

How to Estimate the Cost of.....

HIGHRISE CAST IN PLACE FLAT SLAB CONSTRUCTION

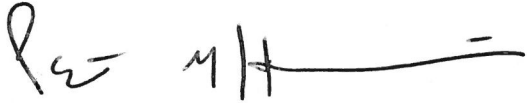
Peter M Hamilton

July 2015

Peter Hamilton is a Senior Estimator for Tutor Perini Building Corp in New York City. Peter's passion for buildings began at a young age and led to pursuing and receiving a Bachelor of Architecture from the New Jersey Institute of Technology. While studying architecture, Peter found interest in construction and detailing which led to furthering his education and receiving a Masters of Civil Engineering from the New Jersey Institute of Technology. His career in construction began as an onsite project engineer for a new college gymnasium and field complex. This led to being an assistant project manager for a new stadium for the New York Red Bull which gave him the insight to the preconstruction and estimating roles through procurement and change order estimating. Today Peter has focused his estimating career on high rise residential and hospitality projects with a focus on concrete systems, exterior enclosures, interiors and new technologies and construction methods.

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A handwritten signature in black ink, appearing to read 'Peter M Hamilton', with a long horizontal line extending to the right.

Peter M Hamilton  
7/1/2015

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Candidate Number: 0115820

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## **Introduction**

Flat slab cast in place concrete is one of the most important systems a core and shell estimator must complete for a high rise building. Often equated to the bones of a building, flat slab concrete systems are the structural system of the building. Through this technical paper, a process for estimating a high-rise flat slab cast in place concrete structures will be presented from the perspective of a General Contractor. This process is intended to provide insight to show one of the many methods for estimating a typical floor which can be extrapolated into a full structural CIP concrete estimate. It is intended at the completion for the estimator to have an outline for identifying the typical floors used for takeoffs and an understanding how to establish a cost estimate for the typical CIP concrete structure based on location and specific construction methods.

High rise, also known as towers or skyscrapers, or a tall building, can be looked at in four distinct zones: the foundations, basement, Podium, Tower. This technical paper will focus on discussing estimating the elements in the Tower zone which can be a single or multiple repetitive floor plans. Flat Slab Concrete is a structural system used to minimize beams and column capitals. In towers with repetitive floors, minimizing the additional material and labor required for work at beams and columns provides a real impact on savings both in schedule and cost. This method of construction is best suited for hotel and residential buildings which have a lower floor to floor height and unit layouts which are repeated.

## **Master Format 2014**

Main CSI Division - 03 00 00 Concrete

Sub Divisions

03 10 00 Concrete Forming and Accessories

03 20 00 Concrete Reinforcing

03 30 00 Cast-In-Place Concrete

## **Types and Methods of Measurements**

### ***Take Off Quantities***

Concrete is taken off by the four elements that make up the structure. These elements are Columns, Walls, beams, and decks. The materials that are taken off which make up these elements are the rebar, formwork, concrete material, and finishing area. These materials use the following take off units in an estimate:

Rebar - pounds or tons

Concrete Material - Cubic Yards

Formwork - Square Footage - contact area of form

Finishing - Square Footage - Surface area

High-rise Concrete buildings present a lot of unique take offs and if not broken down, elements can be missed or over estimated. The first step in estimating a high-rise concrete building is to start by understanding the overall shape and height for each floor and create a matrix with this information, also known as a story pole. Next, once all the floors are reviewed, areas of the building are defined for non-typical (Podium and basement) and typical. Non Typical are those floors and areas which have no repetition between each floor. Each floor in the non-typical will be looked at on an individual basis. Typical floors are those floors which are identical. Identical floors for the purpose of estimating are those floors which have the same height (Floor to Floor), same plan footprint (edge of slab, column sizes, core wall thickness and shape), and which use the same materials. Lastly, this information is used to takeoff each unique floor plan (this will be for the non-typical and each type of typical floor).

Rebar is measured on the plans by rebar size in linear feet and converted per the weight table for the appropriate rebar size to give the estimated quantity in pounds. It may also be necessary to have convert pounds to tonnage. This conversion is done by dividing the pounds by 2000, which is the number of pounds in a ton.

A standard conversion referenced will be the cubic yardage for concrete material is typically taken off in cubic feet, this is the multiplication of length by width, by depth (also known as height) of the

various structural elements. To convert cubic feet to cubic yards, the cubic feet calculated is divided by 27 or multiplied by .037. The cubic feet are divided by 27 because 3 feet is equal to 1 yard, thus 3 feet times 3 feet times 3 feet equals 27 cubic feet.

Column take offs count each different column on the floor plan, using the column schedule to verify each column type and size. Typically the column schedule is given in inches, if this is the case then convert inches to feet by using the given inches and dividing by 12 (ex. 24 inches divided by 12 equals 2 feet). Square or rectangular column concrete material is calculated by using the length multiplied by the width for square / rectangular columns to get the surface area of the column. The surface area is multiplied by the height to get the cubic feet for each column. The cubic footage is divided by 27 to get cubic yards (one yard is equal to 3 feet, thus one cubic yard is equal to 27 cubic feet) Concrete material for a round column uses the diameter (typically given in the column schedule but should be verified) is divided by 2 which is the radius. The radius is multiplied by itself, otherwise known as squaring. The squared radius is then multiplied by the mathematical standard PI (3.14159), this equals the surface area for the round column. Same as a square and rectangular column, the surface area is multiplied by the height to give the cubic yards then divided by 27.

Column formwork and finish area are calculated by quantifying the perimeter of the column and multiplying by the height. The perimeter of the column is determined by reviewing the size of the column shape in the column schedule and multiplying each side by 2 and adding them together. If a column is round the formwork is calculated by multiplying the diameter by PI (3.14159), then multiplying by the height.

Each Wall Type is typically found in a wall schedule, additionally wall thickness is typically shown on the floor plan. Takeoffs should be quantified in linear feet for each wall type and size. Types of wall can be based on those provided in the wall schedule or can be broken down based on the installation method, materials being selected for formwork, or the location in the building. To perform the takeoff for the concrete material in a wall, the linear feet are multiplied by the width to give the surface area of the wall. The surface area is multiplied by the height to get the cubic feet for the wall. The cubic footage is

divided by 27 to get the cubic yards. Wall formwork and finish area are calculated by doubling the linear foot of the wall and multiplying by the height. Doubling allows you to factor formwork on both sides of the wall.

For deck takeoffs, the surface area of the deck is measured direct from the plans. The surface area should remove all shafts, voids for penetrations, columns and walls (this assumes you are using the vertical footage for floor to floor) Each Deck should be taken off by the thickness of the deck. The item take off is calculated using the surface area measured multiplied by the slab thickness (converted to feet) and is divided by 27. Formwork and finish are for the deck will use the square footage. Additionally the formwork area for the slab edge needs to be figured. This will use the perimeter of the area take off multiplied by the thickness of the slab.

Each beam type is typically found in the beam schedule. This should typically be shown on the same sheet as the deck drawing but may be shown on their own sheet, typically the link beams have a separate schedule. Note the unit of measure, typically the beam schedules provide the width and height in inches. These need to be converted to feet. Takeoffs usually are quantified in linear feet for each type of beam of beam. A note should be made if the beam is part of a deck or is standalone. Any beams part of a deck should reduce the height of the beam by the thickness of the deck, if this is not done you are duplicating the area of the beam in the deck.

For beam concrete materials, the thickness of the slab is deducted from the height of the beam, if applicable, this modified height is multiplied by the width of the beam this gives the cross sectional area of the beam. The cross sectional area is multiplied by the linear footage of the beam to provide the cubic feet of the beam. The cubic feet are divided by 27. Beam formwork and finish area are calculated by doubling the linear foot of the beam and multiplying by the height of the beam minus the depth of the slab. This provides the form area of the beam sides. Next the linear footage of the beam is multiplied by the width of the beam, to give the beam bottom. The bottom and the sides are added together to give the beam formwork area.

The quantities taken off are called neat quantities. A neat quantity is a quantity that has no waste, drop, or lost quantities factored into them. Waste, drop and lost factors should be determined by field experience, fabrication methods, and the detail level of the documents being taken off. These factors can range from zero to twenty percent of the neat quantity. Average factors that can be used as starting points are; rebar between 10 and 12 percent, concrete material between 5 and 7 percent, formwork between 0 and 3 percent, and finishing area between 0 and 3 percent.

### **Specific Factors to Consider Affecting Takeoff and Pricing**

#### ***Small Quantities vs Large Quantities***

Many of the materials being used in a flat slab concrete project can benefit from large quantities. Benefits of a project with large and repetitive quantities are prefabrication, reduced trucking, efficiency in workflows, reuse of formwork material, and preferred pricing from vendors due to locked in quantity over the project duration. All of these benefits have a reduction in unit cost for the materials being used in a large repetitive project.

With large quantities being the focus of a high-rise flat slab CIP concrete estimate, the small quantities can easily be overlooked, thus presenting a risk factor to the estimate. Small quantities to be aware of are short concrete loads, limited special formwork areas, short durations of rental, and inefficient trucking of materials. A short concrete load is a load of concrete that is less than 10 cubic yards, which is the amount of concrete a concrete mixing truck can hold and deliver to the project site. Short load quantities should be reviewed with the field crews as they can help determine the number of project pours and areas that would be concerns for short loads. Limited special formwork areas within the typical concrete slab result in a change to the field crew workflow and a need to rent or fabricate the special formwork. Short durations for rental equipment and formwork cause higher rent to be paid as they are not amortized over longer periods. Short durations also require additional trucking in and out of the project site. Inefficient and additional trucking of materials and equipment can be very costly to a project. The number of trucks figured for loading a project and shipping out should be reviewed with the field team to

make sure the expectation is reasonable. A good starting point for estimating needs is a truck for every 40,000 pounds of material to load in, and a truck for every 35,000 pounds of material to ship out.

### ***Geographic Location***

Concrete projects are subjected to cost fluctuation based on geographical location. Geographical location throughout the country have varying wage scale of that locations work force. This is one of the most important factors to investigate when looking at a project in a new geographical location. Many high-rise flat slab concrete projects will be within a city and most cities are subject to union wage scales and union work rules. These work rules can cause a significant increase in labor and overall project costs. Work rules can dictate everything from the means and methods that have to be used, such as no prefabrication, or the number and make up of a crew required for various installations, to name a few. This is important to account for because some local markets are not familiar with or will not embrace a new technology or method of construction which they are not accustomed to performing. Geographic location can be a local issue as well. A projects specific site location can dictate the loading and movement of materials based on street access and potential lay down area for tight city projects. These tight projects can require street closures and extensive pedestrian protection or require additional shoring to create elevated lay down areas.

Concrete materials need to be sourced from a facility that can reach the site within 90 minutes of their batching. This can create complications for projects within a dense city or for projects in rural location that may not be near a batch plant. Location to a batch plant will also determine how many concrete trucks are required to service a project. This count of trucks can be very important because too few trucks will result in an underserved project and have crew members standing around waiting for materials, to many trucks and the project cost for concrete could become too costly. Additionally the cost for concrete materials can be increased if the source of the raw materials, such as aggregate, cement, or blast slag / fly ash, needs to be sourced from a distance requiring costly trucking or shipping methods to the batch plant. Additionally any formwork materials needed for the project can have increased cost due to distance for sourcing of the materials and the proximity to the storage yards for the various suppliers.

### ***Seasonal Effect***

Concrete superstructure is the leading trade in a high-rise concrete building. This results in the trade being subject to all the weather conditions of the local site. It should be understood what the schedule impact will be on the project due to weather conditions of each project site. This should include lost days for snow, rain, and wind. Additionally any specific methods that are needed for the cold days of the winter or the hot summer. These methods could include creating enclosures and heating the formwork and concrete materials before a pour or adding special admixtures to prevent the concrete from freezing while placing. The winter may also require labor to lay out and remove blankets on freshly poured concrete. Conversely hot summer days may require a change in schedule to do work at night, which depending on the local union rules may change the wage rate required. The summer may also require the use of ice in the mixture in lieu of water. These methods should be reviewed with the concrete suppliers on the cost implications for weather and should be considered in the preparation of an estimate.

### **Labor, Material, Equipment, Indirect Costs and Mark Ups**

#### ***Labor***

Labor for a high-rise concrete project is typically done with figuring the necessary crews for constructing each element. This would be to establish a crew for the column formwork, wall formwork, the deck and beam formwork, all concrete placement and all concrete finishing. The duration is determined by the amount of time it is believed the crew requires for the installation of these elements. The construction of the elements are then scheduled to layout the necessary predecessor activities and what activities can be done concurrently. This establishes the duration needed per floor which can then be multiplied across all similar floors and can be added to the durations figured for each unique floor.

#### ***Material***

Concrete materials for a project are determined by their specified mix design. The mix design provides the list of materials and their acceptable ratios to produce concrete that will meet a “PSI” rating needed. In addition to determining the “PSI” rating, the list of materials may include special admixtures which can cause the concrete to set up faster, or slower; achieve the an earlier higher “PSI” rating; or the

materials may be changed to make them easier to use in dense reinforcing conditions. All of these factors should be considered when discussing the concrete material with the supplier and each mix should have an identified cost.

Concrete reinforcing is split into post tension and mild reinforcing. Both materials are calculated by weight. Post tension uses the ultimate kips needed to be achieved divided by the kips realized per strand to determine the number of strands, each strand is then multiplied by the length and weight of the specified strand size to determine the weight of the cable. Mild reinforcing is determined the takeoff length multiplied by the number of each type of bar, then multiplied by the weight of each bar. Reinforcing should be reviewed with the subcontractor to agree on the weight for the project.

Concrete forming materials can be built onsite from plywood, lumber and hardware or steel form systems. When looking at these systems it should be noted what is the more common system in your market. This is based on the knowledge and workflow of the local workforce, weather issues, site constraints, and duration of usage.

Steel form systems are typically rented to the project based on a percentage of the replacement value of all the form elements rented by the number of weeks or months the elements will be on site. Steel forms require the estimator to understand number of columns that will be needed to keep the crews forming, pouring and stripping and how long the forms will be in use. A steel form supplier will provide the material list listed for the number of columns with the replacement value and monthly rented cost. The estimator needs to be aware what the duration of a month means to the supplier, many suppliers rent in a duration of 28 days, which means 13 months equals one year. Steel Forms are typically best for non-typical over height columns, typical and non-typical wall systems, large typical beam, and flyer deck systems.

If wood forms are going to be used, the contact square footage needs to be analyzed and converted to sheets of plywood, linear footage of lumber, hardware to include nails, clamps and wedges. Plywood forms are typically best for typical height columns, non-typical standalone wall systems, large and small non typical beams, and typical and non-typical deck installation. Wood systems can also be

hybrids of rented systems and plywood face. Typically the rented system would be posts, ledgers and beams in a deck system as an example. Typically all over height non typical floors would require the posts to be a scaffold frame system and be determined to be a rented system.

### ***Equipment***

Equipment used can vary greatly from project to project. Equipment cost are typically an entire project cost and figured as an all in cost for the project and not specific to one floor. Most high-rise construction projects will utilize a tower crane for their hoisting requirements and a concrete pump for placing concrete. There are some projects where the height and the site conditions of the tower will allow for a large crawler crane to be utilized in lieu of a tower crane. Additionally it is possible the quantity of material being placed can be done with a concrete bucket. These methods and equipment needs should be reviewed with the onsite field team as to how they would like to construct the project to be the most efficient for their needs and the site.

A major piece of equipment that is typically rented is a cocoon system. This is a safety system and some markets require one as part of the means and methods of construction. The system provides for an enclosure that spans from the working deck to the stripping deck, typically 3 floors. The system is located at the perimeter of the building and provides a means to minimize items from falling from the deck as well as a means to keep men away from the edge. This type of system is typically provided by a vendor and can be reviewed and discussed to understand each vendor's specific needs and installation methods.

Besides just the major equipment for the hoisting of material, methods for maneuvering the material around the job site need to be considered. Forklifts, Flatbeds trailers and trucks, scissors lifts, concrete washout, and any other equipment that your project team may feel is necessary, should all be reviewed as to the needs of the specific site and duration they will be on the project. These can be counted as to the project needs and determined if it is more valuable to purchase these items or more likely what duration they will be needed for and rented.

Lastly small tools and specific crew equipment should be assigned per crew make up or per man hours worked by each crew. Small tools can be difficult to estimate by through experience and detailed cost history and accurate basis can be determined for these items.

### ***Indirect Costs***

The project indirect costs are the costs incurred by the project to support the onsite construction activities. These include but are not limited to:

- Site Supervision
- Project management team
- Surveying / Layout
- Accounting and Payroll
- Office / Fabrication Yard Facility and Items
- Heating and Winter Protection
- Cleanup Labor
- Outside Consulting Services
- Mobilization and Demobilization

These costs are defined by each individual company and should be reviewed and establish internally with executives and the field operations team. Many times the successful company can have a competitive advantage with the methods for staffing a project for a means on providing office and field facilities. These cost are typically defined in a separate estimate and added as a lump sum value at the end of the estimate.

### ***Mark Ups***

Additional mark ups that should be factored into the overall estimate cost could include Fee, Sales Tax, Contingency, Insurance, and Escalation. These mark ups can be specified by the project specification, the project scope of work produced by the general contractor team, as well as government requirements. Fee, Contingency, and some insurance will be dictated and established by the company executives. Additionally it should be noted that sales tax needs to be reviewed in detail, it is possible that

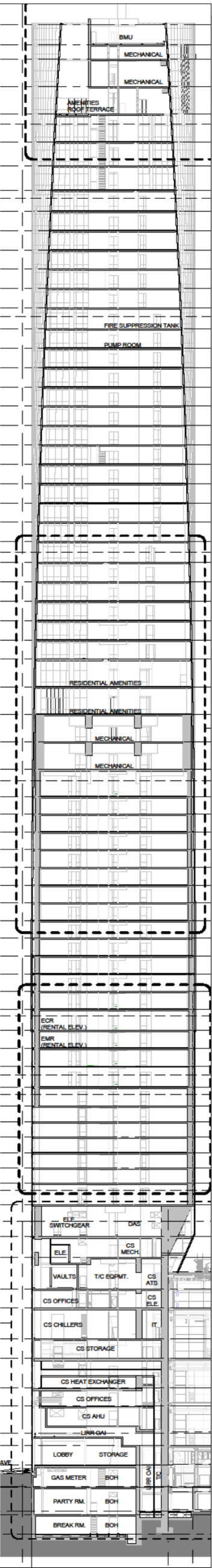
the project permanent materials may be taxed exempted but all temporary materials are to be included. In a concrete project all form work rented or purchased would be subject to all taxes. Any mark ups that are added to the project are typically calculated as a percent of some portion of the project cost or as a lump sum dollar value.

### **Special Risk Considerations**

When reviewing a high-rise concrete project it is important to identify the areas for risk to minimize project exposure. As previously mentioned it is important to review all subcontractor and supplier materials to understand the scope they are providing and the durations that need to be applied to the estimate. It should also be noted how long the subcontractors and suppliers will hold their prices and when they will apply escalation to their material or scope of work. Additional risk to consider when reviewing and preparing a concrete estimate are the things to review when the labor increases will occur during the project schedule, in a high-rise project it is not uncommon to go through two or even three labor increases during a project. It is also important to review the project with the field team to identify any additional site conditions and logistics that could present risk that are not normally in an estimate. These could include moving of equipment multiple times during the project or specific leave outs for hoist or special access.

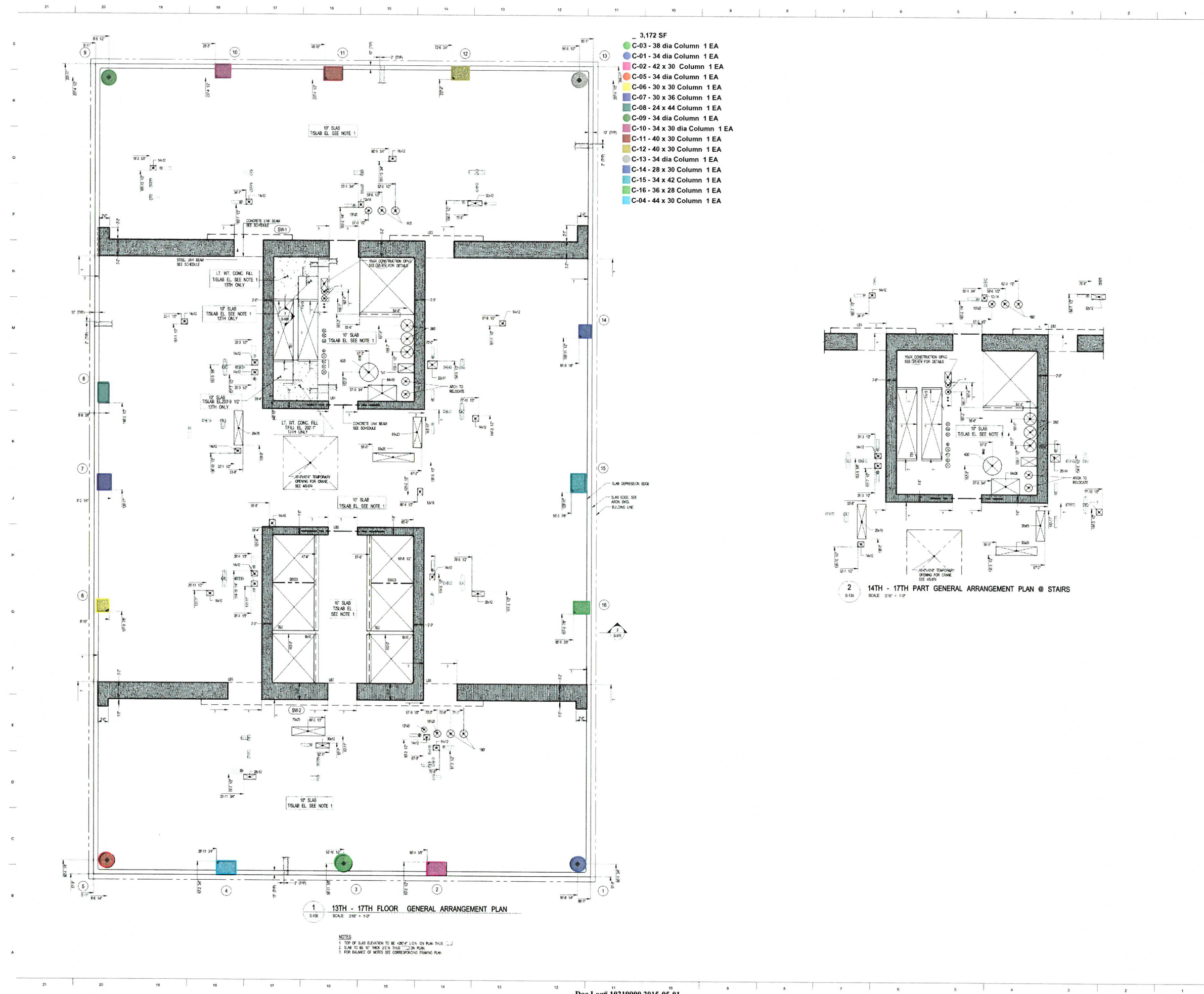
### **Ratios and Analysis**

The cost and elements of the takeoff can be analyzed using many different ratios and factors to check and verify if the takeoff and project make sense and if the total cost follows historical data. The first set of ratios that are recommended to be used are for checking the rebar weight, these ratios are the rebar pounds per concrete yardage or the rebar pounds per square foot. The next analysis is to verify the concrete quantity is in normal range, this is done using the total cubic feet of concrete per square foot. Historical data can be used to verify that cost per cubic yard for each element is in line or cost per square foot. An additional ratio that can be used is historical production rates to establish if the crew sizes are in line with past projects.

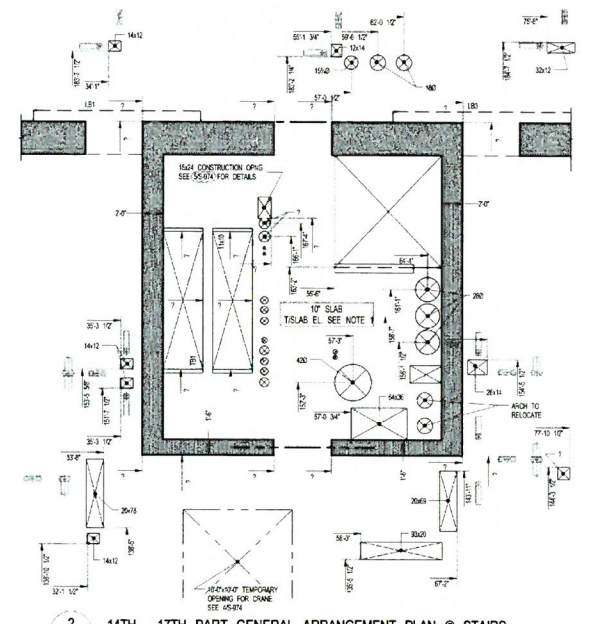
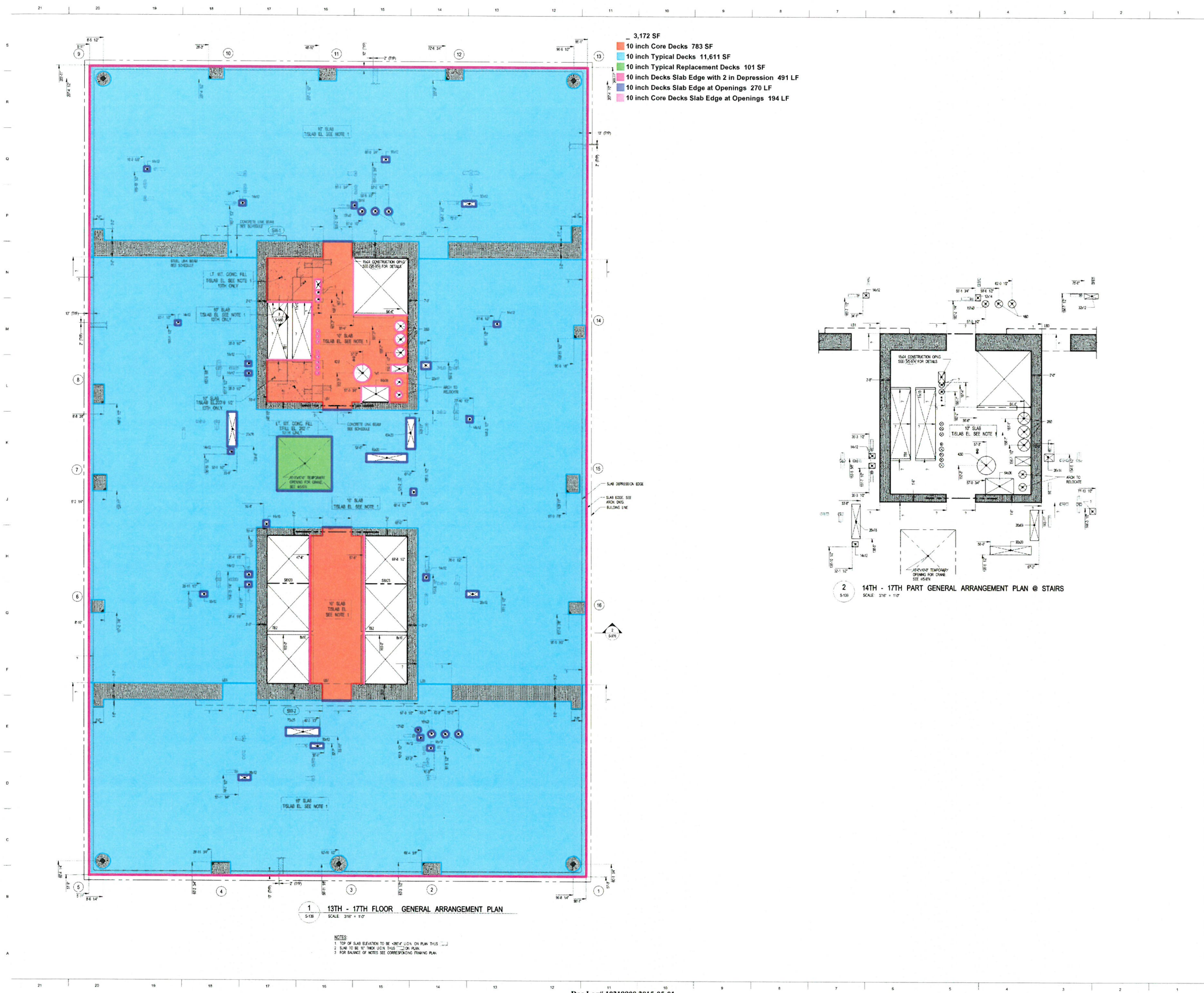


EXTERIOR SKIN											
				Floor	Height	Floor Height	Elevation	GSF	Roof Area	Perimeter	Sqft Ext
EMR/Bulkhead Upper Mech Upper Mech (Total 286 Units)						902.0	917.0		1,750		0
				70	12.50	889.5	904.5	1,750	2,600	1,110	13,875
				69	9.00	880.5	895.5	4,610	2,350	840	7,560
Amenities/Mech				68	17.00	863.5	878.5	6,990	3,880	650	11,050
				67	17.00	846.5	861.5	10,920	2,140	615	10,455
Condo				66	17.00	829.5	844.5	13,300	P	471	8,007
Condo 4 Duplex				65	14.92	814.6	829.6	13,300		471	7,027
Condo 2 Units				64	14.92	799.6	814.6	13,300		471	7,027
Condo 4 Units				63	12.92	786.7	801.7	13,365		472	6,098
Condo 4 Units				62	11.92	774.8	789.8	13,660		475	5,662
Condo 4 Units				61	11.92	762.9	777.9	13,660		475	5,662
Condo 4 Units				60	11.92	751.0	766.0	13,660		475	5,662
Condo 4 Units				59	11.92	739.0	754.0	13,660		475	5,662
Condo 4 Units				58	11.92	727.1	742.1	13,660		475	5,662
Condo 5 Units				57	12.92	714.2	729.2	13,725		476	6,150
Condo 5 Units				56	11.92	702.3	717.3	13,775		476	5,674
Condo 6 Units				55	11.92	690.4	705.4	13,820		477	5,686
Condo 6 Units				54	11.92	678.4	693.4	14,215		486	5,793
Condo 6 Units				53	11.92	666.5	681.5	14,215		486	5,793
Condo 6 Units				52	11.92	654.6	669.6	14,215		486	5,793
Condo 6 Units				51	11.92	642.7	657.7	14,215		486	5,793
Condo 6 Units				50	11.92	630.8	645.8	14,215		486	5,793
Condo 6 Units				49	11.92	618.8	633.8	14,215		486	5,793
Condo 6 Units				48	11.92	606.9	621.9	14,215		486	5,793
Condo 6 Units				47	11.92	595.0	610.0	14,215		486	5,793
Condo 6 Units				46	11.92	583.1	598.1	14,215		486	5,793
Condo 6 Units				45	12.92	570.2	585.2	14,260		487	6,292
Condo 6 Units				44	11.92	558.2	573.2	14,410		491	5,853
Condo 6 Units				43	11.92	546.3	561.3	14,410		491	5,853
Condo 6 Units				42	11.92	534.4	549.4	14,410		491	5,853
Condo 6 Units				41	11.92	522.5	537.5	14,410		491	5,853
Condo 6 Units				40	11.92	510.6	525.6	14,410		491	5,853
Amenities				39	17.00	493.6	508.6	14,450		492	8,364
Amenities				38	17.00	476.6	491.6	14,480		493	8,381
Mechanical				37	17.00	459.6	474.6	14,525		494	8,398
Mechanical				36	17.00	442.6	457.6	14,520		494	8,398
Condo 9 Units				35	17.00	425.6	440.6	14,560		497	8,449
Condo 9 Units				34	10.92	414.6	429.6	14,630		498	5,438
Condo 9 Units				33	10.92	403.7	418.7	14,630		498	5,438
Condo 9 Units				32	10.92	392.8	407.8	14,630		498	5,438
Condo 9 Units				31	10.92	381.9	396.9	14,630		498	5,438
Condo 9 Units				30	10.92	371.0	386.0	14,630		498	5,438
Condo 9 Units				29	10.92	360.0	375.0	14,630		498	5,438
Condo 9 Units				28	10.92	349.1	364.1	14,630		498	5,438
Condo 9 Units				27	10.92	338.2	353.2	14,630		498	5,438
Condo 9 Units				26	10.92	327.3	342.3	14,630		498	5,438
Condo 9 Units				25	10.92	316.4	331.4	14,630		498	5,438
Condo 9 Units				24	10.92	305.4	320.4	14,630		498	5,438
Condo 9 Units				23	10.92	294.5	309.5	14,630		498	5,438
Condo 9 Units				22	13.25	281.3	296.3	14,630		498	6,599
Condo 9 Units				21	10.92	270.4	285.4	14,630		498	5,438
Condo 9 Units				20	10.92	259.4	274.4	14,630		498	5,438
(Total 109 Units)											0
Rental 11 Units				19	12.92	246.5	261.5	14,630		498	6,434
Rental 14 Units				18	11.92	234.6	249.6	14,630		498	5,936
Rental 14 Units				17	9.50	225.1	240.1	14,630		498	4,731
Rental 14 Units				16	9.50	215.6	230.6	14,630		498	4,731
Rental 14 Units				15	9.50	206.1	221.1	14,630		498	4,731
Rental 14 Units				14	9.50	196.6	211.6	14,630		498	4,731
Rental 14 Units				13	9.50	187.1	202.1	14,630		498	4,731
Rental 14 Units				12	12.92	174.2	189.2	14,630		498	6,434
TD				11M		174.2	189.2				0
TD				11	19.67	154.5	169.5	14,625		498	9,796
TD/Culture Shed				10	13.00	141.5	156.5	13,935		489	6,357
TD/Culture Shed				9	19.50	122.0	137.0	12,415		490	9,555
Culture Shed				8	11.50	110.5	125.5	12,155		473	5,440
Culture Shed				7	19.00	91.5	106.5	12,100		469	8,911
Culture Shed				6	12.25	79.3	94.3	11,875		478	5,856
Culture Shed				5	18.00	61.3	76.3	11,785		466	8,388
TD/Culture Shed				4	11.08	50.2	65.2	11,785		469	5,197
TD/Culture Shed				3	17.00	33.2	48.2	11,630		475	8,075
TD/Culture Shed				1M/2	7.67	25.5	40.5	11,325		560	4,295
Resid Lobby				1	12.00	13.5	28.5	11,625	4,575	568	6,816
Resid Common/Lobby				Basemt	13.50	0.0	15.0	13,305		522	2,498
Mechanical				Cellar	17.00		-2.0	11,535		447	
Mechanical				Sub Cellar	12.00		-14.0	6,200		400	

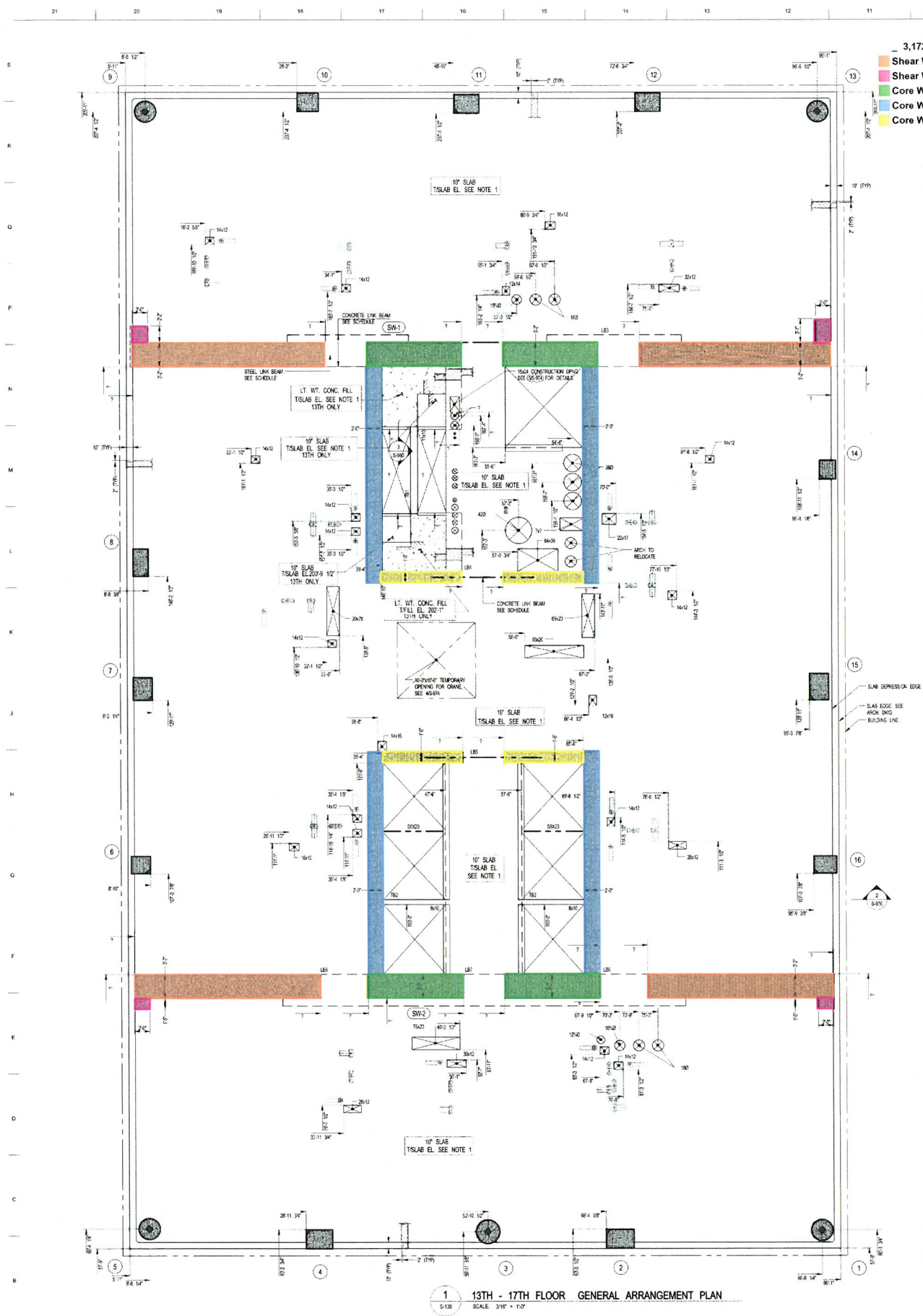
Floor	Height	Floor Height	Elevation	GSF	Roof Area	Perimeter	Sqft Ext
				976,720	17,295	452,977	



- 3,172 SF
- 10 inch Core Decks 783 SF
- 10 inch Typical Decks 11,611 SF
- 10 inch Typical Replacement Decks 101 SF
- 10 inch Decks Slab Edge with 2 in Depression 491 LF
- 10 inch Decks Slab Edge at Openings 270 LF
- 10 inch Core Decks Slab Edge at Openings 194 LF

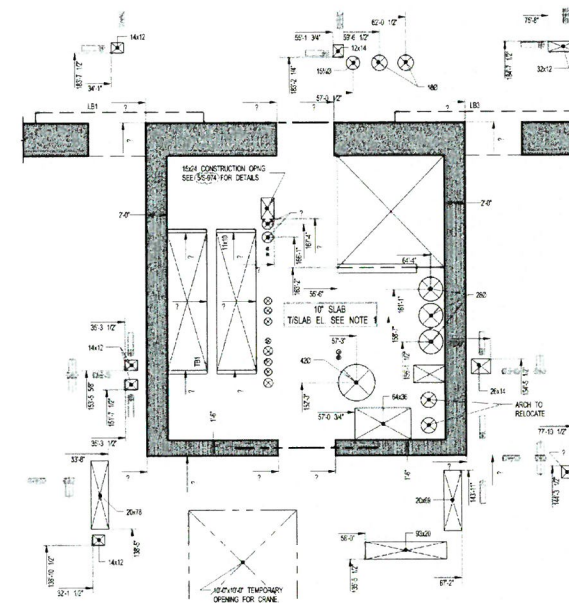


- 3,172 SF
- Shear Wall - 3'-2" Thick 99 LF
- Shear Wall - 2'-0" Thick 8 LF
- Core Wall - 3'-2" Thick 50 LF
- Core Wall - 2'-0" Thick 116 LF
- Core Wall - 1'-6" Thick 42 LF



1 13TH - 17TH FLOOR GENERAL ARRANGEMENT PLAN

- NOTES
1. TOP OF SLAB ELEVATION TO BE SHOWN ON PLAN THIS
  2. SLAB TO BE 10' THICK UNLESS NOTED OTHERWISE
  3. FOR BALANCE OF NOTES SEE CORRESPONDING DRAWING PLAN



2 14TH - 17TH PART GENERAL ARRANGEMENT PLAN @ STAIRS

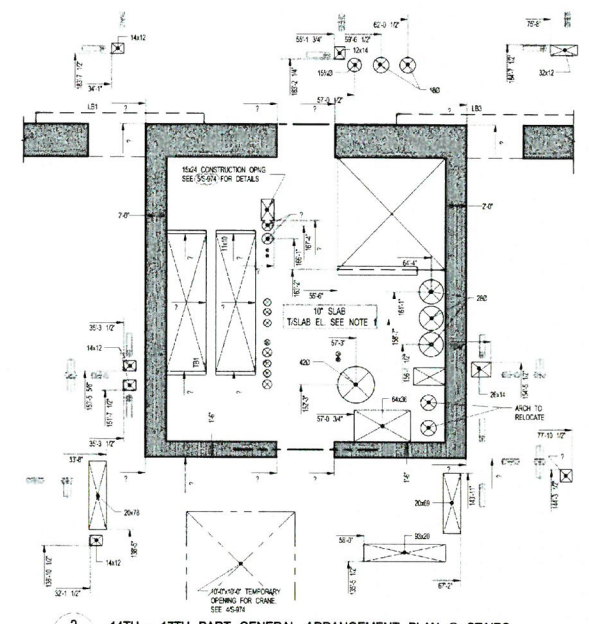
SCALE: 3/16" = 1'-0"

- 3,172 SF
- TB2 - 8 x 10 16 LF
- TB1 - 11 x 10 11 LF
- LB1 - 50 x 16 (10 in Slab) 16 LF
- LB3 - 50 x 16 (10 in Slab) 18 LF
- LB6 - 50 x 16 (10 in Slab) 19 LF
- LB7 - 50 x 16 (10 in Slab) 17 LF
- LB8 - 50 x 16 (10 in Slab) 17 LF



1 13TH - 17TH FLOOR GENERAL ARRANGEMENT PLAN  
SCALE: 3/16" = 1'-0"

NOTES  
1. TOP OF SLAB ELEVATION TO BE SHOWN ON PLAN PLUS 1/4"  
2. SLAB TO BE 10" THICK UNLESS OTHERWISE NOTED  
3. FOR BALANCE OF NOTES SEE CORRESPONDING FRAMING PLAN



2 14TH - 17TH PART GENERAL ARRANGEMENT PLAN @ STAIRS  
SCALE: 3/16" = 1'-0"

## Take Off Sample Calculations

<i>Deck Formwork</i>					<i>Contact Area</i>
10 inch Core Decks					Takeoff Area sf
10 inch Decks Slab Edge with 2 in Depression		Length	lf	Depth ft	Length*Depth sf
<i>Column Formwork</i>		<i>Area</i>		<i>Height</i>	<i>Contact Area</i>
C-02 - 42 x 30 Column	Count EA	(42/12)*(30/12)	sf	9.5 ft	Count*Area*Height sf
C-01 - 34 dia Column	Count EA	(((34/12)/2)*(34/12)/2)*3.14	sf	9.5 ft	Count*Area*Height sf
<i>Wall Formwork</i>		<i>Total Side Length</i>			<i>Contact Area</i>
Shear Wall - 3'-2" Thick	Length LF	Length*2	lf	9.5 ft	Total Side Length*Height sf
<i>Beam Formwork</i>		<i>Sides</i>		<i>Bottom</i>	<i>Total Formwork</i>
TB2 - 8 x 10	Length LF	2*Length*Height	sf	Length*Width sf	Sides+Bottoms sf
<i>Link Beam Formwork</i>		<i>Sides</i>		<i>Bottom</i>	<i>Total Formwork</i>
LB1 - 50 x 16 (10 in Slab)	Length LF	2*Length*Height	sf	Length*Width sf	Sides+Bottoms sf

<i>Deck Concrete Material</i>		<i>Area</i>	sf	<i>Depth</i>	ft	<i>Total Concrete</i>
10 inch Core Decks						Area*Depth/27 cyd
<i>Column Concrete Material</i>		<i>Area</i>		<i>Height</i>		<i>Total Concrete</i>
C-02 - 42 x 30 Column	Count EA	(42/12)*(30/12)	sf	9.5 ft		Count*Area*Height/27 cyd
C-01 - 34 dia Column	Count EA	(((34/12)/2)*(34/12)/2)*3.14	sf	9.5 ft		Count*Area*Height/27 cyd
<i>Wall Concrete Material</i>		<i>Area</i>		<i>Height</i>		<i>Total Concrete</i>
Shear Wall - 3'-2" Thick	Length LF	Length*Thickness	sf	9.5 ft		Area*Height/27 cyd
<i>Beam Concrete Material</i>		<i>Area</i>		<i>Height</i>		<i>Total Concrete</i>
TB2 - 8 x 10	Length LF	Length*Width	sf	0.83 ft		Area*Height/27 cyd
<i>Link Beam Concrete Material</i>		<i>Area</i>		<i>Height</i>		<i>Total Concrete</i>
LB1 - 50 x 16 (10 in Slab)	Length LF	Length*Width	sf	0.83 ft		Area*Height/27 cyd

## Take Off Calculations

Deck Formwork			Area	Depth	Contact Area
10 inch Core Decks					783.00 sf
10 inch Typical Decks					11,611.00 sf
10 inch Typical Replacement Decks					101.00 sf
<b>Total Deck Formwork Area</b>					<b>12,495.00 sf</b>
10 inch Decks Slab Edge with 2 in Depression			491.00 LF	0.83 ft	409.17 sf
10 inch Decks Slab Edge at Openings			270.00 LF	0.83 ft	225.00 sf
10 inch Core Decks Slab Edge at Openings			194.00 LF	0.83 ft	161.67 sf
<b>Total Slab Edge Area</b>					<b>795.83 sf</b>
Column Formwork		Count	Area	Height	Contact Area
C-02 - 42 x 30 Column	1 EA		8.75 sf	9.50 ft	83.13 sf
C-06 - 30 x 30 Column	1 EA		6.25 sf	9.50 ft	59.38 sf
C-07 - 30 x 36 Column	1 EA		7.50 sf	9.50 ft	71.25 sf
C-08 - 24 x 44 Column	1 EA		7.33 sf	9.50 ft	69.67 sf
C-10 - 34 x 30 Column	1 EA		7.08 sf	9.50 ft	67.29 sf
C-11 - 40 x 30 Column	1 EA		8.33 sf	9.50 ft	79.17 sf
C-12 - 40 x 30 Column	1 EA		8.33 sf	9.50 ft	79.17 sf
C-14 - 28 x 30 Column	1 EA		5.83 sf	9.50 ft	55.42 sf
C-15 - 34 x 42 Column	1 EA		9.92 sf	9.50 ft	94.21 sf
C-16 - 36 x 28 Column	1 EA		7.00 sf	9.50 ft	66.50 sf
C-04 - 44 x 30 Column	1 EA		9.17 sf	9.50 ft	87.08 sf
<b>Total Square Column Formwork Area</b>	<b>11 ea</b>				<b>812.25 sf</b>
C-01 - 34 dia Column	1 EA		6.30 sf	9.5 ft	59.87 sf
C-03 - 38 dia Column	1 EA		7.87 sf	9.5 ft	74.78 sf
C-05 - 34 dia Column	1 EA		6.30 sf	9.5 ft	59.87 sf
C-09 - 34 dia Column	1 EA		6.30 sf	9.5 ft	59.87 sf
C-13 - 34 dia Column	1 EA		6.30 sf	9.5 ft	59.87 sf
<b>Total Square Column Formwork Area</b>	<b>5 ea</b>				<b>314.25 sf</b>

Wall Formwork	Length	Total Side Length		Contact Area
Shear Wall - 3'-2" Thick	99 LF	198.00 lf	9.5 ft	1,881.00 sf
Shear Wall - 2'-0" Thick	8 LF	16.00 lf	9.5 ft	152.00 sf
<b>Total Shear Wall Formwork Area</b>				<b>2,033.00 sf</b>
Core Wall - 3'-2" Thick	50 LF	100.00 lf	9.5 ft	950.00 sf
Core Wall - 2'-0" Thick	116 LF	232.00 lf	9.5 ft	2,204.00 sf
Core Wall - 1'-6" Thick	42 LF	84.00 lf	9.5 ft	798.00 sf
<b>Total Core Wall Formwork Area</b>				<b>3,952.00 sf</b>
Beam Formwork		Sides	Bottom	Total Formwork
TB2 - 8 x 10	16 LF	26.56 sf	10.67 sf	37.23 sf
TB1 - 11 x 10	11 LF	18.26 sf	10.08 sf	28.34 sf
<b>Total Beam Formwork Area</b>				<b>65.57 sf</b>
Link Beam Formwork		Sides	Bottom	Total Formwork
LB1 - 50 x 16 (10 in Slab)	16 LF	133.33 sf	21.33 sf	154.67 sf
LB3 - 50 x 16 (10 in Slab)	18 LF	150.00 sf	24.00 sf	174.00 sf
LB6 - 50 x 16 (10 in Slab)	19 LF	158.33 sf	25.33 sf	183.67 sf
LB7 - 50 x 16 (10 in Slab)	17 LF	141.67 sf	22.67 sf	164.33 sf
LB8 - 50 x 16 (10 in Slab)	17 LF	141.67 sf	22.67 sf	164.33 sf
<b>Total Link Beam Formwork Area</b>				<b>328.67 sf</b>

Deck Concrete Material		Area	Depth	Material
10 inch Core Decks		783 sf	0.83 ft	24.17 cyd
10 inch Typical Decks		11,611 sf	0.83 ft	358.36 cyd
10 inch Typical Replacement Decks		101 sf	0.83 ft	3.12 cyd
10 inch Decks Slab Edge with 2 in Depression		491 lf		
10 inch Decks Slab Edge at Openings		270 lf		
10 inch Core Decks Slab Edge at Openings		194 lf		
<b>Total Concrete Material</b>				<b>385.65 cyd</b>
Column Concrete Material		Area	Height	Material
C-02 - 42 x 30 Column	1 EA	8.75 sf	9.5 ft	3.08 cyd
C-06 - 30 x 30 Column	1 EA	6.25 sf	9.5 ft	2.20 cyd
C-07 - 30 x 36 Column	1 EA	7.50 sf	9.5 ft	2.64 cyd
C-08 - 24 x 44 Column	1 EA	7.33 sf	9.5 ft	2.58 cyd
C-10 - 34 x 30 Column	1 EA	7.08 sf	9.5 ft	2.49 cyd
C-11 - 40 x 30 Column	1 EA	8.33 sf	9.5 ft	2.93 cyd
C-12 - 40 x 30 Column	1 EA	8.33 sf	9.5 ft	2.93 cyd
C-14 - 28 x 30 Column	1 EA	5.83 sf	9.5 ft	2.05 cyd
C-15 - 34 x 42 Column	1 EA	9.92 sf	9.5 ft	3.49 cyd
C-16 - 36 x 28 Column	1 EA	7.00 sf	9.5 ft	2.46 cyd
C-04 - 44 x 30 Column	1 EA	9.17 sf	9.5 ft	3.23 cyd
C-01 - 34 dia Column	1 EA	6.30 sf	9.5 ft	2.22 cyd
C-03 - 38 dia Column	1 EA	7.87 sf	9.5 ft	2.77 cyd
C-05 - 34 dia Column	1 EA	6.30 sf	9.5 ft	2.22 cyd
C-09 - 34 dia Column	1 EA	6.30 sf	9.5 ft	2.22 cyd
C-13 - 34 dia Column	1 EA	6.30 sf	9.5 ft	2.22 cyd
<b>Total Concrete Material</b>				<b>41.72 cyd</b>
Wall Concrete Material		Area	Height	
Shear Wall - 3'-2" Thick	99 LF	313.50 sf	9.5 ft	110.31 cyd
Shear Wall - 2'-0" Thick	8 LF	16.00 sf	9.5 ft	5.63 cyd
Core Wall - 3'-2" Thick	50 LF	158.33 sf	9.5 ft	55.71 cyd
Core Wall - 2'-0" Thick	116 LF	232.00 sf	9.5 ft	81.63 cyd
Core Wall - 1'-6" Thick	42 LF	63.00 sf	9.5 ft	22.17 cyd
<b>Total Concrete Material</b>				<b>275.44 cyd</b>
Beam Concrete Material		Area	Height	
TB2 - 8 x 10	16 LF	10.67 sf	0.83 ft	0.33 cyd
TB1 - 11 x 10	11 LF	10.08 sf	0.83 ft	0.31 cyd
<b>Total Concrete Material</b>				<b>0.64 cyd</b>
Link Beam Concrete Material		Area	Height	
LB1 - 50 x 16 (10 in Slab)	16 LF	21.33 sf	4.17 ft	3.29 cyd
LB3 - 50 x 16 (10 in Slab)	18 LF	24.00 sf	4.17 ft	3.70 cyd
LB6 - 50 x 16 (10 in Slab)	19 LF	25.33 sf	4.17 ft	3.91 cyd
LB7 - 50 x 16 (10 in Slab)	17 LF	22.67 sf	4.17 ft	3.50 cyd
LB8 - 50 x 16 (10 in Slab)	17 LF	22.67 sf	4.17 ft	3.50 cyd
<b>Total Concrete Material</b>				<b>17.90 cyd</b>

ASPE Technical Paper																						
Highrise Concrete Flat Slab Construction																						
Description		Takeoff Neat Quantity	Waste	Takeoff Quantity		Crew Size	Days	Hrs /Day	Labor Man Hrs	Avg \$ / Hr	Labor Amount	\$/Unit	Unit/MH	Months	Cost/SF/Month		Material Amount		Equip Amount	Total Unit Price	Total	
COST FOR FLOOR 13																						
	Placing and Finishing		5%																			
		Placement	721.35	cyd	36.07	757.42	cyd	7	4	9.00	252	\$ 95.00	\$ 23,940	3.01						\$ 31.61	/cyd	\$23,940
		Tools and Equipment	721.35	cyd	36.07	757.42	cyd									\$ 2.50	\$ 630			\$ 0.83	/cyd	\$630
		Concrete Materials	721.35	cyd	36.07	757.42	cyd									#####	\$ 117,400			\$ 155.00	/cyd	\$117,400
		Pumping	721.35	cyd	36.07	757.42	cyd											\$ 25.00	\$ 18,935	\$ 25.00	/cyd	\$18,935
		Finish			12,495		sf	5	4	9.00	180	\$118.00	\$ 21,240	69.42						\$ 1.70	sf	\$21,240
		Tools and Equipment			12,495		sf									\$ 2.50	\$ 495			\$ 0.04	/sf	\$495
		Materials			12,495		sf									\$ 0.15	\$ 1,874			\$ 0.15	/sf	\$1,874
	Placing and Finishing Totals							Manhours	432		\$45,180						\$120,399		\$18,935			\$184,514
	Tower																					
		Form Core Walls			3,952.00		sf	15	3	9.00	405	\$105.00	\$ 42,525	\$ 10.76	9.76					\$ 10.76	/sf	\$42,525
		Form Shear Walls			2,033.00		sf	8	3	9.00	216	\$105.00	\$ 22,680	\$ 11.16	9.41					\$ 11.16	/sf	\$22,680
		Form Link Beams			328.67		sf	3	3	9.00	81	\$105.00	\$ 8,505	\$ 25.88	4.06					\$ 25.88	/sf	\$8,505
		Form Columns			1,126.50		sf	5	3	9.00	135	\$105.00	\$ 14,175	\$ 12.58	8.34					\$ 12.58	/sf	\$14,175
		Form Decks			12,495.00		sf	35	3	9.00	945	\$105.00	\$ 99,225	\$ 7.94	13.22					\$ 7.94	/sf	\$99,225
		Form Beams			65.57		sf	2	3	9.00	54	\$105.00	\$ 5,670	\$ 86.47	1.21					\$ 86.47	/sf	\$5,670
		Tools and Equipment			20,000.74		sf									\$ 0.30	\$ 6,000			\$ 0.30	/sf	\$6,000
	Tower Totals							Manhours	1,836		\$192,780						\$6,000					\$198,780
		Concrete Contingency			5%																	\$19,165
		Concrete Fee			10%																	\$40,246
	Concrete Totals							Manhours	2,268		237,960						126,399		18,935			442,705
	Reinforcing																					
		Reinforcing - Mild Steel			211,098		lbs	60	4	9.00	2,160	\$ 98.00	\$ 211,680	\$ 1.00	97.73		\$ 0.48	\$ 101,327				\$313,007
		Reinforcing - Accessories / Stock Bar			21,110		lbs	0	4	9.00	0	\$ 98.00	\$ -	\$ -	#DIV/0!		\$ 0.48	\$ 10,133				\$10,133
		SubBond on Reinforcing Subcontractor			1.8%																	\$5,817
		Reinforcing Contingency			5%																	\$16,448
		Reinforcing Fee			8%																	\$27,632
	Reinforcing Totals							Manhours	2,160		\$211,680						\$111,460					\$373,036
	COST FOR FLOOR 13								4,428		\$ 449,640						\$ 237,859		\$ 18,935			\$ 756,331
COST FOR FLOOR 14 - 17 (Same as Floor 13)					4 ea				449,640		\$ 1,798,560				\$ 237,859		\$ 951,435	\$18,935	\$ 75,742			\$ 2,825,737

ASPE Technical Paper																						
Highrise Concrete Flat Slab Construction																						
Description		Takeoff Neat Quantity	Waste	Takeoff Quantity	Crew Size	Days	Hrs /Day	Labor Man Hrs	Avg \$ / Hr	Labor Amount	\$/Unit	Unit/MH	Months	Cost/SF/Month		Material Amount		Equip Amount	Total Unit Price		Total	
COST SHARED FOR MULTIPLE FLOORS																						
Fabricate and Dismantle Forms																						
	Core Wall																					
	Fabricate			3,952.00	sf	7	10	8.00	560	\$105.00	\$ 58,800	\$ 14.88	7.06						\$ 14.88	/sf	\$58,800	
	Dismantle			3,952.00	sf	5	10	8.00	400	\$105.00	\$ 42,000	\$ 10.63	9.88						\$ 10.63	/sf	\$42,000	
	Form Rental			3,952.00	sf								1.00	\$ 1.65				\$ 7,100			\$7,100	
	Form Material Purchase			3,952.00	sf									\$ 6.00		\$ 25,816					\$25,816	
Shear Walls - Typical																						
	Fabricate			2,033.00	sf	7	10	8.00	560	\$105.00	\$ 58,800	\$ 28.92	3.63						\$ 28.92	/sf	\$58,800	
	Dismantle			2,033.00	sf	5	10	8.00	400	\$105.00	\$ 42,000	\$ 20.66	5.08						\$ 20.66	/sf	\$42,000	
	Form Rental			2,033.00	sf								1.00	\$ 1.40				\$ 3,099			\$3,099	
	Form Material Purchase			2,033.00	sf									\$ 5.00		\$ 11,067					\$11,067	
Link Beams																						
	Fabricate			328.67	sf	3	5	8.00	120	\$105.00	\$ 12,600	\$ 38.34	2.74						\$ 38.34	/sf	\$12,600	
	Dismantle			328.67	sf	3	5	8.00	120	\$105.00	\$ 12,600	\$ 38.34	2.74						\$ 38.34	/sf	\$12,600	
	Form Rental			328.67	sf								1.00	\$ -				\$ -			\$0	
	Form Material Purchase			328.67	sf									\$ 65.00		\$ 23,260					\$23,260	
Columns																						
	Fabricate			1,126.50	sf	5	5	8.00	200	\$105.00	\$ 21,000	\$ 18.64	5.63						\$ 18.64	/sf	\$21,000	
	Dismantle			1,126.50	sf	5	3	8.00	120	\$105.00	\$ 12,600	\$ 11.19	9.39						\$ 11.19	/sf	\$12,600	
	Form Rental			1,126.50	sf								1.00	\$ 0.51				\$ 626			\$626	
	Form Material Purchase			1,126.50	sf									\$ 3.50		\$ 4,293					\$4,293	
Beams																						
	Fabricate			65.57	sf	2	2	8.00	32	\$105.00	\$ 3,360	\$ 51.24	2.05						\$ 51.24	/sf	\$3,360	
	Dismantle			65.57	sf	2	1	8.00	16	\$105.00	\$ 1,680	\$ 25.62	4.10						\$ 25.62	/sf	\$1,680	
	Form Rental			65.57	sf								1.00	\$ -				\$ -			\$0	
	Form Material Purchase			65.57	sf									\$ 65.00		\$ 4,640					\$4,640	
Slab Edge																						
	Fabricate			795.83	sf	5	3	8.00	120	\$105.00	\$ 12,600	\$ 15.83	6.63						\$ 15.83	/sf	\$12,600	
	Dismantle			795.83	sf	5	2	8.00	80	\$105.00	\$ 8,400	\$ 10.56	9.95						\$ 10.56	/sf	\$8,400	
	Form Rental																	\$ -			\$0	
	Form Material Purchase			795.83	sf									\$ 4.25		\$ 3,682					\$3,682	
Shake Material																						
	Unload and Distribute			12,495	sf	5	2	8.00	80	\$105.00	\$ 8,400	\$ 0.67	156.19						\$ 0.67	/sf	\$8,400	
	Dismantle and Ship			12,495	sf	5	2	8.00	80	\$105.00	\$ 8,400	\$ 0.67	156.19						\$ 0.67	/sf	\$8,400	
	Form Rental			12,495	sf								1.00	\$ 0.25				\$ 3,401			\$3,401	
	Reshoring Rental			12,495	sf								1.00	\$ 0.15				\$ 2,041			\$2,041	
	Form Material Purchase			12,495	sf									\$ 5.00		\$ 68,020					\$68,020	
	Form Material Freight			1	ls											\$ 36,161					\$36,161	
	Debri Netting			1	ls											\$ 15,000					\$15,000	
Fabricate and Dismantle Subtotals								Manhours	2,888	\$303,240						\$191,939		\$16,265			\$511,444	
	Concrete Contingency			5%																	\$25,572	
	Concrete Fee			10%																	\$53,702	
Fabricate and Dismantle Totals								Manhours	2,888	\$303,240						\$191,939		\$16,265			\$590,718	
Hoisting																						
	Hoisting				2	20	10.00	400	\$125.00	\$ 50,000						\$ 15,000	\$ 85,000	\$ 92,544			\$157,544	
	Hoisting Contingency			5%																	\$7,877	
	Hoisting Fee			10%																	\$16,542	
Hoisting Totals																		\$92,544			\$181,963	
General Conditions																						
	General Conditions									\$ 540,000						\$ 54,000		\$ 108,000			\$702,000	
	General Conditions Contingency			5%																	\$35,100	
	General Conditions Fee			10%																	\$73,710	
General Conditions Totals										\$540,000						\$54,000		\$108,000			\$810,810	
COST SHARED FOR MULTIPLE FLOORS										\$ 843,240						\$ 245,939		\$ 216,809			\$ 1,583,491	
Total Project										\$3,091,440						\$1,435,233		\$311,486			\$5,165,559	