Metropolis at Dadeland
Phase I

Mathew Nirenberg
Structural Option
5th Year AE Senior Thesis

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METROPOLIS
at Dadeland

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GENERAL INFORMATION

Location: Miami, FL
Size: 29 Stories / 26 Inhabited
433,221 S.F.
Cost: $44,750,000 (Phase I)
$85,550,000 (Full Project)
Use: Condominiums, Parking, Commercial

BUILDING TEAM

Owner: Terra Group (Developer)
CM: Turner Construction
Architect: Nichols Brosch Sandoval & Associates
Structural Engineer: Gopman Consulting Engineers
MEP Engineers: Florida Engineering Services
Civil Engineer: Fortin, Leavy, Skiles, Inc.
Geotechnical Engineer: Langan Engineering
Interior Design: Tessi Garcia & Associates

ARCHITECTURE

•No Building Taller South of Metropolis

•Stucco on CMU façade (non-structural)

•Setbacks indicate space usage

ELECTRICAL / LIGHTING

•Main Service: 75 kVA transformer

•3000 A Main Bus Duct

•20 Circuit panel in each residence

•Recessed Lighting and Sconces in Public Spaces

•No lighting pre-installed in private spaces

STRUCTURE

•Post-Tensioned Concrete Floors

•Reinforced Concrete Columns and Shear Walls

•Auger-Cast Piles and Concrete Mat Foundation

MECHANICAL

•Main Rooftop Unit to serve all public spaces

•Circulates Recycled and Outside Air

•Each living unit has individual Air Conditioner / Heat Pump

Final Thesis Design Report – Executive Summary

Over the course of the past academic year I have been analyzing the Metropolis at Dadeland, Phase I with a focus on the structural system. After an extensive investigation of the structure of the existing building and brief analysis of the construction climate in Miami, Florida I am proposing an alternate system for the building. Since all of the construction of large buildings currently underway in the greater Miami area is concrete with post-tensioned slabs, I chose to analyze whether or not a steel frame work in the given situation.

One thing that I tried to maintain was the existing floor plans as much as possible. This was only a minor challenge when setting up the gravity members of the building. However, this did create a severe lack of ability to locate braced frames in my proposed structure which ended up being its ultimate demise. The moment frames that I was forced to use a lot of were not able to sufficiently carry the lateral load from the 150mph wind that was impacting the building.

I also investigated the electrical system in a typical condominium unit and estimated the difference in cost between the two structural systems. The electrical system was impacted because I chose to add recessed lighting into the dropped ceilings that I introduced to the building due to the steel frame. The result was that I used two more circuits than the existing unit, but the feeder and main breaker were unaffected.

In the estimates the concrete structure ended up being noticeably cheaper than the steel and that is independent of the cost for the new circuit breakers and light fixtures that I have proposed to introduce to the space or the possible savings from reduction in foundation, which could alter the price in either direction depending on exact concrete savings or quality of the lighting fixtures used.

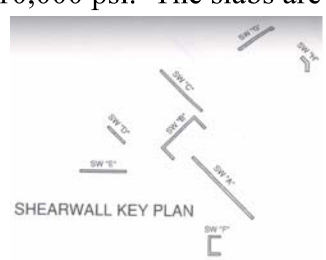
Overall, if the floor plans had been arranged to accommodate the grid of the steel frame, the steel could have worked as a structural system. But as is, there is not enough lateral stiffness to resist the loads. The concrete is also a cheaper system which makes the developer and future tenants happier. In conclusion, there is a reason that all of the current large construction projects in South Florida are concrete even if steel could work given favorable circumstances.

The Existing Building

The Metropolis at Dadeland towers are currently nearing the end of construction in suburban Miami, FL. The two 28 story towers are located in the heart of what is being planned as a second downtown for Miami.

The plan conceived by multiple developers is that there will be a number of these new, primarily residential, buildings in the same area. The land is adjacent to a large mall, other shops, public transportation, and highways.

The towers themselves hold commercial space on the ground floor, parking and lofts from floors 2 through 7, and condominiums from the 8^{th} through 26^{th} floor. At a total height of 313 feet, they are reinforced concrete structures with post-tensioned slabs, aside from the 22^{nd} floor which is normally reinforced and 22" thick. The concrete strengths on vertical elements range from 4,000 to 10,000 psi. The slabs are all 5,000 psi. There is an extensive array of shear walls to limit the lateral loads which are easily controlled by wind, since the building is in a 150 mph wind region.



The team involved in the project is:

-Developer: Terra Group

-Architect: Nichols, Brosch, Sandoval & Associates

-CM: Turner Construction

-Structural Engineer: Gopman Consulting Engineers

-MEP: Florida Engineering Services

-Civil Engineer: Fortin, Leavy, Skiles, Inc.
-Interior Design: Tessi Garcia & Associates

There are a variety of unique aspects about this building other than the structure. Because there are two towers being built as separate phases there were a number of challenges. In the beginning of the process site trailers were located on the ground that was going to be occupied by phase II. Once phase II was began construction those offices were moved into temporary rooms in the parking deck of phase I until very late in the project. The load of having a pool between the two towers also resulted in the second tower needing to reach the eighth level before the pool joining the two towers could be erected.

There was also the challenge of providing personal air handling units for the individual spaces in conjunction with a centralized air handling system for all of the public and retail spaces throughout the building. This included using special sensors and fans in the parking deck to minimize issues with carbon monoxide.

For circulation through the building there are 5 elevators and 3 stairwells so that the parking deck and residences can be accessed separately and efficiently. The architecture, which I plan to keep in tact as much as possible, is most noticed for its irregular floor plans, particularly at the lower levels, and the off-white stucco finish covering the surface of the entire non-glazed façade.

Proposal for Thesis Investigation

In order to investigate other building structural system for the Metropolis at Dadeland I need to begin with creating a grid onto which a structural system can be applied. The only system that can be used effectively without any reasonable grid is a post-tensioned slab, which I am investigating a replacement of. This grid, along with the rest of my design, should not noticeably alter the current layout of the building.

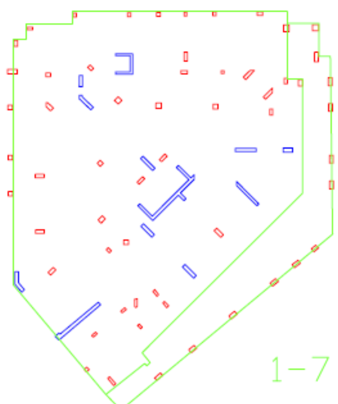
Once the grid has been established I will begin by investigating a steel framed structure. The frame will be responsible for resisting all loads, meaning no shear walls will be used. This is because the existing shear walls, which run in a variety of directions and angles, would not reasonably agree with a uniform, rectilinear grid. To resist the lateral loads I will attempt to utilize braced frames wherever they can be concealed within walls. Otherwise, I will begin applying moment frames until sufficient lateral stiffness has been achieved.

In the existing version of the building most of the living spaces utilize the bottom of the slab above, with a plastered finish, as the ceiling. Because of this, there are no recessed lights in the main living spaces. Since the steel frame inherently utilizes a suspended ceiling, I can now easily incorporate recessed lights throughout the living spaces as there is a ceiling plenum to recess into. Because of this new flexibility my first breadth investigation will be to analyze how the addition of ceiling recessed lights will affect the electrical wiring of the individual residential spaces.

My second breadth investigation will be to look at the economic feasibility of my system. This will include a look at the cost for my proposed system and the system that has already been implemented in the building. Since there are positive and negative aspects to both steel and concrete construction I want to see how greatly cost differences could lead to a decision to use one material over the other for the given situation.

Column Arrangement

The existing building layout was not very conducive to applying a different structural system other that the one that is found in the existing building. To begin my re-design of the structure I began by redesigning the column layout to make it into a grid pattern instead of the seemingly random layout that exists in the post-tensioned design that is currently being employed (a). This was done by overlaying the different floor plans (b) and trying to find the most efficient grid that would cause the least need for adjustment to those plans in order to work. I began by using a 1:1.25 to 1:1.5 ratio suggested by an article published in Modern Steel Construction in April 2000. The result is a 20' by 26.7' grid (c) that runs parallel to the northwest face of the building. There are a couple extra columns around the perimeter to mitigate the largest spans in the structure that arise due to the variations in angles between different walls of the building.



(a)

(b)

(c)

Loading

When trying to size members it has been easiest to start with sizing members for gravity loads. To make the playing field fair for comparison between my proposed structure and the existing building I used the same loads that they referenced instead of trying to select my case specific loads that could be found in ASCE 7-02. I did, however, use the ASCE 7-02 load combinations from section 2.3.

For the majority of the structure the superimposed loads are assumed to be

Dead:
- Units: 20psf
- CMU: 65 psf

Live:
- Units: 40 psf
- Balconies: 60 psf
- Public Space: 100 psf
  - Average ≈ 55 psf
- Roof: 15 psf

The exception is the eighth floor which has much greater loads due to the presence of the fitness areas. Inside the superimposed dead load is 85 psf and live load is 100 psf. Outdoors the superimposed dead load is 95 psf and the live load is 256 psf.

For initial sizing an estimated self weight of 65 psf was used.

Initial Floor Member Sizing

For the standard beam non-composite design would call for a W10x26. Based on the composite design tables a W10x12 would be sufficient. This would only require 4 shear studs, which still maintains a savings of 322 pounds of steel on every beam.

For a standard girder non-composite design calls for a W12x58. Alternatively composite design only requires a W10x26. This would require 26 shear studs per girder which still leads to a theoretical savings of 460 pounds of steel for each girder plus a savings of 2” of depth.

For the floor form deck will be used to support the concrete. From the United Steel Deck, Inc. catalog, UF1X 26-gage deck with 3” of cover will be sufficient for strength, serviceability, and fire protection. This will cause the assumed load to change since this assembly weighs 30 psf.

The eighth floor, the one with different loading conditions, will have noticeably larger members. The part of the floor that is on the interior of the building will require beams that are W10x17 and girders that are W14x38. Outside the footprint of these walls the beams need to be W10x26 and the girders need to be W18x60. All of these beams will be in composite action with the floor slab which will be a 3.5” slab placed on the same form deck as the rest of the building.

While some of the other members could be smaller due to shorter spans from unique geometry, not enough would be gained by having such a variety of sizes. The resulting complexity of fabrication and construction would not be worth saved weight in the structure.

After adjusting the loads for the new slab weight the difference was not substantial enough to cause a reason to resize any of the previously determined members. All of these actual calculations can be found in appendix B.

Initial Column Sizing

The columns were originally sized for gravity loads only. This means that the values were based on a combination of 1.2DL + 1.6LL. Most of the columns in the structure can take advantage of full allowable live load reduction (0.4). Only the top couple of floors do not have enough tributary area to allow for such large reductions. There are also limitations in reduction in the parking deck areas as is stated in ASCE 7-02 - 4.8.3. Beams can have no reduction and columns are limited to 0.2.

Based on the loading these are the resulting column sizes:

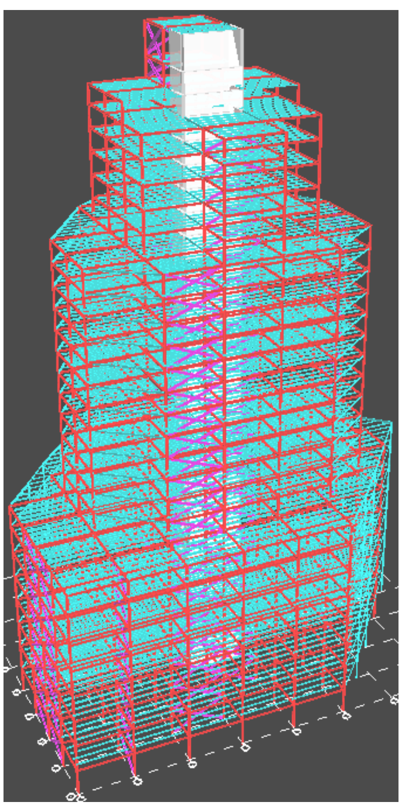
Design		
int	ext	Level
W10x33	W10x33	28
W10x33	W10x33	27
W10x33	W10x33	26
W10x33	W10x33	25
W10x33	W10x33	24
W10x33	W10x33	23
W10x39	W10x33	22
W10x45	W10x33	21
W10x49	W10x33	20
W10x49	W10x33	19
W10x49	W10x33	18
W12x53	W10x33	17
W12x58	W10x33	16
W12x65	W10x39	15
W12x65	W12x40	14
W12x65	W12x40	13
W12x72	W12x45	12
W12x79	W12x45	11
W12x79	W12x50	10
W12x87	W12x50	9
W12x96	W12x53	8
W12x136	W12x72	7
W12x136	W12x72	6
W12x136	W12x72	5
W12x136	W12x72	4
W12x136	W12x72	3
W12x136	W12x72	2
W12x136	W12x79	1

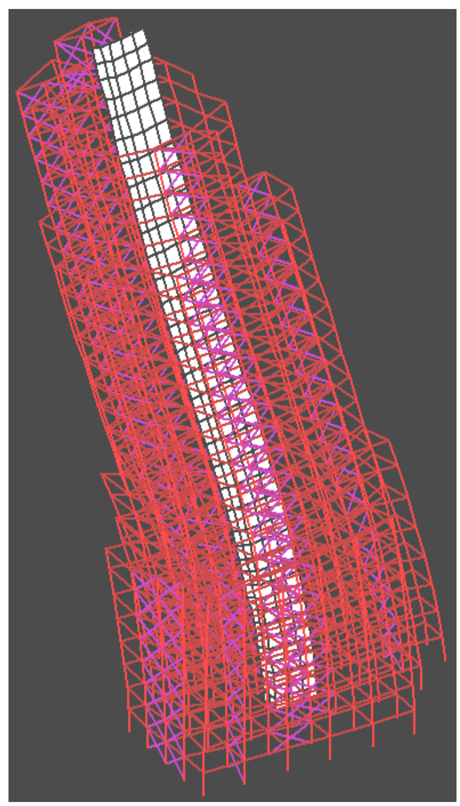
*Calculation Spreadsheet Found in Appendix C

RAM Structural Model

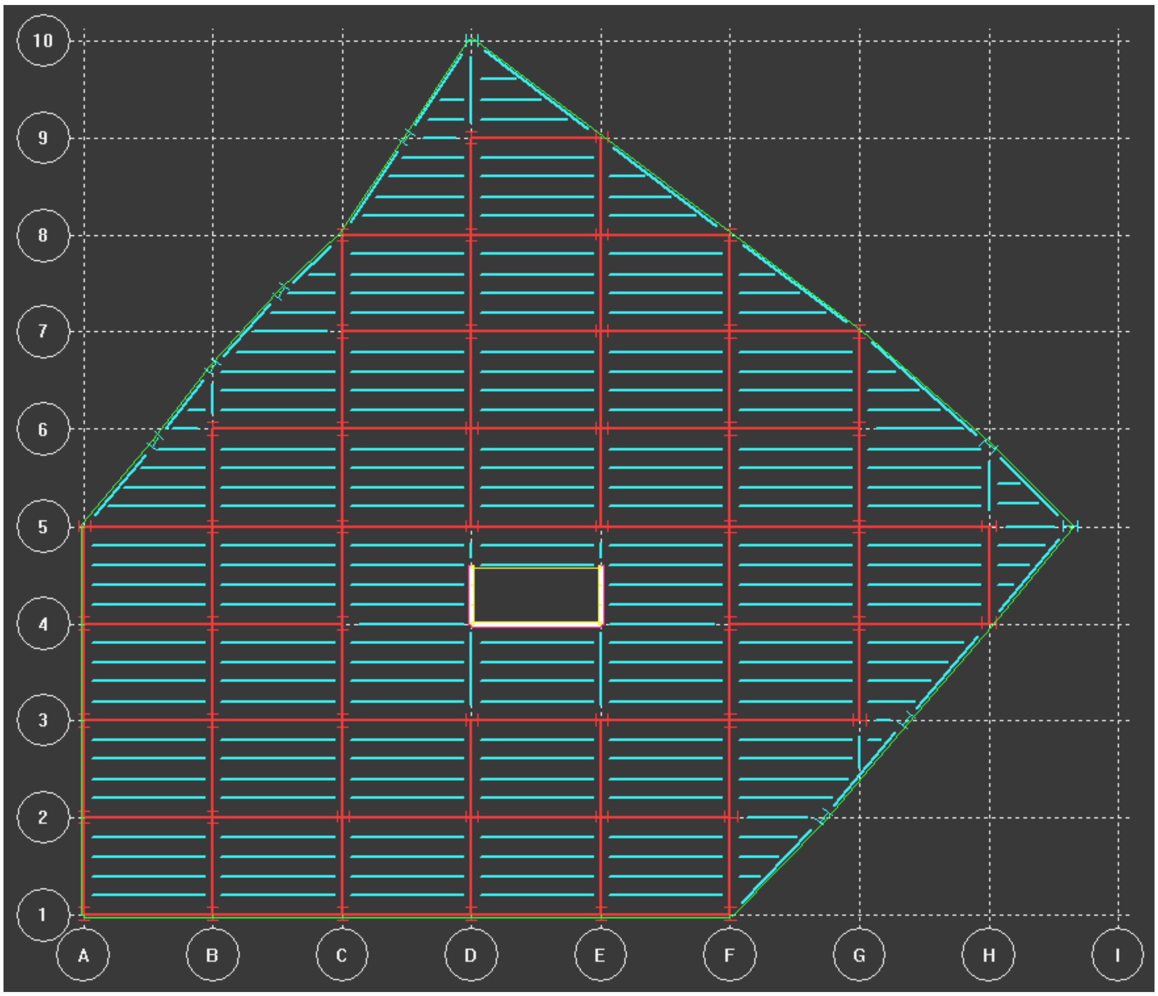
In order to analyze the existing concrete structure I modeled it in ETABS. For analysis of the interaction between structural members I assembled my final model utilizing RAM Structural System. I was planning on using ETABS for the steel model as well in order to keep the comparison between my structural system and that of the existing structure as fair as possible. However, ETABS did not easily allow for regular adjustments to geometry that I needed to implement, and RAM has been presented as the industry standard for steel modeling and design.

A major concern when laying out the framing, aside from locating to columns to minimize necessary changes to the floor plan, has been to keep the top of the building under the height limitation. This has been a concern since a steel frame is inherently taller than post-tensioned concrete. In order to allow this to happen a couple of the higher floor-to-ceiling heights had to be slightly reduced. For instance the 18' ground floor is now only 16'. This offset the increase of some of the residential floors. Also to minimize this issue I brought the floor-to-ceiling heights in the condos down from almost 9' to 8', which is still a reasonable ceiling height for a residence.





The lateral loading I applied to the model is based on ASCE 7-02 chapters 6 and 8 and can be seen in appendix D. In building the model I began with as few lateral resisting elements as possible. I tried to implement as many braced frames into the floor plan as possible without any noticeable changes to the floor plan as I originally proposed. This meant that the number of frames I was able to use was severely insufficient to resist the lateral loads applied by the 150mph wind loads. At that point I began adding moment frames progressively until they engulfed the nearly entire grid of the structure.



The red members shown above in the figure represent the lateral resisting elements. As that was not enough resistance, the sizes were increased until a point was reached that some of the sizes were beginning to be unreasonable, especially in relation to the mitigation of deflection that resulted from the changes. The best that I could achieve was a lateral deflection at the top of the building of 47.8” (appendix E), which is roughly a ratio of H/80. This is nowhere near acceptable. However, if this building were relocated to most locations in the United States, where the mean wind speed is 90mph, the lateral deflection is a very reasonable 16” in the critical direction. There are still some floors that are slightly over allowable drift, but they are close enough to be remedied with some minimal resizing. This would especially be true if more efficient braces other than the cross bracing I used were utilized such as chevron bracing, as has been suggested in past AE thesis reports.

Resulting Design

A detailed member takeoff can be found in appendix F.

Beams

I have maintained the 3” of cover over 1” form deck and ¾” shear studs for composite action from the preliminary designs.

Most of the beams that directly connect columns have been altered to accommodate for their inclusion in moment frames. The intermediate beams on all levels are primarily W10x12’s with the exception of the eighth floor which consists mostly of W12x14’s. The girders on the eighth floor are also larger, up to W24x62, due to the increased loads on that level. There are also some w8x10’s in the structure for the intermediate beams that are cut off by the angles of the building’s exterior.

There are a variety of other sizes in the building (W10x30, W10x39, W10x49, W12x19, W14x22, W16x31, W21x24, and W18x35) which either account for resisting lateral loads or the irregularly long beams along the angled perimeter of the structure.

Columns

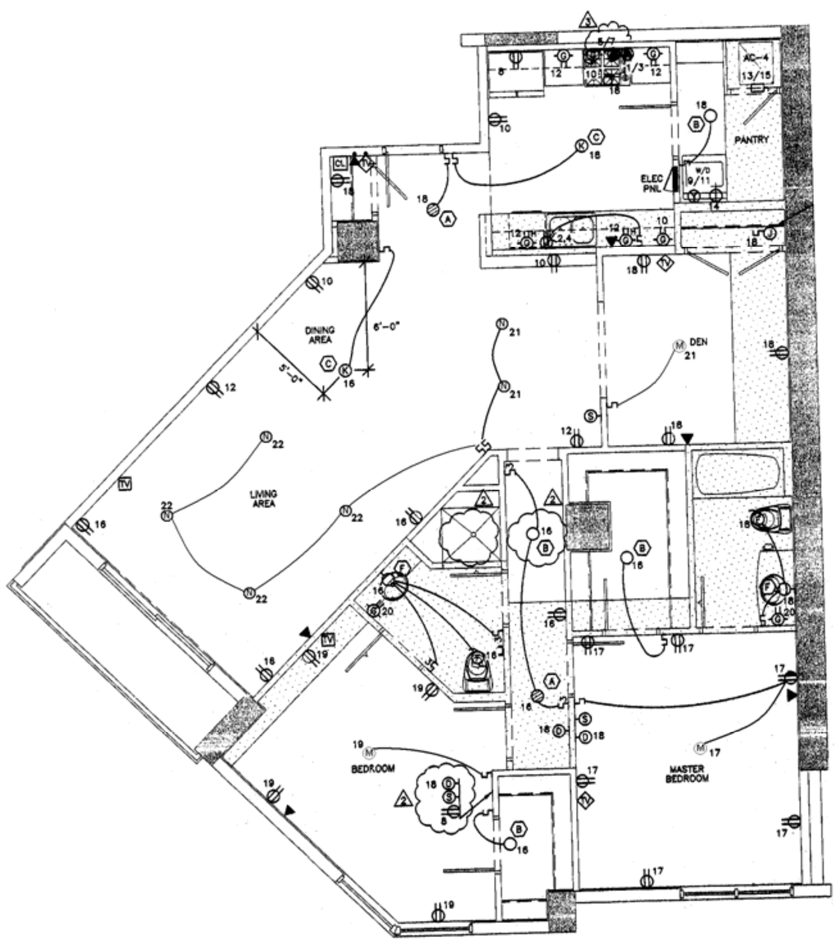
There are only 9 columns, each 8 stories tall, that due not carry lateral load. They are only needed to be W10x33's. The rest of the columns within the structure have been noticeably increased over their required sizes for gravity loads to account for the forces of wind on the structure. That has resulted in the use of columns ranging in size from W10x60 to W14x120. The larger sizes are much more predominant in the building.

Braces

In an attempt to add the most possible rigidity to the available braced frames I opted to use W shapes to allow for easier access of A992 material. I limited the size of these braces to be no larger that the columns which they would be connecting to and control wall thicknesses. This yielded the use of W12x58's for all of the braces.

Breadth 1: Electrical Layout

The electrical system in the Metropolis at Dadeland tower includes an electrical room on each level servicing all of the spaces on that floor. I am going to analyze the wiring and circuitry of an individual unit and show if there is any noticeable impact on the load that this service room is seeing. The original plans for the Metropolis at Dadeland included plaster being applied to the bottom of the slab above to serve as the ceiling. Due to this feature there is not the ability to have recessed lights in most of the living spaces throughout the building. Inherent within a steel framed structure, such as the one that I am proposing, is that there will be suspended ceiling to conceal the structure and the resulting plenum space. I have chosen to use this feature to allow for recessed lighting to be used in the residences. I am not actually designing the lighting of the space. This analysis is just on the resulting adjustments to the electrical system.



Proposed Electrical Layout of a Typical Condominium

I chose to add recessed lighting in the living room, den, and intermediate space between the two. These are all on two new circuits. I have also added ceiling fans with lights to the two bedrooms, which have been connected to existing circuits serving that space. The analysis I performed was based on a typical unit for the building. This is the resulting panel after my design was implemented. The calculations for the loads that were not already defined by the existing conditions can be found in appendix G. The resulting main breaker and feeder wires servicing the panel of this typical unit do not change. This means that the sizes of the elements within the electrical room do not need to be altered to account for the slight increase in electrical load being drawn by the space.

Voltage: 120/208 Main Breaker: 125 A Feeder: THHN 3#1 1-1/4
(#, size wire & conduit)

Description	LOAD (VA)	Brk. Trip (A)	Unit E				LOAD (VA)	Brk. Trip (A)	Description
			Cond. Size	Ckt. #		Cond. Size			
Cooktop	4900	30	10	1	2	12	700	20	Garbage Disposal
				3	4	12	1200	20	Dishwasher
Oven	3800	30	10	5	6	12	1000	20	Microwave
				7	8	12	700	20	Refrigerator
Dryer	5000	30	10	9	10	12	1500	20	Small Appliance
				11	12	12	1500	20	Small Appliance
AC Unit	3900	30	10	13	14	12	1500	15	Washer
				15	16	12	240	15	Lights/Receptacle
Master Bedroom	1584	15	14	17	18	12	1110	15	Lights/Receptacle
Bedroom	1170	15	14	19	20	14	360	20	Bath Receptacles
Lighting	660	15	14	21	22	14	750	15	Lighting
				23	24				
				25	26				
				27	28				
				29	30				
	21014						10560		

Total Load on Phase A: 31574 VA

Total Load on Panel: 21 kVA Demand (after demand factors)
100.962 A

*existing panel in appendix G

Breadth 2: CM – Estimate Comparison

An all important part of choosing a system to implement into a building is the cost of the system relative to its alternatives. When comparing a steel frame to post-tensioned concrete a major consideration is market price for the materials and the local labor force. With this there are a lot of intangibles that can change every month. I will be focusing my estimation on standard numbers from ICE 2000 Estimating. The estimate for the steel building has an inflated number of braced frames in order to mimic a structure that should work for the given loading. Based on this program the steel structure will cost approximately $3.6 million and the concrete structure should cost $9.1 million. The details resulting in these values can be seen in appendix H. This seems like a clear advantage to steel independent of the other variables involved. However, there is a need for fire proofing on the steel which instantly raises its price to $15.5 million. Instantly, concrete seems to be the favorable system based solely on price.

This does not account for the added costs of the circuits and light fixtures that I have proposed to install in conjunction with the steel system. This can be made up for because the foundation can be greatly reduced because of weight of the steel structure versus the existing concrete. The elimination of the mat slab could save nearly $700,000. Depending on the quality of the lighting components to be included would determine exactly which system this comparison favors, but should not greatly effect the overall comparison between the two systems.

Conclusion:

There is much more to selecting a system than just price and drift values. The biggest reason that I had trouble eliminating such outrageous drift from my building was the fact that there were not enough places to implement braced frames without running through the middle of spaces. Had the architect had a grid system in mind with the need to walls to be located in certain places a more suitable floor plan could have been designed to allow for the steel frame to be effective.

When comparing the suitability of the systems from an economic standpoint the concrete structure also shows advantages. However, one thing to keep in mind is that the foundation could be made significantly smaller for the steel framework than the 5 foot thick mat with an array of auger-cast piles that is in place to support the concrete structure. Another thing that is hard to take into account is the local building climate. At the time that this building began design and construction every tall building in Miami was being built with concrete and post-tensioned slabs. It has gotten to the point that the post-tensioning contractors are so busy that is can be challenging to get them to add your building to the list. In a conversation with principals at Bliss & Nyitray, Inc. in Miami, they mentioned that they had just proposed a building out of concrete for this reason among others. There is also the added bonus of the shorter construction time inherent in a steel frame as long as the possible months of lead time necessary can be acceptable.

I also am a fan of having recessed lighting strategically located throughout my living space, which is much easier to implement with a suspended ceiling inherent in a steel structure.

In conclusion, for the building as is, without any major adjustments to the floor plans, there is no building system better than the concrete structure with a post-tensioned slab. The steel frame that I tried to use just does not work. If the building were rearranged, possibly beginning with the footprint, but more importantly the locations of internal walls in the floor plans a steel frame could work and has some distinct advantages. Shorter construction time and some conveniences available to other building disciplines would help. And while the steel structure is more expensive than concrete, the time saved in construction, meaning tenants could move in sooner, may be worth the offset in cost presuming that the structure actually works.

Acknowledgments:

I would like to thank the entire field office of Tuner Construction, Gary Ferguson of Terra Group, and Eugene Crosby from Gopman Consulting Engineers for providing me with the necessary information, materials, and site access to be prepared to undertake this project. I also appreciate the help that was provided for me by Dr. Walt Schneider and the rest of the AE faculty. Also worthy of praise are the variety other students who were there in the thesis studio to answer random question as they arose.

References:

Conversations with: Hope Furrer of Hope Furrer Associates
Paul Zilio and Bart Wallis of Bliss & Nyitray, Inc

Value Engineering for Steel Construction. Modern Steel Construction, April 2000.

ASCE 7-02
For Lateral Loading

Existing building plans
For Gravity Loads and Zoning Requirements

Appendix A

Applicable Load Combinations

1) 1.4 D
2) 1.2 D + 1.6 L + 0.5 (L_r or R)
3) 1.2 D + 1.6 W + L + 0.5 (L_r or R) *
4) 1.2 D + 1.0 E + L *

* positive and negative values in each lateral direction

For initial gravity design:

1. 1.4*(65+20) = 120 psf
2. 1.2*85 + 1.6*55 = 200 psf

With new deck depth values:

1. 1.4*(20+30+[12/4]) = 74.2 psf
2. 1.2*53 + 1.6*55 = 152 psf

Appendix B
Initial Floor Member Sizing

Beams

$w_u = 200$ psf
$l = 25'$
$w = 4'$

$w_u = 200(4) = 0.8$ klf

$M_u = \frac{.8(25)^2}{8} = 62.5'^k$

W10x12 composite

W10x26 non-composite

$\Sigma Q_n = 44.3^k$

w/ $f'_c = 4$ ksi

need 4 total shear studs

≈ 28# steel

save theoretical 322# of steel/beam

Update in loading

152 psf

$w_u = .608$ klf

$M_u = 47.5'^k$

[no design change]

Girder

$w = 200$

$l = 20'$

$w = 25'$

$w_u = 5$ klf

$M_u = \frac{5(20)^2}{8} = 250'^k$

W12x58 non-composite

W10x26 composite

$\Sigma Q_n = 317^k$

26 shear studs

≃ 182#

save 460# steel/girder

2" depth

152 psf

$M_u = 190'^k$

W14x18 non-composite

W10x26 composite

[no change in design chosen]

Decking

	Gage	Span Condition	UNIFORM TOTAL LOAD / Load that Produces l/180 Deflection, psf — Span 3'0"	3'6"	4'0"	4'6"	5'0"	5'6"
	26	Single	279 / 126	205 / 80	157 / 53	124 / 37	100 / 27	83 / 21
		Double	191 / 304	163 / 192	143 / 128	123 / 90	99 / 66	82 / 49
		Triple	217 / 238	186 / 150	163 / 101	144 / 71	124 / 51	103 / 39

Slab	Mesh	+d	-d	+M	-M	Spans, feet 2'0"	2'6"	3'0"	3'6"	4'0"	4'6"
3.0"	66 - W2.0 x 2.0"	1.000	1.500	2.075	3.155	###	260	181	133	102	80
	66 - W2.9 x 2.9	1.000	1.500	2.954	4.520	###	371	257	189	145	114

Appendix C

Column Sizing

	Interior				Exterior				Floor Height (ft)	Design	
Level	area (ft^2)	load (k)	reduction	new load (k)	area (ft^2)	load (k)	reduction	new load (k)		int	ext
28	500	76	0.59	31.5	250	38	0.72	10.5	15	W10x33	W10x33
27	500	152	0.49	78.0	250	76	0.59	31.5	9.5	W10x33	W10x33
26	500	228	0.44	126.8	250	114	0.52	54.3	8.67	W10x33	W10x33
25	500	304	0.42	177.0	250	152	0.49	78.0	11.67	W10x33	W10x33
24	500	380	0.4	228.0	250	190	0.46	102.2	10.67	W10x33	W10x33
23	500	456	0.4	273.6	250	228	0.44	126.8	10.67	W10x33	W10x33
22	500	532	0.4	319.2	250	266	0.43	151.8	10.67	W10x39	W10x33
21	500	608	0.4	364.8	250	304	0.42	177.0	11.67	W10x45	W10x33
20	500	684	0.4	410.4	250	342	0.41	202.4	11.67	W10x49	W10x33
19	500	760	0.4	456.0	250	380	0.4	228.0	9.33	W10x49	W10x33
18	500	836	0.4	501.6	250	418	0.4	250.8	9.33	W10x49	W10x33
17	500	912	0.4	547.2	250	456	0.4	273.6	9.33	W12x53	W10x33
16	500	988	0.4	592.8	250	494	0.4	296.4	9.33	W12x58	W10x33
15	500	1064	0.4	638.4	250	532	0.4	319.2	9.33	W12x65	W10x39
14	500	1140	0.4	684.0	250	570	0.4	342.0	9.33	W12x65	W12x40
13	500	1216	0.4	729.6	250	608	0.4	364.8	9.33	W12x65	W12x40
12	500	1292	0.4	775.2	250	646	0.4	387.6	9.33	W12x72	W12x45
11	500	1368	0.4	820.8	250	684	0.4	410.4	9.33	W12x79	W12x45
10	500	1444	0.4	866.4	250	722	0.4	433.2	9.33	W12x79	W12x50
9	500	1520	0.4	912.0	250	760	0.4	456.0	9.33	W12x87	W12x50
8	500	1596	0.4	957.6	250	798	0.4	478.8	10.67	W12x96	W12x53
7	500	1746	0	1107.6	250	938	0	618.8	18	W12x136	W12x72
6	500	1822	0.2	1122.8	250	976	0.2	626.4	13	W12x136	W12x72
5	500	1898	0.2	1138.0	250	1014	0.2	634.0	13.25	W12x136	W12x72
4	500	1974	0.2	1153.2	250	1052	0.2	641.6	13.25	W12x136	W12x72
3	500	2050	0.2	1168.4	250	1090	0.2	649.2	13.25	W12x136	W12x72
2	500	2126	0.2	1183.6	250	1128	0.2	656.8	13.5	W12x136	W12x72
1	500	2202	0.4	1214.0	250	1166	0.4	672.0	15.67	W12x136	W12x79

Appendix D
Lateral Load Calculation

Seismic

			(k)	(k)	(ft-k)
	$w_x h_x^k$	C_{vx}	F_x	V_x	M_x
1	0.00	0.00	0.00	108.58	0.00
2	160321.47	0.0020	0.22	108.36	2.96
3	449089.53	0.0056	0.61	107.76	16.53
4	808374.61	0.0101	1.09	106.66	44.22
5	1233895.15	0.0153	1.67	105.00	89.57
6	1714993.86	0.0213	2.32	102.68	155.19
7	2234005.89	0.0278	3.02	99.66	241.63
8	4883859.57	0.0608	6.60	93.07	620.59
9	1694130.53	0.0211	2.29	90.78	239.68
10	1935514.49	0.0241	2.61	88.17	300.84
11	2175917.93	0.0271	2.94	85.23	367.59
12	2495551.41	0.0310	3.37	81.86	457.54
13	2764218.66	0.0344	3.73	78.12	545.38
14	3061414.78	0.0381	4.13	73.99	646.74
15	3368478.37	0.0419	4.55	69.44	758.62
16	3685094.91	0.0458	4.98	64.46	881.36
17	4010977.96	0.0499	5.42	59.04	1015.28
18	4345865.26	0.0541	5.87	53.17	1160.70
19	4689515.46	0.0583	6.33	46.84	1317.93
20	5041705.53	0.0627	6.81	40.03	1487.27
21	5402228.51	0.0672	7.30	32.74	1669.02
22	2945562.42	0.0366	3.98	28.76	951.14
23	3137797.50	0.0390	4.24	24.52	1057.01
24	3334009.53	0.0415	4.50	20.02	1169.63
25	3534117.65	0.0440	4.77	15.24	1289.16
26	3738045.70	0.0465	5.05	10.19	1415.71
27	3623519.84	0.0451	4.89	5.30	1414.75
28	2229654.71	0.0277	3.01	2.29	901.66
roof	1694679.74	0.0211	2.29	0.00	717.74
sums	80392541.00	1.00	108.58		20935.47

Wind (controls)

floor #	height (in)	height	kh	kz	alpha	zg	qz	qh	F (klf) (E-W)	F (klf)(N-S)
1	0	0.00	0.85	0.85	9.5	900	41.56	78.82	0.00	0.00
2	164	13.67	0.90	0.85	9.5	900	41.56	78.82	0.63	0.64
3	327	27.25	0.98	0.96	9.5	900	47.13	78.82	0.69	0.69
4	486	40.50	1.05	1.05	9.5	900	51.23	78.82	0.72	0.72
5	645	53.75	1.11	1.11	9.5	900	54.37	78.82	0.76	0.76
6	804	67.00	1.16	1.16	9.5	900	56.95	78.82	0.78	0.79
7	961	80.08	1.22	1.21	9.5	900	59.13	78.82	0.80	0.80
8	1129	94.08	1.26	1.25	9.5	900	61.17	78.82	0.88	0.88
9	1257	104.75	1.28	1.28	9.5	900	62.57	78.82	0.68	0.68
10	1381	115.08	1.31	1.30	9.5	900	63.82	78.82	0.67	0.67
11	1505	125.42	1.33	1.33	9.5	900	64.99	78.82	0.68	0.68
12	1629	135.75	1.35	1.35	9.5	900	66.08	78.82	0.69	0.69
14	1753	146.08	1.37	1.37	9.5	900	67.11	78.82	0.70	0.70
15	1877	156.42	1.38	1.39	9.5	900	68.08	78.82	0.71	0.71
16	2001	166.75	1.40	1.41	9.5	900	69.01	78.82	0.72	0.72
17	2125	177.08	1.42	1.43	9.5	900	69.89	78.82	0.72	0.72
18	2249	187.42	1.44	1.44	9.5	900	70.73	78.82	0.73	0.73
19	2373	197.75	1.45	1.46	9.5	900	71.53	78.82	0.74	0.74
20	2497	208.08	1.46	1.48	9.5	900	72.30	78.82	0.74	0.75
21	2621	218.42	1.48	1.49	9.5	900	73.04	78.82	0.75	0.75
22	2745	228.75	1.49	1.51	9.5	900	73.76	78.82	0.76	0.76
23	2869	239.08	1.51	1.52	9.5	900	74.45	78.82	0.76	0.76
24	2993	249.42	1.53	1.53	9.5	900	75.11	78.82	0.77	0.77
25	3117	259.75	1.53	1.55	9.5	900	75.76	78.82	0.77	0.78
26	3241	270.08	1.55	1.56	9.5	900	76.38	78.82	0.78	0.78
27	3365	280.42	1.56	1.57	9.5	900	76.99	78.82	0.78	0.79
28	3469	289.08	1.58	1.58	9.5	900	77.48	78.82	0.66	0.66
29	3593	299.42	1.59	1.59	9.5	900	78.06	78.82	0.79	0.79
30	3763	313.58	1.60	1.61	9.5	900	78.82	78.82	0.55	0.55

Appendix E

Lateral Displacement / Drift

Critical Load Combinations

LOAD COMBINATIONS: User Specified

3	*	1.200 D + Lp + 1.600 W1
4	*	1.200 D + Lp + 1.600 W2
5	*	1.200 D + Lp - 1.600 W1
6	*	1.200 D + Lp - 1.600 W2

Lateral Displacement / Story Drift

Story	LdC	Displacement		Story Drift	
		X	Y	X	Y
		in	in	in	in
29	3	34.6818	1.3312	1.6828	0.2155
	4	0.6404	47.7400	0.0544	2.1933
	5	-33.4178	0.9603	-1.6087	0.0345
	6	0.6236	-45.4485	0.0196	-1.9433
28	3	32.9990	1.1157	1.0754	0.1323
	4	0.5859	45.5468	0.0378	1.4014
	5	-31.8091	0.9258	-1.0281	0.0224
	6	0.6040	-43.5053	0.0094	-1.2467
27	3	31.9237	0.9834	1.0168	0.1067
	4	0.5481	44.1453	0.0585	1.2987
	5	-30.7810	0.9034	-0.9737	0.0235
	6	0.5946	-42.2586	-0.0154	-1.1686
26	3	30.9068	0.8767	1.3163	0.1222
	4	0.4896	42.8466	0.0609	1.6210
	5	-29.8073	0.8799	-1.2549	0.0188
	6	0.6099	-41.0900	0.0005	-1.4800
25	3	29.5905	0.7545	1.3455	0.1153
	4	0.4287	41.2256	0.0626	1.6805
	5	-28.5523	0.8611	-1.2821	0.0151
	6	0.6094	-39.6101	0.0008	-1.5501
24	3	28.2450	0.6392	1.3666	0.1108
	4	0.3662	39.5452	0.0647	1.7392
	5	-27.2702	0.8460	-1.3031	0.0113
	6	0.6086	-38.0600	-0.0013	-1.6171
23	3	26.8784	0.5284	1.3857	0.1079
	4	0.3015	37.8060	0.0670	1.7979
	5	-25.9671	0.8348	-1.3229	0.0071
	6	0.6099	-36.4428	-0.0042	-1.6829
22	3	25.4927	0.4204	1.4031	0.1059
	4	0.2344	36.0081	0.0680	1.8560
	5	-24.6442	0.8277	-1.3418	0.0030
	6	0.6141	-34.7599	-0.0066	-1.7471
21	3	24.0896	0.3145	1.4147	0.1036
	4	0.1664	34.1521	0.0628	1.9069
	5	-23.3025	0.8247	-1.3557	-0.0000
	6	0.6207	-33.0128	-0.0038	-1.8033

20	3	22.6749	0.2110	1.4266	0.1056
	4	0.1036	32.2452	0.0686	1.9592
	5	-21.9467	0.8247	-1.3695	-0.0054
	6	0.6246	-31.2095	-0.0115	-1.8590
19	3	21.2483	0.1054	1.4355	0.1081
	4	0.0350	30.2860	0.0742	2.0079
	5	-20.5772	0.8301	-1.3799	-0.0095
	6	0.6361	-29.3505	-0.0186	-1.9093
18	3	19.8129	-0.0027	1.4389	0.1092
	4	-0.0391	28.2781	0.0780	2.0466
	5	-19.1973	0.8396	-1.3850	-0.0128
	6	0.6547	-27.4411	-0.0241	-1.9503
17	3	18.3739	-0.1119	1.4386	0.1083
	4	-0.1171	26.2315	0.0803	2.0750
	5	-17.8123	0.8525	-1.3864	-0.0160
	6	0.6788	-25.4909	-0.0280	-1.9826
16	3	16.9353	-0.2202	1.4325	0.1053
	4	-0.1974	24.1565	0.0803	2.0907
	5	-16.4258	0.8685	-1.3820	-0.0172
	6	0.7068	-23.5083	-0.0299	-2.0026
15	3	15.5028	-0.3255	1.4199	0.0996
	4	-0.2777	22.0658	0.0783	2.0913
	5	-15.0438	0.8857	-1.3711	-0.0161
	6	0.7367	-21.5057	-0.0295	-2.0078
14	3	14.0829	-0.4251	1.3984	0.0901
	4	-0.3560	19.9745	0.0731	2.0684
	5	-13.6727	0.9018	-1.3514	-0.0130
	6	0.7662	-19.4979	-0.0261	-1.9913
12	3	12.6845	-0.5153	1.3718	0.0776
	4	-0.4291	17.9062	0.0660	2.0287
	5	-12.3213	0.9148	-1.3271	-0.0082
	6	0.7923	-17.5066	-0.0212	-1.9593
11	3	11.3127	-0.5929	1.3357	0.0606
	4	-0.4950	15.8775	0.0551	1.9644
	5	-10.9942	0.9230	-1.2932	0.0010
	6	0.8135	-15.5473	-0.0126	-1.9028
10	3	9.9769	-0.6535	1.2868	0.0374
	4	-0.5502	13.9130	0.0390	1.8713
	5	-9.7011	0.9221	-1.2465	0.0178
	6	0.8261	-13.6445	0.0014	-1.8160
9	3	8.6901	-0.6910	1.2228	0.0054
	4	-0.5892	12.0418	0.0117	1.7450
	5	-8.4546	0.9043	-1.1846	0.0452
	6	0.8247	-11.8284	0.0265	-1.6944
8	3	7.4673	-0.6964	1.1438	-0.0559
	4	-0.6008	10.2968	-0.0741	1.5817
	5	-7.2700	0.8591	-1.1065	0.1016
	6	0.7982	-10.1340	0.1114	-1.5359
7	3	6.3235	-0.6404	1.4219	-0.1048
	4	-0.5268	8.7151	-0.1008	1.9411
	5	-6.1634	0.7575	-1.3787	0.1479
	6	0.6868	-8.5981	0.1441	-1.8980
6	3	4.9015	-0.5356	1.2163	-0.1078
	4	-0.4259	6.7740	-0.0901	1.6567
	5	-4.7848	0.6096	-1.1822	0.1336
	6	0.5427	-6.7001	0.1242	-1.6309

5	3	3.6853	-0.4278	1.0984	-0.1094
	4	-0.3358	5.1173	-0.0850	1.5066
	5	-3.6026	0.4760	-1.0699	0.1253
	6	0.4184	-5.0692	0.1134	-1.4907
4	3	2.5869	-0.3184	0.9480	-0.1048
	4	-0.2508	3.6107	-0.0807	1.3230
	5	-2.5326	0.3507	-0.9251	0.1176
	6	0.3050	-3.5784	0.1035	-1.3102
3	3	1.6389	-0.2136	0.7694	-0.0943
	4	-0.1702	2.2877	-0.0733	1.0897
	5	-1.6075	0.2331	-0.7525	0.1042
	6	0.2016	-2.2682	0.0902	-1.0798
2	3	0.8695	-0.1192	0.5730	-0.0781
	4	-0.0969	1.1980	-0.0623	0.8134
	5	-0.8550	0.1288	-0.5622	0.0850
	6	0.1114	-1.1885	0.0731	-0.8064
1	3	0.2965	-0.0411	0.2965	-0.0411
	4	-0.0346	0.3847	-0.0346	0.3847
	5	-0.2928	0.0438	-0.2928	0.0438
	6	0.0382	-0.3820	0.0382	-0.3820

Sample of Top Floor at 90mph

Story	**LdC**	**Displacement**	
		X	**Y**
		in	**in**
29	7	11.3815	0.3980
	8	9.2391	1.1542
	9	-0.5242	16.0727
	10	1.3726	15.1247
	11	10.2703	15.5895
	12	10.3503	-14.0373
	13	9.3335	11.2493
	14	6.3040	12.5276
	15	9.3935	-10.9707
	16	6.3641	-9.6925
	17	-12.6638	0.7976

Appendix F
Member Sizes

Lateral

Gravity Beams

Gravity Columns

Frame Takeoff

RAM Frame v10.0
Thesis
DataBase: drifting
Building Code: IBC

03/30/06 14:57:58

Level: 29

Floor Area (ft**2): 1134.5

Columns:

Wide Flange:

Steel Grade: 50

Size	**#**	**Length ft**	**Weight lbs**	**UnitWt psf**
W12X96	4	60.0	5757	
	4		5757	5.07

Beams:

Wide Flange:

Steel Grade: 50

Size	**#**	**Length ft**	**Weight lbs**	**UnitWt psf**
W10X100	1	26.7	2668	
W12X106	3	66.7	7078	
	4		9746	8.59

Braces:

Wide Flange:

Steel Grade: 50

Size	**#**	**Length ft**	**Weight lbs**	**UnitWt psf**
W12X87	8	222.4	19373	
	8		19373	17.08

Level: 28

Floor Area (ft**2): 1134.5

Columns:

Wide Flange:

Steel Grade: 50

Size	**#**	**Length ft**	**Weight lbs**	**UnitWt psf**
W12X96	4	38.0	3646	

Size	#	Length	Weight	UnitWt
	4		3646	3.21

Beams:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X100	1	26.7	2668	
W12X106	3	66.7	7078	
	4		9746	8.59

Braces:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X87	8	201.8	17580	
	8		17580	15.50

Level: 27
Floor Area (ft**2): 3321.4

Columns:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X72	6	52.0	3733	
W12X96	4	34.7	3326	
	10		7059	2.13

Beams:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X88	12	280.0	24678	

Size	#	Length	Weight	UnitWt
	12		24678	7.43

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	2	56.1	3244	
W12X87	2	43.6	3797	
	4		7042	2.12

Level: 26

Floor Area (ft**2): 6601.8

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X72	16	165.3	11867	
W12X96	4	41.3	3965	
	20		15832	2.40

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X60	1	26.7	1597	
W10X88	25	573.4	50531	
	26		52129	7.90

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	8	216.6	12531	

Size	#	Length	Weight	UnitWt
	8		12531	1.90

Level: 25

Floor Area (ft**2): 6601.8

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X72	16	165.3	11867	
W12X96	4	41.3	3965	
	20		15832	2.40

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X88	26	600.0	52882	
	26		52882	8.01

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	8	216.6	12531	
	8		12531	1.90

Level: 24

Floor Area (ft**2): 6601.8

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X72	16	165.3	11867	
W12X96	4	41.3	3965	
	20		15832	2.40

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X60	2	40.0	2396	
W10X88	24	560.0	49357	
	26		51752	7.84

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	8	216.6	12531	
	8		12531	1.90

Level: 23

Floor Area (ft**2): 6601.8

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X72	16	165.3	11867	
W12X96	4	41.3	3965	
	20		15832	2.40

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X88	26	600.0	52882	
	26		52882	8.01

Braces:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	8	216.6	12531	
	8		12531	1.90

Level: 22
Floor Area (ft**2): 6601.8

Columns:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X72	16	165.3	11867	
W12X96	4	41.3	3965	
	20		15832	2.40

Beams:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X88	26	600.0	52882	
	26		52882	8.01

Braces:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	8	216.6	12531	
	8		12531	1.90

Level: 21

Floor Area (ft**2): 13010.5

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X60	15	154.9	9280	
W12X72	11	113.6	8158	
W12X96	4	41.3	3965	
	30		21403	1.65

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X45	1	20.0	905	
W10X77	43	1006.7	77420	
	44		78325	6.02

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	12	318.8	18444	
	12		18444	1.42

Level: 20

Floor Area (ft**2): 13010.5

Columns:

Wide Flange:
Steel Grade: 50

Size	**#**	**Length ft**	**Weight lbs**	**UnitWt psf**
W10X60	14	144.6	8661	
W12X72	12	124.0	8900	
W12X96	4	41.3	3965	
	30		21526	1.65

Beams:

Wide Flange:
Steel Grade: 50

Size	**#**	**Length ft**	**Weight lbs**	**UnitWt psf**
W10X45	1	26.7	1207	
W10X77	43	1000.1	76907	
	44		78114	6.00

Braces:

Wide Flange:
Steel Grade: 50

Size	**#**	**Length ft**	**Weight lbs**	**UnitWt psf**
W12X58	12	318.8	18444	
	12		18444	1.42

Level: 19

Floor Area (ft**2): 13010.5

Columns:

Wide Flange:
Steel Grade: 50

Size	**#**	**Length ft**	**Weight lbs**	**UnitWt psf**
W10X60	12	124.0	7424	
W12X40	2	20.7	823	
W12X72	12	124.0	8900	
W12X96	4	41.3	3965	

Size	#	Length	Weight	UnitWt
	30		21111	1.62

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X45	2	40.0	1810	
W10X77	42	986.7	75882	
	44		77692	5.97

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	12	318.8	18444	
	12		18444	1.42

Level: 18

Floor Area (ft**2): 13010.5

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X60	12	124.0	7424	
W12X72	14	144.6	10383	
W12X96	4	41.3	3965	
	30		21772	1.67

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X45	1	20.0	905	
W10X77	43	1006.7	77420	
	44		78325	6.02

Braces:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	12	318.8	18444	
	12		18444	1.42

Level: 17

Floor Area (ft**2): 13010.5

Columns:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X60	12	124.0	7424	
W12X72	14	144.6	10383	
W12X96	4	41.3	3965	
	30		21772	1.67

Beams:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X77	44	1026.7	78958	
	44		78958	6.07

Braces:

 Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	12	318.8	18444	
	12		18444	1.42

Level: 16

Floor Area (ft**2): 13010.5

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X60	12	124.0	7424	
W12X72	14	144.6	10383	
W12X96	4	41.3	3965	
	30		21772	1.67

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X77	44	1026.7	78958	
	44		78958	6.07

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	12	318.8	18444	
	12		18444	1.42

Level: 15

Floor Area (ft**2): 13010.5

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X60	12	124.0	7424	
W12X72	14	144.6	10383	
W12X96	4	41.3	3965	
	30		21772	1.67

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X77	44	1026.7	78958	
	44		78958	6.07

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	12	318.8	18444	
	12		18444	1.42

Level: 14

Floor Area (ft**2): 13010.5

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X60	12	124.0	7424	
W12X96	18	185.9	17842	
	30		25266	1.94

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X77	44	1026.7	78958	
	44		78958	6.07

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	12	318.8	18444	
	12		18444	1.42

Level: 12

Floor Area (ft**2): 13010.5

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X60	12	124.0	7424	
W12X96	18	185.9	17842	
	30		25266	1.94

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X77	44	1026.7	78958	
	44		78958	6.07

Braces:

 Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	12	318.8	18444	
	12		18444	1.42

Level: 11

Floor Area (ft**2): 13010.5

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X60	12	124.0	7424	
W12X96	18	185.9	17842	
	30		25266	1.94

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X77	44	1026.7	78958	
	44		78958	6.07

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	12	318.8	18444	
	12		18444	1.42

Level: 10

Floor Area (ft**2): 13010.5

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X77	12	124.0	9533	
W12X96	18	185.9	17842	
	30		27375	2.10

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X77	44	1026.7	78958	
	44		78958	6.07

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	12	318.8	18444	
	12		18444	1.42

Level: 9

Floor Area (ft**2): 13010.5

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X77	12	124.0	9533	
W12X96	18	185.9	17842	
	30		27375	2.10

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X88	44	1026.7	90487	
	44		90487	6.95

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	12	318.8	18444	
	12		18444	1.42

Level: 8

Floor Area (ft**2): 24264.8

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X88	26	277.4	24449	
W12X120	6	64.0	7690	
W14X120	18	192.1	23069	
	50		55208	2.28

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X45	12	273.4	12371	
W10X88	68	1593.4	140431	
	80		152802	6.30

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	18	456.5	26406	
	18		26406	1.09

Level: 7

Floor Area (ft**2): 24264.8

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X68	1	14.0	953	
W10X88	25	350.0	30846	
W12X120	6	84.0	10090	
W14X120	18	252.0	30269	
	50		72157	2.97

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X45	11	253.4	11466	
W10X88	69	1613.4	142194	
	80		153660	6.33

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	18	485.1	28061	
	18		28061	1.16

Level: 6

Floor Area (ft**2): 24264.8

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X88	26	340.1	29971	
W12X120	6	78.5	9427	
W14X120	18	235.4	28280	
	50		67678	2.79

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X45	12	273.4	12371	
W10X88	68	1593.4	140431	
	80		152802	6.30

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	18	476.6	27570	
	18		27570	1.14

Level: 5

Floor Area (ft**2): 24264.8

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X120	32	424.0	50929	
W14X120	18	238.5	28648	
	50		79577	3.28

Beams:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X45	14	313.4	14181	
W10X88	66	1553.4	136906	
	80		151087	6.23

Braces:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	18	478.1	27659	
	18		27659	1.14

Level: 4
Floor Area (ft**2): 24264.8

Columns:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X120	32	424.0	50929	
W14X120	18	238.5	28648	
	50		79577	3.28

Beams:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X45	14	320.0	14483	
W10X88	66	1546.8	136318	
	80		150801	6.21

Braces:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	18	478.1	27659	
	18		27659	1.14

Level: 3
Floor Area (ft**2): 24264.8

Columns:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X120	32	424.0	50929	
W14X120	18	238.5	28648	
	50		79577	3.28

Beams:

Wide Flange:
Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X12	1	26.7	321	
W10X45	12	273.4	12371	
W10X88	67	1566.8	138081	
	80		150773	6.21

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	18	478.1	27659	
	18		27659	1.14

Level: 2

Floor Area (ft**2): 24264.8

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X120	32	434.6	52198	
W14X120	18	244.4	29361	
	50		81559	3.36

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X12	2	53.3	643	
W10X45	15	366.7	16595	
W10X88	13	346.7	30556	
W10X100	50	1100.1	110049	
	80		157843	6.50

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	18	481.2	27834	
	18		27834	1.15

Frame Takeoff

Level: 1

Floor Area (ft**2): 24264.8

Columns:

Wide Flange:

Steel Grade: 50

Size	**#**	**Length ft**	**Weight lbs**	**UnitWt psf**
W12X120	32	437.4	52544	
W14X120	18	246.1	29556	
	50		82099	3.38

Beams:

Wide Flange:

Steel Grade: 50

Size	**#**	**Length ft**	**Weight lbs**	**UnitWt psf**
W10X12	4	106.7	1285	
W10X45	76	1760.1	79656	
	80		80941	3.34

Braces:

Wide Flange:

Steel Grade: 50

Size	**#**	**Length ft**	**Weight lbs**	**UnitWt psf**
W12X58	18	482.0	27882	
	18		27882	1.15

TOTAL STRUCTURE FRAME TAKEOFF

Floor Area (ft**2): 388844.3

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X60	125	1291.3	77330	
W10X68	1	14.0	953	
W10X77	24	247.9	19065	
W10X88	77	967.5	85266	
W12X40	2	20.7	823	
W12X72	177	1818.4	130558	
W12X96	150	1558.2	149520	
W12X120	178	2370.5	284735	
W14X120	144	1885.5	226479	
	878		974729	2.51

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X12	7	186.7	2249	
W10X45	171	3940.3	178321	
W10X60	3	66.7	3993	
W10X77	479	11187.5	860333	
W10X88	600	14054.4	1238617	
W10X100	52	1153.4	115385	
W12X106	6	133.3	14156	
	1318		2413054	6.21

Braces:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W12X58	330	8781.2	507959	
W12X87	18	467.8	40750	
	348		548709	1.41

Note: Length and Weight based on Centerline dimensions.

Gravity Beam Design Takeoff

RAM Steel v10.0
Thesis
DataBase: drifting 03/30/06 15:00:07
Building Code: IBC Steel Code: ASD 9th Ed.

STEEL BEAM DESIGN TAKEOFF:

Floor Type: rf
Story Level 28
Steel Grade: 50

SIZE	#	LENGTH (ft)	WEIGHT (lbs)
W8X10	6	122.68	1236
W10X39	4	106.68	4175
	-----		-------------
	10		**5410**

Total Number of Studs = **108**

Floor Type: ++
Story Level 27
Steel Grade: 50

SIZE	#	LENGTH (ft)	WEIGHT (lbs)
W8X10	3	42.67	430
W10X39	5	133.35	5218
	-----		-------------
	8		**5648**

Total Number of Studs = **97**

Floor Type: 28
Story Level 26
Steel Grade: 50

SIZE	#	LENGTH (ft)	WEIGHT (lbs)
W8X10	5	96.01	967
W10X12	21	560.07	6747
	-----		-------------
	26		**7714**

Total Number of Studs = **224**

Floor Type: 23-27
Story Levels 21 to 25
Steel Grade: 50

SIZE	#	LENGTH (ft)	WEIGHT (lbs)
W8X10	3	42.67	430
W10X12	47	1253.49	15099
W12X19	2	40.00	758
	-----		-------------
	52		**16287**

Total Number of Studs = **474**

Floor Type: 9-22
Story Levels 9 to 20
Steel Grade: 50

SIZE	#	LENGTH (ft)	WEIGHT (lbs)
W8X10	29	458.72	4620
W10X12	81	2186.93	26343
W12X19	2	40.00	758
W16X26	2	96.15	2513
W10X30	2	53.34	1604
	-----		-------------
	116		**35839**

Total Number of Studs = **1052**

Floor Type: 8
Story Level 8
Steel Grade: 50

SIZE	#	LENGTH (ft)	WEIGHT (lbs)
W8X10	34	399.31	4022
W10X12	5	99.92	1204
W12X14	64	1663.25	23544
W12X16	6	139.30	2233
W12X19	12	285.90	5419
W14X22	87	2314.03	51103
W16X26	3	74.63	1950
W16X31	3	59.47	1848
W18X35	5	140.01	4907
W18X40	2	50.25	2018
W21X44	1	35.41	1567
W10X49	2	53.34	2614
W24X62	1	26.30	1638
	-----		-------------
	225		**104065**

Gravity Beam Design Takeoff

RAM Steel v10.0
Thesis
DataBase: drifting
Building Code: IBC

03/30/06 15:00:07
Steel Code: ASD 9th Ed.

Total Number of Studs = **3512**

Floor Type: 1-7
Story Levels 1 to 7
Steel Grade: 50

SIZE	#	LENGTH (ft)	WEIGHT (lbs)
W8X10	58	902.69	9092
W10X12	158	4206.23	50668
W12X14	3	85.67	1213
W12X19	2	40.00	758
W14X22	1	26.30	581
W10X30	1	26.67	802
W10X49	2	53.34	2614
	-----		-------------
	225		**65727**

Total Number of Studs = **1962**

TOTAL STRUCTURE GRAVITY BEAM TAKEOFF

Steel Grade: 50

SIZE	#	LENGTH (ft)	WEIGHT (lbs)
W8X10	817	12697.49	127892
W10X12	2339	62614.26	754242
W10X39	9	240.03	9393
W10X49	16	426.72	20909
W10X30	31	826.77	24870
W12X14	85	2262.92	32033
W12X16	6	139.30	2233
W12X19	60	1245.90	23614
W14X22	94	2498.16	55169
W16X26	27	1228.45	32104
W16X31	3	59.47	1848
W18X35	5	140.01	4907
W18X40	2	50.25	2018
W21X44	1	35.41	1567
W24X62	1	26.30	1638
	-----		-------------
	3496		**1094435**

Total Number of Studs = **32669**

Gravity Column Design TakeOff

RAM Steel v10.0
Thesis
DataBase: drifting
Building Code: IBC

03/30/06 15:00:03
Steel Code: ASD 9th Ed.

Steel Grade: 50

I section

Size	#	Length (ft)	Weight (lbs)
W10X33	34	915.5	30249
W10X39	2	27.3	1066
	36		31315

Appendix G
Circuit Calculations

Circuit 17

6 receptacles × 180 VA = 1080 VA
3 VA/ft² × 168 ft² = 504 VA

1584 VA

1584/120V = 13.2 A

Use 15A Breaker

14 AWG Wire

Circuit 19

4 receptacles × 180 VA = 720 VA
3 VA/ft² × 150 ft² = 450 VA

1170 VA

1170/120 = 9.75A

15A Breaker

14 AWG wire

Circuit 21

3 VA/ft² × 220 ft² = 660 VA

15A Breaker

14 AWG Wire

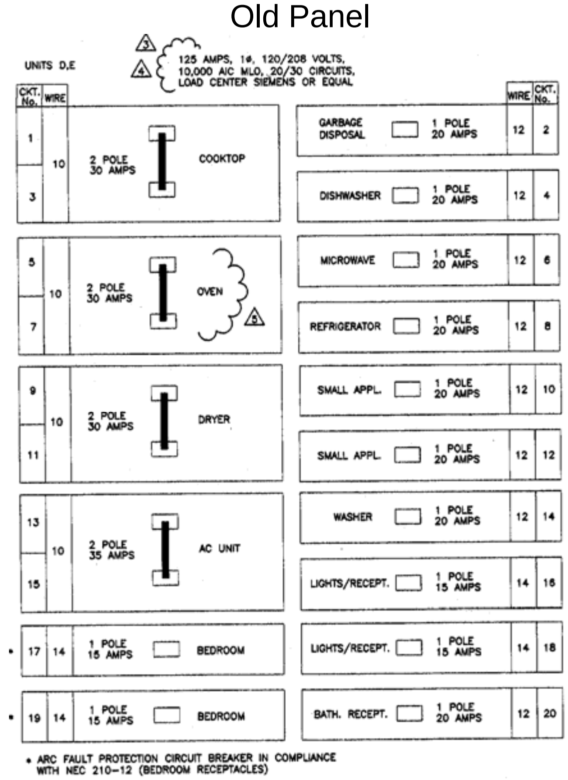
Circuit 22

3 VA/ft² × 250 ft² = 750 VA

15A Breaker

14 AWG Wire

Old Panel



Appendix H
Estimating Details

Existing Concrete Structure

ItemCode	Description	Quantity	UM	Lab.Unit	Mat.Unit	Tot.UnitCost	TotalCost
Concrete							
Formwork							
Structural CIP forms							
03111.114	WALL FORM 16'-18' HIGH	540.00	SQFT	3.4221	1.450	4.873	2,631.15
03111.116	WALL FORM 20'+ HIGH	120,367.50	SQFT	3.8747	1.600	5.475	659,000.03
03111.189	WALL FORM HARDWARE	60,453.75	SQFT		0.102	0.102	6,190.46
03111.206	WOOD COLUMN FORMS, OVER 20'	91,993.17	SQFT	0.9603	1.690	2.651	243,827.89
03111.612	SLAB FORM W/2.6 BM/SF	388,050.00	SQFT	2.5380	1.263	3.801	1,475,016.86
03111.624	SLAB EDGE FORM	11,890.50	SQFT	2.1511	0.853	3.004	35,716.68
	*** Total Structural CIP forms						$2,422,383
Concrete accessories							
03150.650	SCREEDS FOR SLAB	46,566.00	LNFT	0.9219	0.320	1.242	57,830.32
03150.900	FORM RELEASING AGENT	212,900.67	SQFT	0.2095	0.023	0.233	49,499.41
03150.900	FORM RELEASING AGENT	399,940.50	SQFT	0.2095	0.023	0.233	92,986.17
	*** Total Concrete accessories						$200,316
	** Total Formwork						$2,622,699
Concrete reinforcing							
Reinforcing steel							
03210.130	SUPPORTED SLAB REBAR	11,253.45	CWT	32.3636	26.750	59.114	665,231.94
03210.150	COLUMN REBAR	3,330.64	CWT	24.7222	26.750	51.472	171,435.41
03210.160	WALL REBAR	4,677.67	CWT	32.9629	26.750	59.713	279,317.37
03219.750	SUPPORTS		****				
03219.754	PLASTIC	337.00	EACH		1.088	1.088	366.66
	*** Total Reinforcing steel						$1,116,351
Post tensioning							
03250.010	POST TENSIONING		****				
03250.055	SUPPORTED SLABS		****				
03250.057	GROUTED STRANDS	2,173,605.00	LBS	0.7452	1.020	1.831	3,980,522.84
03250.113	POST TENSIONING GROUT	-268.95	CUFT		32.832	32.832	-8,830.05
03250.119	""CONC DISPLACED BY SLEEVES""	199.13	CUYD				
	*** Total Post tensioning						$3,971,693
	** Total Concrete reinforcing						$5,088,044
Cast in place concrete							
Structural concrete							
03310.550	""CONCRETE IN WALLS""		****				
03310.582	5000 PSI W/CRANE	3,184.47	CUYD	16.5977	60.000	76.598	243,923.39
03310.650	""CONCRETE IN COLUMNS""		****				
03310.670	6000 PSI W/CRANE	1,628.44	CUYD	21.7845	68.500	90.285	147,022.57
03311.500	""CONC IN SUPPORTED SLAB""		****				
03311.526	4000 PSI W/CRANE	10,779.17	CUYD	13.9420	56.000	69.942	753,916.48
03315.982	" CONCRETE WALL AREA "	60,453.75	SQFT				
03315.984	" NO. OF COLUMNS "	78.00	EACH				
03315.986	" SUPPORTED SLAB AREA "	388,050.00	SQFT				
	*** Total Structural concrete						$1,144,862
Finishing							
03350.131	POINT & PATCH	212,900.67	SQFT	0.1102	0.013	0.123	26,186.78
03350.131	POINT & PATCH	399,940.50	SQFT	0.1102	0.013	0.123	49,192.68
03350.132	FLOAT FINISH	388,050.00	SQFT	0.2754		0.275	106,868.97
	*** Total Finishing						$182,248
Curing							
03390.010	PROTECT & CURE	388,050.00	SQFT	0.1102	0.019	0.129	50,213.67
	*** Total Curing						$50,214
	** Total Cast in place concrete						$1,377,325
	* Total Concrete						$9,088,068
	Total Estimate						$9,088,068

Proposed Steel Structure

ItemCode	Description	Quantity	UM	Lab.Unit	Mat.Unit	Eqp.Unit	Tot.UnitCost	TotalCost
Concrete								
Formwork								
Structural CIP forms								
03111.800		13,454.00	EACH					
	*** Total Structural CIP forms							
Concrete accessories								
03150.650	SCREEDS FOR SLAB	46,566.00	LNFT	0.9219	0.320		1.242	57,830.32
	*** Total Concrete accessories							$57,830
	** Total Formwork							$57,830
Concrete reinforcing								
Welded wire fabric								
03220.011	6x6 W2.1/W2.1 MESH	4,268.55	SQS	22.0080	10.650		32.658	139,402.31
	*** Total Welded wire fabric							$139,402
	** Total Concrete reinforcing							$139,402
Cast in place concrete								
Structural concrete								
03311.700	""CONC IN SLAB OVER MTL DECK""		****					
03311.726	4000 PSI W/CRANE	3,892.48	CUYD	13.9420	56.000		69.942	272,247.62
03315.991	" SLAB OVER METAL DECK AREA "	388,050.00	SQFT					
	*** Total Structural concrete							$272,248
Finishing								
03350.132	FLOAT FINISH	388,050.00	SQFT	0.2754			0.275	106,868.97
	*** Total Finishing							$106,869
Curing								
03390.010	PROTECT & CURE	388,050.00	SQFT	0.1102	0.019		0.129	50,213.67
	*** Total Curing							$50,214
	** Total Cast in place concrete							$429,330
	* Total Concrete							$626,563
Metals								
Structural framing								
Structural steel								
05129.101	STEEL BEAMS		****					
05129.102	I BEAMS	9,257.75	CWT	28.7300	35.000	5.000	68.730	636,285.16
05129.121	STEEL COLUMNS		****					
05129.122	I SHAPES	8,913.89	CWT	28.7300	35.000	5.000	68.730	612,651.52
05129.181	BRACING		****					
05129.182	I BEAMS	5,920.64	CWT	38.3067	35.000	5.000	78.307	463,625.78
05129.990	" STRUCTURAL STEEL WEIGHT "	1,204.61	TONS					
	*** Total Structural steel							$1,712,562
	** Total Structural framing							$1,712,562
Metal deck								
Steel deck								
05310.011	STD PLAIN CORRUFORM	388,050.00	SQFT	0.4543	0.256		0.710	275,631.92
	*** Total Steel deck							$275,632
	** Total Metal deck							$275,632
	* Total Metals							$1,988,194
Thermal and moisture protection								
Fire and smoke protection								
Applied fireproofing								
07810.031	CEMENTITIOUS FIREPROOFING	217,189.63	BDFT	44.8066	0.448	0.080	45.335	9,846,204.84
	*** Total Applied fireproofing							$9,846,205
	** Total Fire and smoke protection							$9,846,205
	* Total Thermal and moisture protection							$9,846,205
	Total Estimate							$12,460,962