-Mar-07
A3390	Fireproofing	2	2	100%	12-Mar-07	13-Mar-07

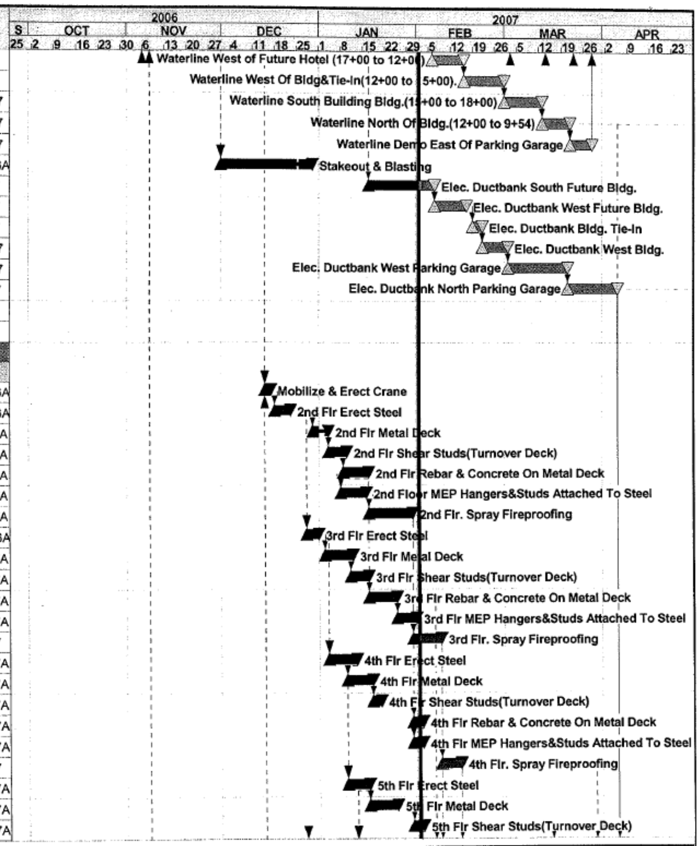


Portfolio: All Projects | User: admin | Data Date: 07-Apr-07 | Access Mode: Shared | Baseline: Current Project

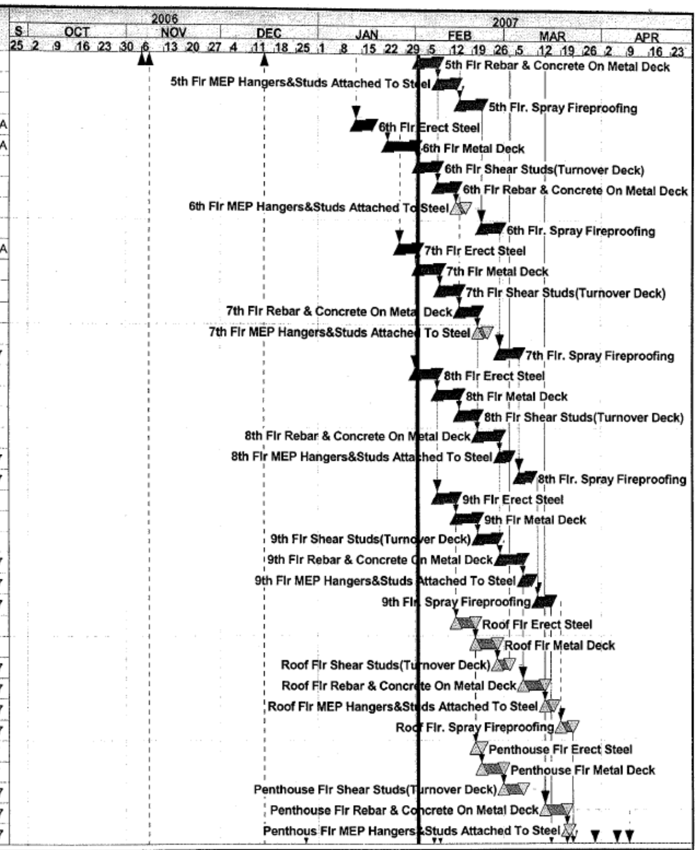
Activity ID	Activity Description	Orig Dur	Actual Duratio	Total Float	Early Start	Early Finish
130	Clear & Grub Trees	10	11		02OCT06A	16OCT06A
140	4,000 SF Gravel Area For Trailors	2	1		16OCT06A	16OCT06A
150	Office Trailor	3	3		19OCT06A	23OCT06A
160	Generators	5	3		30OCT06A	01NOV06A
170	Construction Entrances	3	3		01NOV06A	03NOV06A
180	Temp Road Around Building & Parking	5	0	24	02FEB07	08FEB07
190	Temp Power	15	0	14	02FEB07	22FEB07
EXCAVATION						
1000	Strip Topsoil & Excavate For Building	5	12		12OCT06A	27OCT06A
1010	Excavate For Parking Garage	5	5		26OCT06A	01NOV06A
1020	Excavate/Rough Grade Phase I (Complete	20	7		02NOV06A	10NOV06A
FOUNDATIONS						
2000	Building Control	2	3		31OCT06A	02NOV06A
2010	Underslab Utilities	15	29		06NOV06A	18DEC06A
2020	Excavate & Pour Foundations	15	28		06NOV06A	15DEC06A
2030	Slab On Grade	5	17	1	10JAN07A	05FEB07
SITE UTILITIES						
3000	Stakeout For Blasting	4	4		08NOV06A	13NOV06A
3005	Mobilize & Blasting	4	13		15NOV06A	05DEC06A
3010	Storm 1 to 5A	9	9		28NOV06A	08DEC06A
3020	Storm 5 to 8A	5	8		08DEC06A	19DEC06A
3030	Storm 8 to 10	10	7		02JAN07A	11JAN07A
3040	Storm 10 to 10B	3	3		15JAN07A	17JAN07A
3050	Storm 10 to 11	2	3		19DEC06A	21DEC06A
3055	Storm 11 to 12	2	6		17JAN07A	24JAN07A
3060	Storm 12 to Building Loading Dock	2	4		19JAN07A	24JAN07A
3070	Storm Existing 41A to 41C	2	2		10JAN07A	11JAN07A
3080	Storm Existing 41 to 41B	2	3		08JAN07A	10JAN07A
3090	Sanitary Ex G to G2	2	3		27DEC06A	29DEC06A
3100	Storm Existing 28 to 28B to 28C	2	3		12JAN07A	16JAN07A
3110	Storm Existing 25 to 25B to East Bldg	1	2		03JAN07A	04JAN07A
3120	Sanitary Existing D1 to D2	1	4		26DEC06A	29DEC06A
3130	Storm Existing 23A to 23B to Parking	2	2		12JAN07A	15JAN07A
3140	Storm Existing to 45A	1	2		03JAN07A	04JAN07A
3150	Waterline North Future Hotel (10+00 to	8	7	27	24JAN07A	05FEB07



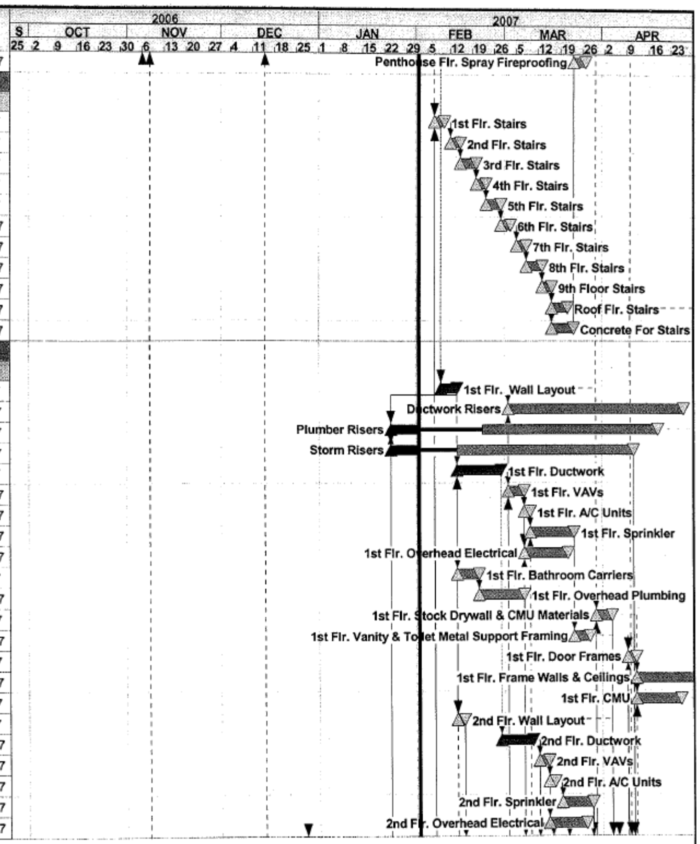
Activity ID	Activity Description	Orig Dur	Actual Duratio	Total Float	Early Start	Early Finish
3160	Waterline West of Future Hotel (17+00 to	8	0	27	06FEB07	15FEB07
3170	Waterline West Of Bldg&Tie-In(12+00 to	9	0	27	16FEB07	28FEB07
3180	Waterline South Building Bldg.(15+00 to	8	0	27	01MAR07	12MAR07
3190	Waterline North Of Bldg.(12+00 to 9+54)	7	0	27	13MAR07	21MAR07
3200	Waterline Demo East Of Parking Garage	5	0	188	22MAR07	28MAR07
3205	Stakeout & Blasting	5	20		01DEC06A	29DEC06A
3210	Elec. Ductbank South Future Bldg.	3	12	16	17JAN07A	06FEB07
3220	Elec. Ductbank West Future Bldg.	8	0	16	07FEB07	16FEB07
3230	Elec. Ductbank Bldg. Tie-In	3	0	16	19FEB07	21FEB07
3240	Elec. Ductbank West Bldg.	6	0	16	22FEB07	01MAR07
3250	Elec. Ductbank West Parking Garage	13	0	16	02MAR07	20MAR07
3260	Elec. Ductbank North Parking Garage	12	0	16	21MAR07	05APR07
3270	Pull Wire & Install Transformer	15	0	112	15JUN07	06JUL07
3280	Generator	5	0	112	09JUL07	13JUL07
STRUCTURAL STEEL & SLAB ON DECK						
4000	Mobilize & Erect Crane	2	1		15DEC06A	16DEC06A
4010	2nd Flr Erect Steel	4	5		18DEC06A	22DEC06A
4020	2nd Flr Metal Deck	5	1		30DEC06A	03JAN07A
4030	2nd Flr Shear Studs(Turnover Deck)	4	4		04JAN07A	09JAN07A
4040	2nd Flr Rebar & Concrete On Metal Deck	4	6		09JAN07A	16JAN07A
4045	2nd Floor MEP Hangers&Studs Attached To	3	6		08JAN07A	15JAN07A
4050	2nd Flr. Spray Fireproofing	5	10		17JAN07A	30JAN07A
4060	3rd Flr Erect Steel	4	2		28DEC06A	31DEC06A
4070	3rd Flr Metal Deck	5	7		03JAN07A	11JAN07A
4080	3rd Flr Shear Studs(Turnover Deck)	4	4		11JAN07A	16JAN07A
4090	3rd Flr Rebar & Concrete On Metal Deck	4	7		17JAN07A	25JAN07A
4095	3rd Flr MEP Hangers&Studs Attached To	3	4		26JAN07A	31JAN07A
4100	3rd Flr. Spray Fireproofing	5	2	-2	31JAN07A	08FEB07
4110	4th Flr Erect Steel	4	7		04JAN07A	12JAN07A
4120	4th Flr Metal Deck	5	6		10JAN07A	17JAN07A
4130	4th Flr Shear Studs(Turnover Deck)	4	2		18JAN07A	20JAN07A
4140	4th Flr Rebar & Concrete On Metal Deck	4	3		31JAN07A	02FEB07A
4150	4th Flr MEP Hangers&Studs Attached To	3	3		31JAN07A	02FEB07A
4160	4th Flr. Spray Fireproofing	4	0	-1	09FEB07	14FEB07
4170	5th Flr Erect Steel	4	5		10JAN07A	16JAN07A
4180	5th Flr Metal Deck	5	7		17JAN07A	25JAN07A
4190	5th Flr Shear Studs(Turnover Deck)	3	3		31JAN07A	02FEB07A



Activity ID	Activity Description	Orig Dur	Actual Duration	Total Float	Early Start	Early Finish
4200	5th Flr Rebar & Concrete On Metal Deck	4	0	0	02FEB07	07FEB07
4210	5th Flr MEP Hangers&Studs Attached To	4	0	0	08FEB07	13FEB07
4220	5th Flr. Spray Fireproofing	5	0	-1	15FEB07	21FEB07
4230	6th Flr Erect Steel	4	3		13JAN07A	17JAN07A
4240	6th Flr Metal Deck	5	7		23JAN07A	31JAN07A
4250	6th Flr Shear Studs(Turnover Deck)	4	0	0	02FEB07	07FEB07
4260	6th Flr Rebar & Concrete On Metal Deck	4	0	0	08FEB07	13FEB07
4270	6th Flr MEP Hangers&Studs Attached To	3	0	2	14FEB07	16FEB07
4280	6th Flr. Spray Fireproofing	4	0	-1	22FEB07	27FEB07
4290	7th Flr Erect Steel	4	4		27JAN07A	01FEB07A
4300	7th Flr Metal Deck	5	0	-1	02FEB07A	08FEB07
4310	7th Flr Shear Studs(Turnover Deck)	4	0	-1	09FEB07	14FEB07
4320	7th Flr Rebar & Concrete On Metal Deck	4	0	-1	15FEB07	20FEB07
4330	7th Flr MEP Hangers&Studs Attached To	3	0	1	21FEB07	23FEB07
4340	7th Flr. Spray Fireproofing	4	0	-1	28FEB07	05MAR07
4350	8th Flr Erect Steel	4	1	-1	01FEB07A	07FEB07
4360	8th Flr Metal Deck	5	0	-1	08FEB07	14FEB07
4370	8th Flr Shear Studs(Turnover Deck)	4	0	-1	15FEB07	20FEB07
4380	8th Flr Rebar & Concrete On Metal Deck	5	0	-1	21FEB07	27FEB07
4390	8th Flr MEP Hangers&Studs Attached To	3	0	0	28FEB07	02MAR07
4400	8th Flr. Spray Fireproofing	4	0	-1	06MAR07	09MAR07
4410	9th Flr Erect Steel	4	0	0	08FEB07	13FEB07
4420	9th Flr Metal Deck	5	0	0	14FEB07	20FEB07
4430	9th Flr Shear Studs(Turnover Deck)	4	0	0	21FEB07	26FEB07
4440	9th Flr Rebar & Concrete On Metal Deck	5	0	-1	28FEB07	06MAR07
4450	9th Flr MEP Hangers&Studs Attached To	3	0	-1	07MAR07	09MAR07
4460	9th Flr. Spray Fireproofing	4	0	-1	12MAR07	15MAR07
4470	Roof Flr Erect Steel	4	0	15	14FEB07	19FEB07
4480	Roof Flr Metal Deck	5	0	15	20FEB07	26FEB07
4490	Roof Flr Shear Studs(Turnover Deck)	4	0	15	27FEB07	02MAR07
4500	Roof Flr Rebar & Concrete On Metal Deck	5	0	13	07MAR07	13MAR07
4510	Roof Flr MEP Hangers&Studs Attached To	3	0	13	14MAR07	16MAR07
4520	Roof Flr. Spray Fireproofing	4	0	13	19MAR07	22MAR07
4530	Penthouse Flr Erect Steel	2	0	19	20FEB07	21FEB07
4540	Penthouse Flr Metal Deck	5	0	19	22FEB07	28FEB07
4550	Penthouse Flr Shear Studs(Turnover Deck)	4	0	19	01MAR07	06MAR07
4560	Penthouse Flr Rebar & Concrete On Metal	5	0	14	14MAR07	20MAR07
4570	Penthous Flr MEP Hangers&Studs Attached	1	0	14	21MAR07	21MAR07



Activity ID	Activity Description	Orig Dur	Actual Duration	Total Float	Early Start	Early Finish
4580	Penthouse Flr. Spray Fireproofing	2	0	13	23MAR07	26MAR07
METAL STAIRS						
5000	1st Flr. Stairs	3	0	85	07FEB07	09FEB07
5010	2nd Flr. Stairs	3	0	85	12FEB07	14FEB07
5020	3rd Flr. Stairs	3	0	85	15FEB07	19FEB07
5030	4th Flr. Stairs	3	0	85	20FEB07	22FEB07
5040	5th Flr. Stairs	3	0	85	23FEB07	27FEB07
5050	6th Flr. Stairs	3	0	85	28FEB07	02MAR07
5060	7th Flr. Stairs	3	0	85	05MAR07	07MAR07
5070	8th Flr. Stairs	3	0	85	08MAR07	12MAR07
5080	9th Floor Stairs	3	0	85	13MAR07	15MAR07
5090	Roof Flr. Stairs	3	0	87	16MAR07	20MAR07
5100	Concrete For Stairs	5	0	85	16MAR07	22MAR07
MEP ROUGH-IN & WALL FRAMING						
6000	1st Flr. Wall Layout	3	0	-2	09FEB07	13FEB07
6005	Ductwork Risers	40	0	46	02MAR07	26APR07
6008	Plumber Risers	40	7	52	24JAN07A	18APR07
6009	Storm Risers	40	7	50	24JAN07A	10APR07
6010	1st Flr. Ductwork	10	0	-2	14FEB07	27FEB07
6020	1st Flr. VAVs	3	0	50	02MAR07	06MAR07
6030	1st Flr. A/C Units	2	0	50	07MAR07	08MAR07
6040	1st Flr. Sprinkler	10	0	50	09MAR07	22MAR07
6050	1st Flr. Overhead Electrical	10	0	52	07MAR07	20MAR07
6060	1st Flr. Bathroom Carriers	5	0	7	14FEB07	20FEB07
6070	1st Flr. Overhead Plumbing	10	0	7	21FEB07	06MAR07
6080	1st Flr. Stock Drywall & CMU Materials	3	0	24	30MAR07	03APR07
6090	1st Flr. Vanity & Toilet Metal Support	3	0	50	23MAR07	27MAR07
6100	1st Flr. Door Frames	3	0	42	09APR07	11APR07
6110	1st Flr. Frame Walls & Ceilings	15	0	42	12APR07	02MAY07
6120	1st Flr. CMU	10	0	47	12APR07	25APR07
6130	2nd Flr. Wall Layout	2	0	6	14FEB07	15FEB07
6140	2nd Flr. Ductwork	8	0	-2	28FEB07	09MAR07
6150	2nd Flr. VAVs	3	0	67	12MAR07	14MAR07
6160	2nd Flr. A/C Units	2	0	67	15MAR07	16MAR07
6170	2nd Flr. Sprinkler	8	0	67	19MAR07	28MAR07
6180	2nd Flr. Overhead Electrical	8	0	69	15MAR07	26MAR07



Appendix E – Acoustics Calculations

Equation Used: $NR = TL + 10log\left(\frac{a}{S}\right)$ & $L2 = L1 - NR$

	Transmission Loss - Mechanical Room » Office Space					
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
AHU Sound Pressure (dB)	120	110	105	103	98	93
Gyp. Bd. & Studs	22	27	43	47	37	46
1 1/2" Sound Blanket	11	16	24	30	35	43
TL(wall construction)	66	86	134	154	144	178
Noise Reduction (NR)	73	95	147	169	160	194
Office Sound Pressure (dB)	47	15	0	0	0	0
Desired Pressure @ NC-35	53	45	41	37	34	33

			Sound Absorption Coefficients					
	Surface Area (sf)		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Ceiling (ACT)		9800	0.14	0.27	0.8	1.11	1.14	1.14
	Sα=		1372	2646	7840	10878	11172	11172
Floor (Carpet)		9800	0.02	0.06	0.14	0.37	0.6	0.65
	Sα=		196	588	1372	3626	5880	6370
Exterior Wall - Glass		1050	0.18	0.06	0.04	0.03	0.02	0.02
	Sα=		189	63	42	31.5	21	21
Exterior Wall - Gyp.		1290	0.29	0.1	0.05	0.05	0.07	0.09
	Sα=		374.1	129	64.5	64.5	90.3	116.1
	ΣSα=		2131.1	3426	9318.5	14600	17163.3	17679.1

	length	height			
wall	260	9	2340	sf	
	units	height	length	area	total area
glass	25	6	7	42	1050

	Transmission Loss - Floor » Floor					
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Office 1 Sound Pressure (dB)	66	72	77	74	68	60
Double-T	39	45	50	52	60	68
Ceiling Tile	0	0	0	0	0	0
TL(floor construction)	39	45	50	52	60	68
Noise Reduction (NR)	35	44	53	57	66	74
Office 2 Sound Pressure (dB)	31	28	24	17	2	(14)
Desired Pressure @ NC-35	53	45	41	37	34	33

			Sound Absorption Coefficients					
	Surface Area (sf)		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Ceiling (ACT)		1000	0.14	0.27	0.8	1.11	1.14	1.14
	Sα=		140	270	800	1110	1140	1140
Floor (Carpet)		1000	0.02	0.06	0.14	0.37	0.6	0.65
	Sα=		20	60	140	370	600	650
Exterior Wall - Glass		0	0.18	0.06	0.04	0.03	0.02	0.02
	Sα=		0	0	0	0	0	0
Exterior Wall - Gyp.		0	0.29	0.1	0.05	0.05	0.07	0.09
	Sα=		0	0	0	0	0	0
	Σ**S**α**=**		160	330	940	1480	1740	1790

	length	height			
wall	260	9	2340	sf	
	units	height	length	area	total area
glass	25	6	7	42	1050